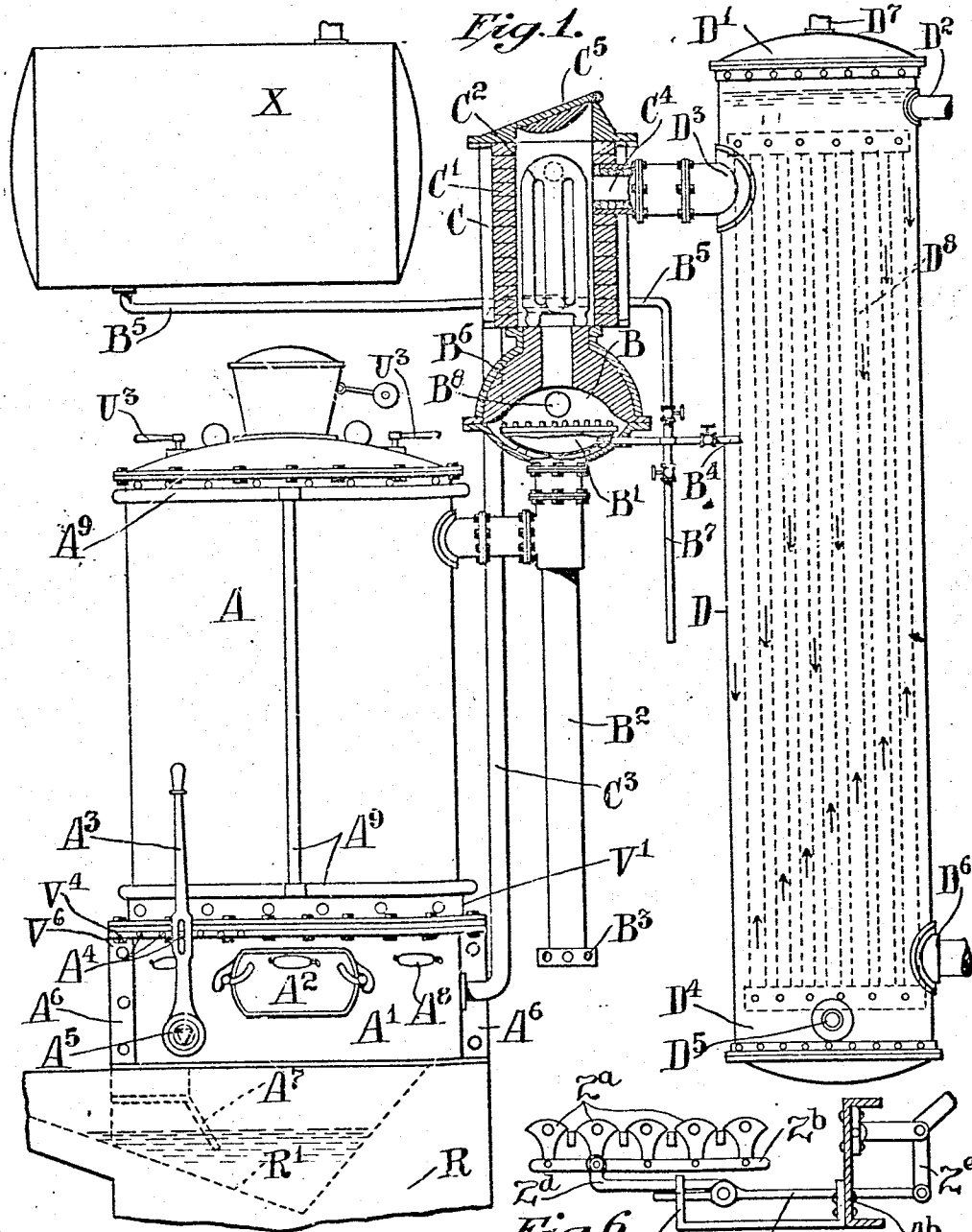
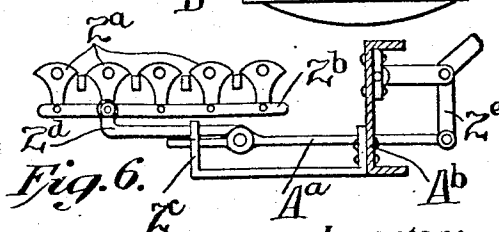


J. M. W. KITCHEN.  
PRODUCER GAS APPARATUS.  
APPLICATION FILED MAR. 8, 1909.

1,008,274.

Patented Nov. 7, 1911.

4 SHEETS-SHEET 1.



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4 SHEETS-SHEET 2.

Fig. 2.

