

## REFERENCES

- Abramowitz, M. & Stegun, I. A. (1965) *Handbook of Mathematical Functions*. National Bureau of Standards, Washington.
- Ackerberg, R. C., Patel, R. D. & Gupta, S. K. (1978) The heat/mass transfer to a finite strip at small Péclet numbers. *J. Fluid Mech.* **86**, 49–65.
- Ackerberg, R. C. & Phillips, J. H. (1972) The unsteady laminar boundary layer on a semi-infinite flat plate due to small fluctuations in the magnitude of the free-stream velocity. *J. Fluid Mech.* **51**, 137–57.
- Adler, M. (1934) Strömung in gekrümmten Rohren. *Z. Angew. Math. Mech.* **14**, 257–75.
- Agrawal, Y. C. (1975) Laser velocimeter study of entrance flows in curved pipes. PhD thesis, University of California, Berkeley.
- Agrawal, Y., Talbot, L. & Gong, K. (1978) Laser anemometer study of flow development in curved circular pipes. *J. Fluid Mech.* **85**, 497–518.
- Anliker, M. (1972) Toward a nontraumatic study of the circulatory system. In *Biomechanics: Its Foundations and Objectives*, ed. Y. C. Fung, N. Perrone & M. Anliker, chapter 15. Prentice-Hall, Englewood Cliffs, New Jersey.
- Anliker, M. & Dorfman, M. (1970) Theoretical model studies of wave transmission in semicircular canal ducts. *Ing. Arch.* **39**, 390–406.
- Anliker, M., Hestand, M. B. & Ogden, E. (1968a) Dispersion and attenuation of small artificial pressure waves in the canine aorta. *Circ. Res.* **23**, 539–51.
- Anliker, M. & Maxwell, J. A. (1966) Dispersion of waves in blood vessels. In *Biomechanics Symposium*, ed. Y. C. Fung, American Society of Mechanical Engineers, New York.
- Anliker, M., Moritz, W. E. & Ogden, E. (1968b) Transmission characteristics of axial waves in blood vessels. *J. Biomech.* **1**, 235–46.
- Anliker, M. & Raman, K. R. (1966) Korotkoff sounds at diastole – a phenomenon of dynamic instability of fluid-filled shells. *Int. J. Solids Struct.* **2**, 467–91.
- Anliker, M., Rockwell, R. L. & Ogden, E. (1971) Nonlinear analysis of flow pulses and shock waves in arteries. I & II. *Z. Angew. Math. Phys.* **22**, 217–46 & 563–81.
- Anliker, M., Wells, M. K. & Ogden, E. (1969) The transmission characteristics of large and small pressure waves in the abdominal vena cava. *IEEE Trans. Bio-Med. Eng.* **BME-16**, 262–73.

- ASME (1966) *Biomedical Fluid Mechanics Symposium*. American Society of Mechanical Engineers, New York.
- Atabek, H. B. (1968) Wave propagation through a viscous liquid contained in a tethered, initially stressed, orthotropic elastic tube. *Biophys. J.* **8**, 626–49.
- Atabek, H. B. & Chang, C. C. (1961) Oscillatory flow near the entry of a circular tube. *Z. Angew. Math. Phys.* **12**, 185–201.
- Atabek, H. B., Ling, S. C. & Patel, D. J. (1975) Analysis of coronary flow fields in thoracotomized dogs. *Circ. Res.* **37**, 752–61.
- Attinger, E. Ö. (ed.) (1964) *Pulsatile Blood Flow*. McGraw-Hill, New York.
- Attinger, E. Ö. (1969) Wall properties of veins. *IEEE Trans. Bio-Med. Eng.* **BME-16**, 253–61.
- Barua, S. N. (1963) On secondary flow in stationary curved pipes. *Q. J. Mech. Appl. Math.* **16**, 61–77.
- Batchelor, G. K. (1956) On steady laminar flow with closed streamlines at large Reynolds number. *J. Fluid Mech.* **1**, 177–90.
- Bellhouse, B. J. (1969) Velocity and pressure distributions in the aortic valve. *J. Fluid Mech.* **37**, 587–600.
- Bellhouse, B. J. (1972) The fluid mechanics of heart valves. In *Cardiovascular Fluid Dynamics*, ed. D. H. Bergel, chapter 8. Academic Press, London & New York.
- Bellhouse, B. J. & Schultz, D. L. (1967) The determination of fluctuating velocity in air with heated thin film gauges. *J. Fluid Mech.* **29**, 289–95.
- Bellhouse, B. J. & Talbot, L. (1969) The fluid mechanics of the aortic valve. *J. Fluid Mech.* **35**, 721–35.
- Benedict, J. V., Walker, L. B. & Harris, E. H. (1968) Stress-strain characteristics and tensile strength of unembalmed human tendon. *J. Biomech.* **1**, 53–63.
- Bergel, D. H. (1961a) The static elastic properties of the arterial wall. *J. Physiol.* **156**, 445–57.
- Bergel, D. H. (1961b) The dynamic elastic properties of the arterial wall. *J. Physiol.* **156**, 458–69.
- Bergel, D. H. (ed.) (1972a) *Cardiovascular Fluid Dynamics*, 2 vols. Academic Press, London & New York.
- Bergel, D. H. (1972b) The properties of blood vessels. In *Biomechanics: Its Foundations and Objectives*, ed. Y. C. Fung, N. Perrone & M. Anliker, chapter 5. Prentice-Hall, Englewood Cliffs, New Jersey.
- Bergel, D. H. (1972c) The measurement of lengths and dimensions. In *Cardiovascular Fluid Dynamics*, ed. D. H. Bergel, chapter 4. Academic Press, London & New York.
- Bergel, D. H. & Schultz, D. L. (1971) Arterial elasticity and fluid dynamics. *Prog. Biophys. Mol. Biol.* **22**, 1–35.

