H. L. DOHERTY.

PROCESS OF REGULATING PRESSURE IN GAS PRODUCING APPARATUS.

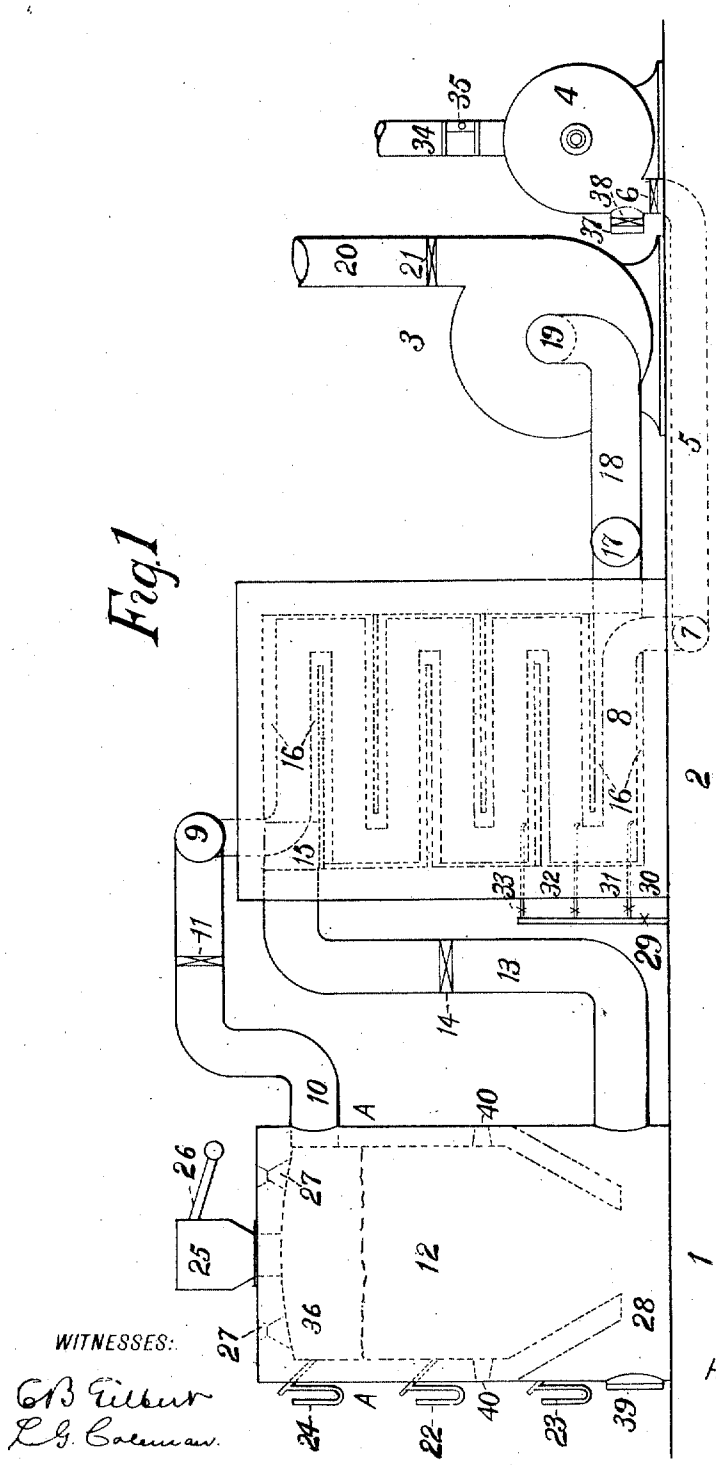
APPLICATION FILED APR. 7, 1909.

1,008,449.

Patented Nov. 14, 1911.

