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THE FORWARD GAS-ENGINE.

THE more thoughtful among us will welcome any improvement in the arts which will modify the conditions under which motive power is available, and render it more accessible to small establishments whose existence depends upon the closest economy in all directions. One means of attaining this end is the introduction of gas-motors into these small industries. The great care and attention which have been paid to economic conditions in Europe have caused this subject to receive more consideration there than in this country: hence many important improvements in this class of machinery have found their origin and their greatest field among our transatlantic kindred. The sharp rivalry, however, engendered among them by the great demand, has stimulated efforts to perfect these motors, which have finally resulted in the group of inventions, patented both in Europe and America, by the producers of the Forward gas-engines. This motor has only been on the market for about a year in Europe, but is rapidly coming to the front. It was exhibited at the recent electrical and industrial exhibition at Birmingham, where, we are informed, it received the only gold medal for excellence of construction in gas-engines, as well as the only medal awarded gas-engines for electric lighting, although the other leading motors of the same class were well represented. It is now for the first time presented in the form of a business enterprise on this side of the Atlantic.

The distinguishing feature of this engine is a rotating valve by which the ignition of the combustible charge in the cylinder is effected. In the valve are eight ignition ports, which come into action successively. Each port, having performed its duty, makes a complete revolution before it comes into action again, and in the mean time is exposed to the air, by which the greater part of the heat which it has absorbed is carried away. This insures the cool working of the valve, which runs scarcely any risk of cutting, while the constant motion in one direction affords another element of safety. Every time the cylinder takes in a charge, the valve gives a partial revolution; but, when the gas is cut off completely, the valve ceases to move, and the small firing charge, which would otherwise be wasted, is saved. The number of missed explosions, however, is not great in this engine, as the strength of the charge is reduced as the work falls off, until it approaches the point at which it would cease to explode; the gas is then cut off entirely, and the valve left stationary until the governor arms again fall.

