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INDEX OF SELECTED GASIFICATION PATENTS
(In Three Parts)

I. UNITED STATES PATENTS

Compiled by Simon Klosky
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(In Three Parts)

I. UNITED STATES PATENTS

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Introduction

The Synthetic Liquid Fuels Act (30 U.S.C., 321–325, and amendments) became law April 5, 1944, and a period of intensive research and development in this field was begun by the Bureau of Mines.

As part of this program, bulletins were published on pressure hydrogenation,\(^3\) the Fischer-Tropsch synthesis,\(^4\) and oil shale.\(^5\)

The Bureau also has published a short bibliography on coal gasification, mostly of a theoretical nature. Because coal gasification is prerequisite to either the Fischer-Tropsch or coal-hydrogenation processes, publishing this sizable collection of technical information in this form will be valuable.

The material will be presented in three parts, as follows:

I. United States Patents.
II. United Kingdom Patents.
III. Other Foreign Patents.

The domestic patents for this bulletin were collected between 1953 and 1955.

WASHINGTON, D.C.
NOVEMBER 25, 1958

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1 Work on manuscript completed November 1958.
I. UNITED STATES PATENTS

62,823
MANUFACTURE OF GAS
James Crutchett, Stroud, England
March 12, 1867; 2 claims.

1. The manufacture of gas for lighting and heating purposes from pulverized or fine coal, or other carbonaceous materials, injected into retorts or ovens in small quantities, either by separate successive injections or in small continuous currents, as herein described.

130,382
IMPROVEMENT IN THE MANUFACTURE OF GAS
Aug. 13, 1872; 8 claims.

1. The arrangement of the cylinder a, having several small air openings or a single continuous air opening at or near its top, the inner cylinder b having several air openings or a single continuous air opening at its lower end, the air space c between said cylinders, the gas burner z or equivalent heater arranged within the cylinder b at or near its bottom, and the draft flue b², opening into the space within the cylinder b, to which it is attached at or near its top, all for the purpose of heating the air used for combustion, substantially as described.
130,383
IMPROVEMENT IN PROCESSES AND APPARATUS FOR MAKING GAS
Aug. 13, 1872; 13 claims.
1. Introducing steam or hydrocarbons and steam into the gas and vapors from the primary generator, at a point between the primary generator and the converting tubes, while the gas and vapors are on their way to the storage gasometer or the furnace, substantially as set forth.

197,061
IMPROVEMENT IN PROCESSES AND APPARATUS FOR THE MANUFACTURE OF GAS
Myron H. Strong, Brooklyn, N.Y.
Nov. 13, 1877; application filed Oct. 11, 1876; 3 claims.
1. The process herein specified of making gas, consisting in introducing carbon in a pulverized condition, in detail or small regular quantities, into the top of a highly heated retort, admitting steam into that retort, and passing the resulting gases through highly heated carbon, for the purposes set forth.
198,725
IMPROVEMENT IN PROCESSES FOR MANUFACTURING ILLUMINATING GAS
Henry Aitken, Falkirk, and William Young, Clippens, North Britain
Dec. 25, 1877; application filed Sept. 2, 1876; 2 claims.

1. The process of manufacturing illuminating gas by carbureting water gases, in diffusing them in regulated quantities through independently controlled or separate retorts, wherein hydrocarbon vapors are being evolved from bituminous substances, thus preventing the deposition of carbon in the retorts, or, if already deposited, utilizing it, substantially as described.

226,397
APPARATUS FOR MANUFACTURING GAS
Apr. 13, 1880; application filed Apr. 21, 1879; 3 claims.

1. The combination of two or more generators, each supplied with a bed of carbonaceous material, and supplied further with steam pipes, blast pipes, and gas flues, with passage or passages between said generators, provided with blast pipe, substantially as and for the purpose specified.

233,860
PROCESS OF AND APPARATUS FOR GENERATING GAS
Erasm J. Jerzmanowski, New York, N.Y.
Nov. 2, 1880; application filed May 28, 1880; 2 claims.

1. A closed gas generator having a coal chamber and steam and inlet pipes, and provided with a fusele hearth consisting of molten metal, arranged to receive and heat the slag and ashes from the chamber, substantially as set forth.
247,333
FEEDING FUEL TO PUDDLING AND OTHER FURNACES
Charles Gearing, Pittsburgh, Pa.
Sept. 20, 1881; application filed Aug. 25, 1881; 5 claims.
1. The method of heating puddling, heating, and other furnaces by projecting into and upon the grate of a vertical generator or combustion chamber adjacent to the puddling chamber or hearth pulverized coal in regulated quantity by means of and intermingled with a blast of superheated steam and air to produce a preliminary combustion, and supplying thereto additional superheated steam and air by means of a counter blast, and passing the incandescent gases directly into the heating chamber, where the combustion is completed, substantially as set forth.

248,070
PROCESS OF AND APPARATUS FOR GENERATING WATER GAS
Burhans Van Steenbergh, Goshen, N.Y.
Oct. 11, 1881; application filed Feb. 24, 1881; 12 claims.
1. The process of manufacturing gas, which consists in introducing oleaginous matter centrally within a body of incandescent carbonaceous material and introducing steam into the decomposing chamber alternately above and below such body of carbonaceous material, whereby the heat thereof is better maintained and decomposition is better effected, as specified.
269,162
PROCESS OF AND APPARATUS FOR MANUFACTURING GAS
Henry M. Pierson, Brooklyn, N.Y., and James S. Pierson, Plainfield, N.J.
Dec. 12, 1882; application filed June 28, 1882; 4 claims.

1. The method herein specified of making nonluminous gas, consisting in superheating steam by passing it through a superheater, then decomposing the steam into hydrogen, carbonic acid, and carbonic oxide by passing it down through a bed of incandescent fuel, and finally converting the carbonic acid of the gases into carbonic oxide by passing the gases down through a second bed of incandescent fuel, substantially as specified.

280,770
PROCESS OF AND APPARATUS FOR MANUFACTURING GAS
Theodore G. Springer, New York, N.Y.
July 3, 1883; application filed Jan. 6, 1883; 17 claims.

1. The process of generating gas, which consists in raising to incandescence by blasts of air the lower portion of a body of carbonaceous fuel, burning the resulting products by air blasts and storing their heat in bodies of refractory material, superheating steam by passing it through a portion of the heated refractory material, decomposing the steam by passing it into and through the incandescent fuel; and causing the resulting hot gases to pass up through a superincumbent body of coal in a state of distillation to combine with and carry off the rich vapors and gases being evolved therefrom, or from oil, in the manner described.
PROCESS OF AND APPARATUS FOR MANUFACTURING GAS
James E. Leadley, Camden, N.J., assignor of one-half to John Hanlon, New York, N.Y.
Nov. 27, 1883; application filed July 2, 1883; 7 claims.

1. The process of generating gas, which consists in superheating steam, then passing it down through a body of incandescent or highly heated fuel, where it is decomposed, resulting in the production of hydrogen, carbonic oxide, and a small percentage of carbonic acid, then passing these gases up through a separate body of heated fuel, thereby converting the carbonic acid into carbonic oxide and passing them through a charge of distilling soft coal for carrying off the rich gases therefrom, and finally converting them into a homogeneous fixed gas in a heated chamber.

INDEX OF SELECTED GASIFICATION PATENTS

PROCESS OF AND APPARATUS FOR MANUFACTURING GAS
Henry C. Rew, Chicago, Ill.
Dec. 25, 1883; application filed May 2, 1883; 9 claims.

1. The process of generating gas, which consists in heating a body of carbonaceous fuel by continuously forcing superheated steam into it, and thereby heating it to the decomposing temperature and causing decomposition of the steam into hydrogen and carbonic oxide, then conducting the gases into a fixing chamber and enriching or carbureting them with hydrocarbon oil, and finally converting the carbureted gases into a fixed gas by passing them through heated refractory material in the fixing chamber.
299,385
PROCESS OF AND APPARATUS FOR PRODUCING HEATING GAS
Hermann Haug, Dortmund, Germany
May 27, 1884; application filed March 1, 1883; 2 claims.

1. The process of producing heating gases from crude carbonaceous materials, which consists, first, in starting the production of gas by the partial combustion of the crude material with cold air; second, in starting the heating of the superheaters by the combustion of the resulting gas, as a minor product, with some air; third, in replacing part of the air for the combustion of the crude material by steam (or its equivalent, carbonic-acid gas) and carrying this mixture (or merely the steam) through the superheater in order to superheat it before it enters the crude material, to produce from it a gas containing more combustible matter than before; fourth, in continuing to use part of this purer gas now turning to be chief product within the combustion chambers of the superheaters, whereby their temperature and the temperature of the converting material to be superheated in them will increase, and will allow of the admixture of an increasing amount of steam to a diminished amount of air, so as to give a still more concentrated heating gas, whereby there results a circle of chemical and physical-mechanical actions in which the increase of the purity of the converting agent being at last pure steam (or carbonic acid, or mixtures of both) the increase of the purity of the produced heating gas, the increase of temperature of its flame within the superheaters, and the increase of temperature and degree of dissociation of the converting agent will react mutually until the maximum of effect as to purity of the heating gas and as to the quantity of it available for external purposes be attained, the said steps being conducted in continuous operation, as described.

331,903
PROCESS OF MANUFACTURING ILLUMINATING GAS
John W. Mitchell, Bayonne, N.J.
Dec. 8, 1885; application filed Aug. 14, 1885; 2 claims.

1. In the art of continuously manufacturing illuminating gas, the process herein described, which consists, first, bringing a body of fuel to incandescence; second, causing the simultaneous currents of superheated steam and of air in relatively regulated volume to pass through said fuel; third, injecting superheated steam and crude petroleum to a chamber with which the water-gas generating chamber is connected under such pressure and in such regulated quantity or volume as to maintain the temperature in said chamber at about 1,600°F; fourth, purifying said gas, and conducting it thence to the holder.
APPROXIMATE OF GAS
Jan. 4, 1887; application filed Dec. 11, 1885, Serial No. 185,379; 2 claims.

1. The combination, in an apparatus for the manufacture of gas, of a
furnace and a series of retorts built up of fire brick and lined with fire
clay or other refractory impervious material, substantially as specified.

378,490
PROCESS OF MANUFACTURING WATER GAS
Reinhold Boeklen, Brooklyn, N.Y.
Feb. 28, 1888; application filed Mar. 26, 1887, Serial No. 232,508; 1 claim.

The process of manufacturing gas, which consists in gradually feeding
the crude petroleum from the top downwardly within the furnace or retort,
thereby subjecting it to successive degrees of heat as it gradually descends,
eliminating the light vapors from the petroleum by subjecting the same to
the heat of the retort, superheated steam, and gases resulting from the
decomposition of the steam and oil by contact with the fuel, and passing
said light vapors through a heated tile-fixing chamber, subjecting the resid-
ual petroleum to a body of incandescent fuel into which steam is delivered,
said petroleum being delivered in proximity to said steam-delivery pipes,
and then conducting the gases thus produced through said fixing chamber
simultaneously with the other gases.
MANUFACTURE OF GAS

Henry M. Pierson, Brooklyn, N.Y.

Nov. 6, 1888; application filed Feb. 3, 1888; Serial No. 263,888; 2 claims.

1. The combined methods herein described of making heating gases from bituminous coal, consisting in distilling the coal and passing the resulting gas through a heated retort containing refractory material and into which steam is admitted and passing the coke from such retorts in an incandescent condition into a generating furnace, blowing up such coke to intensify the combustion, and simultaneously heating the retorts by the escaping products and then passing steam through the incandescent coke when the supply of air is shut off, so as to decompose the steam in the presence of the carbon of the coke and form a heating gas, and conveying the heating gases from the two sources to a holder, where they are mixed, substantially as specified.

PROCESS OF AND APPARATUS FOR THE MANUFACTURE OF GAS

Burdeitt Loomis, Hartford, Conn.

May 28, 1889; application filed May 24, 1887; Serial No. 239,242; 7 claims.

1. The process of manufacturing gas, which consists in heating a body of fuel to incandescence by drafts of air drawn downward into the fuel and by drawing off the gaseous products by an exhauster, whereby the fuel may be better fed, inspected, and arranged in the generator during the operation of heating up, then shutting off the air draft and decomposing steam in contact with the fuel, thereby producing water gas.
MANUFACTURE OF GAS
James M. Rose, Allegheny, Pa.
Aug. 6, 1889; application filed Oct. 16, 1888, Serial No. 288,286; 5 claims.

1. The herein-described process of forming gas, consisting in passing air through a mass of heated carbon and introducing into the gases so formed heated waste products of combustion (such as formed in burning carbonaceous materials to heat a body of water), then passing such gases and waste products through or in contact with heated hydrocarbons and admitting thereto a limited quantity of air, and subsequently passing the resultant gases through a body of heated fixing material substantially as and for the purposes set forth.

PROCES OF MAKING AMMONIA AND GAS
Alphonse Henning, Springfield, Ill., assignor to the Henning Process Co. of Illinois
Sept. 8, 1891; application filed Dec. 24, 1889, Serial No. 334,842; 1 claim.

The process of simultaneously and continuously making gas and ammonia, which consists in injecting air or oxygen and steam into a bed of incandescent fuel, controlling the temperature of the generator, first, by introducing such proportions of steam and oxygen or air as to maintain a zone of combustion at a temperature sufficient to reduce carbonic oxide (CO) practically all the carbonaceous oxide (CO₂) formed by the complete combustion of the fuel and to decompose practically all the steam so introduced in the blast, and, second, by regulating the supply of fresh fuel to maintain beyond the zone of combustion a zone of distillation cool enough not only to allow the formation of ammonia, but to prevent the dissociation of that already formed, leading off the ammonia and gas and separating them by condensers, washers, or other suitable means, substantially as described.
APPARATUS FOR AND METHOD OF PRODUCING GAS

Oct. 17, 1893; application filed Aug. 26, 1892, Serial No. 444,153; 8 claims.
1. In a gas-generating furnace the combination with the fuel chamber of the movable circular grate or hearth, having its upper face upon which the body of fuel rests a plane surface inclined from the horizontal, and mechanism for imparting a rotary motion to the said hearth for the purpose described.

PROCESS OF MAKING ILLUMINATING GAS

William Young, Peebles, Scotland
Feb. 5, 1895; application filed May 9, 1894; Serial No. 510,659; 1 claim.
The process of decomposing or gasifying liquid hydrocarbons to produce illuminating gas, which consists in blowing steam through a mass of carbon raised to incandescence by an air blast in the lower end of a gas producer or decomposing chamber to produce water gas for sweeping out the chamber, then cutting off the steam and passing liquid hydrocarbon in at the top of the decomposing chamber and on to the incandescent carbon, whereby the hydrocarbon is decomposed and illuminating gas is produced, the said gas flowing out against the stream of inflowing hydrocarbon and being scrubbed by it, so that the condensible vapors and flocculent carbon produced are absorbed and again discharged into the decomposing chamber, and the carbon present in the liquid hydrocarbon in excess of what can be gasified by destructive distillation is isolated and deposited in the gas producer so as to render it directly available as the source of heat by its partial combustion with air to effect the destructive distillation of the liquid hydrocarbons and to produce water gas sufficient to wash out the apparatus, substantially as described.
1. The process of producing and delivering cold gas, consisting in first passing air through a mass of incombustible, inert material in which heat has been stored, then passing the air so heated directly through a body of fuel for combustion, mixing the products of combustion while on their passage through the fuel mass with water-vapor or its equivalent whereby hydrogen is furnished as a constituent gas, continuing the passage of the mixture of combustion products and water vapor through incandescent fuel, and, finally, robbing the gaseous products of their heat by passing the same through heat-absorbing and heat-storing, inert and incombustible material, and reversing or interchanging at intervals the inflow of air and outflow of gas so that the hot gases leaving the incandescent fuel shall give up their heat to the heat-storing material, which heat shall, after reversal, be taken up by the entering air to heat said air, while the heat-storing material, which has been cooled by the entering air is, after reversal, heated by the passage through it of the gaseous products leaving the incandescent fuel; whereby the produced gases are delivered in a cooled state and the heat of combustion is preserved for effecting the chemical reactions, substantially as described in the foregoing specification.
633,031
PROCESS OF MAKING GAS
Hans Neumann, Cologne-Deutz, Germany, assignor to the Gas-Motoren Fabrik Deutz
Sept. 12, 1899; application filed May 2, 1898, Serial No. 679,029; 3 claims.
1. The method described for the continuous production of combustible gas from bituminous coal, which consists in forcing air through a body of incandescent bituminous coal and then forcing the gases produced thereby through incandescent coke, together with an additional quantity of air, and converting the volatile constituents into permanent gases, substantially as described.

666,257
PROCESS OF MAKING ILLUMINATING GAS
Eduard R. Besemfelder, Charlottenburg, Germany
Jan. 22, 1901; application filed Sept. 29, 1899, Serial No. 732,089; 2 claims.
1. The herein-described continuous process of making illuminating gas, which consists in subjecting a body of carbonaceous material to dry distillation for producing coal gas, continuously overturning said material while undergoing distillation, continuously conducting a stream of heated water gas in contact with said overturning material, and conducting off for use the mixture of coal gas and water gas thereby produced, substantially as set forth.

652,081
PROCESS OF MANUFACTURING GAS
James W. Chisholm, San Francisco, Calif.
June 19, 1900; application filed July 17, 1899, Serial No. 724,160; 4 claims.
1. The continuous process of making gas, which consists in burning carbonaceous fuel, supplying air and steam to said fuel, then conducting the gases through a heated regenerator containing materials of opposite electric polarity, said filling being so disposed as to leave passages for the gases therethrough, substantially as described.
PROCESS OF MAKING GAS  
Ludwig Mond, Northwich, England  
Apr. 9, 1901; application filed June 1, 1898, Serial No. 682,232; 1 claim.

In the process of obtaining combustible gases from fuel, preventing the waste of heat and disassociation of ammonia by maintaining the fuel uniformly at a dull-red heat by continuously supplying it with a mixture of air, steam, and carbon dioxide definitely proportioned for maintaining this temperature.

683,409
PROCESS OF MAKING GAS  
Howard Lane, Birmingham, England  
Sept. 24, 1901; application filed July 9, 1901, Serial No. 67,632; 1 claim.

The herein-described process of making gas, consisting in introducing an air blast beneath the raw fuel, forcing the gaseous products of combustion downward through the burning fuel located beneath the raw fuel, causing the gaseous products after leaving the burning fuel to flow upward to heat checker work in a regenerator chamber, furnishing a supply of air to the gaseous products of combustion before they reach the regenerator in order to complete combustion then cutting off the air supply and generating steam by causing water to contact in the form of spray with the highly heated checker work, passing this steam downward and scouring out the remanent of the gaseous products of combustion by the steam generated on the introduction of the water spray, passing the superheated steam after scouring into and up through the coked and raw fuel, the superheated steam being decomposed into its constituent gases and the raw fuel being subjected to destructive distillation by the upward-flowing gases, the new gaseous products being formed by the admixture of the vapor with the upward-flowing gases, substantially as described.
An improved process for the direct manufacture of poor gas from bituminous coal in gasogenes, which process consists in extracting a portion of the producer gas, between the reduction and distillation zones and passing it upward around the body of coals to heat the same, causing the remaining body of gas to flow through the said distillation zone and withdrawing it therefrom at the top of the gasogene and returning it together with all the tar and condensable substances into the gasogene between the zone of combustion and the zone of reduction for the purpose of decomposing the tar into hydrocarbons and carbon and thus providing an addition of combustible substances and thereby improving the final product, substantially as set forth.

The method generating water gas which consists in first disposing the fuel in a layer having relatively great breadth and little thickness, secondly, igniting said fuel and using a portion of the heat generated thereby to heat a heat storer, third, depositing a fresh supply of fuel in a thin layer on the first layer of fuel as a support for said fresh layer of fuel and effecting the distillation of said fresh layer of fuel by the heat from said first layer of fuel and from the heat storer and simultaneously bringing together a body of water and another portion of the heat from said ignited fuel so as to evaporate the water, fourth, conducting the vapor generated into operative contiguity to the heat storer so as to superheat the vapor, and, fifth and finally, conducting the thus superheated vapor through the layers of fuel, substantially as described.
735,272
PROCESS OF MAKING GAS
William Kent, Passaic, N.J.
Aug. 4, 1903; application filed Sept. 25, 1901, Serial No. 76,442; 1 claim.
The process of making gas, which consists in blasting a charge of coal
to incandescence then feeding a fresh supply of coal upon said charge and
blowing air directly into the charge itself at points substantially at the top
and bottom of the same, and at the same time feeding steam or water into
the charge at or near the zone of greatest temperature and withdrawing
the gas produced substantially at a point midway of said charge, substan-
tially as set forth.

742,412
METHOD OF MANUFACTURING GAS
Alexander M. Gow, Pittsburgh, Pa., assignor to George Westinghouse,
Pittsburgh, Pa.
Oct. 27, 1903; application filed Jan. 11, 1901, Serial No. 42,840; 6 claims.
1. The process of making gas, which consists of blowing to incandescence
a body of fuel in a gas producer, storing the heat of the waste gases in a
stove, then injecting steam into the body of incandescent fuel to make water
gas, then returning the stored heat to the producer for the purpose of dis-
tilling the volatile portion of a fresh charge of fuel.
753,295
METHOD OF MAKING GAS
Paul Naef, New York, N.Y.
Mar. 1, 1904; application filed Mar. 14, 1899, Serial No. 791,101; 3 claims.
1. The method of producing water gas and byproducts from bituminous fuel, which consists in injecting steam into a portion of a moving body of fuel, withdrawing the reaction products, reheating them, and passing them through another portion of said moving body of fuel.

770,554
PROCESS OF MANUFACTURING GAS
Alfred Bougault, Paris, France, assignor to Société Française de Constructions Mécaniques
Sept. 20, 1904; application filed June 17, 1903, Serial No. 161,933; 3 claims.
1. The hereinbefore-described process of manufacturing poor gas, which consists in mixing gas-producer gas with atmospheric air, the proportion of such gas being in excess to that of the air, and then in forcing the mixture into the solid fuel in a gas producer at substantially the base of such solid fuel.
790,113
PROCESS OF OBTAINING PRODUCER GAS
Adolphe Desgroz, Hanover, Germany
May 16, 1905; application filed Dec. 12, 1904, Serial No. 236,552; 2 claims.

1. A process of obtaining producer gas free of tar and of high calorific value, consisting in introducing combustible gas and an excess of air into a producer above the fuel, igniting the mixture of combustible gas and air, and burning it in the said parts of the producer, passing the products of combustion and the excess of air from above downward through the coal, and leading off the produced gas from the lower part of the producer, substantially as described.

Fig.1:

796,670
PROCESS OF MAKING GAS
Donald McDonald, Louisville, Ky.
Aug. 8, 1905; application filed Sept. 8, 1903, Serial No. 172,405; 1 claim.

The process of making gas, which consists in providing, in a suitable generator, a body of coke and a superposed body of coal in contact with the coke, of a width at its bottom as great as the width at any place in its height and of a height to permit the passage therethrough of heat from the coke beneath; passing a blast through the coke while the coal is above it, but not through the coal, causing the coke to become incandescent, and the coal to give off some gas by heat radiated from the coke; passing steam through the body of coke to produce water gas; passing all the water gas thus formed through the body of coal in order to enrich the water gas; passing the enriched gas through a superheater to fix the gas; mixing the coal gas first given off, with the enriched water gas that has passed through the superheater; and when the coke becomes cooled on its under side then passing steam downwardly through the coke forming water gas, which is passed through the superheater and mixed with the other gas.
METHOD OF MANUFACTURING GAS
Paul Schmidt, Hanover, Germany
Nov. 13, 1906; application filed Dec. 8, 1903, Serial No. 184,297. Divided and this application filed Dec. 10, 1904, Serial No. 286,401; 1 claim.
A method for the continuous and uniform production of gas which consists in blasting, heating, and distilling a bed of fuel; drawing the distilled gases and vapors from the upper part of the generating chamber; heating the withdrawn gases and vapors by the outgoing blast gases to prevent condensation; introducing the heated gases at one side of the generating chamber into the glowing fuel; and leading off the finished gases at the side of the generating chamber opposite to that where the heated gases and vapors are introduced to the generator.

PROCESS OF MANUFACTURING PRODUCER GAS
William H. Adams and Frederick Powell, Portland, Oreg., assignor to Ladd Metals Co., a corporation of Oregon
Jan. 8, 1908; application filed June 29, 1904, Serial No. 218,242; 4 claims.
1. The improvement in the manufacture of producer gas consisting in establishing a horizontal zone of incandescence in the lower portion of a long horizontal body of fuel, admitting air to one end only of the body and giving exit to the gas at the other end, the admission of the air and the exit of the gas taking place at the same level and in the plane of the zone, and such exit being the only exit provided for the gas, whereby the rear portion of the incandescent fuel is caused to decompose the products of combustion from the front portion.
PROCESS OF MANUFACTURING POWER GAS
Emil Fleischer, Dresden-Strehlen, Germany, assignor to Jakob E. Goldschmid, Frankfort-on-the-Main, Germany
Jan. 15, 1907; application filed Nov. 30, 1904, Serial No. 234,933; 2 claims.
1. In the process of manufacturing power gas from bituminous fuel and the like with top and bottom air supply and exhaust of the gases at the mid height of the charge, the auxiliary step of supplying an additional body of air below the point at which the top air supply takes place and in or in the neighborhood of the vertical axis of the charge.

GAS-GENERATING APPARATUS
Godfrey M. S. Tait, Montclair, N.J., assignor to Combustion Utilities Co., of New York, N.Y., a corporation of New York
Feb. 12, 1907; application filed Aug. 16, 1906, Serial No. 274,497; 1 claim.
A continuous-operating downdraft gas producer comprising a producer with an open-ended reduced lower portion, an annular collar surrounding such reduced portion and spaced apart therefrom to form a gas chamber, said collar extending downwardly below the open end of the reduced portion, a gas-outlet pipe tapping the gas chamber, a water-sealing device adapted to maintain a normal liquid level below the end of the producer and above the end of the collar, and an air-draft inlet pipe at the upper end of the producer.
PROCESS OF HANDLING ASH IN GAS PRODUCERS
Harry F. Smith, Lexington, Ohio
Mar. 5, 1907; application filed Nov. 7, 1906, Serial No. 342,372; 2 claims.
1. The described process of removing ash from downdraft gas producers, which consists in agglomerating the ash in relatively large masses or clinkers; and in removing said clinkers from above the fuel bed, out through the upper end of the producer.

METHOD OF MAKING AND DELIVERING GASES
Burdeett Loomis, Hartford, Conn., and Hawley Pettibone, New Rochelle, N. Y.
Aug. 20, 1907; application filed Dec. 7, 1903, Serial No. 184,144. Divided and
this application filed Sept. 15, 1906, Serial No. 334,792; 3 claims.
1. The method of operating a gas engine and supplying explosive mixed gas thereto, consisting in first passing air through a chamber containing a body of ignited fuel and drawing from said chamber a volume of producer gas; cleaning said gas and storing it in a holder, forming a volume of water gas by passing steam through said body of fuel and storing it separately from said producer gas, then commingling in a gas holder or otherwise predetermined quantities of each of said gases and withdrawing volumes of the mixture and delivering them directly to a gas engine and exploding them therein, substantially as described.

Fig. 1.
1. The method of making and utilizing gas, which consists in generating producer gas, consuming the gas in a suitable furnace, preheating the air blast for the producer to a high degree by waste heat from the products of combustion, and simultaneously rendering latent the dangerous excess of temperature of the preheated air blast, by commingling with it, sprays of water, substantially as described.
GAS GENERATOR
Carl Heinz, Görlitz, Germany
Jan. 7, 1908; application filed Aug. 19, 1907; Serial No. 389,215; 1 claim.

In a gas generator, a casing having a gas-delivery pipe passing down through the bottom of the same from the fuel chamber, an air-supply pipe passing up through this gas-delivery pipe and carrying a hood at its upper end, which incloses the upper end of said delivery pipe and is made hollow, an upwardly extending air pipe leading from the upper side of this hood, and a caplike partition inclosed within the hood and having its annular side wall depending into the depending hollow part of the hood, for the purpose set forth.

METHOD OF MANUFACTURING GAS
Henry M. Pierson, New York, N.Y.
Mar. 24, 1908; application filed Apr. 22, 1907; Serial No. 389,467; 5 claims.

1. The method herein described of manufacturing gas, the same consisting in forcing air into and heating a body of fuel and making therein producer gas, passing the producer gas on and directly through a body of bituminous coal superimposed upon the body of fuel and forming an uninterrupted continuation thereof and thereby extracting the chemical substances therefrom and distilling the bituminous coal and conveying the hot gases so produced away for immediate use in the arts.
882,909

METHOD OF MANUFACTURING GAS

Henry M. Pierson, New York, N.Y.

Mar. 24, 1908; application filed Apr. 22, 1907, Serial No. 369,468; 2 claims.

1. The method herein specified of making illuminating gas, the same consisting in blowing up a body of fuel to substantial incandescence and making therein producer gas, passing the producer gas through the body of bituminous coal, which forms a substantially vertical continuation of the heated body of fuel, and heating up the said fuel, adding air to the producer gas beyond this body of bituminous coal and burning the same and so heating up a fixing chamber, closing off all the air and introducing steam and passing the same through the body of incandescent fuel, decomposing the steam and forming water gas and passing the said water gas through the body of bituminous coal for the extraction of the chemical substances therefrom and the production of a fuel coke, simultaneously supplying liquid hydrocarbon to be vaporized and taken up by the decomposed steam or water gas in transit through the coke and bituminous coal and conveying the said gases and commingling and fixing the same in the presence of the stored-up heat of the fixing chamber, and then conveying away the gases to a suitable receptacle.

884,655

PROCESS OF MAKING GAS

Alexander M. Gouw, Edgewood Park, Pa., assignor to Westinghouse Machine Co., a corporation of Pennsylvania

Apr. 14, 1908; application filed Nov. 11, 1907, Serial No. 189,652.

Revised Sept. 18, 1907, Serial No. 393,114; 13 claims.

1. The process of making gas which consists in blowing to incandescence the exterior portion of a body of fuel, forcing fresh fuel into the interior of the body, utilizing the sensible heat of the incandescent fuel in the destructive distillation of the fresh fuel, introducing steam into the interior portion of the body of fuel and causing it to pass, first through the fresh fuel and then through the heated exterior portion of the fuel bed.
PROCESS OF GENERATING AND DELIVERING GAS UNDER UNIFORM PRESSURE

William C. Finck, Elizabeth, N.J., assignor to George H. Benjamin, New York, N.Y.
Apr. 28, 1908; application filed Feb. 26, 1906, Serial No. 302,829.
Renewed Aug. 24, 1907, Serial No. 390,942; 1 claim.

The process for generating and delivering gas to a point of consumption under a uniform pressure, which consists in creating a partial vacuum on the inlet side of a pressure pump, connecting such inlet with a fuel chamber whereby air is sucked through the fuel chamber, the air being previously passed across the surface of warm water, the gas being delivered from the pressure pump against a weighted valve so that the valve is not operated unless a certain predetermined pressure at the outlet side of the pump is exceeded, the stream of gas being then divided in case such pressure is exceeded, by the operation of said valve so that part of the stream passes to the point of consumption under a fixed pressure, while the remainder returns to the inlet side of the pump, and finally adding air to the gaseous stream at a point beyond said valve and at a pressure greater than the pressure of said gas at the outlet side of the pump.

METHOD OF PRODUCING GAS

Fritz Bouke, Berlin, Germany
May 12, 1908; application filed May 2, 1906, Serial No. 314,860; 6 claims.

1. The process of producing gas for power and heating purposes, which consists in preheating the fuel, then spreading it into a shallow burning layer of such dimensions that of itself it would produce a gas too rich in carbonic acid to be available for power or heating purposes, withdrawing gas from one of the broad surfaces of said shallow burning layer, and projecting against the other broad surface of said layer and at an angle to said surface, an intimate mixture of air and carbonaceous material.
METHOD OF MAINTAINING A CONSTANT OR APPROXIMATELY CONSTANT TEMPERATURE IN A GAS PRODUCER

Emil Capitanie, Reisholz, Germany

May 19, 1908; application filed Mar. 27, 1905, Serial No. 252,350.
Divided and this application filed Apr. 6, 1906, Serial No. 310,377; 3 claims.

1. The method of maintaining a constant or approximately constant temperature in a suction gas producer working with a varying consumption of gas, due to varying load on the engine to which the gas is supplied, by causing a greater or small proportion of the gas drawn off from the gas generator to be delivered during periods when the engine is running with a reduced load, or with no load, to a place where it is burned, and transmitting heat resulting from its combustion to the gas generator.
888,969
PROCESS OF MANUFACTURING COMBUSTIBLE GASES
Edward N. Dickerson, Stovall, N.C.
May 26, 1908; application filed Nov. 1, 1904, Serial No. 230,925; 1 claim.

A process of producing combined coal and water gas consisting of blasting a bed of fuel to incandescence by means of a fluid and at the same time heating externally by the blast gases a retort containing coal thereby distilling the coal gas and at the same time utilizing the blast gases to heat a checker-work chamber and simultaneously heating the blast fluid passing through said chamber, then producing water gas in the usual way, and then combining the water gas with the distilled coal gas.

899,690
PROCESS OF MANUFACTURING GAS
Henry W. Benner, Chambersburg, Pa., assignor to International Gas Development Co., a corporation of New York
Sept. 29, 1908; application filed Feb. 2, 1907, Serial No. 355,387; 2 claims.

1. The process of manufacturing gas consisting of forming water gas, passing the water gas through powdered coal falling through a distilling chamber, and collecting the products.
901,232
PROCESS OF PRODUCING GAS
Byron E. Eldred, Bronxville, N.Y.
Oct. 13, 1908; application filed May 7, 1908, Serial No. 431,301; 10 claims.
1. The process of producing gas, which comprises forming a flame of finely divided suspended fuel in the presence of substantially enough air to cause complete combustion, and subsequently distributing a further supply of finely divided fuel in the hot flame gases.

915,034
PROCESS OF GENERATING GAS
Charles E. Lucke, New York, N.Y.
Mar. 9, 1909; application filed Oct. 30, 1907, Serial No. 399,801.
Divided and this application filed May 2, 1908, Serial No. 439,516; 11 claims.
1. The process of making fuel gas, which consists in passing air in proper regulated quantities through burning fuel to distill and completely oxidize the volatile constituents of the fuel and to render incandescent the nonvolatile constituents of the fuel, substantially continuously removing all of the incandescent unoxidized solid constituents of fuel to another location so distinctly separated from the first location as not to be reached by volatile products of distillation from the burning fuel at the first location and which have not yet been completely oxidized, substantially continuously substituting green fuel for that removed, and passing the completely oxidized gases through the removed incandescent unoxidized solids to convert the completely oxidized gases and the oxidizable solids into fixed combustible gases.
939,288

GAS PRODUCER
George Louis Morton, Four Oaks, England

Nov. 9, 1909; application filed Feb. 1, 1909, Serial No. 475,541; 2 claims.

1. In a gas producer a shell having a charging aperture, a lateral air inlet near said charging aperture, an outwardly projecting sloping portion below said air inlet, the angle of inclination of said sloping portion being the angle of the natural slope of the fuel and said portion being constructed to cover the fuel without leaving any intermediary space between the fuel and said portion, and supplementary air inlets at the height of said sloping portion.

940,289

PROCESS OF MANUFACTURING MIXED COAL GAS AND CARBURATED WATER GAS
Walter Thomas, Vancouver, B.C., Canada

Nov. 16, 1909; application filed Apr. 13, 1908, Serial No. 426,748; 2 claims.

1. The process of manufacturing gas, which consists in partly distilling coal in an inclined or horizontal body and freely conducting off the resulting gas without passage through coke for retaining volatile illuminants, pushing the partly distilled coal into a vertical body and completing the distillation; at suitable intervals spraying hydrocarbon oil into the distilling retort and passing the resulting vapor and gas down through the incandescent coke for converting them into fixed enriching gas, and passing such gas off at the base and mixing it with the coal gas.
943,627
MANUFACTURE OF GAS FOR ILLUMINATING, HEATING, OR POWER PURPOSES
Herbert S. Elworthy, St. Albans, England
1. A process for the manufacture of gas rich in methane for illuminating, heating, or power purposes, said process consisting in the production of a gas produced by destructive distillation of carbonaceous material, separating therefrom hydrocarbons other than methane and afterward passing the gas over metallic nickel at a suitable temperature to produce methane and water, the methane produced becoming mixed with the residue of the gas.

Fig. 1.

947,608
METHOD OF UTILIZING BURIED COAL
Anson G. Betts, Troy, N.Y.
Jan. 25, 1910; application filed Dec. 27, 1906, Serial No. 349,606; 5 claims.
1. The process of utilizing unmined coal, which consists in supplying oxidizing gas thereto, gasifying the coal, and utilizing the gas produced.

951,512
OIL-GAS APPARATUS
Earl N. Percy, San Francisco, Calif.
Mar. 8, 1910; application filed July 3, 1909, Serial No. 505,865; 1 claim.
1. An apparatus for manufacturing gas, said apparatus comprising a retort having a vertical chamber with a gas outlet at the bottom; a solid fuel hopper at the top, having a lower cone-shaped end entering the top of said chamber, said hopper having a central tubular portion whose lower end diverges downwardly; an oil-supply pipe passing through said tubular portion of the hopper and adapted to discharge a divergent spray into the top of said chamber and downwardly thereinto; and air and steam pipes entering the central tubular portion of the hopper and discharging in the said divergent portion thereof in juxtaposition with the oil-supply pipe, whereby the steam and air may be commingled with the spraying oil and directed downwardly into the chamber of the retort.
964,901
PROCESS OF TREATING COMBUSTIBLE GASES
Henry L. Doherty, New York, N.Y.
July 19, 1910; application filed Mar. 31, 1909, Serial No. 486,886; 9 claims.
1. The process of improving a combustible gas containing substantial quantities of reducible carbon dioxide, which consists in passing such combustible gas in admixture with air through a deep bed of ignited fuel in a downdraft producer, the proportion of air admixed with said gas being restricted to the quantity required to maintain the fuel bed in said producer at a reacting temperature by counterbalancing the cooling due to the reaction of said carbon dioxide upon said fuel.

967,213
PROCESS OF MAKING PRODUCER GAS
Leon P. Lowe, San Francisco, Calif.
Aug. 16, 1910; application filed Feb. 18, 1909, Serial No. 378,537; 1 claim.
The process of making producer gas, which consists in passing air through an ignited bed of solid fuel to heat the same to incandescence and then passing oil and air into and through said incandescent bed in a downward direction, first, to disassociate the oil into gases and heavy hydrocarbons and then to convert the heavy hydrocarbons into gases and solid carbons, the latter combining with the air to maintain the proper temperature and assist in forming the producer gas in the usual manner, substantially as described.
974,639
GAS GENERATOR
Eduard Braus, Hanover, Germany
Nov. 1, 1910; application filed Aug. 3, 1909, Serial No. 511,016; 3 claims.
1. A gas generator having in combination a generator chamber, a passage for the material to be treated extending downwardly into said chamber, a passage for the blast surrounding said passage for the material to be treated extending downwardly into substantially the level of the stack of material in said chamber and terminating in a passage of less outer diameter of said stack and outlets for withdrawing gas near the lower part of said chamber.

979,818
METHOD OF MAKING PRODUCER GAS
Dec. 27, 1910; application filed Feb. 26, 1908, Serial No. 417,835; 2 claims.
1. The method of making gas, which consists in generating a producer gas in a gas producer, oxidizing the gas in a combustion chamber, recarbonizing the resultant gas by passing it through a second gas producer containing a bed of carbonaceous residue, reversing the flow of gases, introducing a tar-containing fuel into the second producer, and then passing the gas generated in the second producer through the combustion chamber and through a carbonaceous residue formed in the first producer.
981,708
WATER-GAS PRODUCER
Bernhard Spitzer, Frankfort-on-the-Main, Germany

1. An air-suction generator for the production of water gas, having at its upper part a gas outlet provided with a suction fan, a bypass pipe bridging the inlet and outlet of the fan, valve devices for directing the passage of the gases or a portion thereof through the bypass pipe, a hopper for supplying the generator with coal, a steam-inlet pipe opening into the top of the generator, and a water-sealed dip pipe for establishing communication between the lower part of the generator and the scrubber, substantially as described.

Fig. 1.

986,374
METHOD OF WORKING UPDRAFT GAS PRODUCERS
John Fielding, Gloucester, England
Mar. 7, 1911; application filed Jan. 18, 1909, Serial No. 472,997; 2 claims.

1. The method of working upward-draft gas producers for the production of a pure gas from bituminous fuel, which consists in taking off the fixed gases and condensible vapors at different levels in a producer, mixing the condensible vapors with air, and burning the mixture in a steam-generator furnace, and introducing the steam so produced together with the supply of air to the said producer, whereby substantial self regulation of the producer is obtained, the rate of consumption of the fixed gases being accomplished by a corresponding rate of generation of the condensible vapors and consequently of the steam supplied to the producer.
966,495
PROCESS OF MAKING GAS
Joshua J. Nix, Alhambra, Calif.
Mar. 14, 1911; application filed Jan. 21, 1910, Serial No. 539,330; 2 claims.

1. The method herein described, of making a combustible gas, which consists in precipitating carbonaceous material into a receptacle, heating said carbonaceous material with a restricted supply of air, inducting into said receptacle a supply of powdered carbon by aid of a partial vacuum, and supplying to said first-mentioned carbon and said powdered carbon within said receptacle a supply of steam.

1,012,120
PROCESS OF OPERATING GAS PRODUCERS
Charles Barmen, Jr., Paterson, N.J., assignor to Improved Equipment Co., New York, N.Y., a corporation of Colorado
Dec. 19, 1911; application filed Jan. 27, 1911, Serial No. 605,079; 4 claims.

1. Improvement in operating gas producers comprising supplying to a deep fuel bed an intimately mixed heated draft current of air, hot products of combustion, and steam in excess of the quantity of carbon dioxide present, supplying heat to the mixture by the said hot products and maintaining the mixture materially above the boiling point of water, thereby avoiding quenching of the fuel where the draft enters it, and regulating and restricting the temperature of the fuel bed below the objectionable clinkering point by regulating and restricting the relative proportion of air in the mixture.
1,025,198
GAS PRODUCER
May 7, 1912; application filed Oct. 5, 1910, Serial No. 585,524; 11 claims.
1. In a gas producer, a body, a gas-outlet port adjacent the lower end of
the body of the producer, a rotary stirrer positioned in the top of the body
of the producer, and a fixed blast pipe surrounding said stirrer and posi-
tioned to discharge thereon.

1,031,781
PROCESS OF PRODUCING GAS
Forrest E. Fink, Bucyrus, Ohio
July 9, 1912; application filed July 10, 1911, Serial No. 637,590; 7 claims.
1. A process of producing a fixed gas from bituminous coal or other fuels,
consisting in storing a deep bed of fuel in a gas producer and in maintain-
ing a zone of incandescent fire at successively lower elevations throughout
the day and from day to day for a fixed period without substantial vari-
ation of the condition of the fire, and in passing steam and air through the
green bed of fuel from the bottom upward and through said zone of fire.
PROCESS OF PRODUCING GAS
Jules H. Hirt, El Paso, Tex., assignor by mesne assignments, to Allis-Chalmers Co., Milwaukee, Wis., a corporation of New Jersey

Sept. 24, 1912; application filed Feb. 14, 1910, Serial No. 543,724; 1 claim.

In the art of producing gas, introducing into the free space of a chamber an upwardly directed blast of gas-forming combustible material, igniting said blast, introducing into the same free space of said chamber a second upwardly directed blast of gas forming combustible material, changing the direction of the flow of said combined blast, introducing moisture into said blast at the place of change and taking off from the changed flow the gas produced.
METHOD OF REGULATING GENERATION IN GAS PRODUCERS AND APPARATUS THEREFOR

Le Roy C. Chowning, Corning, N.Y., assignor of twenty-six one-hundredths to Alanson B. Houghton and twenty-six one-hundredths to Arthur A. Houghton, both of Corning, N.Y.

July 1, 1913; application filed Jan. 25, 1913, Serial No. 744,256; 4 claims.

1. The hereinbefore described process of regulating the feed of steam and air to a producer by variation in the pressure of the gas generated therein through the instrumentality of a steam valve controlled by the generated pressure, which consists in interposing between the valve and the pressure of the producer a fluid piston of atmospheric air.

PROCESS OF TREATING COMBUSTIBLE METALLURGICAL-FURNACE GAS TO INCREASE ITS CALORIFIC VALUE

Henry L. Doherty, New York, N.Y.

Aug. 12, 1913; application filed Feb. 17, 1910, Serial No. 544,485; 11 claims.

1. The process of treating a combustible furnace gas containing carbon dioxide, which consists in withdrawing the said gas from the furnace at a temperature such that the contained sensible heat of the gas will be sufficient to balance the heat required for the dissociation of the reducible proportion of its carbon dioxide and passing the said gas in contact with ignited fuel, the said gas being first contacted with relatively fresh fuel, whereby the reducible carbon dioxide of the gas is converted to carbon monoxide.
1,069,866
METHOD OF OPERATING GAS PRODUCERS
Henry L. Doherty, New York, N.Y.

Aug. 12, 1913; application filed Jan. 17, 1914; Serial No. 683,682; 9 claims.

1. The method of operating gas producers, which comprises charging into a gas producer a mixture of fuel and flux such that the mineral matter of the charge will form an easily fusible compound, the said flux comprising a proportion of basic material other than alumina, which will establish in the charge a proportion of such bases which shall be at least equal to the alumina, free or combined, present in the mixture of fuel and flux, burning said fuel in said producer by introducing into the ignited fuel an oxidizing draft current to form combustible gas and liquid ash, and withdrawing from said producer the said gas and liquid ash.

1,083,683
PROCESS OF PRODUCING GAS
Jules H. Hirt, El Paso, Tex., assignor, by mesne assignments, to Allis-Chalmers Manufacturing Co., a corporation of Delaware

Jan. 6, 1914; application filed Feb. 14, 1914; Serial No. 638,727; 2 claims.

1. The herein described method of making mainly carbon monoxide gas, which consists in charging finely divided carbonaceous material admixed, except as herein later stated, only with air sufficient to form carbon monoxide into a closed and highly heated chamber in a direction tangentially to the axis thereof, admitting only moisture to the highly heated gas, and withdrawing a portion of the resulting product gas and recharging the same with the material into said furnace.
1,098,534
METHOD OF AND APPARATUS FOR GENERATING PRODUCER GAS
Emmanuel Servais, Luxembourg, Luxembourg
June 2, 1914; application filed Feb. 24, 1913, Serial No. 750,329; 12 claims.
1. An improvement in the manufacture of gas in a gas producer, which
consists in maintaining a gasifying temperature at the lower portion of
the fuel charge by a blast of air introduced through tuyers, cooling the
charge above the tuyers to a temperature below that of slag fusion by in-
introducing thereto a gas or vapor which decomposes with absorption of
heat, permitting molten slag to accumulate on a hearth below the tuyers,
and supplying additional heat to the slag to prevent solidification thereof.

1,110,782
PROCESS OF PRODUCING GAS
Jules H. Hirt, El Paso, Tex., assignor, by mesne assignments, to Allis-Chalmers
Manufacturing Co., a corporation of Delaware
Sept. 15, 1914; application filed Feb. 14, 1910, Serial No. 543,726; 6 claims.
1. In the art of producing gas, causing an ignited mixture of gas-forming
combustible material and air to swirl and to have an upward travel while
in motion, causing the upper portions of said swirling mixture to contract
at a point adjacent the axis of the swirling mixture, and introducing mois-
ture to the mixture near said point of contraction.
1,116,216

PROCESS OF PRODUCING GAS FROM BITUMINOUS FUEL

Otto C. Berry, Glendale, Ohio

Nov. 3, 1914; application filed May 6, 1914, Serial No. 431,777; 4 claims.

1. The process of manufacturing producer gas from bituminous fuel, which consists in maintaining in that part of the producer immediately above the highest point passed through by the finished gas, in the recirculating type of producer, a temperature sufficient to distill all of the tarry vapors from the fuel, by drawing a sufficiently large portion of the hot finished producer gas from below up through said body of fuel to accomplish this, in connection with the heat conducted or radiated to this part, and then in returning the gas, along with these distilled tarry vapors and unmixed with air, into the producer immediately below or into the combustion zone of the fuel column.

1,146,627

METHOD OF OPERATING GAS PRODUCERS

Heinrich Koppers, Essen-on-the-Ruhr, Germany, assignor to H. Koppers Co.,

Chicago, Ill., a corporation

July 13, 1915; application filed July 27, 1914, Serial No. 853,849; 6 claims.

1. The method of operating a gas producer with discharge of the slag in a liquid state, which consists in causing a portion of the hot gas generated to pass with the slag through the slag discharge passage.
1,159,675

METHOD OF MANUFACTURING GAS
John W. Hornsey, Summit, N.J., assignor to General Reduction Gas and By-Products Co., a corporation of Delaware
Nov. 9, 1915; application filed Feb. 21, 1911, Serial No. 609,956; 7 claims.
1. The hereindescribed method of continuously manufacturing gas, which consists in treating carbonaceous material in a closed vessel at a moderate temperature for the removal of the coal gas therefrom, subsequently treating the residuum from the first vessel in a second closed vessel at a higher temperature in the presence of steam for the generation of water gas, the material in both vessels being constantly agitated and maintained in a finely divided state by showering the treated material again and again down through the treating medium.

1,164,408

PROCESS OF PRODUCING GAS
Peter G. Schmidt, Olympia, Wash.
Dec. 14, 1915; application filed Mar. 29, 1913, Serial No. 757,672; 1 claim.
A process of producing gas, consisting in admitting air upwardly into a confined fuel charge from below the bottom thereof and throughout the area of the fuel charge, admitting air downwardly into the fuel charge in a horizontal plane below the top of the fuel charge and at all points around the sides of the charge, and withdrawing the gas upwardly centrally of the fuel charge between the lower and upper points of air admission.
1,165,347
GAS PRODUCER
Godfrey M. S. Tait, Montclair, N.J., assignor to Tait Producer Co., New York, N.Y., a corporation of New Jersey
Dec. 21, 1915; application filed Mar. 4, 1910, Serial No. 547,194; 18 claims.

1. A gas producer having a grate frame, a series of grate bars arranged side by side and spaced from each other, means for mounting said bars on said frame, a second series of grate bars arranged below the first series and respectively under the spaces between the bars of said first series and having ash-supporting top surfaces of a greater breadth than said spaces, whereby the ash falling through the spaces between the bars of the first series lies in angle of repose hillocks upon the bars of the second series, said bars of the second series formed for lateral discharge of the ash, and means for mounting the bars of said second series on the said grate frame.

