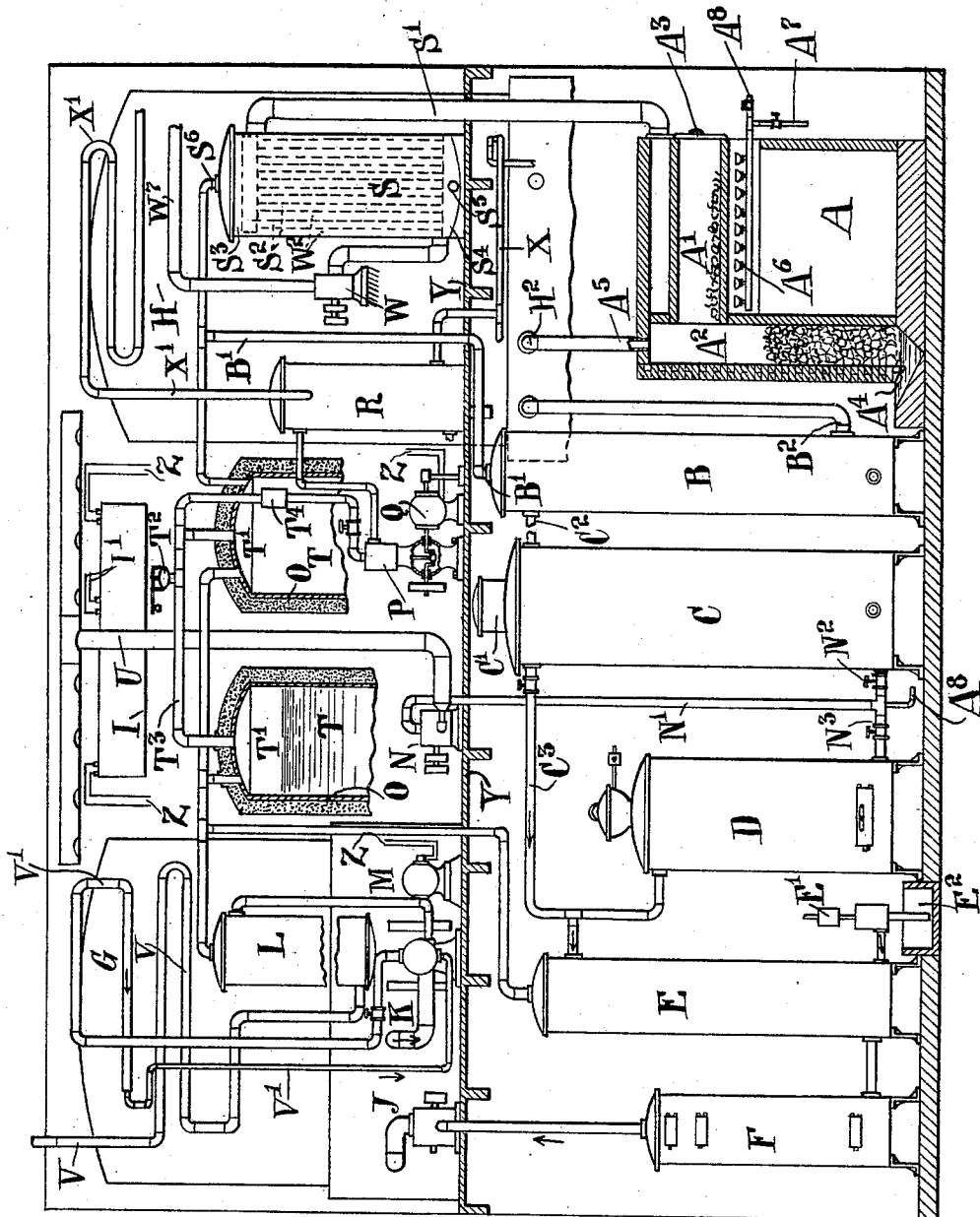


J. M. W. KITCHEN.
 METHOD AND MEANS FOR UTILIZING FUEL WASTES AND GENERATING POWER.
 APPLICATION FILED JUNE 28, 1909.

1,041,810.

Patented Oct. 22, 1912.



Attest:
E. Mitchell
 B. J. Daniels

Inventor:
 by *J. M. W. Kitchen*
Geo. L. W. Trelock
 Atty.

