More on the falling chimney

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When a chimney is being demolished by tipping it over, it is often observed that the falling chimney will break near the middle and that the top part will lag behind the lower part. In a recent note in the section, "Apparatus for Teaching Physics" I gave a brief quantitative discussion of the reason for this interesting phenomenon.[1] The basic reason for the breaks in the falling chimneys can be seen in the example of a uniform bar that is fastened to the table with a hinge. If it is allowed to fall, starting at rest in the vertical position, the outboard end will have a high tangential acceleration which requires that the bar be rigid. After the angle from the horizontal becomes less than about 35° the vertical component of this tangential acceleration is greater than the acceleration of gravity, g. Brick chimneys are not sufficiently strong to supply this large tangential acceleration. As a consequence tension ruptures occur in the leading edge of the falling chimneys and the top of the chimney breaks away and reaches the ground at a later time than the lower part. The note described a classroom demonstration based on this phenomenon and it closed with a request for more information and pictures of this phenomenon. I wish to thank the readers of *The Physics Teacher* who responded.

The first response I received was from Jearl Walker who sent me copies of pages from his book[2] which contain a reference to a textbook treatment of the problem of the stress in a falling rod[3] and which contain what appears to be a complete American bibliography on the subject.[4-7] References 4, 5, and 7 are short notes while number 6 is an 11-page illustrated treatise in which F. P. Bundy calculates the transverse shear force, the longitudinal force, and the bending moment for a "long solid column of uniform rectangular cross section," for a "long solid column with uniform taper and circular cross section," and for a "tapered chimney of uniform wall thickness" when each of these is rotating about

