

J. M. SCHUTZ.
PROCESS OF BURNING FUEL.
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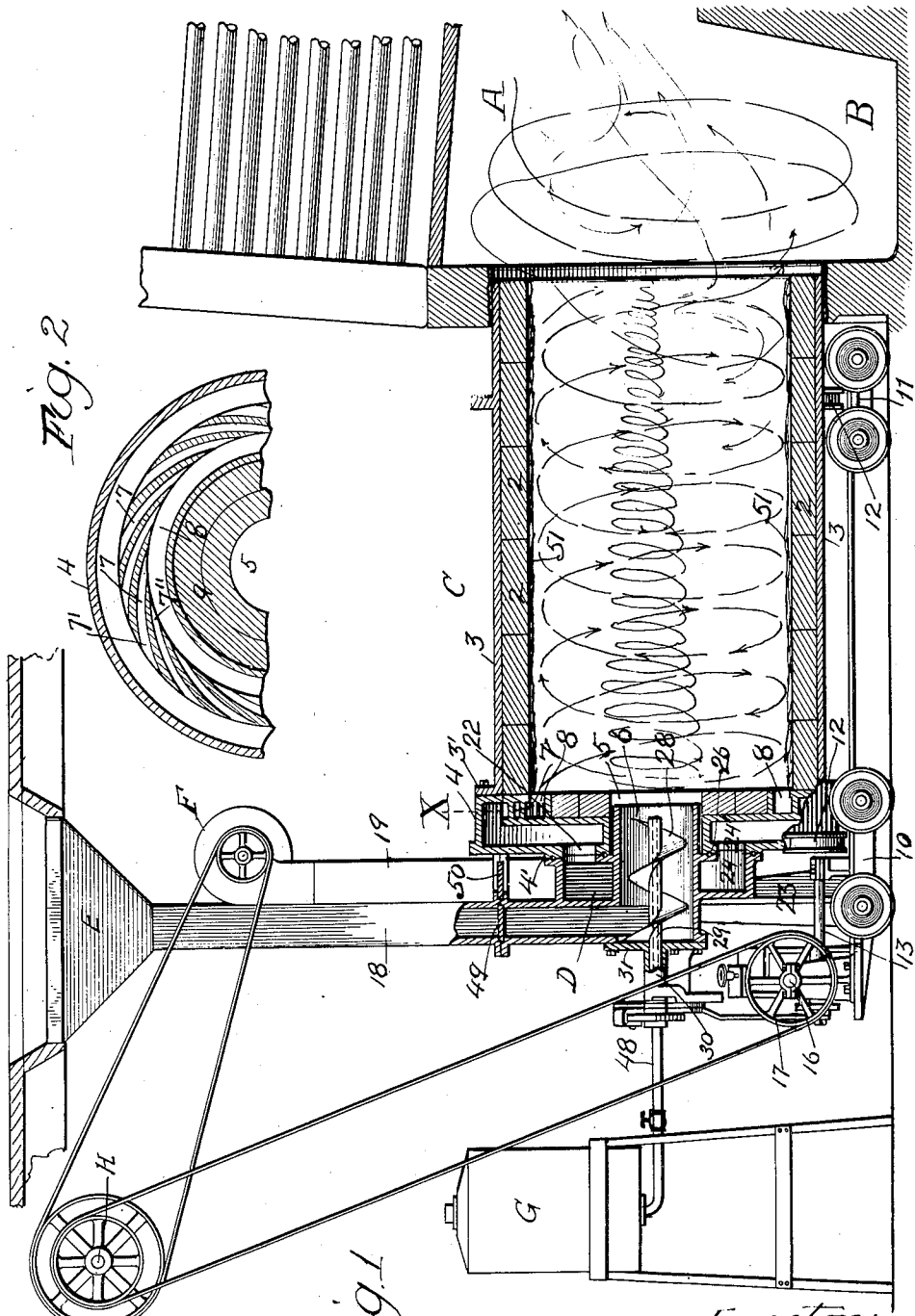


Fig. 2

Fig. 1

Witnesses:
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UNITED STATES PATENT OFFICE.

