No. 869,485. PATENTED OCT. 29, 1907.

B. E. ELDRED.

COMBUSTION PROCESS.

APPLICATION FILED DEC. 15, 1904.

3 SHEETS—SHEET 1.

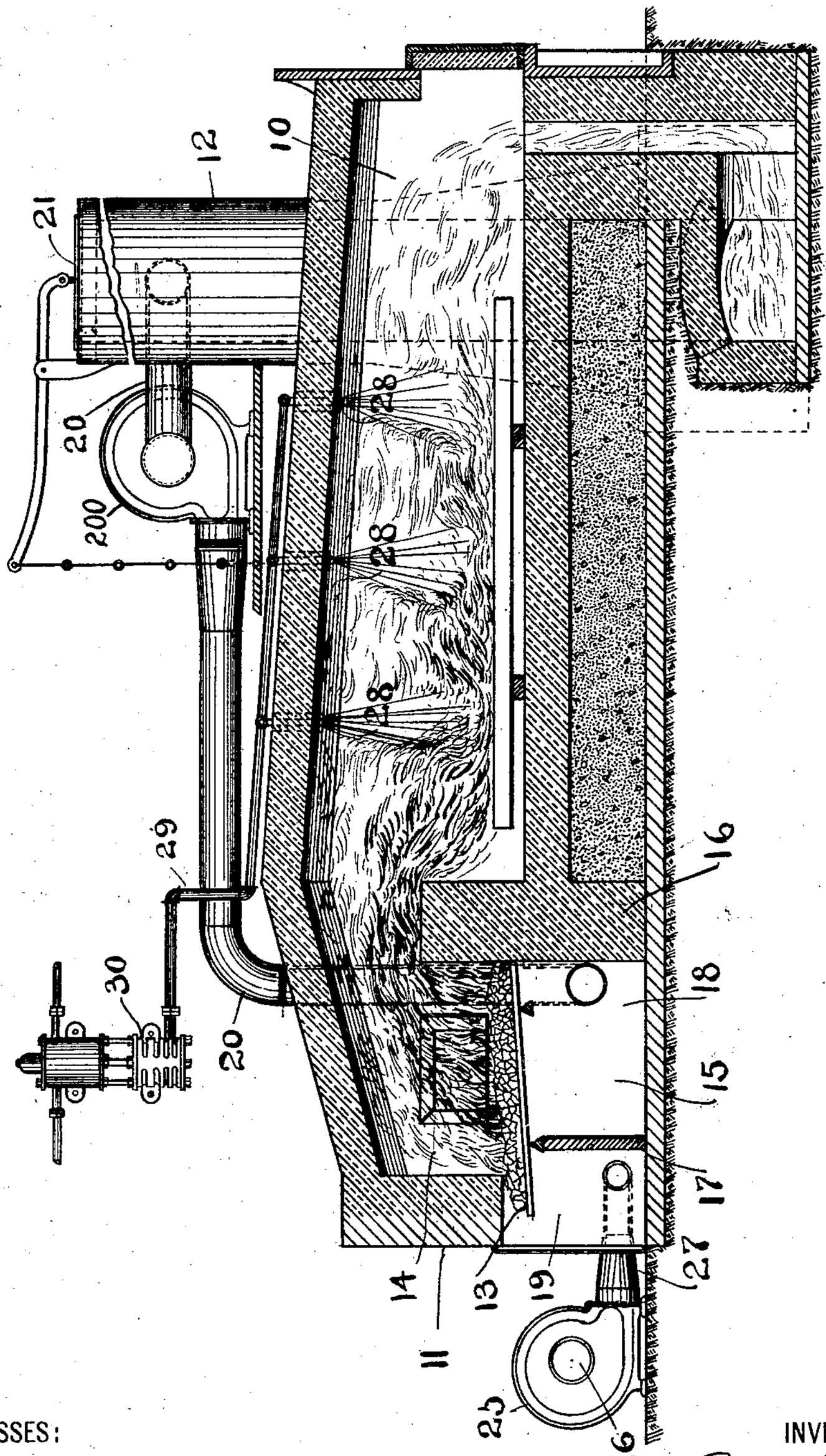

Fig. 1.

