of admission and exhaust ports and of passages in the valves themselves, should be as low as possible, although the passages should not be so constricted as to throttle the steam. This statement may be made obvious by comparing this space to a cylinder into which we should first admit

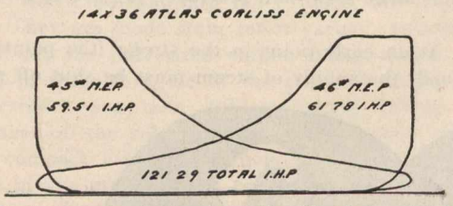

Fig. 3.—Indicator Card from Corliss Engine.—(96 R. P. M.)

steam at condenser pressure and then steam at boiler pressure alternately. Some of the high-pressure steam would be condensed without doing any useful work.

7th. The piston speed should be as high as practicable. The shorter the time during which a cylinderful of steam remains in the cylinder, the less heat it will transfer to the cylinder walls.

Although these conditions have long been understood, their realization in commercial engine practice, like many other things affecting the economy of the steam engine, has been dependent upon slow improvements in mechanical construction.

In 1849, George H. Corliss, of Providence, R.I., perfected a system of engine valves and gears which enabled him to meet most of these conditions more or less completely. He provided his engine with four ports, two in each end, one for the admission of high-pressure steam and one for the escape of the exhaust steam. He made these ports as short as possible by using a rotating form of valve, which could be placed very close to the cylinder bore, and further, in order to decrease the percentage of clearance and the frequency with which the valves would have to act, he made the stroke long in proportion to the diameter of the

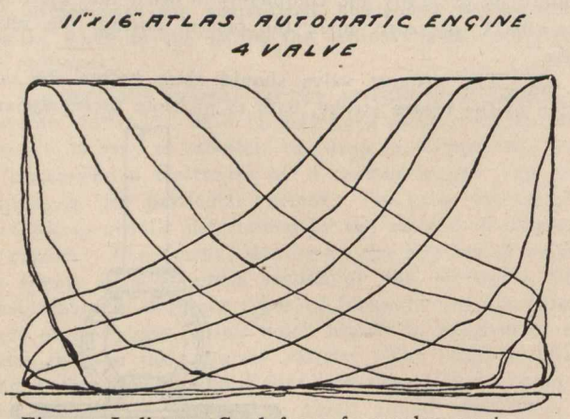

Fig. 4.—Indicator Card from four-valve engine.—(190 R. P. M.)

piston. Finally, and perhaps this is the most distinguishing feature of his system, he devised a gear which opened the admission valves promptly at the beginning of the stroke, closed them sharply at a variable point controlled by a governor and depending upon the load, and in the same manner provided for the prompt opening and closing of the exhaust ports at the proper times.

Corliss at first found great difficulty in selling his engines, as they were necessarily high in price, due not only to the added parts and complication, but also to the fact that the gear controlling the closing of the valves placed a definite limit upon the speed at which they could be run, at the same time limiting the power to be obtained from a given size of engine. However, they were so much more efficient than the throttling, slide-valve engine, then in general use, that he found it possible to sell them upon terms providing that the payment for the engine should equal the cost of the amount of coal saved during the first year's operation, a selling device similar to that used by Watt in introducing his first pumping engines.

The superiority of the Corliss engine, however, soon became so well recognized that until lately no other type of engine has been seriously considered for large power plants in which it is desired to obtain highest economy. As might be expected, however, many attempts were made to attain the advantages of a Corliss gear in high-speed engines which could be sold at lower prices. Ten or twelve years ago this company brought out such an engine in which the rotating valves were operated by cams, and good results were obtained with it, both as regards steam economy and reliability in operation. More recently other manufacturers have built four-valve engines in which the valves are operated by intricate kinematic movements. The complicated mechanisms are adopted to secure the desired steam distribu-

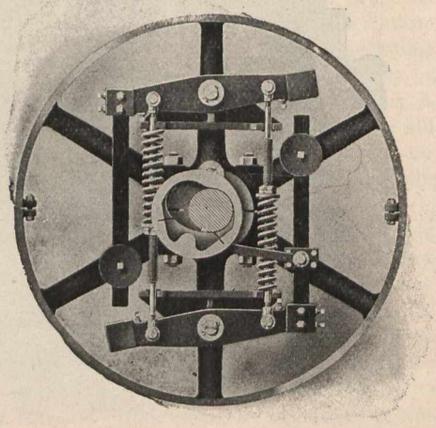

Fig. 5.—Atlas Automatic Shaft Governor four-valve centre crank type.

tion, and it is sometimes said that they secure "dwell" of the valves. This, however, is in itself detrimental, as it gives rise to uneven lubrication and consequent wear. Some of these engines are, it is true, more economical than the automatic slide-valve engine which they are designed to replace, but without exception they are complicated and expensive, both in first cost and cost of maintenance.

The Atlas medium speed four-valve engine possesses all the good features of the Corliss in so nearly an equal degree that its indicator cards can hardly be distinguished from Corliss cards, and which, as a result, gives steam economy nearly equal to that of the Corliss engine. This engine, in price, is only a small advance over the cost of an automatic engine, and does away with dash-pots and the complicated releasing gear of the Corliss engine.

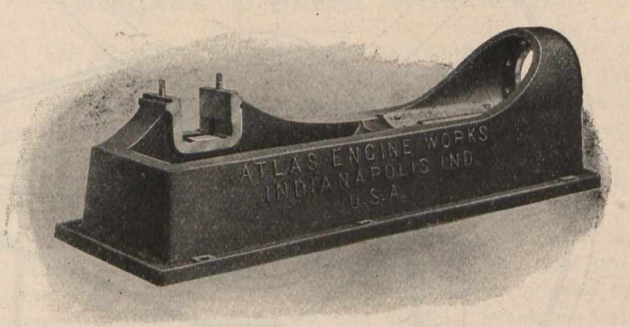

Fig. 6.—Medium-speed four-valve heavy duty frame (Side Crank).

In a test made at Purdue University, Lafayette, Indiana, last year upon a 13 x 12 engine of this type running non-condensing and with a boiler pressure of 121½ lbs., a consumption of 23.7 lbs. of steam per indicated Horse Power hour was obtained. The speed of the engine was 292 R.P.M. and the total indicated Horse Power 105.6, while the mechanical efficiency was 92 per cent.

In another test made upon a compound engine (8 and 14 x 18) running non-condensing, a steam consumption of