CHAPTER XIII
THE CRANKCASE

The crankcase forms the foundation of the whole engine. It is the heaviest engine part and deserves special attention. The chief purpose of a crankcase is the provision of a rigid base for the crank mechanism. Loads from the crankshaft bearings are transmitted through the crankcase to the cylinder heads. For this reason a crankcase must be designed to:

1. transmit loads from the cylinder heads to the crankshaft bearings,
2. resist bending stresses,
3. resist torsion loads.

These properties must be attained with a minimum of constructional material and the design must be suitable from the point of view of production. The crankcases of modern water-cooled engines are always cast in one with the cylinder block, resulting in a very rigid unit.

In air-cooled engines built-up construction is used. This results in the separate mounting of each cylinder and a considerable reduction in the depth of the upper part of the crankcase above the crankshaft axis. This is a basic difference from water-cooled construction practice and one which must be respected by the designer.

For reasons of weight reduction, cast iron crankcases of water-cooled engines are split in the plane of the crankshaft axis, the sump being formed by a light sheet metal stamping. Such a layout cannot be used for air-cooled engines of built-

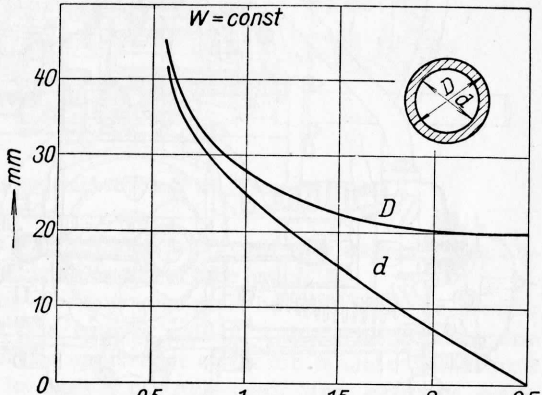
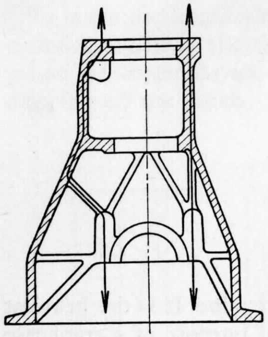


FIG. 261. Weight of tube plotted against diameter and wall thickness.

up construction. The following two forms of crankcase are chiefly used:



1. the crankcase open from below, but with its bottom face deep below the crankshaft axis and,
2. the tunnel-like crankcase into which the crankshaft is assembled endwise from behind or from the front and the sump of which is formed by a light cover.

FIG. 262. Bolt loads distributed according to the left hand side of the illustration involve the use of more material. A more favourable load distribution is shown on the right hand side.

Crankcases of the first group do not differ substantially from these used in water-cooled engines; the most notable differences being in the greater width