WITNESSES:

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M. A. Moder

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Byron E. Eldred

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3 SHEETS—SHEET 2.

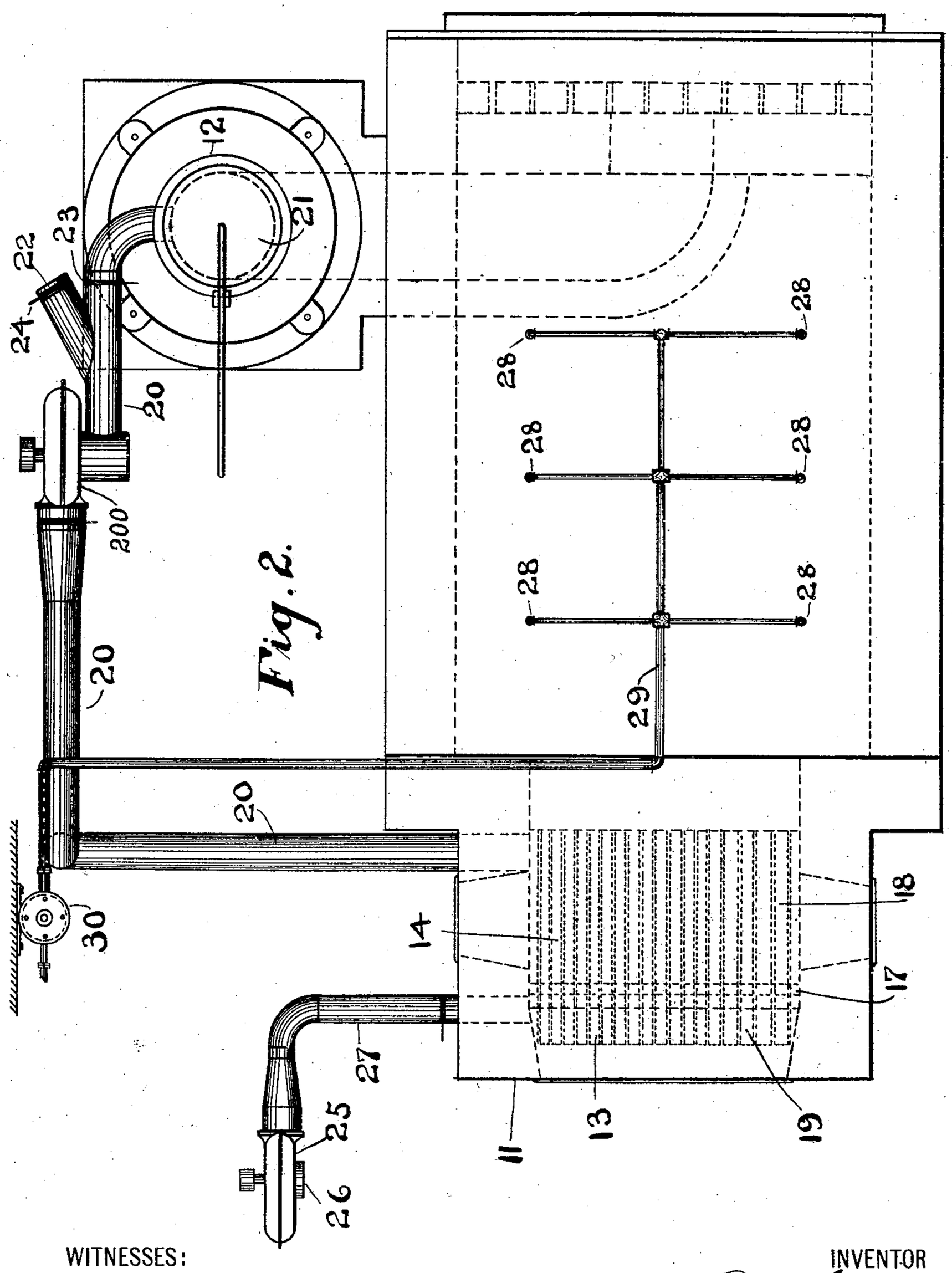

Fig. 2.

