

Producer Gas for Industrial Purposes*

Economy and Convenience Where Both Power and Heat Are Required

By Thomas Wilson

WITHIN the last few years the use of gas for heating purposes in many industries has greatly increased. Cleanliness and convenience and the ease with which it can be controlled so that the temperature can be closely regulated have been the deciding factors. Natural and

would be 24 and 19 cents, respectively. To this must be added the labor item and the interest and depreciation on the producer installation; even then the total cost does not exceed much more than one third the usual charge for city gas. In a preliminary estimate, the equivalent

capacity. The producers are not charged heavily, but are fed uniformly with 150-pound charges at 35-minute intervals. The hoist bucket easily holds ten charges, and is usually filled four times each day.

The coal enters the producer through a double-seal hopper, a counter-weighted bell at the bottom of the hopper preventing the admission of air while the coal is being fed. The sliding plate at the top is closed while the bell is lowered, so that the coal may run down over it and be evenly distributed over the fuel bed. The hopper rests on a water-cooled top having poke holes for attending to the fuel bed.

A feature of the producer is the annular tuyere of dog-house cross-section, which uniformly distributes the air and steam to the fuel bed. This construction facilitates the ash removal, as the ashes can drop around or within the annulus and easily reach the concrete pan at the bottom.

An important part of the plant is the economizer, which in the present installation is 9 feet high and 42 inches diameter, and consists of two concentric steel shells forming two chambers. The gas from the generator passes through the inner one and gives up part of its heat to the air flowing in the opposite direction through the outer chamber to the fuel bed. Ordinarily the gas leaves the producer at 1,200 deg. Fahr., and if it passed directly to the scrubber it would carry about 12 per cent of the heat in the coal. By raising the temperature of the air to 500 degrees in the economizer, two thirds of this heat is reclaimed.

In the pipe connection between the top of the outer chamber and the tuyere of the producer, a steam blower is inserted to saturate the air and equalize the pressure in the top of the producer; otherwise, there would be a slight depression caused by the suction of the engines and of the blower supplying the shop equipment. Atmospheric pressure is thus maintained so that there is no tendency for air to be drawn in or gas to be blown out through the poke-holes when attending the fuel bed.

With the air at this high temperature, combustion is facilitated and the steam is carried to the fuel bed without condensation; it is also claimed that a richer gas is thereby obtained. The steam is supplied by a small vertical fire-tube boiler rated at 15 horse-power and having a pressure of 50 to 80 pounds, depending on the load the producers are carrying. The quantity of steam is controlled by a gasometer connected by block-and-tackle to a weighted lever attached to the stem of the balanced steam valve. The gasometer connects with the top of the producer. As the load increases, the gas pressure tends to drop, so that the gasometer lowers slightly, and, through the connecting links, increases the opening of the steam valve. A drop in load produces the reverse results.

From the economizer to the wet scrubber the gas passes through a three-way water-sealed valve from the top of which the purge pipe leads to the roof. Water-sealing the valve eliminates any possible trouble from tar and soot sticking to a dry seat and makes the tightness of the valve more certain. The scrubber serving the two units is 6 feet 6 inches in diameter by 22 feet high, and contains a coke column supported on trays, water sprinklers above, and at the top a layer of excelsior to remove the moisture.

From the scrubber the gas is drawn directly to the engines by the suction of the pistons. As for industrial purposes, it is necessary to supply the gas at a definite and uniform pressure; there is an exhaustor belt driven

