THE HOT-AIR BOILER.

The development of the automobile and the ever-increasing demand for small motors of high power and light weight have established conditions which are fairly well met by the gasoline engine—far more satisfactorily indeed than by the steam engine or the electric system; and yet a gasoline engine even of the best possible construction is, in regard to flexibility of power and ease of control, by no means the equal of either of its rivals. A gasoline engine generates power very economically and is of light weight and convenient proportions; but it usually requires a variable speed reversible transmission, to render its power available for the purpose of an automobile; and in addition to this it must be cranked by hand to start it. It also requires a considerable amount of dead and otherwise useless weight in the form of a flywheel. in order to convert its sudden explosive impulses into continuous rotary motion.

The steam engine, on the other hand, is instantly reversible, and may be stopped and started and controlled with the greatest ease; but the inevitable steam boiler, with its roaring fire and an insatiable greed for fuel, forms a most unwelcome accompaniment. There is, however, an improvement upon the steam boiler. This is a pressure-generating device which, for the sake of brevity and convenience, we may term the hot-air boiler, otherwise known as the thermic or thermodynamic generator, or continuous-combustion generator, etc. This device, as originally conceived, consists simply of a steam boiler without a stack, and with a firebox or combustion chamber inclosed within the shell, the products of combustion being discharged directly through the water into the steam space of the boiler. A blast of air and gaseous fuel is continuously forced into the firebox, under a pressure which must of course be a little higher than that of the boiler. The products of combustion come into actual contact with the water, mingling with and superheating the steam, and adding their volume to the working fluid of the generator.

The writer once tried an interesting experiment along this line, which any one may repeat with the apparatus shown in Fig. 1, in which *A* is the combustion chamber or firebox, consisting of a piece of 2½-inch iron pipe, 8 inches long, one end of which is open, and the other capped and reduced to receive a piece of ¾-inch pipe, *B*, about 3 feet long. This is the mixer, gas and air being led into it by the arrangement shown at the top. The air enters at *C* under a few pounds pressure, and the gas is admitted at *D*. The firebox, *A*, is lined with asbestos, secured by means of water glass used as a cement. The purpose of this lining is to fire the gas, and burn it completely within the walls of the firebox. After being lighted and properly adjusted, this device was plunged vertically with the open end down into a barrel of water. The effect was an amusing spectacle, a veritable conflict of fire and water. The gas mixture, kept alight by the asbestos lining, continued to burn within the firebox, and issued forth fiercely into the water in spite of the efforts of the latter to extinguish the flame. In a surprisingly short time the water was boiling hot and in a state of violent ebullition, the disengaged steam being doubled in volume by the burnt air and gas which mingled with it.

No accurate test of the arrangement was made to determine the amount of gas necessary to effect a given evaporation, but it is evident that the thermal efficiency must be very high. The fire-box being of sufficient size, the combustion of the fuel is completed within it, and the hot products impart their heat to the water by direct contact as they rise in a torrent of expanding bubbles to the surface.

The basic idea upon which these generators are built is by no means new. Propositions for the construction and use of such generators, usually for stationary power plants, have formed the subject of a number of patents, and have occasionally appeared in the columns of the technical press; but notwithstanding this, the idea would seem to be little known, and so far as the writer is aware, the method has not yet been practically applied to either road or marine locomotion. This is probably on account of difficulties which arise from defects in the compressed-air and fuel-regulating devices. It seems evident, however, that the system is capable of successful development, and promises advantages of such a nature as to merit further consideration.

The intention of the first experimenters with this system of power generation was evidently to construct a boiler in which steam would form the principal part of the working fluid, the stream being superheated and considerably increased in volume by the burnt air and fuel gases which mingle with it. The more modern idea, however, is to so construct the generator that the working agent will consist principally of the highly-heated products of combustion mixed unavoidably with a little steam; the water being used only to cool the gases slightly, and to moderate the otherwise excessive temperature of the generator and engine.