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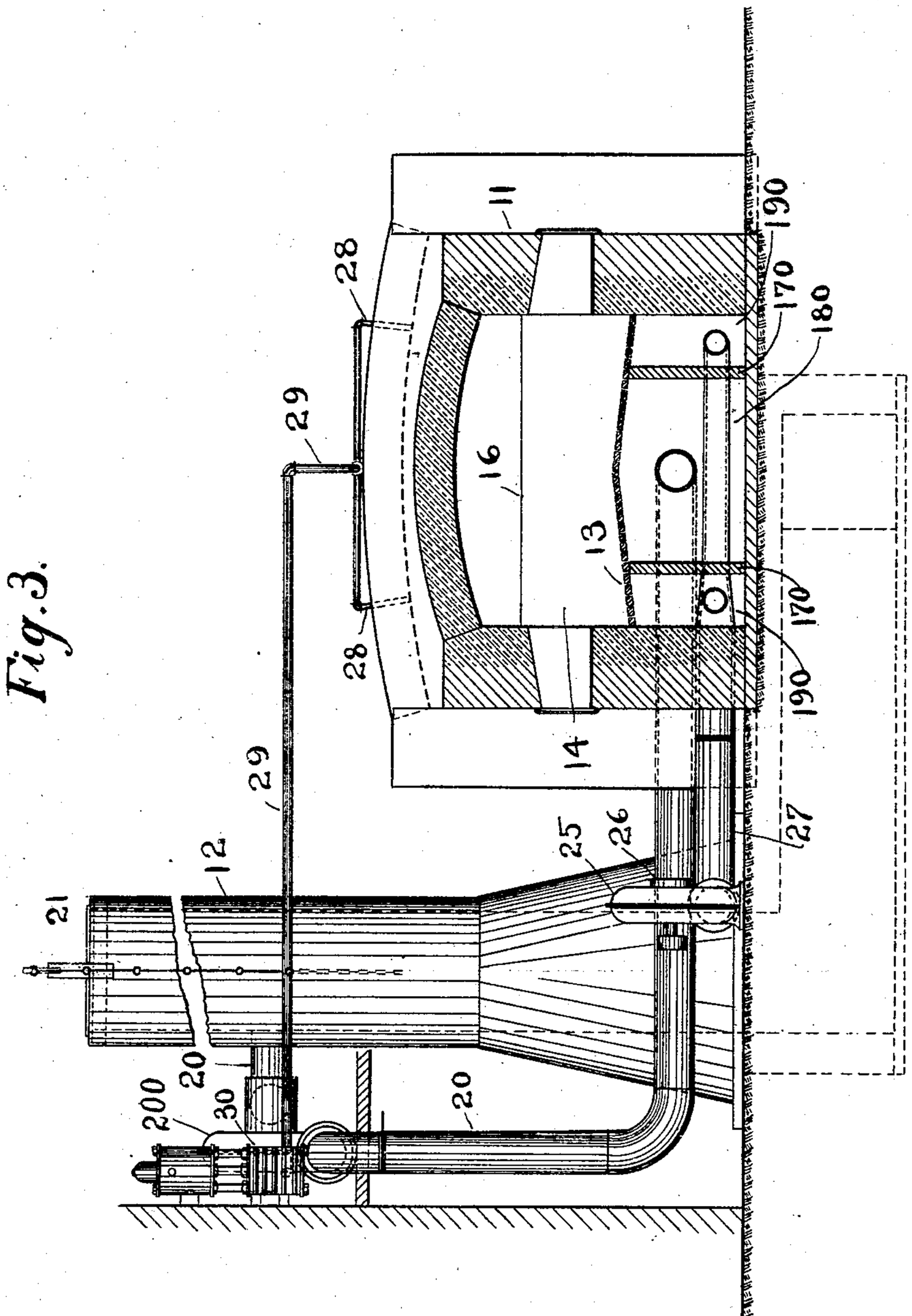
3 SHEETS—SHEET 3.

