CHAPTER - 1

INTRODUCTION

Cams are very widely used in almost all kinds of automatic machinery, which includes internal combustion engines, machine tools, textile machinery, reciprocating and rotory compressors, computing mechanisms and special purpose machines.

In general, a cam can be designed in two ways:

(i) the profile of the cam is designed to give a specified motion of the follower,

(ii) a suitable profile composed of simple curves, like a straight line or a circle is chosen to give a satisfactory performance of the follower.

The latter procedure simplifies the manufacturing process, which is often the bottle-neck in cam design. Most of the low and medium speed cam-follower systems are generally designed in this way, namely, taking into account only kinematics of the follower. Even for low speed machines, such cams, often called as tangent cams, triple curve cams, etc., are not suitable where a definite motion is required. Under these circumstances, the former procedure is adopted by choosing follower motions like straight line, parabolic, simple harmonic or cycloidal motions. But cams designed for particular follower displacements such as the ones mentioned above are generally expensive from the production point of view and in common appliances like internal combustion engines, cams with simple specified contour (tangent cam, circular cam) are used.

However, all the follower motions mentioned above are not suitable for high-speed cams. The velocity, acceleration and jerk do not match at the end points or boundaries of the rise-dwell-return motions. Such mismatchings give rise to repetetive shock loads which in turn lead to excess wear, stresses and dangerous vibrations. With the advent of high-speed machinery, these problems are more predominant and new follower motions, such as polynomial motion (Stoddart,1953) are becoming more popular and satisfactory, and are developed for a proper satisfaction of end conditions. Also, different curves like harmonic, cycloidal and eighth power polynomial can be suitably combined for satisfying the boundary conditions.

With high speeds, it is necessary to reduce the masses of the linkage to keep the inertia forces low, which in turn make the entire system more flexible. This leads to vibrations and the desired output motion may not be achieved. The polydyne cam combines the polynomial equation with dynamics of a follower system , resulting in an excellent approach to a high-speed, highly flexible cam-follower mechanism. Common examples are automotive valve gear linkages, textile machine members and digital computer appliances.

Now, in all the above mentioned curves, namely, the three basic curves — simple harmonic, parabolic and cycloidal, and the polynomial, the most significant single factor is the pressure angle. The maximum value of the pressure angle should always be kept low, because, this establishes the cam size, torque, loads, accelerations, wear life, and other pertinent factors. The other important factor is the shape of the follower acceleration curve. Here also, the peak value should be kept minimum to avoid large inertia forces and hence shock loads.

The sources of vibrations in cam-follower system are of many kinds, the important of them being :

(i) Vibrations due to the shape of the follower acceleration curve,

(ii) Vibrations that are a result of separation of the cam and follower, called as 'jump' conditions. The transient vibrations that result are more serious in highly flexible linkages,

(iii) Vibrations due to cross-over shock, which occurs in positive drive cams with backlash, between the roller and cam,

(iv) Vibrations due to surface irregularities,

(v) Vibrations due to the rate of application of the external load, and

(vi) Vibrations due to cam unbalance.

Of all the factors mentioned above, study of jump phenomena is very important to keep the constraint between cam and the follower. Jump is a transient condition that occurs with high-speed, highly flexible cam-follower systems, when the speed of rotation exceeds a certain limit. Jump, in turn, results in noise, vibration and wear.

As it is well known that most of the theoretical analyses made to explain a physical phenomena are always simplified, it is necessary to check how far such theoretical analyses can be relied upon for an accurate prediction of the problem. In view of this, an experimental set-up is designed and fabricated to determine the output motion and jump characteristics of cam-follower system with (i) simple harmonic, (ii) parabolic, (iii) cycloidal, (iv) 1-2-3 polynomial, (v) 3-4-5 polynomial, and (vi) 4-5-6-7 polynomial motions of RDRD type. For each of these cases mentioned above, the system is idealized as a single degree of freedom model and continuous mass model and the theoretical results obtained are compared with the experimental results.

This thesis contains the following Chapters in order.

In Chapter 1, an Introduction to the study of Dynamic and Jump Characteristics of cam-follower systems is presented.

In Chapter 2, a brief survey of previous literature is presented with sections covering, use of cam mechanisms, cam size, cam displacement curves, design of compression spring, methods for determining the follower response, jump in cam-follower systems, and response curves treating follower rod as a continuous mass model.

In Chapter 3, a theoretical analysis for finding the dynamic response characteristics for a single degree of freedom model is presented along with the effects of mass, stiffness and spring precompression on the output motion.

In Chapter 4, a theoretical analysis to predict the jump characteristics of the cam-follower systems for a single degree of freedom model is presented, and the theoretical results discussed.

In Chapter 5, a theoretical analysis to predict the response and jump characteristics of the cam-follower system for a continuous mass model is presented and the results discussed, to observe how far the theory is valid for the above analysis.

In Chapter 6, Experimental work and procedure to find the response and jump characteristics of different cams with different masses, spring stiffness and precompressions, is presented. The experimental results obtained are also discussed in this Chapter.

In Chapter 7, an over-all discussion of the results is made and conclusions drawn are presented.

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