- Berger, C., Calvet, P., & Jacquemin, C. (1972) Structure d'écoulements de gaz dans des systèmes tubulaires bifurques. Report of DER en mesures. Office nationale d'études et de recherches aérospatiales – Centre d'études et de recherches de Toulouse.
- Bevir, M. K. (1970) The theory of induced voltage electromagnetic flowmeters. *J. Fluid Mech.* **43**, 577–90.
- Blennerhassett, P. (1976) Secondary motion and diffusion in unsteady flow in a curved pipe. PhD thesis, Imperial College, London.
- Blinks, J. R. & Jewell, B. R. (1972) The meaning and measurement of myocardial contractility. In *Cardiovascular Fluid Dynamics*, ed. D. H. Bergel, chapter 7. Academic Press, London & New York.
- Bodoia, J. R. & Osterle, J. F. (1961) Finite difference analysis of plane Poiseuille and Couette flow developments. *Appl. Sci. Res.* **A10**, 265–76.
- Brech, R. & Bellhouse, B. J. (1973) Flow in branching vessels. *Cardiovasc. Res.* **7**, 593–600.
- Brecher, G. A. (1952) Mechanism of venous flow under different degrees of aspiration. *Am. J. Physiol.* **169**, 423–33.
- Brighton, P. W. M. (1977) Boundary layer and stratified flows past obstacles. PhD thesis, Cambridge University.
- Brown, S. N. & Stewartson, K. (1973) On the propagation of disturbances in a laminar boundary layer. I. *Proc. Camb. Philos. Soc.* **73**, 493–503.
- Brutsaert, D. L. & Sonnenblick, E. H. (1969) Force–velocity–length–time relations of the contractile elements in heart muscle of the cat. *Circ. Res.* **24**, 137–49.
- Carew, T. E. (1971) Mechano-chemical response of canine aortic endothelium to elevated shear stress in vitro. PhD thesis, Catholic University of America, Washington DC.
- Carlsson, E. (1969) Experimental studies of ventricular mechanics in dogs using the tantalum-labelled heart. *Fed. Proc.* **28**, 1324–9.
- Caro, C. G., Fitz-Gerald, J. M. & Schroter, R. C. (1971) Atheroma and arterial wall shear: observation, correlation and proposal of a shear dependent mass transfer mechanism for atherogenesis. *Proc. R. Soc. Lond.* **B177**, 109–59.
- Caro, C. G., Foley, T. H. & Sudlow, M. F. (1970) Forearm vasodilation following release of venous congestion. *J. Physiol.* **207**, 257–69.
- Caro, C. G. & Nerem, R. M. (1973) Transport of  $^{14}\text{C}$ -4-cholesterol between serum and wall in perfused dog common carotid artery. *Circ. Res.* **32**, 187–205.
- Caro, C. G., Pedley, T. J., Schroter, R. C. & Seed, W. A. (1978) *The Mechanics of the Circulation*. Oxford University Press.
- Caro, C. G., Pedley, T. J. & Seed, W. A. (1974) Mechanics of the circulation. In *Cardiovascular Physiology*, ed. A. C. Guyton, *MTP International Review of Science, Physiology*, ser. 1, vol. 1. Butterworths, London.

- Carrier, G. F. & Di Prima, R. C. (1956) On the unsteady motion of a viscous fluid past a semi-infinite flat plate. *J. Math. & Phys.* **35**, 359–83.
- Carton, T. W., Dainauskas, J. & Clark, J. W. (1962) Elastic properties of single elastic fibres. *J. Appl. Physiol.* **17**, 547–51.
- Charm, S. E. & Kurland, G. S. (1972) Blood rheology. In *Cardiovascular Fluid Dynamics*, ed. D. H. Bergel, chapter 15. Academic Press, London & New York.
- Clark, C. (1974) Thin film gauges for fluctuating velocity measurements in blood. *J. Phys., Ser. E, Sci. Instrum.* **7**, 548–56.
- Clark, C. & Schultz, D. L. (1973) Velocity distribution in aortic flow. *Cardiovasc. Res.* **7**, 601–13.
- Clément, J., van de Woestijne, K. P. & Pardaens, J. (1973) A general theory of respiratory mechanics applied to forced expiration. *Respir. Physiol.* **19**, 60–79.
- Cokelet, G. R. (1972) The rheology of human blood. In *Biomechanics: Its Foundations and Objectives*, ed. Y. C. Fung, N. Perrone & M. Anliker, chapter 4. Prentice-Hall, Englewood Cliffs, New Jersey.
- Cole, J. D. (1968) *Perturbation Methods in Applied Mathematics*. Blaisdell, Waltham, Massachusetts.
- Collins, W. M. & Dennis, S. C. R. (1975) The steady motion of a viscous fluid in a curved tube. *Q. J. Mech. Appl. Math.* **28**, 133–56.
- Collins, R., Flaud, P., Geiger, D., Kivity, Y. & Oddou, C. (1976) Propagation of shock-like waves in long visco-elastic tubes. *Biomechanika, Sofia*.
- Collins, R. & Tedgui A. (1979) The role of axial tension in the opening and closing characteristics of fluid-filled collapsible tubes. Paper presented at Euromech 118, Zuoz, Switzerland.
- Conrad, W. A. (1969) Pressure–flow relationships in collapsible tubes. *IEEE Trans. Bio-Med. Eng.* **BME-16**, 284–95.
- Conrad, W. A., Cohen, M. L. & McQueen, D. M. (1978) Note on the oscillations of collapsible tubes. *Med. Biol. Eng. Comput.* **16**, 211–14.
- Coppel, W. A. (1960) On a differential equation of boundary-layer theory. *Philos. Trans. R. Soc. Lond.* **A253**, 101–36.
- Cornhill, J. F. & Roach, M. R. (1976) A quantitative study of the localization of atherosclerotic lesions in the rabbit aorta. *Atherosclerosis* **23**, 489–501.
- Cumming, G., Henderson, R., Horsfield, K. & Singhal, S. (1969) The functional morphology of the pulmonary circulation. In *The Pulmonary Circulation and Interstitial Space*, ed. A. P. Fishman & H. H. Hecht. University of Chicago Press.
- Davis, S. H. (1976) The stability of time-periodic flows. *Annu. Rev. Fluid Mech.* **8**, 57–74.
- Dawson, S. V. & Elliott, E. A. (1977) Wave-speed limitation on expiratory flow – a unifying concept. *J. Appl. Physiol., Respir. Environ. Exercise Physiol.* **43**, 498–515.