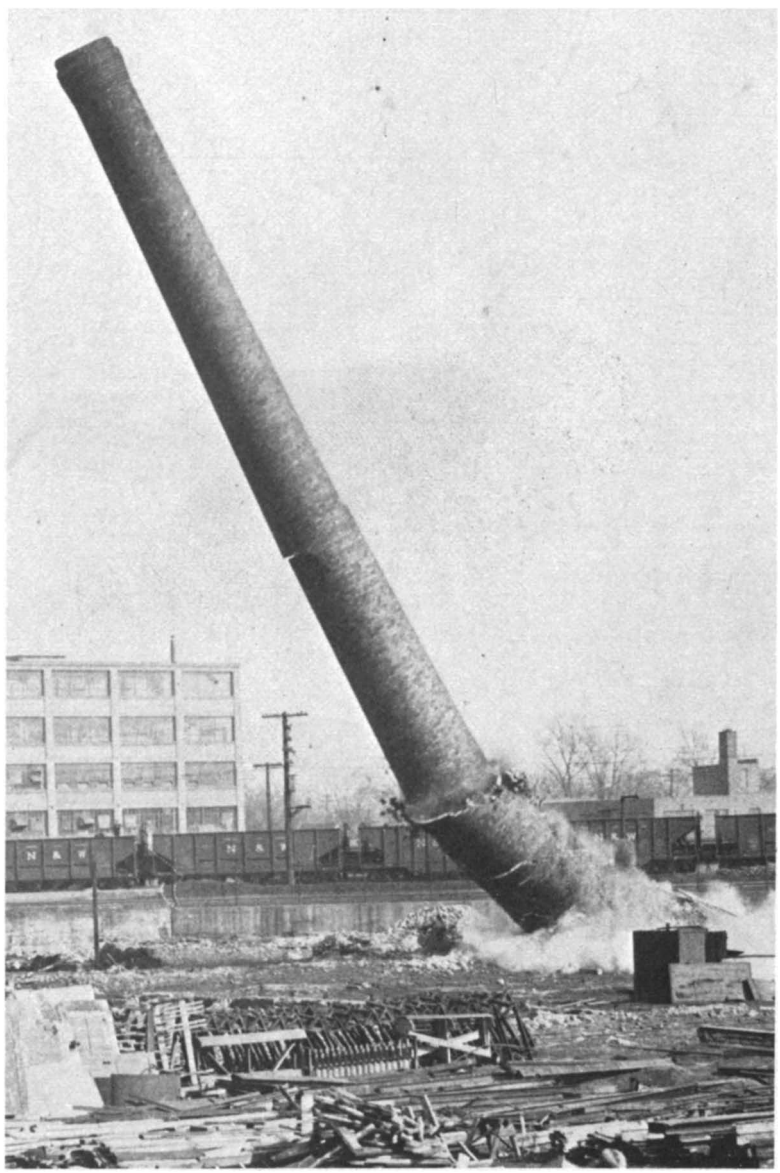

Fig. 1. The fall of a 78.6 m chimney at Detroit. The rupture is seen at about 0.47 h and it first appeared when θ was about 20° to 25°. There are also two breaks near the bottom due to vertical shear. (Wide World Photos, New York)

Fig. 2. The fall of a 49 m chimney in Louisville, KY. The major break is at approximately 0.47 h. Published with the permission of the *Courier-Journal* and *Louisville Times.*

an axis in its base under the action of gravity. Bundy says, "These articles [by Sutton[4] and Reynolds[5]] interested the author and led him to perform some experiments with models. The models acted more nearly in accord with Reynolds' idea than with Sutton's but not exactly in accord with either. This discrepancy showed the necessity of a more complete analysis of the stresses. In this paper, a rather detailed analysis is made of the stresses which are developed in a freely falling chimney. The results are shown to be accurately consistent with data from large falling chimneys." He continues, "The emphasis of this paper is on the prediction of the location of this transverse rupture caused by excessive tension on the leading side (of the falling chimney)." According to Bundy's graphs, if the tensile rupture of the leading edge of the falling chimney first occurs when the chimney has rotated through an angle of 20° then it will appear at about 0.42 of the length of the chimney, measured up from the base. If the tensile rupture of the leading edge does not occur until the chimney has fallen through an angle of about 60° then it will occur at about 0.3 of the length of the chimney measured up from the base. Bundy mentions a second type of break which "... is due essentially to the tension produced by the vertical shear ... which is most likely to occur in very tall chimneys in which the vertical shear is very large near the base — even for very small angles of inclination." Bundy's article was illustrated with four excellent photographs of which Fig. 1 is representative.

I found Bundy listed in the current directory of the American Physical Society and I wrote to ask if he had the originals of the photographs which we might use in this article. With his gracious reply he included the originals of the photos from the 1940 article, about which he wrote, "That was the most successful of my early papers and Prof. F. V. Hunt, Director of the Harvard Underwater Sound Laboratory during WWII, used to get a kick out of introducing me as 'falling chimney Bundy.' Long since then I became known as one of the G.E. diamond growers and as

