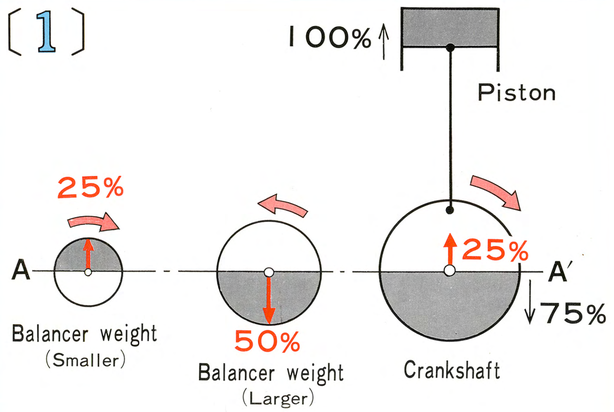
(CRANK BALANCER)

TX750 (1) OMNI-PHASE BALANCER

In a parallel twin-cylinder reciprocating engine, two types of vibrations are generated. One is the primary inertia force of reciprocating parts and the other is the rocking couple of revolving engine components.

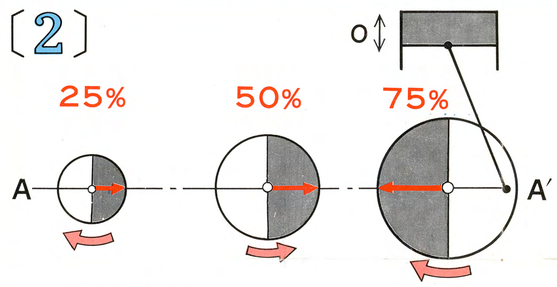
The primary inertia force generated by a reciprocating piston causes a vertical vibration with frequency equal to the rotation speed of the crankshaft, whereas the rocking couple of the revolving internal mechanism of the engine gives rise to vibration in reference to the center of gravity of the whole engine unit. These two types of vibrations are the main factors in overall engine vibration and can be counter balanced to a great extent by means of special balancing devices. The omni-phase balancer is such a device and is employed in the Yamaha TX750 in order to reduce engine vibration.

〔1〕



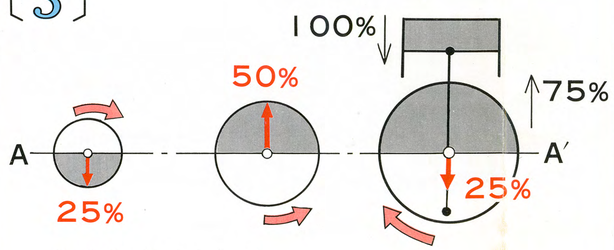
1. Zero degree crank angle
At this crank angle, the upward inertia force generated by the piston is taken as 100%, butit is reduced to 25% by the 75% inertia force of the crank web moving downward. On the other hand, the larger balancer weight generates an inertia force of 50 % in a downward direction, and the smaller balancer weight an inertia force of 25%. The net result is(+25)+(−50)+(+25) =0. That is, the inertia forces completely counter balance each other.
(It is assumed that the crankshaft, larger and smaller balancer weights are arranged coaxially on the A-A' axis.)

〔2〕



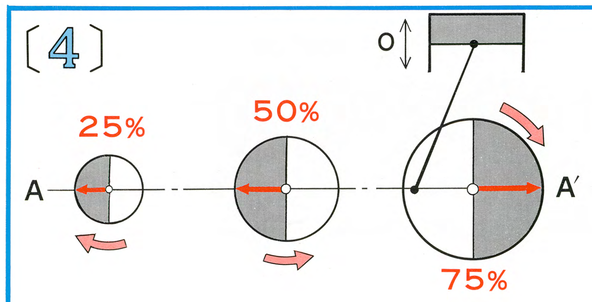
2. At the 90° angle
At this crank angle, the vertical inertia force of the piston is zero, but the leftward inertia force of the crank web is 75%. Accordingly, if both larger and smaller balancer weights generate a total inertia force of 75% in the direction opposing the inertia force of the crank web, the net result is zero.

〔3〕



3. At the 180° crank angle
At this crank angle, the downward inertia force of the piston is taken as 100%, but it is reduced to 25% by the 75% upward inertia force of the crank web. At the same time, the larger balancer generates an inertia force of 50% in an upward direction and the smaller balancer weight 25% in a downward direction. The net result is zero.

