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

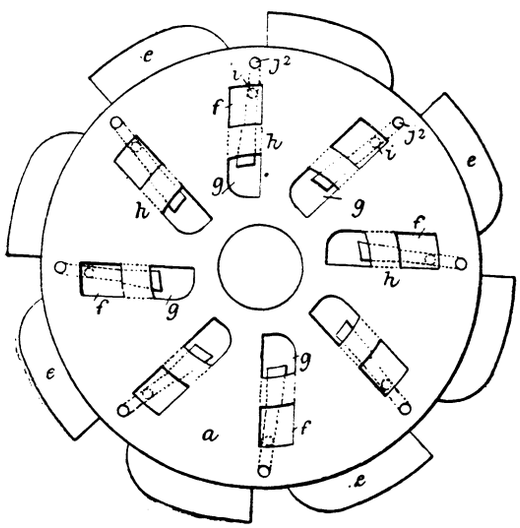

FIG. 4.

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

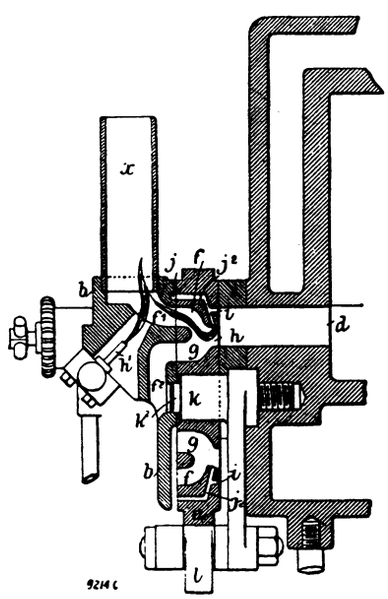

FIG. 5.

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

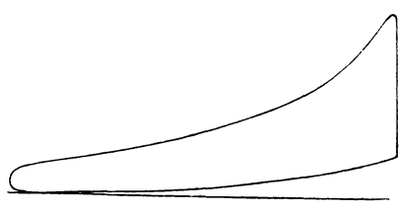

FIG. 7.

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

the gypsy-moth (*Ocneria dispar* Linn.) of Europe; but as the moths were emerging, and laying their eggs for next year's brood, there was nothing to recommend at that time except to destroy the moths and their eggs as far as possible, and prepare for the destruction of the caterpillars when they first appear next spring.

There is a statement in the second volume of the *American Entomologist*, p. 111 (published in 1870), and also in Riley's "Second Missouri Report on Insects," p. 10, that "only a year ago the larva of a certain owlet moth (*Hypogymna dispar*), which is a great pest in Europe both to fruit-trees and forest-trees, was accidentally introduced by a Massachusetts entomologist into New England."

Mr. Samuel Henshaw and Dr. Hagen of Cambridge both state that the entomologist who introduced this insect was Mr. L. Trouvelot, now living in Paris, but at that time living near Glenwood, Medford, where he attempted some experiments in raising silk from our native silk-worms, and also introduced European species for the same purpose.

It seems, then, that this was an accidental introduction, but that they have now become acclimated, and are spreading, and doing so much damage as to cause very great alarm.

The gypsy-moth is abundant in nearly all parts of Europe, northern and western Asia, and it even extends as far as Japan. In this country it occurs only in Medford, Mass., occupying an area in the form of an ellipse about a mile and a half long by half a mile wide. This represents the territory where the outbreak occurred, and where the insects were very abundant. Without doubt, they are distributed in smaller quantities outside of this ellipse, but how far it is now impossible to tell.

This insect was reported as feeding upon the leaves of apple, cherry, quince, elm, linden, maple, balm of Gilead, birch, oak, willow, wisteria, Norway spruce, and corn. The food-plants given in Europe are apple, pear, plum, cherry, quince, apricot, lime, pomegranate, linden, elm, birch, beech, oak, poplar, willow, hornbeam, ash, hazel-nut, larch, fir, azalea, myrtle, rose, cabbage, and many others. Curtis, in his "British Entomology," states that they are sometimes very destructive in gardens. Professor W. P. Brooks reported this insect as very abundant in Sapporo, Japan, in 1883, and gave strawberry as a food-plant in addition to those mentioned above.

The fact that this insect has now been in this country for the last twenty years, and has not only held its own, but has multiplied to such an extent as to cause the entire destruction of the fruit-crop and also to defoliate the shade-trees in the infested region, is sufficient cause for alarm. The citizens of Medford are immediately interested, but the entire Commonwealth and country are threatened with one of the worst insect pests of all Europe. In 1817 the cork-oaks of southern France suffered severely from the attacks of this insect. One of the papers of that time stated that the beautiful cork-oaks which extended from Barbaste to the city of Podenas were nearly destroyed by the caterpillars of the gypsy-moth. After having devoured the leaves and young acorns, they attacked the fields of corn and millet, and also the grass-lands and fruit-trees.