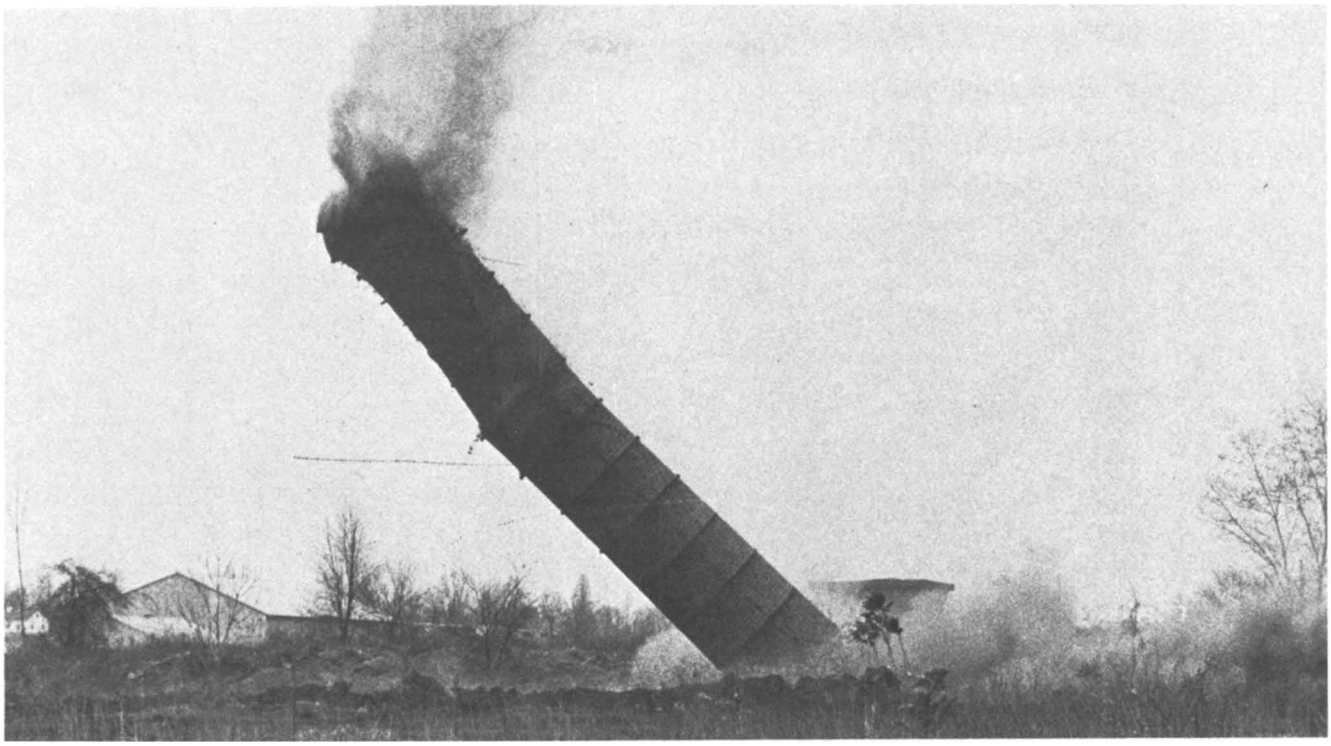

Fig. 3. This was taken a few seconds after Fig. 2, which showed the upper half of a chimney that had broken away from the lower part in the fall. Here we see the upper part has reached the ground and as it falls over it, too, breaks in the characteristic way. Published with the permission of the *Courier-Journal* and *Louisville Times.*

an ultrahigh pressure and temperature physicist."

These four references (4, 5, 6, 7) do not contain any further references on the subject. I suspect that physicists in other countries have written on this subject of falling chimneys and I would appreciate hearing from any who could supply further bibliographical references on the subject of falling chimneys.

Several other readers of TPT wrote in response to my request.

Tom Strickler[8] sent a copy of a clipping of three pictures from *The Courier-Journal*, Louisville, KY, Feb. 12, 1963. I wrote to the paper and they supplied me with three pictures, two of which were different from the three in the clipping. This would indicate that they have a series of five or more pictures of this falling chimney. Two examples are shown in Figs. 2 and 3.

Alfred M. Eich[9] sent copies of clippings of eight scenes from either one or two demolitions from the *Cleveland Plain Dealer* (date unknown).

Tom Sandin[10] wrote to call Ref. 6 to my attention and to note the fact that this article speaks of a picture in the *Philadelphia Recorder* of October 8, 1937.

Joseph Crnkovich[11] sent a clipping from the *Chicago Tribune* of Jan. 1, 1971 and he enclosed classroom material in which he discusses the problem. He said that the same photo had appeared in the *Milwaukee Journal* about Nov. 1, 1970.

M. Russel Wehr[12] sent a copy of a picture that was published "about 25 years ago" in the *Philadelphia Evening Bulletin.* He observed that "it is surprising — that the falling chimney" is not discussed in current physics texts. He says that he became aware of it while serving as a collaborating editor on the AAPT sponsored book *Demonstration Experiments in Physics* which was edited by Richard Sutton in 1938.

If anyone knows of a large chimney that is going to be demolished it would be most useful to take slow-motion movies of the fall which might then be made available to physics teachers as an educational filmloop.

Let me express my sincere thanks to these people whose help was so valuable in supplying information about falling chimneys.

After the manuscript was submitted I received from Herr Ulbricht, the Oberstudiendirektor of the Ina-Seidel-Schule of Braunschweig, Germany, a copy of a clipping from the *Braunschweiger Zeitung* (Nov. 26, 1975) showing five views of a falling chimney.

References

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