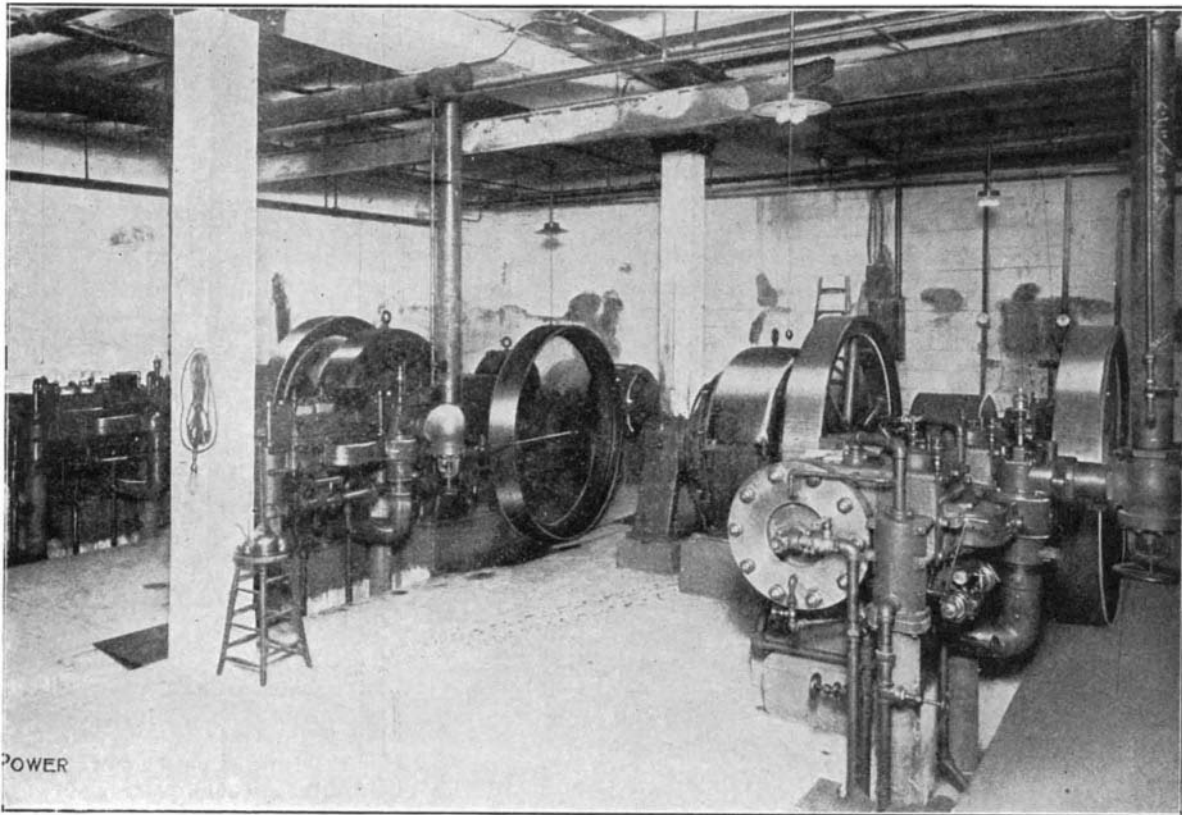


Fig. 1.—Gas-engine plant at Barnhart Brothers & Spindler.

city gas have been used to good advantage, but for low-temperature work up to 2,000 deg. Fahr. anthracite producer gas has given equal satisfaction at a much lower cost. The cost item has induced manufacturers to install gas producers using inferior grades of anthracite to supply gas, not only for heating purposes, but for power.

A plant involving this double service has been installed in the new factory of Barnhart Brothers & Spindler, Chicago, makers of type and printers' supplies. The gas is used for melting the metal in type-casting machines, for hardening furnaces, machine torches, brazing torches, for lead and slug casting, in annealers, copper- and nickel-plating baths, etc. About 70 per cent is required for these purposes and the balance by the engine units generating current for power and lighting.

There are 70 type-casting machines, each equipped with individual motors. All chases are electrically welded, for which fully 75 horse-power is required. A machine shop in which the factory machines are made and repaired takes considerable power; besides, there are electrically driven pumps and fans, and an elevator and conveying machinery to move the product in the course of manufacture. When the plant is running to full capacity, with the chase department in operation, the load will average close to 150 kilowatts, and when chases are not being welded it will drop off one third. Consequently, two units have been installed, one a 125 horse-power, 17 1/4 by 16-inch, four-stroke-cycle tandem gas engine directly connected to a 75-kilowatt direct-current generator, and the other a twin engine of the same type and size of cylinders driving a 150-kilowatt generator; the speed in each case is 250 revolutions per minute. These machines are operated 10 hours a day, and it is the plan to use them alternately, depending on the welding periods. The plant also has a breakdown service; but so far it has been called on only for night lighting, for the fire pumps and for starting the blower, run in connection with the two producers of 350 horse-power each.