JOSEPH M. SCHUTZ, OF MINNEAPOLIS, MINNESOTA, ASSIGNOR OF ONE-FOURTH TO CHARLES G. HAWLEY.

PROCESS OF BURNING FUEL.

No. 836,219.

Specification of Letters Patent.

Patented Nov. 20, 1906.

Application filed January 26, 1903. Serial No. 140,560.

To all whom it may concern:

Be it known that I, JOSEPH M. SCHUTZ, of the city of Minneapolis, county of Hennepin, and State of Minnesota, have invented new and useful Improvements in Processes of Burning Fuel, of which the following is a specification.

This invention relates to the production of heat from fuel, and particularly from broken or pulverized fuel.

Hitherto attempts have been made to burn pulverized fuel, in some cases alone and in others auxiliary to the ordinary grate-fire; but in all such cases that have come to my knowledge it has been necessary to dry and reduce the fuel to a uniform impalpable powder, and the cost of thus preparing the fuel has been prohibitive for ordinary use, so that even for experimental efforts success has not been claimed, and but little progress has been made in the reduction of the art to commercial requirements and uses.

The object of my invention is to make use of all fuel products that may be reduced to a comparatively fine condition, but not necessarily pulverulent, and to consume the fuel with such degree of perfection as to extract a maximum of heat therefrom and also avoid the loss of combustible gases and the escape of smoke.

My invention consists in the improved process of burning fuel, as hereinafter generally and specifically set forth, whereby a maximum of heat may be obtained from solid or fluid fuel in a broken or divided state, its necessary condition being governed by the size of the apparatus employed and the velocity of the air-current used in carrying out my process.

The invention will be more readily understood by reference to the accompanying drawings, forming a part of this specification, and in which—

Figure 1 is a sectional and diagrammatic view of the apparatus that I prefer to employ for the carrying out of my process. Fig. 2 is a sectional detail of the twyer-head of the fuel-burner on the line X of Fig. 1.

I do not in this application make claim for the novel construction of the apparatus shown and hereinafter described, for the reason that the same constitutes the subject-matter of a companion application executed of even date herewith—to wit, Serial No.

104,561, filed January 26, 1903. Moreover, my improved process is not necessarily confined in its practice to the use of any specific form or construction of apparatus beyond the general devices and features required for performing the several steps of the process.

The term "fuel" as employed in this specification is intended to embrace not only coal of the better qualities, but also the poorer kinds of bituminous coal, such as lignite, and the waste or fine parts of all coals, known as "screenings." The term also includes gases, oils, wood-shavings, and sawdust, combustible mixtures, and garbage products in suitable condition for combustion—in other words, any fuel substance or compound that is capable of being shattered, crushed, pulverized, or separated into particles small enough for easy conveyance or which is already in such condition.

The term "pulverized" as used herein is intended to describe or define that broken state of the fuel, whatever the kind, that will admit of carrying, distributing, or feeding of the fuel by an air or gas blast of a velocity suited to the requirements of the given furnace plant or by conveyers, elevators, and the like, as distinguished from large lump-fuel.

As will be made evident hereinafter, it is unnecessary and even objectionable to reduce the fuel to substantial impalpability, for the reason that in my device combustion is induced not spontaneously, but rather by a series of steps or stages, causing, first, the rapid decomposition of the fuel; second, the ignition of the resulting gases, and, third, a thorough admixture of the burning gases with sufficient air to produce complete or perfect combustion.

My process may be broadly defined as comprising the following steps, to wit: forcibly forming a rapidly-moving and rotating column of air and adding fuel thereto, confining the column and fuel particles to spiral paths, thereby causing the projection of the fuel particles and gases away from the axis of the column, and applying heat to the products during the transit of said spiral path, thereby causing decomposition of the fuel and combustion.