2 SHEETS—SHEET 1.

Fig. 1



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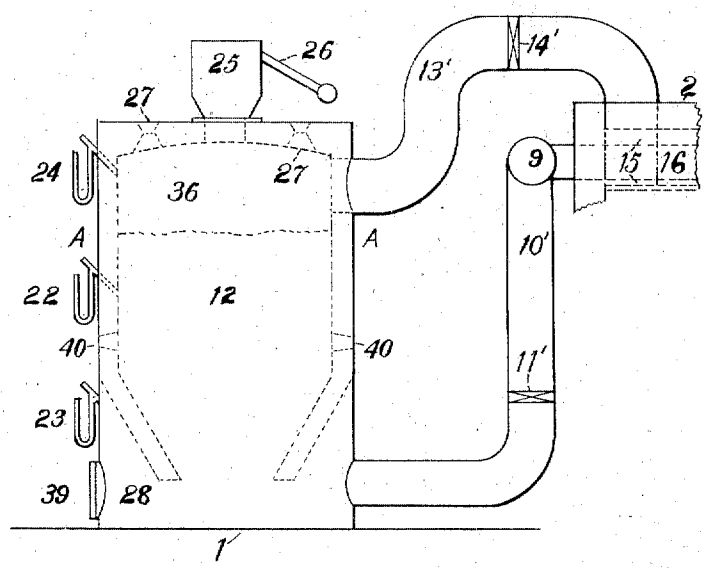
2 SHEETS—SHEET 2.

Fig. 2



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PROCESS OF REGULATING PRESSURE IN GAS-PRODUCING APPARATUS

1,008,449. Specification of Letters Patent. Patented Nov. 14, 1911.

Application filed April 7, 1909. Serial No. 488,378.

To all whom it may concern:

Be it known that I, HENRY L. DOHERTY, a citizen of the United States, residing at New York city, in the county of New York and State of New York, have invented new and useful Improvements in Processes of Regulating the Pressure in Gas-Producing Apparatus, of which the following is a specification.

My invention relates to a process for regulating the pressure in gas producing apparatus and particularly in that kind of such apparatus in which a combustible gas is formed by subjecting fuel in a deep bed to combustion by a limited supply of air.

The object of my invention is the provision of a method whereby, in apparatus of the kind mentioned, the pressure in the gas producer may be brought to and maintained at any zone thereof at a point, above, below or at atmospheric pressure, whereby the danger of explosion due to a sudden inrush of air into the producer through the opening of a door or poke-hole at a point thereon where a partial vacuum may exist, or to a leakage of gas to the outside air due to a plus pressure at the point of opening, may be avoided.

In the operation of gas producers it has heretofore been the practice to either induce the draft through the producer by means of an exhauster or force it through by means of a blower or injector. Either of these methods of operating a producer labors under the objection that for a given speed of driving the producer (a given rate of gas production) the pressure conditions at any given zone in the producer are practically constant and invariable. There is no possibility of altering the pressure at any zone in the producer without at the same time varying the volume of the draft current passing therethrough. Therefore, if it is desired, for example, to bring the pressure in the upper part of the producer above the fuel bed to exactly the pressure of the atmosphere, so that the poke-holes may be opened for barring the fuel bed, it is necessary in the present type of producers to reduce the draft current until the desired pressure conditions have been established. This statement is true in connection with either suction or pressure operated producers. On the other hand, by the method of operating a producer herein revealed and claimed, I can exercise an absolute control over the pressure conditions in the producer and produce any desired indicated pressure at any given point without causing any variation in the speed at which I am driving the producer, *i. e.*, without causing any variation in the volume of gas made. I can bring the pressure above the fuel bed to neutral or atmospheric pressure when I want to open the poke-holes for poking the bed, or I can bring the pressure in the ash-pit to the same point when I want to open the ash door for the purpose of removing the ash, without affecting the production of gas or the temperature conditions in the producer.

In the accompanying drawings I have shown in diagrammatic form an apparatus suitable for applying my invention.

Figure 1 is a diagram showing the apparatus in elevation applied to a down-draft producer. Fig. 2 is a similar view of the producer and connections between producer and recuperator of the apparatus applied to the ordinary up-draft producer.