Fig. 3.



WITNESSES:

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UNITED STATES PATENT OFFICE.

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COMBUSTION PROCESS.

No. 869,485. Specification of Letters Patent. Patented Oct. 29, 1907.

Application filed December 15, 1904. Serial No. 236,915.

To all whom it may concern:

Be it known that I, BYRON E. ELDRED, a citizen of the United States, residing at Bronxville, county of Westchester, State of New York, have invented certain new and useful Improvements in Combustion Processes, of which the following specification and accompanying drawings disclose, as an illustration, one embodiment thereof, which I now regard as the best out of the various forms in which the principles of my invention may be applied.

This invention relates to the art of combustion. I have previously discovered improvements in that art, set forth in my Patent No. 692,257, Feb. 4, 1902 whereby a slow-burning voluminous flame may be obtained by burning coal with an accelerated draft-current containing a predetermined component of inert or indifferent gas such as stack-gas, as a diluent for the oxygen. The flame produced is characteristically "cool" as compared with ordinary combustion being diluted or inflated to some extent with components of the draft current passing the ignited coal without change under the accelerated draft and if used without modification it would in some heating processes produce an insufficient temperature. The object of the present invention is to increase the utility of my aforesaid process in furnaces where an intense heat is required such as in heating plates in iron and steel manufacture, and its further object is to more effectively regulate the quality of the flame in situations where the chemical composition of the heating agent is important. It has for example heretofore been difficult in plate-heating, iron-puddling and other operations, to regulate the flame as to its oxidizing, reducing or neutral character and at the same time retain the desired control of its temperature, volume, etc. The present invention enables me to regulate such matters perfectly, obtaining a temperature high enough to properly heat the plates or other material and a flame which is neutral or reducing on its lower side and hence has none or a minimum of injurious oxidizing effect.

In the preferred method of procedure I subject different portions of the bed of fuel to draft-currents of different compositions with the object of stratifying the flame or heating agent in its early stages. Preferably that portion of fuel which is nearest the hearth-chamber is supplied with stack-gases largely depleted of oxygen, while that portion farthest therefrom is supplied with a draft of pure air or one containing more oxygen than the other draft. This may be done by dividing the ash-pit into compartments and feeding gases of the desired composition to the respective compartments. The result is that the first-said portion of fuel furnishes a long tardily-burning voluminous and relatively-cool flame which is deficient in oxygen or at the least substantially neutral, while the other portion of fuel furnishes a very hot flame or gas-current containing an excess of oxygen. After passing over the bridge-wall the strata begin to mingle gradually in their abutting layers and the oxygen of the upper current combines with the combustible of the lower current; producing a hot combustion. The mingling of the strata may if desired be accelerated or abruptly accomplished by agitation, as by means of a transverse jet of air or other suitable gas.

Of the accompanying drawings, Figure 1 represents a longitudinal section of a reverberatory furnace equipped to carry out my invention, Fig. 2 represents a plan view, Fig. 3 represents a transverse section through the fire-box of a modified apparatus.

The same reference characters indicate the same or similar parts in the views.

