CHAPTER V

CONCLUSIONS

It is well known that 4-cycle 4-cylinder in-line engine produces forces and moments which are not balanced. The disturbances are mainly second orders of inertia force, inertia moment and gas torque. Mitsubishi Corporation foresees that in future 4-cylinder engine will be equipped with vibration sensitive components so designing a new system of second mode counter balancing shafts. This new system is claimed to be able to effectively reducing vibromotive forces and moments. It consists of two eccentric masses turning at twice crankshaft speed.

This study is attempt to find the effectiveness of second mode counter balancing shafts equipped in 4-cylinder in-line engine as compared to a conventional engine.

The study is confined to vibromotive force only since the attempt to study vibromotive moment would require additional instruments such as pressure-volume indicator for measuring gas torque.

Based on this experiment, the author believes that the principle of counter balancing shafts can be applied to other engines and machines to alleviate the problems arising from vibration.

The study shows that:

(1) Of all the vibration modes exist in the engine, it is found experimentally and confirmed by theory that second mode vibration is predominant in conventional engine.

(2) The second mode vibromotive force of conventional engine varies with the square of the engine speed such that at high speed the magnitude is quite large but for balanced engine it is relatively low over the whole range of operating speed.

(3) In spite of the fact that the inertia of reciprocating parts in balanced engine is greater than conventional engine, the first and second mode acceleration of vibration is less and because of greater inertia, its fourth mode acceleration is larger.

(4) Calculated values of second mode inertia force for conventional engine agree closely with experimental results measured at engine support bracket.

(5) Different parts of the engine even subjected to the same exciting force vibrate with different magnitudes because they are mostly bolted down to the engine with gasket or spring washer in between that can of course introduce different spring and damping effects , consequently, their magnitudes of vibration will be modified accordingly.

(6) Theoretically first mode vibration is balanced but experimentally it exists due to small discrepancies of reciprocating masses.

(7) For any conventional engine, the magnitude of fourth mode vibration theoretically should be 1.6 per cent of second mode. The study shows that it can range from 9 to 20 per cent due to limitation inherent in the octave filter set which cannot eliminate the influence of second mode vibration at fourth mode frequency setting.

(8) Magnitudes of vibration for first, second and fourth modes increase as the load increases. Perhaps this is the effect of larger gas force to meet the demand of greater load.