## DIFFERENTIAL ENGINE.

This engine not only displays entire novelty of conception, departing from the received practice both of steam and gas engines, but obtain it results, so it is stated, with great economy in the consumption of gas, and by the simplest possible combination of parts. Compression gas engines have hitherto been constructed in such a maner that they compress a certain amount of gas and air, or gas, air, and residuum from a previous explosion, into a cavity in the end of the cylinder, ignite this charge, and obtain work on the crankshaft from the increased pressure due to the higher temperature during the whole of one stroke or half a revolution, during which time the charge is expanded to the original volume. After this the whole contents of the cylinder are allowed to pass into the exhaust pipe at a pressure of 30 lb. to 40 lb. above the atmosphere and at a very high temperature. The well-known "Otto" engine was placed before the public some seven or eight years ago, and other engines followed it, possessing the same features in these respects, that is to say, expanding the charge to the original volume in half a revolution.

Mr. Atkinson argues that substantially the utmost limit of economy in any engine working in this manner was reached in the "Otto" engine some years ago, and that, unless some other system of working were introduced, no further economy could be attained. The great source of loss in the ordinary gas engine results from the cooling action of the cold-water jacket around the cylinder, and to reduce this, Mr. Atkinson designed the engine shown in diagram in Fig. 1 to 4, and in plan and elevation in Fig. 5 and 6 on the next page, his object being to allow the gases to expand much more rapidly than usual, and thus to be in contact with the cold cylinder wells for a short er period. Referringto the engravings, it will be seen that the cylinder is open at each end, and is fitted with two pistons. The are connected by doubled-ended levers and short connecting rods to one crank-pin. The short connecting rods are an essential feature of the design, as it is through their action that the peculiar differential motion of the pistons is obtained. The pistons travel in the same direction, but at very different relative speeds; when at the outer end of their strokes, they remain almost at rest for nearly half a revolution of the crank-pin, but travel rapidly when at the inner ends of their strokes. When the two pistons have completed the strokes to the right (Fig. 1), they almost touch each other, and have driven out the products of the previous working stroke through a port in the cylinder wall, so that the hot residuum that frequently causes violent premature ignitions, is completely expelled. The crank-pin is at this time on the left, and as it proceeds towards the highest position, the left-hand piston moves rapidly away from the other, leaving a space between them into which gas and air are drawn in suitable proportions through a self-acting suction valve. At this point (Fig. 2) the right-hand piston travels past, and closes the openings to the suction and exhaust valves; and during the next quarter revolution the pistons again approach each other, compressing the charge between them to about 60 lb. pressure, the crank being now on the right-hand side (Fig. 3). At the time of greatest compression the left-hand piston passes the opening to an igniting tube (Fig. 3), which causes the ignition, and an immediate rapid working stroke is made by the right-hand piston, and is completed by the time the crank-pin arrives at the bottom (Fig.4). The exhaust port is now opened by the continued travel of the piston, and the contents of the cylinder driven out through the self-acting exhaust valve by the left-hand piston, which is now in the position first mentioned, the complete cycle being completed in one revolution.

The place between the pistons into which the ignited charge expands, is nearly double the space into which the charge is drawn, consequently the expansion is continued to nearly twice the original volume, and instead of the exhaust being emitted at 30 lb. to 40 lb., it is expanded down to 10 lb. or 12 lb. It will be seen also that the total expansion to twice the original volume takes place in one-fourth of a revolution as compared with other engines which expand to the original volume only in half a revolution, consequently the expansion to the original volume is done in one-fourth of the time, assumming the engine to run at the usual speed. The economy to be gained from the extra expansion is obvious, while the saving due to rapid motion of the piston was demonstrated in the early part of 1883 by Mr. Witz, who made some experiments with a view to determining the effect of increased rapidity of expansion. In one series of experiments he used a mixture of one volume of illuminating gas and 6.33 of air, a very usual proportion in gas engines. This mixture was drawn into an experimental cylinder and exploded, the piston being allowed to travel at the rate of 1.7 metres per second, corresponding to an ordinary piston speed in a medium-sized gas engine, and by means of the diagram he estimated the actual amount of work done. He increased the speed of piston to travel 4.3 meters per second, or 2.54 times as fast, the same amount of gas did 2.9 times as much actual work. This enormous increase is chiefly due to the fact that the intense heat of combustion is not allowed to continue so long in contact with the walls of the cylinder, cooled by the water jacket. It is well known that more than one-half of the total heat in the gas, even if thoroughly consumed, is lost by transmission to the water. If the work is done in one-fourth of the time, three-fourths of this serious loss must be saved, the transmission of heat through metallic substances being directly proportionate to the length of time the differences of temperature exist; hence the great increase of power shown by Mr. Witz's experiments.

It is clear that Atkinson's "differentiale" engine is a great advance from a theoretical point of view, and from a practical one we understand that the British Gas Engine and Engineering Company, of 11, Queen Victoria-Street, E. C., who manufacture them, are prepared to guarantee a considerable saving in gas.

From an inspection of the illustrations it will be seen that the engine is extremely simple; there is no slide valve, a fact that any one practically acquainted with the working of gas engines will appreciate, nor is there any complicated substitute, the working fluid being efficiently controlled by the pistons passing the ports to the two self-acting valves, and the port to the igniting tube; in fact it is more simple than any steam engine. There are no joints under pressure, no delicate passages, no cams or eccentricts; and it has only pistons and bearings for the wearing parts.—*Eng.*

## THE RATE OF RECESSION OF NIAGARA FALLS.

Writing to Nature, Mr. Edward Wesson, of Providence, R. I., discusses the question of the rate at which the Niagara Falls recede Southward, uses as a basis the outliness of the falls as determined by the New York Geological Survey of 1842, the United States Lake Survey of 1875, and by Thomas Evershed for the New York Commission in 1883. He finds as the mean of the measurements of a number of sections along perpendiculars from the contone at the date of each survey, for the Canadian falls, 2½ feet per annum for the 33 years ending 1875, 7½ feet for the 8 years ending 1883, and 2½ feet for the 41 years ending 1883. The American falls, measured in ten sections, gave a total mean recession of 37½ feet in the 41 years ending in 1883, which is at the rate of about 10 inches per year. Mr. Wesson says: "I do not know that I have seen any estimate attempted of the relative volumes of water passing over the two falls. From such imperfect data as I have referring to depth and swiftness I should think that the rate of erosion for each fall give some approximation to the volume of water discharged over each; that is to say, 2⅔ feet per annum for the Canadian fall, 5.6 foot per annum the American fall, would signify that the former pours over its brink three times as much water as the latter. At the rates of recession above shown it is evident that at no very remote age the two falls were united in one, and the entire width was about the same as that of the present Canadian fall alone. Moreover, the mean width of the fall, from the time it commenced its work at the "hights," 7 miles below its present position, according to Lyell's statement as to the gorge of Niagara River, was not greater than the present Canadian fall. Adding together the present work done by both falls, we should have about 3½ feet per annum as the backward work performed when the entire volume poured over single fall of the width of the presnet Canadian fall. At this rate 10,000 years would seem sufficient time for the cutting out of the present gorge terminating at the "hights" toward Lake Ontario, instead of Lyell's estimate of 35,000 years. All attempts to calculate the rate of movement proceed on the assumption that the hardness of the limerock and shale, the volume of water and the height of the fall were for the whole distance much the same as they now are; I merely use these same assumptions. It in no wise reflects on Lyell's judgment that he should have erred so greatly in attempting to estimate the rate of regressing, while yet the contour of the fall at different periods had not been fixed