Solution to this equation yields a value of z_{max}, whence the following expression for P may be obtained

$$P = R\alpha_0 \left[F_0 RK \frac{M_C}{I_\alpha} \right]^{1/2} \left[\frac{\left(1 + \frac{\epsilon}{R\alpha_0 \sin \varphi} \right)^2 - 1}{1 + \frac{M_C R^2}{I_\alpha} \tan^2 \varphi} \right]^{1/2} \frac{\sin \varphi}{\cos^2 \varphi}$$

Equation (25) is identical to the equation describing the impacting of two simple masses with a linear spring interposed. Therefore, the velocities of the bodies after impact can be obtained from the classical impact relationships (references [2, 3]), employing bodies of mass M_C and $I_\alpha/R^2 \tan^2 \varphi$, considering one body as having velocity $\dot{y}$ and the second a velocity of $(R \tan \varphi)\dot{\alpha}$. Equations (16) and (17) are obtained directly by this means.

References

1 P. Barkan, "Spring Driven Cam Systems," *Machine Design*, May 14, 1959, pp. 174–178, also in Proceedings of Fifth Mechanisms Conference, Purdue University, 1958.

2 O. W. Eshbach, *Handbook of Engineering Fundamentals*, John Wiley & Sons, Inc., New York, N. Y., 1936, pp. 4–37.

3 P. Barkan and E. J. Tuohy, "Impact Behavior of the Four-Bar Linkage," Proceedings of Seventh Mechanisms Conference, Purdue University, 1962.

DISCUSSION

Ray C. Johnson[2]

The authors should be commended on this excellent contribution to the solution of a practical design problem. It is particularly good to see the inclusion of some typical realistic constraints in the procedure of design, such as the limit $\pm\lambda\dot{y}_k$ on velocity $\dot{y}_k$ and the permissible range expressed for initial clearance ϵ. The paper should have much value to design engineers working on similar problems of synthesis.

As a final thought, it is interesting to note the discrepancy between calculated and measured values of dynamic force in Fig. 8. The explanation given in the paper is very good, based on the existence of flexibility in the cam support structure which was not accounted for in the calculations. This illustrates a characteristic in design which is of general importance. That is, in mechanical synthesis work, it is generally necessary to employ simplifying approximations in order to obtain a design solution with a reasonable amount of effort. Refinements appropriate for accurate analysis are not always practical for application in the procedure of synthesis. The paper illustrates very well this general characteristic of design.

[2] Associate Professor, Mechanical Engineering, Worcester Polytechnic Institute, Worcester, Mass. Mem. ASME.

Authors' Closure

The authors would like to thank Professor Johnson for his kind remarks. We heartily concur in the importance of rapid, approximate techniques of analysis and synthesis in most design work. The short lead time allowable in much industrial design work frequently prevents the application of highly refined analytical techniques. The type of approach we have described has the virtue of considerable flexibility in application and makes it possible to design directly to minimize sensitivity to variations. Such techniques make it possible to utilize analysis more effectively during the formative stages of many design problems.