

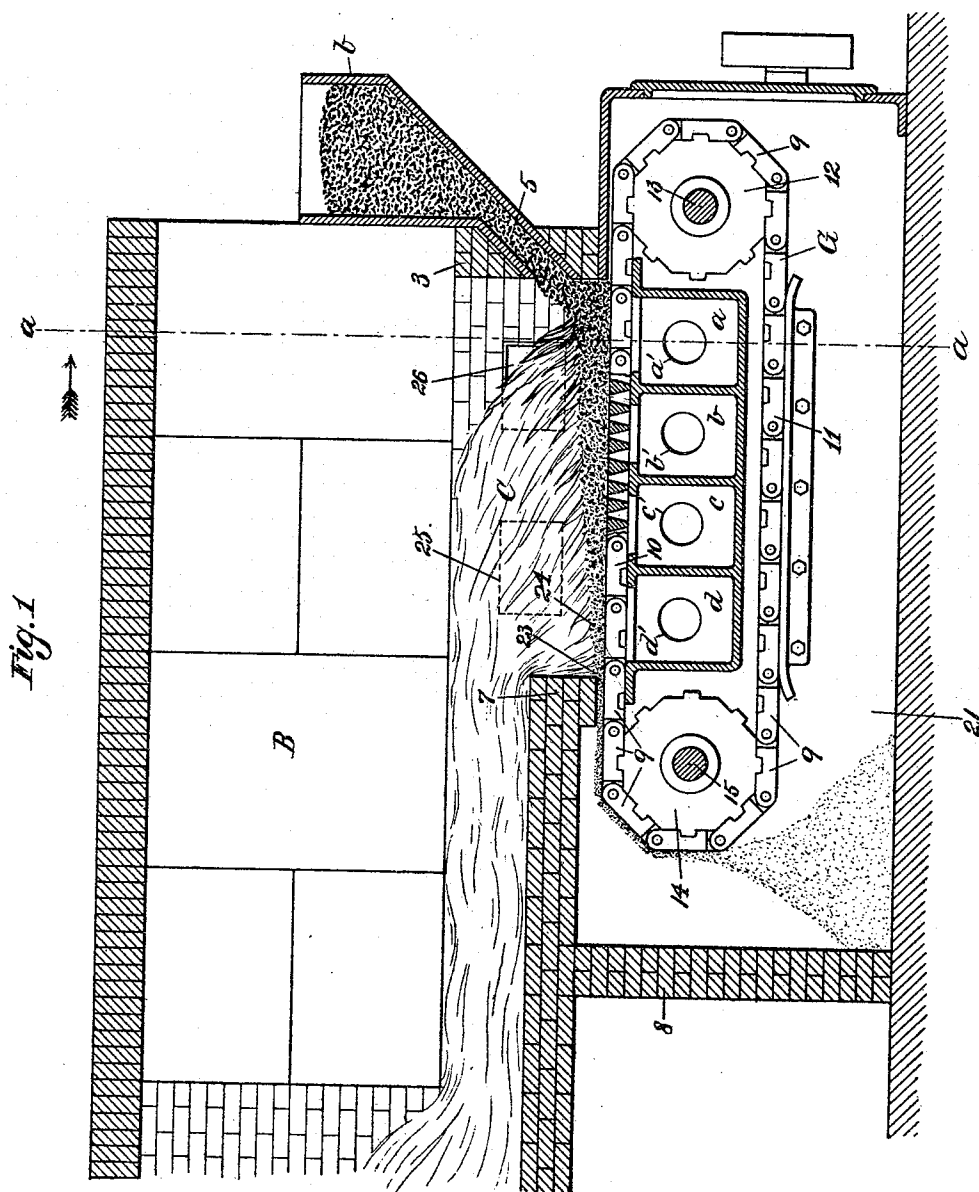
(No Model.)

3 Sheets—Sheet 1.

E. B. COXE.
PROCESS OF BURNING FUEL.

No. 499,715.

Patented June 20, 1893.



Witnesses:

H. Mallon.

W. L. Richards

Inventor:

Eckley B. Cox,

By his Attorney,

J. W. Richards

(No Model.)

