No. 786,061. PATENTED MAR. 28, 1905.

H. F. SMITH.

PROCESS OF REGULATING AIR AND STEAM SUPPLIED TO GAS PRODUCERS.

APPLICATION FILED JUNE 16, 1904.

2 SHEETS—SHEET 1.

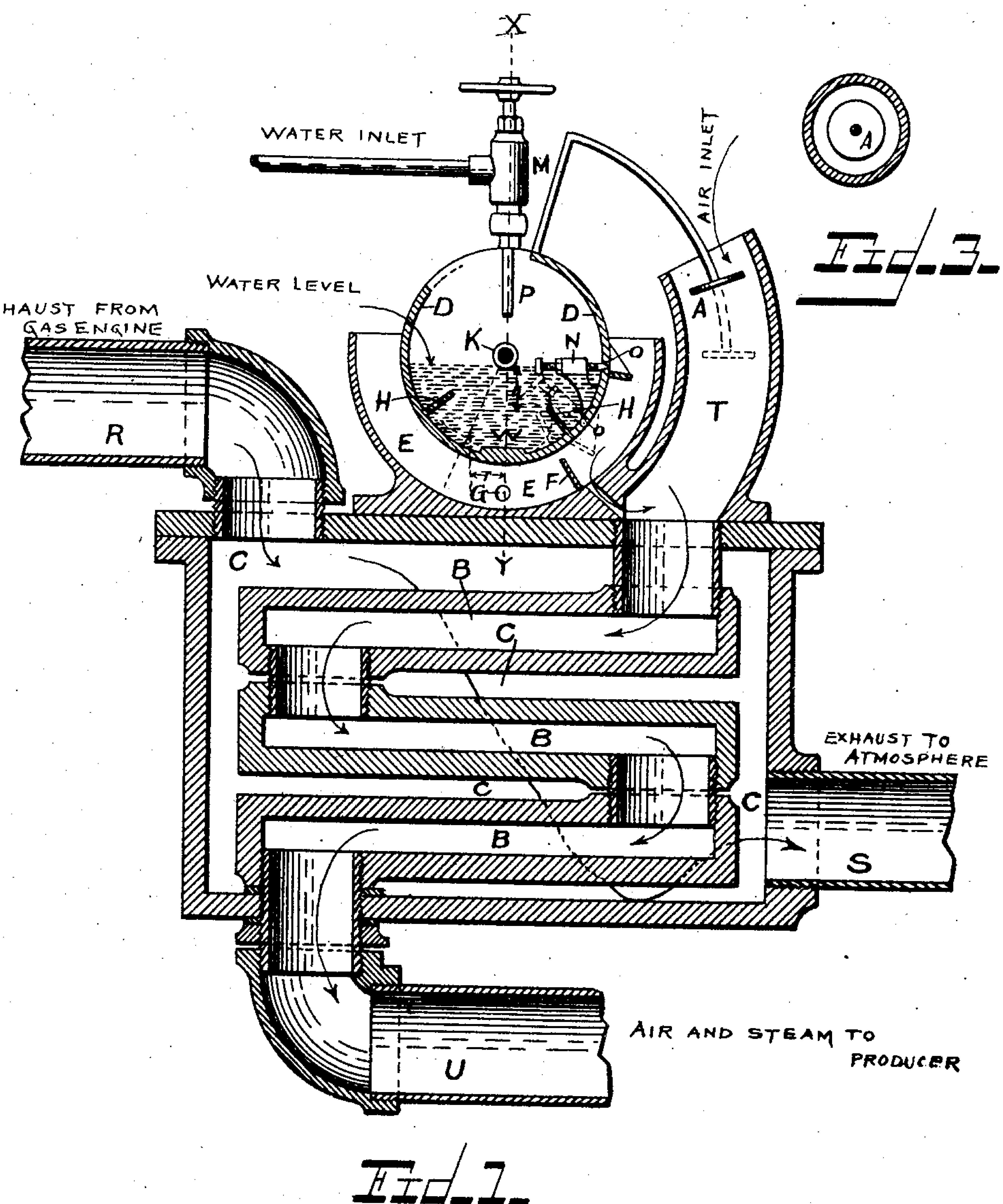


Fig. 3.

Fig. 1.

