cerns the awkward situation when point H falls outside the paper. For purposes of initial design, the equations given in the present paper suffice, but for a complete analysis of the brake the analytical method outlined by Dr. Spotts is a very good one indeed, although one can always use purely graphical constructions. By using projective geometry[5] it is easy to connect a given point with the intersection of two lines, regardless of where that point of intersection lies.

Professor Modrey's kinematic breakdown of the shoe movement provides an interesting sidelight to put brake design into a proper perspective. His point concerning the vital importance of pressure pattern is indeed a crucial one. Actually, to be precise, there are two basic assumptions involved: (*a*) Shape of pressure pattern, and (*b*) validity of Amonton's law of friction.

Concerning some plastics (e.g., Teflon), Amonton's law is not even a first-order approximation.[6] With most brake linings though, it is substantially correct, so long as the lining is neither contaminated locally (e.g., by grease) nor is it subject to excessive pressure or temperature. On this premise, one can turn the problem around and inquire: What are the requirements for a correct pressure pattern? Perhaps the most overriding single factor is a unique and always reproducible relationship between torque and application load. The corollary of this is that the pressure pattern must remain constant, and independent of load. This is possible only if the pressure pattern is uniquely determined by the kinematics alone. When this requirement is not met—i.e., the pressure *pattern* changes with load—instantaneous pressure pattern becomes also a function of the past history of the shoe.[7] Such variation of the pressure pattern leads to corresponding changes of the C. P. locus, so that the torque becomes erratic even without any change in friction! Purpose of well-planned development work is, therefore, to eliminate such a nuisance, which is possible only if the brake complies with the very hypotheses underlying analysis.

This last statement includes the inference that pressure across the shoe width be constant. When this condition is not fulfilled, the shoes tend to skew, and the brake squeaks its protest rather loudly.

[5] K. Doehleman, "Projektive Geometrie," Goeschen, 1905, p. 53.

[6] A. J. G. Allan, "Plastics as Solid Lubricants and Bearings." *Lubrication Engineering*, vol. 14, 1958.

[7] G. A. G. Fazekas, "Temperature Gradients and Heat Stresses in Brake Drums," *Trans. SAE*, vol. 61, 1953, pp. 279–308.

Torsion and Flexure of Slender Solid Sections[1]

L. E. Malvern.[2] The author's formulas provide convenient approximate solutions for those slender solid sections where more exact methods would require tedious numerical solution. These formulas should be useful to designers, especially where a closer design is required than that provided by the elementary theories.

As the author points out, some caution is required in using the elastic-plastic flexure solution. Even the entirely elastic flexure solution may err somewhat for very short blades because the support inhibits the development of the anticlastic curvature. This is of course just as true for the so-called exact solution as for the approximation formula. The designer will wish to be fortified with some kind of experimental confirmation under conditions similar to those in his application. Does the author know of any such confirmation which has been obtained or sought?

[1] By W. J. Carter, published in the March, 1958, issue of the Journal of Applied Mechanics, vol. 25, Trans. ASME, vol. 80, pp. 115–121.

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Velocity and Acceleration Analysis of Plane and Space Mechanisms by Means of Independent-Position Equations[1]

W. J. Carter.[2] As the author states, the solution of kinematics problems using the complex number notation is not new. This method has been used by the writer for determining motion-time derivatives as high as the fourth.[3]

The author is to be commended for presenting this method in a systematic manner and for extending its use to direct-contact mechanisms and space linkages.

T. P. Goodman.[4] The author's analytical method for obtaining velocities and accelerations should prove useful in cases where the relative displacements and/or relative angular positions of consecutive links in a mechanism are known. However, in most practical problems the velocities and accelerations are desired for a range of input positions; the need for calculating the relative angular positions of intermediate links for each input position, before proceeding to the velocity and acceleration solution, is a limitation in the author's approach. If the method were extended to give solutions for output velocity and acceleration directly in terms of input displacement, velocity, and acceleration, as has been done for plane four-bar linkages by Talbourdet[5] and others, and for spatial four-bar linkages by Wörle and Beyer,[6,7] the usefulness of the method would be greatly enhanced.

The definition of complex mechanisms in footnote 3 of the paper is not quite accurate. In the mechanism of Fig. 4, the velocity polygon could be obtained without a trial solution by using the relative instant center of links 3 and 6,[8] and the acceleration polygon could be obtained without a trial solution by using the acceleration of this relative instant center.[9,10]

N. Rosenauer.[11] The method developed by the author to determine velocities and accelerations of various points in an existing mechanism is an interesting one; however, it is not a very simple one. The method is so complicated that the author himself did not derive the accelerations of the complex mechanism of his Fig. 4, and it would be even more complicated if r_2 would be the driving link instead of r_6.

Some further comments on the paper are expressed by the writer as follows: In footnote 3 the author explains that complex mechanisms are those mechanisms which require trial solutions in

[1] By F. H. Raven, published in the March, 1958, issue of the Journal of Applied Mechanics, vol. 25, Trans. ASME, vol. 80, pp. 1–6.

[2] Associate Professor of Mechanical Engineering, The University of Texas, Austin, Texas. Mem. ASME.

[3] W. J. Carter, "Kinematic Analysis and Synthesis Using Collineation-Axis Equations," Trans. ASME, vol. 79, 1957, pp. 1305–1312.

[4] Assistant Professor of Mechanical Engineering, Massachusetts Institute of Technology, Cambridge, Mass. Assoc. Mem. ASME.

[5] G. J. Talbourdet, "Mathematical Solution of Four-Bar Linkages," *Machine Design*, vol. 13, May, 1941, pp. 65–68; June, 1941, pp. 81–82.

[6] H. Wörle, "Getriebeanalytische und getriebesynthetische Unterlagen für den Entwurf zwangläufiger, insbesondere viergelenkiger Raumkurbelgetriebe allgemeiner und spezieller Art," dissertation, Technical University, Munich, Germany, 1955.

[7] R. Beyer, "Zur Synthese und Analyse von Raumkurbelgetrieben," *Verein Deutscher Ingenieure Berichte*, vol. 12, 1956, pp. 5–20.

[8] See Reference 1 (author's bibliography), pp. 239–246.

[9] W. J. Carter, "Acceleration of the Instant Center," Journal of Applied Mechanics, vol. 17, Trans. ASME, vol. 72, 1950, pp. 142–144.

[10] See Reference 4 (author's bibliography), pp. 63–67.

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