UNITED STATES PATENT OFFICE.

JOSEPH MOSES WARD KITCHEN, OF EAST ORANGE, NEW JERSEY.

METHOD AND MEANS FOR UTILIZING FUEL-WASTES AND GENERATING POWER.

1,041,810.

Specification of Letters Patent.

Patented Oct. 22, 1912.

Original application filed April 3, 1909, Serial No. 487,694. Divided and this application filed June 28, 1909, Serial No. 504,778.

To all whom it may concern:

Be it known that I, JOSEPH MOSES WARD KITCHEN, a citizen of the United States, residing in the city of East Orange, county of Essex, State of New Jersey, have invented certain new and useful Improvements in Methods and Means for Utilizing Fuel-Wastes and Generating Power, of which the following is a specification.

A special object of my invention is to generate electric energy at a very low cost through the use of various co-acting heat economies, in using very cheap fuels, such as bituminous slack, which are ordinarily difficult to handle in a satisfactory manner for power producing purposes. In other words, the inventive idea is to transpose a low cost and widely distributed fuel, into a more valuable and salable product in active demand. In gaining this object, the fuel is first distilled, producing what is known as coal gas, and also coke and heat wastes. The coke is gasified, and the gas is used in the internal combustion engine, the motive energy of which is transferred into electrical energy. The heat wastes of the process are captured, concentrated, accumulated and stored, and then also converted through steam power into electric energy. The dually generated electric energy is then unified, and through electric transmission, is distributed in useful work.

A further object of the invention is the making of a fuel gas of satisfactory quality for use in power generation and for various heating purposes, and which gas has as a basis, low cost producer gas. It should be here noted that producer gas made from some very low cost fuels is of an undersirably thin quality, so poor in heat forming constituents that the use of so poor a gas is very limited; but which if even moderately enriched, has a very much wider application in practice. In this invention, I usually enrich the producer gas by admixing water gas with it, or sometimes, coal gas, or both.

In gaining the objects of the invention, my method is advantageously utilized in connection with the manufacture of illuminating gas.

The invention relates to the economization of fuel and heat wastes which commonly occur in various arts, but which especially occur in connection with the manufacture of illuminating and fuel gases. As is well

known, such wastes are very large, and sometimes occur to the extent of over 75% of the value of the fuel used. In coal gas making, among the wastes which occur, are those in which heat escapes in the gases that have heated the retorts used in making the coal gas; those which occur in the making of water gas, both in the sensible heat in the new gas, and as carbon-monoxid gas which is exhausted during the process of highly heating the fuel contents of the water gas generator intermittently with the forcing of steam through the highly heated fuel. A very large amount of heat escapes by being radiated from the various parts of the gas plant. Much loss is sustained through imperfect combustion in heating the coal gas retorts, and in cooling the coke. There is a considerable loss sustained by not using for motive power, the expansive force of steam before using the steam in making water gas after the expansive force has been more or less utilized; and a considerable loss is sustained by not using in creating motive power needed in such plants, or otherwise used, the explosive force of gas, as well as the expansive force of the steam generated from waste heat. In making provision for preventing these losses, I apply among others, the following principles:

1. To use the lowest cost fuels from which coke can be made, to make a large amount of coke, and to utilize that coke in water gas making and in producer gas generation. I secure a better control of the heating process in distilling coal gas from the fuel, by heating the retorts with gas or with gasified solid fuel burned under accurate control as to the supply of air used in the gasification of and in the burning of the gas, or other fuel; and prefer that both the gas and the air used should be pre-heated before using, especially if the pre-heating is secured by utilizing waste heat.

2. I utilize the heat of the incandescent coke to generate water gas, and under certain conditions, to gasify tarry vapors; and I utilize the hot exhaust gases escaping after heating the retorts, to heat water and form steam.

3. I utilize in steam generation, waste hot gases that are formed in the water gas generator, and which if the gas is sufficiently combustible, either alone or by a slight enrichment, for producing motive power by

burning the gas in an internal combustion engine, and then utilizing both the jacket water heat and the exhaust gas heat of the internal combustion engine for heating water. Where an accessory amount of motive power is required, I make producer gas from the coke waste in a separate generator, use it in an internal combustion engine, and utilize the sensible heat of the newly formed producer gas for heating water, and use the heat of the jacket water of the engine in heating air for combustion.

