

BRITISH RHEOLOGISTS' CLUB

BULLETIN No. 16.



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CLUB NOTES.

Annual General Meeting.

At the Annual General Meeting, which was held during the Manchester Conference, the following Officers were elected for the ensuing year:—

President Professor J. B. Speakman.

Hon. Sec. Dr. E. W. J. Mardles.

Hon. Treas. Mr. D. C. Broome.

Hon. Auditor Dr. V. G. W. Harrison.

Members of Committee (other than *ex-officio*)—

Dr. A. H. Nissan, Mr. W. A. Richardson, Dr. G. W. Scott Blair, Mr. M. W. Thring, Mr. A. G. Ward.

International Rheology Conference.

It is now almost certain that the dates of the Conference being organized by our Dutch colleagues will be September 21st—25th, 1948, probably at Scheveningen. It is intended that there shall be two general lectures on each of the first four days of the Conference, the rest of the time being taken up with sectional meetings running simultaneously. Saturday (25th) will probably be reserved for excursions.

Future Meetings.

The Road and Building Materials Group of the Society of Chemical Industry invite members of the Club to a meeting on 18th December, 1947, when Mr. P. J. Rigden of the Road Research Laboratory will speak on The Brittle Properties of Tar and Bitumen.

The Club meeting on War Rheology has been arranged for Wednesday evening, 17th December, 1947, at the Royal Society of Arts.

Reprints, etc.

Dr. M. Reiner, before leaving for Palestine, sent the following reprints to the Club's reference library: The coefficient of viscous traction; The creep of cement and concrete; The tensile test of mild steel; and In search of a law of work-hardening.

Clays Minerals Bulletin No. 1 has been received from the Clay Minerals Group of the Mineralogical Society.

International Council of Scientific Unions.

A Joint Committee on Rheology has been set up by the I.C.S.U., members being nominated by the International Councils of Biological Sciences, Chemistry, Geo-physics, Physics and (later) Applied Mechanics. The Chairman is Prof. T. von Karman, Vice-Chairman, Mme. Dobry, Hon. Sec., Prof. J. M. Burgers. The aim of the Committee is to help the existing national bodies concerned with Rheology and possibly to organize international activities such as Conferences, and the setting up of appropriate Societies in countries where these do not at present exist. It is especially concerned with problems of nomenclature, rheological abstracting, and the choice of rheological standards. For the present, it will not deal with purely theoretical work in such fields as hydrodynamics and classical elasticity. There are three British members—our past-President, Sir Geoffrey Taylor, also Prof. P. Eggleton and Dr. G. W. Scott Blair, both members of the Club.

The Committee is anxious to find reproducible chemical compounds which are Newtonian fluids at room temperature having viscosities $\sim 10^6$ – 10^8 poise. Would any member who can help with information please communicate with the Editor?

American Rheology Bulletin.

In the second part of the 1947 issue of the Rheology Bulletin, the B.R.C. Committee's Report on Nomenclature, presented at the London Conference in 1946, is reprinted *in toto* and already a number of very useful comments and suggestions have been received from our American colleagues. The Committee of the Club hopes to hold a technical meeting in the near future at which these very interesting developments will be discussed. The American and British views will then have to be co-ordinated with the Dutch Report which, it is expected, will soon be presented to the Club, after modification, by the new I.C.S.U. Joint Committee.

News of Members.

Our congratulations to Dr. W. H. Banks on his appointment as Research Superintendent at P.A.T.R.A.

New Members.

5/47. Dr. R. J. L. Allen	Monkhouse & Glasscock Ltd Snowsfields, London, S.E.1.	Food products, starch and gelatine ; thixotropy.
7/47. Mr. R. D. Brace	I.C.I. Ltd., Leathercloth Division, Newton, Hyde, Cheshire.	Polymer/plasticiser system ; pigment/suspension medium systems ; rotation viscometry. Rubber and plastics.
5/47. Mr. W. A. Catte	2 The Gables, Station Rd., Ossett, Yorkshire.	
8/47. Dr. Barbara S. Emödi	Caerlavernock, Nutfield Rd., Redhill, Surrey.	Clays ; suspensions in general.
5/47. Prof. Ewen McEwen	3 Kensington Terrace, Newcastle-upon-Tyne.	Metals ; soils ; pene- trometers.
8/47. Mr. W. S. Penn	Henley's Tyre & Rubber Co., Ltd., Gravesend, Kent.	High polymers, par- ticularly rubber ; plastics ; paints ; rotation viscometers.
8/47. Mr. F. Qaddura	Government Arab College, Jerusalem, Palestine.	Tars and bitumens ; viscosity and viscous traction ; plastic flow and equations.

Report from Dr. J. Topping.

SHORT SUMMER COURSE IN RHEOLOGY.

A short summer course in rheology was held at the Polytechnic, Regent Street, London, W.1., on July 28th-31st, 1947. It was an innovation which was presumably much appreciated by those engaged on rheological problems in industry, for some fifty-three attended. They were drawn from many industries and government laboratories mainly in London and the Home Counties, but several came from the provinces and Scotland, and two from Amsterdam.

The lecturers were Dr. G. W. Scott Blair, who dealt with the history and scope of rheology and the principles of rheological measurement; Dr. M. Reiner, who gave four lectures on theoretical rheology, and Dr. L. R. G. Treloar, who dealt with recent work on rubber and rubber-like materials. Dr. J. R. Scott also gave a lecture on "Measuring Instruments in the Rubber Industry." Each lecture was followed by vigorous discussion, and there was a final session when the lecturers, in brains-trust fashion, answered many questions.

An exhibition of apparatus was also arranged and thanks are due to Sir Charles Goodeve, Mr. Broome and Dr. Mardles, as well as to Dr. Scott Blair, Dr. Treloar and Dr. Scott, who kindly showed interesting exhibits.

J.T.

RHEOLOGY ABSTRACTS.