As the plant has been running only a short time no satisfactory records are available, but it may be said that the gas, which averages about 145 and has reached 151 British thermal units per cubic foot, has given excellent satisfaction both for heating and power purposes. About 95 pounds of buckwheat No. 1 in the producer is equivalent to 1,000 cubic feet of natural gas containing 800 British thermal units per cubic foot, and 75 pounds is equivalent to the same quantity of city gas containing 550 to 600 British thermal units. At \$5 per ton, which is a high charge for such coal in quantities, the fuel cost

of 1,000 cubic feet of city gas was figured to cost 31.3 cents, including a charge for water and interest and depreciation amounting to 16 per cent. For the engines the guarantee was 1 1/2 pound of buckwheat No. 1 per brake horse-power-hour at full load, which at \$5 per ton gives a fuel charge of 0.28 cent. This amount will generate about 79 cubic feet of producer gas, and with a heat content of 145 British thermal units will supply 11,455 British thermal units per boiler horse-power-hour.

THE PRODUCER PLANT.

In this department each of the two Flinn & Dreffein units is rated at 350 horse-power and consists of a producer and an economizer; a scrubber serves the two generators. The producers, of the water-sealed type, have a heavy steel shell 8 feet in diameter by 12 feet high, firebrick lined, and rest on legs in a concrete pan. The fuel is supported on a layer of ashes on the bottom of the pan. Between the bottoms of the shell and the pan there is a clearance of 12 inches, and as the pan diameter is greater than that of the shell, there is room for removing the ashes, which are placed in 400-pound cans, hoisted to the street level and carted away.

Coal from a 100-ton bunker below the street level is delivered by gravity through a chute into the bucket of a 1-ton electric monorail hoist, which for feeding can be moved directly over the hopper of each producer. At their rated load the two require 750 pounds of coal per hour, although they are now running at only two thirds

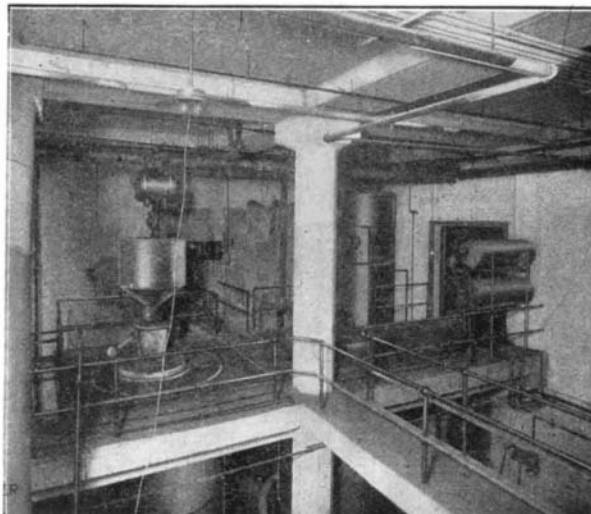


Fig. 2.—Charging floor of producers.

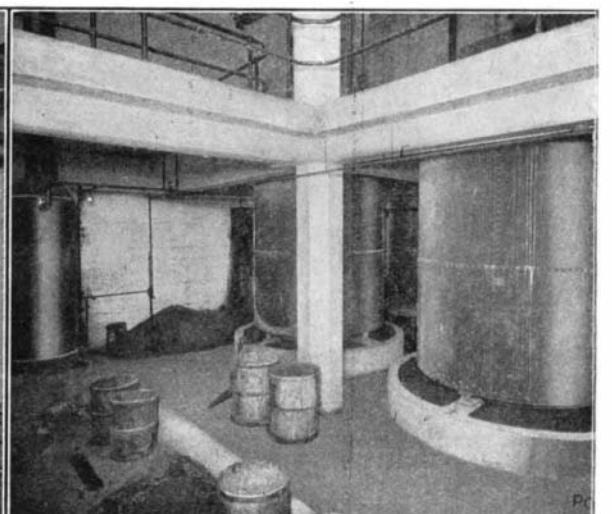


Fig. 3.—Bottom of generators and steam boilers.

