Contents.

The Experimental Foundations of Solid Mechanics. By Professor James F. Bell, The Johns Hopkins University, Baltimore, Maryland (USA). (With 481 Figures)		
I. Intro	luction	1
II. Small	deformation nonlinearity	10
2.1.	Introduction	10
2,2.	Nonlinear vs linear elasticity in the 18th century	13
2.3.	The small deformation nonlinearity of wood: Dupin (1815)	15
2.4.	Dupin's 18th century predecessors: Buffon (1741), Duhamel (1742), and Gauthey (1774)	16
2.5.	Details of Dupin's experiments on wooden beams (1815)	18
2.6.	Experiments on the nonlinear response of wood, iron, and stone, and the introduction of the concept of microplasticity: Hodgkinson (1824-1844)	22
2.7.	"Gerstner's law" for steel piano wire (1824)	30
2.8.	The discovery of the creep of metals: Coriolis and Vicat (1830–1834)	32
2.9.	The first resolution of microstrain: Vicat (1831)	34
2.10.	Experiments on the stability of the permanent deformation of iron wire: Leblanc (1839)	-
2.11.	On the phenomenon discovered by Savart (1837) and Masson (1841), now known as the Portevin-Le Chatelier (1923) effect	38 41
2.12.	The experiments of Gough (1805) and Wilhelm Weber (1830) introducing	
2.12	thermoelasticity; Weber's discovery of the elastic after-effect (1835)	44
2.13.	The large deformation of gut strings: Karmarsch (1841)	52
2.14.	Experiments on the elasticity and cohesion of the principal tissues of the human body: Wertheim (1846–1847)	56
2.15.	Further experiments on the elasticity of organic tissue: The comparison of response functions for live and dead specimens. Wundt (1858), Volkmann (1878)	
0.46	(1859)	62
2.16	The repeal of Hooke's law by the British Royal Iron Commission in 1849.	70
2.17.	Experiments on stress relaxation in glass and brass: The origins of non-linear viscoelasticity, Kohlrausch (1863).	74
2.18.	On the change of volume during plastic deformation: The experiments of Bauschinger (1879)	83
2.19.	Nonlinear torsion including influence on magnetization, 1857 to 1881.	87
2.20.	The decrease of moduli with permanent deformation: The experiments on metals of Wertheim (1844–1848), Kelvin (1865), Tomlinson (1881), and	
	Fischer (1882)	92
2.21.	The cyclical loading of raw silk: Müller (1882)	97
2.22.	The first precise measurement of the nonlinearity of metals for infinitesimal deformation: Joseph Thompson (1891)	101
2.23.	Hartig's nonlinear law: A general response function for the small deformation of solids (1893)	105
2.24.	The Bach-Schüle law (1897): A rediscovery of the parabolic response function of James Bernoulli (1695) and of Hodgkinson (1824)	111
2.25.	Grüneisen's experiments (1906) using an interferometer, which established Hartig's law for the infinitesimal deformation of metals	116
2.26.	On some examples of unwitting rediscovery in the 20th century of non- linear phenomena first observed in the 19th century	
2.26a	. A law for paints and varnish: Nelson (1921)	126
2,26b	. Sayre's nonlinear law for the small deformation of steel (1930)	127
2.260	Nonlinearity in tensile experiments on copper alloys: Smith (1940–1948).	130
2.26 d	An exhaustive study of a single solid in simple loading: The analysis of the small deformation of beryllium copper by Richards (1952)	132

X Contents.