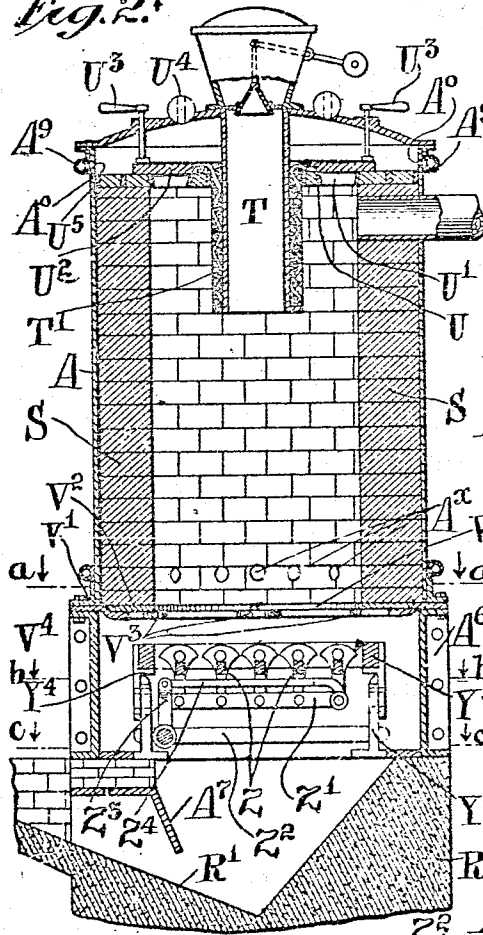


Fig. 2^a

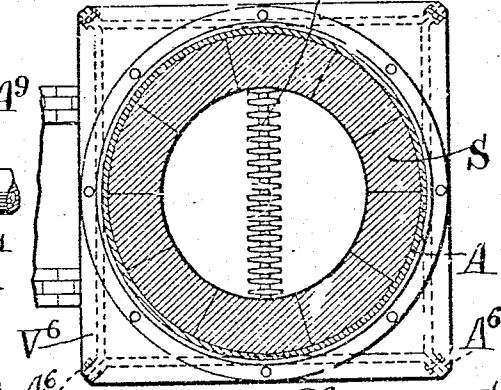


Fig. 2^c

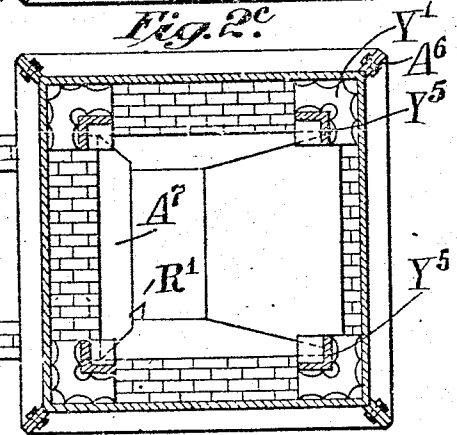


Fig. 2^b

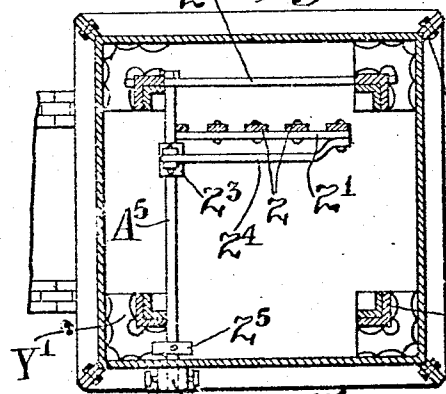
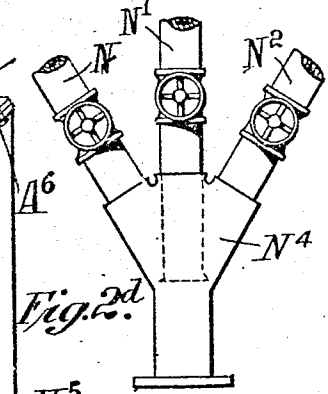


Fig. 2^d

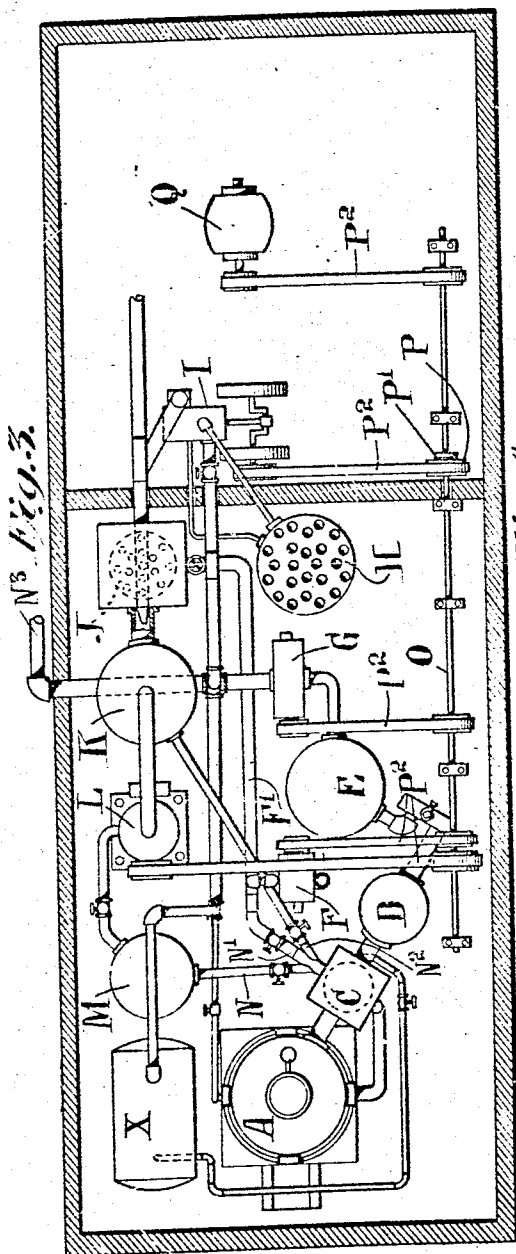
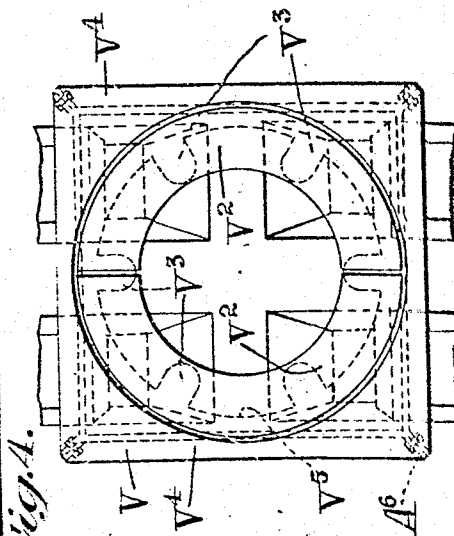
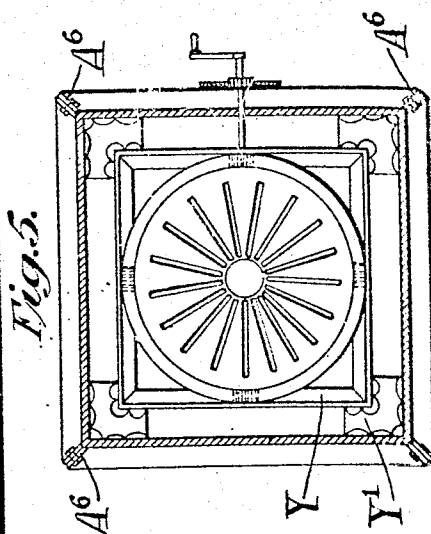
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APPLICATION FILED MAR. 8, 1909.