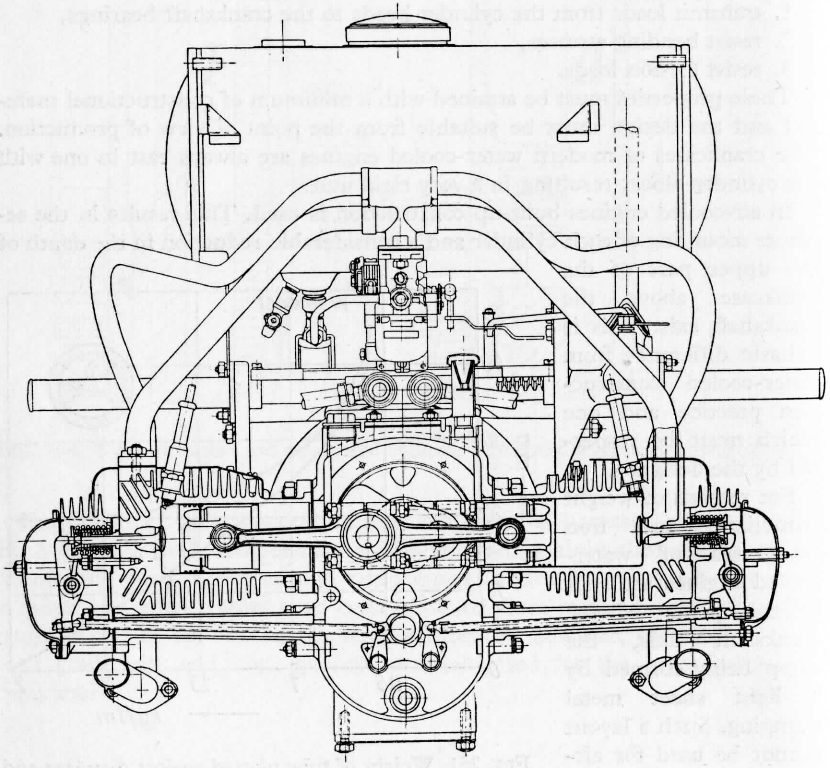


FIG. 263. Transverse section of the Tatra 57 engine.

and the lower location of the bottom face of the air-cooled engine crankcase. Examples of crankcases so designed are shown in Fig. 216 and 217. The great width and depth of the crankcase makes possible a structure which resists bending and torsional stresses with a small quantity of material. To illustrate this, Fig. 261 shows the dependence of the weight of a tube on its diameter with a constant moment of resistance. The graph clearly indicates the rapid

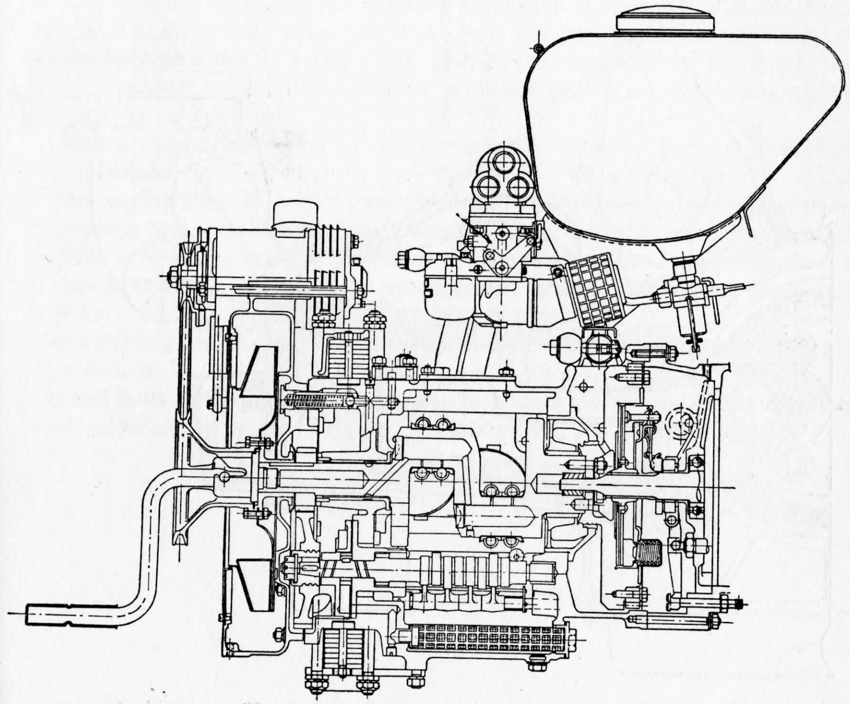


FIG. 264. Longitudinal section of the Tatra 57 engine.

rate at which the necessary wall thickness is reduced with an increase in diameter and the reduction of weight per unit of tube length.

Crankcase wall reinforcing ribs and webs must be used with the greatest caution. The reinforcement of a straight wall by a single rib does increase the rigidity of the wall, but the upper edge of the rib is under great stress whereas the remainder of its mass is not fully used. More desirable would be the use of I section ribs, but these unfortunately are not convenient because of casting complication. Better results are obtained by curvature of the walls and, where necessary, by a gradual increase in wall thickness near the flanges and at the curvatures leading into flanges and partitions or sidewalls.