Referring to Fig. 1, 10 indicates the hearth-chamber of a reverberatory furnace having walls of the usual refractory materials and having fire box 11 at one end and stack 12 at the other. 13 is the grate, 14 the fire-chamber above the grate and 15 the ash-pit below. 16 is the bridge-wall. By a transverse partition 17 underneath the grate, the ash-pit is divided into two compartments 18, 19 and with the larger one, nearest the bridge-wall, connects a pipe 20 leading from the stack below the damper 21. Through this pipe a portion of the stack-gases is drawn back by a fan-blower 200 to the compartment 18 and passed through the body of fuel on grate 13. 22 is an air-inlet to pipe 20 back of the fan, whereby air may be added to the draft-current if there is insufficient free oxygen in the stack-gases to supply the desired combustion to the forward part of the fuel-bed. Regulation is by means of the valves 23, 24 in pipe and air-branch, and by the speed of the fan.

A second fan 25 having air-inlet 26, connects by pipe 27 with the outward compartment 19 of the ash-pit and furnishes a pure-air draft to that portion of the fuel-bed overlying said compartment. This draft, in contrast to the other, supports a vigorous combustion, and an excess of oxygen is passed through the fuel to secure the results desired further on. I have shown part of the compartment 19 in such relation to the grate that some air may if desired be passed above the fuel-bed, without passing through it.

I prefer to have the pure-air compartment covered with coke, and therefore in firing I feed the fresh fuel to that part of the grate overlying the stack-gas compartment 18 and in stoking I work the coked material toward the fresh-air grate. This movement of the coke is favored by the use of a grate inclining toward the fresh-air compartment, as shown.

In operating this furnace, a fire is started on the grate in the usual manner, using preferably natural draft to begin with. The fuel preferred is bituminous coal.

When the fire is well under way, the doors to the ash-pit compartments are closed and the fans 22, 25 started. The proper amount of stack-gases and the most advantageous composition of this draft is judged by the appearance of the fire over the compartment 18. If the fire becomes too cool the stack-gases may be reduced in amount, or more air may be admitted to the fan through the air-damper 24. If on the contrary, the fire on that portion of the grate is too hot and the flame insufficiently long, the air may be reduced or the amount of stack-gases increased. The composition of the flame may also be varied by varying the relative velocities of the two draft-currents. Since the composition and speed of the draft are absolutely under control, the character of the lower stratum of flame in the hearth-chamber may be accurately determined.

It should be observed that no attempt is here made to conserve any considerable proportion of the waste heat passing out the stack nor to burn imperfectly consumed fuel-gases or smoke. Marked fuel-economy is obtained, but rather by reason of the character of the combustion which is brought about. The fire is cooler in the portion fed with the diluted air draft, less excess oxygen or none at all is passed through the fire to carry off heat to the stack, less CO_2 and more CO are created within or near the fuel-bed, and there is less heat-loss by radiation from the fuel bed and fire-box. The excessive heat developed in the fuel by the air component of the draft current is here utilized to reduce the carbon dioxid component in part to form carbon monoxid which burns later in the reverberatory; *i. e.*, the development of heat is transferred from the fire-box to the reverberatory chamber. Part of the dioxid however goes through unchanged and is useful in retarding combustion to form the long flame desired. Part of the air also escapes through the shallow fire-bed unchanged to aid in burning the combustible gases of the effluent from the fire-bed.

From the major portion of the fuel-bed, or that nearest the bridge-wall, I secure as above described, by virtue of the presence of the "inactive" or diluent gas, the evolution of a long voluminous flame with a comparatively cool fire. This flame forms the lower stratum within the hearth-chamber and prevents oxidation of the materials such as occurs from the presence of a large excess of oxygen in the ordinary hot flame. From the minor portion of the fuel-bed, I secure a hot fire with the evolution of an "active" gas carrying a large quantity of highly-heated free oxygen. This gas or flame forms the upper stratum moving along the roof of the furnace without mingling with the lower stratum to any great extent until the bridge-wall is passed. From that point the two strata gradually mix in their abutting layers. The oxygen of the upper stratum combines with the combustible of the lower stratum and a high temperature is produced directly over the materials on the hearth. In this arrangement the intense heat of the oxidizing current is of course next the roof of the furnace which is generally freely exposed to the atmosphere and between it and the reducing current, shielding the latter and the hearth from heat leakages and radiating heat down from the intensely heated refractory material of the arch.

