AMC TWIN ENGINE LUBRICATION RELATIONSHIPS UNDER CONSIDERATION OF OIL PRESSURE, OIL TEMPERATURE AND ENGINE SPEED

My following investigations and measurements have been executed on a 1958 Matchless model G11 (600 cm^3) The twin engine has been major overhauled including regrinding and new crankshaft bearings. The oil pump has been refurbished and improved by RAY SPENCER in England. The bike is equipped with oil pressure and temperature indicators, and the lubrication system is connected to an external oil filter kit.

GENERAL: Engines equipped with ternary alloy plain bearings are nowadays considered as long-life designed, provided sufficient clean lubrication is always given at the lubrication gap between the (rotating) shaft and the (fixed) bearing shell. The shaft is floating on an oil film, and a metallic contact is not given under normal operating conditions. Modern engines are running with oil sump temperatures up to 135^{o}C, and considerably higher in the cylinder head.

The oil film is entirely built-up by hydrodynamic forces of the rotating shaft (Fig. 1), similar to what we experience on the road as aquaplaning: the wheels are floating on the water film.

The oil pressure built up by the oil pump cannot bear the forces of combustion and mass acceleration, but is responsible for the supply of a sufficient oil quantity to the lubrication gap entry. The relevant literature points to the essential of sufficient oil pressure from outside, i.e. thru the crankshaft centre bearing of the AMC twin engine (fig. 2) in order to overcome the centrifugal force casting the oil off the radial bore in the crankshaft.

The calculation below and subsequent measurements will figure out whether the a.m. preconditions ensure the sufficient lubrication of the AMC twin engine.

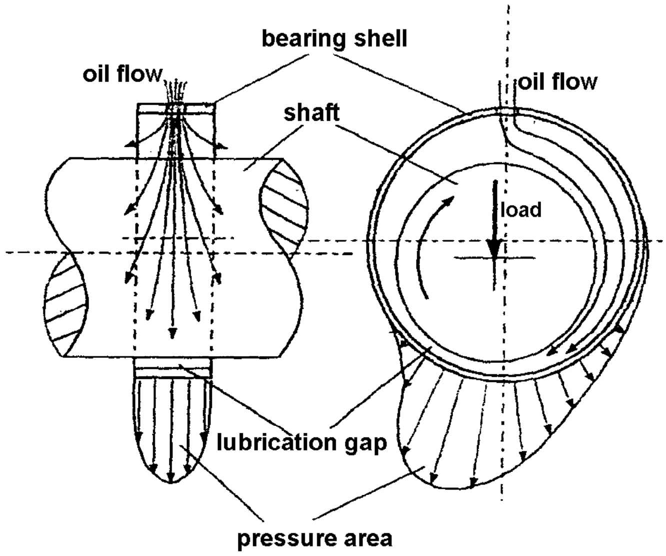

Fig. 1

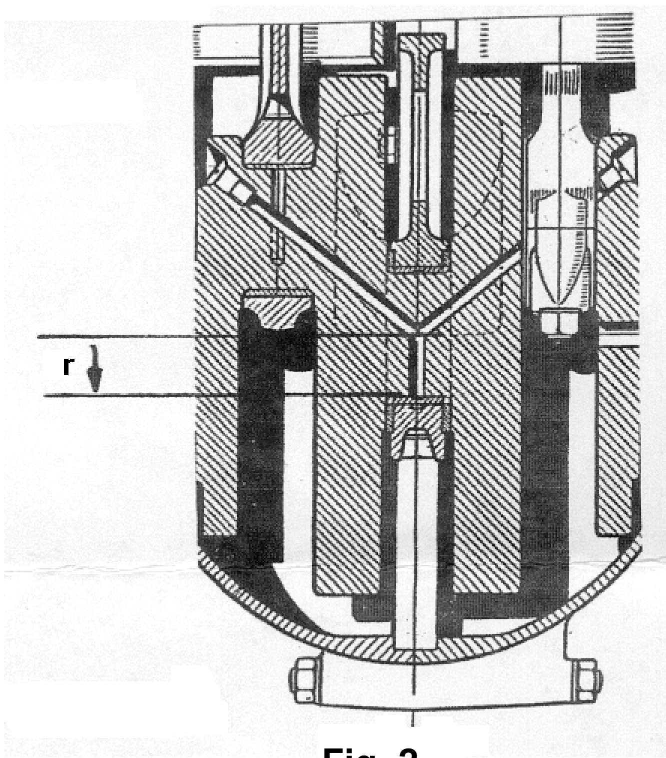

Fig. 2

The oil pressure "p" being necessary to overcome the centrifugal force is calculated as follows:

$$p = \frac{3/4 \cdot r^2 \cdot \gamma \cdot \omega^2}{a}$$

(we disclaim formula differentiation; could be annexed on request)

Measuring units to be applied:

n	sec^{-1}
γ	kg / cm^3
r	cm
a	cm / sec^2

The individual unit items are:

r = radius of center bearing journal (fig. 2) = 2,02 cm

γ = relative density of the oil approx. 0,6 (g/cm^3)

a = acceleration due to gravity = 9,81 (m/sec^2)

ω = 2π n (sec^{-1})

n = crankshaft rpm (sec^{-1})

Example for n = 3100 rpm equivalent to 50 mls/h at my individual transmission ratio:

$$p = \frac{3/4 \cdot 2{,}02^2 cm^2 \cdot 0{,}6 kg \cdot 2^2 \pi^2 \cdot 52^2 \; sec^2}{10^3 \; cm^3 \; sec^2 \; 981 cm} = \underline{\underline{0{,}2 \left[\frac{kg}{cm^2}\right]}}$$

At various crankshaft revs the oil pressure to be overcome:

a) n = 800 rpm (idling speed) p = 0,01 bar (1 bar = 1 kg/cm^2 = 14,22 psi)
b) n = 3100 rpm (my favoured speed) p = 0,20 bar
c) n = 6200 rpm (max) p = 0,80 bar

Measurements on multi-mode operation resulted:

1. **<u>Cold engine</u>:** (after start) at idling speed:
   Oil pressure indicator at max limit **p> 6 bar (min rqd. 0,01 bar)**
2. **<u>Warm engine</u>:** after approx 1 hr at 50 mls/hr oil temperature in the oil tank measures approx. 80°C; oil pressure drops to p = 2 bar at 3100 rpm **(min rqd. 0,02 bar)**
3. **<u>Hot engine</u>**: after approx 1 hr at 60 mls/h on the highway at 25°C air temp. the oil temperature measures 90°C; oil pressure drops to p = 1,4 bar at 3100 rpm, which means "sufficient".

   Hot engine means in my particular case the max allowable load according to the running-in instructions to run the engine at max. 1/3 throttle. In my opinion this should be the limit even after the running-in period taking the Ladies' almost 50 years age into consideration (?)

   4.<u>Coffee break</u>: after a short period the oil temperature drops to 60°C, and the oil pressure rises to 3 bar at 3100 rpm.

<u>Tabular form</u>

Top gear speed (mls/h)	Oil temperature (°C)	oil pressure (bar) (always at 3100 rpm)
50	60	3
50	70	2,5
60	70	3
50	80	2
50	90	1,4

Evaluation and judgement

Resulting from the above (incomplete) measurements the lubrication system appears to be in order. The oil pressure built up by the oil pump is sufficient in relation to the operation conditions. More precise measurements and calculations need to evaluate the loss of flow at all lubrication points and ducts; this would be above our possibilities. Installation of an oil cooler would drop the oil temperature and improve the march of pressure, however the lubrication quality of the oil develops just from 60^{o}C.

Later on investigations of heavy duty oil (for example Castrol RS) are intended regarding a better viscosity progression. Single grade oil seems to be less recommendable (at least for overhauled and sludge-free engines), because of the considerably extended warm-up period. My Matchless G11 for example needs 6 mls at Summertime ambient temperatures, and during this period the engine lubrication is less effective, and poor if single grade oil is used.

Comments, supplements, amendments and contradictions are welcome!

September 2005

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