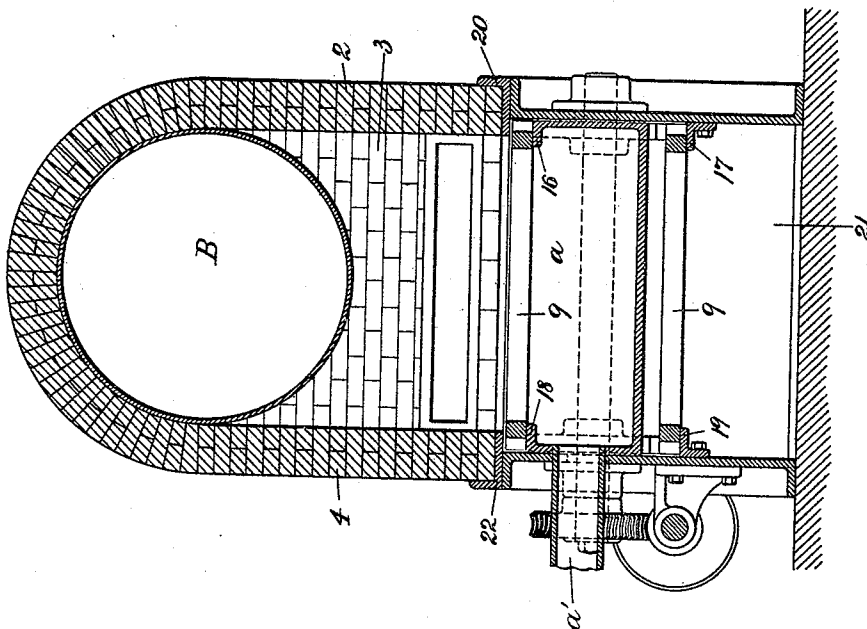
3 Sheets—Sheet 2.

E. B. COXE.
PROCESS OF BURNING FUEL.

No. 499,715.

Patented June 20, 1893.

Fig. 2.



Witnesses:

H. Mallner.

W. G. Richards.

Inventor:

Eckley B. Cox,

By his Attorney,

F. A. Richards.

(No Model.)

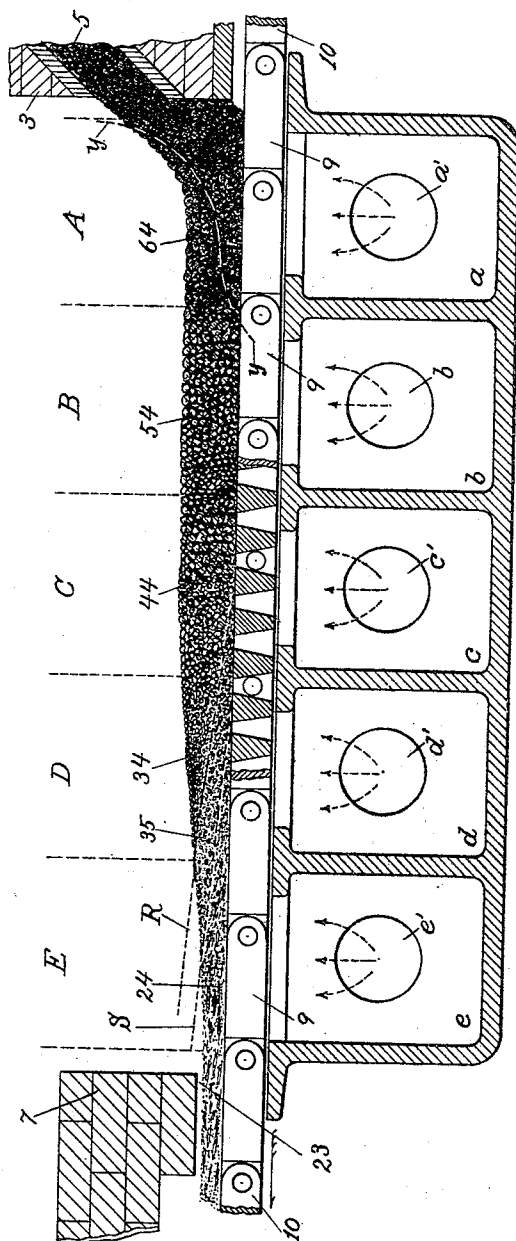
3 Sheets—Sheet 3.

E. B. COXE.
PROCESS OF BURNING FUEL.

No. 499,715.

Patented June 20, 1893.

Fig. 3.



Witnesses:

Fred. J. Dole,

W. L. Richards

Inventor:

Eckley B. Cox,

By his Attorney,

F. A. Richards

UNITED STATES PATENT OFFICE.