Mingling of the strata may be more abruptly brought about and the combustion localized at any predetermined point by one or more gaseous jets. I have shown nozzles 28, 28 in the roof of the hearth-chamber for furnishing jets of this character, directed downwardly and transversely of the gas current, said nozzles supplied by a pipe 29 from an air-compressor 30. Other gases than air, such as neutral stack-gas, might be supplied to the jets, or a mixture of air and neutral gas. A jet of such a character could be made to effect the mixture of the strata without itself participating materially in the combustion nor producing oxidation of the materials. This system of local agitation is generically embodied in another application, Serial No. 225,395, concurrently pending.

Fig. 3 shows a modification in which the ash-pit is divided by longitudinal partitions 170, 170 into a central compartment 180 to which are fed stack-gases, and two side compartments 190, 190 to which is fed pure air. The result of this arrangement is to produce a vigorous combustion along the side walls of the furnace, heating them hotter than the other parts. Such an arrangement is intended to be applied to furnaces having side doors which are opened frequently to insert or withdraw material, and hence having a tendency to be cooler at the sides than in the center. In my arrangement the loss of heat by opening the doors reduces the temperature of the material at the exposed sides, only to or about the temperature of the material at the center, thus producing a more uniform transverse heating.

If desired, the action of the air-jets may be suspended when the doors are opened and resumed when they are closed.

It would of course be within the invention to supply the air compartment or compartments of the ash-pit with a certain proportion of neutral diluent instead of pure air and still retain the stratification. Furthermore I do not limit myself as to the number of ash-pit compartments nor to the number of strata which may be generated. Nor do I limit the invention to being practiced with a single mass of fuel, as for example partitions may be used in the fire-box to separate the fuel into isolated portions to which draft-currents of differing compositions may be supplied.

In a diluted air draft of the character described, the contained carbon dioxid of the stack gases tends to cool the fire, the reduction of CO_2 to CO by C being attended by absorption of heat. On the other hand, the oxidation by the air component of the draft of course tends to develop heat. These two effects balance and by proper adjustment of the proportions, the coking fire can be run at any temperature desired; for instance, one so low that it will give a maximum of gaseous hydrocarbons and a minimum of the cracking effect which produces smoke; a result next to impossible with a pure air draft and fresh coal. Further, since carbon dioxid retards the combustion specifically, aside from its chilling action, the draft can be readily accelerated so as to pass any desired amount of the draft current through the fire unchanged to mix with the distilled gases and the produced carbon monoxid. This is ordinarily done, producing an effluent mass of combustible gases with more or less oxygen and carbon dioxid distributed uniformly throughout. The former makes the gas mass potentially combustible throughout to an extent depending upon its

amount; the latter retards such combustion. As a result, there is produced a slowly burning body of flaming gas of a more or less reducing character, oxygen not being supplied in the full amount necessary, with its character in this respect and its rate of combustion both readily adjustable. Coming from a comparatively cool fire, it tends to flow through the furnace as an undercurrent surmounted by the intensely hot, oxygen-rich gases from the coke fire; vigorous combustion taking place at the joining layer where excesses of combustible gases and of oxygen meet. By this method of operation, an iron or steel plate in the furnace may be shielded from oxidation by a layer of reducing gas and heated therethrough by the combustion taking place in aforesaid film and also by radiant heat from the arch heated by the intensely hot gases from the coke fire.

What I claim as new and desire to secure by Letters Patent is:

1. The process of applying heat in a reverberatory furnace which consists in supplying to the heating chamber of such a furnace a compound stratified flame current arising from fresh fuel cool-coked in the fire-box thereof by a draft current containing an endothermically acting body and from the combustion of coke in the same fire-box, the coal furnishing a relatively cool, reducing flame stratum and the coke a relatively hot oxidizing flame stratum.