671. The Velocity of Fall of Mercury Drops in a Viscous Medium.

I. A. BAGOTSKAYA and A. N. FRUMKIN. *C.R. Acad. Sci. U.R.S.S.*, **55**, 131, 1947.

A theory of Frumkin and Levich (*Acta Phys-Chim.*, **20**, 769, 1945) for the velocity of charged liquid metal drops is mainly verified for fall through ionic solutions saturated with hydrogen. SCI. ABSTR.

672. Further Studies of the Measurement and Control of Physical Factors in Cheese-Making.

M. BARON, *Dairy Industries*, **12**, 548, 1947.

The following rheological and similar measurements were made on Cheddar and Cheshire Curd: Superficial density, sphere indentation hardness and hardening ("Meyer analysis"), penetration-rate of loaded cork borer. The penetration of a light plastic bowl into curd in the junket stage was also measured. Total and third order partial correlation coefficients are given relating these measurements made at different stages of manufacture, one factor being varied at a time in experiments each of which lasted for about a month. Significant correlations are found relating rheological properties to one another and also to acidity of curd, chemical composition of milk, etc. G.W.S.B. (see ABSTR. 262, 368)

673. The Fundamentals of Tackiness and Adhesion.

J. J. BIKERMAN. *J. Colloid Science*, **2**, 163, 1947.

The paper compares the importance of "molecular" forces with that of "rheological" forces on different stages of making and breaking adhesive joints. Adhesives usually are applied in liquid form, and the perfection of the contact between the adhesive and the solids to be joined depends above, all on the wetting power of the liquid towards the solids. This wetting power is primarily a "molecular" phenomenon. The resistance which must be overcome to separate two solids jointed by a liquid adhesive is tackiness. Its mechanism is purely rheological, and tackiness is a function of viscosity. When in the course of its setting the viscosity of an adhesive becomes very high, the resistance to separation is still rheological, but is smaller than would be expected from the viscosity. Some new experiments concerning this intermediate region between tackiness and final strength are reported. When the adhesive has set, the resistance to separation is determined by the final strength of the adhesive, which (for tensile tests) is identical with the tensile strength of the adhesive film of the given thickness; the final strength, too, is a rheological property. The experiments which are claimed to prove disagreement between final strength and tensile strength are given a different interpretation. The rupture occurs usually within the set adhesive, not between the adhesive and a solid, and consequently molecular forces are not involved in the determination of final strength probably because of the universal roughness of solid surfaces. P.A.T.R.A.

674. Finite Elastic Strain of Cubic Crystals.

F. BIRCH, *Phys. Rev.*, **71**, 809, 1947.

Murnaghan's theory of finite strain is developed for a medium of cubic symmetry subjected to finite hydrostatic compression, plus an arbitrary homogeneous infinitesimal strain. The free energy is developed for cubic symmetry to include terms of the 3rd order in the strain components. The effect of pressure upon the 2nd-order elastic constants is found and compared with experiment, with particular reference to the compressibility; the pressure-volume relation in several approximations is compared with the measurements to 100,000 kg/cm². The simplest approximation is shown to give a satisfactory account of most of the experimental data. The results are also compared with some of the calculations based on Born's lattice theory. SCI. ABSTR.

675. The Hydrodynamic Lubrication of Finite Sliders.

C. P. BOEGLI. *J. Appl. Phys.*, **18**, 482, 1947.

Two approximations are made in the solution of Reynolds' lubrication equation for the case of a finite slider, and these lead to a series of equations that are easy and rapid to use. Examples of their use are presented. The method is of special value for wide sliders which are difficult or impossible to analyse by other methods.

SCI. ABSTR.

676. The Pressure Coefficient of Viscosity.

A. BONDI. *J. Chem. Phys.*, **15**, 527, 1947.

Short letter.

677. Hardness and Abrasion Resistance of Plastics.

L. BOOR, J. D. RYAN, M. E. MARKS, W. F. BARTOE. *A.S.T.M. Bull.*, **146**, 68, 1947.

Representative samples of typical commercial plastics were tested by several procedures, for properties associated with the descriptive term "hardness." Included were various indentation (Knoop hardness, Rockwell, Barcol, etc.), scratch (Shore scleroscope, Bierbaum scratch hardness, Moh value, Mar resistance, Kohinoor pencils, etc.), and wear methods. At least five aspects of behaviour, each one contributing in various degrees to the test value obtained by any given method are indicated, namely, (a) indentation under load, (b) indentation after release of load, (c) instantaneous return of the energy of indentation, (d) change of optical properties by abrasive wear, and (e) loss of weight by abrasive wheel wear. Nylon, vinylite and the methacrylates which are among the best in wearing properties are in the medium range of indentation hardness while mineral filled phenolic which is one of the highest in indentation hardness ranks among the poorest in wearing properties.

E.W.J.M.

678. The Rate of Creep at Elevated Temperatures of Four Sillimanite Tank Blocks.

J. BOOW and G. E. WALKER. *J. Soc. Glass Tech.*, **30**, 5, 1946.

As a guide to the possible behaviour of commercial sillimanite tank blocks under industrial conditions, the rate of elongation under load at high temperatures was investigated using specimens taken from four tank blocks designated A, B, C and D. The tests were carried out at 1,400° and 1,450°C., and the rates of elongation were correlated with the texture, apparent porosity and corrosion resistance of the different blocks. The texture of blocks A and D was superior to that of blocks B and C. In keeping with this fact, the value of the apparent porosity was approximately 4% lower for blocks A and D than for the two other blocks. Corrosion proved that block C was inferior and block A superior to the other blocks. In the creep tests only block A withstood a load of 500 g./sq. cm. for 100 hours at 1,450°C. Earlier findings by J. H. Partridge that the creep test is a useful means of assessing the durability of refractory materials were confirmed.

B.R.R.A. (see abstr. 201, 202, 399).