1,175,191
PROCESS OF GENERATING AND UTILIZING PRODUCER GAS
Godfrey M. S. Tait, Montclair, N.J., assignor to Tait Producer Co., New York, N.Y., a corporation of New Jersey

1. The process of making producer gas comprising supplying fuel and draft current to a producer and maintaining incomplete combustion of said fuel and creating a suction or rared state at the outlet side of the producer by the suction of a gas engine and a pressure condition at the draft side of the same by the pressure of the exhaust of said engine and in regulating such conditions automatically to cause the said pressures to balance or equalize at a point within the fuel bed of the producer.
1,195,934
PROCESS OF GENERATING TARLESS GAS
Henning F. Wallmann, Chicago, Ill., assignor of one-half to Adelheid Wallmann, Wilhelm R. Wallmann, and Henning H. Wallmann, all of Chicago, Ill.
Aug. 22, 1916; application filed Dec. 17, 1912; Serial No. 737,734; 12 claims.
1. The continuous process of gasifying, which consists in continuously moving portions of a mass of solid fuel from an inlet thereof through a distillation conduit, heating, and thereby distilling fuel of said mass within said conduit, continuously separating resulting distillates from resulting residue of distillation, heating resulting separated residue to a temperature higher than that of fuel under distillation within said conduit, leading hydrocarbonaceous fluid into resulting hotter residue, thereby decomposing said fluid, separating resulting gaseous products from said hotter residue, and continuously delivering the latter after its said separation from said gaseous products into a receptacle for solid combustible.

1,207,724
METHOD OF MAKING COMBUSTIBLE GAS
Henry L. Doherty, New York, N.Y.
Dec. 12, 1916; application filed Jan. 29, 1915, Serial No. 5,111; 31 claims.
1. The method of manufacturing gas, which comprises maintaining a body of mixed carbonized and bituminous fuel in regulated proportions in a relatively long conduit, producing combustible gas in an intermediate region of the said conduit by passing laterally through that portion of the fuel body in said intermediate region an oxidizing draft current comprising regulated proportions of water vapor and air, the relative proportions of the said water vapor and air being so regulated with respect to their respective endothermic and exothermic action on the fuel in the said intermediate portion that the said fuel will be maintained at the temperature desired, advancing the said body of fuel through the said region of semicom-bustion at a rate greater than the rate of combustion of the said fuel therein, withdrawing a minor portion of the combustible gas formed in the said intermediate region from the said region, contacting the said minor portion of combustible gas with that portion of the said fuel body above the said intermediate region and which is advancing toward the said region, to carbonize the bituminous matter in the said portion of said fuel body, to preheat the said portion of the said fuel body and to cool the said minor portion of combustible gas, contacting with that portion of the said fuel body which has advanced beyond the said region of semicom-bustion the said cooled portion of combustible gas to cool the said portion of said fuel body, withdrawing the cooled mixture of carbonized fuel and ash, separating the carbonized fuel from the ash of the said mixture and returning the said carbonized fuel in admixture with a regulated portion of fresh fuel to that part of the said fuel body, which is advancing toward the said region of semicom-bustion.
1,214,164
PROCESS OF TREATING MATERIALS
John W. Hornsey, Summit, N.J., assignor to General Reduction Gas and By-
Products Co., a corporation of Delaware.
1. The process of continuously making water gas, which consists in intro-
ducing carbonaceous material and steam into a closed vessel in the presence
of a source of heat out of contact with the material maintaining the par-
ticles of the material in a series of falling showers down through the vessel
whereby the steam as it passes through the vessel is brought into repeated
and shifting contact with the particles of the material.

1,230,558
GAS PRODUCER
Leopold F. Burger, Beloit, Wis., assignor to International Harvester Corp., a cor-
poration of New Jersey.
June 19, 1917; application filed June 30, 1913, Serial No. 776,537; 4 claims.
1. In a gas producer, the combination of a generating chamber, a fuel
charger arranged at the top of the generating chamber, a twyer surround-
ing said fuel charger, and a vaporizing chamber connected to said twyer.
1,254,107
GENERATOR FOR GAS-PRODUCER PLANTS
George Hamilton Allen, North Fremantle, Western Australia, Australia.
1. In a gas producer, a combustion chamber, an air intake extending into
the chamber and communicating therewith through laterally arranged ports
in the intake, said chamber having supplementary air ports in the outer
wall thereof whereby air is supplied to the interior and exterior of the mass
of fuel in the chamber and means below the combustion chamber to draw
the generated gas through the fuel.

1,268,763
PROCESS OF AND APPARATUS FOR MAKING NATURAL-GAS SUBSTITUTE
Charles S. Palmer, Pittsburgh, Pa.
June 4, 1918; application filed Oct. 5, 1917, Serial No. 194,834; 7 claims.
1. In the manufacture of water gas, the process, which consists in
confining a charge of fuel in a space having an envelop which consists
principally of a metal associated with iron in the "iron group" in Mendelejeff’s
table and of greater atomic weight than iron, said envelop not exceeding
1 1/2 inches in thickness, being of good heat conductivity and not deleteriously
affected when subjected to the action of a mixture of producer gas and air
heated to a temperature of 1,100° C., for prolonged periods of time, supply-
ing sufficient heat to said charge through said conductive envelop from a
strongly oxidizing, highly heated gaseous medium caused to contact with
the outer surface of said envelop, to promote the water-gas reaction in said
charge, maintaining said temperature by conduction of heat to said charge
through said conductive envelop without the direct introduction to said
chamber of substantial quantities of an air blast, simultaneously supplying
a sufficient quantity of steam to said charge to effect the water-gas reaction
so as to produce a strongly, reducing, highly heated gaseous medium in
contact with a substantial portion of the inner surface of said envelop.
1,270,949
Method of Making Producer Gas
John W. Hornsey, Summit, N.J., assignor to General Reduction Gas and By-Products Co., a corporation of Delaware.
July 2, 1918; application filed Oct. 9, 1911, Serial No. 653,522; 4 claims.
1. The process of continuously making producer gas from carbonaceous material, which consists in introducing carbonaceous material into a heated revolving vessel, causing the material to be retarded in its travel through the vessel and to be picked up and showered down in the interior of the vessel to maintain the material in a finely divided and comminuted condition introducing an oxidizing agent into the vessel while it is being revolved, thus exposing the separated particles of the material to the action of the oxidizing agent and the heat, the shock of the falling particles being adapted to disrupt their seared surfaces and to present fresh surfaces to the action of the heat and oxidizing agent with each revolution of the vessel, the material and the oxidizing agent being introduced into the vessel continuously.

1,286,577
PROCESS FOR MANUFACTURING GASES
Herbert Frederick Freuler, Walla Walla, Wash.
Dec. 3, 1918; application filed June 6, 1916, Serial No. 101,945; 3 claims.
1. The herein described process for the production of gases consisting of first electrically heating a mass of carbon material with a current of comparatively high voltage, reducing said voltage to regulate the temperature of said mass, and then injecting superheated steam into the mass, whereby the fluid is decomposed and the oxygen of the steam combines with the carbon-forming carbon monoxide and free hydrogen.
1,316,339
BYPRODUCT RECOVERY FROM GAS PRODUCERS AND THE LIKE

Sept. 16, 1919; application filed Mar. 7, 1916, Serial No. 82,858; 6 claims.

1. A method of utilizing pitch consisting in gasifying the volatile and nonvolatile constituents thereof in a gas-producing chamber through which it moves to successively hotter zones in admixture with other matter such as fuel and in the reverse direction to air admitted to said chamber.

1,329,853
MANUFACTURE OF GAS
Walter F. Rittman, Pittsburgh, Pa., assignor to Synthetic Hydrocarbon Co., Pittsburgh, Pa., a corporation of Delaware

Feb. 8, 1920; application filed Feb. 28, 1916, Serial No. 89,355; 6 claims.

1. The method herein described of manufacturing gas, which consists in alternating forcing air and steam through a body of incandescent carbonaceous material, utilizing highly heated gases formed in the producer to gasify and crack a hydrocarbon liquid out of contact therewith, subjecting the gas to a pressure not greater than 10 pounds absolute, and mingling the hydrocarbon gases thus produced with the gases formed by the passage of the steam through the highly heated carbonaceous material.
1,367,321
PROCESS FOR MAKING GAS
John Urban McDonald, Decatur, Ill.
Feb. 1, 1921; application filed Mar. 10, 1920, Serial No. 364,651; 1 claim.

The process of making gas consisting in introducing wet garbage into the top of a vertical retort, heating an intermediate zone of the retort sufficiently to render the fixed carbon of the garbage incandescent at that point, thereby heating the garbage above the incandescent zone sufficiently to vaporize the moisture and gasify the volatile matter of the garbage, the resultant gases, tar vapor, and steam being forced down by their own pressure through the incandescent layer, causing all the incandescent carbon to oxidize to form fixed gases which pass down with the gases of the volatile matter through the ashes in the bottom of the retort, thereby causing the total gasification of the combustible constituents of the garbage.

1,379,038
PROCESS OF MANUFACTURING WATER GAS
William Wallace Odell, Urbana, Ill.
May 24, 1921; application filed Nov. 7, 1918, Serial No. 261,567; 1 claim.

A process for the manufacture of combustible gas by an intermittent method, using bituminous coal or other solid fuel containing volatile combustible matter, consisting in first heating a bed of ignited fuel in a generator by blasting it with air, using an up-blast only, from beneath the fuel bed, and using simultaneously with this air blast a relatively small amount of steam also injected from beneath the fuel bed during the forepart of the blast period only, for the prevention of smoke, prolonging said blast, so as to better heat the upper zones in the fuel bed, shutting off said air, as well as the steam used therewith, and making up and down runs, a small quantity of air being injected with the steam, during each of said runs, for the purpose of prolonging the period of said runs, and making at least two up runs to every down run for the purpose set forth.
A process of gas generation from a column of solid fuel consisting of a blow period in which the lower portion only of said column is blown with air and a run period alternating therewith in which steam is passed upwardly through the said lower portion, air added to the water gas so formed, and the resulting products passed through the upper portion of the fuel column.

1. A process for the manufacture of carbureted gas using bituminous coal or other fuel containing volatile matter as generator fuel in three stages consisting in, first, blowing the ignited fuel contained in a generator with an oxygen-containing gas, burning the blast gas so generated to complete combustion in suitable carbureting chambers by supplying oxygen to them; then, when these chambers are sufficiently hot, shutting off their oxygen supply and blasting the generator fuel until it is sufficiently hot for gas-making purposes conducting the blast gas new-generated into a holder; and third, shutting off the fuel bed for the purpose of steam-distilling the fuel and simultaneously making water-gas, carbureting the gas thus produced and conducting it to the holder containing the recovered blast gas, where it is mixed with the latter in proportions as generated, substantially as described.
GASIFICATION OF SOLID FUEL
Friedrich G. C. Rincker, Watergraafsmeer, Netherlands.
Aug. 16, 1921; application filed Oct. 4, 1919, Serial No. 328,452; 4 claims.
1. A method for producing gas from solid fuel such as coal or the like, which consists in passing water gas through said fuel, so as to leave a residue of coke while producing gases which are led off, and then after the said gases have been evolved from the said material, passing steam through the residue of coke before it has substantially cooled, the coke being at a sufficiently high temperature to cause the production of water gas and then passing the water gas so produced without any substantial lowering of the temperature thereof, through another mass of fuel for the purpose of producing gases from said other mass, the said fuel being always at a lower temperature than the water gas acting thereon, and the mixture of water gas and gases produced from said fuel being led directly to a receiver.

GAS GENERATION
Harry F. Smith, Dayton, Ohio, assignor, by mesne assignments, to the Gas Research Co., Dayton, Ohio, a corporation of Ohio.
Oct. 18, 1921; application filed Nov. 20, 1918, Serial No. 263,407; 11 claims.
1. The method of generating gas from solid carbonaceous fuels, which consists in subjecting the lower zones of the fuel bed to partial combustion, passing the resulting hot gases through the upper zone of the fuel bed to drive off the volatile hydrocarbons therein, removing the heavy hydrocarbons from the offcoming gas, and returning such heavy hydrocarbons to the generating chamber in such wise as to distribute them evenly over the fuel bed.

Fig. 1.
METHOD OF MANUFACTURING WATER GAS

Henry L. Doherty, New York, N.Y.

Mar. 14, 1922; application filed Jan. 9, 1912; Serial No. 670,338; 40 claims.

1. A method of making gas, comprising passing fuel in columns through two or more furnaces at such a rate that a part of the fuel leaving the furnace will be unburned, igniting fuel in the columns, blowing air through the ignited fuel in said columns in series, passing steam through said heated columns in a series at a rate to partially decompose said steam in the first column and more completely decompose the steam in the following columns, and diverting a portion of gas formed by the decomposition of said steam and passing it through fresh fuel in one or more of said columns to carbonize the same.

GASIFICATION OF COAL AND OBTAINING OF BYPRODUCTS

Charles Howard Smith, Short Hills, N.J., assignor to International Coal Products Corp., Richmond, Va., a corporation of Virginia.

Apr. 25, 1922; application filed Feb. 16, 1918; Serial No. 217,469; 5 claims.

1. The process of recovering ammonia and tar separately in the distillation of caking or swelling coal and the production of water gas or producer gas therefrom, consisting in subjecting finely divided coal to partial distillation at temperatures below a point where substantial quantities of ammonia pass off, while continuously agitating the coal, withdrawing substantially all the vapors, gases, and tars driven off during said distillation, treating the uniform coal residue of said partial distillation in a byproduct gas producer at considerably higher temperatures, and separately recovering the ammonia which passes out of said producer along with the producer gas or water gas formed therein.
1,426,159
PROCESS OF PRODUCING COMBUSTIBLE GAS AND FOR CARBONIZING COAL
Henry L. Doherty, New York, N.Y.
Aug. 15, 1922; application filed Sept. 7, 1918, Serial No. 253,045; 20 claims.
1. A process of producing combustible gas comprising, supporting a column of fuel in a shaft furnace, intermittently blasting a combustion-supporting gas transversely through a mid portion of said column to produce a mid zone of sufficiently high temperature to decompose steam, and circulating steam upwardly through said column between said blasting operations.

1,428,421
GASIFICATION OF COAL OR OTHER CARBONACEOUS MATERIAL
Sept. 5, 1922; application filed May 2, 1921, Serial No. 466,223; 2 claims.
1. A process of gasifying coal and the like, which consists in carbonizing as completely as practicable the material in an externally heated vessel, receiving the residue from said vessel directly into a generator, heating the residue in the generator to incandescence by a blast of air, heating the said vessel externally by means of the sensible heat of the blow gases and in addition by burning any producer gas formed, substituting a steam blast for the air blast when the residue is incandescent, passing a portion of the water gas thus produced through the material in the said vessel, and burning a portion of the said water gas so as to heat the said vessel externally.
1,430,452
COMBINED GAS GENERATOR AND RETORT APPARATUS
Sept. 26, 1922; application filed Feb. 13, 1922, Serial No. 536,507; 8 claims.

1. Apparatus for distilling and gasifying solid carbonaceous matter, said apparatus comprising in combination a chamber, the lower portion of which forms a generator and the upper portion a retort, the axis of the generator being eccentric to the axis of the retort, means for admitting air and steam to the generator, a combustion chamber situated close to the lower portion of the retort, means for the admission of a moisture-saturated blast to the generator and means for heating said blast by the producer gases generated in and withdrawn from the generator.

1,447,839
CARBONIZING FUEL IN VERTICAL RETORTS
Mar. 6, 1923; application filed May 18, 1922, Serial No. 561,914; 3 claims.

1. A process of carbonizing fuel, which consists in placing the fuel into externally heated vertical retorts, introducing steam into the bottom of the retort, and introducing oxygen mixed with nitrogen, the nitrogen being used in quantities of not more than 40 percent of the volume of the oxygen into the lower part of the retort in such a manner that it comes in contact with the hot coke and maintains the temperature of the latter at the degree necessary for the production of water gas from the steam.
1,451,367
PROCESS OF TREATING SHALE
Stephan Marko, Chicago, Ill.
April 10, 1923; application filed Oct. 10, 1921, Serial No. 506,757; 2 claims.
1. A process of producing combustible gas from oilbearing shale, consisting in agitating ground shale in the presence of dry-heated gaseous products of combustion at temperatures in excess of 600° F., passing the heated shale and gases to a secondary zone of treatment and there continuously agitating the shale and subjecting it to increased temperatures and adding sufficient quantities of superheated steam to the secondary stage of treatment to increase to a predetermined amount the hydrogen content of the evolved gases, separately withdrawing the gas and shale residue from the secondary stage of treatment.

1,467,957
METHOD OF GENERATING GAS
Frederick T. Snyder, Oak Park, Ill.
1. The method of producing gas which comprises subjecting one portion of a mass of carbonaceous fuel to the decomposing action of water gas and steam to generate additional water gas, subjecting another portion of the same mass of fuel to the distilling action of the heat of the produced gas to produce other gas, simultaneously burning some of the gas generated in the one cycle and with the resultant heat heating the gas to which the first-mentioned fuel portion is subjected in a subsequent cycle.
1,468,190
PROCESS FOR MAKING ILLUMINATING GAS
Daniel J. Young, Tacoma, Wash., assignor to Young-Whitwell Gas Process Co.,
Tacoma, Wash., a corporation of Washington.
Sept. 18, 1923; application filed June 14, 1921, Serial No. 477,365; 8 claims.
1. The improvement in the process of making carbureted water gas which
consists in varying the gas-making run by at intervals passing steam in a
reverse direction through the entire apparatus and simultaneously adding
fuel directly to the generator.

1,474,012
COMPLETE GASIFICATION OF SOLID FUEL
Charles W. Andrews, Duluth, Minn.
Nov. 13, 1923; application filed Apr. 20, 1921, Serial No. 462,992; 7 claims.
1. The process of completely gasifying solid fuel which consists in estab-
lishing and externally heating a fuel column, permitting the column to
descend at a rate substantially as described and appropriate for the economic-
ical production of coal gas at the upper part of the column, thus establish-
ing a rate of coke travel from the upper part of the column, converting
substantially all the coke into water gas by the continuous introduction of
steam at the lower part of the column, and coordinating the rate of pro-
duction of water gas with the established rate of coke travel by providing
a sufficiently enlarged heat-exchange surface at the lower portion of the
column.
A method of producing mixed gas, which consists in generating gas in one generator, passing said gas downwardly through a superheater to the lower incandescent zone of a second generator, and thence through the upper distilling zone of the said second generator, air being admitted directly to the said incandescent zone during the upward passage of said gas.

1. The method of treating comminuted carbonaceous material for destructive distillation thereof, consisting in passing such comminuted material in a carrying medium of superheated steam through a plurality of series of retorts containing spiral cores carrying a catalytic agent, each series of retorts being heated to a different temperature to effect changes in the gaseous medium surrounding such comminuted material.
PROCESS OF GENERATING GAS

James H. Reid, Readsboro, Vt., assignor to International Nitrogen Co., Cleveland, Ohio, a corporation of Delaware.

Mar. 11, 1924; application filed Mar. 25, 1920, Serial No. 368,498; 8 claims.

1. The process of making gas which comprises distilling a mixture of bituminous coal with calcium carbonate, supplying acetylene and steam to the incandescent residue, and conducting the evolved gases or gaseous mixture through a mass of incandescent carbonaceous material.
1,505,065
PROCESS FOR PRODUCTION OF HYDROGEN OR GASES RICH IN HYDROGEN
Aug. 12, 1924; application filed Oct. 5, 1922, Serial No. 592,496; 9 claims.
1. A process for the production of gases rich in hydrogen, which consists in completely gasifying coal in an apparatus comprising an upper retort chamber, and a lower producer chamber arranged in open communication with the retort chamber so as to allow the carbonized coal to fall directly from the retort to the producer, the series of steps of completely gasifying the coal consisting in carbonizing the coal by subjecting it to temperatures which increase gradually as the coal passes from the inlet of the retort chamber to the top of the producer chamber, cracking the vapors and gases produced during the carbonization of the coal in the retort chamber by passing them in a downward direction through the zone of highest temperature located in the neighborhood of that part of the fuel bed situated at the bottom of the retort portion and the top of the producer portion of the apparatus, subjecting the carbonized fuel in the producer chamber to simultaneous treatment with steam and air, and regulating the quantities of steam and air employed and the points at which the said steam and air are admitted into the producer chamber so that the zone of highest temperature is located at the top of the producer chamber and the temperature decreases gradually from the aforesaid zone through the fuel bed in the producer down to a temperature of comparatively low value at the bottom of the producer chamber where the gases are drawn off.
1,509,553

PROCESS FOR MANUFACTURING WATER GAS
Sept. 25, 1924; application filed Oct. 17, 1923, Serial No. 595,112; 9 claims.

1. The process of making water gas which consists in making said gas in a generator by a succession of alternate up and down treatments, passing the water gas formed in a single stream into a highly heated economizing chamber, thence dividing said water gas into separated streams by contact with the walls of a highly heated primary mixing chamber, thence into said mixing chamber and thence enriching the water gas, thence into and through the refractory material in a secondary mixing chamber, and thence through the refractory material in a fixing chamber or superheater.

1,510,442

PROCESS OF MANUFACTURING HYDROGEN OR GASES RICH IN HYDROGEN
Sept. 30, 1924; application filed Jan. 10, 1924, Serial No. 611,733; 5 claims.

1. A process for the production of hydrogen or gases rich in hydrogen, which consists in completely gasifying coal in an intermittent mixed-gas generator, taking off from the generator the hot mixture of gases resulting from the complete gasification, the said gases consisting largely of hydrogen and carbon monoxide with some carbon dioxide, subjecting the said mixture of gases while still in the heated condition and without any intermediate cooling to treatment with steam in the presence of a catalyst in a carbon monoxide converter and maintaining a gradual fall of temperature between the two ends of the said converter by introducing a portion of the required amount of steam at or near that end of the converter at which the hot mixture of gases from the generator is admitted and the remainder of the steam required at a plurality of points between the two ends of the converter.
APPARATUS FOR MAKING ILLUMINATING GAS

Daniel J. Young, Tacoma, Wash., assignor to Young-Whitwell Gas Process Co.,
Tacoma, Wash., a corporation of Washington.

Dec. 16, 1924; application filed Jan. 31, 1921, Serial No. 441,369; 3 claims.

1. A gas-making apparatus comprising a plurality of generators, gas superheating means, means for connecting said generators and superheater in series in the circulation with the superheater between generators and with the circulation up in the first generator and down in the last generator of the series, means for reversing the direction of the circulation and means for introducing fuel into the gas after it leaves the superheater and before passing down into the fuel bed in the generator which follows the superheater in the series.

1,530,281
MANUFACTURE OF GAS
John L. Murrie, Yonkers, N.Y.

Mar. 17, 1925; application filed July 26, 1923, Serial No. 654,042; 2 claims.

1. The process of forming a gas of high B.t.u. value direct from solid carbonaceous material which comprises finely pulverizing the material, mixing it with superheated steam, and exposing the mixture to a high temperature in a coil whose volume gradually increases from end to end.
1,554,073
APPARATUS FOR MANUFACTURE OF WATER GAS
Sept. 15, 1925; application filed Aug. 30, 1924, Serial No. 735,121; 1 claim.
Down-run apparatus for the manufacture of water gas from carbonaceous matter in a finely divided condition, having a generator chamber and a superheater chamber associated therewith, said generator chamber having an inlet from the superheater chamber in the upper part of its wall, and a deflector in the generator chamber on the upper part of its wall opposite the inlet and adapted to cause simultaneous deflection of steam or steam and gas mixture from the inlet and the carbonaceous matter, and means adapted to project said carbonaceous matter onto said deflector.

Fig. 1.

1,559,622
PRODUCTION OF COMBUSTIBLE GAS
Max Köhler, Dresden, Germany.
Nov. 3, 1925; application filed July 31, 1924, Serial No. 729,314; 4 claims.
1. Process of producing combustible gas from carbon and an oxygen carrier, consisting in flowing a mixture of powdered fuel and steam into a gas-generating chamber over a molten heat radiating slag bath, stirring by pulsation fuel mixture over said slag bath, and gasifying said fuel mixture by the radiated heat from said slag bath.
1,573,524
GASEOUS FUEL PRODUCTION
James R. Rose, Edgeworth, Pa., assignor of one-half to John Harris, Cleveland, Ohio
Feb. 16, 1926; application filed May 28, 1925, Serial No. 641,883; 5 claims.
1. The process of manufacturing an enriched gas which consists in generating blue water gas, cooling such gas and conducting the same through a mixing tower or chamber, and adding to such gas while in transit through said mixing chamber or tower a regulated quantity of liquefied hydrocarbon gas having a vapor tension of not less than 25 p.s.i. and not greater than 500 p.s.i. at atmospheric pressure and ordinary temperatures.

1,587,564
PROCESS OF THE MANUFACTURE OF GAS
June 8, 1926; application filed June 12, 1924, Serial No. 719,585; 4 claims.
1. A process for the manufacture of gas, which consists in blowing air through hot coke, the blow gases thereby produced being caused to pass through a regenerator, blowing steam through the incandescent coke, passing the water gas thereby produced through coal, forcing some of the mixed water and coal gas thereby produced through the regenerator, passing some of the gas thus heated in the regenerator directly through the coal, and enriching the remainder of such heated gas by oil.
1,587,589
MANUFACTURE OF GAS
June 8, 1926; application filed Nov. 2, 1925. Serial No. 421,270; 8 claims.
1. A method of manufacturing mixed coal and water gas in a generator having a fuel bed, which comprises subjecting the fuel bed to alternate air and steam blasting, injecting pulverized bituminous coal into the generator above the fuel bed as steam is being forced through the fuel bed from beneath, enriching the water gas arising from the fuel bed and resulting from the passage of the steam therethrough by the distillation of the pulverized fuel maintained in suspension by the upward current of water gas, and continuously maintaining the fuel bed at a substantially constant level by by the down-falling carbonized residue of the pulverized coal.

1,598,473
COMPLETE GASIFICATION OF BITUMINOUS FUEL
Albert Breising, Vienna, Austria.
Aug. 31, 1926; application filed Sept. 25, 1922, Serial No. 590,498; 4 claims.
1. A process for the total gasification of bituminous materials in an alternate blast and gas-making water-gas process whereby mixed water-gas and distillation gases are produced, which comprises distilling bituminous material in a distillation zone, alternately blasting with air and gasifying with steam the residual material from said distillation zone in a gasification zone, withdrawing the blast gases generated during the air-blast period, igniting said blast gases, withdrawing a portion of the mixed gas formed in the process, imparting a portion of the sensible heat of the blast gases to said mixed gas, passing said mixed gas through the distillation zone only, imparting a portion of the sensible heat of the blast gases to steam, superheating the steam to a lower temperature than that to which the mixed gas is superheated, and passing said steam through the gasification zone to form water gas.
1,600,375

PROCESS OF PRODUCING ENRICHED WATER GAS

Sept. 21, 1926; application filed June 21, 1921, Serial No. 479,293; 2 claims.

1. The process of producing enriched water gas, consisting in alternately passing streams of air and steam through a bed of ignited carbonaceous fuel in a generator during a plurality of successive blow and gas-making periods, in decomposing the steam during its passage through the fuel bed during each gas-making period, in introducing to said generator during each gas-making period a small quantity of a composite carbonaceous fuel consisting of oil and comminuted carbon in a substantially ribbonlike form from which fuel volatiles are vaporized and mixed with the passing water gas while the carbonaceous residue deposits on the fuel bed before a succeeding air blow at which time the temperature of said bed is raised, and in collecting the enriched water gas thus produced.

1,602,242

PROCESS FOR MANUFACTURE OF COMBUSTIBLE GAS

Oct. 5, 1926; application filed Sept. 23, 1924, Serial No. 739,282; 7 claims.

1. The hereindescribed improvement in the manufacture of a combustible gas from coal of relatively high volatile content, which includes: Disposing the fuel in an annular column and confining the same between inner and outer refractory walls with all portions of the fuel of the annular column within an effective radiating distance of the refractory walls and thereby preventing the formation of an impermeable mass or core in the fuel; and blasting the column of fuel in a vertical direction substantially uniformly throughout the area of the annular column of fuel with air and steam alternately.
METHOD OF JOINTLY MANUFACTURING CARBURATED WATER GAS AND VOLATILE HYDROCARBON MOTOR FUELS


Nov. 30, 1926; application filed Mar. 24, 1921, Serial No. 455,300; 1 claim.

The method of jointly manufacturing carburated water gas and volatile hydrocarbon motor fuel which consists in air blasting a bed of carbonaceous fuel to incandescence, passing the heated blast gases as produced over heat-absorbent material to heat the same to a temperature between 850° F. and 1,050° F., steam blasting the incandescent bed to produce water gas, passing the heated water gas over the said heated material, injecting into the current of heated water gas a heavy hydrocarbon oil and thereby causing the oil in vaporized form to pass with the water gas over the said heated material, controlling the rate of flow of the mixed water gas and oil vapors, with reference to the temperature of the said heated material, so as to secure a production of fixed hydrocarbon gas not less than 15 percent nor more than 80 percent of the weight of oil injected, cooling the mixed gases and vapors to cause condensation of the vaporous portion thereof, separating the condensed oil including volatile hydrocarbon motor fuel from the fixed gases, and controlling the amount of injected oil so that the said fixed gases shall have an average B.t.u. value of not less than 450 nor more than 600 per cubic foot.

PROCESS FOR COMPLETE GASIFICATION OF BITUMINOUS FUELS IN ALTERNATELY OPERATED GENERATORS

Hugo Strache, Vienna, Austria.

Dec. 21, 1926; application filed Aug. 6, 1921, Serial No. 490,364; 4 claims.

1. A process of producing a gas substantially composed of water gas and distillation gas from bituminous fuel, which comprises establishing and maintaining a bed of incandescent coke in a gas-generating chamber and a superimposed mass of bituminous fuel to be distilled upon the same in immediate contact therewith in a distillation chamber, (a) blowing air through the incandescent coke to form producer or blast gas burning at least a part of the said producer gas in flues surrounding the said distillation chamber, (b) passing steam through the said flues and thereby superheating the steam and introducing it at about the junction point of the distillation chamber and the gas-generating chamber, passing a part of this steam through the mass of the fuel in the distillation chamber and simultaneously passing the other part of this steam downwardly through the incandescent coke in the gas-generating chamber, alternately repeating steps (a) and (b) while drawing off the resulting mixture of water gas and distillation gas from the distillation chamber, separately drawing off the water gas formed in the gas-generating chamber from said chamber, and replenishing said fuel to maintain both the fuel and the incandescent coke.
1,624,644
PROCESS OF MAKING COMBUSTIBLE GAS
William D. Wilcox, Idaho Falls, Idaho.

Apr. 12, 1927; application filed Apr. 1, 1921, Serial No. 456,811; 1 claim.

The hereindescribed process of generating coal and water gas by admitting air for blasting at an intermediate level to a body of coal contained in each of two generators, and thereby heating the fuel to incandescence, passing the blast gases downwardly and into corresponding regenerators, adding additional air for the combustion of the blast gases therein, alternately thereafter admitting steam to one of the two generators at the same level at which air was previously admitted, passing the steam downwardly through the incandescent fuel to form water gas, passing the water gas into and up the adjoining regenerator, across, and down the second regenerator, and thereby superheating the water gas, passing the superheated water gas into the second regenerator, and then upwardly through a body of fuel having a layer of uncarbonized coal to a gas outlet above the coal, whereby mixed coal and water gas is produced.

1,634,833
ART OF OPERATING WATER-GAS GENERATORS
Frank A. Howard, Westfield, N.J., assignor to Standard Development Co., a corporation of Delaware

July 5, 1927; application filed Apr. 1, 1920, Serial No. 370,510; 4 claims.

1. The improvement in the art of operating water-gas generators which consists in bringing the fuel in one section of a water-gas generator to the temperature required for water-gas generation, simultaneously bringing the fuel in another section of the generator to a temperature at least suitable for the vaporization of petroleum oil, producing water gas in the first section, subsequently introducing petroleum oil into said second section, separately removing the vapors formed by said petroleum-oil vaporization, and causing the fuel in said second section, with the petroleum coke deposited therein, to move into said first section.
1,667,518
PROCESS OF MAKING CARBURATED WATER GAS
Fred B. Hayes, Fort Wayne, Ind., assignor to Western Gas Construction Co., Fort Wayne, Ind., a corporation of Indiana.
Apr. 24, 1928; application filed Sept. 25, 1924, Serial No. 739,757; 3 claims.
1. The improvement in the process of making carbureted water gas by the alternate up and down steam-run method, which consists in passing the up-run water gas through a carburetor and simultaneously enriching the same with oil floved into said carburetor, in bypassing the down-run blue water gas with respect to the carburetor, in making oil gas in the carbureter during the steam down-run period, and ultimately commingling the bypassed blue water gas, the carbureted water gas, and the oil gas in a holder.

1,672,052
PROCESS FOR GAS MAKING
Harold R. Berry, Brooklyn, N.Y.
June 5, 1928; application filed Apr. 5, 1928, Serial No. 267,699; 12 claims.
1. A process for manufacturing a heating and illuminating gas, which consists in combusting part of a quantity of solid fuel by air blasting and diverting products of such combustion outside and away from the combustion zone, and during such combustion period distilling volatiles out of and away from solid fuel superimposed upon the burning fuel, and, when a desired incandescent heat is attained therein, discontinuing such combustion and then delivering into incandescent fuel steam and volatiles distilled from solid fuel, thereby producing, enriching, and fixing a combustible gas.
METHOD FOR PRODUCING COMBUSTIBLE GAS

William W. Kemp, Baltimore, Md.

July 17, 1928; application filed Nov. 7, 1921, Serial No. 513,444; 7 claims.

1. The method of producing combustible gas from material capable of evolving gas under the action of heat, which consists in charging the gas-producing material into a gas generator, preventing the ingress of air into said generator, and heating the material to form gas therefrom by projecting into the generator the flame produced by the combustion of a thoroughly premixed gas and air mixture, the amount of oxygen in which is not in excess of that required to effect combustion of the mixture and is insufficient to produce combustion of the material.

METHOD OF GENERATING GAS

Claude W. Botsford, Los Angeles, Calif., assignor to William W. Odell, Pittsburgh, Pa.


1. A method of producing carbureted water gas, consisting in air blasting from the bottom of an ignited fuel bed contained in a generator, taking off the resulting blast gas from a point intermediate the ends of the fuel bed, then blasting the fuel for a short period with preheated air from said intermediate point upwardly, then shutting off the blast and admitting steam at the bottom of the fuel bed and simultaneously admitting carbureting material intermediate the ends of the fuel bed, and taking off the gas at the top of the generator.
1,687,118
MANUFACTURING FUEL GAS
Fritz Winkler, Ludwigshafen-on-the-Rhine, Germany, assignor to I. G. Farben-
industrie Aktiengesellschaft, Frankfort-on-the-Main, Germany, a corporation
of Germany.
Oct. 9, 1928; application filed Sept. 27, 1923, Serial No. 665,221; 2 claims.
1. The process of manufacturing fuel gas in a generator having a bed of
small-sized, incandescent, solid carbonaceous material supported by a grate,
consisting in blowing a gas adapted to produce fuel gas through said mate-
rial with sufficient speed to establish a boiling action in the material, thereby
causing gasification thereof by reaction between the incandescent material
and the gas.

1,689,940
PROCESS OF MAKING FUEL GAS
Alfred H. White, Ann Arbor, Mich.
1. The continuous process of making combustible gas with a heating value
of over 200 B.t.u. per cubic foot, which consists in substantially continu-
ously blowing a charge of solid fuel within a gas generator with a gaseous
mixture whose principal reactive constituents are oxygen, and steam in
such proportions and so regulated in quantity that the fuel bed is continu-
ously maintained at not less than a red heat and combustible gas is evolved,
introducing enriching carbonaceous material derived from an external source
into this hot gas capable of itself undergoing destructive distillation at a
red heat and reacting with said hot gases to form gaseous hydrocarbons,
and causing it to undergo destructive distillation and further interaction
with the hot combustible gas out of contact with metallic surfaces and at
temperatures which decrease slowly and are maintained principally by the
energy resulting from the reactions in the fuel charge in the generator,
whereby substantial destructive decomposition into free carbon of the hy-
drocarbons so formed is avoided.
1,695,914
PROCESS FOR PRODUCING GAS
Linus P. Burrows, deceased, late of Erie, Pa., by Leah B. Archer, Executrix, now by change of name Leah Burrows, Navarre, Ohio.
Dec. 18, 1928; application filed Nov. 13, 1922, Serial No. 600,727; 1 claim.
1. A process for producing combustible gas, which comprises surrounding a retort in a furnace with a high-temperature heat zone, generating steam, and conducting said steam through iron pipes embedded in the furnace walls, the temperature of said zone and said walls being sufficiently high whereby a portion of said steam is decomposed into hydrogen and oxygen, the former passing on through the pipes, the latter combining with the iron to form iron oxide, and the remaining portion of said steam is superheated, conducting the hydrogen and superheated steam resulting from passage through the pipes into the retort, positively agitating coal in said retort while maintaining the heat and flow of superheated steam and hydrogen, thereby producing combustible gases, and removing said gases from said retort.

Fig. 1

1,697,920
PROCESS OF MAKING PRODUCER GAS FROM COKING COALS
Karl Koller, Budapest, Hungary.
Jan. 8, 1929; application filed July 18, 1929, Serial No. 44,625; 2 claims.
1. In the process of making producer gas from the total gasification of coal in a gas producer having a distilling zone and a gasification zone, the steps which comprise admitting regulated quantities of mixed air, steam, and carbon dioxide to gasification zone to generate producer gas, passing the hot producer gas through the distilling zone to distill and gasify coal therein, and simultaneously introducing a limited and regulated supply of oxygen directly into the distilling zone to oxidize colloidal constituents of the coal and thereby prevent caking of the coal of the distilling zone.
1,698,493

METHOD OF AND APPARATUS FOR GASIFICATION

Philip d'H. Dressler, Cleveland, Ohio, assignor to American Dressler Tunnel Kilns, Inc., New York, N.Y., a corporation of New York.

Jan. 8, 1929; application filed Apr. 19, 1929, Serial No. 372,970; 10 claims.

1. The method of making water gas in a tunnel kiln, which consists in passing coke through the kiln passageway, supplying steam to the kiln passageway and transmitting heat to the coke from an enclosed source of heat at the sides of the passageway by convection currents of the kiln atmosphere.

1,701,253

METHOD OF PRODUCING WATER GAS

Charles W. Andrews, Duluth, Minn., and Herman A. Brassert, Chicago, Ill.

Feb. 5, 1929; application filed July 15, 1922, Serial No. 575,254; 1 claim.

The method of water-gas production which comprises air blasting a mass of carbonaceous residue to raise its temperature, placing a layer of coal on said residue, passing steam into said heated residue to form blue water gas, passing the heated blue water gas through the coal, whereby the heat of the blue water gas serves to volatilize the volatile content of the coal, agitating the layer of coal during the passage of the blue water gas, and continuing the process by alternately air blasting and then adding coal and passing steam into the mass of residue, the blue water gas passing through the added coal, the blast air and the steam being both preheated by heat derived from the air-blast gases.

1,699,543

MEANS FOR PRODUCING GAS


Jan. 22, 1929; application filed Feb. 7, 1929, Serial No. 356,889; 3 claims.

1. In gas-generating apparatus, in combination, a gas-generating receptacle, means for supplying finely divided carbon to said receptacle, means for supplying a flame under pressure to hold said carbon in suspension, a conduit for conducting the combustible gas produced from said receptacle, said conduit having its communication with said receptacle at a level higher than said flame supply means, and synchronously operating mechanical means for controlling said carbon-supplying means and said flame-supplying means.
1,707,651

METHOD OF GAS PRODUCTION

Charles W. Andrews, Duluth, Minn., and Herman A. Brassert, Chicago, Ill.
Apr. 2, 1929; application filed May 29, 1922, Serial No. 562,337; 2 claims.

1. The process of generating mixed water gas and coal gas by the use of a plurality of similar units, which comprises alternately air blasting and steaming through carbonaceous residue in certain of said units, passing the water-gas generated through heated carbonaceous residue in another unit whereby its temperature is raised, passing the heated gas through a body of fresh coal in said latter unit, the sensible heat of the gas serving to largely remove the volatile contents of the coal thereby producing mixed water gas and coal gas, and agitating the mass of coal.

1,709,107

METHOD OF MAKING WATER GAS

Charles W. Andrews, Duluth, Minn.
Apr. 16, 1929; application filed Jan. 8, 1925, Serial No. 1,157; 2 claims.

1. The method of making water gas from a fuel bed in a dry-bottom closed chamber having a stationary grate, which comprises alternately air and steam blasting the fuel bed, maintaining upper fuel zones, an intermediate clinker formation zone and a lower ash zone, water cooling the walls of said clinker formation zone, and breaking up large masses of clinkers which form by grinding the clinkers against each other and against the walls of the chamber by means of up and down agitation of the fuel and ash beds and continuous agitation of the ash bed from the center outward.
1,709,335

METHOD OF GENERATING GAS

Charles W. Andrews, Duluth, Minn., and William B. Chapman, Jackson Heights, N.Y., assignors of one-half to H. A. Brassett & Co., a corporation of Illinois, and one-half to the Western Gas Construction Co., a corporation of Indiana.

Apr. 16, 1929; application filed July 3, 1928; Serial No. 120,291; 14 claims.

1. The method of making water gas in a gas generator having a firebed containing a zone at an intermediate level extending substantially across the firebed and a zone containing ash underneath said first-mentioned zone, which comprises air blasting the firebed to maintain the first-mentioned zone at a temperature sufficient to liquify a substantial portion of its ash content, passing the liquified ash content downwardly into said second-mentioned zone, maintaining the second-mentioned zone at a red heat somewhat below the ash-solidifying temperature, whereby ash passing downwardly from the first-mentioned zone solidifies in the second-mentioned zone, and passing an agitating member through said second-mentioned zone to break up clinkers while hot and before large masses can form, and passing steam through the heated fires and, thereby forming water gas.

Fig. 2.

1,712,983

METHOD OF MAKING WATER GAS

Caleb Davies, Jr., Poland, Ohio.

May 14, 1929; application filed Mar. 18, 1922; Serial No. 544,938; 2 claims.

1. In a method of making water gas, the steps which consist in blasting the fuel bed of a water-gas generator with air supplied through a highly heated heat-transfer chamber, discharging the blast gas to heat a second heat-transfer chamber and supplying air thereto for combustion, then passing steam through the second heat-transfer chamber and to the fuel bed of the generator, whereby the ash of the latter is maintained at a temperature for slagging conditions, discharging the hot water gas from the generator through the first-mentioned heat-transfer chamber, and then blasting the fuel bed of the generator with air supplied therethrough and passing the hot products thence through fuel for the generator.
PROCESS OF PRODUCING WATER GAS AND EXTRACTING OIL FROM OIL SHALE

June 11, 1929; application filed Aug. 26, 1926, Serial No. 131,590; 1 claim.

The process of producing water gas and extracting oil from oil shale which consists in igniting a confined body of shale at its upper surface, admitting air for combustion above the confined ignited body, drawing the steam and combustion gases downwardly through the shale body to decompose the carbonaceous matter and kerogen contained within the shale by the heat treatment to produce water gas and hydrocarbon vapors, utilizing the water gas produced to generate the steam used, collecting the oil released from the shale by the heat treatment, condensing the hydrocarbon vapors from the water gas, and collecting the water gas and automatically controlling the admission of air for combustion to the upper surface of the confined body in accordance with the temperature of the water gas.

GASIFICATION OF SOLID FUEL

July 9, 1929; application filed Dec. 5, 1922, Serial No. 605,094; 1 claim.

A process of making combustible gas from bituminous fuel, which consists in charging bituminous fuel into a gas producer so as to form a fuel bed having voids between the fuel lumps therein; then air blasting the fuel bed, while it remains quiescent, to form combustible gas until the top portion of the fuel bed is coalesced and the voids partly eliminated; then stopping the air blast; then stirring the coalesced fuel portion; then adding additional bituminous fuel; and then air blasting the fuel bed.
1,725,739

METHOD OF GASIFICATION OF BITUMINOUS COAL


Aug. 20, 1929; application filed June 7, 1928, Serial No. 643,859; 2 claims.

1. In the method for the complete gasification of bituminous coal in a single vessel: the improvement which consists in maintaining a descending fuel bed at the top of which is uncarbonized coal and at the bottom of which is coke immediately supporting the coal, establishing a bottom hot zone across the entire horizontal area of the coke by airblasting the coke from the bottom of the coke upward, establishing a second and upper hot zone in the coke immediately supporting the uncarbonized coal by applying to the coke a second independent airblast at that point, excluding the blast gas from the uncarbonized coal, then generating blue water gas by upwardly steam blasting the coke at the lower hot zone, passing the blue water gas thus formed upward through the upper hot zone whereby the blue water gas is highly heated, and then passing the highly heated blue water gas upward through the superimposed coal to effect its carbonization to coke.

1,751,117

MANUFACTURE OF COMBUSTIBLE GAS CONTAINING HYDROGEN AND CARBON MONOXIDE

Gustav Wietzel, Ludwigshafen-on-the-Rhine, Germany, assignor to I.G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany, a corporation of Germany.

Mar. 18, 1930; application filed Sept. 17, 1925, Serial No. 57,041; 4 claims.

1. An exothermic process for manufacturing a gas rich in hydrogen and carbon monoxide, which comprises gasifying powdered solid carbonaceous fuel by reacting on the fuel with a gas containing substantially all free oxygen.

1,751,502

PROCESS OF MAKING UNCARBURETED WATER GAS


Mar. 25, 1930; application filed July 6, 1929, Serial No. 41,783; 2 claims.

1. A three-cycle process of making uncarbureted water gas; one cycle consisting in air blasting the fuel bed of a single gas generator containing a bed of solid fuel and passing the resulting blast gases through a heat interchanger, whereby the heat interchange is highly heated; a second cycle consisting in making a forward steam run successively through the generator and the heat interchanger, the gas being withdrawn from the end of the heat interchanger remote from the generator; and the third cycle consisting of a backrun, comprising introducing water into the end of the heat interchanger remote from the generator, whereby steam is produced, passing said steam successively through the heat interchanger and through the fuel bed of the generator, and withdrawing the water gas generated during the backrun directly from the gas generator, and passing it directly to a place of storage or use.
GAS-MAKING PROCESS


Mar. 25, 1930; application filed June 22, 1929, Serial No. 570,367; 11 claims.

1. An improvement in the usual two-cycle process of making carbureted water gas, carried out in a plant comprising a single generator having a bed of solid fuel, a single carburetor and a single superheater, one cycle consisting in air-blasting the fuel bed of the generator and storing the resulting heat successively in the carburetor and superheater, a second cycle consisting in making a forward steam run successively through the fuel bed of the generator in an upward direction, then through the carburetor, and superheater, and withdrawing the resulting water gas directly from the superheater: the improvement which consists in making a third cycle in which steam is passed directly to the top of the fuel bed in the generator and the resulting water gas withdrawn directly from the bottom of the generator for storage or use.

BACKRUN METHOD OF OPERATING GAS PLANTS


Mar. 25, 1930; application filed Apr. 26, 1929, Serial No. 584,811; 7 claims.

1. The improvement in the process of making carbureted water gas, which consists in varying the water gas-making run by at intervals passing a mixture of combustible gas and steam successively through a single superheater, a single carburetor and through a solid fuel bed in a single generator whereby water gas is generated.
PROCESS FOR MAKING COMBUSTIBLE GAS

William W. Odell, New York, N.Y., assignor to Columbia Engineering and Management Corp., Cincinnati, Ohio, a corporation of Ohio.

June 3, 1930; application filed Mar. 4, 1927, Serial No. 172,756; 9 claims.

1. A process of generating gas, which gas is substantially free from suspended carbon resulting from hydrocarbon decomposition, which consists in introducing hydrocarbon gas into a mass of solid fuel heated to a degree sufficient to decompose the hydrocarbon gas, simultaneously introducing steam in an amount sufficient to effect substantially complete reaction with the hydrocarbon gas, thereby producing a gas comprising essentially hydrogen and carbon monoxide and in which the ratio of hydrogen to carbon monoxide is substantially from two to one to three to one.

METHOD OF MAKING WATER GAS

Thomas W. Stone, Fort Wayne, Ind., assignor to the Western Gas Construction Co., Fort Wayne, Ind., a corporation of Indiana.

July 22, 1930; application filed Oct. 24, 1923, Serial No. 670,572; 5 claims.

1. In a method of making water gas from a bed of fuel in a gas generator that involves heating a portion of the fuel bed to a temperature at which ash of the fuel fuses, the steps comprising: Air blasting the fuel bed to heat it up; passing steam therethrough and thereby forming water gas; maintaining in the bottom of the fuel bed a zone of high heat but below that at which ash thereof will become fused therein and subjected said zone to a continuous agitation to agitate the fuel and ash therein and to cause a gradual descent of the fuel through said fuel bed; continuously discharging ash and formed clinker from said agitating zone; and maintaining in a hotter zone, just above the agitation zone, the portion of the fuel bed that is heated to a temperature at which the ash fuses, so that ash and fuel from the hotter zone is subjected to the continuous agitating action of the agitation zone and large bodies of clinkers are prevented from forming during gradual descent of such ash and fuel in the upper portion of and through the relatively cooler agitating zone.

Fig. 1
1,771,133
PROCESS FOR MAKING PRODUCER GAS
John U. McDonald, Indianapolis, Ind.
July 22, 1930; application filed Jan. 15, 1923, Serial No. 612,750; 3 claims.
1. A process for making producer gas including feeding fuel in a continuous unbroken gravity-controlled column down through the top of a gas producer, admitting a supply of air to the top of said producer at points circumferentially of said fuel column at the entrance thereof into said producer, withdrawing the liberated gas through a centrally located offtake pipe substantially at the bottom of said producer, and rotating the offtake pipe for agitating the lower portion of the fuel bed in the producer.

1,776,876
MANUFACTURING WATER GAS
Fritz Winkler, Ludwigshafen-on-the-Rhine, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany, a corporation of Germany.
Sept. 30, 1930; application filed Sept. 27, 1923, Serial No. 665,221; 2 claims.
1. The process of manufacturing water gas in a generator having a bed of small-sized, incandescent, solid carbonaceous material, which comprises blowing air and steam through said material alternately with sufficient speed to establish a boiling action in the material, thereby causing gasification thereof by reaction between the incandescent material and the air and steam.
METHOD OF AND APPARATUS FOR GENERATING COMBUSTIBLE GAS AND COKE

Harry F. Smith, Dayton, Ohio, assignor to the Gas Research Co., Dayton, Ohio, a corporation of Ohio.

Nov. 18, 1930; application filed Sept. 9, 1922, Serial No. 587,675; 15 claims.

1. In the distillation of solid carbonaceous material, so as to generate a combustible gas and also produce coke, in which a substantially continuous charge of the material being distilled is maintained within a retort, the method which comprises blasting the outer zone of said charge of ignited material with air to incandescence to generate heat for raising the temperature of the contiguous central zone of said material to cause the driving off of the volatile constituents therefrom; and concomitantly blasting with steam the material within the central zone from which the volatile constituents have been evolved.
1,784,765
WATER-GAS PROCESS

Thomas W. Stone, Fort Wayne, Ind., assignor to the Western Gas Construction Co., Fort Wayne, Ind., a corporation of Indiana.

Dec. 9, 1930; application filed Nov. 22, 1929, Serial No. 676,308; 6 claims.

1. A method of making carbureted water gas, which consists in passing a blast of air vertically upward through a fuel bed in a single water-gas generator, thereby forming airblast gas and passing the airblast gas in independent streams to and burning it in separate compartments of a single shell carburetor and a single shell superheater by admitting secondary air thereto; then discontinuing such passage of air; then passing a flow of steam successively through a compartment of the superheater; a compartment of the carburetor and upwardly through the fuel bed of the generator to make water gas, and passing the water gas from the top of the generator successively through another compartment of the same carburetor and enriching the water gas with oil therein and through another compartment of the same superheater to fix the gas therein; discontinuing such flow of steam and passage of gas and, before again reheating the single generator and the compartments of the single carburetor and superheater, passing a flow of steam successively through the compartments of the superheater and carburetor that were just used for fixing and enriching the water gas and thence downwardly through said fuel bed to make water gas, and passing the water gas from the bottom of the generator successively through the compartments of the carburetor and superheater through which steam was previously passed to the generator and enriching with oil in the carburetor and fixing in the superheater the water gas while flowing therethrough.