ECKLEY B. COXE, OF DRIFTON, PENNSYLVANIA.

PROCESS OF BURNING FUEL.

SPECIFICATION forming part of Letters Patent No. 499,715, dated June 20, 1893.

Application filed October 6, 1892. Serial No. 448,048. (No model.)

To all whom it may concern:

Be it known that I, ECKLEY B. COXE, a citizen of the United States, residing at Drifton, in the county of Luzerne and State of Pennsylvania, have invented certain new and useful Improvements in Processes of Burning Fuel, of which the following is a specification.

This invention relates to methods, or processes, for the economical burning of coals and other fuels; the object being to provide a process especially adapted for the burning of the smaller sizes of anthracite coals, including those sizes known in the market as "pea," "buckwheat," &c.

In the drawings accompanying and forming a part of this specification, Figure 1 is a sectional side elevation of a furnace suitable for carrying out my improved process. Fig. 2 is a transverse vertical section of the furnace, in line *aa*, Fig. 1. Fig. 3 is an enlarged diagrammatic view similar to a portion of Fig. 1, for further illustrating the invention and the manner of practicing the same.

Similar characters designate like parts in all the figures.

According to my present invention, the coal or other fuel to be burned is first placed in a mass or layer of the proper thickness, and the mass or layer ignited; it is then subjected to an air-blast the pressure of which is varied, or gradually reduced, (either continuously or intermittently,) during the combustion period, so that the ignited mass is subjected to varying or successively-reduced pressure-blasts during the successive stages of said period. During the stage of the combustion-period immediately following the ignition, the fuel, especially if it be coal of the kind specified, is found to properly require a different pressure of blast from that suitable for the later stages of the combustion. This is due, in my opinion, in part to the chemical changes of the fuel itself during the period of combustion, and also, in part, to the mechanical change in the mass during said period; both of which changes should, obviously, be provided for in order to effect the burning of the fuel in the most economical manner. Generally, I find the pressure should be reduced as the combustible material disappears from the mass; but in some cases, owing to melting and solidifying of the non-

combustible materials, a higher pressure may be required at the later stage or stages of the combustion-period.

The improved furnace herein shown and described, for the burning of fuel according to my present invention, constitutes the subject-matter of a separate application, Serial No. 452,202, filed November 16, 1892.

A furnace suitable for practicing my invention may consist, as shown in the drawings, of the usual inclosing walls at the sides and ends thereof, and, in the absence of a steam-boiler or other device to be heated over the furnace, of the ordinary top-covering. In the drawings, the side-walls are designated in a general way by 2 and 4, respectively, and the furnace-chamber is shown covered by a steam-boiler, B. At the forward end of the furnace-chamber, this is provided with the end-wall 3, through which is the passage-way 5, for the supply of fuel to the grate, said supply being delivered from a suitable hopper or other source of fuel-supply, as 6. At the rearward end of the furnace-chamber, this is shown provided with a bridge-wall, 7, which is connected with a vertical wall, 8, rearward of the traveling grate.

The under side, or floor, of the furnace-chamber C is formed of the upper run, 10, of an endless traveling grate, designated in a general way by G, and preferably composed of a series of similar grate bars, or sections, 9, pivotally connected and carried by the wheels 12 and 14, that are fixed on the two shafts 13 and 15, respectively. The ends of the several grate-bars are shown supported by guides, of which those for the upper run of the grate are designated by 16 and 18, while those for the lower run 11 are designated by 17 and 19, respectively.

For protection, in practice, of the ends of the grate-bars, and also for prevention of the fine fuel passing over the ends thereof, the side-walls of the furnace are brought over the grate-bar as shown in the sectional view, Fig. 2, the brick-supporting plates, 20 and 22, of the side-wall extending over the grate-bar by a distance equal to, or greater than the width of, the end-bar of the grate-section.

Under the upper, or fire-carrying, run, 10, of the traveling grate is a series of air-supply chambers, *a*, *b*, *c* and *d*, which may be two or

more in number, four of them being shown in Figs. 1 and 2, and five of them in Fig. 3. In general, I prefer to use not less than three such chambers. Each of said chambers is to be suitably supplied with air, which may be done by blowing the air thereinto by corresponding pipes, a' , b' , c' and d' , shown in end view in Fig. 1. The divisional walls between the several air-supply chambers come up close to the under side of the upper run of the traveling grate, so as to practically close the chambers the one from the other, with the exception of a slight leakage insufficient in practice to materially affect the operation of the furnace.

