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# ENGINE PISTONS OF LIGHT METAL.

By G. Becker.

From "Der Motorwagen," March 31, 1922.



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The contest for light-metal pistons, instituted during the past year by the traffic department, resulted in very valuable information for far-reaching improvements in automobile engines. The results of the comprehensive experiments are given under the above title (Vervollkommnung der Kraftfahrzeugmotoren durch Leichtmetallkolben) in a pamphlet published by R. Oldenbourg, Munich, of which the following is an abstract.

In the contest and supplementary experiments, there were tested in all 32 sets of light metal pistons from 16 different aluminum and magnesium alloys, 2 sets of cast iron pistons and one piston of pure electrolytic copper in two engines of different types, a Daimler motor-truck engine with hanging valves in the cylinder head and a Protos automobile engine with standing valves on one side of the engine. The experiments were carried out in the motor car laboratory of the Berlin Technical High School.

The many-fold mutual relations between material properties, shape, thermic and dynamic processes in the engine were clarified by comprehensive technical, thermic, chemical, physical and metallographic investigations of pistons and piston materials. The possibilities of progress in motor car construction have been considerably extended by the results of these investigations and the efficiency and economy of motor-car traffic have been considerably increased. The way has been smoothed out for a rapid thermodynamic improvement of automobile engines.

* From "Der Motorwagen," March 31, 1922, pp. 163-164.

By the employment of light-metal pistons, there have been obtained an increase of 21% in power and a simultaneous saving of 20% of the fuel, besides considerably lower temperatures of the exhaust gases and radiator water, owing to the scientific utilization of the physico-thermal properties of the light metals. The light metals not only possess a high heat conductivity, but also a smaller heat absorption capacity. Cast iron absorbs more than twice as much heat as copper, and 30% more than the light metals. In cast iron pistons, high temperatures prevail on account of the poor heat conductivity and great heat absorption. In light-metal pistons, on the contrary, the running temperature is very much lower.

The effects of these properties of the light metals have a far-reaching significance for all thermodynamical machines. Heat conductivity and absorption will be in future, common characteristics, even ahead of strength data, for classifying building materials for the different engine parts (pistons, cylinders, valves, etc.).

These thermic properties protect the light metals against the high working temperatures of the load and enables the employment of very high loading temperatures, without overheating the engine parts. This is progress of a fundamental nature, which can be utilized in many ways.

The different light-metal alloys showed, with reference to their thermic properties, as well as with respect to their running properties and resistance to wear, very great differences. Of the physical and metallurgical tests, the ball hardness test and the structure are the most important. The magnesium alloys were thermically more favorable than the aluminum alloys and also had better running properties. The results were also correspondingly best with "electron" pistons. The latter also have the advantage of lightness, saving up to 30% of the weight, as compared with aluminum pistons.

As to the shape, there are no narrow limits. Fundamentally, however, the pistons must be treated as heat conductors and be so constructed as to afford an unobstructed path for the flow of heat.

In all the pistons tested, the requisite play was carefully determined. The light-metal pistons require about 50% more play than cast iron pistons.

The location of the piston pin demanded special attention. The great expansion of the light metals from heat necessitates the employment of only such alloys as would be correspondingly affected by the heat. For the piston-pin bearings, the load per unit area must be set considerably lower than for cast iron pistons, in order to prevent the tearing out of the piston-pin bearings. Bushings must be either cast in or pressed into the piston-pin bosses. The most natural and tenable solution is to have the piston-pin immediately in contact with the light metal of the piston with a lower bearing pressure.

The solution of the piston problem by the utilization of the important heat characteristics of the light metals carries with it the improvement of the whole engine. The new scientific information opens new roads to engine constructors and breaks through the restrictions which have many years hindered the development of the automobile engine.

Translated by the National Advisory Committee for Aeronautics.