1,785,519
MANUFACTURE OF COMBUSTIBLE GAS

Henry O. Loebell, New York, N.Y., assignor to Henry L. Doherty, New York, N.Y.

Dec. 16, 1930; application filed June 29, 1921, Serial No. 481,195; 13 claims.

1. In the process of making water gas in which a gas-making zone in a fuel bed is blasted in alternate periods of time with air and steam, the improvement, which comprises introducing water into a vaporizing zone during the steam-blast period, in which zone the water is substantially instantaneously converted to steam, supplying the resulting steam to the gas-making zone during said steam-blasting period, and automatically decreasing at a predetermined time-controlled rate the supply of water to said vaporizing zone during said steam-blasting period thereby to maintain a substantially constant excess of steam in the water gas leaving the gas-making zone.
MANUFACTURE OF COMBUSTIBLE GAS
Henry O. Loebell, New York, N.Y., assignor to Henry L. Doherty, New York, N.Y.
Feb. 3, 1931; application filed Mar. 15, 1924, Serial No. 699,419; 19 claims.
1. A method of making water gas, comprising passing fuel downwardly in an unobstructed column of circular cross section through a gas-generating zone, maintaining high temperatures in said gas-generating zone by periodically blasting air in a substantially radial direction through incandescent fuel in said zone, passing steam through incandescent fuel in the high-temperature zone during periods following the periods of air blasting, and passing hot water gas thereby formed through fuel above said blast zone and advancing toward the same to preheat said fuel.

METHOD FOR TOTAL GASIFICATION OF WET BITUMINOUS FUELS
Hermann Hillebrand, Berlin-Friedrichshafen, Germany.
Feb. 3, 1931; application filed Sept. 3, 1924, Serial No. 735, 692; 1 claim.
1. A method for the total gasification of wet bituminous fuels, which comprises heating alternately operated regenerative chambers by burning a portion of recirculated gas, superheating a mixture of recirculated gas and steam in one of the heated regenerative chambers, passing the heated recirculated gas and steam upwardly into a gasification zone of a fuel bed and thereby regenerating water gas, passing a portion of the generated water and recirculated gas through a superposed distillation zone of the fuel bed and thereby distilling gases and vapors from the fuel, passing another portion of the generated water gas and recirculated gas in heat exchange with the wet fuel and to a collecting main, and recirculating the distillation gases and vapors through the regenerative chamber.
METHOD OF PRODUCING HEATING AND ILLUMINATING GAS


Feb. 10, 1931; application filed June 13, 1930; Serial No. 36,806; 6 claims.

1. The method of producing heating and illuminating gas, which comprises the heating of a mass of coal within a chamber to incandescence, said coal having iron or iron oxide in finely divided form mixed therewith, introducing a mixture of hydrogen and superheated steam into the said mass, simultaneously introducing additional coal into the said chamber, said coal having a small amount of finely divided iron oxide mixed therewith, and subjecting the gases within the said chamber for a period of time to steam pressure which may range from 30 to 300 p.s.i. to cause the hydrogen to combine with the carbon to form hydrocarbon gases.

GASIFICATION PROCESS

Edward A. Dieterle, Glen Ellyn, Ill.

Feb. 17, 1931; application filed Apr. 7, 1930; Serial No. 21,301; 1 claim.

A process of making mixed water gas and coal gas, which consists in providing a hot bed of solid carbonaceous fuel by intermittently blasting with air, causing steam to intermittently pass upwardly through said hot carbonaceous fuel, intermittently introducing powdered carbonaceous material above said hot fuel by causing the powdered material to pass downwardly through a vertically disposed retort located above the hot carbonaceous fuel and heated externally by the rising hot generated gases to effect distillation of the powdered material before it encounters said hot fuel and the generated blue water gas, subjecting the resultant gases and entrained vapors to further fixing by passing the same through vertically arranged elongated heated passages disposed above the carbonaceous fuel bed and about said retort.
PRODUCTION OF COMBUSTIBLE GASES
Feb. 24, 1931; application filed Sept. 24, 1925, Serial No. 58,440; 3 claims.

1. The continuous process of producing combustible gas containing hydrogen and carbon monoxide substantially free from methane, hydrocarbons, and carbon dioxide, which comprises establishing a flow of a mixture of steam and oxygen, preheating said mixture in a preheating stage to a temperature always upwards of approximately 1,000° C., then passing said preheated mixture into and through one of two gasification chambers, feeding finely divided fuel into said chamber to contact and react with said preheated mixture and to generate gas at such intense temperatures as to contain hydrogen and carbon monoxide substantially free from methane, hydrocarbons and carbon dioxide, leading said hot generated gas from said first chamber to, into, and through a second chamber in an empty condition and then into and through a second preheating stage, withdrawing the resultant combustible gas from said second preheating stage, and effecting a reversal of flow of said mixture of steam and oxygen whenever the temperature thereof immediately prior to contact with said fuel tends to fall below approximately 1,000° C., and maintaining in the chamber which functions as the gasifying chamber, as a result of any such reversals of flow, a temperature of approximately 1,300° C.

GAS-PRODUCING APPARATUS
John Urban McDonald, Columbus, Ohio
Mar. 31, 1931; application filed June 13, 1925, Serial No. 36,904; 8 claims.

1. A gas-producing apparatus including a gas-producing chamber, a bonnet supported on said producer, a fuel feed pipe extending into said bonnet, and spaced apart from the walls thereof, said bonnet having an inturned flange between the walls of the bonnet and the feed pipe, and a damper ring seated upon said flange about the feed pipe, said flange and damper ring having openings therein in position to register with each other.
1,799,885
PROCESS OF GENERATING PRODUCER GAS
Louis Chavanne, Paris, France

Apr. 7, 1931; application filed Feb. 12, 1925, Serial No. 8,810; 7 claims.

1. A process of generating producer gases, which comprises blasting at the base of a fuel column a gaseous mixture preheated to above 200° C., containing a higher percentage of oxygen than air and regulated to develop a temperature of about 1,750° C. or more in the gases rising from the lower portion of the fuel bed, maintaining near the blasting level a fusion zone, and thereabove an extended zone of distillation at a low temperature, and collecting gases and entrained byproducts from the top of the distillation zone, and removing molten products from the base of the fuel column.

Fig 1

1,799,886
PROCESS FOR GASIFICATION OF SOLID FUEL
Louis Chavanne, Paris, France.

Apr. 7, 1931; application filed May 25, 1925, Serial No. 32,790; 12 claims.

1. A process of gasification of solid fuels by way of melting ashes, which comprises introducing the fuel lumps of the charges at the top of the fuel column, blasting at the bottom of the column a fluid mixture containing free oxygen, maintaining a thin zone of fusion where ashes are melted and an extended zone of distillation at relatively low temperatures, separately introducing fuel dust in the zone of fusion, collecting gases and products carried by said gases, and removing molten products.
1,801,857
PRODUCING COMBUSTIBLE GASES
Wilhelm Gaus and Wilhelm Wild, Ludwigshafen-on-the-Rhine, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany, a corporation of Germany.
Apr. 21, 1931; application filed Nov. 3, 1923, Serial No. 672,643; 2 claims.
1. The production of combustible gas, which comprises passing a gasifying medium first around the walls of an electric arc space, then through the latter thereby preheating the gas, and then through solid incandescent carbonaceous material, whereby a combustible gas is generated by gasification of the carbonaceous materials.

1,803,686
GAS PRODUCTION
Charles W. Andrews, Duluth, Minn., assignor of one-half to Herman A. Brassert, Chicago, Ill.
May 5, 1931; application filed Nov. 23, 1923, Serial No. 676,478; 2 claims.
1. The process of raising the calorific value of a hot gas containing a considerable proportion of carbon dioxide, which consists in superheating the gas by passing it through a regenerator, then passing the hot gas through a zone of coke and ash at a high temperature, next through a zone of coke at a higher temperature, and then through a zone of bituminous coal, the passage of the gas serving to distill and to coke the coal in said last zone and thereby enrich the heating gas with the distillation products, and agitating the last-named fuel zone during the passage of the gas.
METHOD OF MAKING WATER GAS

June 2, 1931; application filed Apr. 3, 1924, Serial No. 703,893; 2 claims.

1. In the process of manufacture of water gas by alternate air and steam blasting periods, the improvement which consists in providing two separate fuel beds of bituminous fuel in two intercommunicating water-gas generators, hot air blasting from the top part of the fuel bed in one generator to the top portion of the other fuel bed in the second generator and from the bottom part of the fuel bed in the first generator to the bottom part of the fuel bed in the second generator, thereby evolving volatile matter in the fuel bed in the first generator, and introducing secondary air between the fuel beds to burn the volatile matter and thereby facilitate the carbonization of raw fuel and to store heat in the fuel bed in the second generator, and then generating water gas by steam blasting the heated fuel beds.

PROCESS OF PRODUCING MIXED WATER GAS AND COAL GAS

June 2, 1931; application filed Feb. 23, 1927, Serial No. 170,365; 2 claims.

1. A process for producing a mixture of water gas and coal gas of uniform quality from bituminous fuel in a plant comprising an “up” and “down” steam run shaft gas generator with a water gas-generating zone and superimposed coal distillation zone, and a coal-carbonization retort in a detached shell; said process consisting in passing an air blow upwardly through the water gas-generating zone of said generator, passing the resulting air-blow gases directly from said water gas-generating zone into external heating relation to said retort, then alternately passing steam up and down through the gasification zone to generate water gas, enriching both the “up run” and the “down run” water gases from said gasification zone by passing the “up run” water gases through the fuel distillation zone in the shaft of said generator and simultaneously adding superheated steam at the base of the distillation zone, then passing the “down run” water gases through said externally heated carbonization retort, mixing the thus enriched “up run” gases with the thus enriched “down run” gases to produce a rich combustible gas mixture, and passing coke from said detached carbonization retort into the shaft of said generator.
1,814,580

METHOD FOR MAKING PRODUCER GAS

July 14, 1931; application filed Oct. 31, 1925, Serial No. 53,940; 3 claims.

1. The method of making producer gas, which comprises admitting mixtures of air and gases containing a substantial quantity of carbon dioxide gases, said gases being capable of forming more combustible gases through endothermic reactions in a highly heated deep fuel bed, said admissions being alternately from the top and bottom of a gas producer, the periods of alternation being so timed as to cause the sensible heat of the outgoing gases to be largely transferred to the incoming gases, and continuously breaking up and removing mechanically the ashes and clinkers which form.

1,819,838

MANUFACTURE OF CARBURETED GAS
Albert W. Grant, Jr., Wilmette, Ill., assignor to the Koppers Co., Pittsburgh, Pa., a corporation of Pennsylvania.

Aug. 18, 1931; application filed Jan. 22, 1925, Serial No. 3,973; 10 claims.

1. The process of manufacturing carbureted producer gas, which comprises continuously blasting a bed of incandescent solid carbonaceous fuel with a mixture of an oxygen-containing gas and steam, burning a portion of the gas thereby produced, then introducing a liquid hydrocarbon in a separate chamber to at least a portion of the gas thereby produced, and employing said combustion to furnish the heat required for the permanent volatilization of the liquid hydrocarbon and the consequent enrichment of the gas, the portion of the gas burned being such as to supply sufficient heat for said volatilization and enrichment.
METHOD OF MANUFACTURING MIXED WATER GAS AND OIL GAS

Charles W. Andrews, Duluth, Minn., and Herman A. Brassert, Chicago, III., assignors to H. A. Brassert & Co., Chicago, Ill., a corporation of Illinois.

Sept. 1, 1931; application filed Aug. 18, 1926, Serial No. 129,866; 2 claims.

1. The method of manufacture of mixed water gas and oil gas which comprises utilizing a plurality of generators having solid fuel beds therein, agitating the fuel bed in one generator and making water gas therein, gasifying liquid hydrocarbons, in a second generator, carrying out said gasified liquid hydrocarbons with said gas made in the second generator, mixing the gases made in the first and second generators, and passing the mixed gas directly through a superheater to fix the volatiles therein.

PROCESS OF MANUFACTURING GAS


Sept. 8, 1931; application filed Dec. 14, 1925, Serial No. 75,231; 2 claims.

1. The process of manufacturing carbureted water gas which, when practiced in a single generator adapted to contain a descending column of fuel having coal at its upper end and coke at its lower end, a single carburetor and a single superheater, comprises a number of successive steps; the first step is air blast gas the coke at the bottom of the column of fuel, leading off blast gases from a point beneath the coal in said column, and burning gases in the carburetor in the superheater to store heat therein; the second step in passing steam through the superheater and through the carburetor and through the entire fuel column in a direction opposite to the movement thereof forming water gas on the passing through the coke; the third step comprises recirculating a portion of the gas produced in the fuel column together with additional steam through the superheater and carburetor and through the entire fuel column in a direction opposite to the movement of the fuel column; the fourth step is passing saturated steam through the coke and through the coal in a direction opposite of the movement of the fuel column; and the fifth step is introducing saturated steam to the fuel column at a point adjacent the middle thereof and passing it through the coke in the direction of the movement of the fuel column thereby generating blue water gas, passing the water gas through the carburetor, carbureting the gas in the carburetor, then passing through the superheater, and storing the carbureted water gas.
PROCESS OF MANUFACTURING WATER GAS

Walter M. Russell, Wellesley, Mass., assignor to The Gas Machinery Co., Cleveland, Ohio, a corporation of Ohio.

Oct. 13, 1931; application filed Apr. 18, 1925, Serial No. 24,626; 5 claims.

1. A process of making carbureted water gas in a set comprising a single generator having a solid bed of fuel, a single carburetor having checkerbrick therein, and a single superheater having checkerbrick therein, which process comprises air blasting the fuel bed, burning the blast gases, and heating the checkerbrick in the carburetor and superheater, then passing steam through highly heated fuel bed in the generator and generating water gas, passing the water gas through the carburetor and enriching the water gas by adding oil thereto, passing the enriched water gas to the lower portion of the superheater and fixing the oil vapors mixed with the water gas, withdrawing the carbureted water gas from an intermediate portion of the superheater, then admitting water to the heated checkerbrick in the upper portion of the superheater above the intermediate gas oftake, passing the steam generated in the upper portion of the superheater downwardly therethrough, through the carburetor and through the heated fuel bed in the generator, and withdrawing the resulting water gas directly from the generator.

PROCESS FOR PRODUCING FUEL GAS AND CARBONIZED COAL


Oct. 20, 1931; application filed Feb. 16, 1923, Serial No. 619,375; 14 claims.

1. A method of producing fuel gas and carbonizing coal which comprises continuously blastng solid carbonaceous fuel with air and thereby forming hot producer gas, passing the hot producer gas formed downwardly through stationary bodies of coal in retorts and thereby carbonizing the coal therein, withdrawing gases and vapors from the bottom of the retorts, diverting the course of the hot producer gas from the producer through coal in a second set of retorts after the coal in the first set of retorts has been carbonized, quenching the carbonized coal with steam and discharging the same, recharging the retorts of the first set while the coal of the second set of retorts is being carbonized, passing the quenching gases from the retorts into the producer fuel body and thereby generating water gas, and passing the hot water gas from the producer through the coal in said second set of retorts.
1,829,767

PROCESS FOR THE MANUFACTURE OF CARBURETED WATER GAS

Thomas W. Stone, Fort Wayne, Ind., assignor to the Western Gas Construction Co., a corporation of Indiana.

Nov. 3, 1931; application filed Oct. 13, 1927, Serial No. 225,881; 4 claims.

1. The process of manufacturing carbureted water gas which, when carried out in an apparatus comprising a single generator having a bed of solid fuel, a single carburetor, a single superheater, a regenerator containing a body of refractory and heat-accumulative material contiguous to and connected with the base of the generator, and a gas offtake seal connected to said superheater and said regenerator, comprises: First, air blasting the generator fuel bed to heat the same, conducting the resultant gas through said carburetor and superheater and burning it therein to heat the same; subsequently passing steam back through said superheater and carburetor and then downward through said generator fuel bed, conducting the hot backrun water gas thereby produced through said regenerator to heat the same and cool said gas, and withdrawing said backrun gas through said gas offtake seal at intervals subsequent to said air-blasting period and said back-steaming period passing steam through said thereby heated regenerator, conducting the thereby preheated steam upward through said generator fuel bed, conducting resultant uprun water gas through the heated carburetor and superheater and carbureting it during its passage through said carburetor and superheater by introducing oil thereto in said carburetor and withdrawing the thereby carbureted uprun water gas through said gas offtake seal; and substantially continuously removing ash from said fuel bed at a rate corresponding to the rate at which ash is formed by the action of said air and steam upon said fuel bed; whereby heat carried out of the generator fuel bed by said air and said uprun water gas is recovered and returned to said fuel bed by said backrun steam, and sensible heat carried out of the generator fuel bed by said hot backrun water gas is recovered and returned to said generator fuel bed by said uprun steam, and the bottom of said fuel bed is maintained in a highly heated condition facilitating the substantially continuous removal of ash therefrom, without sacrifice of thermal economy.
1,840,649

PROCESS OF PRODUCING FUEL GAS
Fritz Winkler, Carl Messerknecht, and Paul Feiler, Ludwigshafen-on-the-Rhine, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany, a corporation of Germany.

Jan. 12, 1932; application filed Mar. 26, 1927, Serial No. 178,737; 3 claims.

1. The process of manufacturing fuel gas in a generator having a bed of small-sized, incandescent, solid carbonaceous fuel, which comprises blowing a gasifying medium through said material with sufficient speed to establish a boiling action of said material and simultaneously admitting a gasifying medium just above said fuel bed to assist said boiling action, thereby causing gasification of said material by reaction between said incandescent fuel and gasifying medium.

1,848,015

MANUFACTURE OF WATER GAS

Mar. 1, 1932; application filed Jan. 28, 1925, Serial No. 5,245; 4 claims.

1. The method of making water gas, which comprises intermittently blasting primary air through a bed of ignited fuel in a gas generator to raise its temperature to incandescence, preheating the blast air before introducing it into the fuel bed, burning the blow gases thereby formed within the generator, storing heat liberated by combustion of the blow gases in the upper portion of the fuel bed and in preheater and exhausting relatively cool products of combustion to the atmosphere, generating and superheating steam by absorption of heat from said preheaters and passing the superheated steam upward through the incandescent fuel bed between periods of air blasting and thereby generating water gas, superheating the water gas by absorption of heat stored in the upper layers of the fuel bed, and utilizing the heat in the superheated water gas for preheating the blast air of a subsequent cycle.
1,853,084
MANUFACTURE OF GAS
Apr. 12, 1932; application filed Mar. 1, 1928, Serial No. 258,161; 3 claims.
1. A method of producing mixed gases in a water gas-generating set having a solid fuel bed, heat-exchange chambers, a wash box, and an enriching chamber; which comprises air blasting the fuel bed in the gas-generating set, burning a portion of the generated air blast gases in the heat-exchange chambers, and withdrawing the products of combustion from the set, passing the remaining portion of the air blast gases through the heat-exchange chambers and washing the gases by passing through a body of liquid in the wash box, then enriching and cooling the gas by adding butane thereto in the enriching chamber, then discontinuing the air blasting, admitting steam to the heated fuel bed, and generating water gas, passing the water through the heat-exchange chambers, washing the water gas in the wash box, and enriching and cooling the water gas by adding butane thereto in the enriching chamber.

1,857,799
PRODUCTION OF WATER GAS
Fritz Winkler, Ludwigshafen-on-the-Rhine, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany, a corporation of Germany.
May 10, 1932; application filed June 26, 1926, Serial No. 118,849; 3 claims.
1. The process of producing water gas which comprises electrically heating a deep layer of small-sized coke from lignite, supported on a grate, by supplying an electric current to electrodes arranged within the layer of coke, and passing steam through the said layer with sufficient speed to establish a boiling action in the coke and thereby generating water gas.
1,860,138

METHOD OF MAKING WATER GAS

Walter M. Cross, Kansas City, Mo.

May 24, 1932; application filed July 5, 1928, Serial No. 290,418; 2 claims.

1. A continuous method of making combustible gas, comprising the steps of charging solid pulverized carbonaceous material to a stage of reaction with steam, said steam being heated to or above a predetermined temperature of reaction whereby hot gas containing carbon monoxide and hydrogen results, subsequently passing the hot gas into contact with a nickel catalyst whereby methane is formed from carbon monoxide and hydrogen, and automatically controlling the temperature of the gas entering the catalyst.

1,866,399

CONTINUOUS PROCESS FOR PRODUCING HIGH-HEATING-VALUE GAS

William L. De Baubre, New York, N.Y.

July 5, 1932; application filed July 9, 1927, Serial No. 204,445; 1 claim.

A process of making combustible gas, which comprises regularly admitting finely divided coal into the top of a gas-generating chamber of a gas producer, admitting oxygen to an intermediate portion of the gas-generating chamber, admitting steam at the bottom portion of the gas-generating chamber, admitting oil at the upper portion of the gas-generating chamber to enrich the generated gas, and automatically controlling the admission of the oxygen and steam by the temperature in the gasification zone in the gas-generating chamber.
1,867,102

PROCESS OF MAKING WATER GAS

Walter M. Russell, Wellesley, Mass., assignor to The Gas Machinery Co., Cleveland, Ohio, a corporation of Ohio.

July 12, 1932; application filed Sept. 4, 1928, Serial No. 203,745; 11 claims.

1. A process of making carbureted water gas in a set comprising a single generator having a solid fuel bed including an upper coal-carbonizing zone and a lower gas-generating zone, a single carburetor having checkerbrick therein, and a single superheater having checkerbrick therein; which process comprises a special cycle of steps and a regular cycle of steps following said special cycle; said special cycle comprising air blasting the lower zone only of the fuel bed, burning the blast gases, and heating the checkerbrick in the carburetor and superheater, then passing steam through the highly heated lower zone only of the fuel bed and generating water gas, passing the water gas through the carburetor and the lower portion of the superheater, withdrawing the water gas from an intermediate portion of the superheater then passing steam through the upper zone of the fuel bed and withdrawing the resulting gas directly from said upper zone and from the generator, then admitting aqueous fluid to the heated checkerbrick in the upper portion of the superheater above the intermediate gas offtake, passing steam downwardly through the superheater, through the carburetor, and through the fuel bed in the generator, and withdrawing the resulting gas directly from the generator; and said regular cycle comprising air blasting the lower zone only of the fuel bed, burning the blast gases, and heating the checkerbrick in the carburetor and superheater, then passing steam through the highly heated lower zone only of the fuel bed and generating water gas, passing the water gas through the carburetor, and enriching the water gas by adding oil thereto, passing the enriched water gas to the lower portion of the superheater, and fixing the oil vapors mixed with the water gas, withdrawing the carbureted water gas from an intermediate portion of the superheater, then admitting aqueous fluid to the heated checkerbrick in the upper portion of the superheater above the intermediate gas offtake, passing steam downwardly through the superheater, through the carburetor, and through the fuel bed in the generator, and withdrawing the resulting gas directly from the generator.
1,869,949
A PROCESS FOR GASIFYING AND DISTILLING COAL DUST
Aug. 2, 1932; application filed July 23, 1926, Serial No. 124,536; 7 claims.
1. In a process for gasifying and distilling coal dust, wherein the coal in
the form of dust or fine granules is driven through a heated gasifying
chamber in an ascending current of gas and is thereby distilled and par-
tially gasified, a quantity of oxygen insufficient for complete combustion
being employed; the improvement which comprises so regulating the gasi-
fication that an ungasified portion of incandescent coal dust is carried along
with the current of gas, withdrawing combustible gas and a portion at least
of the incandescent fuel from the upper portion of the gasifying chamber,
separating the incandescent fuel from the gas, and continuously introduc-
ing a portion at least of said fuel dust, after separation from the current
of gas, together with fresh coal dust into the lower portion of the gasifying
chamber.

Fig. 2.

1,872,883
PROCESS OF MANUFACTURING GAS AND CARBONIZED FUEL
John F. Byrne, Pittsburgh, Pa., assignor to the Koppers Co., Delaware, a corporation
of Delaware.
Aug. 23, 1932; application filed June 21, 1928, Serial No. 287,193; 4 claims.
1. The process of manufacturing water gas and carbonized fuel in a water-
gas generator having a bed of solid carbonizable fuel, which comprises al-
ternately heating said fuel bed by blasting it with air and generating water
gas by passing steam through the thereby heated fuel bed, maintaining said
fuel body by introducing to it while suspended in steam passed through
the same sufficient finely divided solid carbonizable fuel to provide an ex-
cess over that amount required for the combustion and gasification reac-
tions which are set up in said fuel bed by said air and steam, and remov-
ing from the generator fuel bed solid fuel in carbonized form.

PART I—UNITED STATES PATENTS
PROCESS FOR PRODUCING WATER GAS FROM PULVERIZED COAL AND STEAM

Hermann, Hillebrand, Berlin, Germany.
Aug. 23, 1932; application filed Aug. 30, 1928, Serial No. 303,866; 2 claims.

1. A method of continuously producing water gas from pulverized coal or coke and steam, consisting in passing steam and a mixture of part of the produced water gas with pulverulent coal or coke to a hot regenerator, producing water gas in said regenerator which thereby serves also as a generator, passing a part of the produced water gas to a regenerator temporarily not producing gas, passing off the remainder of the produced water gas from the space between said regenerators, passing combustion air to said latter regenerator and heating the latter regenerator by combustion of the gas therein until such time as the latter regenerator is sufficiently heated, and then reversing the direction of flow by introducing the material into the second-named regenerator to form water gas and heating the first-named regenerator by causing combustion therein of part of the gas produced in the second-named regenerator.

PROCESS FOR HEAT TREATING COAL

Oct. 18, 1932; application filed Nov. 19, 1928, Serial No. 320,364; 5 claims.

1. The processing of coal including the production of combustible fluids therefrom, which comprises combining superheated steam and pulverized coal in a fuel fire-heated conduit, generating low-pressure steam by the heat in the hot products from said conduit, then compressing said low-pressure steam for use in said conduit, and collecting said combustible fluids.
1,901,170
GASIFICATION OF CARBONACEOUS MATERIAL
Lewis C. Karrick, Salt Lake City, Utah.
Mar. 14, 1933; application filed Oct. 29, 1926, Serial No. 144,947; 3 claims.
1. A continuous process for producing water gas from material such as coal, coke, and the like, which comprises preheating granular particles of said material in a chamber, periodically delivering material from the preheated chamber into a second heating chamber which is maintained under pressure, and thereafter continuously discharging said material from the second chamber and passing the same at high pressure by means of steam in a generally downward direction through an externally heated tube of extended length and of restricted cross section at a temperature and period of time sufficient to effect substantially gasification of the carbon constituent of the material, the material while being heated in the preheating chamber being maintained under the working pressure of the second chamber by the medium maintaining pressure therein.

1,913,237
CONTINUOUS WATER-GAS GENERATION
Hermann Hillebrand, Berlin, Germany
June 6, 1933; application filed Aug. 21, 1929, Serial No. 887,997; 5 claims.
1. A method of producing water gas from fuel in finely divided condition in continuous operation in a reaction chamber having no solid-fuel bed, which comprises heating up alternately one of two regenerators by burning gas and air in the one generator and superheating steam in the other generator, injection fuel in finely divided condition into the reaction chamber, admitting superheated steam to the fuel upon its entry into the reaction chamber, admitting additional superheated steam to the current of superheated steam and water gas generated by reaction of steam and part of the fuel, this current carrying the finely divided fuel in state of suspension along with it, at a plurality of points along the initial course of this current in the reaction chamber, and gasifying the fuel.
1,913,395
UNDERGROUND GASIFICATION OF CARBONACEOUS-MATERIAL-BEARING SUBSTANCES

Lewis C. Karrick, New York, N.Y.

June 13, 1933; application filed Nov. 14, 1929, Serial No. 607,924; 12 claims.

1. Process of gasifying solid carbonaceous deposits underground which comprises forming a passage communicating with a deposit, forming another passage within the deposit in communication with and extending from the first mentioned passage by removing a substantial portion of the material in the deposit, effecting a breaking down of the walls of the second passage to an extent where the passage is substantially filled with loosely piled lumps of the material passing reacting gaseous medium into said lumps filled passage at sufficient temperature to react chemically with the carbon for effecting formation of gas from the carbon in heat-exchange relation with the gaseous medium, and conducting the gases from the deposit.

1,913,968
FUEL GAS

Fritz Winkler, Ludwigshafen-on-the-Rhine, Germany, assignor to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany, a corporation of Germany.

June 13, 1933; application filed Jan. 8, 1929, Serial No. 331,005; 4 claims.

1. In the production of fuel gas in a generator having a primary and a large secondary gasification zone from coal having a size ranging from that of particles of dust up to that of nuts, by gasification by means of a gasifying agent blown through the said coal while ignited at such a rate that the particles thereof continuously eddy up and down in such a manner that the ignited coal presents the appearance of a boiling liquid, the step of directly passing the crude fuel gas thus obtained together with the dust particles contained therein through the large secondary gasification zone maintained at a temperature of about 1,000° to 1,100° C., admitting only a further supply of a gasifying agent to the said secondary gasification zone and reacting said gasifying agent with said dust particles while maintaining the dust particles and gasifying medium in contact for a longer period of time than contact is maintained between the fuel and gasifying medium in the primary zone.
1,918,739
GASIFICATION APPARATUS
William B. Chapman, Jackson Heights, N.Y.
July 18, 1933; application filed July 30, 1929, Serial No. 382,222; 3 claims.
1. An apparatus for gasifying fuel, having fire bed enclosing walls substantially symmetrically disposed with regard to a central vertical axis means for feeding air to an annular zone in the fire bed, a fuel underfeed device operating substantially concentrically with said axis for feeding fuel to the central portion of the fire bed, and an offtake pipe for low temperature distillates, also disposed substantially concentrically with regard to such axis, and leading downwardly from the central portion of the fire bed.

1,921,711
PROCESS OF PRODUCING WATER GAS
Paul Wangemann, Berlin, Germany.
Aug. 8, 1933; application filed Mar. 29, 1929, Serial No. 351,074; 3 claims.
1. A process for producing water gas comprising heating carbonaceous fuel on a bath of molten sodium chloride to the temperature of said bath and introducing steam into the said heated fuel, whereby water gas is produced.
1,922,018
CARBURATED WATER-GAS METHOD
Edwin L. Hall, Philadelphia, Pa., assignor to The United Gas Improvement Co.,
Philadelphia, Pa., a corporation of Pennsylvania.
Aug. 8, 1933; application filed Nov. 28, 1930, Serial No. 498,502; 2 claims.
1. A method of generating carbureted water gas in a solid fuel bed containing an oil residue in a water-gas generator for the manufacture of carbureted water gas, which includes air blasting the fuel bed upwardly from the bottom, introducing secondary air marginally adjacent the upper edge of the fuel bed, introducing other secondary air to the center of the top of the fuel bed, burning the blast gases, and consuming, at least partially, any oil residues with the secondary air so introduced, and thereby heating the entire top of the fuel bed to incandescence, then alternately passing steam through the incandescent fuel and generating water gas, and simultaneously carbureting the water gas by spraying heavy oil on the upper surface of the highly heated marginal portion.

1,923,540
GAS-MAKING PROCESS
Alfred Johnson, West Brighton, N.Y., assignor to Combustion Utilities Corp.,
New York, N.Y., a corporation of Maine.
Aug. 22, 1933; application filed June 19, 1932, Serial No. 372,112; 19 claims.
1. The process of producing a combustible gas and concurrently carbonizing fuel in relatively thin stationary layers which comprises passing a fluid through an incandescent fuel bed and concurrently passing the resultant highly heated gases in indirect heat-exchange relation with a column of fuel arranged in a thin annular layer adjacent to and out of direct contact with the said fuel bed, the said hot gases serving to supply at least a portion of heat for carbonizing the said fuel.
CONTINUOUS GAS MANUFACTURE
Oswald Heller, Berlin, Germany.
Aug. 29, 1933; application filed Mar. 23, 1932, Serial No. 600,665; 3 claims.
1. A continuous method of producing a combustible gas which comprises mixing steam, powdered carbonaceous fuel, and a substance of the group consisting of water gas, double gas, and illuminating gas, heating such mixture to substantially 1,000° C., adding oxygen to such mixture, causing the substances to react, and removing the products of the reaction.

COAL AND WATER GAS PROCESS
Theodor Lichtenberger, Stuttgart, Germany
Sept. 5, 1933; application filed Apr. 5, 1929, Serial No. 352,878; 1 claim
A process for distilling coal and gasifying coke by injecting steam into the fuel in a single operation, which consists in exposing the fuel in the form of a descending column in a water-gas generator to the radiating heat of a molten salt bath which is soluble in water.
PROCESS FOR MAKING COMBUSTIBLE GAS
William W. Odell, New York, N.Y., assignor to Columbia Engineering & Management Corp., New York, N.Y., a corporation of Ohio
Oct. 10, 1933; application filed Apr. 11, 1930, Serial No. 44,878; 6 claims.
1. In the process of making combustible gas, which gas is substantially free from suspended carbon resulting from hydrocarbon decomposition, the steps which comprise introducing a mixture of steam and a hydrocarbon gas comprising chiefly propane and butane into a highly heated fuel bed thereby producing a gas comprising essentially hydrogen and carbon monoxide in which the ratio of hydrogen to carbon monoxide is substantially from two to one to three to one, and enriching the resulting gas by at least partially reforming therein in a chamber containing refractory material hydrocarbons which are liquid at normal temperatures and pressures.

PROCESS OF MAKING COMBUSTIBLE GAS
William W. Odell, New York, N.Y., assignor to Columbia Engineering & Management Corp., New York, N.Y., a corporation of Ohio
Oct. 10, 1933; application filed May 22, 1930, Serial No. 45,706; 4 claims.
1. The method of making combustible gas which consists of air blasting an ignited fuel bed with air to bring it to incandescence, discontinuing said air blasting, separately introducing a hydrocarbon into a stream of superheated steam, causing said steam and hydrocarbon to become thoroughly mixed and simultaneously heated to a temperature above 1,000° F., and introducing the heated gaseous product into the incandescent fuel bed from above it, removing the resulting gas from beneath it; the gas generated having a hydrogen to carbon monoxide ratio from about two to one to three and one-half to one, and being substantially free from suspended carbon resulting from pyrolysis of said hydrocarbons.
1,938,139

METHOD OF PRODUCING COMBUSTIBLE GAS

Sven Carl G. Ekelund, Stockholm, Sweden

Dec. 5, 1933; application filed Sept. 15, 1927, Serial No. 219,778; 4 claims.

1. A process of continuously generating producer gas from solid fuel, said gas having a temperature over 1,000° C. and composed essentially of carbon monoxide; hydrogen and nitrogen in the ratio of more nitrogen than carbon monoxide; which comprises injecting hot air into a lower coke zone in a gas producer and thereby generating producer gas and forming molten slag passing a portion of the hot producer gas into a superposed fuel preheating and distillation zone and preheating and coking the fuel therein, withdrawing the mixed producer gas and distillation vapors and gases, then passing the mixture together with air into the incandescent coke zone and decomposing and fixing the vapors into gas, withdrawing the hot producer gas from the upper part of the incandescent zone and from below the superposed preheating and distillation zone, and withdrawing molten slag from the lower portion of the incandescent zone.

Fig. 1.

1,939,018

PROCESS OF MAKING OXIDATION PRODUCTS

William W. Odell, Pittsburgh, Pa.

Dec. 12, 1933; application filed Nov. 22, 1929, Serial No. 409,194; 23 claims.

1. Process of making oxidation products from oxidizable matter by combustion in an internal-combustion engine, comprising admitting said oxidizable matter and an amount of an oxidizing agent insufficient for its complete combustion, into the combustion chambers of said engine, igniting the mixture, causing combustion to occur therein with the formation therein of incompletely oxidized products other than water and the oxides of carbon, removing said products from said engine in the exhaust gas, immediately cooling said gas, and recovering at least one of them separate from the other components of said exhaust gas.
1,939,498

PROCESS FOR GASIFYING FINELY DIVIDED SOLID AND LIQUID FUELS
Franz Herzberg, Leisnig, Germany
Dec. 12, 1933; application filed Dec. 16, 1930, Serial No. 502,839; 11 claims.
1. A process of continuous gasification in an externally heated chamber the size of usual coke-oven chambers, which comprises injecting finely divided fuel into such a chamber, injecting steam into said chamber in a direction opposed to the flow of fuel therethrough, thereby maintaining the fuel in suspension, and withdrawing rich gas from the upper part of the chamber and water gas and ash from the lower part of the chamber.

1,947,792

PROCESS OF MAKING CARBURETED WATER GAS
Gerald J. Nordmeyer and Thomas W. Stone, Fort Wayne, Ind., assignors to The Koppers Co., Delaware, a corporation of Delaware, and to The Western Gas Construction Co., a corporation of Indiana
Feb. 20, 1934; application filed May 16, 1931, Serial No. 537,968; 7 claims.
1. The process of manufacturing water gas which consists in alternately introducing an air blast and a steam run into the fuel bed of a gas generator, and admitting heavy oil into the top of the generator simultaneously with the steam run to enrich the resulting gas, said air blast being introduced in a reverse direction into the generator and downwardly through at least the upper portion of the fuel bed to consume carbonaceous deposits resulting from the admission of said heavy oil, and withdrawing the air blast from the generator at a point below the top of the fuel bed.
1,948,085
PRODUCER-GAS PROCESS USING SODIUM CARBONATE
Alfred H. White, Ann Arbor, Mich., and David A. Fox, Milwaukee, Wis.
Feb. 20, 1934; application filed Mar. 26, 1931, Serial No. 525,437; 2 claims.

1. The process of manufacturing fuel gas low in carbon dioxide from solid carbonaceous fuel in a gas generator which comprises mixing with a carbonaceous fuel less than 10 percent of its weight of a sodium compound which is capable of reacting with the fuel and evolving a continuous stream of the alkali metal vapor, forming said mixture into a fuel bed, igniting the mixture, and blasting it with air and steam so that a reaction zone is formed and CO, H₂, CO₂, and a substantial amount of alkali metal vapor shall be evolved, said alkali metal vapor reacting with carbon dioxide and blast steam remaining undecomposed forming carbon monoxide, and hydrogen with the formation of solid sodium carbonate, filtering out said solid carbonate by its passage through the upper part of said fuel bed and returning said solid carbonate to the reaction zone as the fuel descends through the generator, removing gas as produced, and regularly adding fuel together with additional sodium compound to the extent necessary to replace unavoidable losses thereof.

1,949,563
WATER-GAS PRODUCTION
William Vaughn Duke, Germantown, Pa., assignor to Carsten I. Johnsen, Floral Park, N.Y.
Mar. 6, 1934; application filed Nov. 9, 1928, Serial No. 318,241; 3 claims.

1. The method of manufacturing water gas which comprises the continuous internal heating of a number of spaced hollow bodies and utilizing the entraining action of a current of water gas to carry pulverized coal and steam in proper proportions to form water gas between said bodies and in contact therewith.
1,949,728

PROCESS FOR MANUFACTURING CARBURETED WATER GAS

Gerald J. Nordmeyer, Fort Wayne, Ind., assignor to The Koppers Co., Delaware, a corporation of Delaware

Mar. 6, 1934; application filed May 16, 1931, Serial No. 537,911; 3 claims.

1. The process of manufacturing water gas in an apparatus including a generator having a bed of solid fuel and a superposed carbureting chamber, which process consists in separately and successively passing air blasts and steam in opposite directions through said fuel bed, a portion of the blast in each direction being utilized for the purpose of driving residual gas resulting from a previous steam run into a collecting medium, admitting heavy oil into the carbureting chamber of said generator coincidently with the steam runs to enrich the made gas, and conducting said gas to said collecting medium, the major portion of the reverse air blast passing downwardly through the upper portion only of the fuel bed and thence being withdrawn circumferentially of the generator at a point below the top of said fuel bed, whereby the carbonaceous deposits on the fuel bed resulting from the admission of said heavy oil are consumed.

1,952,654

PROCESS OF MAKING BLUE AND CARBURETED WATER GAS

Hiram J. Carson, Cedar Rapids, Iowa

Mar. 27, 1934; application filed June 17, 1932, Serial No. 199,572; 17 claims.

1. An improvement in the method of manufacturing water gas, consisting in progressively air blasting a generator fuel bed to incandescence at vertically spaced levels in successive zones with the lowermost airblast level in the bottom zone of said fuel bed, and, mainly alternately, admitting steam to the fuel bed above the lowermost air-blast level, introducing fluxing material in bottom zone of said fuel bed, and discharging ash and clinker-forming material as liquid slag.
GAS GENERATOR FOR PULVERIZED FUEL

William B. Plummer, Jackson Heights, N.Y., assignor to Combustion Utilities Corp., New York, N.Y., a corporation of Maine

Apr. 3, 1934; application filed July 27, 1932, Serial No. 295,721; 14 claims.

1. In gas-generating apparatus, the combination of a horizontally elongated, upright wedge-shaped producer gas-generating chamber, means for injecting finely divided solid fuel and a fluid carrier therefor at a controlled rate into one end of said chamber, means for directing hot combustion-supporting gases at high velocity upwardly into said chamber through a narrow opening in the base thereof, means for removing gases formed from said chamber at a controlled slow rate through an offtake in the end of said chamber opposite the point of fuel injection, and means for controlling the temperature, composition, and velocity of said combustion-supporting gases.

PROCESS OF MAKING GAS

Harutyun G. Terzian, Philadelphia, Pa., assignor to The United Gas Improvement Co., Philadelphia, Pa., a corporation of Pennsylvania

Apr. 24, 1934; application filed Apr. 30, 1930, Serial No. 448,795; 16 claims.

1. The process of producing gas rich in hydrogen and substantially free from carbon black resulting from hydrocarbon decomposition which comprises periodically air blasting an ignited bed of fuel, between air blasting steps passing hydrocarbon gases therethrough and decomposing them to carbon and cracked gas consisting principally of hydrogen and methane, and retaining substantially all of the liberated carbon within the fuel bed and on the surfaces of the fuel for subsequent utilization of the carbon therein, preserving the porosity of the fuel bed by reducing the temperature of the surface of the fuel bed prior to the passage of the hydrocarbon gas sufficiently to cause methane contained in the original hydrocarbon gas and such methane as is produced by decomposition of higher hydrocarbons to be decomposed by contact with the surface of the fuel rather than in space in the gas mass.
1,961,464
CARBURATED WATER-GAS GENERATOR
Charles I. Tenney, Minneapolis, Minn.
June 5, 1934; application filed Jan. 12, 1931, Serial No. 508,830; 2 claims.
1. A carbureted water-gas set having, in combination, a unit comprising an enclosing wall having partition extending thereacross, forming chambers constituting respectively, a generator, a superheater, and a carburetor, arranged in order named, means connecting the top of said generator and the top of said carburetor, the partition between the carburetor and superheater having an opening in its bottom affording communication therebetween, an air conduit, means connecting said air conduit to the bottom of said generator for supplying air thereto, means connecting said air conduit to the bottom of the carburetor for supplying air thereto, a conduit leading from the top of the superheater, a wash box with which said conduit communicates, a steam-supply conduit for delivering steam into said latter conduit and back into the superheater, a conduit communicating with the bottom of said generator forming a gas offtake, a grate adjacent the bottom of said generator, and means for delivering steam to said generator below said grate.

1,963,167
METHOD OF AND APPARATUS FOR GENERATING WATER GAS FROM PULVERIZED FUEL
Max Heller, Charlottenburg, Germany
June 19, 1934; application filed Mar. 29, 1929, Serial No. 350,912; 6 claims.
1. A plant for generating gas from finely subdivided fuel, comprising a central tubular structure having two separate longitudinal passages, a series of spaced generating chambers surrounding said tubular structure and communicating with one of its passages, and a series of heating chambers located between said generating chambers and likewise surrounding said tubular structure and communicating with its other passage.
1,963,811

PROCESS FOR PRODUCING A MIXTURE OF OIL GAS AND WATER GAS
Harutyun G. Terzian, Philadelphia, Pa., assignor to The United Gas Improvement Co., Philadelphia, Pa., a corporation of Pennsylvania

June 19, 1934; application filed Nov. 8, 1928, Serial No. 317,907; 10 claims.

1. In a process of the manufacture of gas as practiced in a set comprising a generator adapted to contain a solid fuel bed, a carburetor, and a superheater, the following steps: Air blasting the fuel bed in the generator and burning the blast gases in the carburetor and in the superheater, thereby heating them; introducing a fluid hydrocarbon to the heated carburetor, and passing simultaneously the hydrocarbon gas, in part, through the incandescent fuel bed in the generator, thereby cracking it to reformed oil gas and the remainder through the superheater, thereby lightly cracking it by the heat stored in the superheater.

1,964,207

PROCESS OF MANUFACTURING PRODUCER GAS OF HIGH CALORIFIC VALUE
Karl Koller and Zaigmund Gálicsay, Budapest, Hungary

June 26, 1934; application filed Nov. 28, 1930, Serial No. 498,905; 4 claims.

1. Process of manufacturing producer gas of high calorific value in a continuous unidirectional flow, said process being carried out in two stages, the first stage comprising the burning of suitable fuel with oxygen and mixing the resulting flue gases with steam, thereby preheating the steam to approximately the temperature of the flue gases; the second stage comprising introducing the hot mixture without cooling, directly into the lower part of a column of incandescent solid fuel in a molten slag producer and withdrawing the resulting combustible gas from the upper part of the column.
1,964,299
PROCESS OF MANUFACTURING CARBURETED WATER GAS BY USE OF HIGH CARBON AND LOW CARBON OIL
Joseph A. Perry, Swarthmore, Pa., assignor to The United Gas Improvement Co., Philadelphia, Pa., a corporation of Pennsylvania
June 26, 1934; application filed Nov. 20, 1929, Serial No. 408,454; 3 claims.
1. A process of manufacturing carbureted water gas in a set comprising a generator adapted to contain a solid fuel bed, a carburetor, and a superheater, which comprises the following separate, successive steps: air blasting the fuel bed in the generator and storing the heat of the blast gases in the carburetor and in the superheater; making an uprun with steam introduced to the bottom of the generator, simultaneously introducing heavy carbon oil to the top of the fuel bed at a diminishing rate, and simultaneously introducing lower carbon oil to the carburetor at an increasing rate, and leading the water gas produced in the generator through the carburetor and through the superheater whereby carbureted water gas is produced.

1,964,877
APPARATUS FOR TREATMENT OF FUEL
Alfred J. A. Hereng, Paris, France
July 3, 1934; application filed July 15, 1930, Serial No. 468,036; 3 claims.
1. Apparatus for directly generating gas from solid fuel containing volatile matters, comprising a horizontal endless conveyer permeable to gases, a first chamber above a first part of the upper run of the said conveyer, said chamber being provided with a compartment for the inlet and the distillation of the fuel, said compartment being open at its bottom and provided in its upper part with an exit pipe for the distillation gases, a second chamber adjacent to the first chamber and arranged above the last part of the upper run of said conveyer, said second chamber being provided with means for gasifying substantially all the distilled fuel coming from the first chamber, a damper above the layer of distilled fuel between said chambers permitting the gases produced in the second chamber to pass through the layer of distilled fuel into the first chamber and surround and heat said compartment, and an exit opening for the removal of the gases from the first chamber.
1,966,886
WATER-GAS PROCESS
Frederick H. Dechant, Reading, Pa., assignor to Industries of America, Inc., a
corporation of Delaware
July 17, 1934; application filed Sept. 5, 1928, Serial No. 304,115; 3 claims.
1. In a method of producing gas from culm, the steps which consist in
igniting a body of the fuel, effecting partial combustion thereof, arresting
such combustion before a substantial amount of the ash content thereof
has fused, passing steam through the partially consumed fuel to produce
water gas, withdrawing most of the partially consumed fuel, and adding
fresh fuel to replace the fuel withdrawn.

1,967,013
RECOVERY OF WASTE HEAT IN WATER-GAS OPERATIONS
Frank W. Steere, Scarsdale, N.Y., assignor to Semet-Solvay Engineering Corp.,
New York, N.Y., a corporation of New York
July 17, 1934; application filed Nov. 17, 1928, Serial No. 320,089; 6 claims.
1. In an apparatus for recovering waste heat from hot gases, the combi-
nation of a flash boiler including a surface adapted to absorb heat from
the gases, means for delivering the gases to the boiler and for supplying
water thereto, means for maintaining a body of water, means for delivering
steam produced in the boiler beneath the surface of the water whereby
surplus heat carried by the steam is conserved, and means for recirculat-
ing water which is not converted into steam by initial contact with the
heated surface.
METHOD OF MAKING LOW-GRAVITY GAS

Albert F. Kunberger, Swarthmore, Pa., assignor to The United Gas Improvement Co., Philadelphia, Pa., a corporation of Pennsylvania

Aug. 28, 1934; application filed Mar. 2, 1930; Serial No. 344,023; 6 claims.

1. A method of making low-gravity combustible gas, which comprises the following steps: one step being, air blasting an ignited fuel bed producing blast gas, storing heat in a chamber by partial combustion therein of said blast gas with air, reducing iron oxide and heating the metallic iron by contact with said blast gas; another step being, generating hydrogen by passing steam in contact with the heated metallic iron thereby converting it into iron oxide, carbureting the newly made gas in said chamber by the addition to it of a hydrocarbon and passing it through said heated chamber; and another step being, generating water gas by steaming the fuel bed, and producing a low gravity gas by admixing the water gas and the carbureted gas.

MIXED OIL-GAS AND WATER-GAS PRODUCTION

Joseph A. Perry, Swarthmore, Pa., assignor to The United Gas Improvement Co., Philadelphia, Pa., a corporation of Pennsylvania

Aug. 28, 1934; application filed Mar. 2, 1930; Serial No. 344,072; 5 claims.

1. The process of making mixed water gas and oil gas, which process, when practiced in an intercommunicating generator and heat interchanger includes the following steps: one step being, providing an ignited fuel bed in the generator, air blasting the fuel bed in the generator and the heat interchanger in series, and burning the blast gas in the heat interchanger thereby heating said interchanger; another step being, simultaneously passing fluid hydrocarbon in two separate streams, one stream passing through the generator and fuel bed depositing carbon therein and the other stream passing through the heated heat interchanger, cracking said fluid hydrocarbon in said generator and in said heat interchanger, leading off the resulting gases separately from the generator and from the heat interchanger, and simultaneously introducing some of the gas from the generator to the said heat interchanger and passing it through the heat interchanger and out of the same.
1,977,684

PROCESSES OF PRODUCING WATER GAS
Charles E. Lucke, New York, N.Y., assignor to The Babcock & Wilcox Co., Bayonne, N.J., a corporation of New Jersey


1. In a process for producing water gas, the maintenance of an enclosed column of incombustible bodies constantly moving towards one end of the column, the commingling of solid carbonaceous fuel by delivering said fuel within the moving column while the stream of materials in the column is in a relatively contracted state, subsequently expanding the enclosed stream of the column in a chamber at a position beyond the positions of heating and commingling, passing steam countercurrently through the commingled materials in the stream of the column while it is expanding, continuously withdrawing water gas formed during the movement of the column, and returning the bodies of incombustible material to the entry end of the column after their movement past the position at which the water gas was formed.
1,983,943
PROCESS FOR CARBONIZING CARBONACEOUS MATERIALS
William W. Odell, Pittsburgh, Pa.
Dec. 11, 1934; application filed Dec. 17, 1929; Serial No. 414,709; 9 claims.
1. A process for the low-temperature carbonization of solid carbonizable material, which comprises blowing air through a layer of the said material substantially in granular form and of considerable depth at such a rate that the said layer is maintained in a state of motion such that the layer presents the appearance of a boiling liquid, the temperature of operation being at a carbonizing temperature, and withdrawing the carbonized residue.