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4 SHEETS-SHEET 3.

1,008,274.



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1,008,274.

Fig. 8.

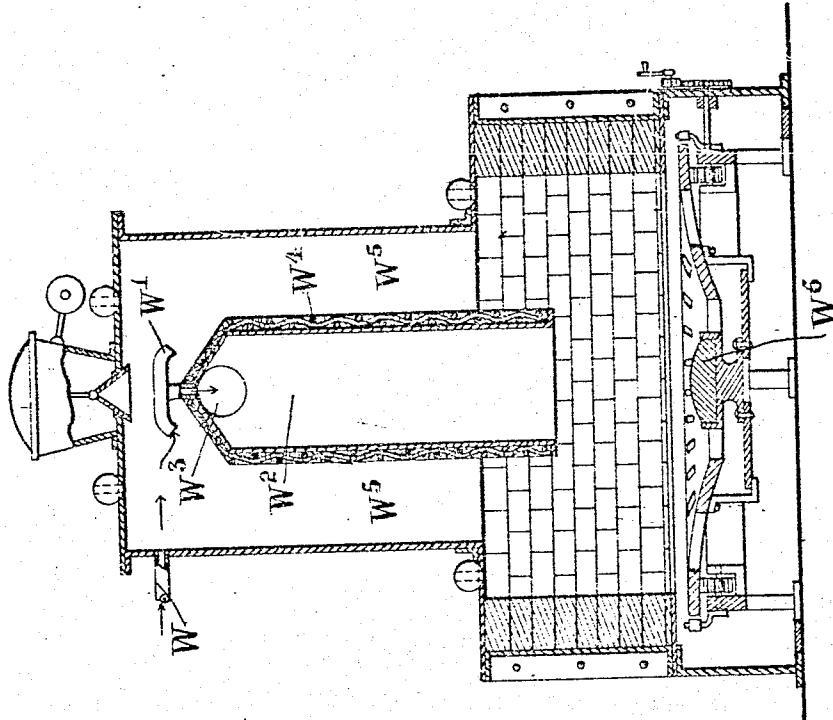
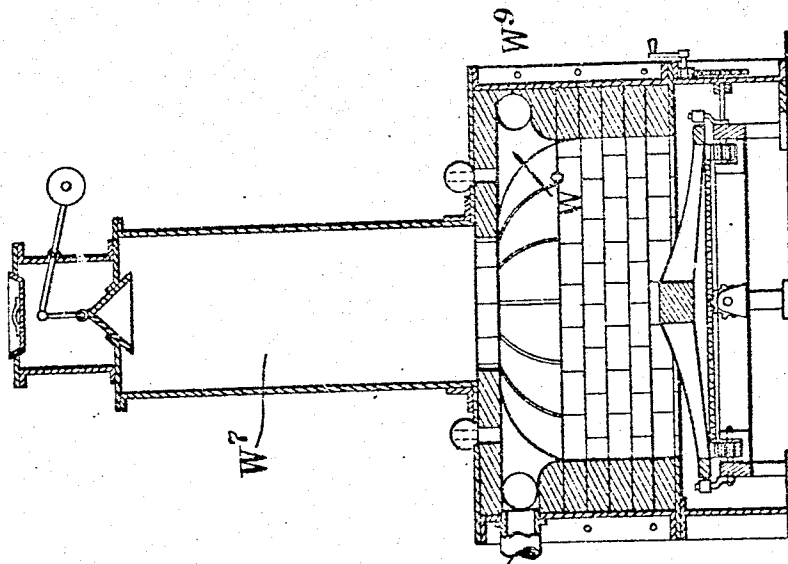


Fig. 7.



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# UNITED STATES PATENT OFFICE.

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

## PRODUCER-GAS APPARATUS.

1,008,274.

Specification of Letters Patent.

Patented Nov. 7, 1911.

Application filed March 8, 1909. Serial No. 452,127.

*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 new and useful Improvements in Producer-Gas Apparatus, of which the following is a specification.

The object of the invention is to facilitate in a convenient manner the making of producer gas from fuels of the lowest cost, and of various physical textures; to make at will, gas of different qualities as needed for special use either in power generation, lighting or heating; and to provide for securing uniformity in the quality of the gas produced and accuracy as to the quantity of the gas generated.

Differences in the structural details of a producer gas generating apparatus are necessary to meet varying requirements in handling fuels of different qualities. With such wide differences as exist in the nature of North American fuels, very considerable variation in the structure of the gas generating apparatus using the various quantities of fuel is necessary in order to secure the best results. Especially is this so in connection with the grate or ash-table on which the fuel rests in the gas producer, and in connection with preparing the gas for use in the internal combustion engine by freeing the gas from tarry, gummy constituents. It is also desirable to be able to have convenient access to the various parts of the fuel mass and ash-bed in operating the gas producer in poking the fuel, for maintaining a desirable density in the various parts of the fuel-mass in regulating the combustion process, for removing clinker from the producer, for keeping the ash-bed of uniform thickness, and for the removal of the ashes without disturbing the gas generating process.

The various features of the invention are illustrated in the accompanying drawings, in which:

Figure 1 is an elevational view of a gas producer, a tar destructor, a primary heat-interchanger, (the last two being in vertical section), a gas cooler, and a gas tank; all of which are comprised in the invention. Fig. 2 represents the gas producer in ver-

tical section. Fig. 2<sup>a</sup> represents in horizontal section the gas producer taken on the line *a—*a**, Fig. 2. Fig. 2<sup>b</sup> is a horizontal section of the gas producer taken on the line *b—*b**, Fig. 2, parts being omitted that are shown in Fig. 2. Fig. 2 represents a horizontal section of the gas producer taken on the line *c—*c**, Fig. 2. Fig. 2<sup>d</sup> represents a three-way air, steam and gas mixer used in the invention. Fig. 3 represents a plan view of an installation comprising the invention, the view being taken from a high level looking downward. Fig. 4 represents a plan view of the top plate of the base of the producer; and also indicates a multiform ash pit arrangement of the producer's sub-base. Fig. 5 represents a plan view of a grate-frame used in the base of my producer; but containing a round grate. Fig. 6 represents a modification of a grate shaking device used in my invention. Fig. 7 represents the gas producer as arranged for using bituminous fuel. Fig. 8 shows a modification of the arrangement shown in Fig. 7.