* Reproduced from *Power*.

by a 15-horse-power motor. Instead of using a gas holder, a pipe connection is made between the delivery and suction sides of the exhauster. In this line is a back-pressure valve weighted for the desired pressure; when this exceeds the predetermined value, the valve opens and returns part of the gas to the suction side of the exhauster. The

latter is run at constant speed so that the maximum output will be available. To the valve spindle is attached a diaphragm subject to the pressure in the gas main, and opposing this are weights on the upper side of the diaphragm. The construction is such that the diaphragm casing may be rotated at will, pulling with it the valve

disk and thus keeping it free from soot or deposit by the grinding action on the seat.

For the engines, the gas is clean enough as it comes from the wet scrubber, but for small burner work it must also be passed through a static washer operating on the impact principle. The washer, Fig. 6, consists of a chamber having two compartments, the upper one giving space for gas admission and a spray of water. Hanging from the dividing wall is a threaded cylinder with a piston having threads of the same pitch, but not in contact with those of the cylinder wall. Both are so tapered that as the piston is moved downward the flow area is lessened and the velocity of the gas is increased, or *vice versa*. The stem attached to the piston has threads of the same pitch also, so that in moving the piston up or down there is no variation in the "mesh."

In passing through this zigzag course, the remaining soot particles in the gas are deposited on the metal surfaces and washed down through the drain at the bottom of the lower compartment. The purified gas passes on to the burners.

ENGINE ROOM.

The engines are of the tandem type directly connected to 110-, 220-volt, three-wire generators, with a balancer set. Rites inertia governors acting through balanced cut-off valves control the speed, and under the severe conditions imposed by the welding department they have maintained close regulation.

The plant is distinctive in design in that any part of either engine, with the exception of the crankshafts and flywheels, is interchangeable, and either half of the twin engine can be run independently of the other. In this way, one tandem unit can be out of service and the other two will be available to furnish the maximum load of 150 kilowatts.

A 10-inch pipe from the scrubber, with 6-inch taps to each tandem unit, supplies the gas to the engines. From the twin engine, two 6-inch exhaust pipes discharge to a 12-inch muffler; this reduces to 8 inches as it leads to the roof. The single tandem engine has a 6-inch exhaust, a 10-inch muffler and a 6-inch riser.

Air for starting is stored in two 30-cubic foot tanks at 200 pounds pressure during the day by a motor-driven compressor. From a 5,000-gallon tank on the roof, cooling water flows through the engine jackets and then to the suction of a 2-inch motor-driven centrifugal pump which returns it to the tank through a cooling tower above the tank. In case of accident to the pump, city water will be used temporarily.

Other equipment includes a pump and air-compressor unit for the sprinkler system, a motor-generator set to supply current of the proper voltage for welding, two bilge pumps to raise the sewage to the necessary level, and a triplex pump to circulate water through the type-casting machines.

For heating the building, two water-tube boilers, each able to serve 10,000 square feet of radiation, supply steam at a 5-pound pressure to a vacuum system having 16,000 square feet of radiation. A steam plant was first considered, but because of the low efficiency in summer, of insufficient exhaust steam to supply the heating for at least part of the winter, and because gas was needed in the shop, the present plant appeared to be the best; considering its brief period of operation, nothing has happened to gainsay this decision. The gas for both services has given satisfaction, and, from the meager data available, the cost has been exceptionally low.