Fig. 2 shows the principle upon which these thermic pressure generators are constructed, in which *A* is the boiler shell, *B* the combustion chamber, and *C* the inlet pipe for the gas and air, the water being carried in the space surrounding the combustion chamber, as shown. The air and vaporized fuel or gas is forced in through the inlet pipe, *C*, under a pressure slightly above that of the boiler. The combustion chamber should be lined partly at least with asbestos, to keep the flame alight. It might also be furnished with an electric sparker for starting. The amount of steam produced by this device would depend upon the size of the combustion chamber and the surface exposed to evaporation. It is desirable, however, to so proportion the arrangement that the steam will constitute from one-fourth to one-third of the total volume of the working fluid. This would probably moderate the temperature of the generator to such an extent that an ordinary double-acting steam engine could be employed. The economy of performance would of course not be quite equal to that of an internal combustion engine, but it would be far superior to that of an ordinary steam boiler. In fact, the fuel cost of driving an automobile by this system should not exceed one cent a mile, per thousand pounds weight, with gasoline or other liquid fuel at 15 cents a gallon; and the quantity of water to be carried would not exceed one-third of that necessary with a steam boiler and engine of equal power. Another welcome advantage would be the small size and light weight of the generator. For a 6-horse-power automobile system, the diameter of the

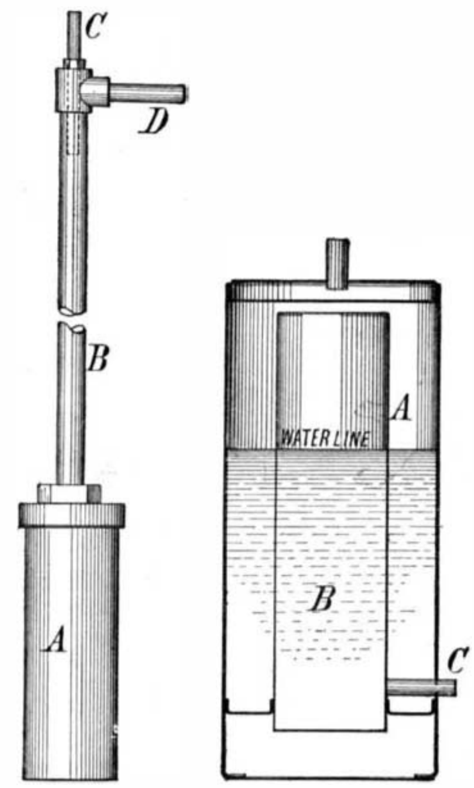

Fig. 1. Fig. 2.

A HOT-AIR BOILER.

outer shell *A*, in Fig. 2, need not exceed 8 inches, with a height of 16 inches. The combustion chamber might be about 3 inches in diameter and 12 inches high. The air required would be about 25 cubic feet per minute at atmospheric pressure; and to compress this air to 250 pounds per square inch would consume something like one-sixth the power developed by the engine; if this was originally 6 horse-power, we would have left 5 horse-power available for work.

There would be no visible fire, or danger from fire, in a power system of this kind, and no flywheel and no transmission. In fact, the convenience and flexibility of the steam engine would be combined, to a considerable extent at least, with the thermal economy of the gas engine. The system might also be recommended as a very useful factor in the solution of that vexed problem, the gas turbine.

The Current Supplement.

The services rendered to mankind by the canal engineer have, perhaps, been undervalued. The opening article of the current Supplement, No. 1589, dealing with canals, ancient and modern, seeks to remove this impression and establish him in favor by reviewing his ancient and modern work. The devotion of Herbert Spencer to the study of philosophy has somewhat obscured the fact that his early life was that of a professional surveyor and engineer. In a brief biography his engineering career is instructively discussed. Statistics are given of the passengers carried by the large Atlantic liners. Mr. J. E. Thornycroft writes authoritatively on gas engines for ship propulsion. Artificial fuel forms the subject of a well-considered article. The English correspondent of the Scientific American writes on some interesting applications of the gasoline motor. R. A. Hadfield presents some unsolved problems in matallurgy. The influence which the discovery and the use of metals have had in uplifting man from his early low estate is discussed by Nelson P. Hulst. Still another metallurgical article is that on the annealing of metals by W. J. May. To secure the greatest efficiency in a battery, the elements must be arranged so as to adapt the electro-motive force and the internal resistance to the resistance of the external circuit. How this may be best accomplished is told in an article by George M. Hopkins on the arrangement of battery cells. Major Ormond M. Lissak writes on primers and fuses for cannon.