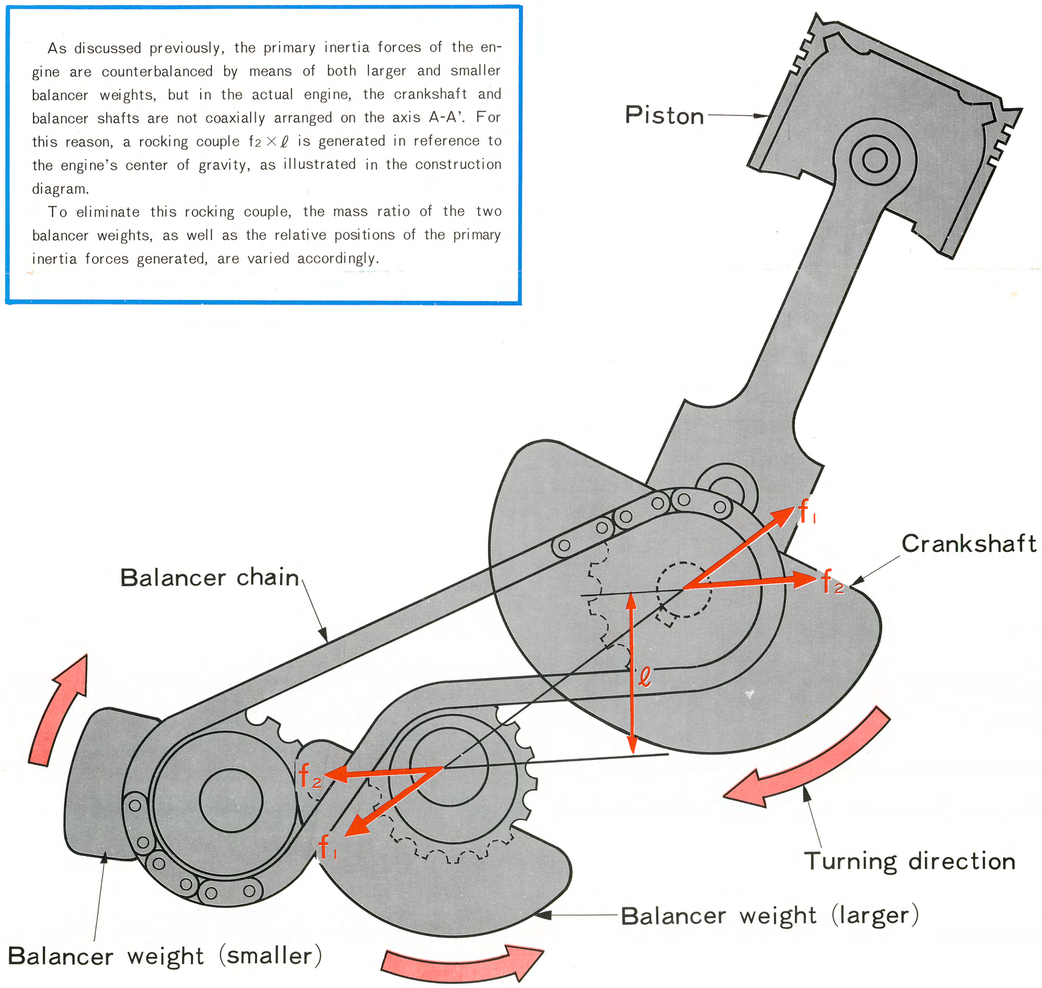
〔4〕



4. At the 270° crank angle
As in the case of the 90° crank angle, the vertical inertia force of the piston is zero, but the rightward inertia force of the crank is 75%. At the 270° crank angle, the larger balancer weight generates a leftward inertia force of 50% while the smaller balancer weight 25% in the same direction. The net result is zero.

As discussed previously, the primary inertia forces of the engine are counterbalanced by means of both larger and smaller balancer weights, but in the actual engine, the crankshaft and balancer shafts are not coaxially arranged on the axis A-A'. For this reason, a rocking couple $f_2 \times \ell$ is generated in reference to the engine's center of gravity, as illustrated in the construction diagram.

To eliminate this rocking couple, the mass ratio of the two balancer weights, as well as the relative positions of the primary inertia forces generated, are varied accordingly.



YAMAHA MOTOR CO., LTD.
PRINTED IN JAPAN