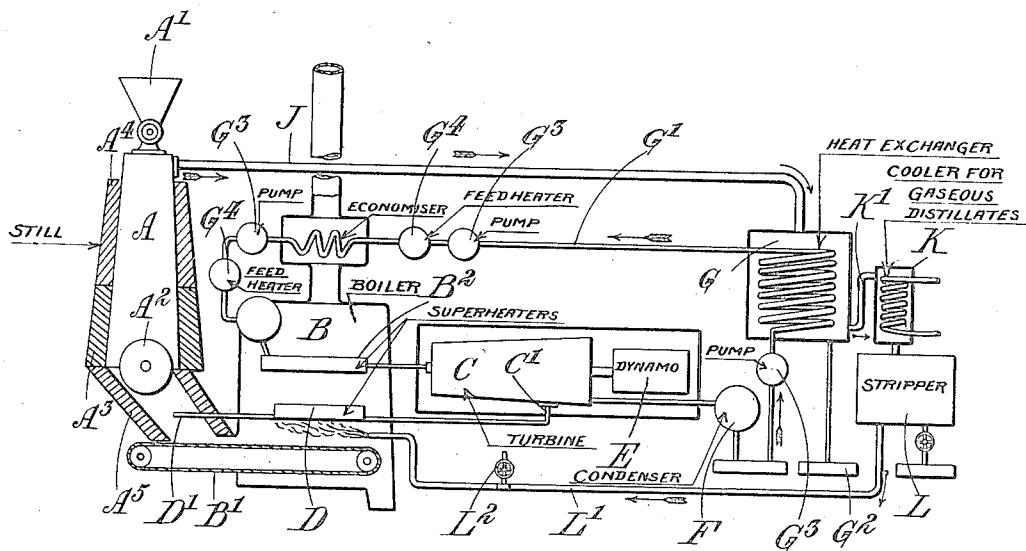


A. C. MICHIE & E. G. WEEKS.
 USE OF SOLID FUEL FOR POWER PRODUCTION.
 APPLICATION FILED MAR. 2, 1918.

1,301,960.

Patented Apr. 29, 1919.



Witnesses

G. B. Blaming
 L. H. Johnson

Inventors

A. C. Michie
 E. G. Weeks

by Bechert, Byrnes, Pannell
 Attys.

UNITED STATES PATENT OFFICE.

ARTHUR CUMMING MICHIE, OF NEWCASTLE-UPON-TYNE, AND EDMUND GEORGE WEEKS, OF NORTHUMBERLAND, ENGLAND, ASSIGNORS TO CHARLES HESTERMAN MERZ AND WILLIAM McLELLAN, BOTH OF WESTMINSTER, LONDON, ENGLAND.

USE OF SOLID FUEL FOR POWER PRODUCTION.

1,301,960.

Specification of Letters Patent.

Patented Apr. 29, 1919.

Application filed March 2, 1913. Serial No. 219,993.

To all whom it may concern:

Be it known that we, ARTHUR CUMMING MICHIE and EDMUND GEORGE WEEKS, subjects of the King of England, and residents, respectively, of Newcastle-upon-Tyne, England, and Northumberland, England, have invented certain new and useful Improvements in the Use of Solid Fuel for Large-Scale Power Production, of which the following is a specification.

This invention relates to the economic use of solid fuel for large-scale power-production by means of low-temperature distillation of the fuel with the consequent separation of valuable distillation products and of combustible gaseous and solid residues. The solid residues are hereinafter and in the claims referred to as the coke or alternatively as the coke-product, the distillation products and combustible gaseous products jointly as the retort gases, and the combustible gases therein which remain gaseous as the power-gases.

It has heretofore been proposed to effect the low-temperature distillation, for example, of coal, by subjecting it to the action of superheated steam at low pressure, without any external heating.