The reference characters represent as follows:

- A<sup>1</sup> and A<sup>2</sup> are gas inlets.
- A represents the gas producer, which may be of any convenient form, though a preferred form is cylindrical for the fuel-container, and rectangular for the base.
- A<sup>1</sup> represents the base.
- A<sup>2</sup> is a door to the base for the removal of clinker and for inspection purposes.
- A<sup>3</sup> is a grate shaker handle.
- A<sup>4</sup> is a device for retaining the grate bars in any desired position for passing air between the grate bars.
- A<sup>5</sup> is the actuating shaft of the grate shaking device.
- A<sup>6</sup> are corner flanges for bolting together the side walls of the base.
- A<sup>7</sup> is a metallic drop-plate for securing a water seal.
- A<sup>8</sup> are holes for observing the combustion process and poking the ash-bed.
- A<sup>9</sup> is a gas conduit for introducing cooled producer gas.
- B is a device for highly heating newly generated gas, and transforming tarry vapors into fixed gas.
- B<sup>1</sup> is a gas burner.
- B<sup>2</sup> is a check draft and air diluter to

- check the draft through the producer when desired, and for keeping the burner B<sup>1</sup> cool.
- B<sup>3</sup> is an air inlet valve.
- B<sup>4</sup> is a compressed gas conduit.
- 5 B<sup>5</sup> is a gas conduit from the tank X.
- B<sup>6</sup> is a heat refractory lining.
- B<sup>7</sup> is an air conduit.
- B<sup>8</sup> is a gas lighting aperture.
- C is a primary heat interchanger for heating air, steam and exhaust gaseous products of combustion.
- 10 C<sup>1</sup> is a non-conducting lining.
- C<sup>2</sup> (Fig. 1) is a cast iron heat-interchanging device.
- 15 C<sup>3</sup> (Fig. 1) is a conduit for conducting pre-heated air, superheated steam, and gaseous products of combustion into the base of the gas producer.
- C<sup>4</sup> is an outlet for partially cooled producer gas.
- 20 C<sup>5</sup> is an explosion relief lid.
- D is a gas-cooler and steam generator.
- D<sup>1</sup> is a steam dome.
- D<sup>2</sup> is a hot water outlet.
- 25 D<sup>3</sup> is a hot-gas inlet.
- D<sup>4</sup> is a feed water chamber.
- D<sup>5</sup> is a feed water inlet.
- D<sup>6</sup> is a cooled gas outlet.
- D<sup>7</sup> is a steam outlet.
- 30 D<sup>8</sup> are heating tubes.
- E is a scrubber.
- F is an air blower.
- F<sup>1</sup> is a hot-air conduit.
- G is a gas exhauster and compressor.
- 35 H is a water cooler and air heater for cooling jacket-water and heating air.
- I is an internal combustion engine.
- J is a gas burning device for auxiliary heating purposes.
- 40 K is a heat economizing boiler.
- L is a steam engine.
- M is a condenser.
- N is an exhaust steam conduit.
- N<sup>1</sup> is a compressed air duct.
- 45 N<sup>2</sup> is a duct for gaseous products of combustion.
- N<sup>3</sup> is a gas main.
- N<sup>4</sup> is a three-way mixing device for compressed air, steam or exhaust gases.
- 50 O is a shaft.
- P is a drive-pulley.
- P<sup>1</sup> is a friction clutch.
- P<sup>2</sup> are belts.
- Q is a dynamo.
- 55 R is the sub-base of the producer.
- R<sup>1</sup> is a shoveling surface for the removal of ashes.
- S is a fire-brick lining.
- T is a fuel feeding cylinder.
- 60 T<sup>1</sup> is a non-conducting casement for the fuel feeding cylinder.
- U is a non-conducting plaque.
- U<sup>1</sup> are poke hole openings in the plaque U.
- U<sup>2</sup> are revolving slides for covering the openings U<sup>1</sup>.
- U<sup>3</sup> are handles to actuate the slides U<sup>2</sup>.
- U<sup>4</sup> are poke hole openings.
- U<sup>5</sup> is a metallic frame in the plaque U.
- V is the top plate of the producer base.
- V<sup>1</sup> is an annular flange. (Fig. 2.) 70
- V<sup>2</sup> are dead half-rings.
- V<sup>3</sup> are projections on which the half-rings rest.
- V<sup>4</sup> is the bolting surface of top V.
- V<sup>5</sup> is an annular flange. V<sup>6</sup> top flanges 75 to sides. (Fig. 1.)
- W is a gas conduit for cool gas leading into the upper part of the producer. (See Fig. 8.)
- W<sup>1</sup> is a cool gas passage to interior of gas exit duct W<sup>2</sup>. W<sup>3</sup> gas duct. W<sup>4</sup> gas exit aperture. W<sup>5</sup> non-conducting incasement to gas duct W<sup>2</sup>. W<sup>6</sup> annular fuel-feeding chamber. W<sup>7</sup> non-conducting plaque. W<sup>8</sup> fuel feeding magazine. W<sup>9</sup> gas exit duct. 80
- W<sup>10</sup> gas traversing duct in the refractory lining of the producer. W<sup>11</sup> gas passages leading to the gas duct W<sup>2</sup>.
- X is a gas storage tank.
- Y is a grate frame. 90
- Y<sup>1</sup> are retaining blocks.
- Y<sup>2</sup> are side plates of grate frame. Y<sup>3</sup> flange support in grate frame. Y<sup>4</sup> legs of grate frame.
- Z is a grate bar shaker arm. Z<sup>1</sup> shaker 95 bar. Z<sup>2</sup> transverse support for actuating shaft.
- Z<sup>3</sup> is a shaft rocker sleeve and arm.
- Z<sup>4</sup> is a link.
- Z<sup>5</sup> is a retaining sleeve. 100
- Z<sup>6</sup> is a rocker sleeve for engagement with the handle A<sup>3</sup>.
- Z<sup>7</sup> is a plan of a grate bar.
- Z<sup>8</sup> are grate bars in elevation.
- Z<sup>9</sup> is a rocker bar. 105
- Z<sup>10</sup> is a base of support for actuating shaft.
- Z<sup>11</sup> is a bell crank shaking device.
- A<sup>1</sup> is an actuating shaft. A<sup>2</sup> is another base of support for the shaft A<sup>1</sup>.
- In further description: 110
- The producer base.*—It is desirable to have the ash-bed of the burning fuel rest on a grate or ash-table, from which the ashes can be frequently dislodged downwardly, in order to keep the ash-bed of a uniform thickness, and the production of gas uniform in quantity and quality. The structure supporting the ash-bed and the superimposed fuel mass should differ in form according to the nature of the fuel that is to be gasified. In order to secure easy access to the base of the producer for the introduction or removal of a grate or ash-table, I construct the base of my producer in removable sections; one or more of the sections being of such size that if the section is removed, the grate or ash-table can be introduced into or removed in its entirety from the base of the producer for inspection, repair or exchange, without dismem- 120 125 130