A further step of the process consists in creating a vortex within the whirling body or column aforesaid, and thereby preventing

the escape of unconsumed products from said spiral path until the same are heated to the point of combustion, and, further, the process consists in supplying air or gas to burning gases through the medium of said vortex.

A further step consists in rotating the medium for continuously storing the heat and in which the gases are momentarily confined, as above described.

The process also includes other and intermediate or auxiliary steps, all of which will be better understood from the description of the apparatus shown in the drawings above referred to.

In said drawings I have shown a burner constructed in accordance with the requirements of my process and as applied to a boiler-furnace, whereof A is the combustion-chamber, and B the ash-pit, which latter is provided with a suitable ash-discharge. (Not shown.)

C is the rotary burner, whereof D is the feeding-head.

E is the coal or other solid-fuel hopper.

F is the air-blast machine, of any suitable kind.

G is an oil tank or reservoir, and H is the source of power.

The burner, as shown in the drawings, is annular or cylindrical or substantially cylindrical in shape. The walls are fireproof or of refractory material, as the same must retain and withstand intense heat. By "refractory material" I mean any material which is inherently sufficiently difficult of fusion to withstand high temperatures or which is rendered difficult of fusion by any of the well-known means, as by a circulating cooling fluid. The end of the burner is open, and from the open end the superheated and burning gases are expelled by the incoming air. The "fuel-laden air," as it may be termed, after the admixture is made in the burner is forcibly blown into the burner in such a way that the air and fuel particles are thrown outward against the burner-walls and move and burn in spiral paths thereupon. The burner interior is intensely hot, and the fuel being held closely upon the same is quickly decomposed, always before reaching the end of the burner, and the gas and vapor mixing with the air in the burner causes a vortex or a rarefaction at the center, which draws back any smoke or unconsumed products that are crowded away from the hot walls by gaseous expansion, and as a result the flame that emerges from the burner is smokeless. Except in the initial heating of the burner-walls and aside from unavoidable radiation from the furnace-chamber in which the burner is located no heat is lost.

Obviously the burner may be double—that is, open at both ends, with a middle inlet or inlets for air and the fuel products; but

for most uses, whether arranged vertically or horizontally, the burner will be made with a closed end, as shown in the drawings.

When the burner occupies a horizontal position, I prefer the construction shown in the drawings, wherein an annulus 2, of refractory material, closed at one end and open at the other, constitutes the burner proper. This annulus 2 is preferably incased by a metal cylinder 3 and may be a true cylinder or may be "choked" or flared at its discharge end, according to the nature of the combustible to be consumed or of the particular duty for which the burner is designed. I have illustrated the annulus as made up of blocks or bricks, and in practice I prefer to employ ordinary fire-bricks, my experiments having proven the same to be enduring. The end of the annulus is closed by the hollow head 4, wherein the air is preheated and which is provided with a central opening 5 to receive the end of the fuel-feeding tube or sleeve 6. The head 4 is attached to the flange 3' of the casing 3 and with said casing may be covered with any suitable material to prevent the radiation of the heat from the burner. Within the head and near its periphery I provide a large number of spiral or tangential air ducts or inlets 7, that lead into the annulus. These ducts or inlets 7 are preferably larger at their intake ends 7' than at their discharge ends 7'' and have the effect of compressing the preheated air which is forced through them, thereby increasing its velocity as it enters the annular space 8 in the inner face of the head 4. This inner face constitutes the closed end of the annulus, and the metal head is protected by the fire-brick lining 9, that is set in the recess of the head. The lining, like the head, is provided with a central opening to admit the fuel-tube. The burner is preferably mounted upon two trucks 10 11, each of which is provided with carrying-pulleys 12, preferably grooved, as shown in Fig. 1, and upon which the annular or cylindrical burner may be rotated by the expenditure of very little power. The burner is rotated at a slow speed through the medium of one of the carrying-pulleys 12, which is arranged upon a shaft 13 and by suitable gears connected with the driven shaft 16, from which the fuel-feeder is operated.