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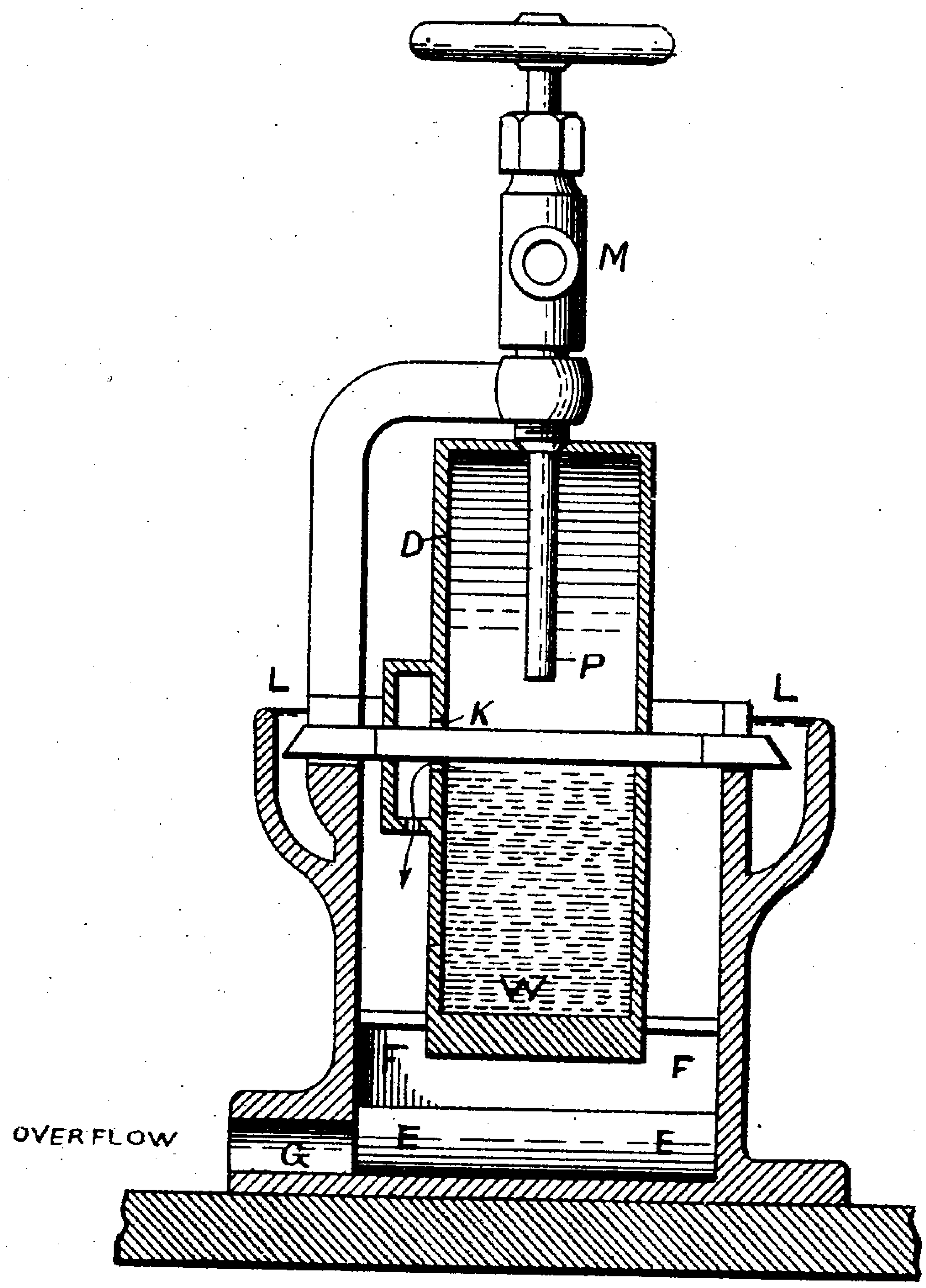
Fig. 2.

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# UNITED STATES PATENT OFFICE.

HARRY F. SMITH, OF LEXINGTON, OHIO.

## PROCESS OF REGULATING AIR AND STEAM SUPPLIED TO GAS-PRODUCERS.

SPECIFICATION forming part of Letters Patent No. 786,061, dated March 28, 1905.

Application filed June 16, 1904. Serial No. 212,887.

*To all whom it may concern:*

Be it known that I, HARRY F. SMITH, a citizen of the United States, residing at Lexington, in the county of Richland and State of Ohio, have invented new and useful Improvements in the Art or Process of Providing and Regulating the Air Supplied to the Producers of Suction Gas-Producers, of which the following is a specification.

This invention has relation to the art or process of providing and regulating the air supplied to the producer of suction gas-producers, so that the said air shall bear a constant percentage of moisture regardless of the actual quantity of air supplied or the rapidity with which this quantity may change to suit varying loads on the engine.