679. Quantum Theory of Liquids.

M. BORN and H. S. GREEN; R. FÜRTH. *Nature*, **159**, 738, 1947.

A brief report is given of the results of a direct application of the laws of quantum mechanics to a dense assembly of particles. The "density matrix" $\rho_N(X, X')$ of two different configurations $X=(X_1, X_2 \dots X_N)$ and $X'=(X'_1, X'_2 \dots X'_N)$ replaces the distribution function of co-ordinates and velocities used in classical theory, and $\hbar \partial \rho / \partial t = W \rho - \rho W$, where W is the energy operator and the products are matrix products. It is found that the quantum laws governing the behaviour of matter in bulk are identical with the classical laws, but the atomistic interpretation of the quantities appearing in the equations show great deviations from "classical".

liquid behaviour. Thus the temp. T_1 defined by the mean kinetic energy, and which determines the flux of energy, is not identical with the equilibrium temp. T , defined as the integrating denominator of the entropy. There is a similar dichotomy between the hydrodynamic and the thermodynamic pressure. The applications to liquid He II are discussed. Fürth supplies a qualitative physical explanation of superfluidity, on the basis of vanishing collision cross-section of atoms at low temps. where the de Broglie wavelength becomes large, in analogy with the Ramsauer effect.

SCI. ABSTR. (see abstr. 598).

680. Plastic Stresses in a Semi-infinite Cohesive Mass due to a Surcharge covering a Strip of the Surface of Infinite Length.

N. S. BOULTON. *Phil. Mag.*, **37**, 733, 1946.

The mass possesses cohesion and internal friction and it has a horizontal surface, a strip of which is loaded uniformly, so that the state of plastic stress is 2-dimensional. The problem is to find the bearing pressure on the strip. The general equations are solved approx. in terms of the first three terms of a series for the stress function. The total pressure on the strip required to maintain plastic equilibrium is calculated.

SCI. ABSTR.

681. A Variable Speed Rotational Viscosimeter.

R. BUCHDAHL, J. G. CURADO and R. BRADDICKS. *Rev. Sci. Instrum.*, **18**, 168, 1947.

The article gives a detailed description of design and construction of an instrument to measure the rheological properties of systems within a viscosity range of 10^{-1} to 10^4 poise. The use of a strain gauge to measure the torque is discussed briefly.

SCI. ABSTR.

682. Recovery and Recrystallization viewed as Processes of Dissolution and Movement of Dislocations. I.

W. G. BURGERS. *Proc. K. Ned. Akad. Wet.*, **50**, 452, 1947.

Part I of a general review. Recovery and recrystallization depend on temp. and time in much the same way, which suggests that recovery is recrystallization on a scale too small to be observed. On the other hand, recovery is never complete, and the state after recovery depends on the degree of cold-working, which suggests that there is a fundamental difference between the mechanisms of recovery and recrystallization. Recovered states are of considerable stability, and are intermediate between the cold-worked and the fully-annealed state.

SCI. ABSTR.

683. Recovery and Recrystallization viewed as Processes of Dissolution and Movement of Dislocations. II. Block-structure of the Crystalline State.

W. G. BURGERS. *Proc. K. Ned. Akad. Wet.*, **50**, 595, 1947.

Real crystals possess a mosaic structure, blocks of 10^{-4} to 10^{-5} cm. in linear dimension being perfect, but adjoining blocks, differing in orientation by a few seconds or minutes of arc. The boundaries of the blocks involve a regular series of Taylor dislocations. In cold-worked crystals there are dislocations throughout the blocks as well as at the boundaries; the energy stored in a cold-worked metal suggests that there are $\sim 10^{12}$ dislocation lines per cm^2 . The stability of 2-dimensional systems of dislocations is discussed.

SCI. ABSTR.

684. On the Internal Friction in the Earth's Crust.

P. CALOI. *Ric. Sci.*, **14**, 4, 1943.

Viscosity, internal friction, strength and relaxation time are discussed and fundamental relations quoted. From a study of superficial tangential waves at the Cansiglio earthquake (1936) the coefficient of internal friction of the earth's crust is 10^{10} poises, the ratio of this coefficient to the mod. of rigidity is $\sim 2 \times 10^{-2}$.

SCI. ABSTR.

685. Slip Flow in Granular Beds.

P. C. CARMAN. *Nature*, **160**, 301, 1947.

New Poiseuille types of equation for capillaries of any shape for application to granular beds are given; the equations include Kozeny's constant and a slip correction factor. E.W.J.M.

686. The sudden Application of a Constant Shearing Motion to Anomalous Fluids.

E. K. CARVER and J. R. VAN WAZER. *J. Phys. Coll. Chem.*, **51**, 751, 1947.

A concentric cylinder viscosimeter which could suddenly be made to rotate at a constant speed is described. Photographic recordings of the variation of shearing force with time were used to differentiate between materials having different rheological structures. An extended study was made of an aluminum soap dissolved in gasoline. The photographic traces of force vs. time for this substance exhibit a pronounced maximum near the time rotation was started. From these traces it can be shown that there is a cross-bonded structure which is partially destroyed under shear. An activation energy of 9 kg.-cal. was found for the process by which the structure is re-formed upon standing. The activation energy for flow is zero, but this is explained by assuming that the mechanism of flow is a combination of breaking bonds and the normal type of internal friction. AUTHORS' ABSTR.

687. X-ray Diffraction Studies of Yielding in Mild Steel.

J. M. COWLEY and M. S. PATERSON. *Nature*, **159**, 846, 1947.

The region of "Lüders lines" in a slightly yielded bar was examined, using a narrow X-ray beam, blurring of spots being taken as indication of plastic deformation. This was found to be greatest at the actual position of a line and, between the lines, greater near the middle of the region of lines than near the end. The conclusion is that as the region of strain-bands grows by the formation of new bands, the bands formed earlier grow laterally by an increase of plastic distortion on either side. SCI. ABSTR.

688. Nature of the Deformation of Clay Strata.

N. I. DENISOV. *Bull. Acad. Sci. U.S.S.R. (Tech. Sci. Div.)*, No. 6, 913, 1946.

The deformation of clay beds under pressure is of great importance to the civil engineer and architect. The porosity of a natural clay depends not only on the pressure to which it has been subjected, but also on the conditions (time, nature of depositing medium) under which it has been formed. The nature and degree of deformation of a clay bed is conditioned by peculiarities of the deposit acquired during and since its formation. The so-called "effective" pressure gives no indication of the pressure to which a clay bed has been subjected or of the magnitude of the capillary pressure. B.R.R.A.

