work steam, owing to the facility with which the strength of the reservoir may be increased. Then, no additional cost is incurred by working at the highest pressure; precisely the same electro-motive force is expended in effecting decomposition at all pressures. Thus the strength of the gas-generator is the only practical limit to this enormous force, the real obstacle to its most economical application, an obstacle which doubtless will gradually yield to the ingenuity of engine manufacturers.

These gases may be wrought expansively, which will result in very great augmentation of the work done by the engine, for the same expenditure of electro-motive force.

After the gases, by passing through the cylinder, have impressed upon the piston the force due to the pressure under which they are generated, they may be utilized in either of the following ways:—

I. By detonating the gases after they have expanded; while in the cylinder, they may be combined by an electric spark. In combining they expand to fifteen times their bulk, and consequently impress a force on the piston equal to fifteen times the pressure which the gases exerted. A heavy fly-wheel would prevent the loss of *vis viva* which might attend the suddenness of the application of this force.

When the gases are combined by an electric spark, they are converted into water, and a vacuum results similar to that occasioned in a condensing steam engine by the condensation of the steam. By the vacuum which is thus formed by the combination of the gases, the advantages of the high-pressure and condensing steam engine may be combined in the electric-gas engine.

The sources of force are, therefore, threefold.

1st. The high pressure in the gas generator, which may be taken at 50 atmospheres, or 736 lbs. to the square inch, although in high pressure steam engines it rarely exceeds 120 lbs. There can be little doubt but that the reservoir might be readily constructed sufficiently strong to work safely at a pressure of 60 or even 100 atmospheres, particularly when all the inducements which economy can hold out are on the side of high pressure in the electric-gas engines.

2nd. The expansion of the gases to 15 times their volume exerts a force on the piston.

3rd. A vacuum which will give a useful effect of from 13 to 14 pounds per square inch.

II. The combustion of the gases after passing through the cylinder, may be employed for heating the gases in the cylinder while expanding, and thereby increasing their elastic force; it is obvious that this heating process must be applied while the gases are in the cylinder, for no advantage would accrue from increasing their tension in the gas generator, as they can be evolved at the highest possible pressure there without additional expense, but if they be heated while expanding, it is obvious that the work done by them would be much increased.

III. By burning the gases after passing the cylinder, for the development of thermo-electricity, to be employed in aid of the electricity used in decomposing water in the gas generator.

IV. By using the gases after passing through the cylinder for the purpose of developing electro-motive force, to go in aid of that employed in decomposing the water in the gas generator, theoretically the electro-motive force developed by the combination of the gases ought to decompose an amount of water equal to their own weight. This is, I believe, the theoretic effect of Groves gas battery.

Thus, then, the gases, after being used in the cylinder, may be employed in one of three ways:—1. For the production of an electro-motive force by thermo-electricity or by voltaic-electricity. 2. For the production of a detonating force, and the resulting vacuum. 3. For increasing by their combustion the tension of the gases in the cylinder.

It may be observed, that in an electric gas engine the gases may be wrought expansively, which will not only result in considerable saving, but will also materially diminish the possible practical inconvenience of the detonation of the gases in the cylinder; if, for example, the gases were wrought at 50 atmospheres, and were allowed, before being detonated, to expand in the cylinder till the pressure was one quarter of an atmosphere, the pressure on the piston when detonated, would be less than one-twelfth of the initial pressure of the gases in the cylinder; what the proper amount of expansion to be allowed is, would very soon be practically determined, when the electric gas engines come into operation.

The strength of the reservoir, or gas generator, in an electric-gas engine, corresponding with the boiler in a steam engine, might be increased to almost any amount required; the difficulties which prevent the strength of a steam boiler from being increased beyond a certain point could not operate as regards a gas generator. One of the main objects kept constantly in view in the construction of a steam boiler, is the securing the largest possible amount of heating surface; now the strength of a boiler is the strength of the weakest part of it, consequently, as its surface is extended, the chances of a flaw or weakness in some part of that surface are increased; then if the thickness of the plates were unduly increased it would interfere with the action of the fire. The rivetting of the plates is estimated to reduce the strength one-third. The highest tension attained in high-pressure steam engines scarcely, if ever, exceeds eight atmospheres, or 120 lbs., per square inch; in an electric-gas engine, the highest pressure may be maintained in the gas generator at precisely the same cost as the lowest; consequently, the higher the pressure the less the expense for equal amounts of work done. With regard to the construction of the reservoir, or gas generator, the form of greatest strength may be adopted, and the thickness of its parts augmented to any conceivable amount.

If necessary, to obviate any danger that might possibly arise from the accidental detonation of the gasses in the gas generator (if such a thing be possible), the gas generator may be divided into compartments, in which each gas may be kept separate, thus rendering such a detonation wholly impossible. With regard to the cylinder, it may, if found requisite, be divided, during the first part of the stroke, into two separate compartments, proportioned in capacity to the respective volumes of the two gases, but so as that during the latter part of the stroke, the gases may become mixed,