17 is the small driving-pulley, operated by a belt and which may be replaced by a small motor mounted upon the rear or outer truck of the burner.

It will be observed that the fuel-tube does not rotate, but is provided in the same casting or head D with the fuel and air tubes or chutes 18 and 19, and which is carried upon the tops of the standards 23 on the truck 10. The fuel-chute or intake-tube communicates directly with the rear end of the fuel-tube 6, while the air-inlet spout or tube 19 communicates with the annular chamber 24, that

surrounds the fuel-tube 6. The feeding-head D is machined off to run against the machined surfaces 4' of the head 4 and is pressed against the same by springs in the standards 23. The inner face of said feeding-head is provided with an annular opening 24, corresponding to the opening 22 in the head 4, whereby the air that is forced through the tube 19 may freely enter the head 4 at all times, although said head 4 is in rotation with the annulus or burner proper. The bearing-faces between the feeding-head D and the head 4 are provided with annular grooves 26, into which I force a heavy lubricant to lubricate the joint and also pack the same to prevent the escape of air at the joint. The fuel instead of being introduced with the air, as in my earlier experiments, is simply pushed through the opening at the center of the closed end of the burner and, falling into the bottom thereof, is picked up by the whirling air and spread upon the inner walls of the burner, to which the fuel adheres until coked.

Various devices may be employed for projecting or feeding the fuel into the burner; but I prefer the short screw or conveyer 28, arranged on the shaft 29, that has a bearing 30 on the detachable plate 31. The shaft and the screw are rotated from the driving-shaft 16. A direct connection may be made between the two shafts, but as this would necessitate and result in a practically fixed speed for the feed-screw or conveyer 28 I prefer to use the speed-regulating connection that is indicated in the drawings.

48 represents a valved oil-pipe from the tank G and communicating with the shaft 29, which, being hollow, serves as a convenient means of introducing oil to the interior of the burner. Suitable valves or slides 49 and 50 are provided in the fuel and air chutes, respectively, for controlling the supply of fuel and air to the burner. The interior of the burner is lined or faced with a glaze or film composed of a metalloid or a composition of metalloids the fusing-point or temperature of which is very high, approximating 3,000° Fahrenheit and resisting volatilization until a much higher temperature is reached. This is derived from the fuel and is composed of high-proof metalloids, such as sulfate of iron, present in most fuels. These, being fused by the intense heat in the burner, accumulate and spread upon the walls, constituting a glazing of slag when the burner is in operation and which is constantly added to from the decomposing fuel in combustion. The percentage of high-proof metalloids present in coal of various kinds is so high that the lining or film is not only maintained at all times, but considerable quantities are thrown off from the burner as slag, comprising the metalloids and the ash. Because of this high-proof glazing or film I am able to employ and easily maintain the annulus of ordinary re-

fractory fire clay or brick which otherwise would quickly melt down in the presence of the great heat created by the forced concentrated combustion that takes place within the burner. In burning oils which contain small percentages of metallic impurities I find it desirable to introduce small quantities of sulfate of iron and the like, which being quickly fused spread upon and protect the walls of the burner.

While my invention is not confined to a burner of the detailed construction herein shown and described or to a burner of any certain size or proportion of parts, a statement of typical facts and dimensions will facilitate the understanding of the principles embodied in and the operation of the burner. Thus the burner illustrated may be described as being six feet in internal length, three feet in internal diameter, rotated from three to five times per minute, supplied with air in ample volumes and traveling with a velocity of from eight to fifteen thousand feet a minute, and supplied with fuel in proper proportion to the supply of air, or vice versa. The capacity of the burner for producing heat is dependent upon the limitation imposed by the ability of the annulus to withstand fusion and within such limits is dependent upon the supply of fuel and the velocity of the properly-proportioned quantity of preheated air that is driven into the burner for the combustion of the fuel rather than upon the dimensions of the burner. Assuming that the pressure of air was such as to yield a velocity of eight thousand feet per minute circularly or spirally upon the walls of the burner, a burner of the foregoing dimensions would consume about one ton of broken coal per hour.