689. The Elastic Constants of Materials loaded with Non-rigid Fillers.

J. M. DEWEY. *J. Appl. Phys.*, **18**, 578, 1947.

A solution is obtained for the elastic constants of a heterogeneous material consisting of an elastic medium containing spherical inclusions of different elastic properties. The solution is valid only for small concentrations of the filler. L.R.G.T. (see abstr. 266).

690. A rapid Method for Accurate Yield Strength Determination without Stress-Strain Curves.

L. J. EBERT, M. L. FRIED and A. R. TOOLE. *A.S.T.M. Bull.*, **145**, 50, 1947.

A method has been developed by means of which the yield strength of non-ferrous materials and heat-treated steels can be determined accurately and quickly by a single operator without the aid of an automatic load-elongation recorder. By

means of charts which relate yield loads and total elongations to yield strengths for test specimens of various cross-sectional areas, it is possible to determine the correct value of total elongation, as measured with an extensometer, at which to read the actual yield load, from the tension machine dial. E.W.J.M.

691. A Dynamical Determination of Adhesion Tension.

D. D. ELEY and D. C. PEPPER. *Trans. Farad. Soc.*, **42**, 697, 1946.

As a generalization of earlier work, equations have been obtained for the motion of a liquid-liquid inter-face through a single capillary, and through a powder treated as a bundle of single capillaries.

These equations are found to hold in experiments with a Pyrex capillary, and with Pyrex glass powders. In the first case the reproducible values of the adhesion tension obtained subsequent to the removal of contamination by wetting the capillary with the displacing liquid correspond to a zero contact angle. In the second case the values of the adhesion tension may vary widely from experiment to experiment. This is attributed to contaminations. In so far as the method may be adopted to a high vacuum technique of handling liquids and powder to remove contamination, it may prove of value. B.R.R.A. (see abstr. 267).

692. Abrasive Strength and Boundary Surface Energy of Hard Materials.

W. v. ENGELHARDT. *Naturwiss.*, **33**, 195, 1946.

Following a general review of the subject, details are given of investigations of the abrasive mechanism with various hard substances in several solutions and pure liquids, which lead to suggestions on the interaction between the hard surfaces and the molecules of the lubricating liquid, and on the nature of the forces arising from hard bodies. Applications of the work to industrial problems are discussed.

SCI. ABSTR.

693. Thermodynamics of Crystallization in High Polymers. I. Crystallization induced by Stretching.

P. J. FLORY. *J. Chem. Phys.*, **15**, 397, 1947.

A theory of oriented crystallization in elongated polymers having network structures (e.g., in vulcanized rubber) is developed through the application of statistical mechanical procedures similar to those employed in rubber elasticity theory. Expressions are derived which, within the limitation imposed by the simplifying assumptions, relate the incipient crystallization temperature with the elongation, the degree of crystallinity with the elongation and temperature, and the retractive force at crystallization equilibrium with the elongation at constant temperature. Apparent disagreements with various observations are attributed to severe departure from equilibrium crystallization when the polymer undergoes crystallization during the stretching process. Reasons for the rapid increase in tension which is observed when crystallization occurs during ordinary stretching of rubber are discussed.

SCI. ABSTR. (see abstr. 220).

694. The Experimental Determination of the Influence of Absorbed Ions on the Ceramic Properties of Clays.

M. FRANCIS. *Verre Silicates Ind.*, **12**, 1, 1947.

In experiments with a 50-g. batch of ball clay opened up by four times its weight of sand, it was found that practically all the exchangeable Na, K, Mg and Ca could be removed by a single washing with 100 ml. of a normal solution of NH_4Cl . Alkalies and alkaline earths removed by subsequent washing were found to have resulted from a slow decomposition of feldspar. On the basis of these experiments it is considered that the true figure for the content of exchangeable bases is obtained by extracting the mean value obtained in subsequent washings from that obtained in

the first washing. In addition, the absorbed hydrogen should be taken into account ; this is normally equal to about two-thirds of the total base-exchange capacity. The remarkable base-exchange capacity of montmorillonite is attributed to the separation of the lattice layers during imbibition. The different properties of the sodium and calcium bentonites, which consist of about 75% montmorillonite, are noted. An important point in base-exchange studies on clay is the dependence of the base-exchange capacity on the pH value of the suspension. The fluidity of a slip is also dependent on its pH value, generally reaching a maximum at about pH 7 ; this property is to some extent inversely proportional to the density of the slip, a fluid slip of high density (1.5 g./ml.) can only be obtained in the pH range 6.4-8. On the other hand, maximum thixotropy is obtained in a pH range about two units lower. When the exchangeable sodium in this clay was replaced by potassium, similar effects were observed although they were less marked.

B.R.R.A.

695. Un Nouvel appareil de Microdureté, le Microscléromètre L.C.

(A new micro-hardness tester, the micro-sclerometer L.C.).

M. R. GIRSCHIG. *Rev. Met.*, **43**, 95, 1946.

New instrument interchangeable with the objective of inverted type microscope, especially the Reichert metal microscope. Load on indenting diamond exerted by leaf spring, load range can be varied from 0 to 1,000 gr. by using one of five different springs. In use, the stage with the specimen is lowered into the indenter, and its displacement indicating the exerted pressure, is measured by optical means. The pressure of each spring is calibrated accurately by a kind of astatic balance. The impression is measured in the usual way in replacing the indenter by a high power objective. Theoretical investigations with regard to the load to be applied for different materials, the spacing of the impressions, the precision of the results, the influence of different loads on the same test piece, the inertia of the moving instrument parts, and the carefully selected examples and details given make this investigation a very valuable contribution to the problem of micro-hardness.

I.D.I.B.

696. The Landau Velocity in Liquid Helium II.

D. V. GOGATE and P. D. PATHAK. *Proc. Phys. Soc., Lond.*, **59**, 457, 1947.

A simple derivation of Landau's expression for the second velocity of sound (in addition to the usual velocity $\sqrt{(dp/d\rho)}$) in He II is given from general physical principles.

SCI. ABSTR.

