[COMMUNICATED AFTER ADJOURNMENT BY MR. GEORGE HILL.]

Professor Elihu Thomson's discussion of Mr. S. Dana Greene's paper "Electricity on Board Ship" presented at the meeting of January 25th, 1899, calls for a comment on certain statements made, which in the opinion of the writer are not borne out by the facts. The intimation is made that a simple single acting non-condensing steam engine can be made by a slight change from the standard design as economical as a triple-expansion condensing engine. The principle of the change is indicated by Professor Thomson in the statement that "I must imitate the cycle of the gas engine in steam, and then I would get high efficiency with other advantages." The cycle of a gas engine as ordinarily understood is as follows:

The admission of a certain amount of mixed gas and air during the forward stroke of the piston; the compression of this gas and air during the returning stroke of the piston; the explosion of this compressed mixture at the instant that the piston begins to move forward, the sweeping out of the products of this explosion on the return stroke of the piston, and the drawing in of a new charge of gas and air with the forward stroke beginning a new cycle. The cycle therefore occupies two complete revolutions, one of which may be called a working revolution and the other an idle one. Nothing in the engine described by Professor Thomson approaches this. In describing the action of the engine he says "now instead of reversing the motion of our steam as it enters back of the piston and throwing it back to the heated surfaces in exhausting, we are careful never to throw it back, but always let it go forward." Such a statement seems very curious from so eminent a source; the steam must act expansively; as a consequence the entire cylinder is filled with steam during the entire forward stroke at a constantly decreasing pressure and consequently a decreasing temperature. When the return stroke begins, the cylinder is filled with steam at atmospheric pressure and this steam is compressed giving the compression line shown in Fig. 2. The entire cylinder being filled with steam of a given temperature at the point of release, it really makes no difference at which end of the cylinder the steam is withdrawn. As a consequence, the engine is no different in principle from the Westinghouse engine. The steam consumption per horse-power hour seems very low, and would be remarkable, if it were ordinary steam at 160 lbs. pressure without superheat, but Professor Thomson states that superheated steam is used, without stating the number of degrees of superheat, which accounts for the low water consumption. If he had expressed the efficiency of the engine in heat units actually utilized, or in pounds of coal of a stated composition per horse-power hour, the result would have appeared very different. The available heat in steam at 160 lbs. gauge pressure, expanded to atmospheric

pressure is 46 H. U. per pound, each degree of superheat adding to the available energy a considerable percentage, which percentage is greater than that due to an increase of one pound in pressure, but both require the expenditure of energy either by the consumption of coal or otherwise, and must be accounted for in stating the economy of the engine. Something too must be allowed for the fact that the engine tested was new, and probably a great deal of pains taken to eliminate all waste. In conclusion it would seem desirable to obtain much more data in regard to the engine and its operation before we flatter ourselves that any material advance has been made in steam engineering by either Professor Thomson or M. Serpollet.

New York, March 28th, 1899.

[A REPLY BY PROF. ELIHU THOMSON to Mr. Hill's comments on his discussion of Mr. S. D. Greene's paper on "Electricity on Board Ship."]

I am too busy to enter into a lengthy discussion with Mr. Hill on the points raised by him, but will venture, for the present, the following remarks :

My comments following Mr. Greene's paper were made off-hand, and were not prepared in advance. They had necessarily to be brief, and nearly as possible to the point. I certainly did not intend to indicate that the best results of triple-expansion engine practice were likely to be excelled by the simple form of engine which I described. But that the effects of simple engines could be made to approach more nearly the highly economical results of more complex types is evident when it is borne in mind that our simple engine of only five and a fraction horse-power, in reality composed of four simple engines of little over one H.P. each, when tested, gave results in water consumption not greatly differing from those of tests of engines of hundreds of horse-power in compound condensing types. A factor in the cost of power is interest, wear and tear and depreciation, which are manifestly the less, the simpler and cheaper the engine, other things being equal. Mr. Hill finds fault with my comparison of the cycle of the small engine with that of a gas engine, seemingly ignoring those types of single cylinder gas engine which make one explosion every revolution. He must admit, however, that in the simple engine, an action is produced every revolution which in the type of gas engine he selects for comparison is only produced for every other revolution, and that in consequence the simple steam engine described has the advantage of less friction and negative work. Besides, I was speaking only in general terms when I referred to the gas engine