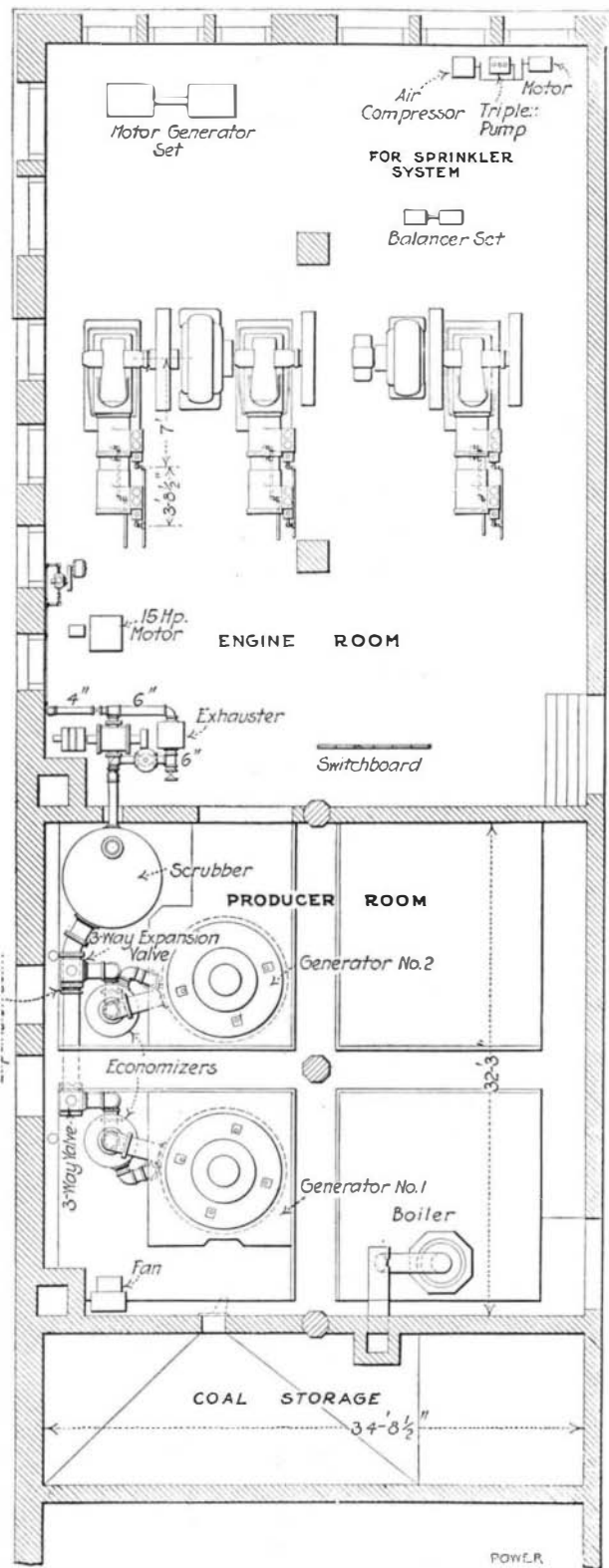


Fig. 4.—Plan view of engine and producer rooms.

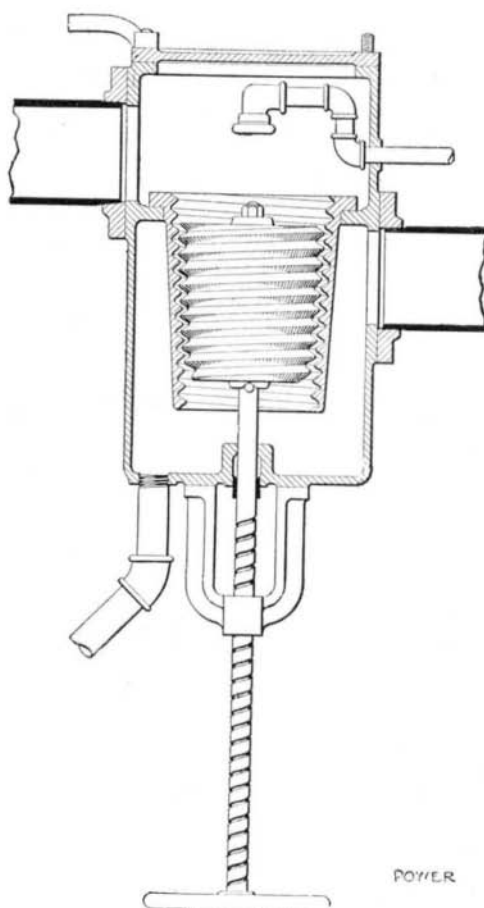
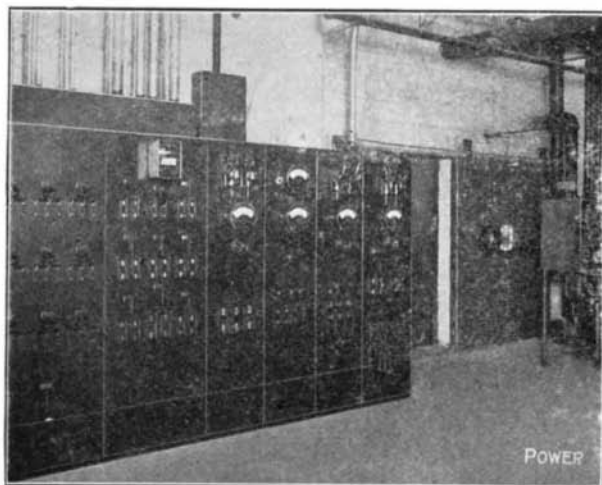


Fig. 6.—Sectional view through static washer.

