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REVIEW

Fluid Transients in Hydro-Electric Engineering Practice. By C. JAEGER. Blackie, 1977. 413 pp. £18.50.

Jaeger's *Engineering Fluid Mechanics* was published in 1956. In spite of its title its scope was restricted, and in fact three-quarters of the book was devoted to surges and water-hammer in pipe lines. After an incursion into rock mechanics the author has now returned to his two original themes and has produced a much enlarged compilation with an accurate title.

Part A deals with surge tanks, and every conceivable case is treated: open and closed at the top, uniform and non-uniform in cross-section, single and multiple, open at the bottom and throttled there, placed upstream and downstream from the turbine. Great complications arise from the nonlinearity of the equations, for pipe friction is taken throughout as varying as the square of the velocity with a numerical factor derived from steady flow experiments. If for simplicity we consider the sudden shutdown of a turbine running steadily, we see that we are dealing with oscillations in a gigantic U-tube, one limb of which is the surge tank and the other the reservoir, which is virtually infinite in cross-section. It is clearly correct to use unidirectional data to calculate the initial level in the tank below that in the reservoir. But what is not so reasonable is to assume invariably that the small effect of friction in modifying the surges follows exactly the same relation. Little is known on this matter, for in direct experiments the inertia effects are large compared with the frictional. There is much to be said for taking friction as varying directly with the velocity, thus linearizing the equations. Not much help on this and other approximate methods can be found in the book, where a great deal of space is devoted to solving the nonlinear equations by step-by-step methods with or without computers and by graphical methods. Stability questions are important and are dealt with at length, though mathematicians may be unhappy at the neglect, as on page 78, of several terms in the governing equations. The systems under review are capable of oscillation which may be slow, as at Fort William. There the pipe line is many miles in length, and the period is so long that it is safe without floating staging to visit the interior of the tank; escape from a rising surge is possible by simply ascending the access ladder. The hydraulic system is controlled by a relatively quick-acting turbine governor with its own characteristics, and the machine may be connected through a generator to an electrical network which itself may become unstable under abnormal conditions.

Part B is concerned with water-hammer, and again many cases are worked out including the effects of adding surge tanks and air vessels to the pipe line. Sharp discontinuities exist, and graphical methods present a picture more readily comprehended than mathematical analysis, although it is clouded by further difficulties caused by friction.

Part C is mostly taken up with descriptions of tests on full-size plants. To verify design calculations and model tests, the supply of information is less than might be expected. If a new plant capable, let us say, of earning tens of thousands of pounds a day passes simple trials, it is commonly set to work at once to earn its keep. An account is given of mishaps that occasionally occur, mostly caused by water-hammer resonance. For example, at Kandergrund (page 307) the culprit was eventually found to be the eleventh harmonic of the tunnel. That being the case, it is surprising that so few installations give trouble.

A feature of the book is the enormous number of references set out in footnotes, together with 18 pages of selected references at the end. An author index appears to cover the former class but not the latter.

A. M. Binnie