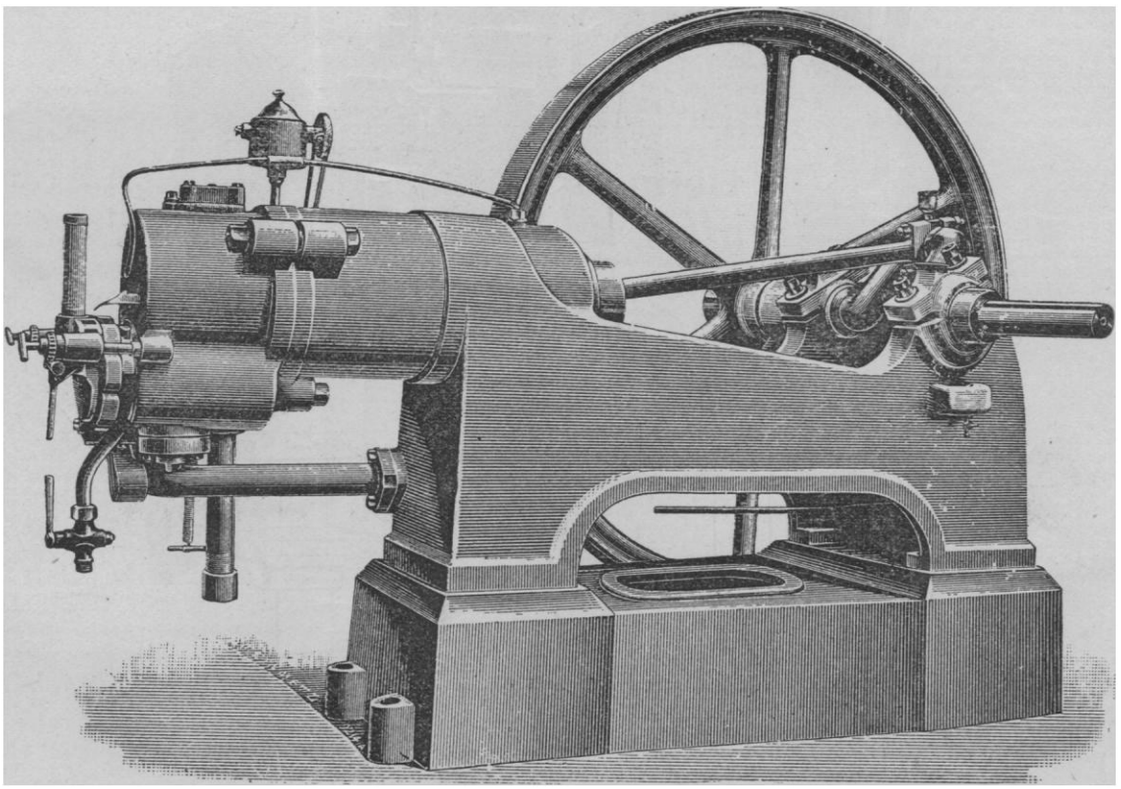

FIG. 1.—THE FORWARD GAS-ENGINE.

The mechanical devices by means of which these operations are performed are shown by the accompanying illustrations. Figs. 1 and 2 are perspective views of a 4-horse-power engine; Fig. 3 is an outline of the working parts, looking from the crank-shaft; and

Figs. 4 and 5 are plan and sectional views of the ignition valve. The valve *a* (Figs. 3, 4, and 5) is mounted on a pivot at the rear of the combustion chamber of the cylinder, and has a number of ratchet-teeth (*e*) around its circumference. It is rotated by a pawl, *l*, worked by a small crank at the end of the side shaft, and a connecting link, *n*. The cylinder being charged with compressed explosive mixture, the port *d* is also charged with the gaseous mixture. The disk *a* is, by the intermittent motion imparted to it, brought into position at the required time for igniting the mixture in the cylinder. The slot or small gas-chamber *f g* in the disk *a*, which is approaching the port *d*, receives inflammable gas from the fixed gas-duct *j* in the cover *b*, the passage j^2 in the rotating disk *a* being brought opposite during the motion of the said disk, and communicating with the duct or curved slot *j* in the cover *b*. The

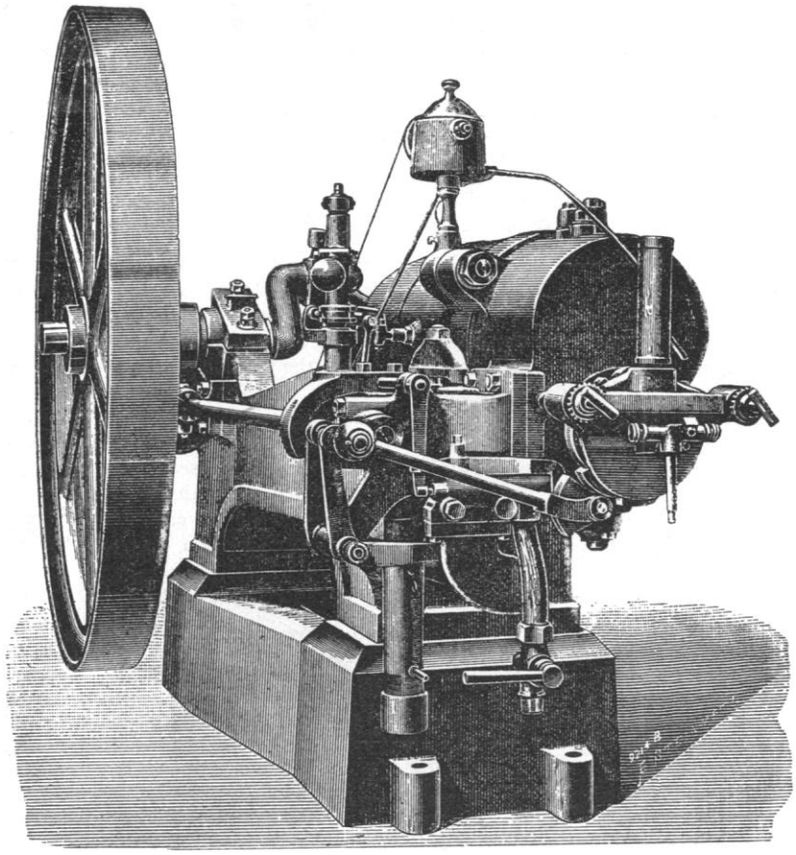

FIG. 2.