1, indicates the producer; 2 a recuperator or heat-interchanger for transferring the heat of the gas leaving the producer to the entering gaseous current; 3 an exhauster; 4 a blower; 5 is the discharge pipe of the blower 4, having a valve 6; 7 is a cross flue distributing the air to the air flues 8 of the recuperator 2; 9 another cross flue connecting the flues 8, at their discharge end; 10 a conduit conducting the heated air to the producer and having a valve 11; 12 indicates the fuel bed of the producer, the upper surface thereof being delineated by the line A A; 13 is the gas conduit conducting the hot producer gas to the distributing cross flue 15 and having a valve 14; 16 indicates the gas flues of the recuperator; 17 a cross flue connecting the various flues 8; 18 is a pipe conducting the gas from 17 to the suction pipe 19 of exhauster 3; 20 is the discharge pipe of exhauster 3, having a valve 21; 22, 23 and 24 are gages or manometers placed at different zones of the producer to indicate the pressure therein; 25 is the charging hopper of the producer having the charging mechanism 26; 27 are poke-holes in the top of the producer for the purpose of providing access to the interior thereof for barring down the fuel bed; 28 is the ash pit of the producer; 29 indicates a system of water pipes for supplying water to the recuperator 2 when the

temperature control of the producer is effected by means of water; 30, 31, 32 and 33 are valves regulating the supply of water to the flues 8 of the recuperator; 34 is the suction pipe of the blower 4, having a damper 35 for regulating the admission of air thereto; 36 indicates the space in the producer above the fuel bed; 37 is an air inlet to pipe 5 controlled by a valve 38; 39 is the ash-door of the producer; 40 indicates pokeholes in the walls of the producer just above the ash zone.

In Fig. 2, the numerals with the superscript prime indicate the same parts as the corresponding numerals in Fig. 1, applied to an up-draft producer.

The method of operating the particular apparatus shown in Fig. 1 is as follows: A bed of ignited fuel is built up in the producer in the customary manner familiar to those skilled in the art. By means of the exhauster 3 and the blower 4 a draft is established through the producer, air from blower 4 passing through the pipe 5 to the cross flue 7. From 7 it is distributed to the air flues 8 of the recuperator, passes through these flues and enters the cross flue 9, thence through the pipe or conduit 10 to the upper part of the producer above the fuel bed. Under the action of the exhauster 3 in connection with the blower 4 the air current entering above the fuel bed is drawn down therethrough, reacting with the incandescent fuel and forming producer gas. This gas passes to the ash pit 28, and from thence through the conduit or pipe 13 to the cross flue 15 of the recuperator. From 15 the hot gas passes to the several gas flues 16, through 16 to the cross flue 17, and from 17 through 18 and 19 to the exhauster 3, and thence to a gas holder or place of use when used directly.

In the type of recuperator shown, the gas flues 16 are a set of parallel return-bend flues enveloping the air flues 8. The travel of the producer gas is therefore parallel but in the reverse direction to that of the air current.

By this device I transfer to the draft current supplied to the producer most of the sensible heat of the producer gas.

It is well known to those skilled in the art that it is necessary for economical operation to supply to the draft current furnished to the producer some agent such as water vapor, or carbon dioxid, which being converted into combustible gases absorbs thereby the excess heat of the fuel bed. By suitably regulating the proportion of water or carbon dioxid supplied to the producer, the temperature therein may be maintained within safe limits. In the apparatus shown I may use either water or carbon dioxid for this regulation. If I am using carbon dioxid I connect the pipe 34 of the blower 4 with some source of carbon dioxid, such as products of combustion for instance. Then by adjusting the dampers 35 and 38 I can furnish to the producer a draft current containing any proportion of air and of the products of combustion that I may desire. If I wish to use water I supply the requisite quantity to the air flues 8 by means of the pipes 29 and valves 30, 31, 32 and 33. In the flues 8 the water is evaporated by the heat transferred from the hot producer gas and is taken up by the air current and conveyed to the producer as vapor.