Fig 1

1,984,380
PROCESS OF PRODUCING CHEMICAL REACTIONS
William Odell, Pittsburgh, Pa.
Dec. 18, 1934; application filed Dec. 17, 1929; Serial No. 414,710; 7 claims.
1. A process of producing vapor-phase chemical reactions in a gaseous fluid stream, comprising, passing a gaseous stream initially comprised of a plurality of gaseous fluids capable of chemically reacting with one another into contact with and upwardly through a confined layer of granular catalytic material of considerable depth at such a rate that said layer is maintained in a state of motion such that the layer presents the appearance of a boiling liquid, meanwhile maintaining the temperature of said material favorable for causing chemical reaction between said fluids, thereby forming chemical-reaction products essentially from said fluids by virtue of their intimate contact with said material, and withdrawing them in said stream.
PRODUCTION OF GASES POOR IN CARBON MONOXIDE
Franz Bössner and Carl Marischka, Vienna, Austria
Dec. 25, 1934; application filed Apr. 24, 1931, Serial No. 532,658; 1 claim.
A process for decreasing the CO contents of water gas and of gaseous mixtures containing water gas, which comprises providing a reacting mass consisting of ankerite within a chamber, passing the water gas together with steam through said reacting mass for transforming the CO contents of the water gas into CO₂, and intermittently heating said reacting mass to effect said transformation and the regeneration of the reacting mass, respectively.

LOW-GRAVITY CARBURETED WATER GAS
1. A process of manufacturing carbureted water gas in a set comprising a generator, carburetor and superheater, which process includes the following steps which are practiced in succession with heat stored by the air blast: air blasting the fuel bed and simultaneously burning the blast gases so produced with secondary air introduced adjacent the upper marginal edge of the fuel bed; making an uprun with steam through the generator; making an uprun with steam through the generator and carbureting the resulting blue water gas with a hydrocarbon in the carburetor; making an uprun with steam through the generator; introducing steam to the superheater, passing the resulting gas down through the generator and simultaneously introducing a hydrocarbon onto the fuel bed adjacent the upper marginal edge thereof; making a down run with steam through the generator; and making an uprun with steam through the generator.
1. The method of continuously making gas, wherein the gas-forming materials flash into chemical combination which comprises maintaining in one chamber a zone of combustion, and in an adjacent chamber a zone of moving gas-making materials, said zones communicating with each other through a gap whereby heat from the combustion zone acts in an unmuffled relation through the gap upon said materials (without substantial mixing of gases of combustion) into the made gases.
2,011,277
MANUFACTURE OF ENRICHED WATER GAS
Aug. 13, 1935; application filed May 4, 1932, Serial No. 609,286; 3 claims.
1. In the process of the manufacture of carbureted water gas, the following steps: upwardly air blasting an ignited fuel bed in a water-gas generator in the absence of secondary air, thereby causing the marginal portion of the upper part of the fuel bed to assume a higher temperature than does the central portion of the upper part of the fuel bed; and spraying tar onto the hot marginal portion of the fuel bed only, and gasifying the tar by means of the heat stored in the fuel bed.

2,033,511
METHOD FOR PRODUCTION OF CARBURETED WATER GAS
Hiram J. Carson, Omaha, Nebr.
Mar. 10, 1936; application filed Apr. 29, 1932, Serial No. 608,277; 12 claims.
1. The herein described process of manufacturing carbureted water gas which includes: blasting a bed of incandescent fuel with an oxygen-containing gas and, in alternate periods, admitting steam thereto; substantially completely burning the blast gases and thereafter passing the resultant products downwardly, first through a body of heat-absorbing material and then downwardly through a carbureting chamber; during the gas-making period, passing the generated water gas also downwardly first through said body of heat-absorbing material and then downwardly through the carbureting chamber; and, simultaneously with the passage of the water gas through the chamber, carbureting the water gas by projecting fluid-enriching agents countercurrent of and into the downwardly moving stream of water gas.
CONTINUOUS GAS-MAKING PROCESS

Mathias Fränkl, Augsburg, Germany, assignor to American Oxythermic Corp., New York, N.Y., a corporation of Delaware.

Mar. 31, 1936; application filed Aug. 2, 1936, Serial No. 472,553; 9 claims.

1. A process for the generation of gas which comprises forming two columns of coke having a communicating channel at their bases, introducing steam into the top of one of said columns previously heated to reaction temperature whereby gases are generated, passing the gases so generated through the communicating channel and thence upwardly through the second column of coke, withdrawing the gases from the top of said second column, alternately and periodically reversing in rapid sequence the flow of gases through said coke columns and maintaining the reaction temperature by partial combustion with a gas enriched in oxygen.

METHOD FOR MAKING GAS

Charles B. Hillhouse, Newport, R.I., assignor to Sylvia Remsen Hillhouse, New York, N.Y.

Apr. 28, 1936; application filed Oct. 4, 1930, Serial No. 486,330; 3 claims.

1. The method of producing gas which consists in feeding fuel for combustion in one direction throughout a zone concentric with the axis of a chamber, directing said fuel inwardly and then in a direction opposite to that of the fuel feed and burning the same to form an axial combustion zone extending in an opposite direction to the fuel feed, and feeding carbonaceous material and steam to be gasified along a helical path to surround the fuel feeding zone, and in direct marginal contact therewith whereby the heat from the axial combustion zone is transferred to the gas-making materials to convert same into a gas.
GAS GENERATOR EQUIPPED WITH ASH- REMOVAL MEANS

Apr. 28, 1936; application filed Apr. 9, 1935, Serial No. 353,749; 4 claims.
1. In combination with a gas generator having a grate therein for supporting a fuel bed thereon and provided with a discharge outlet below the grate, a conical member positioned below the grate with its vertex adjacent thereto and the base thereof provided with a trough leading into said discharge outlet and means to cause liquid to flow over the sides of said conical member into and through said trough and through said discharge outlet.

METHOD FOR PRODUCING GAS

Charles B. Hillhouse, New York, N.Y., assignor to Sylvia Remsen Hillhouse, New York, N.Y.
July 14, 1936; application filed Mar. 24, 1932, Serial No. 601,015; 4 claims.
1. The method of producing a combustible gas which comprises the steps of burning a fuel to produce an axial flame feeding continuously tangentially to said axial flame, a stream of gasifiable materials, directly communicating the inner zone of combustion with the outer zone of gasifying materials to heat the latter thereby, passing said materials at suitable velocity around said flame but spaced therefrom in a whirling stream and the chamber wall and deflecting the stream of materials at spaced points away from the axial flame to prevent mixing of flame and materials.
METHOD OF MANUFACTURING COMBUSTIBLE GAS

Hiram J. Carson, Cedar Rapids, Iowa.

Sept. 15, 1936; application filed July 15, 1929, Serial No. 378,256; 4 claims.

1. In the manufacture of combustible gas from bituminous fuel in apparatus including a gas producer having an upper carbonizing zone and a lower producer gas zone and two regenerators, the improvement which consists in air blasting the column of fuel in the lower portion of the producer gas zone, drawing off the producer gas formed thereby from the upper portion of the lower zone substantially without contact with the fuel in the carbonizing zone, burning a portion of the producer gas alternately in each of the regenerators, admitting steam alternately to each of the regenerators, passing the steam highly superheated therein from the regenerators to the lower portion of the carbonizing zone and thereby substantially blocking off admission of producer gas to the carbonizing zone, passing the steam through the carbonizing zone, drawing off the distillation gas liberated thereby and admixed therewith from the top of the upper zone, and drawing off ash and clinker-forming material as liquid slag.

TREATMENT OF GAS

Walter L. Shively, East Orange, N.J., assignor to The Koppers Co., of Delaware, a corporation of Delaware.

Sept. 22, 1936; application filed Aug. 19, 1931, Serial No. 557,994; 6 claims.

1. The process of treating fuel gas containing gum-forming compounds in gaseous phase, which comprises scrubbing the fuel gas with a solvent for gum-formers while in the liquid state and polymerizing gum-forming compounds occurring in the gas and in the spent solvent aforesaid by subjecting the gas and spent solvent in liquid state simultaneously to the influence of the same ionizing electrical discharge.
2,066,670

METHOD FOR MANUFACTURING GASES
Hiram I. Carson, Cedar Rapids, Iowa.

Jan. 5, 1937; application filed Oct. 31, 1936, Serial No. 492,457; 5 claims.

1. The hereindescribed improvement in the method of manufacturing water gas which includes: air blasting a generator fuel bed to incandescence by air admitted in the lower portion thereof; alternately with the air blasting, admitting steam and a restricted amount of air simultaneously and admixed to the fuel column in the lower portion thereof above the air-blast level for an up run and alternately thereof, steam to the portion of the fuel column for a down run; drawing off the up-run gases from the upper portion of the fuel column; drawing off the gas from the lower portion of the column; admitting air to the lower portion of the fuel bed during the up run of steam and in an amount restricted such that the heat liberated by the combustion thereof is less than the heat absorbed in the decomposition of the up-run steam, and discharging ash and clinker-forming material as liquid slag.

2,067,052

CARBURETED WATER-GAS PROCESS

Jan. 5, 1937; application filed Aug. 29, 1932, Serial No. 630,782; 2 claims.

1. A process of manufacturing combustible gas as practiced in a set including a generator containing an ignited fuel bed, a carburetor, and a superheater, said process including the following steps: air blasting said ignited fuel bed, burning the resulting blast gases, and storing the heat of said combustion in the top of said fuel bed in the top of said generator, in said carburetor, and in said superheater; and another step being introducing liquid hydrocarbon to the top of said generator, vaporizing said hydrocarbon there, passing the resulting gas down through the fuel bed, carcking said gas in the fuel bed, passing the cracked gas into and up through the carburetor, simultaneously introducing liquid hydrocarbon to the top of the superheater, vaporizing said liquid hydrocarbon there, passing the resulting gas down through the superheater, passing said gas up through the carburetor thereby mixing the gas from the generator and the gas from the superheater, and leading off said mixture to storage.
2,084,749

METHOD OF MANUFACTURING WATER GAS

Earl L. Tornquist, Elmhurst, Ill.

June 22, 1937; application filed Aug. 6, 1932, Serial No. 627,681; 2 claims.

1. In a water-gas set having a carburetor and superheater, the method of storing and utilizing sufficient heat for the carburetion of the water gas by relatively large amounts of an enriching ingredient, which method comprises heating the carburetor and superheater to substantially the same predetermined temperature by blasting the carburetor and superheater in series, directing a flow of water gas serially through said carburetor and superheater, injecting into said flow of gas controlled amounts of said ingredient into both the carburetor and superheater, and controlling the proportions injected into each of the carburetor and superheater so as to reduce the temperature in said superheater in accordance with the heat extracted from the carburetor by said injection, again blasting said carburetor and superheater, and employing the excess heat remaining in the blast gases after the subsequent blast has restored the heat extracted from the carburetor for reheating said superheater to said predetermined temperature.

2,088,679

CONTINUOUS FEED GAS PRODUCER

Kiichiro Yamazaki and Shojiro Uchida, Kawaguchi, Japan.

Aug. 3, 1937; application filed Feb. 12, 1934, Serial No. 710,868; 5 claims.

1. Apparatus for producing fuel gas, a furnace having a grate and an enclosed free-combustion chamber, a retort extended through the grate into and opening to the combustion chamber, means to continuously feed solid fuel into and move said fuel through said retort and deliver the same from the opening of the retort onto the grate for combustion, means to supply through the grate an oxygen-containing gas to support and aid combustion of said fuel, and means in communication with the retort intermediate the opening to the combustion chamber and the connection of the fuel-feeding means therewith to conduct the combustion gases from the combustion chamber through the fuel and from the retort.
METHOD AND MEANS FOR PRODUCING GAS

Hiram J. Carson, Omaha, Nebr.

Sept. 14, 1937; application filed Apr. 8, 1929, Serial No. 353,576; 5 claims.

1. The improvement in the manufacture of water gas which, when carried out in a generator having a lower incandescent fuel zone and an upper carbonizing fuel zone and an apertured distillation assembly located in the upper portion of the carbonizing zone, includes: blasting the lower zone of fuel to incandescence with air and withdrawing the resultant products from the upper portion of said zone; alternately with the air blasting, generating water gas by admitting steam to said lower zone of fuel; devolatilizing the fuel in the lower portion of the carbonizing zone by passing steam upwardly therethrough during air blasting periods and also by passing water gas upwardly therethrough during the gas runs, and conducting the steam and the water gas, each admixed with gas liberated from the fuel, upwardly through said apertured assembly and simultaneously drawing into the admixed steam and gas, vapors and gases distilled from the fuel in the upper portion of the carbonizing zone.

MAKING FUEL GAS

Ralph B. Sitzer, Sheffield, Ala., assignor to Tennessee Valley Authority, Wilson Dam, Ala., a corporation.

Sept. 21, 1937; application filed Dec. 4, 1935, Serial No. 52,853; 6 claims.

1. Process of making fuel gas from a coking coal which comprises charging coke continuously into an outer zone in the top of a vertical retort of square cross section, surrounding and gas imperviously separated from an inner zone, with both zones open at the bottom and extending downwardly until they are adjacent to but above the heating zone in a substantially horizontal section of the retort; charging the coal continuously into the inner zone in the top of the retort; passing an electrical current, supplied to the sides of the heating zone, through the charge in the heating zone, the characteristics of the current being regulated so that the heat produced on passing thru the charge in the heating zone is sufficient to carbonize the coal and sufficient to heat the coke in the heating zone to the temperature of conversion of a substantial proportion of steam in contact with the coke into water gas; passing steam into the retort, near the bottom, countercurrent to the direction of flow of the charge to cool the coke below the heating zone, to react with the coke in the heating zone and to heat the coal and coke above the heating zone with the gaseous products formed; passing an inert gas into the top of the inner zone, withdrawing the retort gas, comprising the inert gas admixed into the top of the inner zone, the volatilized products of the carbonization and the water gas formed by the reaction between the steam and the coke, from the top of the outer zone at the top of the retort; separating condensable materials from the vapors so withdrawn to yield a fuel gas; and withdrawing the ash continuously from the bottom of the retort.
2,094,946
HIGH-PRESSURE GAS-MAKING PROCESS
Otto Hubmann, Frankfort-on-the-Main, Germany, assignor to American Lurgi Corp., New York, N.Y., a corporation of New York.
Oct. 5, 1937; application filed Feb. 27, 1931, Serial No. 518,834; 14 claims.

1. Process of producing a gas having a calorific value at least as high as water gas which comprises gasifying a solid carbonaceous fuel in the absence of foreign catalytic agents materially affecting the reaction under a pressure greatly in excess of two atmospheres with a gasifying agent consisting essentially of oxygen and steam in such regulated proportions that the gasification temperature is maintained at about 600° to 900° C., whereby a considerable quantity of methane is produced.

2,099,968
GAS PRODUCER
Géza Szikla and Arthur Rozinek, Budapest, Hungary.
Nov. 23, 1937; application filed Apr. 11, 1934, Serial No. 729,138; 10 claims.

1. In a gas producer for gasifying and distilling combustible dust, especially coal dust, a gasifying chamber with a bottom opening for admission of air and removal of slags, a regulating means controlling said opening, a dust-collecting chamber communicating with the gasifying chamber at its upper part and receiving hot gases and coke dust from said gasifying chamber, a coke-dust return channel directly connecting the bottom portions of said chambers and ending at the bottom of the gasifying chamber whereby continuous circulation of coke dust through said gasifying chamber and said dust-collecting chamber is permitted, and a device provided at the upper part of the gasifying chamber for introducing fresh coal dust in the shape of a screen across the cross sectional area of at least one of said chambers whereby the producer gases generated in said gasifying chamber are cooled to a temperature lower than the melting temperature of the slag.
GASIFICATION OF FINE-GRAINED SOLID FUELS

Fritz Winkler and Eduard Linckh, Ludwigshafen-on-the-Rhine, Germany, assignors to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany. Mar. 22, 1938; application filed June 27, 1934; Serial No. 732,597; 5 claims.

1. A process for the gasification of a fine-grained solid fuel which comprises blowing through an incandescent body of this fuel as gasifying agent at one place of introduction and at the same time blowing through said incandescent body of fuel, and from a place of introduction at a distance from the place of introduction of the gasifying agent, a combustible gas having a lower temperature than the said incandescent body, said gasifying agent and combustible gas being introduced with such a speed that a boiling action is established in the incandescent body of fuel.

METHOD OF MAKING CARBURATED WATER GAS


1. The method of making carburated water gas which comprises intermittently blasting primary air upwardly through a bed of ignited solid fuel in a gas generator, simultaneously introducing secondary air into the top of the generator above the fuel bed thereby burning a regulated portion of the resultant blast gases, storing in the walls and roof of the generator and in the upper layers of the fuel bed the heat liberated by combustion of the said blast gases, exhausting the hot products of combustion through preheaters, and between periods of air blasting passing steam in a reverse direction through the preheaters and through the top of the generator and fuel bed thereby absorbing superheat, passing the superheated steam downwardly through the fuel bed thereby generating water gas and simultaneously spraying oil into the top of the generator and upon the hot fuel bed, thereby vaporizing and gasifying the oil by absorption of heat derived from radiant energy stored in the walls and roof of the generator and in the upper layers of the fuel bed.
PROCESS FOR GASIFICATION OF DUST OR FINE-GRAINED FUELS WITH CIRCULATING GAS

Hans Schmalfeldt, Kassel, Germany.

Apr. 12, 1938; application filed Nov. 7, 1935, Serial No. 48,730; 4 claims.

1. The hereindescribed process of gasifying carbon fuel, comprising the steps of heating the finely divided fuel in a gasifying zone by means of a gas stream of 700° to 1,600° C., containing water vapor thereby bringing said water vapor in reaction with said fuel, withdrawing from said gasifying zone any finely divided unreacted fuel particles, introducing into said latter un divided gas stream, before it has passed a separator, raw fuel to dry and disintegrate the same, separating at least part of the gas from said fuel dust and disintegrated fuel and finally returning at least part of said fuel dust and disintegrated fuel to said gasifying zone.

2,113,774

PROCESS AND APPARATUS FOR MAKING CARBURETED WATER GAS


May 24, 1938; application filed July 24, 1934, Serial No. 736,649; 7 claims.

1. In a carbureted water-gas process involving the step of blasting a fuel bed in a generator and the burning of the resultant blast gases in a carburetor and superheater connected with the generator, alternating with the step of making carbureted water gas by (a) passing steam through the fuel bed and passing the resultant water gas through the carburetor, introducing heavy oil into the water gas passing through the carburetor and fixing the resultant carbureted water gas by passage through the superheater, and (b) passing steam in reverse flow through the superheater, carburetor, and into and through the generator and withdrawing the resultant water gas from the generator, the improvement which comprises igniting the blast gases substantially immediately upon their introduction into the base of the carburetor and passing the burning blast gases always upwardly through the carburetor, passing water gas in step (a) always upwardly through the carburetor and introducing liquid heavy oil in a downward direction into the upflowing gas stream so that the liquid heavy oil particles and the water gas follow their natural flow tendencies, and in step (b) passing steam always downwardly through the carburetor, introducing the heated steam into the top of the generator while simultaneously adding heavy oil to the generator, passing the mixture of oil gas and steam through the fuel bed in the generator and withdrawing the resultant carbureted water gas from the generator.
2,126,150

PROCESS FOR MAKING GAS

Albert R. Stryker, Mariemont, Ohio, assignor of one-half to Chester Tietig, Covington, Ky.

Aug. 9, 1938; application filed Sept. 30, 1935, Serial No. 42,784; 7 claims.

1. That step in the process of making a combustible mixture of gases comprising free hydrogen which comprises dropping finely divided solid hydrocarbonaceous matter thru a space hot enough and deep enough to volatilize substantially all of the gas producible by the pyrolysis of said matter and withdrawing the gas so produced from a selected level of a fuel bed maintained at least in part at incandescence at the bottom of said space from a region below the upper surface of said bed.

2,128,262

CARBON MONOXIDE MANUFACTURE


(C1. 23—204)

1. The process of producing substantially pure carbon monoxide comprising blasting a body of carbonaceous material with an oxygen containing gas until said body of carbonaceous material is raised to an elevated temperature, conducting the hot blast gases thus produced away from said body of carbonaceous material, thereafter utilizing the heat of said hot blast gases to liberate carbon dioxide from carbon dioxide-containing material, and after the said blasting step passing said carbon dioxide through the said heated body of carbonaceous material to produce carbon monoxide.
METHOD OF MAKING COMBUSTIBLE GAS


Sept. 6, 1938; application filed Nov. 1, 1932, Serial No. 640,593; 3 claims.

1. The process of making carbureted water gas of low specific gravity, which, when practiced in a set including a single generator, a single carburetor, a single superheater, in individual detached shells, and a wash box, connected in series, comprises internally preheating the carburetor and superheater solely by air blast gas from the generator, making carbureted water gas by forward steaming and carbureting, introduced hydrocarbon oil into the back-run steam, and generating gas comprising carbureted water gas and hydrogen and of lower specific gravity than the forward-run carbureted water gas and of lower specific gravity than would be the case in the absence of the introduction of the hydrocarbon oil by passing the mixture of steam and oil down through the fuel bed, partially decomposing the hydrocarbon oil to hydrogen and to oil gas, which latter carburets the water gas simultaneously generated in the fuel bed.

PROCESS OF MANUFACTURING CARBURETED WATER GAS

Leon J. Willien, Chicago, Ill., and Louis Stein, Minneapolis, Minn., assignors to The United Gas Improvement Co., Philadelphia, Pa., a corporation of Pennsylvania.

Sept. 6, 1938; application filed Aug. 5, 1932, Serial No. 297,248; 3 claims.

1. The process of making carbureted water gas of low specific gravity, which, when practiced in a set including a single generator, a single carburetor, a single superheater, in individual detached shells, and a wash box, connected in series, comprises internally preheating the carburetor and superheater solely by air blast gas from the generator, making carbureted water gas by forward steaming and carbureting, introducing petroleum oil into the back run steam, and generating gas comprising carbureted water gas and hydrogen and of lower specific gravity than the forward run carbureted water gas and of lower specific gravity than would be the case in the absence of the introduction of the petroleum oil by passing the mixture of steam and oil down through the fuel bed partially decomposing the petroleum oil to hydrogen and to oil gas which latter carburets the water gas simultaneously generated in the fuel bed.
PRODUCTION OF GAS SUITABLE FOR THE SYNTHESIS OF HYDROCARBONS FROM CARBON MONOXIDE AND HYDROGEN

Heinrich Koppers, Essen, Germany, assignor, by mesne assignments, to Koppers Co., Pittsburgh, Pa., a corporation of Delaware.


1. In a method for producing water gas containing carbon monoxide and hydrogen in ratio suitable for catalytic reaction, such as the synthesis of hydrocarbons, from bituminous fuel of the character of brown coal, lignite, bituminous coal, and the like, comprising: Flowing through and thereby reacting with a bed of the fuel, a heated mixture of steam and water gas which has been previously heated in a separate heating stage of a cycle to a temperature at which hydrocarbons will decompose and interact with steam; withdrawing part of the gas thus produced from the cycle at a point in the fuel bed where the fuel is substantially free of hydrocarbons; returning the other part of said gases in cycle to said heating stage at a temperature above the dew point of tar and water, after passing through another part of the fuel bed where hydrocarbons are present and flow off with the gases in admixture therewith; removing tarry constituents in suspension from the latter gas portion while leaving the vaporlike hydrocarbons therein, after the gas leaves the fuel bed but before it re-enters the heating stage; the step comprising distilling the so-removed tar, and conducting the vapors of distillation therefrom back into the aforesaid heating stage into contact with the gas therein.
METHOD FOR GASIFYING FINELY DIVIDED FUEL WITH CIRCULATING GAS
Hans Schmalleit, Kassel, Germany.
Oct. 18, 1938; application filed Nov. 7, 1935, Serial No. 48,729; 3 claims.
1. In the herein described process for gasifying finely divided carbonaceous fuel by periodically circulating gases in series through a regenerating zone and a gasifying zone and in the alternate periods reheating the gases in the regenerating zone to 700°-1,600° C., the steps which comprise permanently choking the flow of the gas at a predetermined point of the path from the regenerating zone to the gasifying zone, producing a substantial pressure difference between said two zones during the circulation period, and introducing sealing steam into said path during the heating period.

PROCESS FOR PRODUCTION OF A GAS OF HIGH CALORIFIC POWER
Friedrich Danulat, Frankfort-on-the-Main, Germany, assignor to American Lurgi Corp., New York, N.Y., a corporation of New York.
The process of producing a nonpoisonous gas of high calorific power which comprises gasifying a solid carbonaceous fuel under a pressure in excess of 20 atmospheres with a gasifying agent consisting of air and steam in such proportions that about 1 part by volume of air is present for about 1.6 parts by volume of steam whereby substantial quantities of methane are produced, and subsequently supercooling the resulting crude gas to eliminate the carbon monoxide and at least part of the nitrogen therefrom.
2,142,676

PROCESS OF MAKING CARBURATED WATER GAS
Jan. 3, 1939; application filed May 27, 1936, Serial No. 82,020; 5 claims.

1. A method of operating a carbureted water-gas set including a generator having a fuel bed therein, a carburetor having the lower portion substantially open and unobstructed to permit settling of carbonaceous material produced in the carburetor, and a superheater, connected in series so that the top of the generator communicates with the top of the carburetor and the bottom of the latter communicates with the bottom of the superheater; comprising blasting the fuel bed to incandescence with an upward stream of air and employing the resultant blast gases in heating the carburetor and superheater; passing an upward stream of steam through the fuel bed and carbureting the resultant water gas by passing downwardly through the carburetor while spraying oil therein so as to vaporize and partially crack the oil and form carbonaceous material resulting in a substantial bed of carbonaceous material extending across the bottom of the carburetor, passing the carbureted water gas up through the superheater to fix the same; and passing steam in reverse direction back through the superheater, carburetor and generator while during at least a portion of this steam flow introducing air into the lower portion of the carburetor and into direct contact with said carbonaceous deposits to produce combustion thereof, the resulting hot combustion products passing upwardly in the carburetor in admixture with the steam and serving to supply heat to the steam and to the fuel bed, the steam being converted to water gas in passing down through the fuel bed.

2,148,298

CONTINUOUS PRODUCTION OF WATER GAS
Heinrich Koppers, Essen, Germany, assignor, by mesne assignments, to Koppers Co., Pittsburgh, Pa., a corporation of Delaware.
Feb. 21, 1939; application filed Dec. 10, 1936, Serial No. 115,121; 7 claims.

1. In a method of producing water gas continuously comprising: passing a hot gas mixture of water gas and steam in cyclic flow through a heating stage, in which the gaseous mixture is preheated to a temperature effective for carrying out a water-gas reaction of the steam with carbonaceous fuel in a subsequent water-gas reaction stage; and thence through a water-gas reaction stage, in which the gaseous mixture flows upwardly through and thereby reacts with carbon in the lower water-gas reaction part of a column of carbonaceous fuel fed at its upper part with fresh fuel to form water-gas from the steam of the gas mixture and thence through the fresh fuel on the subadjacent water-gas reaction part for predistillation of the fresh fuel with off flow of the gaseous mixture for cyclic flow from the fuel bed through the freshly fed-in fuel, and thence back to the heating stage, and which method involves the steps of maintaining the gas mixture in cyclic flow through the heating and lower water-gas reaction and upper distillation stages by mechanical acceleration of the flow of the gas mixture after it leaves the freshly fed-in fuel and before it enters the gas heating stage, with cooling of the gas mixture to a temperature below 2,500° C. before it enters the mechanical acceleration step; the improvement comprising: maintaining in the fresh fuel zone of the water-gas reaction stage fresh fuel having a content of water sufficient to cool, by direct contact therewith, the gas mixture flowing off from column of fuel through the freshly fed-in fuel to a temperature below 250° C., and effecting the aforesaid cooling of the gas mixture for the mechanical acceleration step by heat exchange in the freshly fed-in fuel in the upper predistillation stage between the off flowing gas mixture and the aforesaid water content of the freshly fed-in fuel with the formation of steam therefrom.
CONTINUOUS PRODUCTION OF WATER GAS

Heinrich Koppers, Essen, Germany, assignor, by mesne assignments, to Koppers Co., Pittsburgh, Pa., a corporation of Delaware.

Feb. 21, 1939; application filed July 10, 1937, Serial No. 152,910; 5 claims.

1. In a method of continuously producing water gas of a predetermined definite composition uniformly with respect to its ratio of hydrogen, carbon dioxide, and carbon monoxide and free of hydrocarbons, from distillable solid fuels, which comprises: maintaining in a bed of continuously descending fuel aforesaid a water-gas reaction zone in which the distillation of the fuel thereof is already completed and a predistillation zone therefor, and withdrawing the hydrocarbon free water gas from the zone of the fuel bed in which predistillation of the fuel is already completed; and effecting said maintenance of the zones of the fuel bed by traversing the distillation zone with a preheated gaseous heat carrier medium of water gas and steam and circulation of the medium from the distillation zone together with the hydrocarbons therefrom through a separate gas heating-up stage and thence back to the fuel bed through the water-gas reaction zone; adding steam to the heat carrier medium for the water-gas reaction in fuel bed and for converting the hydrocarbons contained in the heat carrier medium into carbon monoxide and hydrogen in the heating-up stage; and heating the heat carrier medium in the heating-up stage to the temperature critical to convert the hydrocarbons; the improvement comprising cooling the heat carrier medium, after it issues from the heating-up stage but before it enters the water-gas reaction stage fuel bed, down to at least the upper limit of the temperature range critical for producing a gas of predetermined definite composition uniformly with respect to its ratio of \( \text{H}_2 + \text{CO} + \text{CO}_2 \) from the particular fuel being gasified by the heat carrier medium in the fuel bed.
2,151,121
PRODUCTION OF WATER GAS
Heinrich Koppers, Essen-on-the-Ruhr, Germany, assignor, by mesne assignments, to Koppers Co., Pittsburgh, Pa., a corporation of Delaware.
Mar. 21, 1939; application filed June 25, 1936; Serial No. 87,300; 5 claims.
1. Process for the production of water gas, containing hydrogen and carbon monoxide in ratio of 2:1 from bituminous fuels while supplying the heat required for the water gas reaction from outside into the fuel, comprising: distilling the bituminous fuel to be treated in an upper distillation zone of a fuel bed with hot water gas to recover hydrocarbons from said fuel; withdrawing the distillate gas in mixture with the water gas from the distillation zone and converting with steam at high temperature the gaseous fluids resulting from the distillation of the fuel to form hydrogen and carbon monoxide from the hydrocarbons thereof; passing the conversion gas through the distilled fuel in a lower contiguous water gas zone of the fuel bed along with steam and reacting the distilled fuel and steam at high temperature in the water gas zone to form water gas in the presence of the conversion gas therein; splitting the stream of water gas and passing a part thereof from the water gas zone through the fuel in the upper distillation zone and effecting the aforesaid distillation of fuel therewith, and withdrawing the remaining portion of the split stream of water gas in advance of the distillation zone from the water gas zone itself to a point of use outside the system; and regulating the temperatures for the water gas reaction in the lower water gas zone and controlling the time interval for reaction of the fuel therein with the conversion gas and steam therein by removing such quantity of fuel ungasified from the lower water gas zone per unit of time that CO is formed therein in ratio to H as to produce in the mixture of converted distillate gas and water gas withdrawn from the water gas zone itself as aforesaid, hydrogen and carbon monoxide in ratio of 2:1 as a result of control of temperature and time of reaction of the conversion gas with the fuel in the lower water gas zone.

2,153,820
PROCESS FOR PRODUCING WATER GAS FREE FROM TAR AND HYDROCARBONS
Franz Volk, Vienna, Austria.
Apr. 11, 1939; application filed May 8, 1937; Serial No. 141,548; 2 claims.
1. A process for producing water gas from bituminous fuels in a generator having a gasifying chamber and a superimposed distilling chamber, and having a superheater connected thereto, which comprises alternately hot air blowing, making a steam uprun and making a steam down-run, circulating during said uprun the gases from the distilling chamber through the superheater and the fire zone of said gasifying chamber into the generator and discharging the water gas after having passed the gasifying chamber and before having entered into the distilling chamber, and circulating during said downrun the gases from said distilling chamber through said superheater into the generator at the junction zone between said both chambers and discharging the water gas after having passed the gasifying chamber.
SLAGGING WATER-GAS GENERATOR

Willy Linder, Essen-Bredeney, Germany, assignor, by mesne assignments, to Koppera Co., Pittsburgh, Pa., a corporation of Delaware.

June 20, 1939; application filed Mar. 2, 1937, Serial No. 128,599; 5 claims.

1. A slugging water-gas generator designed for alternate air blows and water-gas steam runs with separation of the ash from the bottom of the generator in liquid form comprising a fuel chamber having a sole adapted for liquid slag provided with liquid slag outlet means, means for admitting down run water-gas making steam and for taking off up run air blast gas at the top of fuel chamber, means connected with the bottom of the generator fuel chamber for introducing air for blasting the same and withdrawing downrun water gas from the base of the chamber near the sole for liquid slag, said latter means comprising separate lower ports for inlet of blast air and separate lower ports for off flow of downrun water gas from the generator fuel bed, the ports for inflow of blast air being disposed around the periphery of the sole for liquid slag at approximately the level of the liquid slag outlet means therefor and the outlet ports for off-flow of down run water gas being peripherally disposed around the base of the generator just above the sole at a level above the slag outlet means therefor in spaced relation in alternation with the inlet ports for air, whereby the highest temperature prevails at the sole and the atmosphere on the bottom is of an oxidizing nature so that nearly the whole quantity of fixed iron remains in the slag.

MANUFACTURE OF HIGH CALORIFIC VALUE GAS

Alfred Johnson, Summit, and Morris M. Brandegge, Plainfield, N.J.

July 11, 1939; application filed June 24, 1937, Serial No. 130,658; 7 claims.

1. In manufacturing combustible gas of calorific value and combustion characteristics substantially corresponding to those of natural gas, the cyclic process which comprises periodically raising the temperature of a bed of coke in a gas generator with the range 1,800°-2,000° F. by blowing a mixture of air and steam therethrough, burning the blow gases thereby produced and regenerating heat thereby developed, and between air blasting periods reforming hydrocarbon gas to a gas of lower calorific value by passing the gas through the heated coke bed at a rate of about 100-125 cu. ft. per sq. ft. of generator grate area per minute, and enriching the reform gas by vaporizing and cracking oil, the oil being exposed at substantially atmospheric pressure to cracking temperatures in the range 1,500°-1,900° F. at the rate of approximately 0.6-1.5 gal. of oil per sq. ft. of cracking zone area per minute in an atmosphere of hot reform gas.
APPARATUS FOR PRODUCING GAS

John U. McDonald, Clinton, Mo.

Aug. 8, 1939; application filed July 9, 1937, Serial No. 152,726; 2 claims.

1. In a gas-producing apparatus, the combination with a generator having a chamber with a combustion zone intermediate the top and bottom, means for admitting fuel into the top of the generator, and means for delivering residue ash and gas from the lower end of the generator, of a conduit extending transversely across the interior of the generator in an upper part of said zone to have the conduit supported by opposite sides of the generator, through which conduit gas making fluids may be selectively and simultaneously admitted centrally of said zone, said conduit having an upwardly vertically directed discharge opening.

PROCESS FOR CONTINUOUS PRODUCTION OF WATER GAS, FREE OF HYDROCARBONS, FROM BITUMINOUS FUELS

Willy Linder, Essen-Bredeney, Germany, assignor, by mesne assignments, to Koppers Co., Pittsburgh, Pa., a corporation of Delaware.

Sept. 12, 1939; application filed June 28, 1937, Serial No. 150,709; 8 claims.

1. In a method of continuously producing water-gas free of hydrocarbons from distillable solid fuels, which comprises: maintaining in a bed of continuously descending fuel aforesaid a lower water-gas reaction zone and an upper predistillation zone, and withdrawing the hydrocarbon free water-gas from the fuel bed at a zone intermediate the upper distillation zone and the lower water-gas zone; introducing the fuel to be degasified at the top of the bed and withdrawing the residue as solids from the bed below the water-gas reaction zone; and effecting said maintenance of the zones of the fuel bed by traversing the upper distillation zone with a preheated gaseous heat carrier medium and circulation of the medium from the upper distillation zone together with hydrocarbons therefrom and steam through a separate gas heating-up stage to reheat the medium and hence back to the fuel bed through the lower water-gas reaction zone for the water-gas reaction therewith; the improvement comprising: introducing the gaseous heat carrier medium for each of the upper and lower zones as separate streams individual to the respective zones, and independently of the other zone, and in quantities for the respective zones to supply the heat for the respective zones by the separate streams therefor.
PROCESS FOR PRODUCTION OF GASES
Max Radtke, Essen, Germany, assignor, by mesne assignments, to Koppers Co., Pittsburgh, Pa., a corporation of Delaware.

Oct. 10, 1939; application filed Mar. 11, 1937; Serial No. 130,854; 3 claims.

1. A process for the continuous production, from distillable bituminous fuel, of water-gas practically free from hydrocarbons for subsequent synthesis to hydrocarbons for motor fuel, which process involves circulating a gaseous heat carrier comprising a highly heated water-gas and steam mixture in cycle through a gasification step, in which the distillable fuel is both distilled by the heat of the gaseous heat carrier to liberate hydrocarbons from the fuel and is also reacted with the steam in the heat carrier to form water-gas, and thence from the gasification step to and through a reheating step for the carrier, in which the liberated hydrocarbons in the carrier from the gasification step are reacted to water gas and the carrier also reheated for return to the gasification step; the improvement comprising, flowing water-gas newly generated in each cycle of flow of the carrier through the gasification step also along to the reheating step together with the heat carrier and with the hydrocarbons distilled off in gasification step during their return to the reheating step for conversion of the hydrocarbons to water-gas and reheating of the carrier, and withdrawing the final end product water-gas from the process from the reheated carrier after it has been reheated in the reheating step and before the reheated heat carrier re-enters the gasification step.

METHOD FOR MANUFACTURE OF GAS

Oct. 24, 1939; application filed July 28, 1937; Serial No. 156,147; 6 claims.

1. The method of producing gas of high calorific value from finely divided fuels which comprises projecting the fuel and oxygen in opposed coaxial jets, the fuel being in excess of the amount which will react with the oxygen supplied, maintaining combustion at the zone where the opposing jets collide and exclude steams and simultaneously introducing steam in the region surrounding the jets for reaction with highly heated surplus fuel which is not burned with oxygen.
2.179,650

INTERMITTENTLY OPERATED WATER-GAS GENERATOR

Paul Van Ackeren, Essen, Germany, assignor, by mesne assignments, to Koppers Co., Pittsburgh, Pa., a corporation of Delaware.

Nov. 14, 1939; application filed Aug. 10, 1937, Serial No. 158,819; 5 claims.

1. A water-gas generator comprising a shell having a fuel-bed chamber therein; means for introducing fuel to be gasified at the upper part of the generator and central mechanical gas-diffusion-hood grate-means for withdrawing ash at the lower part of the fuel-bed chamber; means at the lower part of the fuel-bed chamber for up-air-blasting a fuel bed in the chamber with a primary air-blast and for withdrawing down-run water-gas from the fuel-bed chamber through the mechanical gas-diffusion-hood grate-means; and means at the upper part of the fuel-bed chamber for introducing down-run water-gas making steam and or withdrawing up-air-blow gases from the fuel-bed chamber above the top level of the fuel-bed for which the fuel-bed chamber is designed to be charged with fuel; and means comprising a series of secondary air inlet-ports in the generator shell and conduits individual thereto extending through the shell to the ports from outside the shell and a bustle pipe for the conduits, said inlet-ports and conduits and bustle pipe therefor being arranged circumferentially around the upper part of the generator for introducing secondary air circumferentially into the generator chamber above the fuel bed therein concurrently with the operation of the up-air-blast means, for secondary combustion of the blow gases therefrom in the top of the generator above the fuel bed therein in advance of off-flow of the blow gases to the upper offtake means thereof; and in which a separate shut-off valve is provided in each of the aforesaid individual conduits for the respective secondary air inlet-ports, with the shut-off valves located in a portion of their respective pipes that is so very near to the openings for the pipes in the generator shell as to thereby keep the portion of the individual pipes that is exposed to receive gas and air mixtures from the fuel-bed chamber, when the shut-off valves are closed, so small that such exposed portions of the pipe cannot hold a mixture of gas and air to cause a serious explosion thereof therein.
2,187,872
GAS PRODUCER FOR GASIFYING GRANULAR FUELS

Fritz Winkler and Eduard Linckh, Ludwigshafen-on-the-Rhine, Germany, assigns to I. G. Farbenindustrie Aktiengesellschaft, Frankfort-on-the-Main, Germany.

Jan. 23, 1940; application filed Nov. 10, 1937, Serial No. 173,816; 1 claim.

A gas producer for gasifying granular fuel which disintegrates, upon being heated, which comprises a gasification chamber, the upper and lower portions of which are separated by at least one inclined grate, a shaft outside said gasification chamber leading from said grate to the lower part of said gasification chamber, means for conveying hot gases from said gasification chamber through the openings in said inclined grate, means for conveying preheated and at least partially disintegrated fuel from the lower part of said shaft into the fuel bed in the lower part of said gasification chamber, and means for introducing a fluid gasifying agent into said gasification chamber.
PROCESS FOR PRODUCTION OF COMBUSTIBLE GASES FROM BITUMINOUS FUELS

Walter Malkomes, Essen, Germany, assignor, by mesne assignments, to Koppers Co., Pittsburgh, Pa., a corporation of Delaware.

Feb. 13, 1940; application filed Nov. 11, 1936, Serial No. 110,211; 4 claims.

1. In a process for the production of gas of a predetermined ratio of H to CO, and coke in a method comprising, continuously descending coking mass of bituminous fuel in a vertical retort chamber with continuous supply of fuel to be coked at the upper part of the retort mass and with continuous discharge of finished high temperature coke at the bottom of the retort mass; subjecting the fuel in the upper part of the continuously descending mass to externally applied heating laterally inwardly of the mass to initially distill the freshly supplied fuel, and concurrently subjecting the lower portion of the mass to externally applied heating laterally inwardly of the mass to subsequently complete the carbonization of the initially distilled fuel to complete the formation of high temperature coke therefrom; the steps of effecting the external heating of the upper and lower portions by separately controlled heating; controlling the heating of the upper part of the mass so as to expel therefrom only low temperature distillation gas at a temperature of the order of about 350° C., and controlling the heating of the lower part of the mass so as to progressively raise the temperature of the mass in the lower part there of from about 350° C., at the juncture of the upper part, to about 550° C. at the bottom of the lower part and thereby expel from the fuel in the lower part, gas of high temperature coking up to the order of about 950° C.; drawing off the low temperature gas from the upper part of the mass at the upper part thereof; de-tarring the gas, and adjusting the steam content of the so withdrawn low temperature gas to the amount predetermined as critical to produce the predetermined ratio of H to CO on the final gas from the high temperature zone, and then introducing the de-tarred and steam adjusted low temperature coking gas at the lower part of the descending mass of highly heated coke undergoing completion of high temperature coking for flow of the re-introduced gas upwardly through the more highly heated high temperature coke; and withdrawing the high temperature gas produced from the lower high temperature coking part of the descending mass, together with the gas formed from the de-tarred and steam adjusted low temperature coking gas re-introduced into the descending mass from the initial distillation stage, from the descending mass at a region between the higher temperature carbonization zone in the lower portion and the lower temperature carbonization zone in the upper portion of the descending mass.
PROCESS FOR PRODUCING GASOLINE AND GAS

Mar. 26, 1940; application filed June 14, 1937, Serial No. 148,168; 11 claims.

1. The method of conjointly producing gasoline and heating gas which comprises producing air gas by burning at least partly solid fuel in the lower portion of a generator, removing from said portion a major part of said air gas and using said gas to highly superheat steam, introducing said superheated steam to the heated fuel in said generator at a level above the point of removal of said air gas and thereby producing water gas from said steam and heated fuel, introducing oil to said generator above the water gas zone, cracking said oil under conditions of low partial pressure on the oil vapor to change said oil to oil gas and vapors of gasoline and heavier oils, removing the mixed gases, vapors and uncombined steam from the generator, and separating the gasoline vapor and fixed gas from said mixture.

CARBURATING WATER GAS

Robert P. Jones and Robert L. Ellis, Miami, Fla., said Jones assignor to said Ellis.
Apr. 16, 1940; application filed Dec. 4, 1936, Serial No. 114,105; 7 claims.

1. In combination in a carbureted water-gas set; a generator, a substantially vertical carburetor having a refractory lining and having refractory baffles each extending more than half-way across the interior to divide the interior into superposed zones connected in series by large openings at alternately opposite sides of the carburetor, said zones being of a horizontal cross sectional area corresponding substantially to the horizontal cross sectional area of said carburetor, an inlet at the top of the carburetor communicating with the uppermost zone and an outlet at the bottom communicating with the lowermost zone, said openings being of a cross-sectional area at least equal to the cross-sectional area of said inlet, a connection between the generator and the inlet at the top of the carburetor; and means for introducing enrichment oil into the carburetor to carburet water gas passing therethrough from the generator.
METHOD FOR MAKING PURE HYDROGEN

Albert R. Stryker, Lawrenceburg, Ind., assignor of one-fourth to Chester Tietig, Covington, Ky.

May 14, 1940; application filed Oct. 18, 1937, Serial No. 169,662; 6 claims.

1. The method of commercially producing substantially pure hydrogen gas which comprises providing a bed of solid fuel heated to incandescence in a closed reaction chamber, passing a crackable aliphatic hydrocarbon through the incandescent bed of fuel so as to reduce the hydrocarbon to a mixture of completely and incompletely decomposed hydrocarbon gases, recirculating said mixture of hydrocarbon gases through the same incandescent bed of fuel until complete decomposition results and finally withdrawing the pure hydrogen from said chamber.

APPARATUS FOR PRODUCING GAS FROM CARBON-CONTAINING MATERIALS


June 4, 1940; application filed Nov. 23, 1938, Serial No. 242,029; 6 claims.

1. An apparatus for producing water gas from finely divided solid carbon containing materials comprising a horizontally extending gasifying chamber having a flat bottom wall and a semi-cylindrical upper wall, means forming heating chamber surrounding said gasifying chamber with the heating chamber walls spaced from the gasifying chamber walls, means for producing heat in said heating chamber to maintain the gasifying chamber at a high temperature, means for supplying carbon containing material to one end of said gasifying chamber comprising a chute extending thereto, a hopper and means for discharging measured quantities of material from said hopper into the chute and excluding air, means for moving said material along the bottom wall of said gasifying chamber, and means for introducing superheated steam into said gasifying chamber including a plurality of steam pipes positioned with their discharge ends communicating with said gasifying chamber, and electrically operated heating elements surrounding said pipes adjacent their discharge ends.
2,204,001

PRODUCTION OF WATER GAS

Max Radlak, Essen, Germany, assignor, by mesne assignments, to Koppers Co.,
Pittsburgh, Pa., a corporation of Delaware.

June 11, 1940; application filed Sept. 30, 1937, Serial No. 166,486; 3 claims.

1. A method of generating water gas containing carbon monoxide and hydrogen in the ratio of 1:2 from solid carbonaceous fuel poor in hydrocarbons or tarry constituents in a gas generator which comprises establishing a fuel bed of descending fuel aforesaid with supply of the fuel at the top of the bed and discharge of ash at the bottom of the bed, airblasting the fuel bed upwardly from the bottom through the ash in the lower zone of the fuel bed and withdrawing the resultant blast gases from the bed above the top of the same, then alternately passing down-run steam through the fuel bed from above the top of the bed to and withdrawing the down-run water gas generated thereby from the bed through the ash in the lower zone of the bed, and concurrently with the passing of down-run steam through the fuel bed, introducing secondary steam into the ash in the lower ash zone to convert part of the CO of the down-run water gas to CO₂, by reaction of the CO with the secondary steam in the presence of minerals in the ash, and in amount to produce a ratio CO to H in the proportion of 1:2 in the final down-run water gas leaving the ash zone in the lower part of the fuel bed.
PRODUCTION OF WATER GAS

Roman Rummel, Ruhland, Germany, assignor, by mesne assignments, to Koppers Co., Pittsburgh, Pa., a corporation of Delaware.

June 11, 1939; application filed Apr. 9, 1938; Serial No. 201,193; 7 claims.

1. In a method of continuously producing water gas free of hydrocarbons from distillable solid fuels, which comprises maintaining in a bed of continuously descending fuel aforesaid a lower water-gas reaction gasifying zone and an upper predistillation degasifying zone; introducing the fuel to be gasified at the top of the bed and withdrawing the residue as solids from the bed below the water-gas reaction zone; and effecting said maintenance of the zones of the fuel bed by traversing the upper predistillation zone with a preheated gaseous heat-carrier medium of water gas and circulation of the same from the upper predistillation zone together with hydrocarbons therefrom and steam through a separate heating-up stage to reheat the medium and thence back to the fuel bed through the lower watergas reaction zone for the water gas reaction therewith; the improvement comprising: introducing the gaseous heat carrier medium for the upper predistillation and lower water gas reaction zone to the bed intermediate the respective zones, and in quantities for the respective zones to supply the heat requirements for the respective zones; withdrawing the hydrocarbon-free water gas from the fuel bed at a zone intermediate the lower water gas reaction zone and the region of withdrawal of solid residue from below the water gas reaction zone; the heat carrier for the respective zones being introduced to the fuel bed at a region in which the stream divides and the part for the upper zone traverses the upper zone independently of the lower zone and the other part of the stream for the lower water gas reaction zone traverses predistilled fuel from the upper zone before the predistilled fuel and the heat carrier reaches the lower water gas reaction zone.
2,204,902
PROCESS FOR PRODUCING GAS
John U. McDonald, Clinton, Mo.
June 18, 1940; application filed July 9, 1937, Serial No. 152,725; 2 claims.

1. That process of continuously producing gas which comprises feeding solid carbonaceous fuel into the upper part of a gas-sealed generator to allow it to drop downwardly therein, introducing oxygen into said downwardly descending fuel by forcing substantially all of said oxygen vertically and centrally upward against the downwardly moving fuel, establishing a combustion zone in the fuel in the generator, the top of which zone is maintained by the rate of fuel feeding and oxygen flow substantially at the level of the introduction of said oxygen to be substantially at the vertically central part of the generator to have the heat from said combustion transmitted upwardly to the down-feeding fuel for pre-heating of the fuel and intermixing oxygen wherein gases generated in said zone may be reduced in passing through hot fuel therebelow, said oxygen being limited in amount to be completely used up in said zone, and drawing off from the lower end of the generator under said combustion zone the produced gases under pressure generated in the generator.