berment of the grate or ash-table. The shape of the base may be annular; but preferably should be rectangular. In either case the side walls are constructed in sections of sufficient size to allow for the removal of the entire assembled grate or ash-table, which preferably would be held in a grate-frame Y. Inasmuch as the fuel container should preferably be constructed in the form of a cylinder, I construct the top plate V (see Fig. 4) of my base so as to unite it by means of the annular flange V<sup>1</sup> (see Fig. 1) by bolting with the cylindrical shell of the fuel-container of the producer.

The projections V<sup>3</sup> are cast integral with the top of the base, and upon these and on the annular flange V<sup>5</sup> rest the two half dead-rings V<sup>2</sup>, upon which are built the fire-brick lining of the producer.

The perpendicular sides of the producer have flanges V<sup>4</sup>, which are bolted to the top of the base, and corner flanges V<sup>6</sup>, which are bolted together. Asbestos, or other cement, is interposed between the opposing flange surfaces in assembling the sides and top of the square base with the fuel container. The base is so constructed that all the openings therein may be closed, so that if air is forced into the base, a considerable pressure may be maintained in the base and fuel container. By means of the blower F, in conjunction with the exhaustor G, any desirable pressure of air for combustion may be maintained in the producer, and this facilitates the burning of certain hard texture fuels. The producer has means for using fuels of the widest variation in character and for generating fuel gas of very divergent thermic values.

*The sub-base.*—In order that ashes may be conveniently removed, I arrange the sub-base R of the producer, which is made of brick and concrete, with a water seal provided with a dip plate A<sup>7</sup>, which acts as a support for part of the masonry work of the sub-base, as well as for preventing the entrance of air through the water seal. The inner sides of the sub-base slope toward its center, so that ashes will gravitate to the center, and so that only a relatively small amount of water in the water seal will be exposed to evaporation if a gas poor in hydrogen is wished. The shoveling surface R<sup>1</sup> is in one continuous plane so that ashes can be conveniently shoveled from the sub-base. In those cases where I use in the producer a grate divided into sections, the sub-base is divided into as many water seals as there are shaking sections to the grate. (See Fig. 4).

*The grate or ash-table.*—In using some kinds of fuel, it is desirable to have the fuel mass and its underlying ash-bed rest upon a shaking grate. This shaking grate may be square or round. Whatever its shape

may be, it is usually supported and held in place in the base of the producer by being held in a four legged frame V (see Figs. 2 and 3) which can be slid into its place under the fire opening at the bottom of the fuel container, or withdrawn from the base. The frame is held in place by means of corner blocks V<sup>1</sup>, placed between the leg-feet and the side walls of the base. (See Fig. 2<sup>a</sup>). The frame is constructed of the side pieces Y having the flange supports Y<sup>4</sup> (see Fig. 2), and the legs Y<sup>3</sup>. The legs are held in position by bolting to the side pieces and partly support the flanges Y<sup>4</sup>. The grate proper rests in this frame at the top of the flange supports Y<sup>4</sup>, and the grate bars have the usual shaker arms Z, united by the shaker bar Z<sup>1</sup>. Bolted between the two legs of the frame opposite to and farthest from the side of the base through which the actuating shaft A<sup>5</sup> is introduced and supported at the front of the producer, is a transverse bar Z<sup>2</sup> for supporting the other end of the actuating shaft. The actuating shaft is thus held in permanent horizontal position, having a separate base of support at either end. On the actuating shaft is fixed a rocker-device Z<sup>3</sup>, which is connected by a link Z<sup>4</sup> with the shaker-bar Z<sup>1</sup>. Inside the side of the base is bolted a retaining sleeve Z<sup>5</sup>, and outside the base-plate is bolted another sleeve Z<sup>6</sup> (see Fig. 2<sup>b</sup>) having a triangular head for engagement with the lower part of the grate shaking handle A<sup>2</sup>. By means of the two sleeves mentioned the actuating shaft A<sup>5</sup> is held in position, and when the handle A<sup>2</sup> is oscillated the actuating shaft is partly revolved and the motion is conveyed to the grate bars Z<sup>1</sup> of the grate.