4. I also utilize the sensible heat of the newly formed water gas to heat water.

5. The water after being highly super-heated is conveyed from the several devices in which they are heated, into storage tanks well insulated externally against loss of heat by radiation; and steam of working pressure is secured from the super-heated water through a reduction of pressure of steam disengaged from the super-heated water in the storage tanks, and which is then used to actuate one or more steam motors.

6. With the motive power developed in the plant, I generate electric energy, which though separately generated, is united for use and distributed for lighting, traction or other purposes, the wastes of coal gas making being thus applied in work, through the generation of electric energy and through electric distribution of the energy. In order to secure the utmost efficiency from the several sources of electric energy, I generate multiple electric currents and then unify them in work.

In carrying out this conserving method, heat of low temperature is radiated and transferred to air for combustion at a relatively low zone in the plant. The air which is thus primarily heated, rises upwardly to more highly located zones, where at a level above the elements of the plant, the air is progressively more highly heated, and this highly heated air bearing heat radiated from the various elements of the plant, is drawn downwardly by a mechanically actuated exhaustor and blower from the high level zone, and used for purposes of combustion in making the coal gas, and the water gas; and also in making producer gas if steam is used endothermically in making that gas. Those zones of the plant traversed and used by the attendants operating the plant, receive a cool air supply for respiration from properly located air inlets at low levels of the plant. By the application of these several principles, a large part of the fuel wastes of an illuminating gas manufacturing plant are economized by being applied directly in performing work, or indirectly, through performing work regeneratively.

In this economizing method I accomplish

work with low degrees of heat that can be accomplished by such low degrees of heat, and reserve higher and more intense heat to do work which only high degrees of heat are capable of performing. In securing these results I utilize to a large extent the principle of the vertical counter-current travel of gases and water, the gases being first applied to heating surfaces at a high level and being forced or drawn downwardly, while the water to be heated is forced vertically upward in counter-travel to the gases traveling downwardly through the heating device. I utilize mechanical air and gas exhausters and blowers to a considerable extent in securing perfected combustion and transmission of the heat generated, through a controlled compression of the gases burned, that would otherwise not be possible under natural draft, which being an induced draft is the reason of thermic losses due to expansion of gases influenced by an induced draft before the heat in the gases is transmitted.

Through the co-action of the various elements and in the application of the several principles named, I secure the utilization of a large part of the fuel wastes of gas making through the generation of the electric current which is a valuable marketable product; and I also secure the production of electric energy at an unusually low cost.

In the accompanying drawing there is diagrammatically illustrated the application of the principles of the invention in an illuminating gas manufacturing and power plant, in which:

A represents a bank of gas retorts.

B is a water heater and tar condenser for absorbing the heat of newly made water gas and condensing tarry vapors.

B² is a gas conduit leading to the tank H.

C is a water gas generator.

D is a producer gas generator.

E represents a producer gas cooler, water heater and condenser.

F is a scrubber for cleaning the producer gas.

G is a fuel gas accumulating tank.

H is an accumulating tank for illuminating gas.

J is a producer gas exhaustor and blower.

K is an internal combustion engine.

L is a water heater.

M is an electric generator.

N is an air exhaustor and blower.

O is an non-conducting incasement for a hot water accumulating and storage tank.

P is a steam motor.

Q is another electric generator.

R is an exhaust steam condenser and water heater.

S is a gas cooler, water heater and condenser of tarry and other vapors.

T are hot water tanks.

U is a hot air conduit.

V is piping for radiating the heat of warm exhaust gases.

W is an exhaustor and blower.

5 X is steam piping for radiating heat from water of condensation.

Y is a floor.

Z are electrical conductors.

10 Various structural details that would be usually included in a plant of the nature described are omitted from the drawing for the sake of clearness. Reference to some of these details will be made later in the specification.