In carrying out this process it is customary to charge the retorts with coal and periodically to discharge the coke when it has been sufficiently exposed to the action of the superheated steam. In order that the process may be usefully employed in the manner provided by this invention the discharge of coke-product must be continuous, or substantially so, that is to say, it must take place sufficiently regularly to enable it to be discharged by automatic means so as to dispense as far as possible with manual labor or attention and in sufficient quantity to constitute the fuel-feed for an industrial furnace of some kind. It is the object of the present invention to provide means for recovering the volatile products of the fuel—many of which are of great industrial importance—in coöperation with means for utilizing, on the spot, as far as practicable the heat of combustion of the coke-product and power gases, and the recoverable heat contained in the retort gases by suitable heat-utilization devices, and applying the whole of the heat so obtained to the production of steam power. This is only com-

mercially feasible if the construction of the apparatus can be made simple and in sufficiently large sizes to prevent the capital outlay from overburdening the undertaking. We have found that by combining apparatus for low-temperature distillation of fuel by superheated steam with utilization apparatus for the power-gases and the coke-product therefrom and with heat-utilization apparatus for the recoverable heat contained in the retort gases, power can be generated and sold at a lower cost than by methods heretofore in use.

By the present invention, a combination of parts is provided to constitute means for producing power from solid fuel and to recover by-products from the fuel, which parts comprise—

(a) a continuous (or substantially continuous) steam-heated low-temperature distillation plant for solid fuel;

(b) a hot-coke utilization plant consisting of a furnace and steam-boiler with or without auxiliary gas-producers;

(c) means for utilizing for power production the power gases obtained from the said distillation plant;

(d) a steam turbine power-unit or units (with or without auxiliary internal combustion power-units) with provision for the supply of bleed-steam from the turbine-unit or units to the said distillation plant;

(e) a low-pressure superheater for heating the said bleed-steam to the temperature required for distilling the fuel in the said distillation plant;

(f) means for heating the boiler feed-water for the said steam-boiler by means of the recoverable heat (other than their heat of combustion) in the retort gases from the distillation plant.

The development of the energy by the means of the hot coke utilization plant and the transformations to which it is subsequently subjected, constitute a cycle of changes which are hereinafter collectively referred to as "the main power cycle."

Preferably the low-pressure superheater indicated in the item (e) is so combined with a high-pressure superheater for the turbine-unit or units of item (d) as to constitute therewith a single apparatus built in as a unit into the boiler supplying the said turbine or turbines.

The power derived from the combustion of the power-gases may be used, if desired to supplement the main power cycle or in any other way that is convenient and economical.

5 The term "bleed-steam" is hereinafter clearly defined.

This invention is now further described by reference to one embodiment thereof illustrated diagrammatically in the accompanying drawing.

10 In the said diagram a low-temperature distillation retort for treating coal is indicated at A, the retort being of gradually increasing diameter from the top downward to permit the fuel to swell freely as it undergoes distillation and so avoid choking of the fuel and the steam in their passage through the retort. A continuous-feed hoppper A¹ is provided for coal for the retort and a continuous discharge device A² for the coke-product. The device at A² may take the form of a feed-grate of the known type comprising toothed rollers geared together in pairs.

25 The lowest and hottest portion of the retort is preferably lagged with kieselguhr A³ and a greater proportion of the upper part with magnesia A⁴.

The coke-product is discharged by the device A² into a closed and lagged feed trunk A⁵, leading to the grate B¹ of a boiler B, any convenient form of mechanical stoker being employed to receive the coke-product and feed it into the boiler-furnace. High-pressure steam from the boiler B is fed through a high-pressure superheater B² to the high-pressure end of a steam turbine C from which bleed-steam is taken at the point C¹ and fed through a low-pressure superheater D in the boiler B, the discharge from the superheater D serving to supply, through the pipe D¹, the steam required by the retort A for distillation of the coal. The term "bleed-steam" is employed throughout this specification and claims to denote steam taken from the casing of a turbine at a point intermediate between the ends of the turbine, at which point the steam has been partially expanded. It is well-known that by thus increasing the weight of high-pressure steam to be taken in by the turbine without increasing the total weight of steam discharged at the low-pressure end, the high-pressure blades may be made of longer radius and the percentages of leakage, eddy losses, etc., reduced, with a consequent increase of economy.

The turbine is indicated as driving any useful device E, such for example as a dynamo-electric generator.

