In 1888 working plans were prepared for a turbine of the condensing type, which presented hopes of realizing unprecedented economy in the use of steam for motive power and of a great step in the development of the turbine.

It was not until 1891, however, that facilities were available for its construction, and the anticipations were at length fulfilled when, in the following year, a 100-unit condensing turbo generator was found to consume only 27 lbs. of steam per kilowatt hour, thus equalling the performance of the best triple-expansion engines of that date in the driving of dynamos, and foreshadowing the ultimate general adoption of the turbine—at least in large sizes—for the driving of dynamos and alternators and other fast running machinery, and also of its probable ultimate adoption for the propulsion of fast vessels.

The turbine which achieved this result differed materially from that designed in 1888, because of the temporary loss of patent rights under which the work had been carried on up to this period; this loss compelled an alteration of design to the radial or multiple disc type of turbine. This resulted in such modifications in the design as proved to be seriously detrimental to the economy of the engine; yet in spite of these adverse circumstances, the progress was good.

In 1893 the patents were re-acquired; this permitted of reversion to the original and parallel flow type, and subsequent experience has shown that had the 1888 design been constructed in its entirety in 1892, an economy would at that date have been obtained about twenty-five per cent. superior to that actually realized. There is now no question that the turbine in its present perfected and economical form would in that case have come into general use about five years earlier both for land and marine work.

The results that were obtained in 1893, however, were sufficient to place the turbine on a par with the reciprocating engine of that day, and to lead gradually to its extended use for the generation of electricity, and also to justify the formation of a syndicate a year later for practically applying the turbine to the propulsion of vessels. In 1896 the anticipations of eight years before, as to the attainment of very high degrees of economy from the parallel flow type, commenced to be realized in the case of large turbine units on land, culminating in 1900 with the excellent result of 18.8 lb. of steam per kilowatt hour when generating 1,400 kilowatts. Soon afterwards with 15.4 lb. per kilowatt hour when generating 4,000 kilowatts, and finally 14.7 lb. per kilowatt hour with a higher degree of superheat in the steam.

A simple explanation might be asked for as to why the turbine should be more economical than the reciprocating engine. The answer is that the turbine is able to expand the steam fully and economically from the boiler pressure right down to the condenser pressure, while the reciprocating engine is unable to expand it the whole way—as a matter of fact, it can only expand it usefully for about two-thirds of the way.

This is the chief difference; the other differences nearly compensate each other—for instance, the turbine has more waste from leakage, while the piston engine has a large waste from condensation and re-evaporation, which does not occur in the turbine. Then, again, the turbine has fluid friction from steam and water, and very little mechanical friction, while the reciprocating engine has much more mechanical friction and very little fluid friction.

In the case of the "Turbinia" in 1897, the economy obtained in propulsive horse-power in relation to steam consumption was as good, if not better, than had been previously realized with reciprocating engines in similar vessels. The turbine engines worked with greater economy than ordinary engines, but the screw propellers with less efficiency than ordinary screws of the usual pattern employed with reciprocating engines. Since the original trials of the "Turbinia," many experiments have been made with her and with other vessels, which have yielded much information, and have led to a substantial improvement in the proportions of the screws for turbine vessels, and have afforded much assistance in obtaining the excellent results that have been realized in the many turbine vessels which have since been built.

Up to 1895, the compound turbine was manufactured only in England, with the exception of the tentative manufacture of a few small plants in Paris by two licensees. At this time, when about 20,000 HP. had been constructed in England, the Westinghouse Machine Company, of Pittsburgh, acquired the sole rights of manufacture for the United States; but very few plants were constructed by them until 1901, while since that date the manufacture has rapidly increased.

Turning to the Continental development in 1898, Mr. W. H. Lindley, of Frankfurt, advised the purchase of two turbo-alternators for generating electricity at Elberfeld, in Germany. These turbine engines up to that date were the largest constructed in England, and when tested in 1900, gave such excellent results as led to the commencement of turbine construction on an extended scale by Messrs. Brown, Boveri, and Co., at Baden, in Switzerland, a manufacture which has rapidly increased to large proportions, and many large turbo-alternators and dynamos constructed by them are now at work in Germany, France and Russia. In Italy the firm of Tosi are manufacturing turbines for electrical purposes on a large scale, and Messrs. Ansaldo Armstrong have acquired the right to manufacture in Italy for the marine. In Austria some of the largest-sized units are under construction, and in Russia two important firms are commencing to manufacture.

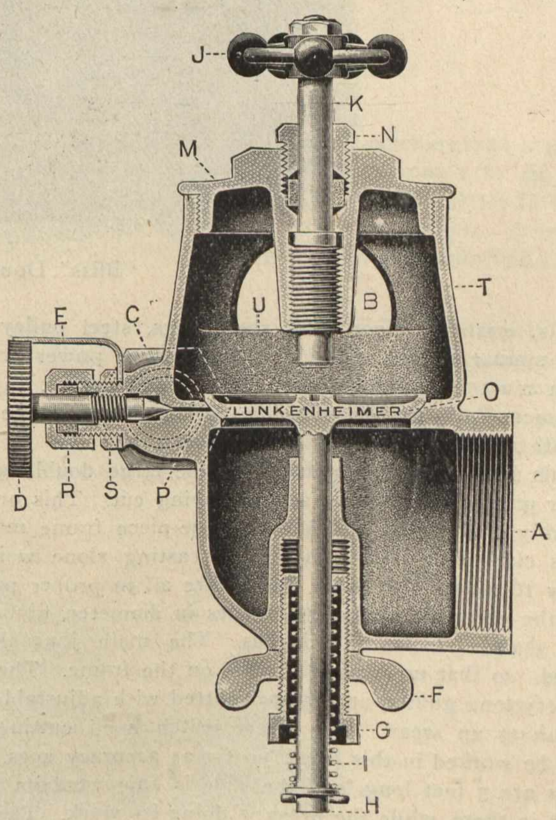
The adoption of the turbine in recent years for the generation of electricity and for marine propulsion will be treated in a second article.

AN IMPROVED GENERATOR VALVE. FOR GASOLINE ENGINES.

The generator valve shown in section below, embodies a number of desirable and important features, which will be appreciated by users.

A noticeable feature is the easy regulation of the spring, which holds the disc in place. This regulation can be done while the engine is running, and does not interfere with the operation of the valve.

Gasoline engines give the best results with the generator valve-disc spring set at a particular tension, and as this



tension can only be ascertained by trial when the engine is running, the adjusting arrangement of the valve illustrated, will be found a great improvement. The lift of the disc is regulated by means of the stem K.

The valves are made of high-grade bronze composition, and the parts subjected to the greatest strain are made extra heavy. Iron or steel is entirely eliminated, owing to the oxydizing effect of gasoline.

The Lunkenheimer Company, of Cincinnati, are the manufacturers.