The fuel is fed to each section of the grate at or before the time this reaches the first air-supply chamber a , and is then carried along maintained substantially in *statu quo*, over that chamber and the succeeding chambers b , c and d , during which period the combustible material of the fuel is consumed, the resulting cinder, or ash, being afterward carried under the bridge-wall 7 and finally delivered over the rearward end of the grate into the ash-pit 21. In practice, the combustion goes on, at one stage or another, throughout nearly the entire length of the furnace, the ignition taking place within a short distance of the point where the fuel falls upon the grate, this being completely reduced to cinder over the last chamber, d or e of the series. The reduction of the fuel by combustion gradually lowers the same on the grate, (by an amount depending on the nature of the fuel,) so that at the point, 23, where the cinder passes under the bridge-wall, the thickness of the cinder is generally much less than the original height of the fuel, as illustrated in Fig. 1. The fuel being maintained during the combustion period, and especially during the later stages thereof, substantially in *statu quo*, avoids that mixing of the de-carbonized mineral with the partially burned fuel which occurs by the old methods of replenishing the grate, and which is wasteful in its effects. The cinder, or ash, 24, over the last chamber, d , of the series of air-supply chambers being blown for a short time after the combustible material is burned therefrom, is cooled down to a relatively low temperature before it passes under the bridge-wall and is discharged from the grate. By this means two economies are effected: first, the air entering the furnace-chamber from said supply-chamber d is heated; and second, this heating is effected by the heat of the cinder, which would otherwise be lost; this statement applies also to the grate itself, which is thus cooled at the earliest practicable moment and before it reaches the wheels, so that the driving mechanism will be heated to the least possible degree. Another feature of the organization described is that the air from the least supply-chamber, after being heated by taking up the heat of the grate and the cinder, is mingled with the partially consumed gases from the more for-

ward portions of the furnace-chamber, and serves to effect the complete combustion of these gases. The cinder carried forward upon the traveling grate, under the wall 7, at the rearward end of the grate, as shown at the left-hand in Fig. 1, is discharged from the grate-sections into a pile, which may be removed, from time to time, by any convenient means, without interrupting the operation of the furnace.

The particular amount of air-pressure required in the respective air-supply chambers will be governed by the kind and mechanical condition of the fuel; but the proper relation of the several air-pressures may be expressed by a formula as follows: Let x represent the normal pressure of the air-supply in the chamber a . Then $x-y$ will represent the air-pressure in the second chamber b , y being the difference between the pressures in the two chambers. The air-pressure in the third chamber will be equal to the pressure in the first chamber less a quantity greater than y , and may be represented by $x-(y+a)$. Following this method of illustration further, the pressure of the air-supply in the next chamber, d , will be represented by $x-(y+a+b)$. In practice, the quantities y , a and b may sometimes be equal, or substantially so; or, these characters may in the formula have different values; so that the pressure in the second chamber may be greater than in the first chamber.

After the furnace has been put into complete operation, the fireman, by occasional observation of the burning fuel through observation-doors at 25 and 26 in the side-wall of the furnace, can, by means of ordinary air-valves (not shown) to be placed in the air-supply pipes a' , b' , c' and d' , readily regulate the pressure in the successive air-chambers so as to produce the best results and completely reduce the fuel to cinder before it reaches the wall 7. By this means the entire floor of the furnace-chamber may be kept covered, and the combustible part of the fuel may be consumed with a high degree of economy.

For a fuller illustration of the principle of the invention, reference should now be had to Fig. 3, where the travel of the fuel is divided into the five spaces or divisions, A, B, C, D and E, corresponding to the five blast-chambers a , b , c , d , and e , respectively. The division A constitutes the ignition area, the normal line of the ignition itself being represented approximately by the curved line yy , shown drawn through the fresh coal (or other fuel) at 64, where the mass of fuel is aerated by a moderate blast from the chamber a . Becoming ignited at 64, the fuel is carried forward to 54, over the high-pressure blast from the chamber b , and is here raised to a high state of combustion, which is continued with but little reduction, if any, over the next succeeding chamber, c . During this period the carbon is reduced by being burned up throughout the depth of the mass, until it is of too