	2.2 6e	. Hodgkinson's parabola and "elastic defect": The microplasticity experiments of Thomas and Averbach (1959) and of Bilello and Metzger (1969)	140
	2.26f	A comparison of the response of fibre and whole muscle: The experiments of Sichel (1935)	
	2.2 6 g	The nonlinear response of artificial stone: The experiments of Powers (1938)	
	2 26 1	i. The "after-effect" in lead single crystals: Chalmers (1935).	
	2.201	The direct effect in feat single crystais. Chamiers (1935)	145
	2.261	The decrease in E with micro-permanent deformation: Lauriente and	
	2.27.	Pond's experiments on aluminum crystals (1956) Some recent experiments on the nonlinearity of infinitesimal deformation	
	_	in crystalline solids	148
	2.28.	New problems for the critic in reviewing experiments described in the	
	2.29.	literature during the past decade	153 155
III.	Smal	I deformation: The linear approximation	156
	3.1.	The 17th century origins: Hooke and Mariotte	156
			130
	3.2.	Experiments before 1780: Riccati, Musschenbroek, s'Gravesande, Coulomb;	
		Euler's introduction of the concept of an elastic modulus	160
	3.3.	The origins of an experimental science of solid mechanics: The torsion	
		studies of Coulomb in the 1780's	168
	3.4.	Coulomb's first measurement of an elastic modulus and his experiments on	
		viscosity and plasticity (1784)	177
	3.5.		179
	3.6.	The experiments of Chladni on the longitudinal vibration of bars (1787)	182
			102
	3.7.	An assessment of fact and myth for the modulus in Young's Lectures on	
		Natural Philosophy (1807)	184
	3.8.	Biot's use of the new Paris water pipes to obtain the first direct measurement	
		of the velocity of sound in a solid (1809)	191
	3.9.	Duleau's introduction of quasi-static measurements into the study of linear	
		elasticity (1813)	196
	3.10.	Research on elastic moduli in the three decades (1811-1841) before Wert-	.,
	J.10.	heim	205
	2 4 4	Guillaume Wertheim: A Faraday without a Maxwell	
			210
	3.12.	Wertheim's memoir of 1842: Values of E for 15 elements and the first study	
		of the effect of ambient temperature, prior history of the specimen, rate of	
		loading, and atomic spacing	220
	3.13.	Wertheim's memoir of 1843: The first experiments on binary and tertiary	
		alloys including, for 64 combinations, the influence upon E of composition	
		and rate of loading	230
	3.14.	Wertheim's memoir of 1844: The first study of the dependence of E upon	-
	J. 2	the strength of electric and magnetic fields	238
	3 4 5	Wertheim's memoirs in 1845-1846 on the elasticity of glass, wood, and	٠,٠
	3.1).	human tissue	240
	2 46		240
	3.10.	Wertheim's first experiments on Poisson's ratio which revealed that the	
		Poisson-Cauchy molecular theory failed to describe crystalline solids (1848)	245
	3.17.	Wertheim succeeds in making the first measurement of the frequency of	
		standing waves in a liquid column (1848)	251
	3.18.	Wertheim on vibration of plates, and the "deep tone" of vibrating rods	254
		The Wertheim controversy viewed from the 20th century	
		Kirchhoff's experiment for the direct measurement of Poisson's ratio	•
	•	(1859)	259
	2 21	Cornu's optical interference experiment for determining Poisson's ratio	-57
	J.21.	(1869)	264
	2 00		
		The experiments of Voigt on the isotropy and moduli of glass (1882)	269
	5.23.	Mercadier's determination of the ratio of elastic constants from the first and	
		second mode frequencies of a vibrating plate (1888)	272
	3. 2 4.	The piezometer experiments of Amagat (1884–1889)	274
	3.25.	The experiments of Bock on the dependence of Poisson's ratio upon tem-	
		perature (1894)	278
	3.26.	Straubel's definitive study of the Cornu experiment for the direct measure-	
		ment of Poisson's ratio (1899)	282
	3.27	Grüneisen's experiments checking isotropic formulae by the independent	
	J- - /·	measurement of F u and u	202