- Dean, W. R. (1928) The stream-line motion of fluid in a curved pipe. *Philos. Mag.* ser. 7, **5**, 673–95.
- Dennis, S. C. R. (1972) The motion of a viscous fluid past an impulsively started semi-infinite flat plate. *J. Inst. Math. Appl.* **10**, 105–17.
- Douglass, R., (1973) Flow in a human lung model at high Reynolds numbers. MS thesis, Duke University, North Carolina.
- Dressler, R. F. (1949) Mathematical solution of the problem of roll waves in inclined open channels. *Commun. Pure Appl. Math.* **2**, 149–94.
- Duck, P. W. (1979) Viscous flow through unsteady symmetric channels. *J. Fluid Mech.* (in press).
- Eagles, P. M. & Weissman, M. (1975) On the stability of slowly-varying flow: the divergent channel. *J. Fluid Mech.* **69**, 241–62.
- Ettinger, S. J. & Suter, P. F. (1970) *Canine Cardiology*. W. B. Saunders, Philadelphia.
- Farthing, S. P. (1977) Flow in the thoracic aorta and its relation to atherogenesis. PhD thesis, Cambridge University.
- Flaherty, J. E., Keller, J. B. & Rubinow, S. I. (1972a) Post-buckling behaviour of elastic tubes and rings with opposite sides in contact. *SIAM J. Appl. Math.* **23**, 446–55.
- Flaherty, J. T., Pierce, J. E., Ferrans, V. J., Patel, D. J., Tucker, W. K. & Fry, D. L. (1972b) Endothelial nuclear patterns in the canine arterial tree with particular reference to hemodynamic events. *Circ. Res.* **30**, 23–33.
- Flügge, W. (1973) *Stresses in Shells*. Springer-Verlag, Berlin, Heidelberg & New York.
- Fry, D. L. (1968) Acute vascular endothelial changes associated with increased blood velocity gradients. *Circ. Res.* **22**, 165–97.
- Fry, D. L. (1973) Responses of the arterial wall to certain physical factors. In *Atherogenesis: Initiating Factors*, ed. R. Porter & J. Knight. Associated Scientific Publishers, Amsterdam.
- Fung, Y. C. (ed.) (1966) *Biomechanics Symposium*. American Society of Mechanical Engineers, New York.
- Fung, Y. C. (1970) Mathematical representation of the mechanical properties of the heart muscle. *J. Biomech.* **3**, 381–404.
- Fung, Y. C., Perrone, N. & Anliker, M. (eds.) (1972) *Biomechanics: Its Foundations and Objectives*. Prentice-Hall, Englewood Cliffs, New Jersey.
- Gaster, M. (1974) On the effects of boundary layer growth on flow stability. *J. Fluid Mech.* **66**, 465–80.
- Goldstein, S. (1938) *Modern Developments in Fluid Dynamics*. Clarendon Press, Oxford.
- Gonzalez, F. (1974) The origin of Korotkoff sounds and their role in sphygmomanometry. PhD Thesis, University of Florida, Gainesville.
- Gow, B. S. (1972) The influence of vascular smooth muscle on the viscoelastic properties of blood vessels. In *Cardiovascular Fluid Dynamics*, ed. D. H. Bergel, chapter 12. Academic Press, London & New York.

- Gradshteyn, I. S. & Ryzhik, I. M. (1965) *Table of Integrals, Series and Products*. Academic Press, London & New York.
- Griffiths, D. J. (1971*a, b, c*) Hydrodynamics of male micturition. I, II & III. *Med. Biol. Eng.* **9**, 581–8, 589–96 & 597–602.
- Griffiths, D. J. (1975*a, b, c*) Negative resistance effects in flow through collapsible tubes: I. Relaxation oscillations; II. Two-dimensional theory of flow near an elastic constriction; III. Two-dimensional treatment of the elastic properties of elastic constriction. *Med. Biol. Eng.* **13**, 785–90, 791–6 & 797–802.
- Grosch, C. E. & Salwen, H. (1968) The stability of steady and time-dependent plane Poiseuille flow. *J. Fluid Mech.* **34**, 177–205.
- Hall, M. G. (1969) The boundary layer over an impulsively started flat plate. *Proc. R. Soc. Lond.* **A310**, 401–14.
- Hall, P. (1974) Unsteady viscous flow in a pipe of slowly varying cross-section. *J. Fluid Mech.* **64**, 209–26.
- Hall, P. & Parker, K. (1976) The stability of the decaying flow in a suddenly blocked channel. *J. Fluid Mech.* **75**, 305–14.
- Harper, J. F. (1963) On boundary layers in two-dimensional flow with vorticity. *J. Fluid Mech.* **17**, 141–53.
- Hill, A. V. (1938) Heat of shortening and dynamic constants of muscle. *Proc. R. Soc. Lond.* **B126**, 136–95.
- Histand, M. B. & Anliker, M. (1973) Influence of flow and pressure on wave propagation in the canine aorta. *Circ. Res.* **32**, 524–9.
- Holt, J. P. (1969) Flow through collapsible tubes and through *in situ* veins. *IEEE Trans. Bio-Med. Eng.* **BME-16**, 274–83.
- Horlock, J. H. & Lakshminarayana, B. (1973) Secondary flows: theory, experiment and application in turbomachinery aerodynamics. *Annu. Rev. Fluid Mech.* **5**, 247–80.
- Horsfield, K., Dart, G., Olson, D. E., Filley, G. F. & Cumming, G. (1971) Models of the human bronchial tree. *J. Appl. Physiol.* **31**, 207–17.
- Hultgren, H. N. (1962) Venous pistol shot sounds. *Am. J. Cardiol.* **10**, 667–72.
- Hunter, P. (1975) Finite element analysis of cardiac muscle mechanics. PhD thesis, Oxford University.
- Ito, H. (1969) Laminar flow in curved pipes. *Z. Angew. Math. Mech.* **49**, 653–63.
- Jackson, P. S. (1973) The flow round obstacles in boundary layers. PhD thesis, University of Cambridge.
- Jaffrin, M. Y. & Hennessey, T. V. (1972) Pressure distribution in a model of the central airways for sinusoidal flow. *Bull. Physio-Path. Resp.* **8**, 375–90.
- Jones, E., Anliker, M. & Chang, I-Dee (1971) Effects of viscosity and constraints on the dispersion and dissipation of waves in large blood vessels. I & II. *Biophys. J.* **11**, 1085–120 & 1121–34.