The operation in detail is as follows: The open end or mouth of the burner is moved up to and thrust into a suitable opening in the fire-box or combustion-chamber to be heated. The plate 30, with the conveyer or feed-screw, is then removed from the feeding-head and a supply of shavings and kindling is thrown into the burner. This is ignited, and then the air-blast is turned into the head and there preheated, after which the air entering the burner through the tangential twyers whirls with great velocity upon the walls of the burner. Centrifugal force operates to confine the air upon said walls. The whirling blast within the burner causes the kindling to burn furiously, and the burner is quickly brought to a temperature that will admit of the introduction of more difficultly-combustible fuel. The feed-screw or conveyer is then replaced in the feed-tube, and the crushed coal or other fuel is let down into said tube. Thereupon the belt is placed upon the driving-pulley 17, and the burner is set into rotation, likewise the feed-screw or conveyer. Thus the fuel begins to be automatic-

ally fed into the hot burner and falling to the bottom of the burner is instantly caught up by the strong whirling blast of air and is thrown forcibly against the hot walls and spread thereon. The velocity of the whirling currents is such that it will cause even large particles of coal to rotate within the walls of the annulus, the same taking a spiral path toward the open end thereof. This spiral, marked by the progress of an incombustible particle, has a great number of convolutions within the burner and before it emerges from the end thereof, the same being due to the fact that the centrifugal force that is developed by the whirling air exceeds the crowding force of the incoming air, which would produce longitudinal movement of the particles within the burner. From the beginning the finely-divided portion of the fuel will be burned in the burner, and the heat generated thereby and by the original kindling under the forced draft or blast quickly raises the refractory walls of the burner to a high temperature, every unit of heat stored therein adding intensity to the combustion within the burner, and vice versa, until the walls of the burner become incandescent and the heat thereof so great that the particles of fuel striking and traveling thereon or even closely approaching the said hot walls in the whirling air-current will be almost instantly decomposed, the gases thereof being added to the elements of the air, which latter has, obviously, been superheated by contact with the hot walls. Ignition takes place almost simultaneously with decomposition, and the gases in combustion form a whirling flame that emerges from the burner at white heat. The burning of a gas-flame within the burner would not be sufficient under ordinary conditions to maintain the walls thereof at incandescence; but by whirling the body of air, gas, and fuel centrifugal force is developed to hold the combustible products in close contact with the walls of the burner which receive the initial and greatest heat of combustion of the particles of fuel thereon, the heat being thus constantly imparted to the burner-walls and by them to the fresh products entering the burner. The walls of the burner are of comparatively small area and little heat is lost therein. The annular form of the burner and the spiral path of the fuel particles therein insure sufficiently long contact between the fuel and the walls to produce decomposition and ignition. The whirling of the fuel mixture upon the walls of the burner and the flame therefrom tends to cause a vacuum and vortex at the center of the cylinder, and this draws back any unconsumed products of combustion that escape into the fire-chamber of the furnace or which are forced toward the center of the burner by expansion of the gases within the same. The result is complete combustion save for a