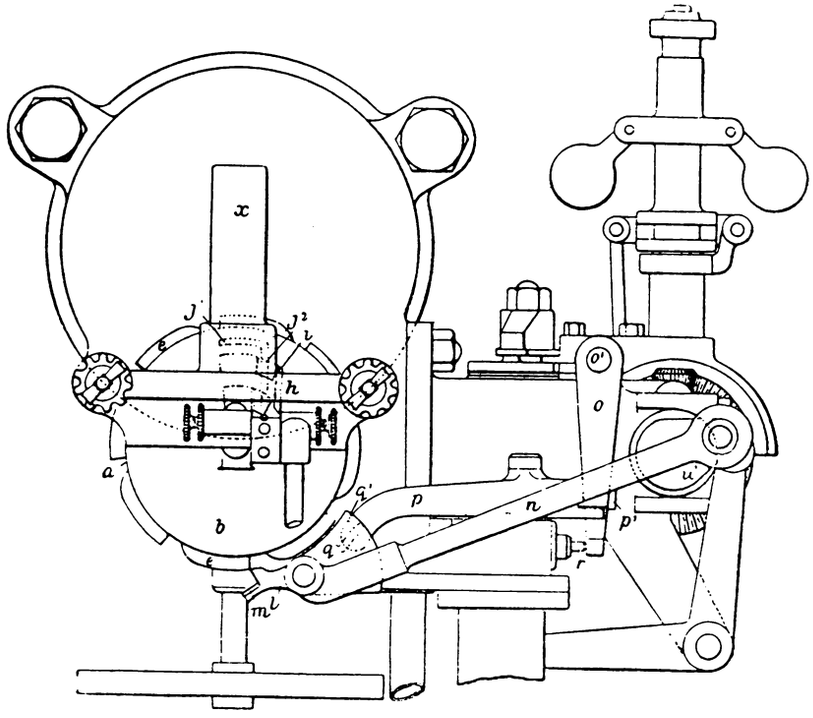

FIG. 3.

slot or small gas-chamber $f\,g$ receives atmospheric air to form an inflammable mixture with the gas in the small chamber through the duct f^2 in the fixed cover b, which duct f^2 communicates with the port g of the small gas-chamber $f\,g$.

By the action of the ratchet motion the small gas-chamber $f\,g$ in the disk a, having been charged in the manner described, is carried rapidly forward, and the gaseous mixture therein is ignited by the fixed relighting gas-jet h^1. The igniting of the charge in the

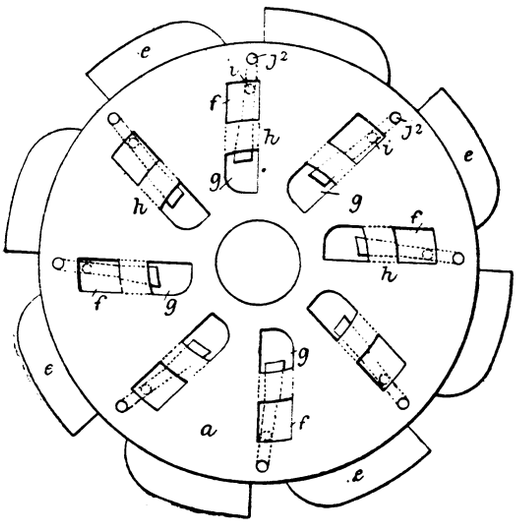

FIG. 4.

small gas-chamber $f\,g$ takes place immediately before the passage h comes opposite the port d into the gas-cylinder a^2. The passage h coming opposite the port d, the flame in the small gas chamber $f\,g$ ignites the gaseous mixture in the port d and the engine cylinder a^2. The passage h opens into the port g of the small gas-chamber $f\,g$ immediately after the small gas-chamber and the port f^2 are closed, the duct i communicating with the port d a little