- Katz, A. I., Chen, Y. & Moreno, A. H. (1969) Flow through a collapsible tube. *Biophys. J.* **9**, 1261–79.
- Kivity, Y. & Collins, R. (1974) Steady state fluid flow in viscoelastic tubes. Application to blood flow in human arteries. *Arch. Mech., Warsaw* **26**, 921–31.
- Knowlton, F. P. & Starling, E. H. (1912) The influence of variations in temperature and blood-pressure on the performance of the isolated mammalian heart. *J. Physiol.* **44**, 206–19.
- Krueger, J. W. & Pollack, G. H. (1975) Myocardial sarcomere dynamics during isometric contraction. *J. Physiol.* **251**, 627–43.
- Kuchar, N. R. & Ostrach, S. (1966) Flows in the entrance regions of circular elastic tubes. In *Biomedical Fluid Dynamics Symposium*, pp. 45–69. American Society of Mechanical Engineers, New York.
- Lambert, R. K. & Wilson, T. A. (1972) Flow limitation in a collapsible tube. *J. Appl. Physiol.* **33**, 150–3.
- Lambert, R. K. & Wilson, T. A. (1973) A model for the elastic properties of the lung and their effect on expiratory flow. *J. Appl. Physiol.* **34**, 34–48.
- Learoyd, B. M. & Taylor, M. G. (1966) Alterations with age in the viscoelastic properties of human arterial walls. *Circ. Res.* **18**, 278–92.
- Lee, J. S. & Fung, Y. C. (1970) Flow in locally constricted tubes at low Reynolds numbers. *Trans. ASME, Ser E*, **37**, 9–16.
- Lévêque, M. A. (1928) Transmission de Chaleur par convection. *Ann. Mines*, **13**, 201–362.
- Lewis, J. A. & Carrier, G. F. (1949) Some remarks on the flat plate boundary layer. *Q. Appl. Math.* **7**, 228–34.
- Libby, P. A. & Fox, H. (1963) Some perturbation solutions in laminar boundary-layer theory. I. The momentum equation. *J. Fluid Mech.* **17**, 433–49.
- Liepmann, H. W. & Skinner, G. T. (1954) Shearing-stress measurements by use of a heated element. *NACA Technical Note*, no. 3268.
- Lighthill, M. J. (1954) The response of laminar skin friction and heat transfer to fluctuations in the stream velocity. *Proc. R. Soc. Lond.* **A224**, 1–23.
- Lighthill, M. J. (1958) *Fourier Analysis and Generalised Functions*. Cambridge University Press.
- Lighthill, M. J. (1975) *Mathematical Biofluidynamics*. Society for Industrial and Applied Mathematics, Philadelphia.
- Lighthill, M. J. (1978) *Waves in Fluids*. Cambridge University Press.
- Lin, C. C. (1956) Motion in the boundary layer with a rapidly oscillating external flow. *Proceedings of the 11th International Congress on Theoretical and Applied Mechanics, Brussels*, vol. 4, p. 155.
- Ling, S. C. (1963) Heat transfer from a small isothermal spanwise strip on an insulated boundary. *Trans. ASME, Ser. C, J. Heat Transfer*. **85**, 230–6.

- Ling, S. C. & Atabek, H. B. (1972) Nonlinear analysis of pulsatile flow in arteries. *J. Fluid Mech.* **55**, 493–511.
- Ling, S. C., Atabek, H. B., Fry, D. L., Patel, D. J. & Janicki, J. S. (1968) Application of heated film velocity and shear probes to hemodynamic studies. *Circ. Res.* **23**, 789–801.
- Ling, S. C., Atabek, H. B., Letzing, W. G. & Patel, D. J. (1973) Nonlinear analysis of aortic flow in living dogs. *Circ. Res.* **33**, 198–212.
- Love, A. E. H. (1927) *Treatise on the Mathematical Theory of Elasticity*. Reprinted by Dover Publications, New York.
- Lusza, G. (1974) *X-Ray Anatomy of the Vascular System*. Butterworths, London.
- Lutz, R. J., Cannon, J. N., Bischoff, K. B. & Dedrick, R. L. (1977) Wall shear stress distribution in a model canine artery during steady flow. *Circ. Res.* **41**, 391–9.
- Lyne, W. H. (1971) Unsteady viscous flow in a curved pipe. *J. Fluid Mech.* **45**, 13–31.
- McConalogue, D. J. & Srivastava, R. S. (1968) Motion of fluid in a curved tube. *Proc. R. Soc. Lond.* **A307**, 37–53.
- McCutcheon, E. P. & Rushmer, R. F. (1967) Korotkoff sounds: an experimental critique. *Circ. Res.* **20**, 149–69.
- McDonald, D. A. (1960, 1974) *Blood Flow in Arteries*, 2 edns. Arnold, London.
- McDonald, D. A. & Gessner, U. (1968) Wave attenuation in visco-elastic arteries. In *Hemorheology*, ed. A. L. Copley, pp. 113–25. Pergamon Press, Oxford.
- Maloney, J. E., Rooholamini, S. A. & Wexler, L. (1970) Pressure-diameter relations of small blood vessels in isolated dog lung. *Microvasc. Res.* **2**, 1–12.
- Manton, M. J. (1971) Low Reynolds number flow in slowly varying axisymmetric tubes. *J. Fluid Mech.* **49**, 451–9.
- Mills, C. J. (1972) Measurement of pulsatile flow and flow velocity. In *Cardiovascular Fluid Dynamics*, ed. D. H. Bergel, chapter 3. Academic Press, London & New York.
- Mills, C. J., Gabe, I. T., Gault, J. H., Mason, D. T., Ross, J., Braunwald, E. & Shillingford, J. P. (1970) Pressure-flow relationships and vascular impedance in man. *Cardiovasc. Res.* **4**, 405–17.
- Mills, C. J. & Shillingford, J. P. (1967) A catheter-tip electromagnetic velocity probe and its evaluation. *Cardiovasc. Res.* **1**, 263–73.
- Milnor, W. R. (1972) Pulmonary hemodynamics. In *Cardiovascular Fluid Dynamics*, ed. D. H. Bergel, chapter 18. Academic Press, London & New York.
- Milnor, W. R. (1975) Arterial impedance as ventricular afterload. *Circ. Res.* **36**, 565–70.