2,216,055
PROCESS OF MANUFACTURING CARBURATED WATER GAS
William E. Steinwedell, Cleveland Heights, Ohio, assignor to The Gas Machinery Co., Cleveland, Ohio, a corporation of Ohio.
Sept. 24, 1940; application filed Apr. 6, 1938, Serial No. 200,448; 5 claims.

1. The process of manufacturing carbureted water gas, with the use of heavy oil as the carbureting medium, in a gas-making set including a generator, carbureting apparatus, a conduit connecting the generator and the carbureting apparatus, and flow-direction control valves disposed exteriorly of the generator and carbureting apparatus and the conduit connecting the same, consisting in first upwardly blasting the fuel bed in the generator with air admitted at the bottom of the generator and burning the blast gases in the carbureting apparatus with air admitted to the latter and passed thereafter, then effecting a steam run upwardly through the fuel bed with steam admitted at the bottom of the generator and simultaneously spraying heavy oil upon the top of the fuel bed, and passing the resultant gaseous products through the carbureting apparatus, then effecting a steam run downwardly through the fuel bed with steam admitted at the top of the generator and withdrawing the resultant gaseous products from the set at the bottom of the generator, and then blasting downwardly through the fuel bed with air admitted to the set adjacent the top of the generator only and removing the blast gases from the set at the bottom of the generator.
PROCESS OF MANUFACTURING CARBURATED WATER GAS

William E. Steinwedell, Cleveland Heights, Ohio, assignor to The Gas Machinery Co., Cleveland, Ohio, a corporation of Ohio.

Sept. 24, 1940; application filed Apr. 6, 1938, Serial No. 200,439; 4 claims.

The process of manufacturing carburated water gas, with the use of heavy oil as the carburating medium, in a gas-making set including a generator, conduits connecting the top of the generator and the bottom of the generator, respectively, with the carburating apparatus, and flow-direction control valves disposed in said conduits between the generator and the carburating apparatus, consisting in first upwardly blasting the fuel bed in the generator with air admitted at the bottom of the generator and burning the blast gases in the carburating apparatus with air admitted to the latter and passed therethrough then effecting a steam run upwardly through the fuel bed with steam admitted at the bottom of the generator and simultaneously spraying heavy oil upon the top of the fuel bed, and passing the resultant gaseous products through the carburating apparatus then effecting a steam run downwardly through the fuel bed with steam admitted at the top of the generator and passing the resultant gaseous products through the carburating apparatus and then blasting downwardly through the fuel bed with air admitted to the set at the top of the generator and passing the blast gases through the carburating apparatus.
SYNTHETICAL PRODUCTION OF LIQUID HYDROCARBONS FROM CARBON MONOXIDE AND HYDROGEN

Michael Steinschläger, Moers, Niederrhein, Germany, assignor, by mesne assignments, to Koppers Co., Pittsburgh, Pa., a corporation of Delaware.

Nov. 5, 1940; application filed Nov. 24, 1936, Serial No. 112,549; 4 claims.

1. A process for making liquid hydrocarbons by catalytically reacting 2H₂ and 1CO by means of a known catalyst capable of forming liquid hydrocarbons from 2H₂ and 1CO, which comprises: making alternate blows of air and runs of water-gas-making steam through a generator fuel bed of carbonaceous fuel to produce original water-gas containing H₂ and CO in ratio 2:1; during the blows, storing the heat of the spent blow gases in a conversion chamber separate from the generator fuel bed; during the runs, purifying the original 2:1 gas and then catalytically reacting it in the presence of a catalyst known to be capable of reacting 2H₂ and 1CO to liquidable hydrocarbons in a primary catalytic reaction chamber to form the liquid hydrocarbons from the 2:1 ratio of H₂ to CO, removing the liquid and solid products from the reaction gas left-over from the primary catalytic reaction and then flowing the residual left-over reaction gas together with the steam by themselves through the aforesaid conversion chamber and converting the gaseous hydrocarbons in the left-over gas reaction gas to H₂ and CO in ratio 2:1 by the heat stored in the conversion chamber from the blow gases of the previous “blow” of the generator fuel bed, thereafter catalytically reacting the so converted 2H₂:1CO in the left-over reaction gas in the presence of separate from the primary catalytic reaction chamber to form further liquid hydrocarbons from the left-over gas, and recovering the further liquid hydrocarbons from the reaction gases of the secondary catalytic reaction chamber.
APPARATUS FOR GASIFYING FINELY DIVIDED GRANULAR FUEL

Arthur Rozinek, Budapest, Hungary, assignor of one-half to Géza Szikla, Budapest, Hungary.

Nov. 19, 1940; application filed Sept. 28, 1937, Serial No. 166,190; 10 claims.

1. An apparatus for gasifying finely divided granular fuel, comprising a gasifying chamber having a bottom opening, means for introducing air for gasification of the fuel through said opening, a cylindrical drum mounted beneath said opening with its cylindrical surface closing the latter, said drum being provided with axially extending slots for dividing the air flowing through said opening into a plurality of jets, and a funnel-shaped intermediate nozzle bottom provided with an opening and positioned above said bottom opening in the range of high temperatures, said intermediate bottom having edges projecting beyond the edges of the bottom opening to insure that slag in a liquid or pasty condition will drip from the edges of the intermediate bottom directly onto the drum.

GAS SET AND METHOD

James G. O'Keefe, Verona, N.J., assignor to Public Service Electric & Gas Co., Newark, N.J., a corporation of New Jersey.

June 24, 1941; application filed Jan. 11, 1939, Serial No. 250,883; 8 claims.

1. The method of preventing accumulation of carbon on the interior surfaces of a water-gas set due to carbureting during the water gas run, comprising flowing carbon consuming air over said surfaces during the blast period at such a velocity and through numerous contiguous openings throughout said surfaces that said surfaces are bathed with the said carbon consuming air during the blast gas flow and without substantial intermingling of said carbon consuming air with said blast gas flow.
PROCESS OF RECOVERING HYDROCARBON OILS AND OTHER BYPRODUCTS FROM OIL SHALE AND THE LIKE

Elmer H. Records and James E. Louttit, Tacoma, Wash., said Louttit assignor to said Records.

Mar. 17, 1942; application filed Oct. 18, 1937, Serial No. 169,554; 8 claims.

1. The process of recovering hydrocarbon oils and gases from oil-shale which comprises enclosing a mass of oil-shale in a reaction retort upon a base of coal, then passing superheated steam through the coal and oil-shale to effect decomposition thereof and in a manner whereby the decomposition products from the coal pass through the mass of oil-shale and finally withdrawing and condensing the said products.

INDEX OF SELECTED GASIFICATION PATENTS

2,276,342

METHOD FOR GASIIFYING LIGNITE

Lloyd H. Reyerson, St. Paul, and Donald C. Gernes, Minneapolis, Minn., assignors to Regents of the University of Minnesota, Minneapolis, Minn., a corporation of Minnesota.

Mar. 17, 1942; application filed Sept. 23, 1938, Serial No. 281,386; 8 claims.

1. A continuous process of making from lignite a gaseous mixture rich in hydrogen, which comprises, introducing a stream of lignite having a natural water content of 25-40 percent into a closed system, moving said lignite through a preheating zone where the temperature of the lignite is elevated to a temperature in the range of about 500° to about 850° C., continuing said movement through a reaction zone in the presence of water containing vapors generated by said preheating of the lignite while maintaining said temperature between about 500° C. to about 850° C., and thereafter moving said lignite through a cooling zone and removing the thus formed gaseous mixture rich in hydrogen.
2,281,210
MANUFACTURE OF WATER GAS AND APPARATUS THEREFOR
Apr. 28, 1942; application filed Apr. 5, 1939, Serial No. 265,902; 7 claims.
1. Apparatus for carrying out the method of operation described comprising a generator, and air supply pipe to the generator base, a regenerator, and outlet from the generator to the regenerator, a secondary air supply pipe to said outlet, a pipe leading from the outlet end of the regenerator to atmosphere, a stack valve thereon, a steam supply main, a steam supply pipe system leading therefrom and comprising three branches leading respectively to the base of the generator, to the generator top and to the outlet end of the regenerator, a three way valve at the junction of said steam supply pipe system with said main, a three way valve at the junction of the branches leading respectively to the base and top of the generator, a pipe loop connecting these two branches and a third three way valve at the junction of said pipe loop with the branch to the generator top.

2,281,562
FUEL-GAS PRODUCTION
May 5, 1942; application filed Dec. 15, 1939, Serial No. 309,504; 13 claims.
1. In the production of combustible gas, introducing a mass of green substantially solid carbonaceous material into the upper portion of a stack and feeding the mass successively through a distillation zone, a reduction zone, and oxidation zone, and an incandescent zone, in the order named, maintaining the incandescent zone in a state of incandescence by blowing air into the lower portion of the mass, injecting an intimate mixture of water and fuel oil in atomized condition into the incandescent zone, burning the fuel oil and some of the resulting combustible gases in said incandescent zone, passing hot gases upwardly from the incandescent zone through said mass and thereby subjecting carbonaceous material above the zone of incandescence to distillation and partial combustion, and discharging the resulting gases from the upper portion of said distillation zone.
PROCESS AND APPARATUS FOR PRODUCTION OF USEFUL FUEL GAS
Friedrich Totzek, Essen, Germany, assignor, by mesne assignments, to Koppers Co., Pittsburgh, Pa., a corporation of Delaware.

Nov. 17, 1942; application filed May 29, 1940, Serial No. 886,124; 9 claims.

1. Apparatus for producing fuel gas of high calorific value from dusty or granular solid carbonaceous fuel, comprising: a gas reaction chamber having an elongated horizontal cylindrical wall; a fuel gas and air burner at one axial end of the cylindrical wall communicating substantially tangentially with the reaction chamber; a mixing chamber in front of the burner directly connecting the same with the reaction chamber; axial gas-outlet means at the end of the cylinder opposite the end thereof at which the burner is arranged; a series of annular channels around the reaction chamber coaxial with its horizontal cylindrical wall; a main distributing duct provided with means for supplying steam thereto, said annular channels being group connected with the distributing duct, and an annular series of nozzles connecting each annular channel with the reaction chamber.

MANUFACTURE OF PRODUCER GAS
Friedrich Totzek and Joseph Daniels, Essen, Germany, assignors by mesne assignments, to Koppers Co., Pittsburgh, Pa., a corporation of Delaware.

Feb. 16, 1943; application filed Apr. 26, 1940, Serial No. 270,076; 9 claims.

1. Apparatus for the production of valuable fuel gas from finely grained or dusty fuels comprising a reaction chamber having essentially the shape of a vertical shaft; a firing chamber separate from the reaction chamber, said firing chamber having burner means for burning primary air and fuel and secondary combustion air-supply means for secondary combustion of the gases of combustion, and said firing chamber communicating with the reaction chamber to deliver the combustion gases to the reaction chamber at its upper part; means for offtake of reaction gas at a lower part of the reaction chamber; and means for feeding finely grained dusty fuel to the reaction chamber, said latter means being arranged to deliver the fuel directly into the gas issuing from the firing chamber as it enters the upper part of the reaction chamber, for co-current flow of the gas and fuel though the reaction chamber to its gas outlet, and in which the reaction chamber is of enlarged area adjacent the firing chamber and gradually decreases in area from the enlarged area towards the vertical middle section of the shaft, and then continues on toward the lower gas outlet and is gradually widened in area from the vertical middle section of the shaft to the lower gas outlet, and in which the gas outlet is constituted of a downwardly and outwardly inclined conduit, and in which the outlet is communicably connected with a fine dust separator, and the lower end of the reaction chamber below the gas outlet constitutes a receiver for the coarse dust.
MANUFACTURE OF WATER GAS


Oct. 26, 1943; application filed May 7, 1940, Serial No. 333,864; 1 claim.

In a process for the manufacture of water gas by a cyclic process in which an ignited fuel bed in a generator is alternately blasted with air to raise its temperature and then steamed to produce water gas, the steps of passing the blast gases from the generator into a heat-recovering zone containing firebrick checkerwork, introducing secondary air and burning the hot blast gases in the said recuperating zone and storing a part of the heat therein, passing the gases from said recuperating zone into a second heat-recovering zone containing metallic heat-absorbing material to absorb residual heat from the blast products whereby the hot blast gases are cooled by the heat absorbing material, discharging to atmosphere the blast gases cooled and rendered nonluminous, terminating the blow or air-blasting period, spraying water on the metallic material after cessation of the blow or air-blasting period to generate steam from the sensible heat of the heat-absorbing metallic material, passing said steam over the firebrick checkerwork in the first mentioned recuperating zone to superheat the steam, and then passing the superheated steam through the generator to effect a backrun.
CONTINUOUS PROCESS OF MAKING CARBURATED WATER GAS


Dec. 14, 1943; application filed Apr. 29, 1940, Serial No. 332,154; 9 claims.

1. The continuous process for making carbureted water gas in a retort, using oil and steam as the initial reacting materials and relying primarily on external heat for bringing about the gas-making reactions, which comprises feeding fragmentary solid refractory material which does not enter actively into the gas-making reactions to the upper part of a retort, externally and continuously heating said retort and the refractory material therein, progressively feeding oil to the heated refractory material in the retort and cracking said oil in an oil-cracking zone, thereby producing oil gas and vapors and oil carbon, which carbon is deposited in and on said refractory material, progressively moving said heated refractory material and the carbon deposited thereon downwardly through said retort, continuously reacting on a portion at least of said deposited carbon by steam admitted to a lower water gas-producing zone in said retort, continuously passing the resulting water gas upwardly through the refractory material in the retort and mixing said water gas with the oil gas and vapors formed in the cracking zone to form a carbureted water gas of increased heating value, progressively removing said carbureted water gas, oil vapors, and any excess steam from the upper part of said retort, and progressively discharging the refractory material and any unreacted carbon from the lower end of the retort.
PRODUCTION OF WATER GAS

Charles W. Hunter, Haverford, and John S. Haug, Philadelphia, Pa., assignors
to United Engineers & Constructors, Inc., a corporation of Delaware.
Oct. 24, 1944; application filed Nov. 9, 1939, Serial No. 303,620; 11 claims.
1. In the manufacture of water gas in a gas-making set containing an
ignited bed of solid fuel by a cyclic process comprising alternately heating
said fuel bed during a heating period by burning a portion of said solid
fuel by air blasting said fuel and alternately generating water gas during a
water gas-generating period by passing steam through said heated fuel bed,
the steps of heating said fuel bed during the first portion of said heating
period of the cycle by introducing liquid hydrocarbon fuel into said set,
burning it therein with air, passing hot products of combustion produced
thereby downwardly through said fuel bed, and during a succeeding portion
of said heating period heating said fuel bed by upward air blasting.

PRODUCTION OF GAS MIXTURE FOR METHANOL

Fredrik W. de Jahn, New York, N.Y.
Aug. 28, 1945; application filed Apr. 17, 1943, Serial No. 483,534; 3 claims.
1. A process of producing a mixture of approximately one volume of
carbon monoxide with two volumes of hydrogen in a form adapted for use
in making synthetic methanol, which comprises decomposing a hydrocarbon
not having substantially more than three molecules of carbon for each
eight molecules of hydrogen with an excess of steam under conditions
adapted to produce a substantial proportion of CO₂, whereby there is pro-
duced a gas mixture comprising hydrogen, carbon monoxide, carbon diox-
ide, and residual steam, and then after removing residual steam passing
such gas mixture through a bed of incandescent carbon to convert CO₂ to
CO while adding steam to the gas mixture passed through the incandescent
carbon, in order to adjust the amount of CO in the residual gas mixture
to the desired proportions.
2,436,938

METHOD OF PRODUCING MOTOR FUEL


Mar. 2, 1948; application filed Feb. 22, 1945, Serial No. 579,300; 13 claims.

1. A continuous method of producing liquid motor fuels from coal which comprises continuously suspending powdered coal in a hydrocarbon oil being essentially free of cyclic hydrocarbons and having an end boiling point of between about 700° and 800° F. in a mixing zone obtain a suspension containing substantially more than 50 percent by weight of coal, continuously conveying said suspension to a distillation-extraction zone, maintaining in said distillation-extraction zone conditions of residence time and temperatures not exceeding about 700° to 800° F. adapted to cause substantial removal of the volatile constituents from said coal, continuously separating distillate from coke residue, continuously withdrawing coked residue from said distillation-extraction zone, reacting at least a portion of said coked residue with steam to produce water gas, recovering from said water gas a mixture of carbon monoxide and hydrogen suitable for the catalytic synthesis of liquid hydrocarbons therefrom, reacting said mixture in contact with a synthesis catalyst to obtain a synthetic hydrocarbon oil, recovering from said synthetic hydrocarbon oil, a fraction being essentially free of cyclic hydrocarbons and having an end boiling point similar to that of the first-mentioned hydrocarbon oil, continuously recycling said fraction to said mixing zone and recovering liquid motor fuels from said distillate.

2,445,327

FLUIDIZING PROCESS FOR GASIFYING CARBONACEOUS SOLIDS


July 20, 1948; application filed Aug. 2, 1944, Serial No. 547,722; 5 claims.

1. A process for the simultaneous pyrolytic distillation and exothermic gasification of a solid material having volatilizable components and a solid, carbon-containing residue, which comprises injecting said solid material in discrete particle form into one zone of a single fluidized mass of solid residue particles deriving from said solid material, maintaining said zone at an elevated temperature to effect pyrolytic distillation of volatilizable components from said solid material pyrolytically distilling said volatilizable components from said solid material by contact with said fluidized mass, introducing oxygen of not less than about 95 percent by volume purity into another zone of said fluidized mass, both said zones being laterally contiguous and being in merging relationship to permit the free movement of the fluidized residue particles therebetweent, reacting said oxygen with said fluidized mass in the last said zone at an elevated temperature above the first said temperature to gasify exothermically carbon contained in said fluidized mass, promoting and controlling circulation of said fluidized mass by maintaining unequal gas velocities through said merging zones to convey heat from the last said zone to the first said zone and thus to maintain the first said temperature in the first said zone, withdrawing from said fluidized mass a single gaseous effluent containing the pyrolytically distilled volatilizable components and the products of the exothermic gasification, and withdrawing from said fluidized mass excess residue particles.
2,449,729
PROCESS FOR PRODUCTION OF INDUSTRIAL OR POWER GASES
Sept. 21, 1948; application filed Dec. 29, 1944, Serial No. 570,482; 6 claims.
1. A process for the production of industrial and power gases in which a bed of solid fuel or a mixture of solid fuel with oil is subjected to alternate blowing and gas-making periods in a generator, which comprises subjecting the fuel in the generator to blowing, withdrawing blowing gases from the generator, passing said gases through a regenerator to heat the same, thereafter passing steam through said regenerator to produce superheated steam, mixing said superheated steam with oil, the said superheated steam being at a sufficiently high temperature and possessing sufficient sensible heat to crack the oil, passing steam through the generator to make gas, withdrawing the made gas from the generator between a boundary of the reaction zone and a boundary of the fuel bed, and mixing said made gas with oil to carburet the same, the carbureting of the made gas being effected solely by the sensible heat of the made gas.

2,452,634
FISCHER-TROPSCH SYNTHESIS GAS FROM OIL SHALE
Alfred Clark, Bartlesville, Okla., assignor to Phillips Petroleum Co., a corporation of Delaware.
1. A process for the production of synthesis gas, which comprises introducing simultaneously particles of oil shale of a size not exceeding about 2 mesh and an oxygen-containing gas into the upper portion of a reaction zone; maintaining a temperature in said upper portion of said reaction zone in the range of about 1,500° to 3,000° F., maintaining a pressure in said reaction zone in the range of about atmospheric and about 250 p.s.i.; maintaining the ratio of oil shale to oxygen in said oxygen-containing gas such that the carbonaceous material in the oil shale will be substantially completely converted to carbon monoxide and hydrogen, passing the resulting hot spent shale to the lower portion of said reaction zone; maintaining the temperature in said lower portion of said reaction zone between about 1,600° and 2,000° F.; introducing a mixture comprising methane and water into the lower portion of said reaction zone, causing said mixture to pass upwardly through said lower portion of said reaction zone and counter-currently to said hot spent shale, whereby said methane-water mixture is converted to synthesis gas, withdrawing an intermediate portion of said reaction zone synthesis gas resulting from the reactions in both the upper and lower portions of said reaction zone, and removing the spent shale from the reaction zone.
MANUFACTURE OF WATER GAS
Harold V. Atwell, Beacon, N.Y., assignor to The Texas Co., New York, N.Y., a
corporation of Delaware.
Feb. 8, 1949; application filed July 24, 1948, Serial No. 496,012; 4 claims.
1. A continuous method of producing carbon monoxide and hydrogen from
a solid carbonaceous material which comprises converting said material to
finely powdered form, introducing said powder to a vertical combustion zone,
introducing to the lower portion of said zone a stream of oxygen-containing
gas, passing said gas upwardly through the combustion zone in contact
with said powder so that powder is maintained dispersed in gas within
said zone, effecting partial combustion of said powder with accompanying
decrease in particle size and formation of ash, discharging from the upper
portion of said zone a stream of hot combustion gas containing entrained
hot carbonaceous particles and ash, separating entrained hot carbonaceous
particles from said discharged gas and ash, passing said residual hot-gas
stream in indirect contact with a stream of steam, injecting said separated
hot particles in the resulting heated stream of steam, continuously withdraw-
ing hot carbonaceous particles from the bottom of said combustion zone,
injecting said withdrawn hot carbonaceous particles into said heated
stream of steam, passing the resulting hot mixture of steam and injected
particles upwardly through a vertical reaction zone, reacting said carbona-
ceous particles with steam at a temperature of about 1,500° F. and above
in said reaction zone so as to form carbon monoxide and hydrogen, rem-
oving from the upper portion of said reaction zone an effluent stream of
carbon monoxide and hydrogen containing entrained particles of uncon-
sumed carbonaceous material and ash, separating entrained, unconsumed
carbonaceous material from said carbon monoxide, hydrogen, and ash, re-
cycling separated unconsumed carbonaceous material to said combustion
zone, and separating ash from said effluent stream of gas so as to provide
a gaseous mixture comprising mainly carbon monoxide and hydrogen.

CATALYTIC SYNTHESIS OF HYDROCARBONS
Frederick Burton Sellers, New York, N.Y., assignor to Texaco Development Corp.,
New York, N.Y., a corporation of Delaware.
Mar. 15, 1949; application filed Sept. 10, 1948, Serial No. 48,740; 10 claims.
1. In the synthesis of hydrocarbons, oxygenated hydrocarbons, and mix-
tures thereof, the steps which comprise generating a high-temperature stream
of synthesis gas comprising essentially hydrogen and carbon monoxide, con-
tinuously passing said gas in heat-transfer relationship with a solid particle
heat-absorptive thermophore, having thereon solid carbonaceous depos-
its as a result of conversion of hydrocarbon fractions, whereby heating the
thermophore to an elevated temperature level at which said carbonaceous
material is reactive with an oxidizing gas of the class consisting of water
vapor and carbon dioxide to form synthesis gas constituents, contacting
said heated thermophore with said oxidizing gas in a regeneration zone,
effecting reaction between said oxidizing gas and said carbonaceous deposit
to an extent such that a substantial proportion, at least, of said carbona-
ceous deposit is removed from the surface of said thermophore, recovering
substantial additional quantities of synthesis gas constituents formed in
said regeneration zone, mixing said synthesis gas constituents with said
first-named synthesis gas stream and effecting substantial catalytic conver-
sion thereof into desired products of the class consisting of hydrocarbons,
oxogenated, hydrocarbons, and mixtures thereof.
2,466,945

GENERATION OF SYNTHESIS GAS
Frank C. Greene, Oakland, Calif., assignor to In Situ Gases, Inc., Reno, Nev., a corporation of Nevada.
Apr. 12, 1949; application filed Feb. 21, 1946, Serial No. 649,295; 10 claims.
1. In a geological formation having a deposit of natural combustible material therein; a pair of separated inlet ducts extending into said formation and converging together within said deposit; an outlet duct extending into said formation and terminating at said point of convergence of said inlet ducts and forming acute angles with the inlet ducts; air blowers discharging into said inlet ducts; and an exhauster sucking from the outlet of said outlet duct, when said deposit is in a state of combustion.

2,476,760

PROCESS AND APPARATUS FOR OPERATION OF GAS PRODUCERS
Olof A. Ohlsson, Stockholm, Sweden.
1. In a gas producer, a branched conduit on the outside of the producer for passing the tarry gases from the distillation zone downwardly to the producer fuel bed, a combustion chamber for the tarry gases, a branch pipe from said conduit connected with the combustion chamber for the tarry gases, said combustion chamber having at least one inlet for an oxygen containing gas and a connecting passage between said combustion chamber and the generator fuel bed above the grate of the producer, an inlet in said passageway for the introduction of the second branched pipe from the distillation zone so situated that the tarry gases from the second branch are heated by being mixed with the hot gases from the combustion chamber before entering said producer.

PART I—UNITED STATES PATENTS
2,482,187
PROCESS FOR PRODUCING HYDROGEN-Carbon MONOXIDE
GAS MIXTURES
Everett A. Johnson, Park Ridge, Ill., assignor to Standard Oil Co., Chicago, Ill., a
corporation of Indiana
Sept. 20, 1949; application filed Apr. 3, 1944, Serial No. 529,268; 1 claim.
The method of making gas mixtures consisting chiefly of hydrogen and
carbon monoxide suitable for the synthesis of hydrocarbons in the presence
of a synthesis catalyst, which method comprises introducing finely divided
carbonaceous solids into a combustion zone, heating a fluent mass of said
finely divided carbonaceous solids to incandescence by passing a gas compris-
ing oxygen upwardly therethrough at a velocity sufficient to maintain
the solids as a suspended dense turbulent phase superimposed by a light
dispersed solids phase in said combustion zone, separating solids from gas-
eous combustion products in the upper part of said combustion zone and
removing said combustion products at the upper part of said zone, separ-
ately removing incandescent solids comprising carbon in dense-phase flu-
idized condition at a point below the dense-phase level in the combustion
zone and introducing said removed solids into a decomposing zone, passing
a conversion gas consisting essentially of oxygen, steam, and methane upward-
ly in the decomposing zone at a rate sufficient to maintain a suspended,
dense, turbulent solids phase therein superimposed by a dilute solids phase,
maintaining said decomposing zone at a temperature upwards of 1,500° F.,
whereby at least a portion of said carbon, methane, oxygen, and steam
react to form a hydrogen-carbon monoxide mixture for hydrocarbon synthe-
sis, separating product gas from solids in the upper part of said decompos-
ing zone and withdrawing the product gases from the upper part of said
zone, separately withdrawing hot solids in dense-phase fluidized condition
from a point below the level of the dense phase in the decomposing zone
and returning at least a part of the withdrawn hot solids to the dense
solids phase in the combustion zone.
METHOD OF GASIFYING CARBON AND THE LIKE

Alfred M. Thomsen, San Francisco, Calif.

Nov. 1, 1949; application filed Feb. 10, 1947, Serial No. 727,671; 5 claims.

1. The method of gasifying carbon which comprises burning fuel in air and storing the heat thus generated in a heat refractory structure; passing a circulating gaseous medium, consisting chiefly of CO and CO₂, alternately through said structure and through a body of carbon, thus heating said gaseous medium by conveyance of heat from said refractory structure and cooling said medium by the reduction of CO₂ to CO incident to its passage through said body of carbon; splitting off a definite fraction of said circulating medium as accepted gas and compensating said circulating medium for such loss of volume by the addition of the corresponding volume of CO₂.
METHOD FOR PRODUCTION OF WATER GAS
Apr. 4, 1950; application filed June 4, 1949, Serial No. 67,198; 4 claims.
1. A method of producing from coal a substantially nitrogen-free water gas, which comprises reacting coal with steam at water-gas reaction temperatures in a gas producer to form a hot water gas consisting predominantly of hydrogen and carbon monoxide, passing said hot water gas in contact with a mass of relatively cool, movable discrete heat-exchange solids in a solids preheating zone, removing the resulting preheated solids to a solids heating zone and heating them to a temperature above the desired water-gas reaction temperatures by contact with hot products of combustion therein, separating the cooled water gas into a plurality of streams, adding steam to one of said streams, and recycling it through a gas-heating zone and back to the gas producer for reaction with coal, heating the recycled gas to water-gas reaction temperatures by introducing the hot heat-exchange solids into the path of said recycled gas in said gas-heating zone removing the solids from the gas-heating zone and recycling them to said solids preheating zone, and withdrawing a second stream of said cooled water gas as product gas from the process.

PROCESS OF PROMOTING REACTIONS IN A FLUIDIZED BED COMPRISING A PLURALITY OF CATALYSTS
William W. Odell, Washington, D.C.
Apr. 11, 1950; application filed Mar. 14, 1945, Serial No. 582,692; 31 claims.
1. A process for promoting chemical reactions in a reaction chamber, comprising passing an aeriform fluid upwardly through a fluidized stratified mass of subdivided small-size solids confined in said chamber substantially from beneath said mass while said solids are at a temperature suitable for promoting chemical reactions, said mass of solids comprising particles having different physical and catalytic characteristics, introducing a volatile liquid into one of the layers of said stratified mass above the bottom thereof, causing said liquid to substantially completely vaporize in said mass the vapors forming with said aeriform fluid a combined stream having sufficient velocity to maintain said solids in a fluidized condition in said chamber, promoting chemical reaction in said stream while passing through said chamber in contact with said solids, at least one of the components of said combined stream entering said reaction, and discharging the stream containing at least one valuable reaction product and recovering it, said fluidized mass of solids comprising a plurality of different layers, the particles of one layer comprising largely different catalysts from those of an adjacent layer.

INDEX OF SELECTED GASIFICATION PATENTS
2,514,340

PRODUCTION OF GASES RICH IN HYDROGEN

Walter H. Rupp, Mountainside, N.J., assignor to Standard Oil Development Co., a corporation of Delaware.


1. A process of increasing the value of synthesis tail gas obtained by reacting CO with \( \text{H}_2 \) in a synthesis zone in the presence of a synthesis catalyst at synthesis conditions and removing normally liquid constituents from the total synthesis product, which comprises dividing the total amount of said tail gas into a minor stream and a major stream, contacting said minor stream in a first contacting zone with a liquid absorbent for hydrocarbons and carbon oxides, in an amount at least sufficient to absorb a major proportion of hydrocarbons and carbon oxides present in said total tail gas, and at conditions conducive to the absorption of a major proportion of hydrocarbons and carbon oxides and insignificant proportions of hydrogen contained in said minor stream, withdrawing a minor tail-gas stream of increased value from said first contacting zone, withdrawing liquid absorbent enriched with hydrocarbons and carbon oxides from said first contacting zone, contacting said major stream with said withdrawn absorbent in a second contacting zone at conditions conducive to the absorption of at least a major proportion of hydrocarbons contained in said major stream, withdrawing a major tail-gas stream from said second zone and withdrawing rich liquid absorbent from said second zone.
2,516,141
APPARATUS AND METHOD FOR GASIFYING CARBONACEOUS MATERIAL
July 25, 1950; application filed July 1, 1949, Serial No. 102,652; 6 claims.
1. An apparatus for producing a fuel gas comprising a substantially vertical chamber for carrying on the primary and secondary stages of the reaction, a plurality of nozzles for introducing the finely divided solid fuel admixed with an oxygen-bearing gas positioned on substantially opposite sides of this chamber for the pairing member, at least one nozzle for introducing a gas of the member of the group consisting of steam and carbon dioxide, positioned within this chamber at a point of elevation below that of the nozzle for introducing dispersed fuel, an enlarged chamber overlying the primary reaction chamber and joined directly thereto, a restricted portion above this chamber and a conduit connected to it for leading off the resulting fuel gas, a chamber below the primary reaction chamber and directly joined thereto for collecting the ash.

2,516,974
METHOD AND APPARATUS FOR GASIFYING CARBONACEOUS MATERIAL
Aug. 1, 1950; application filed Dec. 4, 1946, Serial No. 713,885; 4 claims.
1. In the method of gasifying solid carbonaceous fuel wherein water vapor is passed in contact with a mass of said solid fuel in a gasification zone at an elevated temperature at which reduction of the water vapor by the carbon proceeds with the formation of hydrogen and carbon monoxide, the improvement which comprises separating hydrogen from the gaseous reaction products by diffusion through a diffusion member in the gasification zone, heating the diffusion member by burning the diffused hydrogen adjacent the effusion surface of said member by supplying a stream of oxygen to said last-named surface, supplying at least a portion of the thermal requirements of said gasification zone by exchanging sensible heat energy directly from said diffusion member to the gasification zone, and separately recovering the products of gasification and the products of the said combustion of hydrogen.
PROCESS FOR HEAT TREATMENT OF CARBON-CONTAINING FEED STOCK
Ervin G. Bailey, Easton, Pa., assignor to The Babcock & Wilcox Co., Rockleigh, N.J.,
a corporation of New Jersey.

Aug. 22, 1950; application filed Mar. 28, 1944; Serial No. 527,726; 8 claims.

1. A process of heat-treating coal as a feed stock, which comprises passing a
mixture of the feed stock and a heated solid heat-transfer material
in a porous fluent mass downwardly through a retort chamber, maintaining
heat-transfer contact between the feed stock and said heat-transfer mate-
rial for a period sufficient to effect a low temperature gasification of the
feed stock in a zone at the upper part of said mass, then passing the mixed
mass of remaining feed stock and heat-transfer material through a sub-
jacent high temperature zone for further heat treatment, supplying com-
bustion air to the lower part of said chamber for burning the feed stock
residual carbon in said mass in a subjacent zone below said high-tempera-
ture zone to supply the heat requirements of the process, returning the
heat-transfer material to the low-temperature gasification zone with a heat
content sufficient to effect said low-temperature gasification, and withdrar-
ging gaseous end products directly from the high-temperature heating zone
of said chamber.
2,520,860
PROCESS FOR PRODUCTION OF WATER GAS AND LIKE SYNTHESIS GASES
Aug. 29, 1950; application filed Aug. 6, 1945; Serial No. 609,235; 5 claims.
1. A discontinuous process for the manufacture of water gas, which comprises subjecting a generator containing a carbonaceous fuel bed to blowing with an oxygen-containing gas, heating a regenerator by passing a hot gas therethrough, and during the make run splitting the made gas issuing from the generator into two streams, mixing with one of said streams a gas rich in methane and at least one substance selected from the group consisting of steam and carbon dioxide, and passing the mixture thus obtained through the regenerator and then into the generator.

2,523,384
METHOD OF MANUFACTURING HYDROGEN AND CARBON MONOXIDE
du Bois Eastman, Scarsdale, N.Y., assignor to The Texas Co., New York, N.Y., a corporation of Delaware.
Sept. 26, 1950; application filed Aug. 17, 1945; Serial No. 611,173; 8 claims.
1. In the preparation of synthesis gas containing CO and H₂ by conversion of normally gaseous hydrocarbons, the method comprising maintaining separate exothermic and endothermic reaction zones, maintaining a particle mass of solid catalyst-bearing heat carrier continuously moving through both said zones in succession, said catalyst being effective for converting gaseous hydrocarbons into CO and H₂, continuously introducing a stream of said gaseous hydrocarbons to said exothermic zone, continuously introducing thereto a gas rich in free oxygen, effecting substantially complete combustion of hydrocarbons and free oxygen in said exothermic zone and in proportions effective to produce a high temperature combustion gas consisting essentially of CO₂ and H₂O in the presence of said catalyst whereby said catalyst is raised to an elevated temperature in excess of about 2,000° F. prior to passing from the exothermic zone to the endothermic zone, discharging combustion gas from the exothermic zone at said elevated temperature, passing a stream of said discharged gas while substantially at said elevated temperature, directly into said endothermic zone, continuously introducing a separate stream of feed hydrocarbons to said endothermic zone, effecting substantial reaction of said separate stream of hydrocarbons with CO₂ and H₂O constituents of said combustion gas in the presence of heated catalyst moving through said endothermic zone at a temperature above about 1,800° F., thereby producing synthesis gas consisting essentially of CO and H₂, discharging resulting synthesis gas from the endothermic zone, continuously removing catalyst from the endothermic zone, and recycling removed catalyst to said exothermic zone.
PROCESS FOR MANUFACTURE OF INDUSTRIAL AND POWER GASES
Oct. 10, 1850; application filed June 10, 1944, Serial No. 539,686; 3 claims.

1. An intermittent process for the manufacture of water gas in a generator operated to produce an ash bed resting on a grate in the bottom thereof, a reaction zone above the ash bed formed by blasting the fuel to incandescence, and a fuel bed above the reaction zone, comprising the steps of blasting fuel in said reaction zone to incandescence by means of a blast of air passing in an up direction successively through said grate and said ash bed hot from a previous operation, passing the hot blast gases leaving the top of said reaction zone to a regenerator to heat the same, then initiating the gas-making cycle by passing steam through the heated regenerator and thence downwardly through the reaction zone to produce water gas, passing the water gas from said reaction zone downwardly into the ash bed and removing said water gas through an outlet in the generator wall, which is located at a fixed point above the grate, regulating the depth of the ash bed between the point of withdrawal of the water gas and the bottom of the reaction zone so as to store therein a large part of the sensible heat of the water gas passing therethrough, and utilizing the thus extracted heat from the water gas made in said gas making down run to preheat gases led to said generator through said ash bed in a succeeding up run.

MANUFACTURE OF WATER GAS
Oct. 10, 1950; application filed June 21, 1945, Serial No. 600,694; 1 claim.

An intermittent process for the manufacture of carbureted water gas in a generator operated to produce an ash bed resting on a grate in the bottom thereof, a reaction zone above the ash bed, formed by blasting the fuel to incandescence, and a fuel bed above the reaction zone, comprising the steps of blasting fuel in said reaction zone to incandescence by means of a blast of air passing in an up direction successively through said grate and said ash bed hot from a previous operation, passing the hot blast gases leaving the top of said reaction zone to a regenerator to heat the same, then initiating the gas-making cycle by passing steam through the heated regenerator and thence downwardly through the reaction zone to produce water gas passing the water gas from said reaction zone downwardly into the ash bed and removing said water gas through an outlet in the generator wall, which is located at a fixed point above the grate, regulating the depth of the ash bed between the point of withdrawal of the water gas and the bottom of the reaction zone so as to store therein a large part of the sensible heat of the water gas passing therethrough, utilizing the thus extracted heat from the water gas made in said gas making down run to preheat gases led to said generator through said ash bed in a succeeding up run, and mixing the water gas leaving the generator with a gas containing carbon monoxide and hydrogen, which has been obtained by decomposing a hydrocarbon-containing gas mixed with a gas selected from the group consisting of carbon dioxide and steam by passage through a regenerator, which has been heated at least partly by means of gases leaving said generator in a blast period.
2,527,197

METHOD OF PRODUCING A CARBON MONOXIDE AND HYDROGEN GAS MIXTURE FROM CARBONACEOUS MATERIALS


1. A continuous process for producing a mixture of CO and H₂ of sufficient purity to be utilized in a hydrocarbon synthesis process which comprises charging a subdivided carbonaceous material to a burning zone of a gas-generating system containing a plurality of contiguous zones disposed in the form of cylindrical sectors about a common axis within the same general confined space, said zones being in continuous open communication, some of said zones being burning zones, some water gas-generating zones and the remainder neutral zones, passing air upwardly in said burning zone at a velocity sufficient to fluidize said carbonaceous material, partially burning the carbonaceous material in said first-named burning zone, withdrawing partially burnt carbonaceous material from a point above the bottom of said first-named burning zone and passing the same to the top of a contiguous neutral zone, whereby said partially burnt carbonaceous material flows downwardly to the bottom of said neutral zone in the form of a dense suspension, passing said partially burnt carbonaceous material from the bottom of said neutral zone into a contiguous water gas-generating zone, introducing steam into said last-named zone under conditions to fluidize said partially burnt carbonaceous material, maintaining water gas-generating temperatures in said last-named zone, forming a mixture of CO and H₂ in said zone, withdrawing water gas from said zone substantially uncontaminated by flue gas from said burning zone, withdrawing unConsumed carbonaceous material from a point above the bottom of said water gas generation zone, passing the same into a second neutral zone contiguous to said water gas generation zone, flowing said material downwardly in said second neutral zone and passing it therefrom to a second burning zone.

2,527,198

APPARATUS FOR GASIFYING CARBONACEOUS SOLIDS


1. A treating apparatus of the character described comprising in combination a cylindrical treating vessel, at least one plate extending diametrically from the top to a point above the bottom of said treating vessel, thus forming at least two cylindrical sectors in continuous open communication at their lower portion, at least one additional plate extending upwardly from the bottom of said treating vessel diametrically and at an angle to the first-named plate, the plates together thus forming a plurality of cylindrical sectors, said last-named plate extending from the bottom of said vessel to a point above the lower end of said first-named plate below the top of said vessel, conduit means for introducing finely divided solids into at least one of said cylindrical sectors, at least two separate conduit means for introducing gasform material in said cylindrical sectors for treating said solids, means for withdrawing gasform material from an upper portion of said treating vessel, and means for withdrawing treated solids from the lower portion of said treating vessel.
METHOD FOR FLUIDIZED LOW-TEMPERATURE CARBONIZATION OF COAL
Dec. 12, 1950; application filed Nov. 22, 1946; Serial No. 711,755; 4 claims.

1. In the low-temperature carbonization of subdivided bituminous coal at carbonization temperatures of about 800°-1,200° F. in the form of a dense turbulent fluidized mass maintained at said carbonization temperatures in a carbonization zone by burning a portion of said coal in said carbonization zone, the improvement which comprises maintaining the bituminous coal to be carbonized as a dense turbulent fluidized mass of solids having a fluidizable particle size in a drying zone at a drying temperature, withdrawing substantially dry moisture-absorbing fluidizable char having a particle size similar to that of said bituminous coal downwardly from said carbonization zone, adding said withdrawn char to said drying zone substantially at said carbonization temperature, said added char supplying in the form of sensible heat of solids substantially all the heat required for drying, and supplying a fluidized mixture of bituminous coal and char from said drying zone to said carbonization zone.

PROCESS OF MANUFACTURING CARBURATED WATER GAS
Kenneth W. Stookey, Cleveland, Ohio, assignor to The Gas Machinery Co., Cleveland, Ohio, a corporation of Ohio.
Jan. 9, 1951; application filed June 30, 1944; Serial No. 542,862; 6 claims.

1. In the processes of manufacturing carbureted water gas, in a gas-making set, which includes a generator, carbureting apparatus, a conduit connecting the generator and the carbureting apparatus, and flow-direction control valves, and in which a known cycle of operations consists in first upwardly blasting the fuel bed in the generator with air admitted at the bottom of the generator and burning the blow gases in the carbureting apparatus with air admitted to the latter and passed therethrough, then effecting a steam run upwardly through the fuel bed with steam admitted at the bottom of the generator and simultaneously spraying heavy oil upon the top of the fuel bed and passing the resultant gaseous products through the carbureting apparatus, and then effecting a steam run downwardly through the fuel bed with steam admitted at the top of the generator and withdrawing the resultant gaseous products from the bottom of the generator, the improvements which consist, in using soft fuel as a preponderant percent of the generator fuel, periodically charging fresh fuel into the top of the generator, and after charging fresh fuel in effecting the following steps before the blasting phase of at least the first of the subsequent cycles: admitting a small amount of steam to the bottom of the generator and overblasting the fuel bed with air admitted to the generator adjacent above the fuel bed to burn in the top of the generator the blue water gas and the coal gas thus generated therein, thus creating additional heat in the top of the generator and insuring the carbonizing of the soft fuel charged therewith.
2,538,219
COAL GASIFICATION
Jan. 16, 1951; application filed Sept. 27, 1946, Serial No. 699,656; 27 claims.
1. A method of converting solid carbonaceous material into a commercial mixture containing CO and H₂, which comprises continuously supplying to a water gas-generating zone a supply of carbonaceous particles and essentially inert particles of different sizes, said inert particles being of a fluidizable size such that they will be suspended in an upwardly flowing stream of steam, while said carbonaceous particles are predominantly of a non-fluidizable size such that they will gravitate downwardly as a loosely compacted moving bed countercurrent to said stream, maintaining in said zone a temperature sufficiently high to support a reaction of the steam with said carbonaceous particles to form CO and H₂, passing steam upwardly through the downwardly moving bed, at a velocity sufficient to entrain said inert particles and carbonaceous fines present in said bed, and to form a dense phase of carbonaceous fines and inert particles above said bed, the dense phase being separated by an interface from a superimposed dilute phase of these materials, withdrawing inert particles and carbonaceous fines from said dense phase and conducting them with added air to a heating zone, the quantity of inert particles being in large excess over the quantity of carbonaceous fines, burning some of said carbonaceous fines with said air in said heating zone whereby said inert particles are heated and returning inert particles thus heated to the water gas-generating zone at a lower point thereof.
PROCESS FOR CARRYING OUT ENDOThERMIC CHEMICAL REACTIONS

Vernon F. Parry, Golden, Colo.
Jan. 30, 1951; application filed Apr. 20, 1945, Serial No. 589,450; 1 claim.

The endothermic chemical-reaction process, which comprises stage heating a noncaking solid material having gas-forming and liquefiable constituents in size-graded condition along a vertically ranging course sealed from the atmosphere through which it passes by gravity, first feeding the solids downwardly into an annular preheating zone of relatively large cross-sectional area in said course, directing heated gases upwardly in the central space bounded by the inner surface of said annular zone in heat transfer and physically separated relation to said descending solids, next directing the descending solids into a second annular heating zone of lesser cross-sectional area than the first-named annular zone, subjecting the solids in said second zone to the heat-transfer action of products of combustion contacting the outer surface thereof, causing evolved gases to travel concurrently with the solids throughout substantially the vertical extent of said second zone, passing said evolved gases into the central space bounded by the inner surface of said second annular zone to permit their ascent in heat-transfer relation to the descending material, passing said gases after their ascent to the central space bounded by the inner surface of the first annular zone to form the supply of heated gases named above, then directing the descending solids into a third annular heat-transfer zone in which they are subjected to heat-transfer influences applied both centrally and externally of said zone, causing relatively cool carrier gases to pass through the solids in said third zone in a direction countercurrent to the solids movement therein to extract heat units and evolved gases therefrom, and then passing the carrier gases from the top of the third annular zone to the central space bounded by the inner surface of the second annular zone.
2,543,795

PRODUCTION OF LIQUID AND GASEOUS FUELS BY SYNTHESIS FROM COAL
Mar. 6, 1951; application filed Oct. 1, 1949, Serial No. 119,142; 7 claims.

1. A continuous process for producing a fuel gas of high heating value, which comprises charging a subdivided carbonaceous material and a subdivided catalytic material to an initial zone, procuring said carbonaceous solid and said catalyst in the form of a turbulent well-mixed fluidized mass, contacting the said mass with a gas containing hydrogen and carbon monoxide at carbonization and methane synthesis conditions for a sufficient period of time to cause substantial conversion to methane, withdrawing carbonized carbonaceous solids and catalyst from the methane synthesis zone and charging them to an elutriation zone, causing a gasform material to flow upwardly in said elutriation zone in contact with said solids at a low velocity regulated to effect the segregation of two layers of aerated solid, the upper of which is a coke layer and the lower of which is a catalyst-containing layer, withdrawing the catalyst-containing layer from said elutriation zone, adjusting the temperature of the withdrawn catalyst, returning the said catalyst to the methane synthesis zone, withdrawing the coke from the elutriation zone, charging it to a gasifying zone, contacting the coke in the form of a fluidized mass in said last-named zone with steam and oxygen under gasification conditions for a sufficient period of time to effect the desired conversion to gasform product containing a high proportion of H₂ and CO, withdrawing the gasform product from said gasifying zone, and thereafter charging said gas containing hydrogen and carbon monoxide to said carbonization and methane synthesis zone and recovering from said carbonization and methane synthesis zone a fuel gas of improved heating value.
2,549,117
FLUIDIZED CARBONIZATION
Apr. 17, 1951; application filed Oct. 2, 1946; Serial No. 700,684; 9 claims.

1. In the process of carbonizing carbonizable fuels at carbonization conditions of temperature and pressure in the form of a dense turbulent bed of finely divided solids fluidized by an upwardly flowing gas wherein volatile carbonization products carrying entrained solids fines are passed through a gas-solids separation zone to remove entrained finely divided solids therefrom and a heat transfer is provided for between said bed and said separation zone sufficient to prevent a substantial temperature drop between said bed and said separation zone, the improvement which comprises passing a separate stream of solids at a temperature at least as high as that prevailing in said bed from said bed directly to said separation zone.

2,552,308
LOW-PRESSURE HYDROCARBON SYNTHESIS PROCESS
Fred J. Buchmann and Alexis Voorhies, Jr., Baton Rouge, La., assignors to Standard Oil Development Co., a corporation of Delaware.
May 8, 1951; application filed June 16, 1949; Serial No. 99,378; 6 claims.

1. An improved process for converting CO and H₂ to normally liquid hydrocarbons of high olefin content, which comprises contacting CO and H₂ in synthesis proportions under synthesis conditions comprising pressures of from about 50 to about 100 p.s.i.g. with a dense turbulent fluidized mass of finely divided synthesis catalyst, said catalyst comprising an activated carbon support carrying as active component iron promoted with not less than 0.4 and not more than 1.0 percent by weight of the total catalyst, of an alkali metal promoter.
MANUFACTURE OF WATER GAS


May 15, 1951; application filed May 1, 1944, Serial No. 533,540; 3 claims.

1. A continuous low-pressure process of making water gas and the like, which consists in heating finely divided carbonaceous material of the class consisting of peat, lignite, and wood, in the presence of oxygen to char the carbonaceous material, pumping a stream of said charred carbonaceous material at about 30 feet per second, injecting superheated steam under superatmospheric pressure of 50 to 500 p.s.i. into said material to suspend said material in said steam and thereby render the same fluent, externally heating about 800 to 2,000 feet of said steam to a temperature between 800° and 1,600° F. and throttling said stream to maintain it under a static pressure of 50 to 500 p.s.i.

2,554,263

GASIFICATION OF CARBONACEOUS SOLIDS


May 22, 1951; application filed Dec. 18, 1946, Serial No. 717,064; 6 claims.

1. The process of converting solid carbonaceous fuels into gases containing carbon monoxide by an endothermic reaction with a gaseous gasifying medium conducted at an elevated conversion temperature in a conversion zone, which comprises contacting carbonaceous solids with a sufficient amount of said gasifying medium at a conversion temperature to convert a substantial proportion of the carbon of said fuels into said gases in said conversion zone, withdrawing product gas from said conversion zone, withdrawing solid carbonaceous gasification residue from said conversion zone, passing said withdrawn residue to a heating zone, subjecting said residue in said heating zone to a heat-generating incomplete combustion at a temperature substantially above said conversion temperature and below the fusion point of its ash, withdrawing flue gas from said heating zone, withdrawing carbonaceous heating-zone residue from said heating zone, passing a portion of said heating-zone residue to a combustion zone, subjecting said portion to combustion with a combustion-supporting gas in said combustion zone at a combustion temperature above the fusion point of the ash of said carbonaceous solids and at a ratio of combustion-supporting gas at least sufficient to burn completely the carbonaceous constituents of said portion subjected to said combustion, withdrawing liquid ash from said combustion zone, passing hot flue gases from said combustion zone substantially at the temperature of said combustion to said heating zone and passing another portion of said heating zone residue substantially at the temperature of said heating zone to said conversion zone to supply at least a portion of the heat required by said reaction.
2,554,264

PROCESS FOR TREATING HYDROCARBON SYNTHESIS TAIL GAS
May 22, 1951; application filed Oct. 28, 1948, Serial No. 56,682; 5 claims.
1. In the process of reacting CO with H₂ and making synthetic hydrocarbons in which some of the tail gas is recirculated back to the reactor along with the fresh feed (gas comprising essentially CO+H₂), the step of preparing the tail gas for said recirculation by passing it as a stream upwardly through and in contact with a downwardly flowing deep mass of finely divided hot solids while the temperature of said solids in at least a zone between the top and bottom of said mass in said reactor is between about 1,200° F. and 1,500° F. at a rate adapted to maintain said mass in said reactor in a fluidized state, at a contact time greater than one second and sufficient substantially to decompose acetylenic compounds thereby beneficiating said tail gas.