697. Rheological Properties of Paints, Varnishes, Lacquers and Printing Inks.

H. GREEN. *J. Colloid Science*, **2**, 93-8, 1947.

An outline is given of the development of the application of rheological theory to the study of paints, varnishes, lacquers, and printing inks.

P.A.T.R.A. (see abstr. 203, 457, 458, etc.).

698. High speed Compression Tests on Copper.

M. GREENFIELD and E. T. HABIB. *J. Appl. Phys.*, **18**, 645, 1947.

Dynamic shortening of one-half inch long copper cylinders is achieved by striking them with a hardened steel projectile at high velocities. The average strain rate was about 1,200 per second. Energy per unit volume absorbed by the copper is plotted against strain. A true stress-logarithmic strain curve is computed. This curve is compared with a similar curve derived from high speed tests on copper in tension.

AUTHORS' ABSTR.

699. **Residual Lattice Strains in Plastically deformed Metals.**

G. B. GREENOUGH. *Nature*, **160**, 258, 1947.

A development of the X-ray diffraction method of measuring locked-up stresses in fabricated metal parts; the change of the atomic interplanar spacing during a tensile or compressive test was measured and the lattice strain plotted as a function of stress.

The author shows that the internal stresses arise mainly from the plastic anisotropy of the metal, the yield tension of the grain depending on the orientation of the glide planes and glide directions.

The X-ray diffraction technique picks out grains of certain orientations, the normals to the reflecting planes being in a direction fixed geometrically by the X-ray beams. E.W.J.M.

700. **On the Law of Deformation of Amorphous and Poly-crystalline Bodies.**

G. GUREVICH. *C.R. Acad. Sci., U.R.S.S.*, **55**, 493, 1947.

The author shows that for several high polymers, and also for Al, Pb and Cu under certain conditions, the following equation holds: $\log (v/\sigma_{const.}) = A \sigma_{const.} - B$ where v = rate of strain, $\sigma_{const.}$ = yield stress. At high temperatures or with softer bodies the equation changes into one representing Newtonian flow. SCI. ABSTR.

701. **The General Theory of Cylindrical and Conical Tubes under Torsion and Bending Loads. Part V.**

J. HADJI-ARGYRIS and P. C. DUNNE. *J.R. Aero Soc.*, **51**, 757, 1947.

The paper deals with the stresses and deformations of conical and cylindrical tubes under arbitrary loading. A unification of the theory of bending and torsion has been achieved.

The axial constraint stresses may in general be calculated as if caused by torque about axes different in each mode and they cannot be calculated from the torque about the flexural axis. E.W.J.M.

702. **A Method for Measuring the Body of Cultured Cream.**

L. D. HILKER. *J. Dairy Res.*, **30**, 161, 1947.

The consistency of mayonnaise is measured in the container, to avoid disturbing false-body, by dropping into it a graduated Al. rod with tapered ends, called a "Plummet." The depth of penetration is recorded. G.W.S.B.

703. **The Speed of Propagation of Brittle Cracks in Steel.**

G. HUDSON and M. GREENFIELD. *J. Appl. Phys.*, **18**, 405, 1947.

Brittle failure was produced in notched steel tensile specimens. The measured speed of propagation was $\sim 40,400$ in/sec. SCI. ABSTR.

704. **Increasing the Mechanical Strength of Paper made from weak semi-finished Products.**

L. A. KANTOR. *Bumazhnaya Prom.*, **41**, 31, 1946.

The mechanical strength of paper was raised considerably by saturating its surface with adhesive suspensions. The suspensions tested were 6.5% gelatine, 7 to 8% animal glue, 15% casein, and starch paste. The paper used was newsprint, paper made from bleached straw, and blotting-type paper. Samples of paper were treated for 10 seconds in a suspension and then dried. The breaking length of the treated newsprint increased 2 to 3 times. The flexing strength rose from 4 to 1,700 to 3,000. The colour of the paper expressed in % white by the Ostwald method increased from 66 for the untreated paper to 91 for paper treated with starch suspension. Next largest increase in whiteness (84%) was for paper treated with casein

suspension. The whiteness for gelatine- and animal-glue treated papers was 78 and 70% Ostwald, respectively. The results for paper made of straw and blotting-type paper made of low grade linter were analogous. P.A.T.R.A.

705. Stress relaxation across Grain Boundaries in Metals.

T. S. KÊ. *Phys. Rev.*, **72**, 41, 1947.

The temp.-dependence of internal friction and rigidity modulus of 99.991% Al have been measured as a function of frequency of torsional vibration and of grain size. An increase of frequency of vibration shifts the internal friction curve and the rigidity relaxation curve (Q^{-1} and G/G_u v. temp.) to higher temps.; and when the frequency of vibration is kept constant, a change in grain size of the specimen has the same effect as a change of the frequency of vibration. The observed internal friction and rigidity relaxation can be expressed as functions of the parameter $(G.S.) \times f \times \exp(H/RT)$, where (G.S.) is the grain size or average grain dia. of the specimen, f is the frequency of vibration, and H is the heat of activation. It is shown that all these observed phenomena are necessary manifestations of the stress relaxation across grain boundaries arising from the viscous behaviour of the grain boundaries in metals, which behaviour has been demonstrated by previous anelastic-effect measurements. SCI. ABSTR.

706. On the Theory of Superfluidity of Helium II.

L. LANDAU, *J. Phys., U.S.S.R.*, **11**, 91, 1947.

The author makes some modifications in the assumptions of his earlier theory to remove the discrepancy with the experimental value of "second sound" velocity. These lead to a form of energy spectrum of the excitations ("phonons" and "rotons") of He II in which the energy at first rises linearly with momentum, then decreases to a minimum at a certain value p_0 of the momentum. The values of the roton momenta thus lie mainly in the neighbourhood of p_0 , and the roton mass μ is constant, approx. the mass of the He atom. The main conclusions of the theory are unchanged. SCI. ABSTR.