The exhaust steam from the turbine is taken to a condenser F, from whose hot-well F¹ the condensed water is pumped by a pump or pumps G² through the retort-gas condenser G as cooling medium therefor, and

thence through auxiliary feed-water heating devices such as are ordinarily employed, for example, through an economizer or a feed-water heater G⁴, back to the boiler B by way of the piping G¹.

Reverting now to the retort A, the retort-gases are taken by a discharge main J and passed through the device G which serves not only as a condenser and cooler for the retort-gases but also as a heat exchanger in the main power cycle. The distillates from the retort which are here condensed to liquid form are collected at G² for further treatment or sale, and the distillation products which still remain gaseous pass by a pipe K¹ to a cooler K where they are finally cooled, and then passed to a gas-stripping plant L for the recovery of the light oils and other by-products.

After this treatment the power-gases are fed to any utilization devices and are used for the production of steam and power, either, as indicated in the diagram, by being passed to the furnace of the boiler B through a pipe L¹ and there burned to assist in raising steam, or thus used and in part also, if desired, by means of a pipe such as L² passed to internal-combustion engines or other heat-utilizing devices. By such means the gas is immediately utilized, that is to say is not held in store nor transmitted a great distance before use.

Instead of feeding the whole of the coke-product to the boiler B, as shown in the diagram, it may be fed, in part at least, to the furnace of a gas-producer, the gas from which may be burnt under the boilers or employed in internal-combustion engines for power-production.

Owing to the continuous operation of the retort A, which result is in fact obtained by constructing it of sufficient size to insure the fuel being properly and fully treated in its passage from top to bottom of the retort, and in sufficient quantity to be immediately utilized in a furnace, the temperatures of the different portions of the retort are constant and closely predetermined, and hence the structure as a whole is not subjected to the disturbances arising from alternate heating and cooling, or from large fluctuations of temperature.

Moreover, since the cold coal in traveling down the retort meets the hot gases rising from the coking zone, the coal is preheated and the hot gases are cooled. In this way, the lowest portion of the retort is the hottest and forms the coking zone, while the upper regions are relatively cool. This state of things is favorable to economy in working and the reduction to a minimum of the heat lost by radiation. The latter can be reduced to a permissible amount by suitably lagging the retort.

The construction of the retort as a whole

is rendered relatively cheap by reason of the large units which can be employed and the operating costs are reduced to a minimum by the provision for its continuous operation in the manner described. Owing to the adoption of an inclosed direct feed of the coke-product from the retort to the furnace, the plant may be kept clean and free from dust with a minimum of labor.

It will be observed that the bleed-steam is not recovered as feed-water for the boiler, but is lost in the form of water, although the heat contained in it is usefully employed. This bleed-steam passes with the retort-gases into the combined feed-water heater and condenser and is then condensed to water with a portion of the distillation products from which it is subsequently separated. At the same time the arrangement of apparatus to take bleed-steam from the turbine in the manner described permits a greater quantity of bleed-steam to be taken than is ordinarily the case where the practice is adopted of passing it through plain feed-water heaters, the cost of which—with engineering considerations—prohibits employment of a sufficient number of heaters for the utilization of a large quantity of bleed-steam by such means. An increase in the amount of bleed-steam, tends to increase the mechanical efficiency of the turbine, as is known, because it permits the length of the high-pressure blades to be increased relatively to that which would be employed if bleedings were not adopted and so reduces the percentage of the leakage, eddy losses, etc., incidental to the high-pressure blading. At the same time, the thermal efficiency of the power cycle as a whole is enhanced. The facility afforded by the above described arrangements for increasing the relative amount of bleed-steam is thus advantageous.

The use of steam in the manner provided by the present invention in the cycle of operations above described is advantageous, commercially and otherwise, for various reasons, among which may be mentioned the following:—The condensation and cooling of the gases prior to their entry into the stripping plant reduces their volume and thus the size of the stripping plant required; the employment of bleed-steam has the advantages above referred to, and further the employment of steam as the distilling agent and employed in such a way as to be put into direct contact with the fuel appears to have a favorable effect as regards the character or volume of the distillates obtained. Further advantages afforded by the present invention, by reason of the direct discharge of coke provided by it from the distillation-plant to the furnace comprise saving of the heat contained in the coke and the avoidance of combustion thereof by combination with the air such as arises when

the coke is discharged into the open air and allowed either to cool there or to undergo some degree of cooling before it is quenched.