In the description of my improved method or process it becomes necessary to deal with the means employed or with some form of means in order that the method may be understood.

Inasmuch as by my invention I provide an improved process whereby the amount of steam or moisture in the air supplied to the producer is made or regulated to agree to all intents and purposes with the amount required whether the exact requirement at particular times varies or not, it is seen that I must deal to some degree with the machine itself or employ some parts of the machine as a tangible vehicle, whereby my improved art can be made effective.

In another application for a patent of even date herewith I have shown, described, and claimed an apparatus for supplying steam and heated air to suction gas-producers, and I have chosen said machine to illustrate and describe my present improvements in the art, and, furthermore, in order to make my present improvements effective, and as it is ever tangible, I have also chosen to employ the functions of the air-tube and vane shown and described in said other application as the tangible things dealt with, and hence they are fully referred to without in their embodiment as mechanical features of the machine becoming any part of this invention. So, also, with other parts and features of this machine, while it may be deemed advisable to show and describe the process it is not in its constructive nature made a part of this invention. Again, it is to be noted that equations of the form herein used are universally accepted by engineers and physicists in dealing with the quantities involved. The formulas used, it will be noted, are matters of no concern in this case excepting with respect to the form of the equations and not with the actual values of any of the constants mentioned, and even then only in the fact that the two equations have the same form, regardless of what that form may be.

Before proceeding to describe the mode of operation of this invention it may be well in order to give a clear understanding of the same to explain that in suction or aspirating gas-producers which are used for power-gas generation no storage of gas is attempted, the gas as made passing directly from the producer to the engine.

Since mixtures of producer-gas and air mixtures are explosive only over a very narrow range of possibilities, it is readily seen that even a very slight variation in the quality of gas furnished to the engine will cause a serious loss in the power of explosion and will frequently require a readjustment of air to gas. It therefore becomes apparent that great uniformity in the quality of gas to its requirements is necessary; but uniform gas cannot be made unless there is a uniform percentage of steam incorporated with the air-blast to the furnace.

To maintain a uniform percentage of steam at varying loads on the engine, it is necessary that the supply of water from which the steam is generated should not only be proportioned to the load on the engine, but should vary quite as rapidly as the load changes—that is to say, the variation in the requirement should as quickly have a variation in effects to answer the requirement.

By long, careful, and intelligent experiments I have produced an important improvement in the art, as will appear from a description of the construction and operation of the apparatus or device shown in the accompanying drawings, forming a part of this specification, which apparatus, based on the said experiments, does the work for which it is designed in a highly satisfactory manner and preserves the proper proportion of air to steam so nearly constant that no disturbance is observable in the operation of the producer.

In the said drawings, Figure 1 is a substantially vertical central sectional view of the entire apparatus or so much thereof as is necessary to give an understanding of the invention. Fig. 2 is a transverse vertical central sectional view of the apparatus designed to regulate the supply of air and water to the heating means to furnish the required air and steam to the producer. Fig. 3 is a sectional detail view, hereinafter referred to.

In the drawings, D is a cylindrical vessel supported by the shaft L on suitable bearings, preferably "knife-edge," so as to rotate freely about its center through an arc of twenty or thirty degrees. This vessel is provided with a slot in its circumference to admit the stationary water-pipe P. An annular overflow-outlet, arranged as an annular opening K, surrounds the central supporting-shaft in such a manner that its lower edge shall be tangent to the same horizontal plane in whatever position the cylinder may be rotated about its supporting-shaft. O is an orifice whose size can be controlled by a valve N. W is a weight so placed on the circumference of the cylinder as to be directly under the supporting-shaft when the orifice O lies in the plane of water-level—*i. e.*, the horizontal plane tangent to the lower edge of the overflow-orifice K. Vanes H H are arranged to act as dash-pots to steady the movement of the whole. A vane A is carried upon the extremity of a curved arm, so as to move freely and occupy a central position in the curved air-pipe T. As it has already been noted, this vane A and air-pipe T have been taken as one of the important means for carrying this invention into effect. This cylinder D is supported by and carried within a semicylindrical housing E, which is divided into two parts, one of which receives the drip from the overflow K and discharges it through the opening G into a waste-pipe (not shown) and another above and to the right, which receives the water discharged from the orifice O and conducts it through the opening into the air-pipe T.

C is a chamber through which pass the hot gases as the exhaust from the gas-engine, and which contains the hollow disks B, or it may be other extended heating-surfaces which contain and convey the air and water admitted into the air-pipe T.

