CAM FOLLOWERS - A REVIEW

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Abstract: A cam follower, also known as a track follower, is a specialized type of roller or needle bearing designed to follow cams. Cam followers come in a vast array of different configurations; however the most defining characteristic is how the cam follower mounts to its mating part; stud style cam followers use a stud while the yoke style has a hole through the middle. The modern stud type follower was invented and patented in 1937 by Thomas L. Robinson of the McGill Manufacturing Company. It replaced using a standard bearing and bolt. The new cam followers were easier to use because the stud was already included and they could also handle higher loads.

I. INTRODUCTION

Cams are used for essentially the same purpose as linkages, that is, generation of irregular motion. Cams have an advantage over linkages because cams can be designed for much tighter motion specifications. In fact, in principle, any desired motion program can be exactly reproduced by a cam. Cam design is also, at least in principle, simpler than linkage design, although, in practice, it can be very laborious. Automation of cam design using interactive computing has not, at present, reached the same level of sophistication as that of linkage design. The disadvantages of cams are manufacturing expense, poor wear resistance, and relatively poor high-speed capability. Although numerical control (NC) machining does cut the cost of cam manufacture in small lots, costs are still quite high in comparison with linkages. In large lots, molding or casting techniques cut cam costs, but not to the extent that stamping and so forth, can cut linkage costs for similar lot sizes. Unless roller followers are used, cams wear quickly. However, roller followers are bulky and require larger cams, creating size and dynamic problems. In addition, the bearings in roller followers create their own reliability problems. The worst problems with cams are, however, noise and follower bounce at high speeds. As a result, there is a preoccupation with dynamic optimization in cam design. Cam design usually requires two steps (from a geometric point of view):

1. Synthesis of the motion program for the follower and
2. Generation of the cam profile. If the motion program is fully specified throughout the motion cycle, as is the case, For example, with the stitch pattern cams in sewing machines, the first step is not needed. More usually, the motion program is specified only for portions of the cycle, allowing the synthesis of the remaining portions for optimal dynamic performance. An example is the cam controlling the valve opening in an automotive engine. Here the specification is that the valve should be fully closed for a specified interval and more or less fully open for another specified interval. For the portions of the cycle between those specified, a suitable program must be synthesized. This can be done, with varying levels of sophistication, to make the operation of the cam as smooth as possible. In general, the higher the level of dynamic performance required, the more difficult the synthesis process. The second stage of the process, profile generation, is achieved by kinematic inversion. The cam is taken as the fixed link and a number of positions of the follower relative to the cam is constructed. A curve tangent to the various follower positions is drawn and becomes the cam profile. If the process is performed analytically, any level of accuracy can be achieved.

II. CAM-FOLLOWER SYSTEMS

A general cam-follower system consists of three elements as shown in Fig. 8.1. The first two are the cam and follower, and the third is a spring or other means of ensuring that the Follower remains in contact with the cam. The function of the spring can be replaced by gravity or by constraining the follower between the two surfaces on the cam or constraining the cam between two surfaces on the follower. Both of these approaches are usually more expensive than using a spring and therefore are not commonly used. A follower is characterized by its motion relative to the ground link and by the geometry of its face that between roller and rigid cylindrical-faced followers. Obviously, there is a significant difference from an overall design standpoint, however. Although here we will consider only planar, rotating cams, in practice a large number of different cam geometries are found. Some of the different types of cams and follower systems are shown in Fig