The problems of crankcase construction were thoroughly investigated by the Continental concern manufacturing aircraft engines and the result of this development is reflected in a crankcase without reinforcing ribs which is stiffer and lighter than its ribbed predecessors. Experience gained with the design of aircraft engines was used in the construction of an open-bottom crankcase for a V 12 air-cooled compression-ignition engine which is remarkable for its small overall dimensions and low weight (Fig. 393).

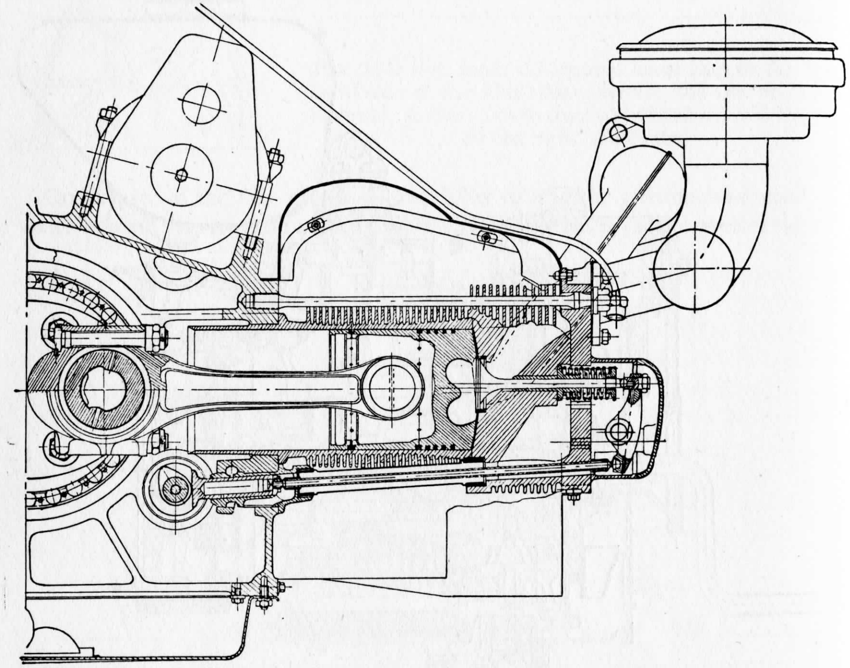


FIG. 265. Transverse section of the flat six-cylinder Tatra 116 engine.

Further attention must be paid to the transmission of loads acting upon the cylinder head to the crankshaft main bearings. The path of such forces should be as short and straight as possible. Fig. 262 shows the correct and incorrect path of a load acting upon the crankcase. The indirect path results in bending stress on the crankcase with the accompanying incomplete utilization of constructional material which makes for increased weight. The most convenient means is a straight, wide rib stressed in tension. If long bolts are used and the cylinder anchored at the main bearing housings, the crankcase will be free of stress.

If the crankcase partitions incorporate breather holes, the periphery of these holes must show an increased thickness, otherwise a similar concentration

of stress takes place as on the upper edge of a simple stiffening rib. Cracks appearing in crankcases often originate from such holes.

The tunnel-type crankcase offers many advantages which commend it for use in air-cooled engines. In principle such a crankcase is similar to a tube with its high torsional and bending resistance for a minimum given weight. An example of such a design is provided by the Tatra 111 engine crankcase (Fig. 407). As the crankshaft must be inserted into the crankcase from one end, the use of roller bearings and a built-up crankshaft is advisable. Plain bearings can be employed only when the crankshaft has two main bearings only as in the flat-four Tatra 57 engine (Figs. 263, 264) or several other small engines. The crankshaft is introduced into the crankcase during assembly through the rear end cover aperture.

With a design incorporating roller bearings, it must be borne in mind that the assembled crankshaft must pass through the inner circumference of the outer bearing ring. In such a case a built-up crankshaft is suitable. The separate crankshaft members are steel castings. The small width of roller bearings enables a close grouping of cylinders even when two connecting rods share a common crankpin, which is an arrangement offering advantages in manufacture.

For flat engines, the monoblock tunnel-type crankcase may also be employed, as shown in Fig. 265. A large sump cover facilitates assembly. The nuts of big end bolts on flat air-cooled engines always face the pistons, facilitating the removal of any individual cylinder and connecting rod assembly.