- Minton, P. & Selvalingam, S. (1970) Flow in an oscillating pipe. In *The Measurement of Pulsating Flow*. Institute of Measurement and Control Symposium, University of Surrey.
- Moore, D. W. (1963) The boundary layer on a spherical gas bubble. *J. Fluid Mech.* **16**, 161–76.
- Moore, F. K. (1951) Unsteady laminar boundary layer flow. *NACA Technical Note*, no. 2471.
- Moore, F. K. (1957) Aerodynamic effects of boundary layer unsteadiness. *Proceedings of the 6th Anglo-American Conference, Royal Aeronautical Society, Folkestone*, Royal Aeronautical Society, London, pp. 439–76.
- Moreno, A. H., Katz, A. I., Gold, L. D. & Reddy, R. V. (1970) Mechanics of distension of dog veins and other very thin-walled tubular structures. *Circ. Res.* **27**, 1069–80.
- Murata, S., Miyake, Y. & Inaba, T. (1976) Laminar flow in a curved pipe with varying curvature. *J. Fluid Mech.* **73**, 735–52.
- Nerem, R. M., Mosberg, A. T. & Schwerin, W. D. (1976) Transendothelial transport of  $^{131}\text{I}$ -albumin. *Biorheology* **13**, 71–7.
- Nerem, R. M., Rumberger, J. A., Gross, D. R., Hamlin, R. L. & Geiger, G. L. (1974a) Hot-film anemometer velocity measurements of arterial blood flow in horses. *Circ. Res.* **34**, 193–203.
- Nerem, R. M., Rumberger, J. A., Gross, D. R., Hamlin, R. L. & Geiger, G. L. (1974b) Hot-film measurements of coronary blood flow in horses. In *Fluid Dynamic Aspects of Arterial Disease, Proceedings of a Specialists' Meeting*, Columbus, Ohio.
- Nerem, R. M. & Seed, W. A. (1972) An *in vivo* study of the nature of aortic flow disturbances. *Cardiovasc. Res.* **6**, 1–14.
- Nerem, R. M., Seed, W. A. & Wood, N. B. (1972) An experimental study of the velocity distribution and transition to turbulence in the aorta. *J. Fluid Mech.* **52**, 137–60.
- Newman, D. L. & Bowden, L. N. R. (1973) Effect of reflection from an unmatched junction on the abdominal aortic impedance. *Cardiovasc. Res.* **7**, 827–33.
- Newman, D. L., Gosling, R. G., Bowden, N. L. R. & King, D. H. (1973) Pressure amplitude increase on unmatching the aortic-iliac junction of the dog. *Cardiovasc. Res.* **7**, 6–13.
- Newman, H. A. I. & Zilvermit, D. B. (1962) Quantitative aspects of cholesterol flux in rabbit atheromatous lesions. *J. Biol. Chem.* **237**, 2078–84.
- Newman, J. (1973) The fundamental principles of current distribution and mass transport in electrochemical cells. In *Electroanalytical Chemistry*, ed. A. J. Bard, vol. 6, p. 187. Marcel Dekker, New York.
- Noble, M. I. M. (1968) The contribution of blood momentum to left ventricular ejection in the dog. *Circ. Res.* **23**, 663–70.

- Noble, M. I. M., Trenchard, D. & Guz, A. (1966) Left ventricular ejection in conscious dogs. I. Measurement and significance of the maximum acceleration of blood from the left ventricle. *Circ. Res.* **19**, 139–47.
- Obremski, H. J., Morkovin, M. V. & Landahl, M. (1969) Portfolio of the stability characteristics of incompressible boundary layers. *AGAR-Dograph*, no. 134.
- Olsen, J. H. & Shapiro, A. H. (1967) Large amplitude unsteady flow in liquid filled elastic tubes. *J. Fluid Mech.* **29**, 513–38.
- Olson, D. E. (1971) Fluid mechanics relevant to respiration – flow within curved or elliptical tubes and bifurcating systems. PhD thesis, Imperial College, London.
- Olson, R. M. (1968) Aortic blood pressure and velocity as a function of time and position. *J. Appl. Physiol.* **24**, 563–9.
- O'Rourke, M. F. & Taylor, M. G. (1966) Vascular impedance of the femoral bed. *Circ. Res.* **18**, 126–39.
- O'Rourke, M. F. & Taylor, M. G. (1967) Input impedance of the systemic circulation. *Circ. Res.* **20**, 365–80.
- Ostrach, S. (1964) Laminar flows with body forces. In *Theory of Laminar Flows*, ed. F. K. Moore, *High Speed Aerodynamics and Jet Propulsion*, vol. IV. Oxford University Press.
- Pacome, J.-J. (1975) Structures d'écoulement et pertes de charges calculées dans le modèle d'arbre bronchique de Weibel. Doctoral thesis, Paul Sabatier University, Toulouse.
- Parker, K. H. (1977) Instability in arterial blood flow. In *Cardiovascular Flow Dynamics and Measurement*, ed. N. H. S. Hwang & N. A. Normann, pp 633–63. University Park Press, Baltimore, Maryland.
- Patel, D. J., de Freitas, F. M. & Fry, D. L. (1963a) Hydraulic input impedance to aorta and pulmonary artery in dogs. *J. Appl. Physiol.* **18**, 134–40.
- Patel, D. J., de Freitas, F. M., Greenfield, J. C. & Fry, D. L. (1963b) Relationship of radius to pressure along the aorta in living dogs. *J. Appl. Physiol.* **18**, 1111–17.
- Patel, D. J. & Fry, D. L. (1966) Longitudinal tethering of arteries in dogs. *Circ. Res.* **19**, 1011–21.
- Patel, D. J., Janicki, J. S., Vaishnav, R. N. & Young, J. T. (1973) Dynamic anisotropic viscoelastic properties of the aorta in living dogs. *Circ. Res.* **32**, 93–107.
- Patel, D. J. & Vaishnav, R. N. (1972) The rheology of large blood vessels. In *Cardiovascular Fluid Dynamics*, ed. D. H. Bergel, chapter 11. Academic Press, London & New York.
- Pedley, T. J. (1972a) On the forced heat transfer from a hot film embedded in the wall in two-dimensional unsteady flow. *J. Fluid Mech.* **55**, 329–57.
- Pedley, T. J. (1972b) Two-dimensional boundary layers in a free stream which oscillates without reversing. *J. Fluid Mech.* **55**, 359–83.