707. Simplified Flow Resistance Measurements.

R. W. LEONARD. *J. Acoust. Soc. Amer.*, **17**, 240, 1946.

A simplified apparatus for measuring the flow resistance of porous acoustical materials consists of an analytical balance, by which is established the pressure drop through the sample, and a cylindrical container which determines the volume current by the rate of displacement of air. Flow resistance of the sample is the ratio of pressure drop to volume current. B.R.R.A.

708. A Kinetic Energy Correction for the flow of Plastic Liquids through Circular Pipes.

T. R. LOMER. *Phil. Mag.*, **37**, 571, 1946.

If P is the total pressure difference across the ends of the tube, p the pressure used in overcoming plastic resistance, W the kinetic energy imparted per sec. to the liquid, and V the volume flowing per sec. through the tube, then $pV = PV - W$. Thus W/V is the correction term to be subtracted from the applied pressure, and an expression for W/V is obtained on the basis of Scott Blair's recent formula for the rate of flow. SCI. ABSTR.

709. Measurement of Dynamic Stretch-Modulus and Hysteresis of Tire Cords.

W. J. LYONS and I. B. PRETTYMAN. *J. Appl. Phys.*, **18**, 586, 1947.

Short letter.

(see abstr. 478).

710. Stress-Rupture Properties of High-Temperature Alloys.

E. S. MACHLIN and A. S. NOWICK—"Stress-Rupture of Heat-Resisting Alloys as a Rate Process." *Amer. Inst. Mining and Metallurgical Engineers, Tech. Publ.* 2137; *Metals Technology*, 1947.

In view of the importance of stress-rupture properties as criteria of the service behaviour of high-temperature alloys, it has been found desirable to obtain a closer knowledge of the quantitative dependence of time-to-rupture on stress, temperature, composition, and structure. Research on this subject was initiated, early in 1945, at the Cleveland Laboratories of the National Advisory Committee for Aeronautics. This paper, giving an account of the first stages of the research, contains data on cast and wrought S816 alloy and on low-carbon N155 alloy, selected for study as typical of the best alloys yet developed in America for high-temperature applications.

After discussing the theory of rate processes as a general theory, the authors show that if stress-rupture of heat-resisting alloys is to be treated as a rate process certain equations must be satisfied. Finally, it is demonstrated that such equations are satisfied. Although the application of these principles to prediction of the behaviour of the three alloys examined has not conclusively proved that stress-rupture is a rate process, it is considered that the results form a basis on which a recommendation may be made that the rate-process stress-rupture equations obtained should be used to interpolate and extrapolate data for different temperatures and to reduce the number of stress-rupture tests.

It is indicated that stress may have an effect on the crystal structure by causing a phase-change, and it is also considered probable that the same rate-process mechanism is responsible for both transcrystalline and intercrystalline failure and that a correlation may exist between stress-rupture and creep.

NICKEL BULL. (see abstr. 630).

711. The Use of Rheo-electrical Analogies in certain Aerodynamical problems.

L. MALAVARD. *J. R. Aero. Soc.*, **51**, 739, 1947.

By the method of electrical analogies, an attempt is made to represent the solutions to certain problems of mathematical physics which depend on Laplace's equation or more generally on an equation of the type

$$\frac{\delta}{\delta x} \left(\lambda \frac{\delta \phi}{\delta x} \right) + \frac{\delta}{\delta y} \left(\lambda \frac{\delta \phi}{\delta y} \right) = 0$$

by the distribution of electrical currents in conductors. Electrical analogies give graphical representations of the fields under investigation in the form of an orthogonal network of equipotential lines and lines of flux. Experiments and equipment are described for recording equipotentials in the electric tank, by which solutions to aerodynamical problems are obtained.

E.W.J.M.

712. Tension and Torsion-Creep Properties of Cloth Laminates.

J. MARTIN. *A.S.T.M. Bull.*, **143**, 38, 1946.

Tension and torsion creep-test data are given. These are analysed by log-log, semi-log and the hyperbolic sine methods. A theoretical correlation is given between the tension and torsion-creep values based on a distortion energy criterion.

E.W.J.M.

713. Measurement of the Viscosity and Shear Elasticity of Liquids by means of a Torsionally Vibrating Crystal.

W. P. MASON. *Trans. Amer. Soc. Mech. Engrs.*, **69**, 359, 1947.

Theory and experimental details are given. The elastic properties are determined from observations of the reactance and resistance loading of the crystal,

resulting in a lowering of frequency and raising of resistance at resonance. The shearing stress can be varied by varying the voltage on the crystal. Results on light oils (viscosity 0.01–10 poises) check with previous determinations within a few %.
SCI. ABSTR.

714. A Discussion of the Pressure-Tendencies associated with Gradient and Horizontal Geostrophic Flow. A Formula for the Variation with Height of the Vertical Velocity.

A. G. MATTHEWMAN. *Phil. Mag.*, **37**, 706, 1946.

Horizontal flow with an appreciable north or south component implies a pressure tendency $\gg$ normally observed; the excess may be reduced or extinguished by certain methods, and these are described. Gradient flow implies terms in the formula for the divergence $\gg$ the term involving the pressure tendency, and such flow through a horizontal neighbourhood of unsaturated air implies a gradient of vertical velocity; a formula is obtained for this.
SCI. ABSTR.

715. Stationary Cellular Waves in the Sea.

G. NEUMANN. *Naturwiss.*, **33**, 282, 1946.

Extremely short period waves not connected with discontinuity surfaces can occur in air or water with vertical stability and are related more to cellular gravitational waves. The form of the cellular oscillation depends on vertical velocity distribution. Observations at sea at two Baltic stations of temperature and vertical density gradients show agreement with theory. Causes of the initial disturbance are discussed.
SCI. ABSTR.

716. Acoustic Determination of the Physical Constants of Rubber-like Materials.

A. W. NOLLE. *J. Acoust. Soc. Amer.*, **19**, 194, 1947.

The necessary relations for computing Young's modulus and the associated viscosity coeff. from acoustic data are given. An experimental method is described for measuring the sound phase velocity and attenuation of longitudinal waves in thin narrow samples from 1–26 kc/s. A vibration generator excites one end of a sample held under small tension, while a receiving element moves along the strip. The r.m.s. error in attenuation measurements is 6–12%, and in velocity 2–9%. Sample data and elastic and viscous coefficients are given for a carbon-black buna-N cement.
SCI. ABSTR.