Automobile Notes.

The next test to attract the attention of automobilists in America is the second annual economy test of the New York Motor Club. This test will be conducted on the ton-mile basis, the total cost of operating a car per ton-mile being compared with the railroad fare. The test will occupy three days—June 20, 21, 22—and will be run from New York to Albany, Springfield, and New York. The total distance is 430 miles. Accurate records will be made of fuel and oil consumption and repairs of all kinds.

Out of the forty-eight contestants who started in the 2,444-mile Coupe d'Or endurance test in Italy on May 10, but sixteen succeeded in finishing on May 24. The test ended at Milan, the last day's run being but 98 miles. The first cars to finish were a San Giorgio-Napier driven by McDonald, an Itala driven by Cagno, and a Fiat driven by Lancia. The winner of the test will be announced later. The test was an exceedingly strenuous one, and only one-third of the starters finished. This was a much poorer showing than has been made in any of the several endurance tests that have been held in this country.

Upon the arrival of the 16-horse-power Reo "Mountaineer" touring car in New York on June 10, the first "round trip" across the continent in an automobile was completed. Percy F. Megargal and David F. Fassett have driven this car over 12,000 miles since last August, under all sorts of conditions and in all kinds of weather. That an automobile can survive such a test, during the course of which its drivers several times nearly lost their lives, is the best proof of the soundness of construction of the American car.

The first big touring event of the year—the contest for the Herkomer trophy—was started in Germany on June 6. The first day's run from Frankfort to Munich was marred by the overturning of a car on a sharp turn and the serious injury of its occupants. The test was for touring cars carrying four persons. It consisted of six daily runs of from 200 to 250 miles each, and also of a series of hill-climbing and brake tests. The only American entrant was Percy Pierce, of Buffalo, who drove an "Arrow" touring car of his own make, similar to the one with which he won the Glidden trophy in this country last summer. The most notable entrant in the tour was Prince Henry of Prussia, the brother of the German Emperor.

The course and rules of the Glidden tour have at last been determined. The contestants for the trophy will start from Buffalo on July 12 and travel eastward to Saratoga, thence north to Montreal and Quebec, and then south again to the Rangeley Lakes in Maine and the White Mountains in New Hampshire. The total distance of the tour is 1,443 miles. The cars will be obliged to keep to a schedule, a pacemaker being provided, and points will be deducted for falling behind or on account of stops for repairs. No repairs or adjustments will be allowed in the garages, and the time for these and for filling the oil and fuel tanks will be counted in the running time. This event is open to touring cars carrying four people of an average weight each of 125 pounds. Non-contestants for the Glidden trophy may enter the tour and not be obliged to obey all the rules under which it is conducted, unless they so desire. The following additional trophies will be given: One trophy, offered by Paul H. Deming to the entrant, not a contestant for the Glidden trophy, who has the lowest penalization under the rules; repairs, replenishments, replacements and inspection in garage being permitted. This trophy is to be competed for between Buffalo and Bretton Woods. One trophy to the club from whose membership the largest number of entries are received in proportion to the total active membership of the club. One trophy to the winner of a hill-climbing contest. One trophy to the winner of a brake test. One trophy to the winner of an obstacle race. One trophy to the car having the least tire trouble during the contest. One trophy to the car which shall complete the tour from Buffalo to the end of the tour under the most adverse conditions and with the greatest number of tire and mechanical troubles.

A writer in the American Machinist stated recently that a steam pipe of 6 inches to 8 inches diameter was covered with a wooden box of 12 inches diameter which was filled with a sawdust mortar, one barrel of lime to five of sawdust. Before covering the pipe—nearly 700 feet in length—it condensed 1,440 pounds of water hourly; after covering it condensed 195 pounds hourly.