15 The coal gas generator represented by A, may vary in type and be charged by usual methods.

A¹ represents one of the retorts which is open at the end leading into the coke well A². After a charge of coal has been heated in the retort A¹, the coke is pushed backward from the charging mouth A³ into the coke well, and is precipitated to the bottom of the well, which is protected from gas emission and entrance of air at the bottom by the water seal A⁴. The coke is withdrawn through the water seal A⁴; and by means of suitable provisions, such as a wheel barrow and a mechanically actuated elevator, is conveyed to the floor Y; and from the floor Y, is charged into the water gas generator C through the charging inlet C¹, or can be used in the producer gas generator D. As the incandescent coke reaches 35 the water in the water seal A⁴, steam is generated, which, passing up through the incandescent coke, generates water gas, and this along with the coal gas from the retort A¹, is conveyed to and stored in the illuminating gas tank H after going through the ordinary process of cleaning, the means for performing which process are not shown in the drawing. This illustration merely 40 points out the idea of making water gas in any one of a number of ways as a co-acting economy. The retort is heated by the compound burner A⁶, which is supplied with fuel gas by the conduit A⁷, and with air by the conduit A⁸, both being under compression, the air and the gas, both being preferably preheated, would be forced into the burner A⁶ by pressure blowers indicated by J and N. In the instances in which the coal gas would not be injured by excessive heat, 50 the coke well A² would be entirely filled with the incandescent coke and also the rear part of the interior of the retort A¹, in which case the volatilized gases passing through the incandescent coke would have the tarry vapors decomposed and transformed into fixed gas. Other means for heating the retort may be used. The hot gases after passing over the retort, pass through the conduits S¹ into the upper part 65 of the water heater S, which has the water

tubes S², and the water chambers S³ and S⁴. Cold feed water is forced through the water inlet S⁵ upwardly through the tubes S² and through the outlet S⁶ into the super-heated water storage tank T; the water being 70 heated in the upper levels of the device S to a degree that is proportionate to the pressure given to the exhaust heating gases, and to the rapidity with which the water is passed through the heater. An induced draft may be created through the heater by 75 the exhaustor and blower W which may draw the gases upward through the gas spaces W², and force them out through the exhaust conduit W⁷.

The water gas generator C is of usual construction, and in connection with it there can be used a device for enriching the gas with oil, but which is not shown in the drawing. The newly made water gas is 85 conveyed through the conduit C² into the water heater B, which is of substantially the same construction as that of the water heater S, as are also the water heaters E and L. More water is highly heated in 90 this device, and finally finds exit through the pipe B¹ and is conveyed into the hot water storage tank T. The cool, cleaned gas, after passing through the water heater B, is finally stored in the tank H. Some of 95 the poor quality producer gas that is made in the generator C intermittently with the generation of water gas, instead of being exhausted into the atmosphere, is in this case conveyed, along with as much water gas as 100 may be desired to secure a burnable gas of sufficient richness, through the conduit C³, through the water heater and gas cooler E, through the scrubber F, and through the exhaustor and blower J into the fuel gas 105 tank G, from which it can be taken as required for use in the internal combustion engine K, or for heating the retort A¹. Or it may be distributed anywhere within practical distances, and utilized for power 110 generation, heating or other fuel gas purposes. It will be noted that in this way I economize sensible heat and also unburned gaseous constituents that are too diluted with unburnable gases to be ordinarily 115 burnable. By adding more burnable constituents to the poorer gas, I secure a gas that is burnable under ordinary compression in the internal combustion engine. Note should be made that producer gas generated 120 from fuel like cinders and very highly heated coke, is poor in easily volatilized thermal constituents, and hence it is desirable to enrich such gas for special purposes.

The producer gas generator.—A plant of 125 this kind would usually have connected with it a special producer gas generator for creating an accessory supply of producer gas for generating power or for producing any needed additional supply of fuel gas. The 130

producer indicated by D may be of any type suitably designed for gasifying the fuel used; but in a plant of this kind the coke produced in the coal gas making would
 5 be conveniently and economically utilized for making producer gas as well as making water gas. When I generate much producer gas from the coke, I usually admix some fine fuel dust with the more porous coke for
 10 the purpose of enriching the producer gas and in order to enable higher heat to be more easily maintained in the generator. Fuels like some cokes, and like cinders, require unusually high heat to secure their
 15 volatilization; and this high heat is promoted by adding ashes or fine fuel dusts to the coke and cinders and by gasifying the fuel under considerable pressure. Inasmuch as gas house coke usually carries a considerable
 20 amount of tar forming matters in it, the usual centrifugal device used for freeing producer gas from tar will be used in this connection; and hence a certain proportion of fine bituminous dust could be
 25 used to advantage in connection with the coke used, the tar from both fuels being eliminated by the one centrifugal device.