2. The process of applying heat in a reverberatory furnace which consists in burning fresh coal in the fire-box of such a furnace by a draft current containing stack gases and the minimum amount of air required to support free combustion in said coal, burning a portion of coke in the same fire-box with an excess of air, passing the flames arising from the coal and coke into the reverberatory chamber as distinct strata, and there completing their combustion.

3. The process of applying heat in a reverberatory furnace which consists in passing into the heating chamber of such a furnace a compound stratified flame current comprising a stratum of relatively cool tardily burning flame of reducing characteristics and containing admixed stack waste gases and also comprising another stratum of relatively hot flame containing an excess of oxygen, and completing the combustion of the stratified flame in said chamber.

4. The process of applying heat in a reverberatory furnace which consists in passing into the heating chamber of such a furnace a compound stratified flame current comprising a relatively hot oxidizing flame stratum flowing next a wall exposed to atmospheric cooling and another relatively cooler reducing flame stratum separated from such wall by the oxidizing stratum, and mixing and completing the combustion of such strata prior to emergence from the heating chamber.

5. The process of applying heat in a reverberatory furnace which consists in supplying to the heating chamber of such a furnace a compound stratified flame current comprising a voluminous tardily burning flame arising from fresh coal burned at a low temperature by a draft current containing a diluting gas and also comprising a flame from carbon burned with an excess of air and causing said strata to mingle after traveling a predetermined distance in such chamber and completing their combustion.

6. The process of applying heat in a reverberatory furnace which consists in producing in the heating chamber of such a furnace a flaming stratum containing an excess of free oxygen and a flaming stratum containing an excess of combustible and causing said strata to mingle after traveling a predetermined distance therein as distinct strata.

7. The process of applying heat in a reverberatory furnace which consists in supplying to the heating chamber thereof a voluminous tardily burning flame stratum of reducing nature and a hotter oxidizing flame stratum in cooperative relation thereto.

8. The process of applying heat in a reverberatory furnace which consists in supplying to the heating chamber thereof a voluminous tardily burning flame stratum of reducing nature and a hotter oxidizing flame stratum in cooperative relation thereto and causing said strata to mingle after traveling a predetermined distance therein as distinct strata.

9. The process of heating metal articles in a reverberatory furnace which consists in maintaining in the heating chamber of said furnace an underlying current of flaming but reducing gases in a state of retarded combustion and an overlying current of intensely hot, oxygen-rich gases.

10. The process of applying heat in a reverberatory furnace which consists in supplying to the heating chamber thereof a voluminous tardily burning flame stratum produced by the action upon fresh cool-burning coal of a draft current of air diluted with neutral gas and a hotter flame stratum by a draft current of normal composition.

11. The process of applying heat in a reverberatory furnace which consists in supplying to the heating chamber thereof a voluminous tardily burning flame stratum produced by the action upon fresh cool-burning coal of a draft current of air diluted with neutral gas and a hotter flame stratum by a draft current of normal composition and causing said strata to mingle after traveling a predetermined distance therein.

12. The process of burning bituminous coal and heating furnaces thereby which consists in maintaining fresh supplies of said coal in the fire-box of such a furnace at an efficient gasifying temperature by a draft current of admixed air and products of combustion, after coking is completed supplying a separate draft current of air, and simultaneously passing the gaseous products of the two reactions in stratified relationship into the heating chamber of a furnace.

13. The process of heating reverberatory and other furnaces which consists in burning bituminous coal in the fire-box of such a furnace by an accelerated diluted air draft while such coal is in the coking stage, by a separate purer air draft after the coking stage is completed, and simultaneously passing the gaseous products of both combustions into the heating chamber in stratified relationship.