The operation of the apparatus in carrying out the process is as follows: The valve M is opened and water is admitted to the interior of the cylinder D until it is filled to the height of the overflow K, at which point the water-level is maintained, the surplus passing out of the overflow to waste. When air is passed or is caused to pass through the apparatus, the vane A is acted upon by the air-current passing through the pipe T. Numerous experiments have demonstrated the action of air-currents on a vane so exposed to be of the following nature: Let P equal pressure exerted on the vane; V equal velocity of air-current; C equal a numerical constant; then P equals $CV^2$. Consequently since for small pressures and velocities quantity equals area $x$V, quantity of air equals $C'\sqrt{P}$; but, similarly, considering the flow of water through an orifice, quantity of water equals $C''\sqrt{H}$, where H is the head of water above the orifice. Comparing these equations, (and perhaps we should before have noted that $C'$ $C''$ $C'''$ are different numerical constants,) we observe that if we made P equal $C'''$ H, then Q air equals $C''''$ Q water, ("Q air" and "Q water" meaning quantity of air and quantity of water)—that is, if the head of water over an orifice is kept proportional to the pressure on the vane A then the flow of water through the orifice will always be proportional to the flow of air through the pipe T; but the pressure on the vane A is determined by the resistance it offers to displacement—*i. e.*, by the resistance offered by the cylinder D to axial rotation—since if no resistance were offered to such movement the vane would move with equal velocity with the air-current and no pressure would be exerted upon it. In this construction, however, the weight W tends continuously to return the vane A to its original position, and hence determines the pressure on the vane A; but for any given displacement like that shown in the dotted lines the turning moment exerted by W equals W$r$ where $r$ equals perpendicular distance from center of gravity of W to the vertical line through the center of rotation. This turning moment is balanced by that exerted by the vane A—viz., P$r'$—where $r'$ is the distance from the center of rotation to the center of pressure on A. Consequently W$r$ equals P$r'$, and since W and $r'$ are constants $r$ equals constant $x$P; but from the construction it is obvious that $h$—the head of water over the orifice O—is proportional to $r$. Consequently for this construction P equals constant XH, and for any rate of flow of air such a displacement of the vane and attached cylinder will occur as to cause a proportional flow of water from the orifice O. The actual quantity of water discharged per cubic foot of air can be regulated by the valve N. Since the water discharged at the orifice O is at once conveyed to the hot surfaces B and there entirely converted into steam, the percentage of moisture carried by the air to the producer will be constant and remain constant regardless of the quantity of the air passing.

The exact arrangement need not of course be that shown. For instance, the gases discharged from the producer could be used instead of the exhaust. The water from the orifice O could be vaporized in a separate chamber and afterward mixed with the air. However, the arrangement shown is desirable, since by the use of the exhaust considerable heat is returned to the producer that would be otherwise wasted.

It might be well to observe that in case it should be found that an exact proportion is not maintained, or if for any reason other than a direct proportion of water to air should be desired, suitable correction can be made or such other proportion secured by suitably varying the area of the tube T at the several sections successively occupied by the vane A.

In view of the fact that I have already constructed and operated a machine of the type described and claimed in this case, and in view of the further fact that it is understood that I am not limited in the manufacture of my machine to the detailed dimensions stated, and that further disclosures in this regard are not essential in order to enable those skilled in the art to make and use the machine, but that it might be helpful to them in making a machine to avoid tedious experiments, it may be further stated that in the machine in use at present by me the dimensions are as follows: diameter of vessel D, five and one-half inches; diameter of orifice O, nine one-hundredths of an inch; weight of weights W, fourteen hundred and fifty grains; diameter of pipe T, two and eleven-sixteenths inches; diameter of vane A, two inches.

I claim—

1. The art of supplying steam and heated air to suction gas-producers, which consists in causing the air and water to be heated to pass through an air-tube, interposing a vane in said tube to be acted upon and moved by the air as well as to control the water-supply by its movements, and heating the air and converting the water into steam and supplying the steam and air to the producer, as set forth.

2. The art of supplying air to be heated and water to be converted into steam to be supplied to suction gas-producers, which consists in causing the air to pass through an air-tube, interposing a vane in said tube to be acted upon and moved by the air as well as to control the water-supply by its movements, as set forth.

3. In the art of supplying steam and heated air to suction gas-producers, the improvement in the step of supplying water to generate steam proportioned to the load on the engine and in time with the changes occurring in the load, consisting in arranging a vane in the air-tube in such manner as that it may be moved coincident in time and distance with the time and strength of the air-current causing its movements, and employing said movements to control the water-supply.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

HARRY F. SMITH.

Witnesses:

A. B. BEVERSTOCK,

H. B. SOWERS.