717. Some Determination of the Elastic Properties of Ice.

T. D. NORTHWOOD. *Can. J. Res.*, **25A**, 88, 1947.

Young's modulus found to be 9.8×10^{10} dynes/cm.² and Poisson's ratio, 0.33.
G.W.S.B.

718. Two-dimensional Plastic Flow of a Bingham Solid. A Plastic Boundary-layer Theory for slow motion.

J. G. OLDROYD. *Proc. Camb. Phil. Soc.*, **43**, 383, 1947.

The equations of motion as given and the derived equations for the stream function are much more difficult to solve than the corresponding equations obtained by putting $\theta = 0$ for a viscous fluid. The approximate plastic boundary layer equations are much easier to handle. Their conditions of applicability are discussed. Some of the results derived for infinite masses of material may be expected to hold with reasonable accuracy for finite amounts, since it has not been necessary to specify in great detail the outer boundary conditions in the elastic region. The possibility of experimental test thus arises.
SCI. ABSTR.

719. Rectilinear Plastic Flow of a Bingham Solid. I. Flow between Eccentric Circular Cylinders in relative Motion.

J. G. OLDROYD. *Proc. Camb. Phil. Soc.*, **43**, 396, 1947.

On the basis of the general equations of plastic flow between coaxial cylinders in relative motion an approximate velocity distribution is derived for the case of eccentric circular cylinders as rigid boundaries and zero pressure gradient. The approximation is valid only if a dimensionless parameter S , proportional to the yield value, is sufficiently small, and that there is flow in the whole region between the cylinders. The differences in velocity distribution in the cases of a Bingham solid and a Newtonian liquid are illustrated. It is shown that the effect of a finite yield value is to cause the contours of equal velocity in a normal section to become more nearly concentric with the inner boundary as the yield value increases from zero. Confirmatory experimental data are lacking. SCI. ABSTR. (see abstr. 633).

720. Provisional Methods for Testing the Strength of Wet Paper.

PAPER MAKERS' ASSOC., TECH. SECT. Preprint. *Proc. Tech. Sect. Paper Makers, Assoc.*, 19th March, 1947.

The conditions which must be standardized in a specification for the determination of wet tensile and bursting strengths are discussed and details are given of tentative procedures. P.A.T.R.A.

721. The Friction of Heated Sleigh Runners on Ice.

P. M. PFALZNER. *Can. J. Res.*, **25F**, 192, 1947.

An attempt was made to reduce the sliding friction of sleigh-runners on ice at 20°F., 0°F. and -10°F. by applying heat to the runners. The efficiency of the method was found to be less than 20%. Some doubt is thrown on the simple theory that the low friction on ice is due to a lubricating film of water.

AUTHOR'S ABSTRACT.

722. The Influence of Viscosity and Thermal Conductivity on the Propagation of Sound.

C. POSSIO. *Atti. Accad. Torino*, **78**, 274, 1942-43.

A mathematical analysis is made of the propagation of a sound pulse in a gas possessing viscosity and thermal conductivity. Expressions are given for the velocity of propagation of the wave-front, and the variation of the velocity with distance is shown graphically in a particular case. SCI. ABSTR.

723. New Physico-Chemical Phenomena in the Deformation and Mechanical Treatment of Solids.

P. REHBINDER. *Nature*, **159**, 866, 1947.

A brief account of investigations on the action of surface-active substances, absorbed on the surface of micro-cracks, in lowering the resistance of a solid to strain. Mica has been found to show an elastic after-effect when wetted with such substances. The yield value of Sn was halved by immersing in a fluid containing oleic acid or cetyl alcohol, and the number of slip planes increased 15 times. SCI. ABSTR.

724. The Rise of Air Bubbles in Lubricating Oils.

J. V. ROBINSON. *J. Phys. Coll. Chem.*, **51**, 431, 1947.

Rates of rise of small air bubbles in oils were measured and found to obey Stokes's law, except when the oil contained foam inhibitors or lubricating additives. In this case a gel structure is formed round the bubbles, and to account for the abnormally slow velocity a liquid shell of max. thickness equal to the bubble diameter, must be assumed to move with the bubble. SCI. ABSTR.

725. Contribution to the Study of Rigidity.

V. ROMANOVSKY. *J. Phys. Radium*, **4**, 13, 1946.

Coarse suspensions such as mud or clay, like colloidal solutions, possess the property of rigidity. This completely masks viscosity, and makes interpretation of results difficult. An apparatus known as the "B.F.R. Rigiditymeter" is described. It is based on an earlier instrument by Schwedoff, and measures the force necessary to destroy the internal structure of the material and to turn a cylinder which is part of the apparatus. The results are expressed in dynes/sq. cm., and the formula by means of which they are obtained is given. Rigidity figures are quoted for 6 samples of materials varying from a muddy sand to a marine mud, and range from 0.06 to 4.1 dynes/sq. cm. Materials with a very low water content cannot be measured, but resistance to shear of all materials from colloidal solutions to concentrated coarse suspensions can be determined, and results for solutions of agar-agar compare closely with those obtained by Michaud, whose apparatus and technique for measuring the modulus of rigidity of colloidal solutions is also described. B.R.R.A.

726. Increasing the Workability of Clays and Shales.

A. B. SEARLE. *13th Annual Conference, N.A.C.M.*, p. 1, 1946.

The workability of a clay depends on the size of the particles, the extent to which they are separated from each other, and the quantity of water contained within the crystal lattice, or in contact with the crystal surfaces. Treatment or chemicals which enable water to penetrate or adhere more readily to the clay surfaces will increase workability. There is need for increased study of the pH of clay pastes and the interfacial tension between water and clay particles. B.R.R.A.

727. Fundamental Equations of Motion of Compressible Fluids through Compressible Media.

V. N. SHCHELKACHEV. *C.R. Acad. Sci., U.R.S.S.*, **52**, 103, 1946.

The differential equation of continuity is developed and applied to the motion of water-oil-bearing layers, such as occur in oil wells. SCI. ABSTR.