Assuming that the producer has been brought to its normal working condition, if it is desired to bring the pressure in the upper part of the fuel chamber of the producer above the fuel bed to atmospheric pressure without affecting the quantity of gas made (when charging the producer for instance) this can be done in two ways. The first is by regulating the speed of the exhauster and blower and the other is by manipulating the valves and dampers without changing the speed of 3 and 4. By the first method, assuming that the pressure in the space 36 is above atmospheric, I increase the speed of exhauster 3 and decrease the speed of blower 4 until the gage 24 reads zero, that is, atmospheric pressure is indicated; when the original pressure in 36 is below atmospheric I decrease the speed of exhauster 3 and increase the speed of blower 4 until 24 reads zero as before. By the second method I run 3 and 4 at constant speed and effect the regulation by manipulating valves 6 and 21 until the gage 24 reads zero. Ordinarily, the latter method is the preferable one as it is simpler to operate the valves 6 and 21 than to regulate the steam supply to the engines driving 3 and 4, or to regulate the pressure by varying the speed of the motors when a variable speed motor drive is used.

It is evident that if we run 3 at constant speed, the volume of gas which it will pass in a given time will vary, in the first place, with the pressure of the gas on the suction side of the fan, and in the second place, with the pressure on the discharge side. Likewise, with the fan 4. Under normal working conditions it is, usually, preferable to operate the producer under a more or less diminished pressure. By opening valve 38, it is clear, that I can operate my producer wholly by the exhauster 3 if I so desire. In this case it is evident that from the valve 38 to the exhauster 3 there will exist a gradually increasing vacuum. If now I want to bring say the space 36 to atmospheric pressure I start blower 4, close 37, and partially close 21. It is evident that this closing of 21 is necessary owing to the fact that by putting the blower in action and supplying the air through 5 by forced

instead of induced draft I have raised the pressure throughout the system up to exhauster 3. Since I am assuming this run at constant speed, it is evident that, the increase of pressure on the suction side will result in a greater volume passing through in a given time unless the pressure on the discharge side is increased by (in the apparatus shown) throttling the area of the discharge outlet.

By properly manipulating 6 and 21 the pressure in 36 may be brought to that of the atmosphere. When this condition is reached the fact is indicated by the gage 24 being at zero reading. It is plain that with this condition I may open the poke-holes or the charging hopper without any danger of short circuiting my recuperator and drawing cold air instead of hot into the producer. In a similar manner, when I wish to open the poke-holes 40, I can bring the pressure at the level of 40 to atmospheric, thus permitting the fuel bed to be worked through 40 with entire safety, and without any interference with the working of the producer. Likewise when I wish to remove the accumulated ash from the ash pit I can readily bring the pressure in the ash pit 28 to atmospheric pressure, by manipulating the valves 6 and 21 until the gage 23 reads zero. This permits me to remove the ash without interfering with the operation of the producer, something which cannot be done with a down-draft producer run in the ordinary manner.

When applied to an ordinary up-draft producer the manipulation to bring about atmospheric pressure in any part of the producer is the reverse of the above. For instance, if in this case I wish to bring the pressure in 28 to atmospheric without increasing or diminishing the make of the producer I increase the opening of valve 21 and decrease that of valve 6 until the gage 23 reads zero. Thus, by the suitable manipulation of valves 6 and 21 I can bring any zone of my producer to above, below or at that of the atmosphere without changing the speed of the blowers, or changing the make of gas.

