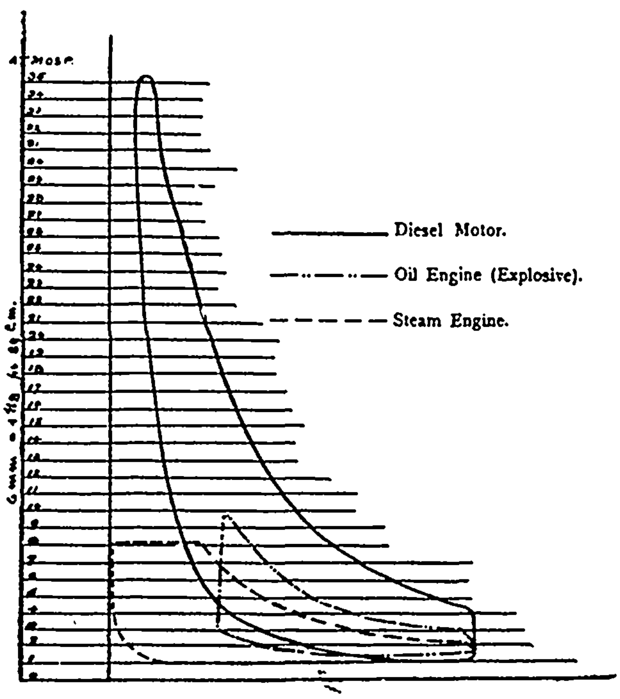
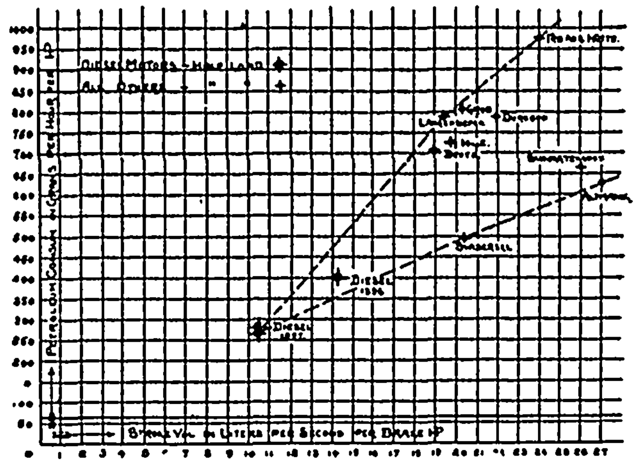
ture of ignition and the temperature of combustion; the first is a constant value at each pressure, and dependent only on the physical qualities of the fuel, the higher the pressure the lower the temperature of ignition. The temperature of combustion on the other hand is variable, depends on many conditions, and especially on the quality of the air by which the combustion is maintained, but it is always higher than the temperature of ignition. Diesel's radical departure from all previous practice is in generating a combustion temperature by mechanical compression of pure air, utilizing this temperature to ignite the fuel, and by so introducing the fuel that the heat lost by expansion is practically balanced by the heat added by combustion.

Before the completion of this perfect engine, certain critics of Diesel's theories contended that the dimensions of the cylinder, and all other working parts would become so great as to make it impracticable to build such engines. But in Diesel's engines the increase and the decrease in pressures are so gradual that there is no shock. The change from one to the other is always accomplished at a dead point. In all motors relying on explosion for their moving force, and even in the steam engine, there is a direct blow at the moment of ignition or admission. I present here a drawing on which indicator diagrams of a high pressure steam engine, of an explosion type motor, and of a Diesel motor have been drawn, based on the same piston displacement.

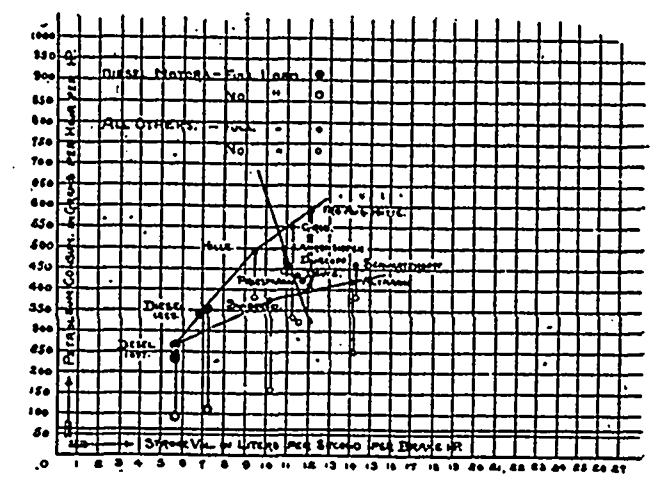


Comparative Diagrams—Diesel Motor Oil Engine and Steam Engine.

Diesel's and the explosion motor diagrams can be directly compared, since both work on the four-stroke cycle. The steam engine diagram should be quadrupled. This disposes of the objections just referred to. These second and third diagrams are graphic comparisons of the Diesel motor, with a number of the best petroleum motors as to economy in fuel and volume swept by the piston per second. They are given on the authority of Professor Hartmann, well known as a careful and conscientious observer in the field. The abscissae represent piston displacement in liters per second, the ordinates petroleum consumption in grams per hour, both figured on the effective or B.H.P. The full lines embrace the results for full loads, the dotted lines those for half loads. The comparison is between engines which burn ordinary safe lamp petroleum and kerosene; results obtained on benzine or naphtha are not considered, since motors depending on such dangerous fuels can never be generally adopted for industrial purposes. The calorific value of these highly inflammable and explosive liquids is no greater than that of safe kerosene or of fuel oil. You will notice that we find the Diesel results in both cases near the apex of the angle; or plainly put, both at rated capacity and at half load the Diesel motor shows the smallest cylinder dimensions and the least expenditure of fuel. Remember that the others represent the best results from engines carefully developed and improved in all mechanical details, while the Diesel motor is but the third one ever built, and that in its construction the practical realization of the theoretical cycle was the primal consideration, mechanical improvement being left for the future commercial exploitation of the machine. Broadly speaking, the absolute



Comparative Chart—Fuel Consumption and Stroke Volume, Half Load.



Comparative Chart—Fuel Consumption and Stroke Volume, Full Load.

efficiencies of the best known heat engines of to-day range about as follows, taking into account actual calorific values of the fuel and effective or brake horse-power:

	Per cent.
Small auxiliary steam engines, pumps, etc.	6-10 to 1
Plain slide valve engines in good condition	3 to 5
Single cylinder Corliss engines	6
Compound condensing engines	8
Reheating compound or triple expansion steam engines	12
Best oil engines (explosion type)	16
Best gas engines (explosion type)	19
Diesel motor	28 to 30

All these are compared when running steadily at full load or rating at point of best economy. But in a large majority of the applications of all these prime movers, the exigencies of the service require them to be run frequently at three-quarters and half load for a large part of their daily service. It is conceded that in most engines the internal frictions or mechanical losses are a fixed amount, so that a loss of 15 per cent. at full load becomes 30 per cent. at half load. And thermal losses increase even more rapidly, for instance, in steam engines by cylinder condensation. In gas and oil engines the absolute efficiencies have in some cases shown a measured loss of nearly 60 per cent. In the Diesel motor the thermal efficiency is shown to increase with decreasing loads, thus counteracting in a marked degree the loss in mechanical efficiency which it shares with other machines. From a number of carefully checked tests I found the average drop in absolute efficiency from full to half load to be only 15 to 16 per cent. in the Diesel motor. So promptly and easily does it respond to a change of load that a sudden addition of 80 per cent. to the electrical load on the