2,556,019

MANUFACTURE OF WATER GAS OR GAS CONSISTING LARGELY OF CARBON MONOXIDE AND HYDROGEN
June 5, 1951; application filed Jan. 7, 1947, Serial No. 720,655; 3 claims.
1. In a cyclic process for the manufacture of water gas or the like the steps of passing air and reaction gas upwardly through the generator for blasting the fuel bed and for uprun gas making, respectively, the said air and reaction gas being first preheated in a recuperator by heat exchange with the product gases of their respective passage through the generator, passing the said product gases first through a regenerator on their way to the recuperator, thereby reducing in extent and rapidity cyclic fluctuations in the temperature of the product gases entering the said recuperator; and passing reaction gas for backrun gas making through part of the regenerator disposed nearest to the generator without directly cooling the remaining part of the mass in the regenerator disposed nearest to the recuperator and then downwardly through the fuel bed.
PROCESS FOR PRODUCING GAS MIXTURES

Frank T. Barr, Summit, N.J., assignor to Standard Oil Development Co., a corporation of Delaware.

June 12, 1951; application filed Dec. 29, 1949; Serial No. 658,428; 4 claims.

1. An improved process for converting hydrocarbon gas to hydrogen and an oxide of carbon, which comprises compressing air and burning the fuel with said air in at least one or more than two heat regenerative zones for alternate combustion and reforming cycles both operated at substantially the same pressure within the range of 3-50 atmospheres, continuing the combustion until the respective regenerative zone is raised to a reforming temperature while withdrawing combustion products under pressure, utilizing the energy of such combustion products to compress the air, discontinuing combustion and passing hydrocarbon gas along with a reforming agent through said respective regenerative zone under substantially the same pressure whereby hydrogen and an oxide of carbon are produced, discontinuing the passage of the hydrocarbon and the reforming agent when the temperature of said respective zone falls below the reforming temperature, continuing thereafter alternative cycles of combustion and reforming under substantially the same pressure, conducting the same cycles in all of said zones, and operating said cycles out of phase with respect to different zones, in such a manner that a substantially continuous and constant flow of heating exhaust gases is maintained to said utilizing stage.
FLUIDIZED PROCESS FOR CARBONIZATION OF CARBONACEOUS SOLIDS
June 19, 1951; application filed Feb. 15, 1947, Serial No. 728,794; 5 claims.

1. In the process for heat-treating carbonaceous solids by intimately contacting a dense turbulent bed of subdivided carbonaceous solids fluidized by an upwardly flowing gas stream in a reactor with a hot subdivided solid heat carrier having a lower gas entrainability than said carbonaceous solids, which carbonaceous solids are also highly heated in a separate heater in the form of a fluidized solids mass, separately heat-treated carbonaceous solids from cooled heat carrier by virtue of the different fluidizable characteristics between the carbonaceous solids and the heat carrier and returning cooled heat carrier to said heater, the improvement which comprises feeding said carrier to the upper portion of said heater, feeding fuel and a combustion-supporting gas to a lower portion of said heater conducting a heat-generating combustion in said lower portion passing hot combustion gases from said lower portion to said upper portion, adjusting the superficial velocity of said combustion gases so as to percolate said carrier from said upper portion downwardly to said lower portion countercurrently to upflowing combustion gases through a multitude of narrow passageways irregular with respect to shape, diameter, and direction extending over a substantial height and occupying the entire cross-sectional area of an intermediate portion of said heater, further heating said carrier in said lower portion by said combustion, withdrawing hot heat carrier from said lower portion, introducing hot heat carrier so withdrawn and fresh carbonaceous solids into an intermediate area of said reactor, adjusting the superficial gas velocity in said reactor so as to cause said heat carrier to flow downwardly in said reactor, withdrawing cooled heat carrier from a lower portion of said reactor and returning said cooled heat-carrier solids to an upper portion of said heater, passing carbonaceous solids upwardly through said reactor as a result of said adjusted gas velocity to an upper expanded portion of said reactor, withdrawing volatile heat-treated products overhead from said reactor, and withdrawing heat-treated carbonaceous solids from the said upper expanded portion of said fluidized bed.
PRODUCTION OF CARBON MONOXIDE AND OTHER GASES FROM CARBONACEOUS MATERIALS

Leon P. Gaucher, Mount Vernon, N.Y., assignor to The Texas Co., New York, N.Y., a corporation of Delaware.

July 3, 1951; application filed Feb. 10, 1948, Serial No. 7,446; 5 claims.

1. In a process for the generation of carbon monoxide and hydrogen from a solid carbonaceous fuel by reaction with oxygen and steam, the improvement which comprises introducing said solid carbonaceous fuel in powdered form into the upper end of a vertical elongated cylindrical reaction zone, contacting said powdered fuel in said zone at the upper end adjacent the fuel inlet with a gas containing in excess of 90 percent free oxygen by volume in an amount sufficient to oxidize only a portion of said powdered fuel thereby liberating heat and producing a gaseous reaction product containing carbon dioxide, passing the resulting hot gaseous reaction product and heated residual powdered fuel through said reaction zone to the lower end thereof, and introducing steam into said reaction zone at a plurality of spaced points on the periphery of said zone and along the path of said fuel at an angle upwardly toward the inlet end from 5° to 30° from the horizontal and inwardly from 5° to 30° from the tangent to impart a rotary motion to the reactants and products, and withdrawing the resulting product gases comprising carbon monoxide and hydrogen from said lower end of said reaction zone.

HYDROCARBON SYNTHESIS


July 3, 1951; application filed Aug. 24, 1946, Serial No. 692,874; 7 claims.

1. In the catalytic production of hydrocarbons from carbon monoxide and hydrogen, a process which comprises generating a synthesis gas containing carbon monoxide and hydrogen but substantially no oxygenated hydrocarbons in a gas-generation zone under conditions involving partial combustion of hydrocarbonaceous material at a temperature in order of 2,100° F. and higher with oxygen, which result in a generator effluent gas having entrained therein small amounts of difficulty removable solid carbonaceous particles formed in said generation zone, scrubbing said particles from said effluent gas with liquid obtained at a subsequent point in the process, passing resulting scrubbed gas to a synthesis reaction zone containing a synthesis catalyst maintained under conditions effective for the reaction of carbon monoxide with hydrogen, removing from said synthesis zone a product containing hydrocarbons, water, and some oxygenated hydrocarbons, separating from said product a liquid fraction consisting essentially of water containing dissolved oxygenated hydrocarbons and eecting the aforesaid scrubbing with said separated liquid fraction.
METHOD FOR PROCESSING CARBONACEOUS SOLIDS
Maurice H. Arveson, Flossmoor, Ill., assignor to Standard Oil Co., Chicago, Ill., a corporation of Indiana
July 10, 1951; application filed Apr. 3, 1944; Serial No. 529,240; 9 claims.

1. The process of producing carbon monoxide and hydrogen and recovering hydrocarbons which comprises maintaining a body of finely divided carbonaceous solids within a first zone in a dense turbulent solids phase, maintaining said body at a high temperature by introducing hot solids into said first zone, reacting water vapor with the carbonaceous solids whereby carbon monoxide and hydrogen are produced, continuously separating gaseous products and solids separately withdrawing incandescent solids from the dense turbulent solids phase, introducing the withdrawn incandescent solids into a second contacting zone in an amount sufficient to all heat required therein, introducing raw finely divided carbonaceous solids into said second contacting zone, maintaining the finely divided solids within said second zone in a dense turbulent solids phase continuously separating gases and solids within said contacting zone, separately withdrawing solids from said second zone, transferring the withdrawn solids to a third contacting zone, supplying an oxygen-containing gas to said third zone and passing it through the zone at a rate sufficient to maintain a dense turbulent solids phase therein, maintaining the temperature of the solids within said zone at a high level by burning a portion of the carbonaceous solids with said oxygen-containing gas, withdrawing a portion of the hot carbonaceous solids from the dense turbulent suspended phase, and supplying at least a part of said withdrawn solids to the first zone.

METHOD FOR CONDUCTING AN ENDOOTHERMIC CHEMICAL REACTION INVOLVING BOTH GASEOUS AND SOLID FEED MATERIALS
Vernon V. Parry, Golden, Colo.
Oct. 28, 1951; application filed Apr. 20, 1945; Serial No. 580,450; 2 claims.

1. A method for conducting an endothermic chemical reaction involving gaseous and solid materials which comprises passing a comminuted non-caking coal, having at least 10 percent by weight of oxygen content on a moisture- and ash-free basis, together with from 0.2 to 2 pounds of steam per pound of coal, through a heated annular reaction zone of progressively increasing temperature from about 700° F. to about 2,000° F., then separating evolved gases and vapors from the heated solids passing them in indirect heat-exchange relationship to said reaction zone countercurrent to material flow therein and recovering said evolved gases and vapors, then passing the partially reacted coal through a second annual reaction zone maintained at a temperature gradient, measured in the direction of solid material flow, proceeding from about 2,000° F. to about 700° F. while passing an oxygenated gas from the group of air, steam, oxygen, and carbon dioxide first in indirect co-current heat-exchange relation to said coal in said second zone and then in a direct countercurrent heat-exchange relation to said coal in said second zone, whereby said oxygenated gas reacts with said heated coal and is replaced by evolved hydrogen and carbon monoxide, and finally combining said evolved gases from said second zone with the evolved gases and vapors from said first zone.
2,572,829
COAL-GASIFICATION PROCESS AND APPARATUS
Robert G. Atkinson, Bartlesville, Okla., assignor to Phillips Petroleum Co., a corporation of Delaware
1. The process for gasifying a carbonaceous material in a reaction chamber of generally circular transverse cross section which comprises introducing into said reactor in a direction parallel to the longitudinal axis through a reactant inlet port in one end of said reactor a mixture of the finely divided carbonaceous material, free oxygen, and steam; maintaining a reactor temperature above 750° C.; simultaneously passing into said reactor through a port adjacent the reactant inlet a suspension of the finely divided carbonaceous material and an endothermic gas-making fluid containing oxygen, said suspension being introduced into said reactor in a direction and in sufficient quantity as to be maintained adjacent the whole inner surface of the reactor sidewall, thus forming a separating layer of said finely divided solid and gas between said sidewall and the reaction zone in the center of said chamber, thereby shielding the walls of said reaction chamber from the heat radiations from the reaction zone and simultaneously preheating said finely divided carbonaceous material; removing the gaseous reaction products from said chamber; removing the mixture of finely divided carbonaceous material and suspending gas from said chamber and reintroducing said mixture together with a free oxygen-containing gas into said chamber through the reactant inlet port for conversion into gaseous products.

2,577,017
PREPARATION OF HEAVY HYDROCARBONS OF HYDROGEN ISOTOPES
Lebbeus C. Kemp, Jr., Scarsdale, N.Y., assignor to The Texas Co., New York, N.Y., a corporation of Delaware
Dec. 4, 1951; application filed Nov. 28, 1948, Serial No. 61,592; 9 claims.
1. In the production of desired deuterocarbon fractions, the steps which comprise preparing carbon monoxide by the reaction of carbon dioxide with free carbon at an elevated temperature in a gasification zone, reacting a portion of the carbon monoxide thus formed with D₂O in a shift reaction zone, under reaction conditions including an elevated temperature at which the reactants are shifted to form free deuterium and carbon dioxide, separating carbon dioxide from the resultant stream and supplying said separated carbon dioxide to said gasification zone for the production of additional carbon monoxide, passing resulting deuterium and an unconverted portion of said carbon monoxide in contact with a synthesis catalyst in a synthesis zone maintained at a temperature and pressure such that a substantial portion of the feed is converted into deuterocarbons, withdrawing from contact with said catalyst a reaction effluent including said deuterocarbons, together with byproduct D₂O, recovering therefrom desired fractions of deuterocarbon, subjecting remaining deuterocarbon fractions to contact with D₂O in a reforming zone, under conditions including an elevated temperature effective to reform free deuterium and carbon monoxide and recycling said reformed products to the inlet of said synthesis zone.
PROCESS FOR SUPPLYING PLASTICIZABLE CARBONACEOUS SOLIDS INTO A GASIFICATION ZONE

Bruno E. Roetheli, Cranford, N.J., assignor to Standard Oil Development Co., a corporation of Delaware

Dec. 4, 1951; application filed Aug. 27, 1946, Serial No. 693,298; 8 claims.

1. In the process of supplying finely divided solids which pass through a plastic state at elevated temperatures, to a treating zone operated at a temperature higher than said plasticizing temperature, wherein said solids are maintained in the form of a dense turbulent mass of finely divided solids fluidized by an upwardly flowing gas to resemble a boiling liquid having a well defined upper level, the improvement which comprises passing finely divided solids of a fluidizable particle size under the pseudohydrostatic pressure of a vertical aerated column of said solids the upper level of which is substantially above said first-named level, through a confined path opening into said treating zone below said first-named level at a point above, but close to, the bottom of said mass, and introducing a gaseous medium which does not detrimentally affect the desired treatment in said treating zone and which has a temperature lower than said plasticizing temperature, in heat exchange with and in the direction of flow of said finely divided solids, into said treating zone, at a rate not substantially exceeding that required to maintain the temperature of said finely divided solids below plasticizing temperature prior to the entry into said treating zone.
METHOD FOR HANDLING FUELS
Bruno E. Roetheli, Cranford, N.J., assignor to Standard Oil Development Co., a corporation of Delaware
Dec. 18, 1951; application filed May 15, 1948; Serial No. 487,187; 18 claims.

1. The continuous process of carbonizing and gasifying finely divided solid carbonaceous material while said material is in a fluidized state which comprises continuously charging a finely divided fuel and steam into a fluidized mass of previously carbonized finely divided solids at a carbonization temperature in a carbonizing zone so that the thus-mixed solids are in a fluidized state therein, whereby carbonizing said fuel, continuously circulating the hot carbonized solids from said zone to a separate combustion zone in which they are fluidized along with previously carbonized fuel, burning some of the fluidized solids in the said combustion zone by blasting them continuously with a combustion supporting fluid, thereby heating them to a gas-making temperature, continuously withdrawing hot solids from said combustion zone, charging them while at a gas-making temperature into a separate gas-generating zone in which they are also fluidized, blasting them in the latter zone with steam to generate combustible gas, continuously withdrawing a solid residue from said gas-generating zone and returning at least a portion of it continuously to said combustion zone to be reheated, recirculating a portion of the said hot carbonized fuel from said combustion zone to said carbonizing zone, removing the volatile products of carbonization from said carbonizing zone, and separately removing the said combustible gas from said gas-generating zone.
METHOD FOR HANDLING FUELS
Bruno E. Roetheli, Cranford, N.J., assignor to Standard Oil Development Co., a corporation of Delaware
Dec. 18, 1951; application filed Aug. 8, 1945, Serial No. 609,662; 9 claims.

1. An improved process for producing valuable liquid and gaseous products from solid carbonaceous materials, which comprises passing a stream of finely divided carbonaceous solid material into a carbonization zone to form a fluidized mass of solids therein maintained at a carbonization temperature, whereby distillable portions of the material are removed, leaving a coky residue in finely powdered fluidized form, withdrawing said fluidized residue and passing the same into a gasification zone to form a fluidized mass of solids therein, reacting said mass with steam at a gasification temperature, withdrawing a fuel gas and withdrawing a fluidized residue of low carbon content from the gasification zone, feeding said latter residue to a combustion zone to form a fluidized mass of solids, therein, generating heat in said combustion zone by burning the carbonaceous constituents of said latter residue, withdrawing hot fluidized solid combustion residue from said combustion zone and feeding said hot combustion residue to said carbonization zone and to said gasification zone to supply heat required therein.

APPARATUS FOR CONTINUOUS PRODUCTION OF WATER GAS
Arthur R. Broadman, New York, N.Y., assignor to Heyden Chemical Corp., New York, N.Y., a corporation of Delaware
Jan. 8, 1952; application filed June 27, 1946, Serial No. 679,604; 2 claims.

1. An apparatus for the continuous production of water gas from a solid combustible carbonaceous material, which comprises a plurality of chambers through which passes a continuous traveling grate, each of said chambers communicating with a stack-gas flue and a water-gas flue, means on each of said chambers for closing the communication of said chamber with each of said two flues, means for charging the carbonaceous material to the traveling grate as a substantially uniform layer thereon, means for igniting the carbonaceous material on the traveling grate, and means in each of the chambers for blasting fluids through the layers of carbonaceous material while it progressively passes through said chamber on the traveling grate.
METHOD FOR CONVERSION OF CARBONACEOUS SOLIDS INTO VOLATILE PRODUCTS

Homer Z. Martin, Roselle, N.J., assignor to Standard Oil Development Co., a corporation of Delaware


1. The method of treating carbonaceous solids at an elevated temperature, which comprises maintaining in a treating zone a dense turbulent bed of finely divided solids having a particle size predominantly within the range of about 50- to 400-mesh fluidized by passing a gas upwardly through the carbonaceous solids at such velocity within the approximate range of 0.3-3 ft. per second that a lower dense fluidized phase having an apparent density of about 15-30 lb. per cu. ft. and a superimposed dilute phase separated by an interface are formed, burning a fuel in a combustion zone separated from, confined within, and in open communication with, said bed at a temperature substantially higher than said elevated temperature, supplying solids from said bed to said combustion zone, passing a gas upwardly through said combustion zone into said bed at a linear velocity within said combustion zone of the order of about 10-20 ft. per second and sufficiently high to maintain the apparent density of said solids in the neighborhood of about 1-2 lb. per cu. ft., whereby carbonaceous solids in said combustion zone are entrained and carried by said second-named gas in the form of a relatively dilute phase through said combustion zone into said bed, and controlling the temperature of said combustion and the supply of solids to said combustion zone so that the sensible heat of products of combustion and entrained solids entering said bed from said combustion zone is sufficient to heat said bed to said elevated temperature.

Fig. 1.

MANUFACTURE OF SYNTHESIS GAS

du Bois Eastman, Whittier, Calif., and Leon P. Gaucher, Tuckahoe, N.Y., assignors to The Texas Co., New York, N.Y., a corporation of Delaware


In Italy Apr. 4, 1950 : 11 claims. (Cl. 48—196)

1. In a process for the production of gas consisting essentially of carbon monoxide and hydrogen substantially free from solid carbon by reaction of a hydrocarbon with an oxygen-containing gas selected from the group consisting of substantially pure oxygen and oxygen-enriched air containing at least 40 volume-percent oxygen, the improvement which comprises continuously passing the reactants into a substantially completed closed reaction zone free from packing and catalyst and having an internal surface area not more than about 1.5 times the area of a sphere of equal volume; supplying said oxygen-containing gas to said reaction space in an amount such that the total quantity of oxygen supplied to the reaction space is in excess of that amount required theoretically for conversion of all of the carbon in the feed to carbon monoxide but substantially less than the amount theoretically required for conversion of all of the carbon in the feed to carbon dioxide while autogenously maintaining the reaction zone at a temperature in the range of 2,250°F. and higher; and continuously removing from the reaction zone an effluent stream of gas comprising carbon monoxide and hydrogen substantially free from carbon and uncombined oxygen, and containing not more than about 5 mol-percent methane.
METHOD FOR GASIFYING CARBONACEOUS FUELS

Frank T. Barr, Summit, Bruno E. Roetheli, Cranford, and Walter G. Schar mann, Westfield, N.J., assignors to Standard Oil Development Co., a corporation of Delaware

Mar. 4, 1952; application filed Dec. 18, 1945, Serial No. 634,762; 22 claims.

1. The process of converting solid carbonaceous material into valuable volatile fuels, which comprises passing finely divided carbonaceous material through a circuit comprising an endothermic conversion zone and a combustion zone, maintaining said material as a mass of fluidized solids in said conversion and combustion zones at elevated temperatures suitable for the production of volatile fuels from said materials, maintaining a substantial positive temperature gradient from said conversion zone to said combustion zone, feeding fresh carbonaceous solids of fluidizable particle size to said conversion zone, recovering a volatile fuel from said conversion zone, passing finely divided solid conversion residue from said conversion zone to said combustion zone, maintaining in said combustion zone at least two separate superimposed fluidized beds of solids, supplying said residue to a lower one of said beds so as to maintain a relatively high carbon concentration in said lower bed, maintaining in an upper one of said beds a fluidized mass of refractory solids containing carbon in relatively low concentration, not exceeding 5 percent, while adding thereto extraneous non-carbonaceous refractory solids from a source other than the ash particles leaving said lower bed, subjecting said residue to combustion in said lower bed with an oxidizing gas to produce a combustion gas containing substantial amounts of CO, passing said combustion gas in the presence of free oxygen and substantially at the temperature of said lower bed upwardly from said lower bed directly into a lower portion of said upper bed at combustion conditions conducive to burn CO completely to CO₂ at a temperature substantially higher than said lower-bed temperature, and passing finely divided solids highly heated in said combustion zone from the latter separately from said combustion gas to said conversion zone to supply heat required in said conversion zone.
METHOD FOR GASIFYING FUELS

Edwin J. Gohr, Summit, N. J., assignor to Standard Oil Development Co., Corporation of Delaware

Mar. 4, 1952; application filed Dec. 28, 1949; Serial No. 637,616; 3 claims.

1. The method of producing gaseous fuels from solid carbonaceous materials, which comprises maintaining finely divided solid carbonaceous materials in a vertical elongated conversion zone in a series of beds of dense, ebullient, fluidized condition by an upwardly flowing gas under reaction conditions suitable for the production of gaseous fuels therefrom, feeding finely divided solid carbonaceous material to the upper portion of said conversion zone, withdrawing fluidized relatively spent low carbon solids from a lower portion of said conversion zone, regulating the free circulation of solids within said fluidized beds essentially in a vertical direction downwardly from the upper high carbon portion of said conversion zone to the lower low carbon containing portion of said conversion zone, subjecting the carbonaceous constituents of said withdrawn solids to combustion with a combustion-supporting gas in a vertical elongated combustion zone, maintaining in said combustion zone a plurality of separate superimposed, dense, turbulent, fluidized solids beds, maintaining a relatively high carbon concentration in a lower one of said solids beds and a relatively low carbon concentration in a higher one of said solids beds, passing said withdrawn solids to said lower solids bed, supplying said combustion-supporting gas to said lower solids bed to support combustion therein, passing combustion gases and entrained low carbon solids from said lower to said higher solids bed at conditions suitable for converting substantially all of the CO produced to CO₂, passing combustion residue from said lower solids bed substantially at the temperature of the latter to said lower portion of said conversion zone and combustion residue from said upper solids bed substantially at the temperature of the latter to said upper portion of said conversion zone to supply heat required in said portions.
METHOD FOR CONTROLLING TEMPERATURE OF EXOTHERMIC REACTIONS SUCH AS GASIFICATION OF CARBONACEOUS SOLIDS

Henry J. Ogorzaly, Summit, N.J., assignor to Standard Oil Development Co., a corporation of Delaware

Apr. 1, 1952; application filed Sept. 29, 1949, Serial No. 118,688; 5 claims.

1. In the high-temperature treatment of subdivided solids with gases reacting exothermically with said solids to form a product gas and a solid reaction product in a reaction zone wherein said solids are maintained in the form of a dense, turbulent mass fluidized by upwardly flowing gases, product gas containing a substantial proportion of solids entrained is withdrawn upwardly from said mass and passed upwardly through a second fluidized solids mass maintained at a temperature substantially below said high temperature by means of heat exchange with a cooling agent and solids are returned from said second mass to said reaction zone, the improvement which comprises feeding fresh solids to said first-named mass returning solids at said lower temperature from said second mass to said first-named mass at a rate controlled to limit said high temperature at a desired maximum level by a direct heat exchange between said returned solids and said first-named mass, withdrawing product gas upwardly from said second mass, and recovering solid reaction product from said second mass independently of said product gas.

MANUFACTURE OF GAS MIXTURES CONTAINING CARBON MONOXIDE AND HYDROGEN

Frank T. Barr, Summit, and Homer Z. Martin, Roselle, N.J., assignors to Standard Oil Development Co., a corporation of Delaware

Apr. 8, 1952; application filed Aug. 8, 1946, Serial No. 689,156; 14 claims.

1. The process of producing carbon monoxide and hydrogen which comprises passing steam upwardly through a dense fluidized bed of finely divided carbonaceous solids of fluidizable particle size maintained in a gasification zone at gasification conditions of temperature and pressure in the presence of fluidizable particles of a metal oxide which oxidized carbonaceous materials at the gasification conditions and which has a lower buoyancy in gas than that of the solid gasification residue of said carbonaceous solids, said metal oxide being added in amounts and at a temperature sufficient to supply at least a substantial portion of the heat required to maintain said gasification temperature, withdrawing a gas containing carbon monoxide and hydrogen upwardly from said bed, passing the steam upwardly through the dense fluidized bed at a velocity such that metal oxide particles of reduced oxygen content are concentrated in the lower portion thereof to a relatively greater extent than in the upper portions of said fluidized bed, withdrawing a stream of solids from the lower portion of the fluidized bed passing said stream to a dense fluidized bed of finely divided metal oxide, passing air upwardly through said second named bed at conditions adapted to reoxidize said withdrawn metal oxide by an exothermic reoxidation reaction, and returning reoxidized metal oxide from said second-named bed to said first-named bed.
2,592,749
GAS TURBINE ENGINE ASSOCIATED WITH A GAS PRODUCER UNDER PRESSURE
Apr. 15, 1952; application filed Nov. 13, 1947, Serial No. 785,772; 7 claims.
1. The combination with a gas turbine plant including an air compressor, a combustion chamber connected to the delivering side of said compressor so as to be fed with combustion air therefrom and a gas turbine connected to the exit of said combustion chamber so as to be fed with motive gases therefrom, of a combustible gas-producing plant comprising a combustion gas producer adapted to operate and deliver combustible gas under a pressure much greater than that existing in said combustion chamber, a second air compressor the suction side of which is connected to the delivering side of the first-named compressor while its delivering side is connected to the air inlet of said gas producer so as to supercharge it, and a second gas turbine the inlet of which is connected to the gas-delivering side of said gas producer while its exit is connected to said combustion chamber in order to feed said chamber with combustible gas, said second gas turbine being adapted to expand the combustible gas from the high pressure existing in said gas producer to the pressure in said combustion chamber.

Fig. 1

2,593,477
PROCESS OF UNDERGROUND GASIFICATION OF COAL
Louis L. Newman, Washington, D.C., and Wilburn C. Schroeder, Clinton, Md., assignors to the United States of America as represented by the Secretary of the Interior
Apr. 22, 1952; application filed June 10, 1949, Serial No. 98,843; 5 claims.
(CI. 262—1)
1. An improved process for rapidly gasifying large areas of underground carbonaceous minerals with a minimum of underground work, involving the simultaneous use of a plurality of boreholes from the surface of the ground to the bed of the carbonaceous mineral, comprising the steps of forming a gallery of considerable length in a bed of carbonaceous mineral, forming a first set of boreholes communicating from the surface with said gallery, forming a plurality of additional sets of boreholes essentially parallel to and spaced laterally from said first set and from each other, and extending from the surface to said bed of carbonaceous mineral initiating combustion within said gallery, supplying oxygen-containing gas to said bed through alternate boreholes of said first set thereby maintaining a combustion zone along said gallery at the face of said carbonaceous mineral, removing the gases produced from intervening boreholes of said first set, continuing to supply oxygen-containing gas to, and to remove produced gas from, said first set of boreholes thereby advancing the combustion zone toward said second set of boreholes along a line essentially parallel to said gallery, transferring the operations of supplying oxygen-containing gas and of removing produced gases to said second set of boreholes as the combustion zone reaches said second set, and continuing to advance said combustion zone in like manner toward successive sets of boreholes, thereby rapidly and systematically advancing said combustion zone into said bed of carbonaceous mineral along a line essentially parallel to said initial gallery.
2,594,329

GAS GENERATOR


Apr. 29, 1952; application filed Apr. 30, 1947, Serial No. 745,052; 3 claims.

1. A gas generator for the production of carbon monoxide by the interaction of a carbonaceous fuel with oxygen at an elevated pressure, which comprises a relatively elongate and substantially vertical cylindrical inner shell closed at its lower end and having a refractory lining; a refractory partition extending across said inner shell dividing it into an enclosed reaction chamber adjacent the lower end of said inner shell and an elongate cooling chamber directly above said reaction chamber, said cooling chamber being open at its upper extremity; reactant inlets in said reaction chamber; an opening in said partition permitting product gas to pass from the reaction chamber to the lower portion of the cooling chamber; a pressure-resistant closed outer shell concentric with said inner shell and spaced around the outer walls of said inner shell to define an annular passage therebetween; an outlet in said outer shell communicating with said annular passage and located adjacent the lower extremity of the outer shell, the open upper extremity of said inner shell communicating with the upper closed end of said outer shell; and means for cooling said gases in the elongate cooling chamber within said inner shell comprising a multiplicity of bayonet heat-exchange tubes extending downwardly from the upper extremity of said outer shell into said cooling chamber within the inner shell.
2,594,330

GAS GENERATOR

Robert L. Mayhew, Great Neck, N.Y., assignor to Hydrocarbon Research, Inc.,
New York, N.Y., a corporation of New Jersey

Apr. 29, 1952; application filed May 6, 1947; Serial No. 746,346; 2 claims.

1. A gas generator for the production of carbon monoxide by the interaction of a carbonaceous fuel with oxygen at an elevated pressure comprising a relatively elongate and substantially vertical cylindrical inner shell having a refractory lining, a refractory partition extending across said shell dividing it into a reaction chamber and an elongate cooling chamber, said reaction chamber being in the lower extremity of said inner shell, reactant inlets in said reaction chamber, a passageway in said partition permitting the product gases to pass from the reaction chamber to the cooling chamber, gas outlet means from said cooling chamber adjacent the upper extremity of said inner shell, a pressure-resistant outer shell concentric with said inner shell and spaced around the outer wall of the inner shell to define an annular passage space therebetween, an outlet in said outer shell from said annular passage space located adjacent the lower extremity of said outer shell, said gas outlet means from said cooling chamber in the upper extremity of said inner shell communicating with the upper portion of said annular passage space, means for cooling the gases in the cooling chamber comprising a steam drum supported in the upper portion of said cooling chamber, a mud drum adjacent the lower end of said cooling chamber, a plurality of steam-generating tubes extending longitudinally of said cooling chamber between said steam and mud drums to form a pattern extending over the transverse area of said cooling chamber, a plurality of downcomer tubes between said drums, and refractory means surrounding said downcomer tubes effective to substantially limit heat transfer between said downcomer tubes and the product gases in said cooling chamber.
PROCESS FOR PRODUCTION OF FUEL GAS FROM CARBONACEOUS SOLID FUELS

du Bois Eastman, Whittier, Calif., assignor to The Texas Co., New York, N.Y., a corporation of Delaware

May 6, 1932; application filed June 15, 1949, Serial No. 99,182; 5 claims.

1. In a process for the generation of fuel gas from a solid carbonaceous fuel containing volatilizable constituents, the improvement which comprises admixing said solid carbonaceous fuel in particle form with sufficient water to form a fluid suspension, passing said suspension through a heating zone at an elevated temperature such that substantially all of the water is vaporized thereby forming a dispersion of coal in steam, passing the resulting dispersion into a fluidized bed of solid carbonaceous material in a methanization zone into contact with carbon monoxide and hydrogen at a temperature within the range of from about 900°F to about 1,800°F, whereby carbon monoxide and hydrogen are converted to methane and volatile constituents of said solid carbonaceous material are distilled therefrom withdrawing carbonaceous material from said methanization zone and passing it into contact with oxygen and steam in dilute phase in a gasification zone maintained at a temperature within the range of from about 2,000°F to about 3,000°F, passing the resulting gases comprising carbon monoxide and hydrogen from the gasification zone into the methanization zone as the source of carbon monoxide and hydrogen therefor, and discharging the gaseous products of the methanization zone as the raw product fuel gas.

METHOD OF AND APPARATUS FOR MANUFACTURE OF CARBURETED WATER GAS


May 6, 1952; application filed June 3, 1948, Serial No. 30,846; 13 claims.

1. In the cyclic manufacture of carbureted water gas by a blow and run process which comprises during a heating period of the cycle blasting an ignited bed of solid fuel with air to raise the temperature thereof and to store heat therein, burning the resulting producer gas with secondary air and storing its heat by leading the products of combustion along a heat storage path in contact with refractory heat-storage material arranged therein, and during a carbureted water gas-generating period of the cycle utilizing a portion of the heat stored during the blow in the endothermic reaction of steam with the fuel bed to generate blue water gas, and simultaneously utilizing another portion of the stored heat for the gasification of petroleum oil in the presence of steam and of said blue water gas; the improvement comprising preheating said petroleum oil prior to gasification by subjecting, during the blow period of the cycle, a relatively quiescent batch of said oil, retained in metal tubes in a preheating zone, to indirect heat transfer from said hot combustion products passed through said preheating zone; and during a run period of the cycle flowing oil preheated to a temperature above approximately 600°F and at a pressure sufficiently elevated to maintain said oil substantially in liquid phase at said temperature of preheating, from said preheating zone to the oil-gasification zone of the carbureted water gas-generating system while replenishing said preheating zone with oil to be preheated therein during the subsequent blow period, and reducing the pressure on said oil between said preheating zone and said oil-gasification zone to cause the flash vaporization of a considerable proportion of the preheated oil into said oil-gasification zone by reason of the preheat therein with the deposition of unvaporized material upon the top of said fuel bed, the volume of preheated oil in the system at any time at a temperature above approximately 600°F, not exceeding the volume of said preheated oil utilized in said process within three successive cycles.
CONVERSION OF CARBONACEOUS MATERIALS


June 17, 1952; application filed Aug. 9, 1947; Serial No. 767,685; 5 claims.

1. The process of treating a hydrocarbon oil and a solid carbonaceous material containing volatile constituents and a solid carbonaceous residue to produce valuable products, which comprises continuously circulating solid residue from said carbonaceous material through three intercommunicating zones, subjecting said solid residue in a gasification zone to an exothermic gasification reaction with a gaseous reactant, passing resulting heated solid residue from said gasification zone to a carbonization zone into admixture with fresh carbonaceous material, thereby effecting volatilization of volatilizable constituents from said material and formation of an additional amount of said solid residue, introducing said solid residue into a cracking zone into contact with said hydrocarbon oil, thereby effecting cracking of said hydrocarbon oil with the resulting deposition of free carbon on said residue, and returning said solid residue from said cracking zone to said gasification zone wherein said carbon from said hydrocarbon oil and a portion of said solid residue is gasified.

PROCESS FOR PROMOTING ENDOThERMIC REACTIONS AT ELEVATED TEMPERATURES

William W. Odell, Washington, D.C.

July 1, 1952; application filed Aug. 23, 1947; Serial No. 770,270; 12 claims.

1. The process of promoting endothermic chemical reaction at temperatures below about 925° C. but above about 300° C. in an elongated vertical reaction zone containing a body of checker bricks intermediate the ends thereof and a continuous, deep mass of finely divided contact solids extending from below to above said body of checker bricks, which comprises passing a gasiform stream initially containing at least one material adapted to react endothermically at the temperature of said zone upwardly through said mass of solids at a superficial velocity sufficient to fluidize said, mass as a continuous, deep, dense bed having a well-defined top level while said solids are at a temperature within the aforesaid range, feeding a stream of finely divided solids containing CaO and having different buoyancy than the contact solids into a portion of said bed outside of said body of checker bricks, passing the latter solids initially containing said CaO through said bed and through the interstitial spaces of said body to that portion of said bed of the other side of said body and reacting said CaO with CO present in the said zone during such passage to form CaCO₃ and generate heat, the thus generated heat promoting the endothermic reaction of the material adapted to react endothermically, withdrawing CaCO₃ from the portion of said bed to which it is passing and discharging the fluid stream containing gasiform products of said endothermic reaction from above said bed.
2,602,809

TREATMENT OF SOLID CARBON-CONTAINING MATERIALS TO PRODUCE CARBON MONOXIDE FOR SYNTHESIS OF ORGANIC MATERIALS

Norman L. Dickinson, Basking Ridge, N.J., assignor to The M. W. Kellogg Co., Jersey City, N.J., a corporation of Delaware


1. A process for the gasification of solid carbon-containing material, which comprises introducing finely divided reducible metal oxide selected from at least one of the group consisting of the oxides of iron, cobalt, nickel, molybdenum, manganese, barium, vanadium, chromium, and copper and solid carbon-containing material into a reaction zone, suspending such finely divided reducible metal oxide and said solid carbon-containing material in a gasiform fluid substantially free from free oxygen passing through said reaction zone, maintaining said reaction zone under endothermic conditions and at a temperature such that carbon is oxidized to carbon monoxide as the principal reaction by reduction of said metal oxide, withdrawing from said reaction zone reduced metal oxide, reoxidizing by contact with free oxygen said withdrawn reduced metal oxide under exothermic conditions and at a higher temperature than maintained in said reaction zone, reintroducing the reoxidized metal oxide into said reaction zone at a temperature above the temperature level maintained therein such that heat is supplied to said reaction zone thereby, and withdrawing from said reaction zone an effluent comprising carbon monoxide as a product of process, said reducible metal oxide being the principal source for the oxidation of carbon to carbon monoxide.

2,605,174

SYNTHESIS GAS MANUFACTURE

Joseph C. Krejci, Phillips, Tex., assignor to Phillips Petroleum Co., a corporation of Delaware


1. A process for producing synthesis gas, comprising injecting a mixture of natural gas and oxygen at a velocity described hereafter, into a first cylindrical zone having a diameter greater than its length, in a direction tangent to the inner sidewall of said first cylindrical zone, and in a mole ratio of oxygen to natural gas higher than an overall oxygen to natural gas mole ratio described hereafter and lower than that required for completely burning the tangentially introduced natural gas; burning said tangentially introduced natural gas in said first cylindrical zone, and regulating said burning as described hereafter; passing combustion gas formed from said burning, from said first cylindrical zone into and through a second cylindrical zone longer than, coaxial with, and adjacent to said first cylindrical zone and having a diameter smaller than that of said first cylindrical zone regulating said burning to produce heat to maintain a temperature through said first and second cylindrical zones within the limits of 2,000° to 2,500° F.; maintaining said velocity of tangentially injected natural gas and oxygen sufficiently high that said combustion gas follows an inward spiral path in said first cylindrical zone and a helical path through said second cylindrical zone adjacent the inner wall of at least an initial portion thereof; passing oxygen and natural gas axially into said first cylindrical zone in a mole ratio of oxygen to natural gas lower than said overall mole ratio, and through said second cylindrical zone, whereby axially introduced gas passes longitudinally through said first cylindrical zone and then into said second cylindrical zone in an initial state of annular separation from helically flowing gases; maintaining a mole ratio of total axially and tangentially introduced oxygen to total axially and tangentially introduced natural gas within the limits of 0.6:1 to 0.9:1 as said overall mole ratio described above; maintaining the volume of total axially introduced hydrocarbon to total tangentially introduced hydrocarbon within the limits of 18:1 to 9:1; withdrawing effluent from said second cylindrical zone and quickly quenching same to a temperature below 1,000° F.; and recovering from the quenched effluent a hydrogen-carbon monoxide gas mixture suitable for use as synthesis gas in a process of the Fischer-Tropsch type.
INTERNAL-COMBUSTION-ENGINE PRODUCTION OF SYNTHESIS GAS
Everett M. Barber, Wappingers Falls, N.Y., assignor to The Texas Co., New York, N.Y., a corporation of Delaware

July 29, 1952; application filed Dec. 7, 1948, Serial No. 44,005; 3 claims.

1. In a process for the production of carbon monoxide and hydrogen by the partial combustion of a hydrocarbonaceous fuel with oxygen in an internal-combustion engine wherein a mixture of said hydrocarbonaceous fuel and oxygen in approximately the required proportions for substantially complete conversion of said fuel to carbon monoxide and hydrogen is compressed and ignited in the combustion zone of an internal-combustion engine, the improvement which comprises injecting a minor amount of additional oxygen into said mixture following compression and at the approximate instant of ignition into a localized minor section of the combustion zone whereby the oxygen concentration within said section is at least 50 percent in excess of that amount theoretically required for partial combustion of the fuel in said section to carbon monoxide and hydrogen, and igniting ignition of the mixture within said localized section of the combustion zone.

CONVERSION OF HYDROCARBONACEOUS MATERIAL INTO SYNTHESIS GAS
Leon Jacovec, Irvington, N.J., and Leon P. Goucher, Mount Vernon, N.Y., assignors to The Texas Co., New York, N.Y., a corporation of Delaware

Aug. 12, 1952; application filed Mar. 27, 1948, Serial No. 17,518; 5 claims.
(Ct. 48—196)

1. The method of converting carbonaceous material containing hydrogen into high yields of synthesis gas containing a mixture of hydrogen and carbon monoxide of relatively high hydrogen content, which comprises reacting said carbonaceous material in a partial combustion zone maintained above about 2,000°F., with substantially pure oxygen in a proportion effective to result in a gaseous product composed essentially of H₂ and CO, injecting the hot effluent product gas into a dense fluid phase of solid-particle material continuously maintained at a substantially lower temperature, thereby effecting continual quenching of the hot, effluent product gas and continually maintaining the said dense fluid phase of solid-particle material at said substantially lower temperature by transferring thermal energy therefrom into a reforming zone disposed in heat-transfer relationship therewith, passing a mixed stream of hydrocarbon and steam upwardly through said reforming zone, maintaining within said reforming zone a dense fluid phase of particulate solid reforming catalyst active at the temperature prevailing therein to convert said mixed stream of hydrocarbon and steam into H₂ and CO, and introducing said mixed stream of hydrocarbon and steam into the reforming zone at a rate sufficient to support said reforming catalyst in dense fluid phase condition as aforesaid, and to regulate the endothermic reaction of said hydrocarbon and steam in said reforming zone such that said fluid phase of solid-particle material is maintained thereby at said lower temperature.
2,606,827
METHOD OF PRODUCING LOW-NITROGEN-CONTENT GAS
Clarence B. Glover, Springfield, Pa., assignor to United Engineers & Constructors,
Inc., Philadelphia, Pa., a corporation of Delaware
Aug. 12, 1952; application filed May 21, 1948, Serial No. 28,324; 12 claims.
1. In a cyclic method for generating a product gas which comprises during
a heating portion of the cycle burning fuel with a combustion-supporting
gas in a primary combustion zone to raise the temperature thereof and to
store heat therein while leading the resulting hot-blast gases downstream
therefrom through a separate heat-recovery path containing heat-storage
material, and during a product gas-generating portion of the cycle utilizing
heat thus previously stored in said primary combustion zone for the gen-
eration of the product gas by reacting therein a suitable gas-making fluid
therefor, at least a portion of said separate heat-recovery path being traversed
during said product gas-generating portion of the cycle by vapor phase
material the contamination of which by blast gases results in the contami-
nation of the product gas thereby; the improvement comprising in combi-
nation during the latter part of said heating portion of the cycle the steps
of continuing the primary combustion of said fuel in said combustion zone
while diverting blast gases resulting therefrom around at least a portion of
said separate heat-recovery path previously traversed by the blast gases
during the earlier part of the heating portion of the cycle and to be traversed
by said vapor phase material during said product gas upstream gener-
ating portion of the cycle, and simultaneously passing a purging gas into
said portion of said heat recovery path thus bypassed by the blast gases to
purge residual blast gases therefrom while said combustion and heat storage
in said primary combustion zone continues.

2,606,828
METHOD AND APPARATUS FOR THE MANUFACTURE OF CARBURETED WATER
GAS
Gerald L. Eaton, Lansdowne, Pa., assignor to United Engineers & Constructors, Inc.,
Philadelphia, Pa., a corporation of Delaware
Aug. 12, 1952; application filed Nov. 15, 1947, Serial No. 785,672; 15 claims.
1. In the cyclic blow and run method of manufacturing carbureted water
gas in which blue water gas generated in an ignited fuel bed during a run
period of the cycle is carbureted with hydrocarbon oil gasified by the aid
of heat stored in a heat storage zone including the top of said fuel bed
during a previous blow period of the cycle; the improvement comprising
preheating said carbureting oil in stages under pressure conditions suf-
ciently elevated to maintain said oil substantially in liquid phase, and to
a temperature sufficiently high to cause the evaporation of a considerable
part thereof by reason of its preheat upon reduction of its pressure to
approximately that of said heat-storage zone, by passing said oil through
a relatively low temperature oil-preheating zone and thereafter through a
relatively high-temperature oil-preheating zone, said oil being passed con-
tinuously through said low-temperature oil-preheating zone into a hot pres-
sure-storage zone, being recirculated between said storage zone and said
high-temperature oil-preheating zone during noncarbureting portions of the
cycle, and being delivered from said high-temperature oil-preheating zone
during a carbureting period of the cycle and flashed into a relatively low-
pressure zone in gas communication with the top of said fuel bed, so as to
admix the resulting vapor phase hydrogen material with the blue water
gas being simultaneously generated, and so as to deposit highly heated
residue from said flashing upon the top of said fuel bed for further heating
thereon.
CONVERSION OF CARBONACEOUS MATERIALS INTO A FUEL GAS

Sept. 2, 1952; application filed Aug. 9, 1947; Serial No. 767,793; 1 claims.

1. In a process for producing fuel gas of high heating value from a solid carbonaceous material containing volatilizable constituents, the improvement which comprises simultaneously hydrogenating and carbonizing autogenously said solid carbonaceous material by continuously contacting said carbonaceous material in comminuted form in a dense phase fluidized bed with a stream of hydrogen at a pressure within the range of from about 500 to about 750 p.s.i. gauge and at a substantially uniform temperature within the range of from about 1,000° to about 1,500° F. in a carbonization zone, continuously introducing said carbonaceous material into said carbonization zone discharging a gaseous product comprising hydrocarbons and unreacted hydrogen from said carbonization zone, continuously withdrawing carbon-containing residue from said carbonization zone and reacting said residue in a gasification zone with an oxygen-containing gas and steam to produce a mixture of carbon monoxide and hydrogen, separating hydrogen from said mixture, passing said hydrogen to the carbonization zone as the source of hydrogen for reaction with said solid carbonaceous material, and admixing carbon monoxide separated from said mixture with said gaseous product from the carbonization zone produce a fuel gas of relatively high heating value.
PRODUCTION OF HYDROCARBON SYNTHESIS GAS

Bertrand J. Mayland, Bartlesville, Okla., assignor to Phillips Petroleum Co., a corporation of Delaware

Sept. 2, 1952; application filed Dec. 31, 1948; Serial No. 68,466; 2 claims.

1. In a process for the preparation of a feed for a Fischer-Tropsch synthesis and for an oxo-catalytic chemical synthesis operation wherein a first and a second portion of natural gas are subjected to partial oxidation to form a synthesis gas comprising hydrogen and carbon monoxide, and said products of partial oxidation of said second natural gas portion are subjected to Fischer-Tropsch synthesis, the improvement which comprises subjecting products of partial combustion of said first portion of natural gas directly and without intermediate treatment to a diffusion by passing said gas into contact with one side of a porous physical partition; passing an entrainer medium consisting essentially of a third portion of natural gas over the opposite side of said partition; maintaining substantially the same static pressure on both sides of the partition, thus obtaining the diffusion of hydrogen and carbon monoxide to said opposite side of said partition, the hydrogen diffusing at a rate substantially greater than the carbon monoxide; withdrawing from said one side of said partition a synthesis gas having a substantially lower hydrogen content than the starting synthesis gas and from the opposite side of said partition said entrainer medium containing a synthesis gas having a substantially higher hydrogen content than the starting synthesis gas; combining at least a portion of said entrainer medium containing said synthesis gas having a higher hydrogen content than the starting synthesis gas with said products of partial combustion of said second natural gas portion prior to said Fischer-Tropsch synthesis; and mixing olefinic hydrocarbons with said synthesis gas having a hydrogen content substantially lower than the synthesis gas treated, thereby forming a feed suitable for oxo-catalytic chemical synthesis.
2,609,987

ADSORPTION PROCESS AND APPARATUS
Clyde H. O. Berg, Long Beach, Calif., assignor to Union Oil Co. of California, Los Angeles, Calif., a corporation of California
Sept. 9, 1952; application filed Apr. 30, 1949; Serial No. 99,798; 22 claims.

1. A process for separating a gaseous mixture, which comprises passing a substantially compact moving bed of solid granular adsorbent by gravity successively through a separation zone, a desorption zone, a seal gas-removal zone, and a cooling zone, dividing said adsorbent into a first and second stream for passage through said separation zone as independent and substantially compact moving beds, contacting one adsorbent stream with said gaseous mixture, contacting the other adsorbent stream with another gas stream, subsequently combining said first and second adsorbent streams upon withdrawal from said separation zone prior to introduction into said desorption zone, heating the adsorbent containing adsorbed constituents within said desorption zone, contacting the heated adsorbent with a countercurrent flow of stripping gas to desorb the more readily adsorbable constituents as a rich gas leaving a lean adsorbent, passing said lean adsorbent through said seal gas-removal zone and subsequently through said cooling zone, passing a portion of the unab sorbed lean gas fraction of said gaseous mixture through said cooling zone countercurrent to said lean adsorbent, passing a portion of said stripping gas from said desorption zone concurrently with said adsorbent into said seal gas-removal zone, maintaining said seal gas-removal zone at a pressure below the pressure of said desorption and cooling zones, combining said portion of said lean gas with said portion of stripping gas in said seal gas removal zone, removing the mixture thus formed as a seal gas therefrom and employing another portion of said lean gas to suspend cool lean adsorbent removed from said cooling zone for conveyance back to said separation zone.
PRODUCTION OF SULFUR-FREE WATER GAS

Frank T. Barr, Summit, N.J., assignor to Standard Oil Development Co.,
a corporation of Delawarea

1. In a process for the production of fuel gases free of sulfur compounds
by the gasification of solid carbonaceous materials with a reactant gas
adapted to convert carbon into carbon monoxide at temperatures of about
1,400°-2,400° F., followed by the removal of H₂S from the fuel gas pro-
duced, the improvement which comprises subjecting said solid materials
admixed with about 0.2-1 percent by weight of a catalyst promoting the
scrutiny of organic sulfur compounds, to said gasification at said tempera-
tures to produce a fuel gas containing H₂S but free of organic sulfur com-
pounds quenching said fuel gas to a temperature not exceeding 600° F. so
as to prevent the formation of organic sulfur compounds in said fuel gas,
subjecting said quenched fuel gas to a treatment adapted to remove H₂S
therefrom, and recovering from said treatment a fuel gas essentially free of
sulfur compounds.