- Pedley, T. J. (1976*a*) Viscous boundary layers in reversing flow. *J. Fluid Mech.* **74**, 59–79.
- Pedley, T. J. (1976*b*) Heat transfer from a hot film in reversing shear flow. *J. Fluid Mech.* **78**, 513–34.
- Pedley, T. J. (1977) Pulmonary fluid dynamics. *Annu. Rev. Fluid Mech.* **9**, 229–74.
- Pedley, T. J. (1978) The fluid mechanics of circulatory systems. In *Comparative Physiology – Water, Ions and Fluid Mechanics*, ed. K. Schmidt-Nielsen, L. Bolis & S. H. P. Maddrell. Cambridge University Press.
- Pedley, T. J., Schroter, R. C. & Sudlow, M. F. (1970*a*) Energy losses and pressure drop in models of human airways. *Respir. Physiol.* **9**, 371–86.
- Pedley, T. J., Schroter, R. C. & Sudlow, M. F. (1970*b*) The prediction of pressure drop and variation of resistance within the human bronchial airways. *Respir. Physiol.* **9**, 387–405.
- Pedley, T. J., Schroter, R. C. & Sudlow, M. F. (1971) Flow and pressure drop in systems of repeatedly branching tubes. *J. Fluid Mech.* **46**, 365–83.
- Pedley, T. J., Schroter, R. C. & Sudlow, M. F. (1977) Gas flow and mixing in the airways. In *Bio-engineering Aspects of the Lung*, ed. J. B. West, chapter 3. Marcel Dekker, New York.
- Pedley, T. J. & Seed, W. A. (1977) The fluid mechanics of left ventricular ejection. In *Cardiovascular and Pulmonary Dynamics*, ed. M. Y. Jaffrin, pp. 311–19. *Proceedings of Euromech 92*. Éditions INSERM. Institut national de la santé et de la recherche medicale, Paris.
- Peronneau, P., Deloche, A., Bui-Mong-Hung & Hinglais, J. (1969) Débitmétrie ultrasonore: développements et applications expérimentales. *Eur. Surg. Res.* **1**, 147–56.
- Peronneau, P., Leger, F., Hinglais, J., Pellet, M., & Schwartz, P. Y. (1970) Vélocimètre sanguin à effet Doppler à émission ultrasonore pulsée. *Onde électr.*, **50**, 369–89.
- Porter, B. (1967) *Stability Criteria for Linear Dynamical Systems*. Oliver & Boyd, Edinburgh.
- Porter, R. & Knight, J. (eds.) (1973) *Atherogenesis: Initiating Factors, CIBA Foundation Symposium*. Associated Scientific Publishers, Amsterdam.
- Proudman, I. & Pearson, J. R. A. (1957) Expansions at small Reynolds numbers for the flow past a sphere and a circular cylinder. *J. Fluid Mech.* **2**, 237–62.
- Raines, J. K., Jaffrin, M. Y. & Shapiro, A. H. (1974) A computer simulation of arterial dynamics in the human leg. *J. Biomech.* **7**, 77–91.
- Reiss, L. P. & Hanratty, T. J. (1962) Measurement of instantaneous rates of mass transfer to a small sink on a wall. *AIChEJ.* **8**, 245–7.
- Reyn, J. W. (1974) On the mechanism of self-excited oscillations in the flow through collapsible tubes. *Delft Prog. Rep.* **F1**, 51–67.

- Riley, N. (1965) Oscillating viscous flows. *Mathematika* **12**, 161–75.
- Riley, N. & Dennis, S. C. R. (1976) Flow in a curved pipe at high Dean numbers. Paper presented to the Workshop on Viscous Interaction and Boundary-layer Separation, Columbus, Ohio.
- Rittgers, S. E., Karayannacos, P. E., Barrera, J. G., Talukder, N., Nerem, R. M. & Vasko, J. S. (1976) Acute and chronic studies of velocity profiles in arterial vein grafts. In *Proceedings of the 29th American Conference on Engineering in Medicine and Biology, Boston*. Alliance for Engineering in Medicine and Biology, Chevy Chase, Maryland.
- Roach, M. R. (1972) Poststenotic dilatation in arteries. In *Cardiovascular Fluid Dynamics*, ed. D. H. Bergel, chapter 13. Academic Press, London & New York.
- Roach, M. R. & Burton, A. C. (1957) The reason for the shape of the distensibility curves of arteries. *Can. J. Biochem. Physiol.* **35**, 181–90.
- Rosenhead, L. (ed.) (1963) *Laminar Boundary Layers*. Clarendon Press, Oxford.
- Rowe, M. (1970) Measurements and computations of flow in pipe bends. *J. Fluid Mech.* **43**, 771–83.
- Rubinow, S. I. & Keller, J. B. (1972) Flow of a viscous fluid through an elastic tube with applications to blood flow. *J. Theor. Biol.* **35**, 299–313.
- Rumberger, J. A. (1976) A non-linear mathematical model of coronary blood flow. PhD thesis, Ohio State University.
- Rumberger, J. A. & Nerem, R. M. (1977) A method-of-characteristics calculation of coronary blood flow. *J. Fluid Mech.* **82**, 429–48.
- Sarpkaya, T. (1966) Experimental determination of the critical Reynolds number for pulsating Poiseuille flow. *Trans. ASME, Ser. D, J. Basic Eng.* **88**, 589–98.
- Schaaf, B. W. & Abbrecht, P. H. (1972) Digital computer simulation of human systemic arterial pulse wave transmission: a nonlinear model. *J. Biomech.* **5**, 345–64.
- Scherer, P. W. (1972) A model for high Reynolds number flow in a human bronchial bifurcation. *J. Biomech.* **5**, 223–9.
- Scherer, P. W., Kamm, R. D. & Shapiro, A. H. (1975a) External pneumatic compression for the prevention of deep venous thrombosis. *Proceedings of the San Diego Biomedical Symposium*, vol. 14. Academic Press, London & New York.
- Scherer, P. W., Shendalman, L. H., Greene, N. M. & Bouhuys, A., (1975b) Measurement of axial diffusivities in a model of the bronchial airways. *J. Appl. Physiol.* **38**, 719–23.
- Schlichting, H. (1968) *Boundary Layer Theory*, 6th edn. McGraw-Hill, New York.
- Schoenberg, M. (1968) Pulse wave propagation in elastic tubes having longitudinal changes in area and stiffness. *Biophys. J.* **8**, 991–1008.
- Schoendorfer, D. W. & Shapiro, A. H. (1977) The collapsible tube as a prosthetic vocal source. *Proceedings of the San Diego Biomedical Symposium*, vol. 16, 349–56. Academic Press, London & New York.