Amputations Less Frequent in War

INTERESTING figures of the cost of medical service in war and the percentages of death from wounds in modern warfare are given in an editorial in the *New York Medical Journal*. The *Journal* quotes Prof. Charles Richet of the University of Paris as authority for the assertion that ambulance service alone for 500,000 wounded or ill costs \$1 a day for each, or \$500,000.

"This is a startling sum," says the editorial, "but apparently it does not take into consideration the cost of feeding the doctors, nurses, and either chauffeurs, or drivers of horses connected with the ambulance service, while there is no estimate of the first cost of the elaborate paraphernalia, drugs, apparatus, instruments, etc., required."

Roughly speaking, the editorial asserts, battle casualties in recent wars have varied from 10 per cent to 20 per cent of the number of soldiers engaged. The ratio of killed and wounded has been about one to four. Of the casualties, from 65 to 80 per cent were caused by rifle fire and from 20 to 30 per cent by artillery fire, chiefly shrapnel. Bayonet and saber wounds have been of comparatively infrequent occurrence, and little mention is made of them in reports. In the civil war in this country 90 per cent of the total wounds recorded were caused by small arms, while the injuries from artillery amounted to only 9.87 per cent of the total wounds.

"The increase in range, the rapidity and accuracy of fire developed in modern military firearms, supplemented by the relative increase in the strength of field artillery, will have an important bearing upon the character of the wounds and the number of the casualties," say the *Journal* in commenting on the present war. "Experience in recent wars has demonstrated the character of the injuries produced by modern firearms. The European powers have all adopted rifles with similar ballistic properties. The bullet is jacketed, of small caliber, varying from 6.5 millimeters to 8 millimeters, and weighs from 150 to 200 grains. It is either ogival or pointed in shape and has an initial velocity of from 2,000 to 2,700 feet a second.

"The pointed or 'spitz ball' has been adopted by England, Germany, Turkey, and the United States. The wounds inflicted are, therefore, entirely different from those inflicted by the rifle in use several decades ago. This weapon had a low velocity and carried a soft leaden bullet of large caliber.

"Experiences in the Russo-Japanese and Balkan wars have demonstrated that at the greater ranges perforations of the abdomen, chest, and skull may take place with astonishingly slight effects. This statement must be modified so far as the pointed bullet is concerned, since this bullet has its center of gravity near its base, and is usually 'set up' on meeting with slight resistance, thus forcing its way through the tissues in its length instead of in its diameter.

"Fatal primary hemorrhage occurs much more frequently than in earlier wars, because the small-caliber jacketed bullet is more likely to sever vessels, while the large-caliber bullet, moving with less velocity, affords time for the blood vessel to be pushed aside from its course.

"It has been estimated that 85 per cent of deaths on the modern battlefield are due to hemorrhage. Secondary hemorrhage, which in former wars was of such common occurrence, nowadays rarely occurs, while traumatic aneurism is much more frequent.

"Amputations are much less frequently necessary, and then only where there is extensive destruction of limb, as in wounds by large shell fragments, or injuries to blood vessels completely arresting circulation. Wounds inflicted by the modern rifle bullet, if properly protected against infection, never require amputation unless the circulation is arrested. Machine guns use the rifle ammunition, and the wounds inflicted by them are identical in character with those inflicted by other small arms.

"The wounds inflicted by shrapnel differ from those caused by the rifle bullet in that they are accompanied by a greater contusion and involve a greater amount of tissue, shrapnel bullets being of greater size and having a much lower velocity. Shrapnel wounds are frequently multiple, and almost invariably suppurate, since they are very apt to carry foreign material from the clothing into the wound."