It will be noted that wherever in this plant there is generated waste hot gases, the
 30 heat of the gases, if of sufficiently high temperature, is economized by running the gases through a water heater; and that the waste heat is thus economized through the formation of steam, which generates electric
 35 energy through the agency of a steam motor, an electric current thus being made available for the various practical purposes to which electric energy can be applied. The principle is applied of progressively
 40 heating water in a primary and in successive heaters, as is also the process for progressively heating air for combustion with waste heats of progressively higher degrees of temperature, as is indicated by
 45 the arrangement of the radiating conduits V, V¹, W¹ and X¹.

It will be noted that in this invention I generate coal, water and producer gases, and electric energy, in an economic manner
 50 through a co-active method. The various gases may be used separately or in any desired combination, such as may be suited for illuminating, heating and power generating purposes; and the richness of either
 55 gas may be varied by ordinary methods, or through the methods I describe in the hereafter referred to patents, or co-pending applications for patents.

With the ultimate object of securing both
 60 motive power and a low cost fuel gas, I start with a very cheap grade of fuel like bituminous slack, and subject it to sufficient heat to drive off its easily volatilized constituents, which process produces a non-
 65 clean illuminating gas, coke and waste hot

gases. Then I commence with the coke product produced, and first utilize the coke in its highly heated state to fix the tarry vapors resulting from distilling subsequent
 70 charges of the fuel, (2) I make a certain amount of water gas from the heat of the newly formed hot coke through the process of cooling the coke, (3) I make directly, more or less other water gas from the coke, and (4) I make producer gas from coke.
 75 These several gas products are used as desired, either in combination, or singly; and in combination with motive power otherwise produced, I utilize the heat wastes of the several steps taken, in capturing, accumulating and storing heat energy which
 80 in the form of disengaged steam is finally applied in work, and preferably, in the form of the electric current.

Accumulating and storing waste heat.—
 85 In order that the process of making illuminating gas may be economically conducted, the process of generating that gas, as well as that of the generation of other gases, should be continuously carried on, and in
 90 order that the waste heat of gas manufacture may be conserved with substantial completeness and economy, it is necessary to concentrate, accumulate and store that waste heat, so that the heat thus concentrated, accumulated and stored, can be
 95 utilized at will in generating the electric current, or in doing other work during those hours when there is greatest need for motive power. Hence I adopt and utilize the following described method as that preferred
 100 in economizing the waste heat. Inasmuch as water is the greatest heat absorber known, I make as main feature in this process of heat economization, the heating of water to a high degree in the specially designed
 105 water heaters shown in the drawing, and then store the super-heated water in strongly built water tanks designed to resist very high internal pressures, and which are well protected from loss of heat in the water by insulating incasements. Such tanks are represented by T in the drawing, and the insulating incasements by O. Feed water is forced through the water heaters of the
 115 plant at high pressure, there being no steam space in any of the water heaters. Steam spaces T¹ however, are provided in the water tanks. The steam disengaged under high pressure in the tanks T, is conveyed through the steam conduit T², having the safety valve T³, and through the pressure reducing valve T⁴, to such steam motor as may be used for creating motive power from the steam thus reduced in pressure. Such
 125 a steam motor may be a reciprocating engine, or in certain cases, it may be a steam turbine, the activity of which would be enhanced by condensing the exhaust steam in the condenser R. The condensing water is
 130

progressively heated in its progress through the condenser in counter-direction to the travel of the exhaust steam, and can then be used as feed water in the water heaters of the plant, or its latent heat may be radiated and thus heat air for combustion.

Utilizing low degrees of heat.—Provision is made in a plant of the nature herein described, for utilizing the low degrees of heat which may remain in the exhaust gases after passing through the water heaters, or that which would still be contained in the water of condensation and in the condensing water that has passed through the condenser R. Radiating pipes for these purposes are indicated by V, V¹, X and L. In heating air for combustion with low degrees of heat, say below 200° F., the arrangement of the radiating surfaces is such that there will be a progressive heating of the air, which arrangement provides for the gradual heating of the air by progressively higher degrees of heat. In addition to such features for radiating heat there will be other features added when necessary for radiating heat from the jacket water of the internal combustion engine K. The water which is primarily heated in the jacket of the engine, along with the water of condensation that has been partly cooled, may be used as feed water in the various water heaters, it being pumped from the well E² by a suitable pump indicated by E¹, capable of overcoming the pressure in the water heaters and water storage tanks T. Some of the connections with the pump E¹ and the water heaters are omitted in the drawing for clearness. The heat of the jacket water may be transferred to air for combustion by circulating the feed water in a closed water cooler, the circulation being effected by gravity. Usually in plants of this type, I utilize the air heated by radiated heat, for purposes of combustion in the furnace of the gas generator A. In case of need for condensing tar vapors in the newly generated gas, I may secure the condensation of the tar on tubes through which water specially refrigerated by mechanical means, is passed.