- Schreck, R. M. & Mockros, L. F. (1970) Fluid dynamics in the upper pulmonary airways. In *AIAA 3rd Fluid and Plasma Dynamics Conference, Los Angeles*. American Institute of Aeronautics and Astronautics, New York.
- Schroter, R. C. & Sudlow, M. F. (1969) Flow patterns in models of the human bronchial airways. *Respir. Physiol.* **7**, 341–55.
- Schultz, D. L. (1972) Pressure and flow in large arteries. In *Cardiovascular Fluid Dynamics*, ed. D. H. Bergel, chapter 9. Academic Press, London & New York.
- Schultz, D. L., Tunstall-Pedoe, D. L., Lee, G. de J., Gunning, A. J. & Bellhouse, B. J. (1969) Velocity distribution and transition in the arterial system. In *Circulatory and Respiratory Mass Transport*, ed. G. E. W. Wolstenholme & J. Knight, *CIBA Symposium*. J. & A. Churchill, Edinburgh.
- Schwartz, C. J., Bell, F. P., Somer, J. B. & Gerrity, R. (1974) Focal and regional differences in aortic permeability to macromolecules. In *Fluid Dynamic Aspects of Arterial Disease, Proceedings of a Specialists' Meeting*, Columbus, Ohio.
- Seed, W. A. & Wood, N. B. (1970a) Development and evaluation of a hot-film velocity probe for cardiovascular studies. *Cardiovasc. Res.* **4**, 253–63.
- Seed, W. A. and Wood, N. B. (1970b) Use of a hot film velocity probe for cardiovascular studies. *J. Phys., Ser. E., Sci. Instrum.* **3**, 377–84.
- Seed, W. A. & Wood, N. B. (1971) Velocity patterns in the aorta. *Cardiovasc. Res.* **5**, 319–30.
- Seeley, B. D. & Young, D. F. (1976) Effect of geometry on pressure losses across models of arterial stenoses. *J. Biomech.* **9**, 439–48.
- Seminara, G. & Hall, P. (1976) Centrifugal instability of a Stokes layer: linear theory. *Proc. R. Soc. Lond.* **A350**, 299–316.
- Seminara, G. & Hall, P. (1977) Centrifugal instability of a Stokes layer: non-linear theory. *Proc. R. Soc. Lond.* **A354**, 119–26.
- Seymour, B. R. (1975) Unsteady flow in flexible tubes: a modulated simple wave. *Int. J. Eng. Sci.* **13**, 579–94.
- Shapiro, A. H. (1977) Steady flow in collapsible tubes. *Trans. ASME, Ser. K., J. Biomech. Eng.* **99**, 126–47.
- Shayo, L. K. & Ellen, C. H. (1974) The stability of finite length circular cross-section pipes conveying inviscid fluid. *J. Sound Vib.* **37**, 535–45.
- Singh, M. P. (1974) Entry flow in a curved pipe. *J. Fluid Mech.* **65**, 517–39.
- Skalak, R. (1972) Synthesis of a complete circulation. In *Cardiovascular Fluid Dynamics*, ed. D. H. Bergel, chapter 19. Academic Press, London & New York.
- Skalak, R. & Stathis, T. (1966) A porous tapered elastic tube model of a vascular bed. In *Biomechanics Symposium*, ed. Y. C. Fung. American Society of Mechanical Engineers, New York.

- Smith, F. T. (1974) Laminar flow over a small hump on a flat plate. *J. Fluid Mech.* **57**, 803–24.
- Smith, F. T. (1975) Pulsatile flow in curved pipes. *J. Fluid Mech.* **71**, 15–42.
- Smith, F. T. (1976a) Steady motion within a curved pipe. *Proc. R. Soc. Lond.* **A347**, 345–70.
- Smith, F. T. (1976b) Fluid flow into a curved pipe. *Proc. R. Soc. Lond.* **A351**, 71–87.
- Smith, F. T. (1976c) Pipeflows distorted by non-symmetric indentation or branching. *Mathematika* **23**, 62–83.
- Smith, F. T. (1976d, e) Flow through constricted or dilated pipes and channels. I & II. *Q. J. Mech. Appl. Math.* **29**, 343–64 and 365–83.
- Smith, F. T. (1977a) Steady motion through a branching tube. *Proc. R. Soc. Lond.* **A355**, 167–87.
- Smith, F. T. (1977b) Upstream interactions in channel flows. *J. Fluid Mech.* **79**, 631–55.
- Smith, F. T., Sykes, R. I. & Brighton, P. W. M. (1977) A two-dimensional boundary layer encountering a three-dimensional hump. *J. Fluid Mech.* **83**, 163–76.
- Smith, K. A., Colton, C. K. & Freedman, R. W. (1974) Shear stress measurements at bifurcations. In *Fluid Dynamic Aspects of Arterial Disease, Proceedings of a Specialists' Meeting*, Columbus, Ohio.
- Sobey, I. J. (1976a) Inviscid secondary flow in a tube of slowly varying ellipticity. *J. Fluid Mech.* **73**, 621–39.
- Sobey, I. J. (1976b) Bio-fluid dynamics of bifurcations. PhD thesis, University of Cambridge.
- Sobey, I. J. (1977) Laminar boundary-layer flow past a two-dimensional slot. *J. Fluid Mech.* **83**, 33–47.
- Sokolnikoff, I. S. (1956) *Mathematical Theory of Elasticity*. McGraw-Hill, New York.
- Springer, S. G. (1973) The solution of heat transfer problems by the Wiener–Hopf technique. PhD thesis, Imperial College, London.
- Springer, S. G. (1974) The solution of heat-transfer problems by the Wiener–Hopf technique. II. Trailing edge of a hot film. *Proc. R. Soc. Lond.* **A337**, 395–412.
- Springer, S. G. & Pedley, T. J. (1973) The solution of heat-transfer problems by the Wiener–Hopf technique. I. Leading edge of a hot film. *Proc. R. Soc. Lond.* **A333**, 347–62.
- Stahl, W. R. (1967) Scaling of respiratory variables in mammals. *J. Appl. Physiol.* **22**, 453–60.
- Steinfeld, L., Alexander, H. & Cohen, M. L. (1974) Updating sphygmomanometry. *Am. J. Cardiology* **33**, 107–10.
- Stewartson, K. (1957) On asymptotic expansions in the theory of boundary layers. *J. Math. & Phys.* **36**, 173–91.

