

# Effects of heat in assemblies

By GEOMETER

**A**LL metals and alloys expand with heat-but not at the same rate; and as engines and machines usually include a variety of metals in their construction, it is essential to allow for the different rates of expansion of parts. This is a concern of every engineer from designer-draughtsman to machinist-assembler.

It comes about for the reason that metals and alloys are chosen for parts because of a particular or a general suitability. For example, cast iron has excellent wear-resisting properties, and is often employed for cylinders. While it is no less suitable for pistons and structural members like crankcases, aluminium alloy is usually preferred, because it is lighter than cast iron and has a higher rate of heat conductivity.

There is a great difference between the expansion of cast iron and of aluminium alloy through the same range of temperature. What this means in practice can be shown by example. An i.c. engine could be made with a cast-iron cylinder, piston and crankcase. The piston would have a running clearance in the crankcase and the ball races would be an interference fit. Now, if the piston and crankcase are made in aluminium alloy to the dimensions used for cast iron, the piston will certainly seize, and the ball races will probably work loose, at normal running temperature.

On the other hand, in avoiding these faults, one should not move too far to the other extreme of a sloppy piston and ball-race seatings machined unnecessarily small.

The designer-draughtsman can arrive at dimensions from tables of limits and fits and coefficients of expansion of metals, together with some information about temperature -or some inspired guessing. The machinist-assembler can solve most problems practically.

In assembling and dismantling parts made of dissimilar materials, many opportunities occur for employing heat. To fit ball races into aluminium casings, races and casings can be heated in oil, which may be above normal working temperature. Alternatively, casings can be heated in boiling water.

To remove a ball race, an aluminium casing can be heated in water or oil, or by a blowlamp and then slapped on a wood block, as at *A*, so that the race falls out. This cannot be done with cast-iron or steel casings. To remove an aluminium pulley from a taper, it can be heated with a blowlamp, when it will prise off. Asbestos string and a piece of tube protect the end of the shaft, as at *B*. To remove a bush from a blind hole without tapping, a well-fitting punch and oil can be employed; and an aluminium casing can be heated as well. Pistons can be wrapped in hot rags for removing gudgeon pins. To fit the pins, pistons and all can be immersed in boiling water.

From normal room temperature to boiling point of water, aluminium alloys expand about 0.0025 in. per inch. Cast-iron expands about 0.0008 in., and steel about 0.001 in. At 1 in., a driving fit requires a difference of 0.00075 in. to 0.001 in. on the diameters.

At *C*, if an aluminium housing is

machined to 0.999 in. (*W*) for a 1 in. rack, there will be an interference fit at normal temperature. If the assembly reaches 212 deg. F., the race will be loose at 1.001 in. in a housing (*X*) at 1.0015 in. To be certain this cannot happen, the housing should not be more than 0.9985 in. (*Y*) in. machining.

For a piston, *D*, allowance must be made for expansion. At 1 in., running clearance can be 0.001 in. to 0.0015 in. At 212 deg. F., the cast-iron cylinder is about 1.001 in., and the piston should be 0.9995 in. to 1 in. And so in machining, it should not be more than 0.9975 in.

Greater clearance is needed at the crown. A way of checking expansion is to heat the part-machined piston to 300-350 deg. F. in oil, as at *E*, take away the can, and quickly measure diameter *Z*.

Gudgeon pin bores can be machined hot to be correct at working temperature, and an assembly can be held between plugs, *F*, for fitting a connecting rod clamping screw. □