In the operation of a gas producer, as is well known to all persons skilled in the art, the maintenance of proper and uniform temperature conditions is a point of the greatest importance. If the temperature in the fuel bed be allowed, even momentarily, to rise to the fluxing point of the ash of the fuel the result will be the formation of large aggregate masses in the fuel bed commonly called "clinkers." This necessitates frequent and thorough cleaning of the fuel bed in order to keep the producer in an operative condition. In the types of producers in common use, during this clinkering operation, it is practically impossible to maintain the proper working conditions in the producer. The rush of air into the latter through the poke-holes and clinkering doors has a tendency to follow up the sides of the producer instead of going into the interior of the fuel bed. This results in a localized development of heat and in a large part of the carbon dioxid, which is the initial product of the combustion of the oxygen, going through the fuel bed unchanged, since it is not sufficiently contacted with the incandescent fuel to insure its reduction to carbon monoxid. The presence of a considerable proportion of carbon dioxid in the gas greatly diminishes its calorific value. Besides, owing to the fact of the air short-circuiting (so to speak) up the sides of the producer, the draft through the interior of the fuel bed is diminished and the amount of carbon monoxid and hydrogen formed when water vapor or steam is used in the producer is lessened. That is, a large part of the carbon monoxid which is normally formed is replaced by carbon dioxid. The presence of carbon dioxid in the gas, therefore, not only dilutes it but in effect robs it of part of its normal calorific value due to the reduction of the actual weight of carbon monoxid formed in a given time. The actual B. T. U. which the producer can furnish to whatever gas consuming apparatus it is supplying is consequently greatly reduced during the operation of clinkering. In many of the uses to which producer gas is put this variation in the quality of the gas is not only annoying but, in some cases, very serious. For instance, when the producer supplies gas directly to a gas engine, sudden variations in the quality of the gas produce all sorts of troublesome results in the operation of the engine, and consequently in the amount of power which it supplies, also in many delicate metallurgical operations it is necessary to maintain very uniform conditions in the furnaces. Any fluctuations in temperature due to a sudden drop in calorific value of the gas, might entail a serious loss due to an imperfect product.

The maintenance of perfectly uniform temperatures and production of gas in gas producers have long been recognized in the art to be ideal conditions of operation. Hitherto, however, these have been practically unattainable. It is true that, by my process of temperature regulation in producers, by the use of a proper proportion of flue gas in the draft current supplied to the producer (described and claimed in my Letters Patent No. 829,105, dated Aug. 21, 1906, No. 848,729, dated Apr. 2, 1907, and others) I have been able to approximate very closely to these ideal conditions. Even with this process, however, there still remained the defect in operation due to imperfect control of the pressure conditions in

the producer. It was to overcome this defect of operation, and to enable me to realize the ideal conditions of operation in practice, that I have invented the herein revealed process.

Having described my invention, what I claim is:

1. In the operation of a gas producer, the process of controlling local pressure therewithin which comprises submitting the fuel mass to the balancing action of draft pressure and suction simultaneously applied to opposite ends of said fuel mass, said pressure and said suction being so mutually regulated as to produce a desired indicated local pressure at a given point in said fuel mass.

2. In the operation of a gas producer containing a mass of fuel, the process of controlling local pressures therein which comprises maintaining one end of said fuel mass under an indicated pressure greater than atmospheric pressure by a forced draft and maintaining the other end under an indicated pressure less than atmospheric pressure by suction, the degree of pressure of said forced draft and the degree of suction being so relatively controlled as to establish an indicated atmospheric pressure at a given intermediate point in said mass.

3. The method of bringing the pressure in the draft current in any desired zone of a gas producer to atmospheric pressure which consists in subjecting said draft current at the same time to an inductive and a forcing action so adjusted that the combined effects of the two produce a pressure substantially equal to that of the atmosphere in such zone of the producer.

4. In the operation of a gas producer, the process of controlling local pressures and conditions therein which comprises submitting the fuel mass to the action of a draft current of mingled air and an endothermically acting body, said draft current being introduced under pressure at one end of said fuel mass, and simultaneously applying suction to the other end of said fuel mass, the degree of said pressure and of said suction being mutually so regulated as to produce a desired local pressure at a given point in said fuel mass.

5. The method of regulating the pressure in any zone of a gas producer which consists in supplying to the ash pit of said producer, under pressure, a draft current containing air and an endothermically acting constituent, withdrawing the gas from said producer under a partial vacuum and varying the pressure of the entering draft current and the vacuum of the issuing gas current so as to produce the desired pressure at any desired zone of the producer.

Signed at New York city, in the county of New York and State of New York this 31st day of March, 1909.

HENRY L. DOHERTY.

Witnesses:
LOUIS F. MUSIL,
C. B. GILBERT.