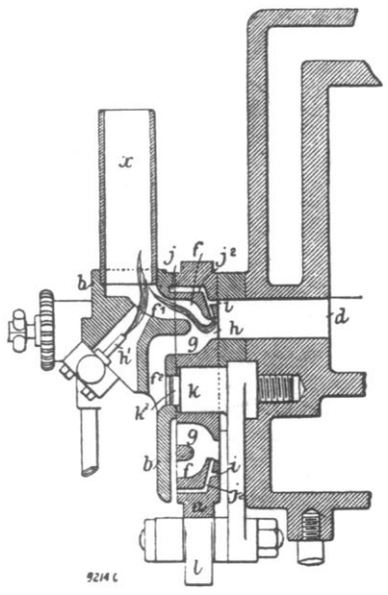

FIG. 5.

before the port h communicates with the port d to effect the ignition of the gaseous mixture in the gas-chamber or cylinder a^2.

The supply of gas is regulated by the lever o and the gas-valve r. The lever receives its motion through a spindle, o^1, from a second lever, which is acted upon by a cam on the side shaft. This cam is under the control of the governor. The lever o carries a cam, p^1, which engages with a lever, p, having at its end a stud, q^1, taking into a slot, q, in the pawl l. Upon the lever o moving so as to open the gas tappet-valve, the cam p^1 operates upon the lever p, causing the stud q to be disengaged from the slot, and allowing the pawl to fall into the teeth of the valve. When the engine is running so fast that the gas-valve is not opened, the stud holds the pawl out of gear.

This engine has been subjected to a series of tests by Professor R. H. Smith of Mason College, Birmingham, and has given most satisfactory and economical results. It was tried at full working load, at half load, and without load, the latter test being divided into three parts, — at fast, medium, and slow speeds. The full working load trial lasted 85 minutes, the speed being 176.86 revolutions per minute. The indicated horse-power was 5.54, and the brake horse-power 4.807, giving a mechanical efficiency of 0.8677. The gas consumed in driving the engine was 163.2 feet, or 20.79

FIG. 6.

Initial pressure	220 lbs. per sq. in.
Average mean pressure	77.73 " "
Revolutions per minute	175

cubic feet per hour per indicated horse-power, and 23.97 feet per brake horse-power. Fig. 6 shows an average indicator card taken during this trial; and Fig. 7, a high-pressure card, illustrating how the governor supplies a richer charge of gas when any sudden demand is made on the engine. At half-power, the brake horse-power was 3.084, equal to a gas consumption of 31.86 feet per horse-power per hour. The lighting jet burned about two feet an hour in both cases. When the engine was running empty, it burned 53 feet of gas per hour at the high speed, 44 feet at the medium speed, and 34 feet at the low speed. A comparison of these results with those obtained in the Society of Arts trial in England shows that the Forward gas-engine ranks very high in the matter of economy, while its mechanical simplicity is a great additional recommendation.

One of these engines, of 4 horse-power, is now on exhibition in

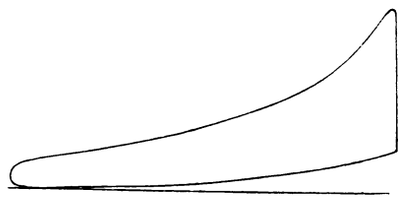

FIG. 7.

Initial pressure	165 lbs. per sq. in.
Average mean pressure	65.11 " "
Revolutions per minute	177

Boston, by the Forward Gas Engine Company, who, we understand, control the patents for this country, and will soon begin their manufacture.

A DANGEROUS INSECT PEST IN MEDFORD, MASS.

MR. C. H. FERNALD of the Division of Entomology of the Hatch Experiment Station of the Massachusetts Agricultural College, Amherst, Mass., has issued a special bulletin on "A Dangerous Insect Pest in Medford," known as the gypsy-moth (*Ocneria dispar* L.). On the 27th of last June, during his absence in Europe, several caterpillars were received at the station from Hon. William R. Sessions, secretary of the Board of Agriculture, with the request for information as to what they were, and the best methods of destroying them. These caterpillars were brought into the secretary's office by Mr. John Stetson of Medford, Mass., who stated that they were very destructive in that town, eating the leaves of fruit and shade trees. Mrs. Fernald, who had charge of the entomological work during Mr. Fernald's absence, determined the insect to be