Exhausting and forcing heated air.—It will be noted that air heated by radiation is drawn through the conduit U by the exhauster and blower N, and through the conduit N¹ and branch conduits N², N³ and A⁸, to the several places where the warmed air would be utilized for combustion processes. The electric generators M and Q would have their energy united through the conductors Z, with or without the storage battery I; and the current would find delivery and be distributed in work through the conductors I¹.

Preventing radiation.—Most of the elements of the plant herein described would be protected by non-conducting insulation

against loss of heat by radiation; but heat that would necessarily escape through its radiation, would mostly be used regeneratively in generating the several gases produced.

Unifying the two motive forces.—It will be noted that there are two electric generators in the system; one operated by gas power and one by steam power, and that I unite the two forces through the generation and storing of electric energy developed through the action of the two electric generators. This is one of the methods which I adopt of uniting steam and gas power in action without loss of efficiency due to inharmonious rates of speed in the gas engine and steam motor.

Inasmuch as producer gas power is somewhat intractable and undependable, I, in composite power generation, prefer to exercise a power of control over the gas engine by an outside auxiliary source of power, such as steam power. It will be obvious that this control can be exercised through the intermediate action of an electric motor connected in any convenient manner with the gas engine, and actuated by an electric current generated by the steam power. This method may be practically desirable under certain conditions, though I usually prefer a more positive and direct transmission of the control power as is indicated in my co-pending application, Serial No. 453,275, filed September 16th, 1908, and in several other of my co-pending applications hereinafter referred to.

In the claims herewith made, when and wherever I use the term "vertical counter-current water heat or boiler", I refer to a device in which the hottest gases are first applied to the highest level of the device where the hottest water is to be found, and in which the gases make a plunging downward travel and find an exit at the bottom of the device, while the feed water enters the device at a low level is progressively heated in an upward travel of the water in counter-current to the travel of the gases.

Subject matter is disclosed in this application which is not herein claimed, but which is more or less claimed in each of the following named applications: Serial No. 415,983 filed February 14th, 1908; Serial No. 453,275 filed September 16th, 1908; Serial No. 460,267 filed October 30th, 1908; Serial No. 465,966 filed December 4th, 1908; Serial No. 482,127 filed March 8th, 1909; Serial No. 487,649 filed April 3rd, 1909; Serial No. 504,132 filed June 24th, 1909.

This application is a division of an application Serial No. 487,694, filed April 3, 1909.

What I claim as new is:

1. The method herein described for utilizing fuel wastes and generating power, which

- consists in, (1) distilling fuel and producing the separate products, coal gas, coke and exhaust hot gases, (2) generating producer gas from the coke product in a step separate and apart from the step of distilling the fuel, (3) generating motive energy from the producer gas, (4) generating motive energy from the exhaust hot gases, and (5) uniting the two motive energies.
2. The method herein described of utilizing fuel wastes and generating power, which consists in, (1) distilling fuel and producing a combustible gas, coke and exhaust hot gases, (2) making water gas from the coke, (3) making producer gas from the coke, (4) enriching the producer gas with the water gas, (5) generating motive power from the gas generated, (6) generating motive power from the exhaust hot gases, and (7) uniting for work the two motive powers generated.
3. The method herein described of utilizing fuel wastes and generating power, which consists in, (1) distilling fuel and thereby producing a combustible gas, coke and hot exhaust gases, (2) super-heating water with the hot exhaust gases, (3) accumulating and storing the super-heated water, (4) generating motive power from the accumulated and stored super-heated water, (5) generating motive power from the coke, and (6) uniting the two motive powers generated for useful work.
4. The method herein described of utilizing fuel wastes and generating power, which consists in, (1) distilling fuel, said step producing a combustible gas, coke and hot exhaust gases, (2) generating motive power from the coke, (3) generating motive power from the hot gases exhausted in said first and second steps, and (4) using, regeneratively in the step of distilling the fuel, the low temperature heat exhausted in the two steps of generating motive power.
5. The method herein described of utilizing fuel wastes and generating power, which consists in, (1) distilling fuel and producing a combustible gas, coke and hot exhaust gases, (2) generating combustible gas from the coke by heating the coke, (3) generating steam from the heat wastes of both of the said steps, (4) generating and uniting electric energy from the steam and from the combustible gas generated in heating the coke.
6. The method herein described of utilizing fuel wastes and generating power, which consists in, (1) distilling fuel, (2) super-heating water with the waste heat of distilling said fuel, (3) generating steam and motive power from the super-heated water, (4) condensing the exhaust steam formed in generating the motive power, (5) heating air with heat radiated in the step of condensing, and (6) utilizing the heated air regeneratively in the step of distilling the fuel and of air heated by low degrees of heat radiated from a fluid that has parted with high heat in producing motive power.
7. The method herein described of utilizing fuel wastes and generating power, which consists in, (1) generating coal gas, (2) generating water gas, (3) admixing the two gases for applied use, (4) collecting and storing some of the water gas and waste carbon-monoxid generated in the making of the water gas, (4) generating motive power from burning the admixed gases thus collected and stored, and (5) applying in useful work the motive power generated.
8. The method herein described of utilizing fuel wastes and generating power, which consists in, (1) heating fuel and producing a combustible gas, coke and waste hot gases, (2) generating producer gas from the coke, (3) generating motive power from the producer gas, and (4) applying in unitary useful work waste heat developed in performing the three first named steps.
9. The method herein described of utilizing fuel wastes and generating power, which consists in, (1) distilling fuel and producing a combustible gas, coke and exhaust hot gases, (2) generating combustible gas from the coke, (3) generating motive power from the exhaust hot gases, (4) generating motive power from the combustible gas, and (5) uniting in applied work the two motive powers.
10. The combination of, (1) means for distilling fuel, said means producing coal gas, coke and waste hot gases, (2) means comprising a counter-current water heater for heating water and forming steam from the hot waste gases, (3) means for generating motive power from the steam, (4) means for generating motive power from the coke, and (5) means for uniting in one flow of distributable motive energy the two motive powers generated.
11. The combination of, (1) means for generating coal gas, said means producing coke and hot waste gases, and for super-heating and giving high expansive power to water with the heat of the hot waste gases, (2) means for generating water gas and for super-heating and giving high expansive force to water from the sensible heat of the newly made water gas, (3) means for capturing and storing producer gas generated and exhausted in the process of water gas generation, (4) means for making further amounts of producer gas from coke produced in the generation of the coal gas, (5) means for highly heating water and generating steam from the waste heat of the newly generated producer gas, (6) means comprising an internal combustion engine for generating motive energy from the producer gas, (7) means for highly heating

water and forming steam from the heat wastes of the internal combustion engine, (8) means for accumulating and storing the highly heated water from the several named sources for heating the water and for disengaging steam from the highly heated water in said last named means, (9) means for generating motive energy from the steam, and (10) means for uniting the two motive energies in one outflow of distributable energy.

12. The combination of, (1) means for generating coal gas, said means producing incandescent coke and hot exhaust gases, (2) means for cooling the incandescent coke and producing water gas in the process of cooling the coke, (3) means comprising a storage tank for conveying to and admixing and storing said coal and water gases, (4) a vertical counter-current boiler for generating steam from the hot exhaust gases, and (5) means comprising an engine and blower for using the steam and for producing a flow of the hot gases through said boiler and to the atmosphere after leaving the boiler.

13. The combination of, (1) means for making coal gas, said means comprising an externally fired retort, said means producing coke, (2) an internally fired gas generator for making gas from the coke, and (3) means for utilizing regeneratively in the process of making the gases the waste heat of making gas in the two means for making gas.

14. The combination of, (1) an externally fired gas generator and an internally fired gas generator, said generators generating and exhausting hot waste gases, (2) a vertical counter-current boiler and water heater for generating steam from the high heat of the hot gases and for progressively heating water from the lower heat of the hot exhaust gases, and (3) means for generating motive power from the steam generated and for using the steam and motive power in the generation of gas in the combination.