low a percentage to longer normally maintain the previous high rate of combustion under the high-pressure blast from the chambers *b* and *c*. Accordingly, pursuant to my present improvement, the air-blast of chamber *d* is reduced in pressure, to a point sufficient to normally continue the combustion of the fuel in its reduced low-carbon condition, without chilling the same by over-blowing, but still to continue the combustion through nearly the whole depth of the mass of fuel, and thereby reduce the carbon to the lowest burning-point thereof, considering both the temperature of the mass and the admixture of non-burning mineral with the small residue of carbon. Continuing the process, the hot and slightly-burning cinder at 35 is carried along and subjected to a still lower air-blast from the chamber *e*, which blast, being relatively small in quantity, is so carbonized by the burning carbon of the lower layers of fuel,—below the “cinder-line” *R*,—as to complete the combustion and leave the mass below the lower “ash-line,” *S*, without any fire therein. The described operations, continuing while the mass of fuel is slowly carried along over the successive varying air-blasts, the cinder-line and the ash-line naturally assume inclined positions in the mass, as indicated in Fig. 3; and during the later stages of the process, this being considered in respect of any particular portion of the mass of fuel, the combustion is completed from the lower side of the mass upward, and the rate of combustion is so regulated as to be normal at each successive stage of the entire operation.

By means of this process, I am enabled to burn the smallest sizes of anthracite coals with the highest efficiency, and to do this in a practicable manner, and especially without any re-mixing of the particles during the later stages of the combustion.

The process of preparing and igniting the fuel, by feeding the same over a heated wall or slope, and delivering the heated fuel over a falling-ledge onto a traveling-grate moving away from said slope, which process, being supplemental and preparatory to that herein claimed and therefore only partially shown or set forth herein, constitutes the subject-matter of a separate application, Serial No. 474,559, filed May 17, 1893.

Having thus described my invention, I claim—

1. The herein-described process of burning coal and other fuels, consisting in igniting the mass spread in a layer, and subjecting said ignited layer maintained substantially in *statu quo* during the successive stages of the combustion-period, to successive air-blasts of varying pressure, substantially as described.

2. The herein-described process of burning coal and other fuels, consisting in igniting the mass spread in a layer, subjecting said ignited layer maintained substantially in *statu*

quo to an air-blast, and reducing the air-blast pressure during the combustion-period, substantially as described.

3. The herein-described process of burning coal and other fuels, consisting in igniting the mass spread in a layer and subjecting the ignited layer maintained substantially in *statu quo*, to successive air blasts of successively reduced pressures during the successive stages of the combustion period, substantially as described.

4. The herein-described process for the economical burning of coal and other fuels, consisting in igniting the mass, subjecting the ignited mass maintained substantially in *statu quo* to a relatively high pressure air-blast during the earlier part of the combustion-period, subjecting the burning mass during the later part of the combustion-period to a relatively low pressure air-blast, and mingling said low-pressure air-blast, after this has passed through the nearly consumed fuel, with the gases from freshly ignited fuel, whereby the partially consumed air of the low-pressure blast is heated and furnishes oxygen for completing the combustion of said gases, substantially as described.

5. The herein-described process for the economical burning of coal and other fuels, consisting in igniting the fuel and subjecting the same to an air-blast, transferring the ignited fuel maintained substantially in *statu quo* during the combustion-period to successive areas of reduced air-pressure, supplying the place of the transferred ignited fuel with fresh fuel subjected to ignition and air-blast, and commingling the low-pressure air-blast passing through the cinder with the products of combustion from the freshly ignited fuel, whereby the heat of the cinder is utilized for heating air for supplying the later stages of combustion, substantially as described.

6. The process of burning coal and other fuels which consists in igniting the fuel upon a grate subjecting the ignited fuel to an air-blast through the grate, and during the succeeding combustion-period reducing the pressure of the blast in a ratio corresponding to the reduction of combustible in the fuel, substantially as described.

7. The herein-described method of burning coal and other fuels by a continuous operation, which consists in spreading and igniting the fuel upon a traveling grate, subjecting the traveling layer of ignited fuel to successive air-blasts of varying pressures at successive points in its course of travel, and supplying fresh fuel at the point of the first air-blast, to maintain the continuity of the traveling layer, substantially as described and for the purpose specified.

ECKLEY B. COXE.

Witnesses:

JNO. R. WAGNER,
HARRY J. DAVIS.