- Stewartson, K. (1958) On rotating laminar boundary layers. In *Proceedings of the IUTAM Symposium on Boundary Layer Research*, ed. H. Görtler, p. 59. Springer-Verlag, Berlin, Heidelberg & New York.
- Stewartson, K. (1968) On the flow near the trailing edge of a flat plate. *Proc. R. Soc. Lond.* **A306**, 275–90.
- Stewartson, K. (1973) On the impulsive motion of a flat plate in a viscous fluid. II. *Q. J. Mech. Appl. Math.* **26**, 143–52.
- Stewartson, K. (1974) Multistructured boundary layers on flat plates and related bodies. *Adv. Appl. Mech.* **14**, 145–239.
- Streeter, D. D., Vaishnav, R. N., Patel, D. J., Spotnitz, H. M., Ross, J. & Sonnenblick, E. H. (1970) Stress distribution in the canine left ventricle during diastole and systole. *Biophys. J.* **10**, 345–63.
- Streeter, V. L., Keitzer, W. F. & Bohr, F. F. (1963) Pulsatile pressure and flow through distensible vessels. *Circ. Res.* **13**, 3–20.
- Talukder, N. (1975) An investigation on the flow characteristics in arterial branchings. *Trans. ASME* **75-APMB-4**.
- Talukder, N. & Nerem, R. M. (1978) Flow characteristics in vascular graft models. *Digest of the First International Conference on Mechanics in Medicine and Biology, Aachen*, pp. VII 281–4.
- Taylor, D. E. M. & Wade, J. D. (1970) The pattern of flow around the atrioventricular valves during diastolic ventricular filling. *J. Physiol.* **207**, 71–2.
- Taylor, G. I. (1929) The criterion for turbulence in curved pipes. *Proc. R. Soc. Lond.* **A124**, 243–9.
- Taylor, M. G. (1965) Wave travel in a non-uniform transmission line, in relation to pulses in arteries. *Phys. Med. Biol.* **10**, 539–50.
- Taylor, M. G. (1966) The input impedance of an assembly of randomly branching elastic tubes. *Biophys. J.* **6**, 29–51.
- Ur, A. & Gordon, M. (1970) Origin of Korotkoff sounds. *Am. J. Physiol.* **218**, 524–9.
- Van Dyke, M. (1970) Entry flow in a channel. *J. Fluid Mech.* **44**, 813–23.
- Van Dyke, M. (1975) *Perturbation Methods in Fluid Mechanics*, 2nd edn. Parabolic Press, Stanford, California.
- Van Dyke, M. (1978) Extended Stokes series: laminar flow through a loosely coiled pipe. *J. Fluid Mech.* **86**, 129–45.
- van Steenhoven, A. A. & van Dongen, M. E. H. (1979) Model studies of the closing behaviour of the aortic valve. *J. Fluid Mech.* **90**, 21–32.
- Weibel, E. R. (1963) *Morphometry of the human lung*. Springer-Verlag, Berlin, Heidelberg & New York.
- Weinbaum, S. & Caro, C. G. (1976) A macromolecule transport model for the arterial wall and endothelium based on the ultrastructural specialization observed in electron microscopic studies. *J. Fluid Mech.* **74**, 611–40.
- Weinbaum, S. & Parker, K. H. (1975) The laminar decay of suddenly blocked channel and pipe flows. *J. Fluid Mech.* **69**, 729–52.

- Wells, M. K., Winter, D. C., Nelson, A. W. & McCarthy, T. C. (1974) Hemodynamic patterns in coronary arteries. In *Fluid Dynamic Aspects of Arterial Disease, Proceedings of a Specialists' Meeting*, Columbus, Ohio.
- West, J. B., Glazier, J. B., Hughes, J. M. B. & Maloney, J. E. (1969) Pulmonary capillary flow, diffusion ventilation and gas exchange. In *Circulatory and Respiratory Mass Transport*, ed. G. E. W. Wolstenholme & J. Knight, *CIBA Symposium*. J. & A. Churchill, Edinburgh.
- Wexler, L., Bergel, D. H., Gabe, I. T., Makin, G. S. & Mills, C. J. (1968) Velocity of blood flow in normal human venae cavae. *Circ. Res.* **23**, 349–59.
- White, C. M. (1929) Streamline flow through curved pipes. *Proc. R. Soc. Lond.* **A123**, 645–63.
- Whitham, G. B. (1974) *Linear and Non-Linear Waves*. Wiley, New York.
- Whitmore, R. L. (1968) *Rheology of the Circulation*. Pergamon Press, Oxford.
- Wiederhielm, C. A. (1972) The interstitial space. In *Biomechanics: Its Foundations and Objectives*, ed. Y. C. Fung, N. Perrone & M. Anliker, chapter 11. Prentice-Hall, Englewood Cliffs, New Jersey.
- Wiener, F., Morkin, E., Skalak, R. & Fishman, A. P. (1966) Wave propagation in the pulmonary circulation. *Circ. Res.* **19**, 834–50.
- Wild, R., Pedley, T. J. & Riley, D. S. (1977) Viscous flow in collapsible tubes of slowly-varying elliptical cross-section. *J. Fluid Mech.* **81**, 273–94.
- Wilson, S. D. R. (1971) Entry flow in a channel. II. *J. Fluid Mech.* **46**, 787–99.
- Womersley, J. R. (1955) Method for the calculation of velocity, rate of flow and viscous drag in arteries when the pressure gradient is known. *J. Physiol.* **127**, 553–63.
- Womersley, J. R. (1957) The mathematical analysis of the arterial circulation in a state of oscillatory motion. *Wright Air Development Centre, Technical Report WADC-TR 56-614*.
- Yao, L-S. & Berger, S. A. (1975) Entry flow in a curved pipe. *J. Fluid Mech.* **67**, 177–96.
- Young, D. F. & Tsai, F. Y. (1973*a, b*) Flow characteristics in models of arterial stenosis. I. Steady flow. II. Unsteady flow. *J. Biomech.* **6**, 395–410 & 547–60.
- Young, T. (1809) On the functions of the heart and arteries. *Philos. Trans. R. Soc. Lond.* **99**, 1–31.
- Zeller, H., Talukder, N. & Lorenz, J. (1970) Model studies of pulsating flow in arterial branches and wave propagation in blood vessels. In *Fluid Dynamics of Blood Circulation and Respiratory Flow, AGARD Conference Proceedings*, no. 65.
- Zweifach, B. W. (1974) Quantitative studies of microcirculatory structure and function. I & II. *Circ. Res.* **34**, 843–57 & 858–66.