15. The combination of, (1) an externally fired retort, producing gas and coke, and exhausting hot gases, (2) means for superheating water with the hot exhausted gases, (3) means for accumulating and storing the super-heated water, (4) means for generating motive power from the coke, said means exhausting waste heat, (5) means for superheating water with the exhaust waste heat of the means for generating motive power from the coke and from the means for accumulating and storing super-heated water, (5) means for generating motive power from steam disengaged from the super-heated water, and (6) means for generating from the two motive powers generated a store of distributable energy.

16. The combination of, (1) a gas gener-

ator, and (2) means comprising a boiler and steam motor for generating motive power from the high degree of exhaust heat of the gas generator, (2) means for heating air for combustion with the low degrees of exhaust heat of the gas generator, said last named means comprising an arrangement of heat radiating surfaces constructed and disposed to progressively heat the air by heat of progressively increasing temperatures, and (3) means comprising mechanism operated by said steam motor for securing in the gas generator the use of the heated air for purposes of combustion.

17. The combination of, (1) means for generating a burnable gas, (2) means for generating motive power from burning the gas, (3) means for heating water and for heating air with the waste heat of the means for generating the combustible gas, (4) means for generating motive power from the heated water, and (5) means for utilizing said motive power and the air heated in the means for generating a combustible gas.

18. The combination of, (1) means for distilling fuel, said means producing coke and hot waste gases, (2) means for generating motive power from the hot waste gases, (3) means for generating motive power from the coke, and (4) means for generating and accumulating a store of distributable energy from the two motive powers generated, said elements co-acting to secure a utilization of the fuel wastes of the combination.

19. The combination of (1) means for distilling fuel, said means producing coke and hot waste gases, (2) means for capturing, accumulating and storing heat energy generated by said means for distilling fuel, (3) means for generating motive power from the coke and for capturing and accumulating and storing heat energy generated by said means of generating motive power, (4) means for generating motive power from the dually generated, captured, concentrated, accumulated and stored heat energy, and (5) means comprising electric generators and conductors for uniting in one store of distributable energy the two motive powers generated.

20. The combination of, (1) means for generating gas, said means burning fuel, said means comprising provision for controlling, distributing and forcing air into contact with said fuel, whereby a substantially perfect combustion of the fuel burned is secured, (2) means for controlling the compression of the air and fuel being burned in said means for generating gas, (3) means for highly heating water with the completely burned gases exhausted from the combination, and (4) means for generating

15 motive power from the heated water and for utilizing the motive power generated in operating the means for generating the gas.

21. The combination of, (1) means for 5 driving tar and sulfur from fuel by heating, (2) means for generating water gas with the heated fuel, (3) means for generating producer gas from the heated fuel, said water gas and producer gas being gen- 10 erated separately and intermittently, (4) means for admixing at will water gas with the producer gas, whereby the producer gas is enriched with the water gas in desired proportions, and (5) means comprising an 15 internal combustion engine for generating motive power from the admixed gases.

22. The method herein described for utilizing fuel wastes and generating power which consists in, (1) heating a coking 20 fuel, said heating producing combustible gas, coke and hot waste gases, (2) freeing the combustible gas from contaminants by passing the gas through the newly produced hot coke, (3) making water gas from the 25 coke, (4) making producer gas from the

coke, (5) generating motive power from the several gases and from the hot waste gases produced in the several steps, and (6) uniting the motive powers severally generated. 30

23. The method herein described for utilizing fuel wastes and generating power, which consists in, (1) distilling fuel, and producing from the fuel distilled, the several 35 products, coal gas, coke, and hot exhaust gases, (2) generating producer gas from the coke, (3) generating motive power from the producer gas, (4) generating steam from the hot exhaust gases, (5) generating motive 40 power from the steam, said last named motive power being generated separate and apart from the power generated by the producer gas, and (6) generating electric 45 energy from each of the two generated motive powers and uniting the two electric energies generated.

JOSEPH MOSES WARD KITCHEN.

Witnesses:

GEO. L. WHEELOCK,
ELIZABETH B. KING.

Copies of this patent may be obtained for five cents each, by addressing the "Commissioner of Patents, Washington, D. C."