minute quantity of the fine ashes and the metalloids referred to. Smoke is not thrown off by the furnace except during the first two or three minutes of the starting of the fire. The intensity of the flame of the burner is regulated by the supply of pulverized or broken fuel and by the velocity of the air-blast, and the degree of heat that is attainable is very high. It is preferred that the burner shall project into a furnace-space or combustion-chamber that is larger than the burner, whereby the velocity of the burning gases is reduced after leaving the burner and the pressure thereof also reduced, the effect being to retain the heat in the combustion-chamber for a longer time and to perceptibly increase the vacuum or vortex or return current in the burner. As before explained, if the burner has not previously been lined with high-proof metalloids or slag it will quickly become coated therewith from the fused fuel products. The rotation of the burner may be increased to such an extent as to develop centrifugal force within the burner to retain the fuel particles and the air upon the walls thereof; but I prefer to operate the same at a slow speed, and thereby consume little power. The slow rotation of the burner prevents the collection or massing of any considerable quantity of slag in the bottom of the burner, which collection would tend to deflect the fuel particles from their rotary paths and to cause them to fly through the burner unconsumed. In addition to this advantage gained by the rotation of the burner it has another function—namely, that of constantly bringing the necessarily hotter top of the burner-annulus down to the freshly-admitted fuel, markedly increasing the rapidity of the fuel decomposition, the fuel particles adhering to the hot brick until completely coked. Air is obviously drawn from the combustion-chamber by the vortex. When oil is introduced to the burner at either end thereof, it is drawn to the closed end by the vortex and is projected to the hot walls of the burner, being there burned with great rapidity.

It is obvious that solid and fluid fuel may be used simultaneously in my burner. The feed-screw operates at any desired speed within the capacity of the burner, and the feed-tube 6 is kept full of the pulverized or broken fuel, always presenting a wall of fuel at the end of the burner. The wall of fuel thus exposed to the heat of the burner and which protects the feed-screw insures the drying of the fuel practically before it reaches the hot walls of the burner. I am better able, therefore, to burn fuel that contains a large percentage of water and wholly avoid the common necessity of drying the fuel before feeding it to the burner.

There are many fuel products which at present are practically worthless on account of the matting of the fuel when burned on an

ordinary grate and also because of the presence in many of the fuels of elements, aside from carbon, which are ordinarily incombustible.

5 My process makes it possible to consume many elements and products which under present methods are either deposited in the furnace chamber or flues or go into the ashes. In the actual operation of this burner the
10 quantity of ashes is so small that for all practical purposes the combustion may be termed complete and perfect, every possible unit of heat being extracted from the fuel.

With a given area of refractory material
15 the annulus offers the longest path of travel for the fuel particles, and the annular burner is therefore preferred; but satisfactory burners as distinguished from the furnace-chamber in which the same are used may be built
20 in other shapes and positions.

It is obvious that many modifications of my invention and the apparatus illustrated herein will readily suggest themselves to one skilled in the art, and I therefore do not
25 fine my invention to the specific steps or constructions herein shown and described.

Having thus described my invention, I claim as new and desire to secure by Letters Patent—

30 1. The improvement in the art of burning fuel, that consists in forming an annulus of air in rapid rotation and having relatively slow longitudinal movement, confining said annulus during a portion of its travel, feeding
35 fuel by gravity to the interior of said annulus and applying heat to the exterior of said annulus to liberate the gases of the fuel and ignite the same, substantially as described.

40 2. The improvement in the art of burning fuel, that consists in heating air and forming an annulus of heated air by the action of centrifugal force, continuously supplying heated air to said annulus, thereby causing longitudinal
45 movement thereof, confining said annulus during a portion of its longitudinal movement and feeding fuel by gravity to the interior of said annulus within the confining means, substantially as described.

50 3. The improvement in the art of burning fuel, that consists in preheating air and forming therefrom an annulus having longitudinal movement and in rapid rotation, feeding fuel to the interior of said annulus, confining said
55 annulus during a portion of its travel and through the medium of the confining means applying heat to the fuel-laden annulus to liberate and ignite the gases of the fuel, substantially as described.

60 4. The improvement in the art of burning fuel, that consists in preheating air and forming therefrom an annulus having longitudinal movement and in rapid rotation, feeding fuel to the interior of said annulus,
65 confining said annulus during a portion of its

travel and through the medium of the confining means applying heat to the fuel-laden annulus to liberate and ignite the gases of the fuel, and slowly rotating said confining means, as and for the purpose set forth. 70

5. The improvement in the art of burning fuel, that consists in continuously heating and rotating a refractory annulus, creating a whirling and longitudinally-moving column
75 of air therein, feeding fuel to said column within said annulus and therein liberating and igniting the gases of said fuel and discharging the resulting burning gases from said annulus, thereby creating a vortex, substantially as described. 80

6. The herein-described improvement in the art of burning fuel, that consists in continuously heating and rotating a refractory annulus, lining the interior thereof with a
85 protecting agent, creating a whirling and longitudinally-moving column of air in said annulus, permitting the discharge thereof at the end of said annulus, and axially feeding fuel into said annulus, therein admixing the
90 fuel with the air, decomposing the fuel and igniting the gases thereof and creating a vortex in said annulus, substantially as described.