	3.28.	The mid-20th century repetition of Kirchhoff's experiment for determining	
		Poisson's ratio	
	3.29.	The confusion generated by the experiments of Kupffer (1848-1863)	296
		The Mallock method for the quasi-static determination of the bulk modulus.	303
		Grüneisen's use of Mallock's method to compare elastic constants in iso-	•••
		tropic solids (1910)	304
		The linear approximation and one-dimensional wave propagation: Wert-	
		heim and Breguet (1851)	306
		The axial collision of rods with an assumed linear response function: The	308
	3.34.		242
	2 25	Boltzmann experiment (1881 et seq.) vs Saint-Venant's theory (1867)	313
	3.35.	Hausmaninger's use (1884) of the time of contact technique of Pouillet (1844) in the Boltzmann experiment, and the half century of similar	
		experiments (1884–1936)	245
	2 26	The first use of electric resistance elements to study wave profiles in the	313
	3.30.	Boltzmann experiment: Fanning and Bassett (1940)	320
	3 37	Davies' (1948) use of a capacitance displacement technique for the first	347
	3.37.	comparison of pulse profiles with Pochhammer's (1876) three dimensional	
		theory for cylindrical rods	331
	3.38.	Experiments on the propagation of waves of small amplitude in metal cylin-	55.
	3.50.	ders during the past two decades: A sequence of changes in techniques and	
		interpretation	338
	3.39.	Ultrasonic determination of elastic constants	352
		Short-time loading histories	
	3.41.	On temperature dependence of elastic constants (1843–1910)	360
	3.42.	A comparison of ultrasonic and quasi-static temperature coefficients	377
	3.43.	On temperature dependence of elastic constants and damping coefficients,	
		after 1910	380
	3.44.	The quantized distribution of elastic shear moduli at the zero point for iso-	
		tropic bodies, and the multiple elasticities for a given isotropic solid: Bell	
		(1964–1968)	397
	3.45.	Anisotropy	406
	3.46.	Thermoelasticity	411
	3.47.	Viscoelasticity	413
	3.48.	Summary	417
IV.	Finit	e Deformation	419
	4.1.	Paucity of experiment before 1800	419
	4.2.	1800 to 1850: The experiments on creep of Navier and Coriolis, and the	,
	•	summary by Poncelet of research before 1840	421
	4.3.	Tresca on the flow of solids (1864–1872)	427
	4.4.	The punching and extrusion experiments of Tresca	429
	4.5.	Thurston's discovery of the dependence of the elastic limit upon the previous	
		stress history and the elapsed time (1873)	449
	4.6.	Experiments on yield limits, elastic limits, and fatigue, preceding those of	
		Thurston and Bauschinger: Thalén (1864), Wiedemann (1859), and Wöhler	
		(1858–1870)	457
	4.7.	The experiments of Bauschinger on the yield limit and the elastic limit	
	_	(1875–1886)	462
	4.8.	On the cohesion of solids under pressure: The experiments of Spring (1880).	474
	4.9.	Early 20th century experiments on the flow of solids under high pressure:	
		Tammann (1902)	478
	4.10.	The beginning of the experimental study of the large deformation of crystal-	
		line solids responding to loading histories with more than one non-zero stress	400
		component: Guest (1900)	483
	4.11.	The ductility of marble and sandstone when responding to a general state of	406
	4.40	stress: von Kármán (1911)	400
	4.12.		400
	4 4 2	(1909–1961)	490
	4.44	Further study of the Guest experiment: Lode (1926), and Taylor and	マソソ
	T. 1 T.	Quinney (1931)	504
	4,15.	On the relation between response functions for large deformation, for	,01
		different radial loading paths: E. A. Davis' experiments on polycrystals	

	Bridgman's experiments during the 1940's on the plastic deformation of steels	213
4.17.	Experiments on single crystals: Quantitative order in response functions	
4.40	for the large deformation of solids	514
4.18.	Quantized parabola coefficients and second order transitions in the resolved finite strain of single crystals: Bell (1960-1968)	524
4.40	On stress definition and strain measure in presenting experimental results	334
4.19.	for large deformation	EA 2
4.20	Quasi-static experiments on polycrystals at finite strain: Uniaxial tests .	547
4.21.	Quantized parabola coefficients and second order transitions for the finite	J.,
,	strain of fully annealed polycrystals	550
4.22.	Quasi-static experiments on polycrystals at finite strain: The torsion of	τ-
	hollow tubes	562
4.23.	Experiments on thermoplasticity	565
4.24.	Viscoplasticity in metals: Experiments before 1940	570
	The impact experiments of J. Hopkinson (1872) and Dunn (1897)	579
4.26.	On the effort for seventy-five years to extend Dunn's experiment, based upon his assumption that quasi-static and impact tests on short specimens	
	are identical	E 9.6
4 27	Finite amplitude wave propagation in annealed polycrystals: Experiments	300
7.27.	from 1942 to 1956	597
4.28.	On the direct measurement of strain profiles during finite amplitude wave	,,,
	propagation: Bell (1956–1972)	621
4.29.	The experimental study of unloading waves in dynamic plasticity: Bell	
	(1961)	
	The dynamic elastic limit	646
4.31.	Discontinuous finite deformation: The Savart-Masson (Portevin-Le Chate-	
4.20	lier) effect	649
4.32.	On the prediction of the response functions and second order transitions of the aggregate, from a knowledge of the deformation of the free crystal	666
4 33	On the study of the yield surface after 1948, based upon extensions of the	000
7.55.		676
4.34.	A brief summary of experiments after 1960 describing additional aspects of	-,-
	propagation of waves of finite amplitude in crystalline solids	690
4.35.	On experiments leading toward a general theory of plasticity for the loading	
	response of annealed crystalline solids	702
4.36.	On the discovery of shock waves in the tensile deformation of rubber	
	strings: Kolsky (1969)	716
4.37.		740
4 38	impact	
4.30.	Experiments on the finite elasticity of rubber: From Joule to Rivlin	, 21
	(1850's to 1950's)	726
4.40.	(1850's to 1950's)	741
D - /		- 4 -
Referen	ces	742
Namenve	erzeichnis. — Author Index	779
Sachverz	eichnis (Deutsch-Englisch)	787
Subject 1	Index (English-German)	801
	, —	