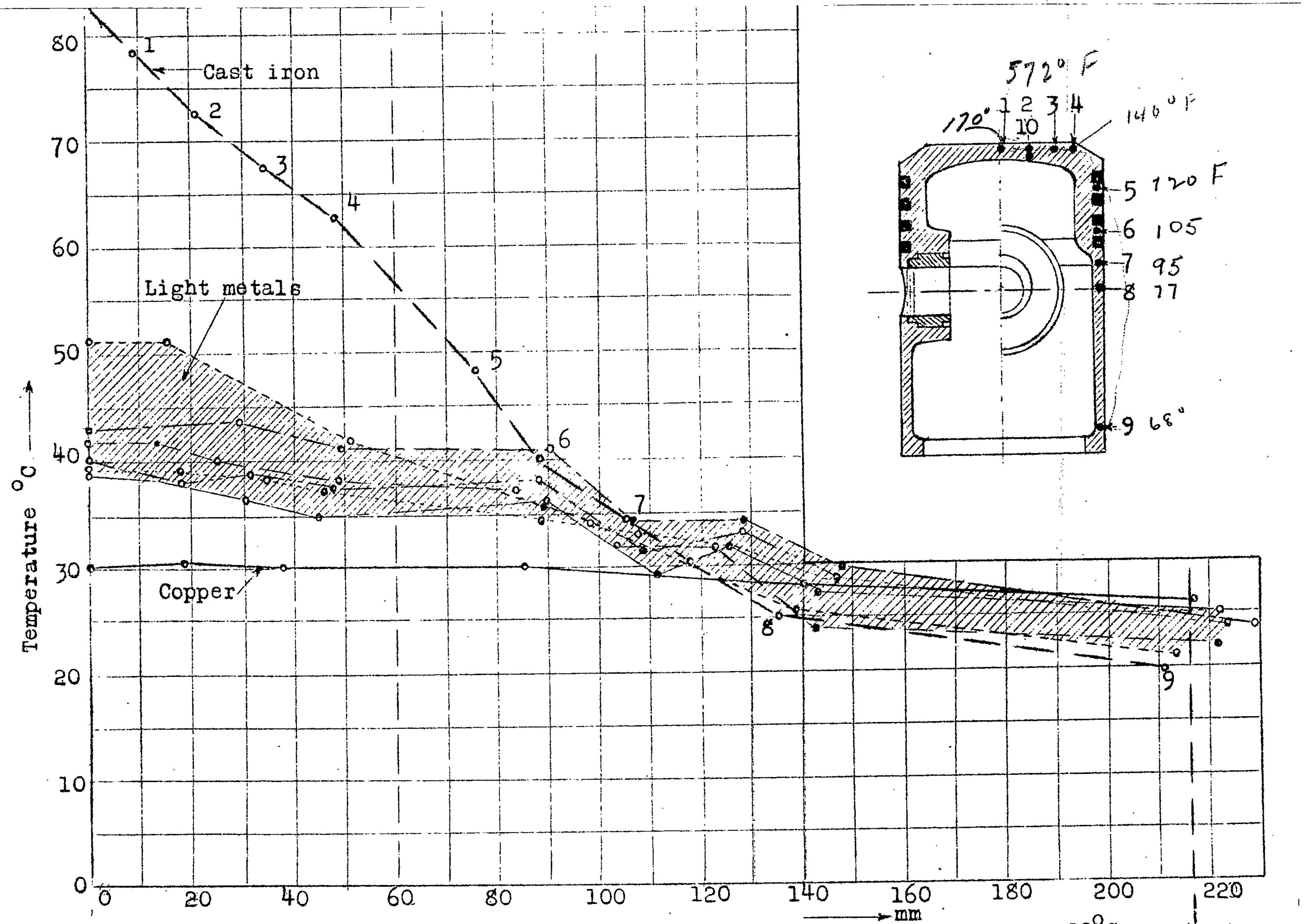

Fig.1. Temperature drop in cast iron, light metal and copper pistons, at 300°C constant temperature of combustion chamber and 22°C temperature of water in cylinder.

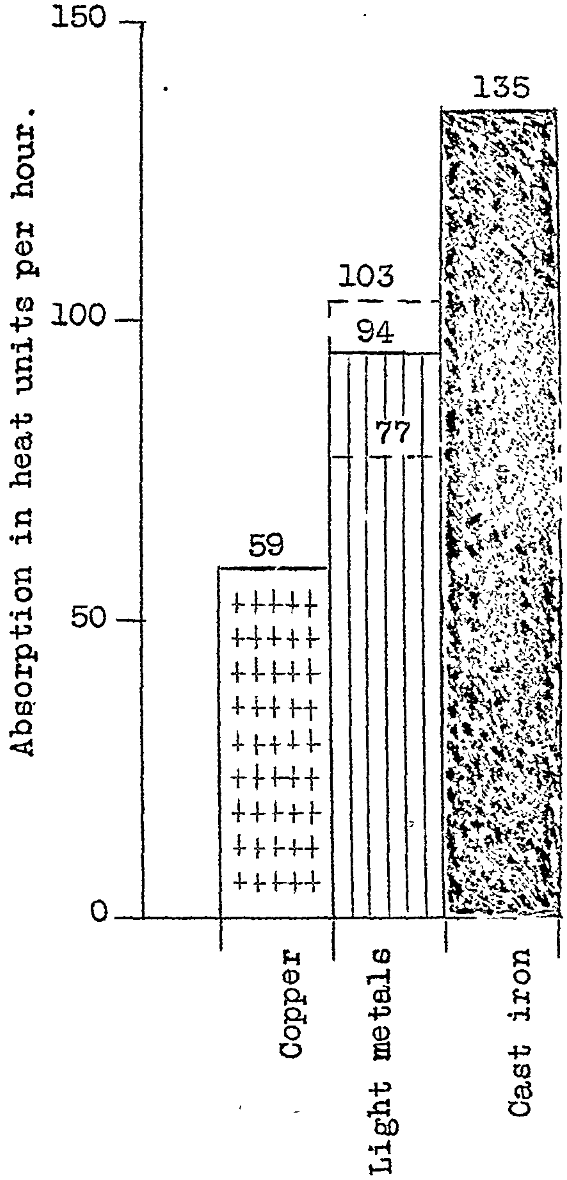


Fig. 2. Heat absorption by copper, light metal and cast iron pistons.
The numbers in the diagram are for clean piston heads. Those coated with carbon absorb about 2.6 times as much heat on the average.