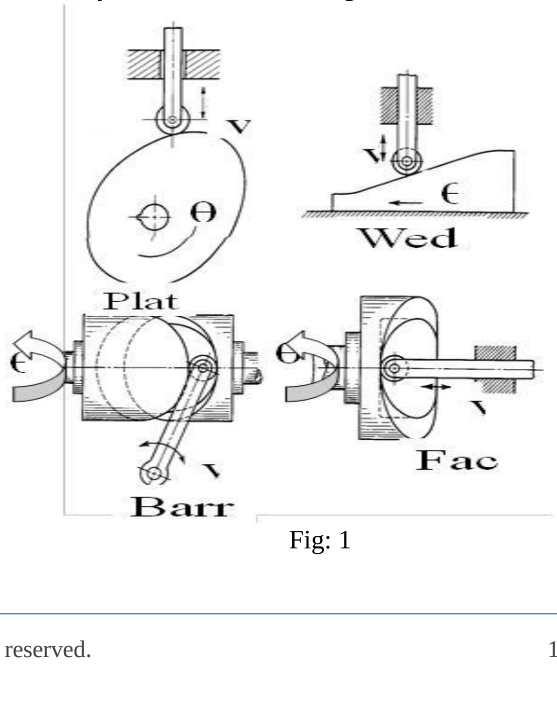

Fig: 1

III. FOLLOWERS

- Knife-edge
- Flat-face
- Roller
- Sperical-face

A. Displacement diagrams

- Cam-follower: usually 1-DOF system

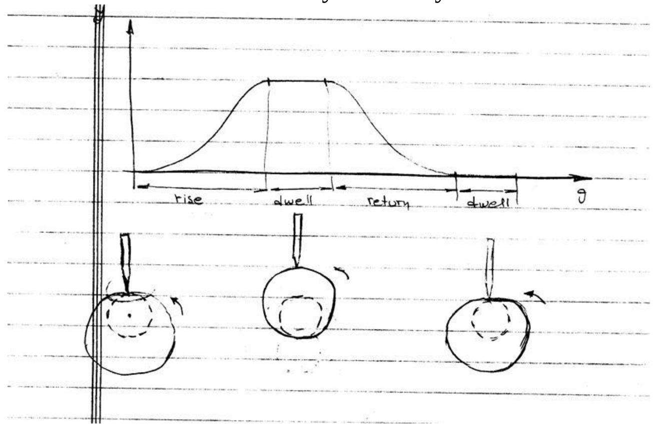

Fig: 2

B. Displacement diagram types

Uniform motion,

- Constant velocity
- Problem: infinity acceleration at point where dwell portion starts

Parabolic-uniform

- Can be shown that acceleration is constant

Sinusoidal (simple harmonic motion)

- Cycloidal

Cycloidal displacement diagram

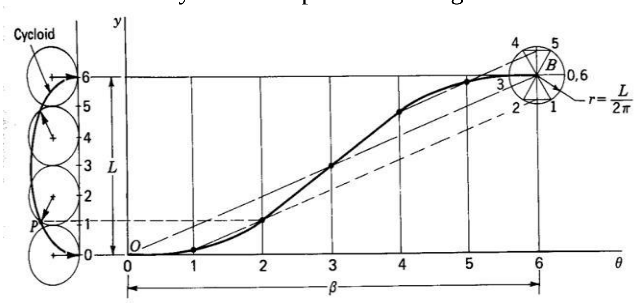

Fig: 3

C. Graphical layout of cam profiles

Terminology

- Trace point: on follower; point of fictitious knife-edge follower. Center of roller, surface of flat-faced follower.

Pitch curve

- Locus generated by trace point as follower moves relative to cam

Prime circle

- Smallest circle that can be drawn with center at the cam rotation axis and is tangent to the pitch circle

Base circle

- Smallest circle centered on cam rotation axis and is tangent to the cam surface

Layout of cam profile: roller follower

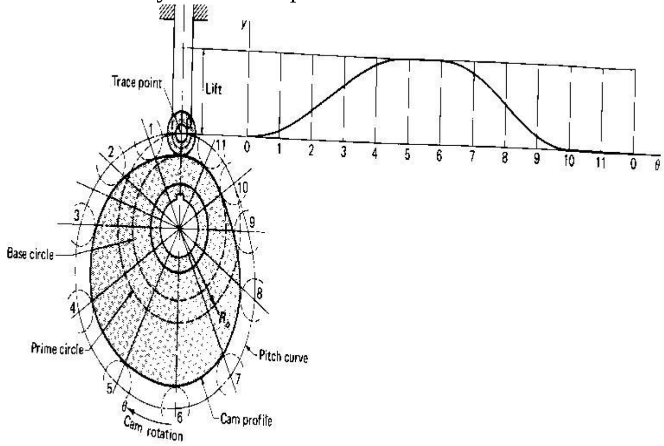

Fig: 4

IV. CONCLUSIONS

The cam-follower pair works usually under critical conditions due to the continuous variations of load, speed and radius of curvature that produce big variation of film thickness. The contact can range from full to mixed till to boundary lubrication conditions so that friction and wear problems can arise. It is not easy to study in depth what happen in the cam follower contact, so that experimental studies are necessary but very difficult, as evidenced by the literature review reported. Figure 9: Alternative version of the follower support with integral gas bearing (a); details of the internal frame with gas bearing: fixed (b) and rotating (c) frame solution. The analysis made of several design solutions for a versatile apparatus for cam-follower simulation has evidenced many important aspects that must be taken into account for developing of a final design. Particularly, the test rig should be able to measure instantaneous contact forces and film thickness for different cam-follower configurations. A dynamic simulations of the proposed solutions is currently under way and will furnish important indications for the final design. The possibility of versions able to simulate also contact between gear teeth will be also investigated. . The system developed will allow a deep analysis of the behaviour of non-conformal contacts under transient conditions. Useful indications for the design optimisation of cams and gears systems will be available. Furthermore, experimental results would be used to modify and develop theoretical and numeric models to evaluate cam-follower failure by pitting and scuffing.

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