CARBONIZING SUBDIVIDED SOLIDS

George L. Matheson, Union, N.J., assignor of Standard Oil Development Co.,
a corporation of Delaware

1. In the method of carbonizing subdivided carbonaceous solids in the
form of a dense turbulent mass fluidized by an upwardly flowing gas to
form a well-defined upper interface and comprising component particles
readily entrainable in said gas at the fluidization conditions and other
component particles tending to settle out of the fluidized mass at the
fluidization conditions, the improvement which comprises supplying readily
entrainable particles to a lower portion of said mass, supplying particles
having a settling tendency to an upper portion of said mass so as to main-
tain a substantially uniform particle-size distribution throughout said mass,
withdrawing solids having said particle-size distribution from a lower por-
tion of said mass, separating entrainable particles from said withdrawn
solids, and returning at least a portion of said separated particles to a
lower portion of said mass.
MANUFACTURE OF SYNTHESIS GAS
Joel H. Hirsch, Oakmont, Pa., assignor to Gulf Research & Development Co., Pittsburgh, Pa., a corporation of Delaware
Oct. 21, 1952; application filed Nov. 24, 1947, Serial No. 787,829; 3 claims.

1. A process for the production of a synthesis gas mixture of hydrogen and carbon monoxide wherein a finely divided coal is fluidized, continuously introduced into a reaction zone, reacted with steam and oxygen under superatmospheric pressure, and the hot gaseous reaction products are expanded with the production of external work, the steps which comprise fluidizing finely divided coal in a stream of recycled synthesis gas, passing said stream of fluidized coal into one of at least two storage zones maintained under substantially atmospheric pressure, interrupting the passage of said fluidized coal into said storage zone while maintaining the coal therein in fluidized condition, increasing the pressure in said storage zone to a superatmospheric pressure at least equal to that existing in the reaction zone, maintaining a vertical column of said fluidized coal below said storage zone and communicating therewith, said vertical column being of sufficient height to produce a fluid pressure head over the bottom of said column, opening the bottom of said vertical column to said reaction zone, conveying said fluidized coal from said storage zone through said column into said reaction zone by a stream of recycled synthesis gas, closing the bottom of said vertical column from said reaction zone when said storage zone is nearly empty, venting said storage zone until the pressure therein is substantially atmospheric and repeating said cycle while at least one other storage zone is being filled and emptied in an alternate sequence.

MANUFACTURE OF A GASEOUS MIXTURE RICH IN HYDROGEN
Cruzan Alexander, Jackson Heights, N.Y., and George H. Palmer, Fanwood, N.J., assignors to The M. W. Kellogg Co., Jersey City, N.J.
Nov. 18, 1952; application filed Feb. 27, 1948, Serial No. 11,474; 7 claims.

1. A process for producing hydrogen and carbon monoxide as the principal products which comprises reacting steam and a hydrocarbon in a first reaction zone at a temperature below 1,300° F. in the presence of a finely divided contact material under condition such that hydrogen and carbon monoxide are produced, the steam and hydrocarbon being introduced into the first reaction zone in a relatively low mole ratio in relation to the temperature employed such that the mole ratio corresponds to that of the mole ratio of steam to methane not greater than about 1:1 and such that a substantial portion of the hydrocarbon is converted, to carbon which is deposited in the first reaction zone in association with the product gas and contact material and associated carbon from the first reaction zone, introducing the withdrawn contact material and associated carbon into a separate second reaction zone, simultaneously with the reaction in said first reaction zone contacting carbon and contact material in the second reaction zone with oxygen at a higher temperature than said first reaction zone and in a relatively low ratio of oxygen to carbon such that carbon is exothermically converted to gas comprising a substantial proportion of carbon monoxide whereby the mass of solids in the second reaction zone is heated to a temperature substantially higher than the temperature maintained in the first reaction zone, withdrawing heated contact material and product gas from the second reaction zone, combining product gas from the second reaction zone with product gas from the first reaction zone, reintroducing into the first reaction zone heated contact material withdrawn from the second reaction zone and cyclically circulating contact material between said first and second reaction zones in the above manner whereby carbon deposited in the first reaction zone is converted to carbon monoxide in the second reaction zone and at least a portion of the heat of reaction required in the first reaction zone is supplied thereto by the passage of the hot contact material from the second reaction zone to the first reaction zone.
GASIFICATION OF CARBONACEOUS MATERIALS
Nov. 18, 1952; application filed June 29, 1951, Serial No. 234,412; 7 claims.

1. A process for forming a gaseous fuel from finely divided solid carbonaceous material, which comprises charging fresh powdered solid carbonaceous material to a gaseous fuel-generation zone, charging steam to said generation zone where it contacts said charged carbonaceous material at temperatures within the range of from about 1,500° to 2,100° F., causing the steam to flow upwardly in said generation zone at a sufficiently low rate so as to cause the said carbonaceous material undergoing treatment to form a fluidized bed, withdrawing carbonaceous material from said generation zone, mixing the withdrawn carbonaceous material with an oxygen-containing gas and causing the said carbonaceous material to undergo at least partial combustion to add heat to said carbonaceous material, while the said carbonaceous material is in the form of a confined stream in a zone of restricted cross section, limiting the time period of combustion of said carbonaceous material within the limits of from about 0.5-0.7 second, separating the unburnt carbonaceous material from the resulting combustion fumes to prevent substantial reduction of the formed carbon dioxide and returning the thus heated carbonaceous material to the said generation zone for the purpose of supplying the heat necessary to support the gaseous fuel generation therein taking place.

SUPPLY OF HEAT TO FLUIDIZED SOLIDS BEDS FOR PRODUCTION OF FUEL GAS
Nov. 25, 1952; application filed Aug. 15, 1956, Serial No. 690,818; 8 claims.

1. The method of converting carbonaceous materials into volatile fuels at elevated temperatures within the range of about 700°-2,000° F. in two essentially endothermic conversion stages carried out in two dense turbulent beds of subdivided solids fluidized by an upwardly flowing gas to resemble a boiling liquid having a well defined upper level, which comprises maintaining one of said beds at a relatively low conversion temperature and the other bed at a relatively high conversion temperature, within said range, passing said fluidizing gas in series first through said bed of low temperature and then through said bed of high temperature, said fluidizing gas containing constituents reacting endothermically with carbon at said high temperature to produce a fuel gas containing carbon monoxide, feeding fresh carbonaceous materials to said low-temperature bed, passing solids from said low-temperature bed substantially at said low temperature to said high-temperature bed, maintaining said high temperature in said high-temperature bed by contacting the latter with a tubular heating surface heated to a temperature above said high temperature by a fluid combustion mixture burning in contact with said surface separating said bed from said mixture, passing solids from said high-temperature bed substantially at said high temperature to said low-temperature bed, withdrawing volatile fuels upwardly from the bed last passed through by said fluidizing gas, and withdrawing a discard stream of relatively spent solids from said high-temperature bed.
HYDROCARBON SYNTHESIS PROCESS WITH TWO-STAGE COKE GASIFICATION


1. An improved process for the catalytic synthesis of hydrocarbons from CO and H₂, which comprises passing steam and carbonaceous solids to an initial gasification stage, carrying out a water-gas reaction in said stage, passing water gas wherein the H₂ to CO ratio is at least 1.0 to an initial hydrogen synthesis reaction zone, maintaining a fluidized bed of iron-containing synthesis catalyst and hydrocarbon synthesis conditions in said zone, withdrawing from said zone a tail gas comprising CO₂ and having a higher H₂ to CO ratio than said feed gas to said zone, passing at least a portion of said tail gas to a second-stage hydrocarbon synthesis reaction zone, passing partially spent carbonaceous solids of relatively low carbon content from said primary gasification zone to a secondary gasification zone, passing steam, CO₂, and a free oxygen-containing gas to said last-named zone, maintaining water-gas-generation conditions in said last-named zone to give a relatively high steam conversion, converting at least a portion of said CO₂ to CO, withdrawing from said second gasification zone a gaseous mixture comprising H₂ and CO wherein the H₂ to CO ratio is less than unity, passing at least a portion of said gas mixture to said second hydrocarbon synthesis zone responsive to the H₂ to CO ratio of said tail gas from said first hydrogen synthesis reaction zone to produce a total gas feed to said second hydrocarbon synthesis zone adapted to produce high yields of hydrocarbons, and maintaining an iron-containing catalyst in said zone.
PREPARATION OF HYDROGEN AND CARBON MONOXIDE GAS MIXTURES


Dec. 9, 1952; application filed Mar. 11, 1947, Serial No. 733,838; 8 claims.

1. In a process for the production of a gas comprising carbon monoxide by reaction of a carbonaceous reactant with oxygen, the improvement which comprises the steps of charging a stream of oxygen-containing gas to a reaction zone, charging a stream of carbonaceous reactant to said reaction zone annularly about said oxygen stream to surround said oxygen and in sufficient amount to react with substantially all of the oxygen with the formation of completely oxidized reaction products, charging an additional stream of carbonaceous reactant to said reaction zone annularly about the zone of reaction of oxygen with the first stream of carbonaceous reactant and into intimate contact with said reaction products immediately following their formation to react therewith and form a final product gas comprising carbon monoxide and withdrawing the resultant product gas from the reaction zone.

METHOD FOR GASIFYING SOLID FUELS

Frank T. Barr, Summit, N.J., assignor to Standard Oil Development Co., a corporation of Delaware.


1. The process of converting solid carbonaceous materials into valuable volatile fuels by means of heat generated by partial combustion of said carbonaceous materials in a fluidized bed of solids, which comprises passing finely divided solid carbonaceous material through a circuit comprising at least two conversion zones, maintaining said material as a mass of fluidized solids in said conversion zones at elevated temperatures suitable for the production of volatile conversion products, maintaining substantial temperature gradients between said conversion zones, subjecting a portion of said material to combustion in at least one of said conversion zones at a temperature of about 1,600°-2,500° F., subjecting said material to a gasification reaction in one of said conversion zones, supplying heat required in said conversion zone wherein the gasification reaction is effected by circulating finely divided solids highly heated by the heat generated by said combustion thereto adding fluidizable extraneous solid particles produced outside said combustion-conversion zone and consisting of solid noncombustible materials to said combustion conversion zone to maintain the concentration of carbon therein at 0.1–1 percent of the fluidized solids in said combustion conversion zone and circulating said noncombustible materials together with said highly heated solids through said conversion zones.
APPARATUS FOR GASIFYING CARBONACEOUS FUEL

Bruno E. Roetheli, Cranford, and Charles E. Hemminger, Westfield, N.J., assignors
to Standard Oil Development Co., a corporation of Delaware.

Dec. 30, 1952; original application filed Nov. 23, 1948, Serial No. 630,518.
Divided and this application filed May 14, 1949, Serial No. 21,054; 1 claim.

An apparatus of the character described which consists essentially of a
vertically substantially cylindrical treating chamber, at least two horizontally
disposed plates arranged in spaced relationship within said chamber
dividing the latter into at least three treating zones, at least one of said
horizontal plates being perforate and at least one of said horizontal plates
being imperforate, one of said imperforate plates separating the lowermost
treating zone from an intermediate treating zone a conduit for introducing
finely divided solids into the uppermost treating zone, a conduit for with-
drawing finely divided fluidized solids disposed in the lowermost of said
treating zones, a conduit disposed in a lower portion of the lowermost
treating zone for introducing thereto gasiform material, a standpipe for
conveying finely divided solids from the uppermost treating zone into the
lowermost treating zone, a second standpipe for conveying solids from the
intermediate treating zone to the lowermost treating zone, conduit means
for conveying solids from the lowermost treating zone to said intermediate
treating zone, means for injecting gas into said last-named conduit means
in the direction of solids flow therein means for withdrawing volatile mate-
rial from the uppermost treating zone, conduit means for recycling a por-
tion of the withdrawn volatile material to the lowermost zone and conduit
means for withdrawing volatile material from said lowermost zone.
2,623,816

METHOD FOR PRODUCTION OF HIGH-HEATING-VALUE FUEL GAS


1. A process for the production of a fuel gas of high heating value from a solid carbonaceous material having volatile components and a solid residue containing carbon, which comprises maintaining a fluidized mass of said solid residue in a gasification zone, maintaining a fluidized mass of said solid carbonaceous material and a solid residue in a carbonization zone, gasifying the carbon of said solid residue exothermically with oxygen and steam in said gasification zone, passing remaining hot gases from said gasification to said carbonization zone, introducing said solid carbonaceous material in comminuted form into said carbonization zone to effect distillation of the volatile components thereof and produce additional solid residue, passing solid residue from said carbonization zone to said gasification zone, passing gas containing hydrogen and carbon monoxide from said carbonization zone through a fluidized mass of carbon maintained in a methanation zone at an elevated pressure within the range of from about 150 to about 450 p.s.i. gauge and a temperature within the range of from about 1,000° to about 1,550° F., whereby carbon monoxide and hydrogen are consumed with concomitant production of methane and carbon, recovering a fuel gas of high heating value, and gasifying produced in said methanation zone to said gasification zone for the production of additional carbon monoxide and hydrogen.

2,623,817

PRODUCTION OF FUEL GASES


Dec. 30, 1952; application filed Apr. 5, 1946, Serial No. 659,408; 14 claims.

1. A process for preparing a fuel gas from solid carbonaceous material, which comprises reacting said carbonaceous material with a gasifying material which reacts endothermically with said carbonaceous material to generate fuel gas rich in CO in a first reaction zone, reacting in a second zone carbonaceous material and a gasifying material which reacts exothermically with said carbonaceous material to form carbon dioxide, passing a moving stream of finely divided inert solids of high heat capacity in a closed cycle including said zones, whereby said inert solids move from one zone to the other in sequence, feeding finely divided fresh carbonaceous material to said first zone to reduce gas off gases from said second zone, at least a portion of said off gases reacting endothermically with said carbonaceous material to form said fuel gas in a manner such as to maintain said carbonaceous material and said inert solids in said zone in a fluidized condition, feeding partially spent carbonaceous material and inert solids from said first zone to said second zone, feeding gasifying material capable of reacting exothermically with said partially spent carbonaceous material to said second zone in a manner such as to maintain the carbonaceous material and inert solids in said second zone in a fluidized condition, said last-named gasifying material being further characterized in that it contains sufficient free oxygen to consume the carbon fed to said zone, maintaining an exothermic reaction-producing carbon dioxide in said second zone, withdrawing a mixture of ash and hot inert solids from said second zone separating ash from said hot inert solids and returning at least a portion of said separated hot inert solids to said first zone.

Fig. 1

(part of the figure)

STEAM INLET

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SPLITTER

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HOPPER

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SEPARATOR

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HEAT EXCHANGER

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REDUCTION REACTOR

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OXIDATION REACTOR

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CUT OFF

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GASIFICATION PROCESS AND APPARATUS
Clyde H. Berg, Long Beach, Calif., assignor to Union Oil Co. of California, Los Angeles, Calif., a corporation of California

1. An apparatus for the gasification of coal by reaction at elevated temperatures with oxygen and steam, which comprises a vertical conical gasification kiln widening in an upward direction positioned within a gasification vessel adapted to withstand elevated internal pressures, a baffle separating the annular space between the gasification vessel and the gasification kiln into an upper portion comprising an ash bin and a lower portion comprising a feed bin, pressure lock means for introducing said coal into said feed bin for subsequent introduction into said gasification kiln to be gasified, pressure lock means for removing ashes from said ash bin, means for introducing reactant gases into the upper part of said kiln, withdrawal means for removing product gases and liquids from the lower part of said kiln, and positive solids feeder means for passing said coal upwardly through said gasification kiln so as to maintain a bed of said coal at elevated temperatures in an oxidation zone in the upper portion of said gasification vessel where said coal is subjected to a small fraction of the weight of coal present within said kiln.

GENERATION OF SYNTHESIS GAS
William P. Gee, Plainfield, N.J., assignor to Texaco Development Corp., New York, N.Y., a corporation of Delaware.
Mar. 8, 1953; application filed July 25, 1949, Serial No. 106,367; 6 claims.

1. In the process for the generation of synthesis gas comprising essentially hydrogen and carbon monoxide from high-boiling-point liquid hydrocarbon relatively deficient in hydrogen, the improvement which comprises reacting said hydrocarbon at a temperature within the range of 1,600° to 2,600° F. with high-purity free oxygen in a regulated amount substantially below that stoichiometrically necessary to convert said hydrocarbon completely into hydrogen and carbon monoxide thereby maintaining carbon-forming conditions such that the high boiling hydrocarbon is substantially completely converted into solid carbonaceous material together with gases comprising essentially hydrogen and carbon monoxide, separating the carbonaceous solids thus liberated, reacting said carbonaceous material in a separate succeeding step with a mixture of steam and high-purity oxygen in relative proportion effective to maintain said reaction zone autogenously at an elevated temperature such that said reaction proceeds with the production of additional hydrogen and carbon monoxide, and recovering the product hydrogen and carbon monoxide thus produced.
2,631,086
WATER-GAS-SHIFT CATALYST PREPARATION AND WATER-GAS SHIFT-PROCESS
Otis W. Mock and William E. Spicer, Baton Rouge, La., assignors to Standard
Oil Development Co., a corporation of Delaware.
Mar. 10, 1953; application filed Oct. 27, 1949, Serial No. 125,995; 11 claims.
1. An improved process for converting a gaseous mixture comprising CO,
CO₂, and H₂ into a product rich in hydrogen and low in carbon monoxide,
which comprises passing said mixture and steam through a carbon monoxide
conversion zone in the presence of a CO converter catalyst comprising a
major portion of Fe₂O₃ and a minor portion of Cr₂O₃ prepared by impregnat-
ing iron oxide with an aqueous solution of chromic acid, extruding and
pelletting the resulting mixture, and activating the pellets at temperatures
in the range of 1,000°F-1,300°F.

2,631,932
SYNTHESIS GAS GENERATOR AND WASTE-HEAT BOILER
Ward S. Patterson, Chappaqua, and Wilbur H. Armacost, Scarsdale, N.Y.,
assignors to Combustion Engineering-Superheater, Inc., a corporation of Dela-
ware.
Mar. 17, 1953; application filed Aug. 8, 1947, Serial No. 767,550; 11 claims.
1. Apparatus for containing a high-pressure exothermic gas synthesis re-
action and for extracting waste heat resulting therefrom, comprising a
generally vertical metal pressure casing defining a high-temperature reaction
section and a cooling section above the reaction section, water cooling
means for said casing in said reaction and cooling sections, a unitary gas-
collecting dome defining a low-temperature section, gas-tight joint means
detachably securing the lower part of said dome to the upper part of said
casing, and a bundle of boiler tubes freely extending from within said low-
temperature section above said joint means into said cooling section, said
tubes being suspended from said dome by direct mechanical interconnection
between the dome and upper portions of tubes passing through the dome,
header means positioned exteriorly of the dome and connected to the tubes
passing through the dome, and severable joint means connecting the header
means last-named into the circulation of a waste-heat boiler.
2,631,934

METHOD OF MANUFACTURING A GAS RICH IN CARBON MONOXIDE
Mar. 17, 1953; application filed Apr. 3, 1946, Serial No. 659,408; 5 claims.

1. The method of manufacturing a gas rich in carbon monoxide from solid carbonaceous material, which comprises contacting powdered carbonaceous material at a temperature of from about 1,500°-2,000° F. in the form of a dense fluidized mass in a gas-producing zone with a feed gas containing carbon dioxide, steam, and free oxygen for a sufficient period substantially completely to reduce CO₂ and steam present in said zone by the carbon of said carbonaceous material at said temperature, maintaining the free oxygen content of said feed gas sufficiently high to maintain said temperature by combustion in said zone, withdrawing a product gas rich in carbon dioxide and steam from said zone, withdrawing carbonaceous material from said zone, charging it to a second physically separated zone, maintaining the carbonaceous material in said second zone in the form of a dense fluidized mass, passing a combustion-supporting gas containing steam and sufficient free oxygen to provide the desired composition in said feed gas upwardly through said second zone, maintaining a temperature between about 1,500° and 2,500° F. in the second zone adequate for the combustion of carbon and higher than said first-named temperature but below the sintering temperature of the resultant ash, withdrawing hot gases from said second zone and discharging them into said first-named zone to supply said feed gas thereto, and withdrawing ash from said second zone.
2,633,416
GASIFICATION OF CARBONACEOUS SOLIDS
1. In the process of producing gas mixtures containing CO and H₂ from solid carbonaceous materials and an oxidizing gas containing steam, wherein the oxidizing gas is contacted, a gasification zone at gasification temperatures of about 1,000°-2,000° F., with a dense, ebullient, fluidized mass of finely divided carbonaceous solids, and the heat required by said gasification process is supplied by combustion of a portion of said carbonaceous solids and direct heat exchange of burned solids and solids undergoing said gasification, the improvement which comprises maintaining at least two dense, ebullient fluidized beds of finely divided fresh carbonaceous solids in a preheating zone, passing hot gases produced in said gasification process by the oxidation of carbonaceous materials upwardly through said beds in series, passing finely divided solids from bed to bed countercurrently to said hot gases, heating the solids in a bed first contacted by said hot gases to a relatively high temperature of about 500°-700° F. but below the level of beginning carbonization of carbonizable solids in heat exchange with said hot gases, and the solids in a subsequent bed in heat exchange with gases leaving said first bed to a relatively low temperature but above the dew point of said hot gases, feeding preheated solids from said first bed directly to said gasification zone, maintaining the carbon concentration in said gasification residue of about 30-70 percent, supplying gasification residue of said carbon concentration substantially at said gasification temperature to a combustion zone and subjecting it to combustion therein, and converting the heat available in said combustion zone into steam.
GASIFICATION OF CARBONACEOUS SOLIDS

1. In the process of producing gas mixtures containing CO and H₂ from solid carbonaceous materials and an oxidizing gas containing steam, wherein the oxidizing gas is contacted in a gasification zone at gasification temperatures of about 1,000°-2,000° F. with a dense, ebullient, fluidized mass of finely divided carbonaceous solids, and the heat required by said gasification process is supplied by combustion of a portion of said carbonaceous solids and direct heat exchange of burned solids and solids undergoing said gasification, the improvement which comprises maintaining at least two dense, ebullient, fluidized beds of finely divided fresh carbonaceous solids in a preheating zone, passing hot flue gases produced in a combustion zone by the combustion of solid gasification residue upwardly through said beds in series, passing finely divided solids from bed to bed countercurrently to said hot gases, heating the solids in a bed first contacted by said hot gases to a relatively high temperature of about 500°-700° F. but below the level of beginning carbonization of carbonizable solids in heat exchange with said hot gases, and the solids in a subsequent bed in heat exchange with gases leaving said first bed to a relatively low temperature but above the dewpoint of said hot gases, feeding preheated solids from said first bed directly to said gasification zone, supplying gasification residue from said gasification zone to said combustion zone subjecting it to combustion therein to produce said hot flue gases and heating said residue at least to said gasification temperature, and returning the residue so heated to said gasification zone at a temperature and in amounts adequate to support said gasification temperature.
2,634,198

COAL CARBONIZATION AND GASIFICATION


Apr. 7, 1953; application filed June 11, 1947; Serial No. 753,975; 7 claims.

1. In a process for carbonizing and gasifying a solid carbonaceous material containing volatilizable constituents wherein said material is subjected to carbonization by the distillation of volatilizable constituents thereof in a distillation zone and the resulting carbonized material is subjected to gasification with an oxygen-containing gas in a gasification zone, the improvement which comprises passing said carbonaceous material in finely divided form as a dispersed phase entrained in a stream of nonoxidizing gas flowing at a velocity sufficient to inhibit settling of said carbonaceous material therein through the distillation zone in indirect heat exchange with a reacting dense phase fluidized mass of the carbonized material undergoing gasification in the gasification zone whereby heat required for the carbonization is transferred from the gasification zone to the distillation zone, separating the resulting carbonized material from gases comprising volatilized constituents from the solid carbonaceous material, introducing at least a part of said carbonized material into the gasification zone, and separately discharging the gases from the distillation zone and from the gasification zone.
2,634,286
PRODUCTION OF HYDROCARBON SYNTHESIS GAS FROM COAL
Martin A. Elliott, Ezekial L. Clark, and Henry H. Storch, Pittsburgh, Pa., assignors to the United States of America as represented by the Secretary of the Interior.
Apr. 7, 1953; application filed Nov. 7, 1949; Serial No. 126,062; 2 claims.
1. An integrated continuous process for the production of liquid hydrocarbon fuels from coal as a starting material, involving substantial savings in compression energy and in gas-purification costs comprising the steps of passing a stream of hydrogen containing gas upwardly through a hydrogenation reaction zone containing a mass of coal particles at a velocity sufficient to fluidize said mass, maintaining said hydrogenation reaction zone at an elevated temperature of from 450° to 650° C. and under a pressure of from 250 to 1,500 p.s.i., reacting said hydrogen with said coal to produce a major proportion of liquid hydrocarbons and a minor proportion of gaseous hydrocarbons together with a finely divided, solid, low-sulfur content char, continuously withdrawing said char from said fluidized mass and passing said char directly into a gasification zone maintained at elevated temperature and under a pressure less than that in said hydrogenation reaction zone and ranging from 300 to 600 p.s.i., whereby said char flows from said hydrogenation reaction zone into said gasification zone by virtue of the differential pressure between said zones, reacting said char in said gasification zone with steam to produce a mixture of hydrogen and carbon monoxide at a pressure of from 300 to 600 p.s.i., said mixture being substantially free from organic sulfur and containing only small amounts of inorganic sulfur, without substantial reduction in pressure, passing said compressed low-sulfur content hydrogen-carbon monoxide mixture to a Fischer-Tropsch reaction zone, and therein acting said hydrogen-carbon monoxide mixture in the presence of a catalyst to produce predominantly liquid hydrocarbons, passing another portion of said compressed low-sulfur content hydrogen-carbon monoxide mixture to a water gas shift reaction zone wherein the carbon monoxide content of said mixture is converted to hydrogen and carbon dioxide, scrubbing out said carbon dioxide from said hydrogen-carbon dioxide mixture, and then passing the compressed hydrogen to said hydrogenation reaction zone.
PRODUCTION OF FUEL GAS FROM CARBONACEOUS SOLIDS


May 26, 1953; application filed Apr. 30, 1948, Serial No. 90,645; 6 claims.

1. In a process for the hydrogenation of a solid carbonaceous material at an elevated temperature and pressure, the improvement which comprises forming a slurry of said solid carbonaceous material in particle form with a liquid hydrocarbon which is substantially completely vaporizable under reaction conditions, passing said slurry into admixture with a hydrogen-rich gas in a hydrogenation zone, vaporizing said liquid hydrocarbon within said hydrogenation zone, maintaining a dense-phase fluidized bed of said carbonaceous material in said hydrogenation zone, passing said hydrocarbon vapors and hydrogen-rich gas upwardly through said bed thereby effecting fluidization and reaction of said carbonaceous material with hydrogen, and recovering from the reaction zone the products of hydrogenation and vaporized liquid hydrocarbon.

PRODUCTION OF MIXTURES OF CARBON MONOXIDE AND HYDROGEN


May 26, 1953; application filed June 4, 1946, Serial No. 674,355; 4 claims.

1. The continuous process of producing mixtures of hydrogen and carbon monoxide serving as feed gas to a hydrocarbon synthesis process and containing controlled molecular proportions of hydrogen from solid carbonaceous materials and steam which comprises continuously feeding fresh finely divided carbonaceous solids to a heated water gas-generation zone, subjecting said finely divided solid carbonaceous material, in the form of a dense, turbulent bed of solids fluidized by an upwardly flowing gas and resembling a boiling liquid having a well-defined upper level, to a water-gas reaction with steam in said zone to produce a hot stream of water gas, continuously circulating solid carbonaceous residue of the water-gas reaction to a heating zone and subjecting it therein in the form of a similarly fluidized bed of solids to incomplete combustion with air and steam to produce a hot combustible gas containing about 25 to 35 percent carbon monoxide and about 10 to 15 percent hydrogen, continuously supplying part of the heat generated by said combustion to said water-gas reaction in the form of sensible heat of solid combustion residue returned from said heating zone to said water-gas-generation zone, continuously subjecting steam to a reducing treatment at a steam-reducing temperature with a finely divided reduced metal oxide maintained in a similarly fluidized bed of solids to form hydrogen and finely divided metal oxide, continuously regenerating said reduced metal oxide in a separate regeneration zone by reducing said metal oxide in a similarly fluidized bed of solids heated to a temperature higher than said steam-reducing temperature by said hot combustible gas and reduced, thereby producing a completely burned vent gas substantially free of carbon monoxide, continuously supplying to said steam-reducing treatment at least part of said hot water gas together with reduced metal oxide from said regenerating zone substantially at said higher temperature, controlling the molecular ratio of hydrogen to carbon monoxide in the gas from said steam-reducing treatment by controlling the amounts of hot water gas and steam fed thereto together with said reduced metal oxide, mixing said gas with any remaining water gas bypassing the steam-reducing treatment and recovering the hydrogen-enriched mixture.
2,644,745
PRODUCTION OF GASES FROM CARBONACEOUS SOLIDS
July 7, 1953; application filed Apr. 1, 1947; Serial No. 738,709; 7 claims.

1. In the process of converting solid carbonaceous ash-containing materials into gases containing carbon monoxide, the improvement which comprises forming a suspension of finely divided carbonaceous ash-containing solids in a gaseous medium containing oxygen in admixture with a member selected from the group consisting of steam, carbon dioxide, and mixtures thereof, forcing the resulting suspension at a high linear velocity tangentially into a lower part of an upright extended conversion zone having a circular horizontal cross section and thereby causing violent agitation of said suspension in said conversion zone, maintaining in said conversion zone a pressure between atmospheric and about 400 p.s.i. and a conversion temperature above the fusion point of the ash constituents of the carbonaceous solids in the range from 2,100° to 2,500° F., passing the introduced suspension upwardly through the conversion zone, providing a gradually increasing conversion space for said upwardly passing suspension, thereby gradually reducing the linear velocity of the suspended gas during its upward path through said conversion zone and thus causing fused ash to be deposited on the circumference of the conversion zone and to collect in a slag-collecting zone located at the bottom of the conversion zone, cooling the walls of said conversion zone by indirect heat exchange to a surface temperature just below the fusion point of said ash constituents to form a thin solidified layer of fused ash on the walls of the conversion zone, withdrawing a gas which contains carbon monoxide from an upper portion of said conversion zone and separately withdrawing fused ash constituents from said slag-collecting zone.
2,647,045
GASIFICATION OF COMBUSTIBLE MATERIALS
Roman Rummel, Düsseldorf-Benrath, Germany.
July 28, 1953; application filed May 12, 1949, Serial No. 92,832; 11 claims.
1. In the gasification of combustible material of the coal type, the improvement comprising substantially continuously introducing such a material in substantially particled form into a molten slag below the surface thereof, substantially continuously contacting said material in said slag with a combustion-supporting gas and with an endothermic gasification reactant for said material, and recovering a combustible gas mixture therefrom.

2,649,468
HYDROCARBON SYNTHESIS PROCESS AND PRODUCTION OF SYNTHESIS GAS
Aug. 18, 1953; application filed Nov. 12, 1947, Serial No. 785,552; 4 claims.
1. In a process for the generation of carbon monoxide and hydrogen from coal wherein coal is reacted with oxygen and steam to produce a gas stream rich in carbon monoxide and hydrogen and containing carbon dioxide and hydrocarbons, the improvement which comprises separating carbon dioxide from said gas stream and thereafter converting the hydrocarbons to additional carbon monoxide and hydrogen by reacting said hydrocarbons in admixture with said carbon monoxide and hydrogen in said gas stream with substantially pure oxygen in an amount sufficient only for reaction with said hydrocarbons at a temperature within the range of from about 2,000° to about 2,500° F. and a pressure above about 20 atmospheres in an unpacked reaction zone and in the absence of a catalyst to produce carbon monoxide and hydrogen substantially free from hydrocarbons and carbon dioxide.
2,650,160

PRODUCTION OF IRON SPONGE FROM IRON ORE
Friedrich Totzek, Essen (Ruhr), Germany, assignor to Koppers Co., Inc., Pittsburgh, Pa., a corporation of Delaware.


1. A method of reducing sponge iron ore comprising reacting a solid carbonaceous fuel with a gas containing at least 85 percent oxygen at above temperatures suitable for the reduction of sponge iron ore to produce a reducing gas containing at least 70 percent by volume carbon monoxide and hydrogen, the preponderant proportion of said reducing gas being carbon monoxide, cooling said reducing gas to about 1,000°F, contacting said reducing gas with said sponge iron ore in an amount sufficient to reduce said iron ore to at least 85 percent metallic iron and to produce a spent reducing gas containing substantially carbon monoxide, hydrogen, and carbon dioxide, and removing carbon dioxide from said spent reducing gas.

2,652,319

PROCESS FOR WATER-GAS GENERATION

Sept. 15, 1953; application filed Jan. 3, 1949, Serial No. 63,876; 8 claims.
(Cl. 48—206)

1. The process of producing gas mixtures containing carbon monoxide and hydrogen which comprises passing a stream of finely-divided carbonaceous solid material into an initial water gas reaction zone, forming a fluidized mass of solids therein, subjecting said mass to a gasification reaction with steam at temperatures of from about 1,700°F to 2,000°F to produce a gas rich in H₂ and CO, withdrawing said gas from said water gas reaction zone, finely divided char of high surface area, passing at least a portion of said char into a catalyst impregnation zone, impregnating in said zone said char with a catalyst promoting gasification of carbon, recycling said impregnated char of high surface area to said water gas reaction zone and recovering a gas rich in H₂ and CO from said last named zone.
GASIFICATION OF CARBONACEOUS SOLIDS
John A. Phinney, Mount Lebanon, Pa., assignor to Pittsburgh Consolidation Coal Co., Pittsburgh, Pa., a corporation of Pennsylvania.

Oct. 6, 1953; application filed Feb. 21, 1950, Serial No. 145,574; 1 claim.

The method of gasifying finely divided carbonaceous solid fuel which comprises continuously supplying finely divided carbonaceous solid fuel of different particle sizes to a confined gasification zone to thereby establish and maintain a bed of solids in said zone, passing steam upwardly through said bed at a velocity sufficient to maintain the solids as a suspended dense turbulent phase superimposed by a dilute solids phase in said gasification zone, continuously supplying hot substantially carbon-free ash fines derived from said fuel to said gasification zone, passing said ash fines upwardly through said dense phase in said gasification zone and into said dilute phase, the particle-size range of said ash fines being such that substantially all of said ash is carried into said dilute phase by the effluent gas from said dense phase, separating said ash fines and any entrained carbonaceous fines from said dilute phase, withdrawing solids having an average carbon content corresponding to that of said dense phase directly from said gasification zone and combining said solids with said separated fines outside of said gasification zone, passing said combined solids to a combustion zone, circulating an oxidizing gas in contact with said solids in said combustion zone under conditions such that the temperature of the combustion zone is maintained above that of said gasification zone and such that said solids are reduced to a substantially carbon-free state, separating from the ash produced in said combustion zone a portion having a particle size range corresponding to that of the first mentioned ash fines, recycling that portion only to said gasification zone, and recovering the gaseous products from said gasification zone.

LOW-TEMPERATURE DISTILLATION OF COAL
John A. Phinney, Mount Lebanon, Pa., assignor to Pittsburgh Consolidation Coal Co., Pittsburgh, Pa., a corporation of Pennsylvania.

Oct. 6, 1953; application filed May 3, 1950, Serial No. 159,727; 7 claims.

1. In the process for low-temperature distillation of coal to yield gaseous and liquid products and a solid distillation residue composed of particles having substantially the same volatile matter content, the steps comprising circulating finely divided fresh coal of a predetermined particle size consistency through a distillation zone, circulating preheated finely divided previously distilled coal through said distillation zone in direct heat-exchange relation with said fresh coal so as to form a mixture of solid products with said fresh coal, the heat required to effect distillation of said fresh coal being derived solely from said previously distilled coal, said previously distilled coal having a particle size consistency sufficiently different from that of said fresh coal to permit its ready separation from the distillation residue of said fresh coal, the total amount of distillation residue including previously distilled coal present in said distillation zone at any one time being sufficient to prevent agglomeration of said fresh coal by dilution thereof, recovering the gaseous and liquid products of distillation, separating the distillation residue of said fresh coal from said solid products, circulating at least a portion of the remaining solid products to a combustion zone where the temperature is raised by partial oxidation, recycling at least a portion of the partially oxidized solids to the distillation zone to serve as said preheated previously distilled coal and replenishing said recycled previously distilled coal with a portion of the distillation residue.
SYNTHESIS GAS GENERATION
Frederic H. Moore, Long Beach, Calif., assignor to The Texas Co., New York, N.Y., a corporation of Delaware.


(Cl. 48—206)

1. In a process for the production of a gaseous mixture comprising hydrogen and carbon monoxide from a solid carbonaceous fuel by reaction with steam and oxygen, the improvement which comprises introducing a stream of solid carbonaceous fuel suspended in steam into an elongated vertical cylindrical reaction zone at a point adjacent the upper end thereof and in a direction substantially tangent to the periphery of said zone, introducing a stream of oxygen-containing gas free from fuel into said zone at a point of introduction of said stream of steam and solid fuel into confluence with said stream of steam and particulate carbonaceous material whereby the reactants and resulting product gases are given a spiral motion downwardly along the wall of the reaction zone, and withdrawing all of the gaseous product comprising carbon monoxide and hydrogen axially through the upper portion of the reaction zone from a point within said zone along the axis thereof below the point of introduction of said reactants and above the center of said zone, all of the reactants being introduced into said zone above the level of said point of withdrawal, whereby the reactants and resulting reaction products form a stream flowing spirally downwardly in an annulus from the upper portion of the reaction zone to the lower portion of said zone and thence upward along the axis thereof to said point of withdrawal in direct radiant-heat-transfer relation with said downwardly flowing spiral.
MANUFACTURE OF HYDROGEN


Oct. 20, 1953; application filed Feb. 2, 1949; Serial No. 74,213; 13 claims.

1. A process for producing hydrogen, which comprises combusting carbon-containing material with oxygen containing gas under conditions suitable for the production of a major proportion of carbon monoxide and a minor proportion of carbon dioxide, passing excess steam upwardly through an oxidizing zone in the presence of finely divided reduced metalliferous contact material at a velocity effective to suspend the contact material in a pseudoliquid condition at a temperature below about 1,100° F. but sufficiently high such that hydrogen is produced under endothermic conditions at a desired rate by the reaction of steam with the contact material and the contact material is oxidized, passing oxidized contact material from the oxidizing zone to a first reduction zone, passing carbon monoxide which is prepared from combusting carbon-containing material in excess upwardly through said first reduction zone at a velocity effective to suspend the oxidized contact material in a pseudoliquid condition therein at a temperature significantly above the temperature of said oxidizing zone under exothermic conditions such that the metalliferous contact material is reduced by the carbon monoxide which is converted to carbon dioxide and the heat generated therein is sufficient to constitute the principal source of heat for the oxidizing zone, passing a relatively small proportion of contact material from the first reduction zone to a second reduction zone wherein the contact material is further reduced by the unconverted carbon monoxide from the first reduction zone at a temperature below about 700° F. but sufficiently high to obtain the desired rate of reaction, removing an effluent from the said second reduction zone comprising carbon dioxide and substantially free of carbon monoxide, recycling reduced metalliferous contact material to the said oxidizing zone at a temperature and in an amount sufficient to constitute the principal source of heat thereto, at least a portion of the reduced contact material is recycled from the first reduction zone, and recovering hydrogen from the oxidizing zone as the product of the process.
2,657,124

GENERATION OF HEATING GAS FROM SOLID FUELS
Leon P. Gaucher, Mount Vernon, N.Y., assignor to The Texas Co., New York, N.Y., a corporation of Delaware.
(CL. 46—197)

1. A process for the gasification of a solid carbonaceous material containing volatilizable constituents which comprises maintaining a dense phase fluidized bed of particles of said solid carbonaceous material in a distillation zone wherein said volatilizable constituents are distilled therefrom, disposing said distillation zone directly above a gasification zone and in direct communication therewith through an intermediate zone of restricted cross-sectional area permitting free flow of particles of solid carbonaceous material from the lower portion of said fluidized bed into the upper portion of said gasification zone and free flow of gas from said gasification zone to said distillation zone, introducing oxygen-containing gas into said gasification zone into contact with carbonaceous particles from said distillation zone effecting reaction with said carbonaceous particles in said gasification zone, passing gaseous reaction product from the upper portion of said gasification zone into the lower portion of said distillation zone through said intermediate zone countercurrent to the flow of said particles entering the gasification zone at a velocity such that said particles are admitted into said gasification zone at a limited rate, and withdrawing additional gaseous reaction product from the lower portion of said gasification zone.

2,657,986

PRODUCTION OF WATER GAS
Nov. 3, 1953; application filed Aug. 15, 1946, Serial No. 690,816; 3 claims.
(CL. 46—197)

1. The process of producing gas mixtures containing carbon monoxide and hydrogen from solid carbonaceous materials and steam which comprises contacting steam in a gasification zone at gasification temperatures with a dense ebullient mass of finely divided carbonaceous solids fluidized by an upwardly flowing gas to resemble a boiling liquid having a well-defined upper level, said carbonaceous solids being low-temperature carbonization coke formed by coking carbonaceous material in a coking zone at temperatures within the range of from about 600°—900° F. to produce a coke having an oxidation reactivity of about T<sub>15</sub>=200°—210° C. and T<sub>75</sub>=250°—260° C. to produce carbon monoxide and hydrogen when treated with steam at gasification temperatures, withdrawing coke from said coking zone and passing it directly to said gasification zone, withdrawing solid carbonaceous gasification residue from said gasification zone and passing it to a combustion zone,subjecting said solid carbonaceous gasification residue to combustion with an oxidizing gas in said combustion zone to generate heat and supplying heat of combustion to said gasification zone as sensible heat of finely divided combustion residue to said mass by withdrawing hot carbonaceous solids from said combustion zone and passing them with said carbonaceous solids withdrawn from said coking zone to said gasification zone.
PRODUCTION OF WATER GAS

Frank T. Barr, Summit, N.J., assignor to Standard Oil Development Co., a corporation of Delaware.

Nov. 3, 1953; application filed Oct. 12, 1946, Serial No. 702,992; 4 claims.

1. The process of producing gas mixtures containing carbon monoxide and hydrogen which comprises subjecting carbonizable materials to a low-temperature carbonization in the form of a dense turbulent bed of finely divided carbonaceous solids fluidized by an upwardly flowing gas in a carbonization zone at temperatures around 1,000° F., conducive to substantial cracking of carbonization products boiling above about 700° F. to produce volatile carbonization products and highly reactive coke having an activity of about T_{15}=200° C. and about T_{25}=245° C., separating tar fractions boiling above about 700° F. from the volatile products, returning said fractions to said carbonization zone substantially completely in the liquid state to be converted therein into lower boiling volatile products and highly reactive coke of said activity, and contacting said highly reactive coke directly with a gasifying medium consisting essentially of steam in a separate gasification zone at gasification conditions adapted to produce said gas mixtures.
PROCESS FOR GENERATION OF CARBON MONOXIDE AND HYDROGEN

Charles F. Teichmann, Crestwood, N.Y., assignor to Texaco Development Corp.,
New York, N.Y., a corporation of Delaware.

Nov. 24, 1953; application filed May 18, 1950, Serial No. 162,645; 3 claims.

1. In the production of gas consisting mainly of hydrogen and carbon monoxide by the partial combustion of a fluid hydrocarbon with oxygen in a combustion gas turbine having a combustion section and an expansion section, the steps which comprise introducing a fluid hydrocarbon and an oxygen-rich gas containing at least 40 percent molecular oxygen into the combustion section of a combustion gas turbine at a pressure substantially above atmospheric pressure, effecting reaction of said hydrocarbon and oxygen in said combustion section at a substantial superatmospheric pressure under exothermic combustion conditions effective to maintain the temperature of said reaction zone in the range of 2,000°F. and above, and in relative proportions yielding a product gas stream consisting mainly of hydrogen and carbon monoxide at said elevated reaction temperature, and immediately thereafter reducing the temperature and pressure of said high-temperature product gas stream through the range of from about 1,600°F. to about 600°F. by expansion and cooling of said gas stream in said gas turbine.
MANUFACTURE OF SYNTHESIS GAS

Thomas B. Hudson, Bartlesville, Okla., assignor to Phillips Petroleum Co., a corporation of Delaware.


1. In the manufacture of synthesis gas by the reaction of methane with steam to form a synthesis gas containing hydrogen and carbon monoxide with the hydrogen being in molar excess of the carbon monoxide, the improvement which comprises passing a reaction mixture comprising methane and steam downwardly through a vertical reaction chamber, passing downwardly through said chamber a mass of preheated refractory pebbles at an inlet temperature sufficient to effect the desired reaction, flowing the reaction mixture and pebbles concurrently through said reaction zone whereby the temperature in the direction of flow decreases due to the endothermic nature of the reaction, introducing catalyst for said reaction into said reaction zone for downward flow therethrough, said catalyst being introduced at a plurality of points spaced along the line of flow and being admixed with said pebbles and reaction mixture in said zone, separately regulating the quantity and activity of the catalyst introduced at each of said points so as to provide an increasing catalyst activity in the direction of flow, said increasing activity tending to counteract the depressing effect of said decreasing temperature on the extent of reaction in the lower portions of said reaction zone, recovering said pebbles from the bottom of said reaction zone, reheating same, and reintroducing same into the top of said reaction zone in a continuous cycle, separating said catalyst from admixture with said pebbles, subjecting a portion of said catalyst to reactivation while returning the remaining portion to the reaction zone without reactivation, introducing said unreactivated catalyst into said zone at a plurality of the aforesaid points including the first and excluding the last of said points in the direction of flow, the unreactivated catalyst introduced to said first point being the sole catalyst introduced thereto and a diminishing quantity of unreactivated catalyst being introduced at each succeeding point in the direction of flow, introducing said reactivated portion of said catalyst into the reaction zone at a plurality of points excluding the first and including the last of said points in the direction of flow, the reactivated catalyst introduced to said last point being the sole catalyst introduced thereto and an increasing quantity of reactivated catalyst being introduced at each succeeding point in the direction of flow, and so portioning the relative amounts of unreactivated and reactivated catalysts introduced at the respective points as to maintain an increasing catalytic activity in the direction of flow such as to establish a substantially constant extent of reaction throughout the reaction zone despite said decreasing temperature, otherwise decreasing catalyst activity and decreasing concentration of reactants.

FIG. 1
2,662,004

METHOD OF PREPARING SYNTHESIS GAS AT ELEVATED PRESSURES
Leon P. Gaucher, Tuckahoe, N.Y., assignor to The Texas Co., New York, N.Y., a corporation of Delaware.
Dec. 8, 1953; application filed Oct. 1, 1948; Serial No. 52,824; 2 claims.
1. A process for continuously generating carbon monoxide and hydrogen, which comprises passing a stream of a hydrocarbon gas and a reactant selected from the group consisting of steam, carbon dioxide, and a mixture thereof into a reaction zone maintained at a temperature above 1,200°F. and a pressure above about 150 p.s.i. gauge into contact with a bed of solid contact material in particle for maintained in dense fluid phase condition by the flow of reactants therethrough, effecting reaction between said hydrocarbon and said reactant within said reaction zone to form carbon monoxide and hydrogen, subjecting carbonaceous material to combustion in a separate combustion zone maintained at a temperature in the range of 1,800° to 3,900°F. and a pressure substantially equivalent to the pressure in said reaction zone and passing the resulting combustion gases maintained under said elevated pressure through said fluidized bed of solid contact material in indirect heat exchange therewith to supply heat to said reaction zone.

2,662,007

GASIFICATION OF POWDERED CAKING-TYPE COAL
Dec. 8, 1953; application filed June 2, 1947; Serial No. 751,728; 11 claims.
1. A process for the gasification of carbon-containing material to produce a gas rich in hydrogen and carbon monoxide and substantially free from methane, which comprises suspending in a reaction zone a caking-type coal in finely divided form containing initially no more than a minor proportion by weight of material whose average particle diameter is greater than about 250 microns in a flowing gaseous mixture comprising oxygen and steam under conditions such that hydrogen and carbon monoxide are produced as products of the process, supplying the required heat of conversion to said reaction zone by direct heat exchange, maintaining the linear gas velocity sufficiently high such that the heaviest particles of finely divided solid continuously move in the direction of flow of the gases, maintaining the temperature of reaction above 1,800°F. and below 2,600°F. and a pressure between about 250 and about 1,000 p.s.i. gage and a residence time of solid material in said reaction zone less than about 5 seconds, and removing a gaseous effluent containing hydrogen and carbon monoxide from said reaction zone substantially free from methane as a product of the process.
CARBONIZATION OF COAL

Ernest F. Pevere, Beacon, George B. Arnold, Glenham, and Howard V. Hess, Beacon, N.Y., assignors to The Texas Co., New York, N.Y., a corporation of Delaware.
Dec. 29, 1953; application filed Nov. 19, 1948, Serial No. 61,013; 3 claims.

1. A process for the carbonization of a fusible coal containing volatilizable constituents with the production of dry solid powdered coke and recovery of said volatilizable constituents, which comprises contacting said coal in particle form with a normally liquid hydrocarbon solvent for coal substance, agitating said coal particles with said solvent at a temperature above the temperature at which said coal is rendered plastic and within the range of from about 550° to about 700° F., whereby said coal becomes miscible with said oil solvent and a substantially homogeneous liquid mixture containing all of the original components of said coal is obtained, atomizing said liquid mixture into a stream of a substantially inert gas, thereby suspending said atomized liquid therein, passing the suspension upwardly through an externally heated carbonization zone maintained at a temperature of from about 900° to about 1,300° F., maintaining said atomized liquid in suspension in said carbonization zone for a period of time sufficient to effect substantially complete volatilization of said hydrocarbon solvent and volatilizable constituents of said coal and form dry solid particles of coke suspended in vaporous product of volatilization, and subsequently separating said solid particles of coke from volatilized products.

PROCESS FOR PRODUCING HYDROGEN AND CARBON MONOXIDE FROM GASEOUS HYDROCARBONS


1. A method for producing an industrial gas containing carbon monoxide and hydrogen from a gaseous hydrocarbon, which comprises establishing a closed cycle, circulating through said cycle a finely divided solid containing a metal oxide capable of yielding oxygen in the presence of said hydrocarbon, establishing in said cycle a pair of separate beds of said finely divided solid, passing upwardly through one of said beds a preheated mixture of a gaseous hydrocarbon and steam at a velocity sufficient to maintain the finely divided solid in said bed in a fluidized condition while maintaining in said bed a temperature at which said hydrocarbon reacts with said metal oxide, recovering a product gas from the upper part of said bed, passing said product gas in heat exchange relation to the gaseous feed to said bed, passing upwardly through the other of said beds an oxidizing gas at a velocity sufficient to maintain the finely divided solid in said bed in a fluidized condition while maintaining in said bed a temperature at which said metal is oxidized, recovering a hot residue gas from the upper portion of said bed and passing said hot residue gas in heat-exchange relation to the oxidizing gas fed to said bed.
PROCESS FOR GENERATION OF CARBON MONOXIDE
Charles R. Carkeek, Pasadena, Calif., assignor to The Texas Co., New York, N.Y., a corporation of Delaware.