What we claim as our invention and desire to secure by Letters Patent is:—

1. The method of generating power from coal, comprising the steps of feeding coal to a retort, then passing at least some of the coke from the retort to a steam generating plant in which it is consumed to generate steam, passing the steam from the steam generator to a motor, delivering the bleed steam from the motor to the retort, returning the exhaust steam from the motor through a heat exchanger to the steam generator, and also passing the gases from the retort through the heat exchanger to partially condense said gases, substantially as described.

2. The method of generating power from coal, comprising the steps of feeding coal to a retort, passing at least some of the coke from the retort to a steam generating plant in which it is consumed, passing the steam from the steam generator to a motor, delivering the steam from the motor to the retort, returning the exhaust from the motor through a heat exchanger to the steam generator, passing the distilled products from the retort through the heat exchanger to partially condense said products, removing the condensed products to a receiver and passing the gases from said heat exchanger through a condenser, and passing the gases from said condenser to a point of use, substantially as described.

3. The method of generating power from coal, comprising the steps of feeding coal to a retort, passing at least some of the coke from the retort to a steam generating plant in which it is consumed, passing the steam from the steam generator to a motor, delivering steam from the motor to the retort, returning the exhaust from the motor through a heat exchanger to the steam generator, passing the distilled products from the retort through the heat exchanger to partially condense said products, removing the condensed products to a receiver and passing the gases from said heat exchanger through a condenser, and passing at least some of said gases to the steam generator, substantially as described.

4. A power plant, comprising a still for the low temperature distillation of solid fuel, a steam generator, means for feeding some of the solid fuel in a heated condition from the retort to the steam generator, means to convey the combustible gases from the retort to the furnace of the generator, a steam turbine, means for conveying bleed-steam from the turbine to the retort, means for conveying the exhaust products from the steam turbine back to the steam gen-

erator through a heat exchanger, said heat exchanger being in the line for transferring the combustible gases from the retort to the furnace of the steam generator, substantially as described.

5 5. A power plant, comprising a retort, means for feeding coal to the retort, a steam generator having a combustion chamber, means for feeding the hot coke from the retort to the combustion chamber of the steam
10 generator, a motor connected to the steam generator, means for conveying bleed-steam from the turbine to the retort, a heat exchanger, connections between said heat exchanger and the turbine for the remainder
15 of the exhaust products, a second connection from said heat exchanger to the steam generator, means for forcing the exhaust products from the turbine to the boiler through
20 the heat exchanger, a connection from the retort to the heat exchanger, and a connection from said heat exchanger to the combustion chamber of the steam generator for conveying at least some of the gases from
25 the heat exchanger to the combustion chamber, substantially as described.

6. A power plant, comprising a still for the low temperature distillation of solid fuel, a steam generator, means for feeding some
30 of the solid fuel in a heated condition from the retort to the steam generator, means to convey the combustible gases from the retort to a utilization device therefor, a steam turbine, means for conveying bleed-steam
35 from the turbine to the retort, means for conveying the exhaust products from the

steam turbine back to the steam generator through a heat exchanger, said heat exchanger being in the line for transferring the combustible gases from the retort to the
40 furnace of the steam generator, substantially as described.

7. A power plant, comprising a still for the low-temperature distillation of solid fuel, a steam-generator fitted with a high-pressure
45 and low-pressure superheater built as a unit into the generator, means for feeding some of the solid fuel in a heated condition from the retort to the steam generator, means to convey the combustible gases from the retort
50 to a utilization device, a steam turbine and means to feed it with steam from the said high-pressure superheater in the generator, means for conveying bleed steam from the turbine to the retort through the said low-
55 pressure superheater in the steam-generator, means for conveying the exhaust products from the steam turbine back to the steam generator through a heat exchanger, said heat exchanger being in the line for trans-
60 ferring the combustible gases from the retort to the utilization device, substantially as described.

In testimony whereof we have signed our names to this specification in the presence of
65 two subscribing witnesses.

ARTHUR CUMMING MICHIE.
EDMUND GEORGE WEEKS.

Witnesses:

H. NIXON,
F. F. P. BISARRE.