In Fig. 3 I show a modified form of my grate shaking device, involving an application of the principle of having two points of support for the actuating shaft and maintaining the shaft in a continuous horizontal position, and thus preventing the entrance of undue amounts of air through the apertures in the base of the producer through which the actuating shaft is introduced. In the case of the modification shown, the grate bars would have to be placed with their axes parallel with the front of the producer base; but in the first described device the axes of the grate bars can be placed at right angles to the front of the producer base, and thus allow for greater facility in dislodging clinker that may collect on the grate, by means of a poker or slicer introduced between the grate bars and through the opening covered by the door A<sup>2</sup>. A square form of grate has the advantage of a lessened first cost, a greater durability of the grate bars, and avoids confusion when ordering renewals, by having the grate bars all of one shape and size. Furthermore, by having a square grate, the grate surface of

a large producer can be constructed in sections, in which case each section would be placed over an individual sub-base pit such as is shown in Fig. 4 and each section can be shaken separately by hand without requiring undue manual force. For the removal of any clinker that may accumulate on the corners of the square grate, special poke holes  $A^5$  are provided on the sides of the base, near the corners of the base immediately above the level of the grate surface. The grate bars  $Z^a$  are formed with cutting edges which cut and comminute clinkers that may be formed in the producer; the action of the grate when the bars are rocked being to grind the clinkers and pass the ground material downward through the grate.

*The fuel container.*—The fuel-container is preferably made of cylindrical shape; but under special conditions, especially where very hard fuel is used, it may be made of rectangular form. In small sized producers, the fuel is usually fed from the top through one feeding device in the center of the producer; but in large generators a number of feeding devices may be used in securing a better distribution of the fuel. In other cases the fuel is fed from an annular magazine. The fuel feeding conduit is preferably carried to a depth in the fuel-container that will prevent too much fuel being fed onto the fuel bed, the depth of fuel that is desirable being determinable by the nature of the fuel. The fuel feeding conduit  $T$ , (see Fig. 2) when fusing fuel is used is protected by an annular non-conducting incasement  $T^1$  composed of heat refractory material in which is embedded a woven wire web to hold the refractory material together in case of cracking of the incasement. In some cases I water-jacket the fuel feeding conduit. To prevent damage from too much heat to the top plate of the producer I may introduce a refractory plaque  $U$ , having poke holes  $U^1$ , and cover slides  $U^2$ , which are operated by the handles  $U^3$ . This plaque is usually made with a cast iron frame  $U^5$  embedded in the plaque. As a further protection against overheating of parts, I may inject cool producer gas through the conduits  $A^5$  and apertures  $A^6$ . I sometimes also may inject cool producer gas at the base of the fuel container through the apertures  $A^x$  to secure a cooling effect around the periphery of the fuel mass for preventing the accumulation of clinkers on the fire-brick and preventing the formation of too much carbon dioxide at that point.

*Using bituminous fuel.*—The form of producer shown in Figs. 1 and 2 is especially adapted to the use of anthracite and other fuels of hard texture, having small amounts of volatile constituents. Bituminous coal can be used in it by careful management;

but I prefer to use a different principle in the construction and management of a producer for the burning of soft bituminous coal. For this special fuel, instead of applying old principles in preventing or getting rid of the tar, which is so easily volatilized from such fuel, I adopt the principle of providing a producer having an unusually wide fuel container or cylinder, and secure a long horizontal travel of the burning gases underneath the fuel bed, having a considerable part of the combustion carried on at a point directly underneath the place where the fuel gravitates onto the fuel bed, and have the gaseous products of combustion conveyed along underneath the fuel to a point where the fuel has become more or less coked, and then have the gases rise through the coked fuel, and out through a gas exit at a higher level in the producer. In this way I act more in accord with the force of gravity and secure a better result than is gained by what is called the inverted combustion process, in which the volatilized gases are drawn downwardly through the ignited fuel mass.

In carrying out the principle I have stated, the fuel may be fed at the center of the producer, as in Fig. 7, in which case the combustion would proceed from the center outwardly; or, the fuel may be fed from an annular feeding magazine at the periphery of the producer, as in Fig. 3; and the combustion would proceed from the outside of the producer to a central point. To secure satisfactory results in this connection, the character of the grate used must be suited to each particular case. Where the fuel feeding is from the center, I prefer to have a round grate so constructed and arranged that a relatively large proportion of the air needed for gas generation would pass through the grate at or near the center, while a relatively small proportion of the air would pass through the grate at its periphery. The surface of the grate should be arranged so that its agitation through suitable mechanical means would secure a centrifugal conveyance of the fuel. In case the fuel is fed peripherally as in Fig. 8, more air would be fed at the periphery of the grate, and little or no air would be fed at the center of the grate. In such cases, I prefer to have a solid plaque  $W^6$  of heat-refractory material placed in the grate at the center to entirely prevent air from passing through the grate at that point. In some cases, where the fuel used produces a small amount of ashes, it is satisfactory to have a stationary grate, which would be so constructed as to allow air in proper proportions to enter at the right places. Provision must be made in all cases for the removal of clinkers, either above or through the grate or ash-table provided. For this purpose I prefer to use a clinker

grinding grate. In the form of producer shown in Fig. 7 the gas passes through the coked fuel at the periphery of the fuel mass, through the gas passages  $W^a$  and through the gas conduit  $W^b$ , which is formed in the upper part of the refractory lining of the producer, and finally out through the exit  $W^c$ . Much tarry vapor is changed into a fixed gas by being brought into contact with the hot brick work in which the gas passages  $W^a$  and  $W^b$  are formed.

*The tar destructor.*—Inasmuch as there is always more or less tar carried out with producer gas from the zone of distillation of the fuel bed, I introduce in my apparatus a means for highly heating the newly formed gas, decomposing water vapor in the gas, and burning the tarry vapors in the gas, transforming the vapors into a fixed gas. The principle involved is that of subjecting the newly formed gas to a close impingement with the high concentrated heat formed by a flame-blast mechanically forced and concentrated over and on surfaces or matters capable of being highly heated in the line of travel of the newly formed gas after its generation in the producer. The flame used may be formed by the pre-admixture of a combustible gas, such as producer gas, and air, one or other, or both, being under mechanically produced pressure, and either cold or preheated. The carrying out of this principle may be practiced in various ways. One method is indicated diagrammatically in the drawings by the devices B shown in Fig. 1. This device contains a burner  $B^1$ , which is supplied with pre-mixed air and gas through the gas conduits  $B^4$  and  $B^5$  and the air conduit  $B^7$ . The gas may be lighted through the aperture  $B^8$ , or by electrical ignition, or in other ways. An intense heat is evolved by the burning flame, which heat may be modified and controlled by the amounts of gas and air forced through the burner, or by means of the check draft  $B^2$  controlled by the air inlet  $B^3$ . The flame blast highly heats the refractory lining  $B^6$ , and the gases emerging from the producer A are conveyed up around the burner B, and follow the under side of the refractory lining  $B^6$ , the tarry vapor and water vapor in the gas being transformed into a fixed gas through high heating of the newly formed gas. In starting the burner, gas is taken from the storage tank X, which may be of any convenient type, and which is kept charged by means of the gas exhauster and blower G, (see Fig. 3). Air alone may be injected in any desired way, as through the check draft  $B^3$ , though less effectively, in the line of the travel of the gas to secure the desired change in quality of the gas, and the arrangement of the burning device can be of any of numerous types. I prefer to inject cleaned producer gas under pressure, burn-