In 1878 the plane trees of the public promenades of Lyons were nearly ruined by this same insect. Mr. Fernald states that only last summer he saw the moths in immense numbers on the trees in the Zoölogical Gardens of Berlin, where the caterpillars had done great injury; and the European works on entomology abound with instances of the destructiveness of this insect. When its long list of food-plants is considered, it will be seen how injurious this insect may become if allowed to spread over the country, and become established.

The opinion was expressed to him by prominent entomologists in Europe, that, if the gypsy-moth should get a foothold in this country, it would become a far greater pest than the Colorado potato-beetle, because it is so prolific, and feeds on so many different plants, while the potato-beetle confines itself to a small number.

In Europe eleven species of the *Ichneumonidæ*, and seven species of flies (*Tachina*), have been known to attack the eggs and caterpillars of this moth; but it is not known that there are any parasitic insects in this country that destroy it. Undoubtedly our predaceous beetles and bugs destroy more or less of them, and mud-wasps and spiders are also to be counted among their enemies.

All the masses of eggs should be scraped from the trees and other places where the females have deposited them, and burned. Crushing is not sufficient, as possibly some might escape uninjured. This should be done in the fall, winter, or early spring, before the eggs hatch. It is not at all probable that one will find all the egg-masses even with the most careful searching on the trees in a small orchard; but, when one remembers that this insect deposits its eggs on all kinds of shade and forest trees also, it appears a hopeless task to exterminate this pest by an attempt to destroy the eggs. It is a habit of these caterpillars, after they have emerged, to cluster together on the trunks or branches of the trees between the times of feeding, and this affords an opportunity of destroying vast numbers by crushing them; and after they have changed to pupæ they may be destroyed wherever they can be found. The female moths are so sluggish in their flight, and so conspicuous, that they may be easily captured and destroyed as soon as they emerge; yet any one or all of these methods which have been employed in Europe are not sufficient for their extermination. At best they will only reduce the numbers more or less, according to the thoroughness with which the work has been done. Mr. Fernald could not learn that any attempts have ever been made in Europe to destroy this insect by means of poisonous insecticides, and it is to this method that we may look for positive results in this country.

If all the trees in the infested region in Medford be thoroughly showered with Paris-green in water (one pound to a hundred and fifty gallons) soon after the hatching of the eggs in the spring, the young caterpillars will surely be destroyed; and, if any escape, it will be because of some neglect or ignorance in the use of the insecticide. It will be absolutely necessary to shower every tree and shrub in that region; for, if a single tree be neglected, it may yield a crop sufficiently large to eventually restock the region.

We can hardly feel confident that all these insects can be exterminated in one year; but if this work of showering the trees be continued during the months of April and May for two or three years under competent direction, we have no doubt but that they may be entirely destroyed.

This is, in the opinion of Mr. Fernald, the cheapest and surest method of exterminating this pest, but its effectiveness depends entirely upon the thoroughness and carefulness with which it is done; and those who do the work must have authority to shower the trees not only on public, but on private grounds.

As this insect was introduced into this country by an entomologist who carelessly allowed it to escape, the same thing may occur elsewhere if the people of Medford allow the eggs or caterpillars to be sent out of the town. The only proper thing to do with such a dangerous and destructive enemy is to burn it.

Several different common names have also been given to the insect in Europe, as the "sponge-moth," the "gypsy-moth," the "great-headed moth," the "fungus-moth," and others.

ELECTRICAL NEWS.

SPECIFIC INDUCTIVE CAPACITY. — Mr. W. A. Rudge writes on the above subject to *Nature* as follows: "On p. 669 of Ganot's 'Physics' (eleventh edition) the following statement is found: 'At a fixed distance above a gold-leaf electroscope, let an electrified sphere be placed, by which a certain divergence of the leaves is produced. If, now, the charges remaining the same, a disk of sulphur or of shellac be interposed, the divergence increases, showing that inductive action takes place through the sulphur to a greater extent than through a layer of air of the same thickness.' If this statement were correct, there should be less electric action on the side of the ball farthest from the electroscope when the dielectric is interposed. To test this, I arranged an experiment as follows: The knob of a charged Leyden jar was placed midway between two insulated plates of metal, each plate being in connection with an electroscope. The leaves of each electroscope now diverged to an equal extent. A plate of ebonite was now placed between the knob of the jar and one of the plates. If the statement above quoted is correct, the leaves of the electroscope in connection with this plate should show an increased divergence, but the reverse