1. In a process for the production of carbon monoxide from carbonaceous fuels wherein said fuel is reacted with oxygen in a reaction zone to produce a product gas stream comprising carbon monoxide and containing entrained free carbon, the improvement which comprises intimately contacting said product gas stream in a gas scrubbing zone with water and thereby effecting removal of carbon from said gas stream and producing a dispersion of carbon in water, withdrawing said dispersion from said gas scrubbing zone, separating water from said dispersion to form an aqueous slurry, intimately contacting said aqueous slurry with a liquid hydrocarbon whereby carbon particles are transferred from said aqueous slurry to said liquid hydrocarbon to form a slurry of carbon particles in liquid hydrocarbon, and passing said liquid hydrocarbon containing carbon so recovered from the gas stream into said reaction zone for the conversion of said hydrocarbon and said recovered carbon to said product gas.

GAS PRODUCER
Otto Hubmann, Homburg vor der Höhe, Germany.

1. A gas producer for the gasification of solid fuel, which comprises a vertical cylindrical shaft furnace having a rotatable center shaft, a combustion zone for such fuel defined in said furnace with said rotatable center shaft extending therethrough, a grate mounted for rotation with said shaft positioned at the lower end of the combustion zone, a fuel-holding receptacle positioned within said furnace above said combustion zone with at least the bottom portion thereof connected to said shaft for rotation therewith, the bottom of said receptacle defining at least one opening therethrough in spaced relationship to the axis of said rotatable center shaft for the discharge of fuel, and means for rotating said shaft.
2,668,101

METHOD OF PREPARING MIXTURES OF HYDROGEN AND CARBON OXIDES
Feb. 2, 1954; application filed Jan. 21, 1948, Serial No. 72,986; 11 claims.

1. In the continuous process for the production of hydrogen and carbon oxides by reforming hydrocarbons of higher molecular weight than methane by passing said hydrocarbons mixed with an oxygen-containing gas over an externally heated reforming catalyst maintained at a reforming temperature within the range of 1,200° to 2,000° F., there being present sufficient oxygen-containing gas to convert substantially all of the hydrocarbons into hydrogen and carbon oxides, the improvement which comprises passing as a continuous stream in turbulent flow through a tubular heating zone within said reaction zone at a pressure in excess of the pressure in said reaction zone a suspension of particles of said fuel in a liquid which is substantially inert with respect to reaction with said fuel under the conditions existing in said heating zone, vaporizing said liquid within said heating zone by heat exchange with said reaction thereby forming a dispersion of particles of said fuel in vapor with said heating zone and removing heat from said reaction zone, and continuously introducing resulting dispersion of solid carbonaceous fuel in vapor into said gasification zone as reactant for the production of carbon monoxide and hydrogen.

2,669,509

PROCESS FOR GASIFYING CARBONACEOUS SOLIDS
Frederick B. Sellers, New York, N.Y., assignor to Texaco Development Corp., New York, N.Y., a corporation of Delaware.
Feb. 16, 1954; application filed Sept. 16, 1948, Serial No. 49,582; 4 claims.

(Cl. 49—206)
APPARATUS FOR TREATING GASEOUS AND FLUIDIZED POWDER STREAMS
Corsten I. Johnson, Floral Park, N.Y.

1. In the process for treating a fluidized powder stream, the steps in separating solid particles from the stream which comprise passing the stream upwardly in a confined passage, applying heat to said stream during its upward movement, then passing said stream downwardly through a confined passage which is cooler than said first passage, the decrease in velocity of the stream effecting separation of solid particles from the stream, and collecting solid particles at the bottom of said cooler passage.

Fig. 1
2,671,013

METHOD FOR PRODUCING A SYNTHESIS GAS
Claude W. Watson, Port Arthur, Tex., assignor to The Texas Co., New York, N.Y., a corporation of Delaware.

Mar. 2, 1954; application filed Nov. 10, 1949, Serial No. 126,491; 7 claims.

1. In the conversion of a carbonaceous feed material containing hydrogen into synthesis gas comprising essentially hydrogen and carbon monoxide, the steps which comprise subjecting a metal capable of being readily carbidized and subsequently decarbidized, and oxidizable by steam to an oxide which is readily reducible by carbon monoxide, to reaction with said carbonaceous feed material at an elevated temperature at which said metal is thereby carbidized, yielding a stream of gaseous hydrogen, subjecting an additional quantity of said metal to contact with water vapor at a high temperature at which the metal is converted to an oxide yielding additional free hydrogen, introducing said metal oxide and metal carbide into a reaction zone in the presence of a substantial stream of carbon dioxide at an elevated temperature at which interaction takes place with the formation of elemental metal and the liberation of a product stream of carbon monoxide and recovering product carbon monoxide thus formed.

Fig.1.

2,671,014

METHOD FOR PRODUCING A SYNTHESIS GAS
Claude W. Watson, Port Arthur, Tex., assignor to The Texas Co., New York, N.Y., a corporation of Delaware.

Mar. 2, 1954; application filed Nov. 10, 1949, Serial No. 126,492; 2 claims.

1. In the production of synthesis gas comprising essentially hydrogen and carbon monoxide, for the catalytic production of desired fractions of hydrocarbons, oxygenated hydrocarbons and mixtures thereof, the improvement which comprises reacting a hydrocarbonaceous feed material with a finely divided, solid particle metal, capable of being readily carbidized and subsequently decarbidized, in a carbidizing zone at an elevated temperature in the range at which said hydrocarbonaceous material is decomposed to liberate hydrogen and form finely divided, solid particle metal carbide, recovering said product hydrogen, withdrawing said solid particle metal carbide from said carbidizing zone to a decarbidizing zone, thereafter reacting said metal carbide in said decarbidizing zone with substantially pure carbon dioxide in such amount as to reduce substantially all of the metal carbide to the elemental form and at an elevated temperature such that the carbon dioxide is converted into carbon monoxide and said metal carbide is reduced to a solid particle, relatively decarbidized form, recovering said product carbon monoxide, withdrawing the relatively decarbidized metal particles from the decarbidizing zone, returning them to the carbidizing zone, and mixing the hydrogen and carbon monoxide so formed to form a synthesis gas.

PART I—UNITED STATES PATENTS
CONTINUOUS PROCESS FOR MANUFACTURE OF A SUPPLEMENT GAS

Ernest G. de Coriolis, Toledo, Ohio, assignor to Surface Combustion Corp., Toledo, Ohio, a corporation of Ohio.

Mar. 9, 1954; application filed Dec. 23, 1948; Serial No. 66,943; 4 claims.

1. A continuous process for the manufacture of a supplement gas which comprises (1) mixing a hydrocarbon vapor with air and steam in proportions such that the total oxygen content of the air and steam is at least sufficient to form carbon monoxide with all of the carbon in the hydrocarbon vapor, (2) converting the resulting mixture to a producer gas-water gas mixture, in the presence of an externally heated catalyst, by carrying the producer-gas and water-gas reactions substantially to completion so that the methane content of the product is not more than about 8 volume-percent and the caloric value of the product is not more than about 347 B.t.u. per cubic foot, and (3) mixing said product with a hydrocarbon vapor in such proportions as to produce a supplement gas of the desired caloric value and specific gravity.

PRODUCTION OF INDUSTRIAL-GAS MIXTURE OF HYDROGEN AND CARBON MONOXIDE


Mar. 9, 1954; application filed Aug. 3, 1946; Serial No. 688,351; 9 claims.

1. A method for producing an industrial mixture of carbon monoxide and hydrogen under pressure, which comprises establishing a column of a fluidized solid, including a metal oxide capable of reacting with a hydrocarbon at temperatures between about 1,600° and 2,000° F., the metal of which is capable of catalyzing the reaction between a hydrocarbon and steam and carbon dioxide at a temperature between about 1,500° and 1,900° F., of sufficient height to provide the required hydrostatic pressure, continuously feeding said solid into a flowing stream of hydrocarbon maintained under a suitably elevated pressure, causing said hydrocarbon and finely divided solid to flow concurrently while maintained at a temperature within the ranges above specified for a period sufficient to effect the conversion of said hydrocarbon first into a gas comprising substantial proportions of carbon dioxide and steam, simultaneously to convert at least a portion of said metal oxide into solid particles comprising said metal, and thereafter converting further amounts of hydrocarbon with said initially produced carbon dioxide and steam, under the catalytic influence of said metal-containing solid particles into a gas containing carbon monoxide and hydrogen and recovering said gas mixture under the pressure prevailing in the system.
2,671,720

PRODUCTION OF HYDROCARBON SYNTHESIS GAS

Mar. 9, 1954; application filed Aug. 3, 1946; Serial No. 688,352; 10 claims.

1. Improved process for the production of carbon monoxide and hydrogen from hydrocarbon gases, which comprises contacting hydrocarbon feed with a fluidized iron group metal catalyst selected from the class consisting of iron, cobalt, and nickel, maintained in the form of a turbulent fluid bed within a reaction zone at an intermediate level by passing said hydrocarbon gas upwardly therethrough at such a velocity that said bed assumes a definite upper surface, maintaining the major portion of the catalyst in said reaction zone in the form of free metal particles with at most 30 percent of metal oxide, continuously circulating a relatively small percentage of said catalyst to an oxidation zone and back to said reaction zone at such a rate that substantially one atom of oxygen combined as reducible metal oxide is introduced into said reaction zone per atom of carbon in the total hydrocarbon feed, forming a suspension of said metal oxide at reaction temperature in at least part of said hydrocarbon feed in a reactant feed line and causing the rapid oxidation of the hydrocarbon in this suspension to a gas containing carbon dioxide and water vapor while reducing the reducible metal oxide therein to the form of solid particles of the free metal, thereafter introducing said suspension upwardly through the turbulent fluid bed of metal catalyst in said reaction zone and reforming the carbon dioxide and water vapor therein together with the remaining portion of said total hydrocarbon feed to produce a product gas consisting essentially of carbon monoxide and hydrogen.
PRODUCTION OF INDUSTRIAL GAS COMPRISING CARBON MONOXIDE AND HYDROGEN


Mar. 9, 1954; application filed Aug. 3, 1946; Serial No. 688,853; 1 claim.

A method for producing a mixture of carbon monoxide and hydrogen from a gaseous hydrocarbon, which comprises feeding the hydrocarbon into a reaction zone, simultaneously feeding to said reaction zone an oxide of a metal in finely divided form in an amount substantially in excess of that stoichiometrically necessary to convert all the carbon in the hydrocarbon to an oxide of carbon, the said finely divided metal oxide being established in the form of an elongated vertical fluidized column of said finely divided metal oxide of sufficient height to exert a pressure at near the bottom of said column of upwards of 200 p.s.i., which thus pressurized metal oxide is withdrawn from the bottom of said column and fed to said reaction zone, maintaining in said reaction zone a temperature suitable for the reaction between the metal oxide and the hydrocarbon, maintaining a pressure in said reaction zone of upwards of 200 p.s.i., controlling the feed rate of the gaseous hydrocarbon so as to maintain the finely divided solid in said zone in a highly turbulent dense suspension and fluidized state, continuously withdrawing solid, finely divided metal oxide particles of reduced oxygen content downwardly from the bottom of said reaction zone, discharging the withdrawn metal oxide particles into a transfer line and conveying them to a reoxidizing zone, treating said particles with air at substantially atmospheric pressure to convert the metal oxide particles to higher oxides, discharging the higher oxide particles from said reoxidizing zone to the top of said vertical, fluidized column for recycling to the said reaction zone, recovering a product gas from said reaction zone and passing it in admixture with a gaseous hydrocarbon over a reforming catalyst at a temperature suitable for the reaction of water and carbon dioxide with said hydrocarbon to form a mixture of carbon monoxide and hydrogen and recovering said mixture under a pressure of upwards of 200 pounds per square inch.
2,672,410
GASIFICATION OF CARBONACEOUS SOLIDS
William I. Matte, Baton Rouge, La., assignor to Standard Oil Development Co., a corporation of Delaware.


1. In the production of gas mixtures containing H₂ and CO by reacting solid carbonaceous materials simultaneously with steam and oxygen in a gasification zone, the improvement which comprises adding to said reaction an extraneous metal halide yielding a reaction product selected from the group consisting of elemental halogen and volatile halogen compounds at the reaction conditions, said halide being present in amounts providing a halogen equivalent corresponding to that of about 0.01-1 percent by weight of alkali metal halide based on carbon present, and said amounts being adequate to inhibit the formation of CO₂ in favor of CO formation.
2,674,525

GASIFICATION OF CARBONACEOUS SOLIDS


Apr. 6, 1954; application filed July 2, 1948, Serial No. 36,596; 2 claims.

(Cl. 48—206)

1. In a process for the gasification of a solid carbonaceous feed material by an endothermic gasification reaction, the improvement which comprises admixing said solid carbonaceous material in particle form with particles of a solid inert heat-carrier material at a temperature substantially in excess of the temperature required for the gasification reaction, maintaining a bed of the resultant mixture of solids in a gasification zone, passing a gaseous reactant through said bed in said gasification zone to effect endothermic gasification of said solid carbonaceous material, withdrawing resulting gases from said gasification zone, discharging ungasified residue from said carbonaceous material admixed with said heat-carrier material from said gasification zone, introducing said mixture withdrawn from said gasification zone into the upper portion of a combustion zone, maintaining a downwardly moving bed of solid heat-carrier material and ungasified residue from said carbonaceous material in said combustion zone, contacting said bed in said combustion zone with a stream of oxygen-containing gas passing downwardly through said bed in an amount sufficient for substantially complete combustion of carbon in said mixture thereby heating said heat-carrier material, withdrawing heated heat-carrier material from the lower portion of said combustion zone, separating said particles of solid inert heat-carrier material from residue from said carbonaceous material, and returning heated heat-carrier material from said combustion zone to said gasification zone.
PREPARATION OF SYNTHESIS GAS
Bradford E. Bailey, Elizabeth, N.J., assignor to Standard Oil Development Co.,
a corporation of Delaware.
Apr. 20, 1954; application filed May 19, 1950; Serial No. 163,057; 10 claims.

1. The process of preparing a hydrocarbon synthesis gas consisting essentially of hydrogen and carbon monoxide which comprises feeding into a gas-inlet zone at one end of a methane reforming zone, a gas stream comprising a thick layer of the order of at least 10 feet of methane, CO₂, and H₂O, feeding a fuel gas and a combustion-supporting gas to a combustion zone spaced vertically from said gas inlet zone, carrying out a combustion reaction wherein a flue gas comprising substantial amounts of CO₂ and H₂O is produced, maintaining the temperature of said combustion zone at about 2,800° to 4,000° F., passing said flue gas as a thick layer of at least 10 feet, moving horizontally and concurrently with the thick layer of said first-named gas stream through said reaction zone, carrying out a methane reforming reaction in said zone, furnishing substantially all the heat required for said reforming reaction as radiant energy from said flue gas, absorbing substantially all of said radiant energy in said thick layer of said gas undergoing reforming, whereby said thick layer acts substantially as a black body for said absorption, and separately withdrawing flue gas and a gas mixture comprising synthesis gas at the opposite end of said reaction zone from said gas-inlet zone.
CARBONIZATION OF LIGNITE TO PRODUCE MOTOR FUELS

Henry M. Noel, Summit, N.J., assignor to Standard Oil Development Co., a corporation of Delaware.

Apr. 27, 1954; application filed Dec. 1, 1948; Serial No. 62,837; 2 claims.

1. An improved continuous process for producing valuable motor fuels from low-grade carbonaceous solids of the type of lignite and peat which comprises initially mixing finely divided carbonaceous solids with minor proportions of a carboxylic acid salt of calcium and 1 to 4 percent of extraneous sodium carbonate in a mixing zone, passing a stream of said finely divided mixture into a carbonization zone, forming a fluidized mass of solids therein maintained at a carbonizing temperature of about 800° to 1,100° F., subjecting distillable portions of said carbonaceous solids to a chemical reaction in said carbonization zone whereby phenolic constituents of said portions are converted into aromatic hydrocarbons, removing volatile products from said carbonization zone, leaving a coky residue in finely powdered fluidized form, withdrawing from said carbonization zone a stream of fluidized carbonaceous coky solids, containing a minor proportion of sodium carbonate, passing the same directly into a gasification zone to form a fluidized mass of solids therein, reacting said mass with steam at a gasification temperature of about 1,400° to 2,000° F. to form a gas rich in H₂ and CO, adding oxygen and a fuel gas to said gasification zone, supplying all the heat required for said gasification reaction above and beyond the sensible heat of said stream, steam, oxygen, and added fuel gas by controlled combustion of said fuel gas and said carbonaceous solids to form further quantities of gas rich in H₂ and CO, withdrawing a gas rich in H₂ and CO from said gasification zone, withdrawing hot fluidized solid combustion residue containing sodium carbonate from said gasification zone, discarding a minor portion of said residue adequate to prevent excessive solids buildup in said zones, feeding the remainder of said hot combustion residue to said carbonization zone to supply heat required therein, progressively decreasing as the reaction proceeds, the amount of extraneous sodium carbonate added to said mixing zone at a feed rate of extraneous sodium carbonate corresponding to the amount of sodium carbonate discarded with said discarded minor portion and further increasing the yield of product boiling within the gasoline boiling range by recycling at least a portion of the distillation products from said carbonization zone boiling above the gasoline-bolling range and subjecting said material to a cracking reaction by contacting with hot ash recycled from said gasification zone at a temperature above that at which said products were distilled.
CONTACTING SOLIDS AND FLUIDS
Karl I. Neison, Cranford, N.J., assignor to Standard Oil Development Co., a
corporation of Delaware.
1. The method of contacting fluids with a dense turbulent mass of finely
divided solids having a well-defined upper level in a treating zone at con-
stant conditions of treating temperature and solids residence time, which
comprises passing said fluids upwardly through said mass, supplying a sub-
stantially constant amount of finely divided solids heated to a temperature
not below said treating temperature at a substantially constant temperature
to said mass to supply a constant amount of heat thereto, said amount of
heat being sufficient to maintain said temperature, feeding a stream of fresh
finely divided solids having a temperature substantially below said treating
temperature to said mass, said heated finely divided solids being supplied
independently of said fresh solids, withdrawing a stream of finely divided
treated solids from said mass, changing the rate of flow of said stream of
fresh solids in the same direction as said treating temperature changes
so as to maintain said treating temperature substantially constant and
changing the rate of flow of said treated solids in the same direction as
the height of said mass changes so as to maintain said level substantially
constant.

PRODUCTION OF INDUSTRIAL GASES CONTAINING CARBON MONOXIDE
AND HYDROGEN
Eugene S. Corner, Roselle, N.J., assignor to Standard Oil Development Co., a
corporation of Delaware.
May 11, 1954; application filed Aug. 12, 1947, Serial No. 768,246; 4 claims.
1. In a process in which interconnected beds of a fluidized finely divided
oxygen carrier are maintained by passing upwardly through one of said beds
a gas consisting essentially of gaseous hydrocarbon, at a velocity sufficient
to maintain said bed in a fluidized state, at a temperature between about
1,600° and 2,000° F. and by passing upwardly through the other of said beds
an oxidizing gas at a velocity sufficient to maintain said bed in a fluidized state and at a temperature at which oxygen is added to said
carrier and by continuously circulating finely divided oxygen carrier from
each bed to the other and a gas containing carbon monoxide and hydrogen
is recovered from said first-mentioned bed, the step of using as an oxygen
carrier a composition consisting essentially of magnesia, from about 10 to
about 50 percent by weight chromium oxide and comprising no more than about 25
percent by weight iron oxide as Fe₂O₃ when 0 to about 5 percent by weight
chromium oxide is present in which the magnesia and the iron oxide are
thoroughly intermixed to the extent afforded by mixing in an aqueous
medium an iron salt and a magnesia salt, coprecipitating magnesia and
iron oxide, separating the said precipitate from the aqueous medium, dry-
ing, and roasting.
METHOD FOR MANUFACTURE OF A GAS RICH IN HYDROGEN


1. A process for the production of a gaseous mixture comprising hydrogen and carbon monoxide in relatively large proportions, which comprises passing reactants and products of reaction upward through a mass of finely divided contact material in a reaction zone at a velocity sufficient to suspend said mass in a pseudoliquid condition whereby a dense phase of contact material is formed, introducing oxygen and methane into the lower portion of said dense phase of contact material and reacting same to produce hydrogen and carbon monoxide, introducing methane and steam into the upper portion of said dense phase and reacting same to produce hydrogen and carbon monoxide, removing an effluent from said reaction zone comprising hydrogen and monoxide as the product of the process, withdrawing a portion of hot contact material from the dense phase of said reaction zone, cooling said hot contact material withdrawn from said reaction zone to a temperature below the temperature of said dense phase, returning a portion of the cooled contact material to said reaction zone as a means of controlling the temperature of the dense phase of contact material therein, and admixing another portion of said cooled contact material with said withdrawn contact material adjacent to the point of withdrawal.
2,681,273

PROCESS FOR MAKING COMBUSTIBLE GAS

June 15, 1954; application filed Aug. 23, 1947; Serial No. 770,271; 6 claims.

1. The process of making combustible gas comprised of CO and H₂ from reactants adapted to yield said CO and H₂ by reaction at elevated temperatures, in an elongated upright generator having a deep mass of checkerwork confined therein as a pervious stratum extending across it between the top and bottom thereof, comprising, disposing a deep body of finely divided solids in said generator in part in the interstitial space of said mass and also above said mass, densely fluidizing the thus disposed solids as a deep, single, substantially stationary, continuous bed, having a well defined top level in said generator above said mass, by passing a gasiform stream initially containing a combustion supporting fluid and a fuel upwardly at a particular fluidizing velocity through said bed of solids and through said interstitial space, promoting combustion of said fuel in said stream in said bed thereby heating both the said solids and said checkerwork to a reaction temperature below about 1,800°F., discontinuing the heating operation after the reaction temperature has been reached in said bed, then similarly passing a gasiform stream initially containing steam and at least one combustible reactant upwardly at a superatmospheric pressure through said bed at a velocity that maintains said solids in said densely fluidized state in said bed, thereby making said combustible gas in the latter stream in said bed and discharging the latter gas in said latter stream from above said bed and recovering it, meanwhile confining said solids in said bed in said generator substantially as a permanently retained body; said particular velocity being such that top to bottom circulation of said solids in said bed is inhibited.
METHOD FOR PARTIAL COMBUSTION OF CARBONACEOUS MATERIALS
Harold V. Atweil, Beacon, N.Y., assignor to The Texas Co., New York, N.Y., a corporation of Delaware.
June 22, 1954; application filed May 28, 1948, Serial No. 29,823; 2 claims.
(Cl. 48—206)

1. In a process for the production of carbon monoxide and hydrogen by reaction of a solid carbonaceous fuel in particle form with steam and uncombined oxygen wherein said reaction is conducted at a temperature above about 2,000° F. autogenously maintained by said reaction, the improvement which comprises introducing said fuel and oxygen substantially free from steam into one end of a compact unobstructed reaction zone, effecting reaction of only a portion of said fuel with substantially all of said oxygen forming a stream of primary reaction products containing unconsumed fuel particles and flowing said stream of primary reaction products through a predetermined path of flow along the axis of said reaction zone toward the opposite end thereof, introducing into said stream of primary reaction products at the opposite end of said reaction zone substantially all of the steam required in the process free from solid fuel, reversing the direction of flow of said stream at said opposite end of said reaction zone forming a secondary stream enveloping said primary stream and flowing countercurrent to said primary stream, and withdrawing product gases from said reaction zone from an area adjacent the point of introduction of said fuel and oxygen.

GASIFICATION OF CARBONACEOUS SOLID FUELS
Everett Gorin, Castle Shannon, Pa., assignor to Pittsburgh Consolidation Coal Co., Pittsburgh, Pa., a corporation of Pennsylvania.
June 29, 1954; application filed June 16, 1949, Serial No. 99,561; 4 claims.

1. The method of making water gas which comprises charging lime and a carbonaceous solid fuel to a steam-carbon gasification zone in the relative proportions of at least 120 parts by weight of lime for each 100 parts by weight of carbon contained in said carbonaceous fuel, passing steam in reactive relationship with said carbonaceous fuel in said gasification zone at a temperature within the range 1,430° to 1,500° F. and under a superatmospheric pressure whose minimum value is determined by the expression

\[ p = 3.40 - 1.89 \times 10^{-2} (t - 1,430) + 4.48 \times 10^{-4} (t - 1,430)^2 \]

where \( p \) is the pressure in atmospheres and \( t \) is the temperature in ° F., whereby water gas and calcium carbonate in admixture with a carbonaceous ash are produced, recovering the water gas, passing air at substantially atmospheric pressure through a mixture of said carbonate and carbonaceous ash while the latter are still at substantially the same temperature that prevailed in the gasification zone until substantially all the combustible carbon in said mixture is oxidized, whereby the carbonate is converted to lime and the carbonaceous ash is rendered substantially free of carbon, separating the ash from said regenerated lime, and repeating the above cycle with said regenerated lime and fresh carbonaceous fuel.
GASIFICATION OF CARBONACEOUS SOLID FUELS

Everett Gorin, Castle Shannon, Pa., assignor to Pittsburgh Consolidation Coal Co., Pittsburgh, Pa., a corporation of Pennsylvania.


1. The process for making water gas which comprises charging finely divided carbonaceous solid-fuel particles and finely divided particles of barium oxide to a reaction zone under fluidized conditions in such size relation that the barium oxide particles are separable by elutriation, maintaining a temperature within said reaction zone within the range of 1,550° to 2,150° F. and a pressure of at least one atmosphere when the temperature of the reaction zone is within the range of 1,550° to 1,900° F., and when the reaction-zone temperature is within the range of 1,900° to 2,150° F. a pressure whose minimum value is determined by the expression

\[ p = 1.0 + 6.27 \times 10^{-4} (t - 1,900)^2 \]

where \( p \) is the pressure in atmospheres and \( t \) is the temperature in ° F., passing steam into said reaction zone in reactive relationship with said carbonaceous solids to produce a gas containing carbon dioxide, converting said barium oxide to barium carbonate by the reaction with said carbon dioxide, regulating the linear velocity of the fluidizing gas passing up through said reaction zone so that the barium carbonate particles are carried up from the fluidized reaction bed and pass overhead to a regeneration zone, withdrawing from said reaction zone a portion of the relatively coarse carbonaceous solids and charging said carbonaceous solids to a producer-gas generator, burning the resulting producer gas with air in said regeneration zone to provide the heat necessary to reconvert said withdrawn barious carbonate to barium oxide, withdrawing said reconverted barium oxide from said regeneration zone and returning said reconverted barium oxide to said reaction zone concurrently with the introduction of additional carbonaceous solids to said reaction zone in such proportion that there are at least 325 parts by weight of barium oxide charged to said reaction zone for each 100 parts by weight of carbon contained in the carbonaceous solids charged to said reaction zone, and recovering the gaseous products from said reaction zone.
GASIFICATION OF CARBONACEOUS SOLID FUELS

Everett Gorin, Castle Shannon, Pa., assignor to Pittsburgh Consolidation Coal Co., Pittsburgh, Pa., a corporation of Pennsylvania.

June 29, 1954; application filed June 16, 1953; Serial No. 99,563; 2 claims.

1. The process for making water gas which comprises charging finely divided carbonaceous solid-fuel particles and finely divided particles of strontium oxide to a reaction zone under fluidized conditions in such a size relationship that the strontium oxide particles are separable by elutriation, maintaining a temperature within said reaction zone within the range of 1,550°F to 2,100°F and a pressure of at least one atmosphere when the temperature of the reaction zone is within the range of 1,550°F to 1,800°F, and when the reaction-zone temperature is within the range of 1,800°F to 2,100°F, a pressure whose minimum value is determined by the expression

\[ p = 1.0 - 5.9 \times 10^{-5} (t - 1,800) + 2.69 \times 10^{-4} (t - 1,800)^2 
+ 0.558 \times 10^{-6} (t - 1,800)^3 \]

where \( p \) is the pressure in atmospheres and \( t \) is the temperature in °F, passing steam into said reaction zone in reactive relationship with said carbonaceous solids to produce a gas containing carbon dioxide, converting said strontium oxide to strontium carbonate by the reaction with said carbon dioxide, regulating the linear velocity of the fluidizing gas passing up through said reaction zone so that the strontium carbonate particles are carried up from the fluidized reaction bed and pass overhead to a regeneration zone, withdrawing from said reaction zone a portion of the relatively heavy carbonaceous solids and charging said carbonaceous solids to a producer-gas generator, burning the resulting producer gas with air in said regeneration zone to provide the heat necessary to reconvert said withdrawn strontium carbonate to strontium oxide, withdrawing said reconverted strontium oxide from said regeneration zone and returning said reconverted strontium oxide to said reaction zone concurrently with the introduction of additional carbonaceous solids to said reaction zone in such proportion that there are at least 220 parts by weight of strontium charged to said reaction zone for each 100 parts by weight of carbon contained in the carbonaceous solids charged to said reaction zone, and recovering the gaseous products from said reaction zone.
2,682,458

GASIFICATION OF CARBONACEOUS SOLIDS

Everett Gorin, Whitehall, Pa., assignor to Pittsburgh Consolidation Coal Co., Pittsburgh, Pa., a corporation of Pennsylvania.

June 29, 1954; application filed Feb. 4, 1950; Serial No. 142,466; 2 claims.

1. The method of gasifying a carbonaceous solid fuel which comprises feeding said solid fuel in a finely divided state that includes a range of particle sizes to a gasification reaction zone, passing steam in contact with said solids fuel in said reaction zone under steam-carbon reacting conditions and at a linear velocity sufficiently high to establish and maintain a turbulent dense solids phase superimposed by a dilute solids phase discharging ash from said reaction zone as required to maintain the level of said dense solids phase, withdrawing the effluent gases including unreacted steam together with entrained solid fines from said dense solids phase and conducting same to a second and separate gasification reaction zone, passing said effluent gases including said unreacted steam in contact with said solid fines in said second reaction zone under steam-carbon reacting conditions and at a linear velocity which is less than that of the gas passing through said first reaction zone but which is sufficiently high to establish and maintain a turbulent dense solids phase superimposed by a dilute solids phase, maintaining the carbon inventory in said second reaction zone at least twice that in the first reaction zone, and recovering the gaseous products from said second reaction zone.

2,683,152

PREPARATION OF HYDROCARBON SYNTHESIS GAS


July 6, 1954; application filed Nov. 28, 1951; Serial No. 258,730; 8 claims.

1. A process for the preparation of a hydrocarbon synthesis feed gas, which comprises introducing a normally gaseous hydrocarbon from an external source into separate reforming and combustion zones arranged in parallel; reacting the hydrocarbon with steam in the reforming zone under reforming conditions to produce a gaseous effluent comprising hydrogen and carbon monoxide in a relatively high mol ratio; simultaneously reacting in the combustion zone under partial combustion conditions free oxygen, the hydrocarbon and a recycle product stream containing hydrogen and methane of an effluent from a synthesis reaction for the production of hydrocarbons from carbon monoxide and hydrogen to produce a gaseous effluent comprising hydrogen and carbon monoxide in a relatively low mol ratio, and combining the effluents from the reforming and combustion zones to produce a synthesis feed gas of the desired hydrogen-carbon monoxide mol ratio.
2,683,158

HYDROCARBON SYNTHESIS PROCESS


July 6, 1954; application filed May 21, 1949, Serial No. 94,632; 4 claims.

1. The process for producing valuable synthetic products from a normally gaseous hydrocarbon which comprises subjecting said hydrocarbon in a synthesis gas-generation zone to partial thermal combustion with free oxygen at a temperature of about 2,000° to 2,500° F., operating exclusively at a pressure above about 400 p.s.i.g. to produce a gas mixture containing H₂, CO, and water vapor, cooling said gas mixture in indirect heat exchange with H₂O, said hydrocarbons, and said oxygen substantially at said pressure to a temperature not substantially below 175° F. and removing as liquid water the H₂O condensed therefrom at said temperature, reheating said gas mixture to a temperature of 250° to about 300° F., contacting said reheated gas mixture with a dense turbulent mass of a subdivided fluidized iron-type catalyst in a synthesis zone substantially at said pressure, indirectly cooling said catalyst with water to maintain a synthesis temperature of about 600° to 700° F., withdrawing a gasiform effluent from said synthesis zone at substantially said synthesis temperature and pressure, cooling said effluent exclusively in indirect heat exchange with water to a temperature within the range of about 350° to 470° F. at which substantially no liquid condensation takes place, further cooling said effluent by adding thereto a minor amount of heavy oil boiling above said latter temperature, passing the resulting mixture of liquid and vapors in indirect heat exchange with said gas mixture of not below about 175° F. to reheat said mixture to about 250°-300° F., and finally condensing normally liquid products from said effluent.
with said contiguous mass of pebbles; introducing a portion of said natural gas to be converted, together with oxygen in a volume ratio of oxygen to natural gas within the limits of 0.8:1 and 0.9:1, into said pebble heating zone, the remaining portion of said natural gas utilized as described hereafter; burning natural gas with oxygen in said pebble heating zone, each having been introduced thereto as already described, whereby the resulting flame is formed at a temperature above a predetermined temperature level required for steam-carbon dioxide reforming of natural gas as described hereafter and products of combustion comprise carbon monoxide, oxygen, steam, and carbon dioxide; continuously contacting that section of said contiguous pebble mass gravitating through said pebble heating zone with combustion gas resulting from said burning to heat said pebbles therein to a temperature substantially above said predetermined temperature level; withdrawing total combustion gas from said heating zone and admixing same with said remaining portion of natural gas and passing the resulting admixture at a flow rate through that section of said pebble mass flowing through said reaction zone regulated to insure heating said admixture to said predetermined temperature level, whereby steam, natural gas, and carbon dioxide in said reaction zone interreact to form carbon monoxide and hydrogen; and withdrawing carbon monoxide and hydrogen from said reaction zone as a product of the process.
PROCESS OF PROMOTING CHEMICAL REACTIONS

William W. Odell, New York, N.Y.

Aug. 10, 1954; application filed May 13, 1949, Serial No. 93,132; 23 claims.

1. The process of promoting chemical reactions between gasiform reactant substances and finely divided solid combustible materials, such as finely divided mineral solid fuels, coke, and mixtures of them, comprising passing a gasiform fluid stream initially containing at least one gasiform reactant and a finely divided comminuted solid fuel adapted to react chemically therewith, upwardly through a deep substantially stationary mass of small-size noncombustible refractory solids which are of larger size than said comminuted solid fuel, which solids are initially substantially uniformly sized, being smaller than about 1/2-inch but larger than about 1/3-inch mean diameter, and which solids are confined as a deep bed in a generator at an elevated temperature adapted to promote reaction of said fuel with said reactant, at such a velocity that said refractory solids are substantially densely fluidized and substantially continuously retained in said bed substantially in elutriated motion in said generator, thereby causing said reaction to occur with substantially complete consumption of said fuel in said stream in said generator as said stream passes by a mobile tortuous path upwardly through said bed while hindering the passage of said solid fuel particles through said bed, and removing the gaseous reaction products from said generator in said stream.

HYDROCARBON SYNTHESIS

Don R. McAdams and Fred L. Buchmann, Baton Rouge, La., assignors to Standard Oil Development Co., a corporation of Delaware.


1. An improved low-pressure once-through process for preparing high yields of valuable olefinic hydrocarbons from synthesis gas containing appreciable quantities of nitrogen which comprises passing a gas mixture containing H₂ and CO in synthesis proportions diluted with nitrogen into a hydrocarbon synthesis reaction zone, contacting said gaseous mixture with a dense turbulent mass of finely divided synthesis catalyst consisting of an activated carbon support, said support carrying as active component from 8-20 percent of reduced iron metal promoted with 0.3 to 5.0 percent of a potassium compound and a minor amount of cobalt, maintaining a pressure of about 50-100 p.s.i.g. and a temperature of about 550°-950°F. within said zone, and withdrawing a product containing high yields of liquid olefinic hydrocarbon product substantially uncontaminated with wax.
SIMULTANEOUS PRODUCTION OF HYDROCARBONS AND OXYGENATED COMPOUNDS


Aug. 17, 1954; application filed Sept. 27, 1954; Serial No. 776,518; 9 claims.

1. An improved process for producing organic compounds from normally gaseous hydrocarbons, which comprises reacting a carbonate feed with oxygen in a first conversion zone under conditions to produce the gaseous effluent comprising hydrogen and oxides of carbon in a molar ratio less than about 2:1, passing said gaseous effluent from said first conversion zone to a first synthesis reaction zone under conditions such that hydrogen and an oxide of carbon are converted to organic compounds, simultaneously reacting a normally gaseous hydrocarbon with steam in a second conversion zone under conditions to produce a gaseous effluent comprising hydrogen and oxides of carbon in a molar ratio greater than about 2:1, passing said effluent from said second conversion zone to a second synthesis reaction zone under conditions such that hydrogen and an oxide of carbon are converted to organic compounds, recycling normally gaseous components of the effluent from said first synthesis reaction zone to said second conversion zone, and recycling normally gaseous compounds from said second synthesis reaction zone to said first conversion zone.

APPARATUS AND A PROCESS FOR TAPPING LIQUID SLAG FROM PRESSURE GAS PRODUCERS

Friedrich W. S. Donulat, Frankfurt-am-Main Eschersheim, Germany, assignor to Metallgesellschaft Aktiengesellschaft, Frankfurt-am-Main, Germany, a corporation of Germany.


1. A process for tapping liquid slag from a gas producer operating at greater than atmospheric pressure comprising removing said slag through the wall of said producer in the form of a jet stream formed by the pressure within the producer and surrounding said slag jet stream with a fluid medium before said slag jet stream reaches the atmosphere.
2,689,786
PROCESS FOR GASIFICATION OF SOLID FUELS
Otto Hubmann, Bad Homburg, Germany,
Sept. 21, 1954; application filed Dec. 18, 1948, Serial No. 132,773; 5 claims.

1. A process for the continuous gasification of solid fuels under at least atmospheric pressure in a shaft furnace, which comprises introducing an oxygen-containing gas into a fuel bed of coarse-grained fuel in a lower zone of the furnace from below to gasify such fuel, simultaneously separately gasifying fuel dust in a suspended state in an upper zone of the furnace with an oxygen containing gasifying medium withdrawing the gases emitted in both gasifying zones jointly from a portion of the furnace above the fuel bed and feeding the coarse-grained fuel to the fuel bed through the zone in which the fuel dust is gasified.
A gas generator comprising a first vertical reactor vessel having a particulate solids inlet adjacent the top and a particulate solids outlet adjacent the bottom, a steam inlet adjacent the lower part of the first reactor vessel and a water-gas outlet at the upper part, a second vertical reactor having a particulate solids inlet adjacent the top and a particulate solids outlet adjacent the bottom, interconnected conduit means extending from the bottom of the first reactor vessel to the solids inlet of the second reactor vessel, a part of said conduit means being substantially vertical and having a heavy oil inlet at approximately the lowest point thereof, a re heater vessel in communication with the bottom of the second reactor, means to introduce fuel gas in said re heater vessel, means to remove products of combustion from the upper and lower parts of said re heater vessel, control means in said products of combustion, removal means to vary the amount of products of combustion removed from the upper and lower part of the re heater vessel, interconnected conduit means in communication with the bottom of the re heater vessel and the solids inlet to the first reactor, part of said communicating conduit means being substantially vertical, a steam inlet at the lowermost part of said communicating conduit means to carry particles from the lowermost part of said communicating conduit means to the first reactor vessel, means to add coke to the said communicating conduit means, and means to draw off coke from the generator, said second reactor vessel having a gas drawoff for the removal of oil-gas therefrom, said generator being adapted to the circulation of coke which is preheated in the re heater vessel and in which the heated coke in passing through the first reactor vessel at a high temperature will convert the steam to water gas, after which the coke at a slightly lower temperature will pass through the second reactor vessel wherein it reacts with the oil to produce oil-gas, after which the coke is returned to the re heater vessel.
PREPARATION OF HYDROCARBON SYNTHESIS GAS


Oct. 5, 1954; application filed Sept. 15, 1948; Serial No. 59,449; 4 claims.

1. A process for preparing synthesis gas, which consists in passing a normally gaseous paraffinic hydrocarbon into a carbonization zone, contacting said gaseous hydrocarbon at gaseous hydrocarbon cracking conditions with a dense fluidized mass of finely divided cracking catalyst consisting essentially of about 12 percent by weight of nickel, about 2 percent by weight of chromia, about 3 percent by weight of cupric oxide and about 85 percent by weight of kaolin, maintaining cracking temperatures within said carbonization zone, permitting the paraffinic hydrocarbon to remain resident in said zone for a sufficient period of time to effect cracking of said paraffinic hydrocarbon and deposition of carbon on the fluidized cracking catalyst, withdrawing hydrogen from said carbonization zone, withdrawing carbonized catalyst from said carbonization zone, conveying at least a portion of said carbonized catalyst into a catalyst regeneration zone, maintaining said material in a dense, turbulent suspension in said regeneration zone, contacting said carbonized catalyst at catalyst regeneration conditions with an oxidizing gas chosen from the group consisting of oxygen and carbon dioxide whereby carbon deposited upon the catalyst is converted substantially into carbon monoxide and said catalyst is regenerated, withdrawing a total gaseous effluent consisting essentially of carbon monoxide from said catalyst regeneration zone and mixing said withdrawn hydrogen and carbon monoxide in proportions suitable for employment in a hydrocarbon synthesis operation.

2,691,573

DESULFURIZATION IN GASIFICATION OF COAL

Bertrand J. Mayland, Bartlesville, Okla., assignor to Phillips Petroleum Co., a corporation of Delaware.


1. A process for the gasification of a solid powdered carbonaceous material containing sulfur, which comprises introducing said material and a metal carbonyl into a gasification zone, subjecting said mixture to gasification conditions with the introduction of an oxygen-supplying gas so as to supply the heat of reaction and react the metal of the metal carbonyl with the sulfur component of the carbonaceous material to produce the metal sulfide, removing the metal sulfide from the gases produced and recovering said gases.
2,692,192

FLUIDIZED TREATING OPERATION

Homer Z. Martin, Cranford, N.J., assignor to Standard Oil Development Co., a corporation of Delaware

Oct. 19, 1954; application filed June 27, 1951, Serial No. 293,731; 6 claims.

Improved process for the production of gases comprising carbon monoxide and hydrogen from hydrocarbon gases which comprises passing hydrocarbon feed gases upwardly through a zone containing finely subdivided hot solid particles of a reducible metal oxide maintained in the form of a fluidized bed in a treating zone, said metal oxide particles being maintained at a temperature sufficient to cause the particles to react with the hydrocarbon to produce a gaseous mixture of hydrogen, carbon monoxide, carbon dioxide, steam, and unreacted hydrocarbon gases, then passing said product gases through a continuous zone containing subdivided hot solid particles of a reforming catalyst also maintained in the form of a fluidized bed, the said bed of fluidized reforming catalyst being maintained at a temperature sufficient to cause the steam-hydrocarbon and carbon dioxide-hydrocarbon reactions between these components of the aforesaid product gases from the first treating zone to produce additional hydrogen and carbon monoxide, maintaining relatively large solid nonfluidized packing in said treating zone, and withdrawing product gases containing hydrogen and carbon monoxide from an upper portion of said second bed.

2,694,003

ENGINE GENERATION OF FEED GAS FOR AMMONIA SYNTHESIS

Jay B. Malin, Whittier, Calif., assignor to The Texas Co., New York, N.Y., a corporation of Delaware.

Nov. 9, 1954; application filed Nov. 29, 1950, Serial No. 198,145; 4 claims.

1. In the combustion-engine generation of hydrogen and carbon monoxide by the reaction of a hydrocarbon with an oxygen-containing gas wherein said reactants are charged into the combustion space of a four-stroke-cycle internal-combustion engine in approximate relative proportions for the formation of hydrogen and carbon monoxide, mixed and compressed therein, subjected to internal combustion with the generation of mechanical energy, and products of reaction thereafter exhausted from the combustion space, the improvement which comprises charging a limited amount of air to the combustion space immediately following and only immediately following the period in which products of reaction are exhausted therefrom and prior to the introduction of the hydrocarbon thereinto, thereafter introducing said hydrocarbon and a limited amount of relatively pure oxygen to the combustion space into admixture with said air, said air thereby effecting cooling of the combustion space prior to the introduction of relatively pure oxygen, compressing the mixture of reactants, igniting said mixture to produce products of reaction comprising carbon monoxide and hydrogen containing a predetermined amount of nitrogen and exhausting said products from the combustion space.
PRODUCTION OF GAS COMPRISING HYDROGEN AND CARBON MONOXIDE

Edwin M. Glazier, Verona, Pa., assignor to Gulf Research & Development Co., Pittsburgh, Pa., a corporation of Delaware.

Nov. 9, 1954; application filed Oct. 27, 1950, Serial No. 192,491; 7 claims.

1. A process for continuously producing a gas comprising hydrogen and carbon monoxide at an elevated reaction temperature and superatmospheric pressure above about 100 p.s.i. which comprises introducing powdered coal at atmospheric pressure into a storage zone; increasing the pressure in said storage zone from atmospheric to said superatmospheric pressure; passing powdered coal under said superatmospheric pressure from said storage zone to a pressure storage zone; passing a portion of powdered coal from said pressure storage zone into a reaction zone maintained at an elevated reaction temperature and said superatmospheric pressure; passing another portion of the powdered coal from said pressure storage zone into a heat-exchange zone maintained at said superatmospheric pressure; burning the powdered coal in the presence of air in said exchange zone in heat-exchange relationship with solid, inert, high-heat-capacity particles also introduced into said heat-exchange zone; passing the heated inert particles from said heat-exchange zone into a gas-heating zone; introducing a gas comprising steam into the gas-heating zone to effect heat exchange between said gas and the heated inert particles to heat said gas above the elevated reaction temperature; and introducing said heated gas into the reaction zone whereby the heated stream fluidizes powdered coal, furnishes the heat of reaction to maintain the reaction zone at said elevated reaction temperature, and reacts endothermically with said coal to produce a gas comprising hydrogen and carbon monoxide at an elevated temperature and superatmospheric pressure.
MANUFACTURE OF A HYDROGEN-RICH GAS


Dec. 21, 1954; application filed Dec. 31, 1947, Serial No. 794,856; 11 claims.

1. A process for the manufacture of a gas rich in hydrogen and carbon monoxide, which comprises in a first reaction zone partially combusting methane with oxygen under exothermic conditions such that hydrogen and carbon monoxide are produced at a temperature between about 1,700° and about 2,000° F., removing from said first reaction zone and effluent at an elevated temperature, passing said effluent from said first reaction zone upward through a mass of finely divided catalyst in a second reaction zone at a velocity sufficient to suspend said mass of catalyst therein, introducing steam and additional methane into said mass of finely divided catalyst in said second reaction zone, reacting steam with methane in said second reaction zone, reacting steam with methane in said second reaction zone under endothermic conditions of reforming at a temperature between about 1,200° and about 2,000° F. to produce hydrogen and carbon monoxide, maintaining said second reaction zone under substantially isothermal conditions with the endothermic heat reaction being supplied principally from the sensible heat of the effluent from said first reaction zone, removing finely divided catalyst from said second reaction zone and passing same to a third reaction zone, passing an oxidizing gas upwardly through said finely divided catalyst in said third reaction zone at a velocity sufficient to suspend said catalyst in said third reaction zone, regenerating catalyst in said third reaction zone, removing regenerated catalyst from said third reaction zone and returning same to said second reaction zone, removing from said second reaction zone an effluent containing finely divided entrained catalyst, scrubbing said effluent from said second reaction zone with a liquid scrubbing medium under conditions such that the effluent is cooled and finely divided entrained catalyst is removed therefrom by the scrubbing medium and returning same to said third reaction one, recovering scrubbed effluent containing hydrogen and carbon monoxide as a product of the process, and maintaining said first and said second reaction zones at a substantially elevated pressure between about 150 and about 600 p.s.i.
PREPARATION OF SYNTHESIS GASES


Dec. 21, 1954; application filed July 26, 1949; Serial No. 106,936; 12 claims.

1. A process for the preparation of a synthesis gas wherein a gaseous mixture from a modified water-gas reaction, using as the oxidizing gas a gas of the group consisting of air rich in oxygen and at least 90 percent oxygen, is combined with a portion of the gaseous mixture from a water-gas reaction, containing low nitrogen blue gas from the last half of the steam run of said reaction, which comprises in the water-gas reaction gasifying a solid carbonaceous material by heating it to incandescence with air and thereafter forcing steam through the incandescent material, in a modified water-gas reaction gasifying a solid carbonaceous material by heating it with an oxidizing gas of the group consisting of air rich in oxygen and at least 90 percent oxygen in the presence of steam, mixing the gaseous mixture of the modified water-gas reaction with a portion of the gaseous mixture of the water-gas reaction, containing low nitrogen blue gas from the last half of the steam run of said reaction, to give a gaseous mixture containing less than 15 percent carbon dioxide, and scrubbing the resulting gaseous mixture with a sulfided and oxidized alkaline solution of a metal of the tin group whereby the sulfur content of the purified gas is not more than approximately 5 grains of hydrogen sulfide per 100 cubic feet.

METHOD OF PRODUCING GASOLINE


Dec. 21, 1954; application filed Sept. 29, 1949; Serial No. 118,552; 5 claims.

1. The process of converting coal which comprises establishing a first, second and third fluidized bed of hot finely divided coke, each in a separate zone, by passing a gas stream upwardly through each of said beds, the fluidizing gas in the second bed being combustion-supporting gas and the fluidizing gas in the third bed comprising gas reactant with said coke to produce hydrogen and carbon monoxide, the process comprising preheating finely divided coal to a temperature between about 250° and 600° F., continuously feeding said preheated coal into mixture with the coke in said first bed, maintaining the mixture of coke and coal at coal-carbonizing temperature in said first bed to distill off volatile constituents including tar from said coal and thereby convert said coal to a residue coke, continuously feeding coke from said first bed to said second bed, carrying out combustion in said second bed to raise bed temperature substantially above the temperature in the first bed, continuously feeding a stream of hot coke from the second bed to the first bed, continuously feeding a stream of hot coke from the second bed to the third bed, recovering a gas containing hydrogen and carbon monoxide from the third bed, catalytically synthesizing liquid hydrocarbons from part of said last-mentioned gas, and recycling an unconverted residue part of said last-mentioned gas to hydrogenate the coal tar and thereby increase the yield of liquid product.
PREPARATION OF SYNTHESIS GASES FROM CARBONACEOUS SOLIDS
Luther C. Feery, Robert H. McKane, and Douglas V. Moses, Charleston, W. Va., assignors to E. I. du Pont de Nemours & Co., Wilmington, Del., a corporation of Delaware.
Dec. 28, 1954; application filed Nov. 4, 1948; Serial No. 58,212; 5 claims.
1. A process for the preparation of a synthesis gas containing carbon monoxide and hydrogen from pulverized coal, which comprises suspending pulverized coal in superheated steam, mixing the coal-steam suspension, in a nonignited state, with a sufficient amount of oxygen of at least 90 percent purity to convert the coal to carbon monoxide and hydrogen but insufficient to convert the coal to carbon dioxide and water, passing the suspension, with the steam superheated and the coal at a temperature such that it is under incipient distillation, into a combustion zone, in a nonignited state, and at a sufficiently high velocity to prevent flashback of the flame into the suspension during mixing, and in said zone subjecting the suspension to partial combustion at a temperature between 1,200° and 1,700° C.
**LIST OF INVENTORS AND ASSIGNEES**

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**Notes:**
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- See Gaus, Wilhelm.
- See Dickinson, N. L.
- See Benedict, M.