ing the gas with air; the injective effect carrying in a sufficient amount of air with the gas. If the gas is forced directly from the gas exhauster and blower, when that device stops running, injection of the gas and air also necessarily stops, as is desirable. But an auxiliary gas supply should be provided to burn the tarry vapors volatilized, when the blower G is not running.

In some cases the device just described may be advantageously replaced by a furnace burning tar-free coke in two furnaces cylinders used alternately, as in the usual method of water gas production. It will be understood that the special method employed in fixing the tarry vapor varies with the nature of the fuel used and of the gas required. When gas is wanted high in thermic constituents, there would be intermissions in heating the tar destructor, followed by runs through it of the gas evolved in the gas generator. Having control of compressed air and of the steam supply, I can make a gas that is practically a water gas high in hydrogen content, or one that is almost a pure carbon monoxid gas, or any admixture of the two. When running a rich gas by the intermittent process, the gas would be stored in a tank of sufficient size to furnish a supply of gas continuously, bridging over the so-called blowing periods.

*The primary heat interchanger.*—The sensible heat of the newly formed gas is increased in passing through the device B. In order to economize some of this heat, I pass the highly heated gas through the heat interchanger C. This heat interchanger is lined with a refractory lining, and has a cast iron device  $C^2$ , through which air and steam or spent gaseous products of combustion may be drawn under the producer A through the conduit  $C^3$ , after receiving some of the heat of the highly heated gases before the gases emerge through the exit  $C^4$ . The upper part of the device  $C^2$  is connected with the three-way mixing device  $N^1$ . When using coal fuel having only slight tarry elements, the device C is omitted, and the relatively moderate heat of the newly formed gas is almost entirely absorbed in the higher level of the device B, in which case the mixing device  $N^1$  is attached directly to the base of the producer.

*The mixing device.*—The mixing device  $N^1$  (see Figs. 2 and 3) is arranged to inject as much compressed air, steam or gaseous products of combustion under the producer grate as may be needed, through the action of a forced air blast produced by the blower F and forced through the pipes  $F^1$  and  $N^1$  (see Fig. 3). Exhaust steam is drawn through the conduit N from the upper part of the condenser M, which condenser receives the exhaust steam from the engine L. The gaseous products of combustion are conveyed

through the conduit  $N^2$  from the bottom part of the economizer boiler K, and the relative amounts of exhaust steam, air and cooled gaseous products of combustion, are controlled by suitable valves in the several conduits  $N$ ,  $N^1$  and  $N^2$ , the injecting effect of the compressed air forcing the exhaust steam and products of combustion and securing effective admixture of the gases and steam. It will be obvious that through the use of this device and connected parts, a large variation in the nature of the gas produced can be secured.

*The gas cooler.*—The gas cooler D is used to cool the gas, economize the greater part of the balance of the sensible heat of the newly formed gas and in condensing any undecomposed tarry vapors and ammonia vapors in preparing the gas for the scrubber. The steam if any is produced in this device, I usually utilize expansively in motor work in a manner indicated in Fig. 3, and utilize the exhaust steam after its expansive work is accomplished in the generation of gas in the producer. The gas cooler D is of special structure to provide against damage to the heating surfaces of the cooler from highly heated gases and sulfur compounds. To provide against such damage, all the heating surfaces of the boiler proper are submerged in water. Cold feed water enters the device through the inlet  $D^5$  into the water compartment  $D^4$ , and passes up through the water tubes  $D^3$  into the high level water space under the steam dome  $D^1$ . In case this device is connected with a heating system, the hot water passes out of the outlet  $D^2$ , while steam, either for power or heating purposes, passes through the apertures  $D^7$ . The hot gases pass into the device through the inlet  $D^3$ , and down through it, and out through the aperture  $D^6$ , progressively heating the feed water which ascends through the tubes  $D^3$ . By having the gas cooler of sufficient size, and using very cold feed-water for introduction into it, the heat of the new gas can be absorbed at a high level into the water while the tar vapors will be condensed on the water tubes at lower levels, and thus protect the heating surfaces from injury due to sulfur vapors. I have found this provision a satisfactory one in preparing producer gas for use.

*The gas tank.*—If low grade producer gas is being generated, and this gas is only being burned in the gas engine of the system, no gas accumulating tank would be necessary. But if a higher grade of gas is being produced by the intermittent process of gas generation, or if the gas is burned otherwise than in the engine, a means for accumulating a small store of producer gas would be needed in the working of the apparatus in starting and to secure an even pressure in the delivery of the gas.

In the plant shown in plan view in Fig. 3, the gas is drawn through the producer, tar destructor, primary heater interchanger, gas cooler and scrubber by the suction effect of the internal combustion engine I, and the exhausting effect of the exhaust G, in connection with a moderate plenum effect of the air blower F blowing air into the base of the producer. The gas, besides being used in various places for a number of uses, as for example, in the engine I may be used in the burner J to effect an auxiliary heating of water in the economizer boiler K, along with the heating of the water effected by the exhaust gases from the engine I, which are exhausted through the economizing boiler K. The steam, which is generated in this boiler runs the steam engine L; and the kinetic energy of this engine and that of the internal combustion engine I is yoked up by differential pulleys and belts through the shaft O. The motion of this shaft actuates the dynamo Q. The exhaust steam from the engine is either condensed in the condenser M, or is injected under the producer A along with more or less of the waste cooled gases of combustion that have passed through the economizer boiler J, from the engine I. In such an installation there is a large economy in fuel effected in creating power through the co-action of the various elements in the plant.