14. The process of heating reverberatory and other furnaces which consists in burning bituminous coal in the fire box of such a furnace by an accelerated diluted air draft while such coal is in the coking stage, by an air draft after the coking stage is completed, and simultaneously passing the gaseous products of both combustions into the heating chamber in stratified relationship.

15. The process of applying heat in a reverberatory furnace which consists in producing within the heating chamber of such a furnace parallel flame strata, one such stratum being rich in fuel gases and another of an oxidizing nature, causing such strata to travel through the chamber a predetermined distance as distinct strata, and finally commingling such strata at a predetermined point by a transverse gaseous jet.

16. The process of applying heat in reverberatory furnaces which consists in producing within a hearth-chamber of such a furnace a tardily-burning voluminous flaming under-stratum rich in combustible, and a flaming upper-stratum of an oxidizing character, and commingling said strata at a predetermined point in operative relation to the materials on the hearth by a transverse gaseous jet directed downwardly upon said materials.

17. The art of direct-heating of materials subject to injury by oxidation, which consists in producing a neutral or reducing flame-stratum adjacent to said materials, and an oxidizing flame-stratum more remote therefrom, and commingling said strata after a definite period of travel adjacent said materials.

18. The method of regulating the intensity of furnace-combustion which consists in producing flame-strata of different compositions, and varying the composition of one or more of said strata in accordance with the heat desired.

19. The method of regulating the intensity of furnace-combustion which consists in producing distinct flame-strata of different compositions, one of which is inflated

by a neutral gas, and varying the proportion of said neutral gas relatively to the free oxygen of the draft current producing the inflated stratum according to thermal needs.

20. The method of regulating the intensity of furnace-combustion which consists in producing distinct flame-strata of different compositions, one of which is inflated by a draft-current of neutral gas supplied to the fuel, and varying the relative velocities of the draft-currents supplying the different flame-strata according to thermal needs.

21. The process of conducting combustion in the heating chamber of a reverberatory furnace which consists in subjecting a portion of a mass of ignited fresh fuel to a draft of oxygen-impoverished air of predetermined composition and in simultaneously subjecting a second and adjacent coked portion of said mass of fuel to a draft of atmospheric air, and causing the two draft-currents, augmented in volume by carbonaceous gases, to mingle gradually at a distance from the initial seat of combustion.

22. The process of conducting combustion in the heating chamber of a reverberatory furnace which consists in subjecting a portion of a mass of ignited fuel to an artificially-accelerated draft of oxygen-impoverished air of predetermined composition, simultaneously subjecting a second and adjacent portion of said mass of fuel to an artificially-accelerated draft of atmospheric air, and causing these two draft currents, augmented in volume by carbonaceous gases, to mingle at a predetermined distance from the initial seat of combustion.

23. The process of conducting combustion in a reverberatory furnace consisting in supplying the heating chamber thereof with two or more heterogeneous and distinct flaming gaseous strata, one or more of said strata containing sufficient oxygen to burn the combustible carried in the other, and commingling said strata after traveling a definite distance in the chamber and before leaving the same.

24. The process of combustion consisting in coking fuel over a seat through which is supplied an air-draft containing a predetermined proportion of waste products of combustion, moving the coke onto an adjacent seat, burning the coke thereon by a draft-current supplied through said seat and containing a greater proportion of free oxygen than the aforesaid draft-current, and simultaneously passing the gaseous products of both combustions into the heating chamber in stratified relationship.

25. The process of heating a reverberatory furnace with bituminous coal which consists in coking the coal in the fire-box of said furnace with an accelerated draft of diluted air, burning the resultant coke with a separate air draft passed therethrough, passing a modicum of air over the coke, and leading the resulting gaseous strata into the heating chamber of the furnace in coöperative relation with each other.

In witness whereof I have hereunto set my hand this 10th day of November 1904.

BYRON E. ELDRED.

Witnesses:
JAS. D. NEILL,
M. W. BALOU.