7. The improvement in the art of burning fuel, that consists in creating a whirling and
95 longitudinally-moving annulus of air, confining the same during a portion of its longitudinal travel, creating a return vortex within the same, adding fuel to said annulus while confined, continuously storing heat from and
100 applying heat to said annulus while confined to liberate the gases of the fuel and ignite the same, and rotating the confining means, substantially as and for the purpose specified.

8. The improvement in the art of burning fuel, that consists in creating a hollow cylinder
105 of air, mixing fuel therewith by gravity, igniting the fuel within said cylinder, confining said cylinder, rapidly rotating said cylinder of air and causing it to move longitudinally within the confining means, storing
110 heat from and applying heat to the exterior of said cylinder to continuously liberate and ignite the fuel-gases and rotating said confining means, substantially as described.

9. The herein-described process of burning
115 fuel, that consists in forcibly creating a rapidly-rotating and longitudinally-moving column of preheated air, thereafter supplying fuel to the interior of said column and mixing the fuel with the air, meantime confining
120 said column during a portion of its longitudinal movement, rotating the confining means and through the medium thereof continuously storing heat from and applying heat to the confined mixture of air and fuel and thus
125 liberating and igniting the fuel-gases during the rotation of said column within said confining means, substantially as described.

10. The improvement in the art of burning fuel, that consists in creating a rotating and
130

longitudinally-moving annulus of air, supplying fuel to the interior of said annulus and by gravity and centrifugal force adding and admixing the fuel with the air of said annulus, confining the annulus and applying heat thereto throughout a given area, thereby decomposing the fuel, igniting and burning the gases and creating and maintaining within said annulus a vortex that prevents the escape of combustible products, substantially as described.

11. The improvement in the art of burning fuel, that consists in forcibly creating a spirally-progressing annulus of air, thereafter interiorly admixing fuel with the air of said annulus, applying heat to a given area thereof, thereby igniting and burning the fuel products, the resulting flame being delivered from the area of heat application, and a vortex being created with said annulus, substantially as described.

12. The improvement in the art of burning fuel, that consists in forming by centrifugal force a substantial annulus of air mixed with fuel and rarefied at its axis, continuously supplying air and fuel at one end of said annulus and thereby imparting longitudinal movement to the annulus, confining said annulus against peripheral expansion during a portion of its longitudinal travel, afterward permitting the expansion thereof, meantime igniting the combustible constituents of the

annulus, causing the same to burn while confined and rotating the confining means to advance the freshly-supplied fuel, substantially as described.

13. The improvement in the art of producing heat from fuel that consists in establishing a high temperature in a heat-retaining annulus, rotating said annulus, forcing air tangentially into said annulus, thereby establishing centrifugal action and a vortex within said annulus, feeding fuel into said annulus, causing the combustibles to ignite and burn within said annulus and maintain the heat thereof for the purpose of continuously decomposing the supplied fuel, substantially as described.

14. The improvement in the art of producing heat from fuel, that consists in heating a refractory annulus, then creating a whirling column of air therein and causing it to move through said annulus, then adding fuel to the column of air, igniting the gases within said annulus, and rotating said annulus to continuously present its hottest portions to the incoming fuel.

In witness whereof I have hereunto set my hand, this 12th day of January, 1903, at Chicago, Cook county, Illinois.

JOSEPH M. SCHUTZ.

In presence of—

E. G. VREELAND,
C. G. HAWLEY.