*Enriching the gas.*—If it is desired to enrich the gas I blow into the producer above the fuel or into an auxiliary heater, a hydrocarbon oil through any of the inlets of the apparatus, using the cleaned producer gas forced by the gas compressor G, and usually blow the enricher in counter-current to the outgoing flow of the gas. This process of atomization by blowing is different from atomization by spraying, the blowing making a more mist like spray or vapor. The gas carrying this vapor is then subjected to heat to transform the vapor into a fixed gas, in any of the methods suggested in this application.

Subject matter is herein disclosed that is not here claimed but which is claimed or will be claimed elsewhere.

What I claim as new is:

1. In a gas generator, the combination of (1) a fuel container, (2) a sectional base for supporting the fuel container, (3) a sub-base for supporting the sectional base, said sub-base comprising a water seal and means for the removal of ashes through the water seal, and (4) a removable fuel table or grate within the sectional base, said fuel table or grate being non-integral with the sectional base but resting on the sub-base, said sectional base being composed in its entire elevational periphery of removable sections arranged for the assembling or dis-

assembling of the sections by movable bolts, one or more of said sections being of sufficient size to allow for the introduction or removal of said fuel table or grate without  
5 dismemberment of said fuel table or grate.

2. In a gas generator, the combination of (1) a fuel container, (2) a square base supporting the fuel container, and (3) a fuel table or grate in the base non-integral with  
10 the base but resting on the bottom of the base, said base having detachable sides of the full width and height of the interior of the base, said sides being attachable and detachable with each other, and with other  
15 parts of the base by removable bolts.

3. In a gas generator, the combination of (1) a cylindrical fuel container, said container having at the lower edge of its shell a flange ring extending outwardly from the center of the container, (2) a square base supporting the fuel container, said base comprising a square top plate having a central fuel opening, said opening being equal in diameter and uniformly in alignment  
25 with the inner surface of the shell of the fuel containing cylinder, lugs projected toward the center of the container from the top plate into said opening, a loose dead ring resting on the lugs, said dead ring supporting a fire brick lining for the fuel container, four sides, each side having cast  
30 integral therewith a horizontal top flange, a horizontal bottom flange, and 45° corner flanges, said top and corner flanges being arranged to assemble by bolting with each other and with the top plate to form said square base, and (3) a grate in said base, said base comprising openings in the sides of the base for the admission of air or other  
40 gases to said base, and for cleaning the fuel bed resting on said grate, the external edges of the square top plate being entirely outside of the external surface of the cylindrical fuel container.

4. In a gas generator, the combination of (1) a cylindrical fuel container, (2) a square sectional base supporting the fuel container, the side sections of said base being placed peripherally outside a line perpendicularly outside of the outer periphery  
50 of the fuel container for giving room for the horizontal extension of a grate surface supporting the fuel in said container, (3) a sub-base supporting the square base, said sub-base comprising surfaces for precipitating ashes to a central part of the sub-base, a shoveling surface dipping from without said base to said base and to said central part, and a dip plate effecting a water seal for said sub-base through which seal ashes  
60 are removed, and (4) a grate resting on said sub-base.

5. In a gas generator, the combination of (1) a fuel container, (2) a base supporting  
65 the fuel container, (3) a sub-base support-

ing the base, (4) a grate or fuel table and a frame for the grate or fuel table in said base but non-integral with said base, said frame resting on said sub-base, said frame comprising means for holding said grate  
70 or fuel table in position at a desired level, said base comprising means for a removal from said base said frame and said grate or fuel table in its entirety, and (5) means for preventing side movement and for holding  
75 in desired positions said frame in said base.

6. In a gas generator, the combination of (1) a fuel cylinder, (2) a sectional square base supporting the fuel cylinder, said base  
80 comprising a movable section sufficiently large to provide for the removal of a framed grate or fuel table from said base, (3) a grate or fuel table frame in said base but non-integral with said base, and (4) a grate  
85 or fuel table in said frame.

7. In a gas generator, the combination of (1) a base, (2) a fuel container resting on said base, (3) a grate supporting the fuel in said container, (4) means for introducing  
90 air and heat decreasing agents under the grate, (5) means for introducing heat decreasing agents above the grate and above the fuel in the container, (6) means for decomposing vapors in the gas generated, and (7) means for controlling the pressure  
95 of the gas and vapors in the gas, under the grate in the fuel container, and in the means for decomposing vapors.

8. In a gas generator, the combination 100 with the generator proper, of (1) a square sectional base supporting the generator proper, (2) an ash sifting and clinker grinding grate in the base, and (3) means  
105 for actuating the grate, said means comprising mechanism for actuating the grate from without the base and for preventing the escape of air or gas under pressure in said base from said base on the line of or in  
110 connection with the means for actuating the grate.

9. In a gas generator, the combination with a fuel container, of a square base supporting the container and an ash sifting and clinker grinding grate in the base, said  
115 grate comprising rocker bars having clinker cutting edges, rocker bar arms and means for actuating the rocker bar arms from without the base, said means being held permanently in one horizontal position by two  
120 points of support, said bars being given motion from outside the base, and means for preventing escape of air and other gas from the base along the line of the actuating means.  
125

10. In a gas generator, the combination of, (1) a square four sided sectional base, (2) a cylindrical fuel container resting on the base, having a lower opening of the full  
130 internal diameter of the container, and (3)

a grate in said base, said grate being composed of a plurality of rocking bars of uniform length, having clinker cutting edges, the assembled bars forming a square four  
5 sided grate, the sides of the grate extending laterally to or beyond the periphery of the lower opening of said fuel container, said

sides of the base being perpendicular to vertical lines laterally outside of said grate.

JOSEPH MOSES WARD KITCHEN.

Witnesses:

GEO. L. WHITELOCK,  
W. A. TOWNER, Jr.