728. Analysis of Unidimensional Motion of a Compressible Fluid in a Compressible Porous Medium.

V. N. SHCHELKACHEV. *C.R. Acad. Sci., U.R.S.S.*, **52**, 203 1246.

The differential equation of a previous paper is solved in the special case of transient motion in one dimension; the solution is used to plot graphs showing the increase of the fall of pressure with time. SCI. ABSTR.

729. Some Applications of the Theory of Flow in Compressible Water- and Oil-bearing Strata.

V. N. SHCHELKACHEV. *C.R. Acad. Sci., U.R.S.S.*, **52**, 395, 1946.

Good agreement is found between experimental data and the author's previous theory of the flow. SCI. ABSTR.

730. The Flow Properties of some Anhydrous Sodium Soaps.

F. W. SOUTHAM and I. E. PUDDINGTON. *Can. J. Res.*, **25B**, 125, 1947.

Soap blocks, melted *in vacuo*, to remove traces of water, were extruded through a capillary, the amount flowing in five minutes being weighed. Curves of an approximately Bingham type were obtained. Some explanation is offered for the complex curves found to relate mobility to temperature. G.W.S.B.

731. Emulsion Paints.

G. M. SUTHEIM. *Chem. Industries*, **60**, 948, 1947.

This is a good discussion, chiefly from a practical point of view, of the relative merits of emulsion and oil paints. The use of emulsions in interior and exterior

paints and in textile coatings is indicated and the relatively new "emulsifiable" paints are considered. Fifty-five references of a general type are included. F.H.

732. The Temperature dependence of Viscosities of Liquids and Activation Energy.

M. S. TELANG. *J. Chem. Phys.*, **15**, 525, 1947.

Short letter.

(see abstr. 507).

733. The Behaviour of Water under Hydrostatic Tension. III.

H. N. V. TEMPERLEY. *Proc. Phys. Soc., Lond.*, **59**, 199, 1947.

Some further experiments are described which appear to confirm earlier conclusions. Under favourable conditions, water in a glass tube can support tensions

as high as 60 atmos. A simple theoretical investigation shows that the commonly held view that the tensile strength of a liquid should be numerically equal to the "intrinsic pressure" is false. For water, a reasonable theoretical value would be 500 to 1,000 atmos., and two possible explanations of this discrepancy, which is much less serious than is usually supposed, can be suggested.

SCI. ABSTR.

(see abstr. 508, 509)

734. The Photo-elastic Properties of Rubber. I. Theory of the Optical Properties of strained Rubber.

L. R. G. TRELOAR. *Trans. Faraday Soc.*, **43**, 277, 1947.

The statistical theory of rubber elasticity is applied to the problem of calculating the principal stresses and principal refractive indices in rubber strained in the most general (homogeneous) manner. The rubber is shown to acquire the optical properties of a biaxial crystal. The birefringence in a principal plane is proportional to the difference of the principal stresses, and to the difference of the squares of the principal extension ratios. The effect of swelling the rubber with solvent is considered.

L.R.G.T.

735. The Photo-elastic Properties of Rubber. II. Double Refraction and Crystallization in stretched Vulcanized Rubber.

L. R. G. TRELOAR. *Trans. Faraday Soc.*, **43**, 284, 1947.

Experiments on vulcanized natural rubber both swollen and unswollen, subjected to a simple extension, are interpreted in the light of the theory given in I. Departures from the theoretical formulæ are attributed primarily to crystallization.

L.R.G.T. (see abstr. 27, 128, 147, 510, 568).

736. Experimental Investigations on the Viscosity of Gases at High Temperatures.

V. VASILESCO. *Ann. Phys., Paris (Sér. 11)*, **20**, 138, 292, 1945.

Precision measurements are described on the viscosity of air, N₂, A and CO₂ between 0°C and 1,600°C, in terms of the viscosity of air at 0°C, by the determination of the pressure drop along a capillary through which the gas flows at a constant flow rate. The accuracy of the viscosity ratio is 1/700 to 1/1000. The temperature is measured with an accuracy of 1°C up to 530°C and of 1.5° near 1,500°C. Two different methods for heating and for measuring the temperature are used; the results are in good agreement. The author gives the results in terms of the Sutherland formula in which he replaces the constant *C* by a variable slowly changing with the temperature. The various corrections and sources of error are discussed and the whole problem of viscosity measurement is reviewed in detail. White's empirical formula on the flow through coiled tubes is confirmed by experiments on air, N₂, A and CO₂ at 0°C.

SCI. ABSTR.

737. Characteristic Features of a Liquid Flow in an Open Channel.

V. V. VEDERNIKOV. *C.R. Acad. Sci., U.R.S.S.*, **52**, 207, 1946.

The flow is classified according to the propagation of wave motion in the channel. A certain function, f , of the channel parameters is introduced, and if $f < 1$ the flow is tranquil or rapid, and positive or negative waves, when moving along the stream, decrease in height, become damped and the original steady motion is restored. If $f > 1$, waves become steeper and tend to move along without change of shape. These results are extended to the case where the initial motion is not uniform.

SCI. ABSTR.

738. Some Thermodynamic Relations of Rigid Hygroscopic Gels.

F. L. WARBURTON. *Proc. Phys. Soc.*, **58**, 585, 1946.

In studying the absorption of liquids by rigid gels, certain thermodynamic relations are required in terms of stress components and generalized co-ordinates. These have been derived using the analytical methods of Gibbs as developed by Guggenheim, and the conditions under which they hold are clearly defined. The analysis includes a new derivation of Kirchhoff's relations for the heat of absorption, in which it is shown to be an exact relation between the isopiestic and isothermal heat of absorption and the isopiestic and isosteric variation of equilibrium humidity with temperature, where the pressures concerned are the external pressures on the gel-liquid phase. The effect of internal stresses existing in a homogeneous gel-liquid phase due to the absorption of the liquid is obtained by assuming that the energy of expansion of the gel is the same for expansion due to absorption as for expansion due to external forces. The effect of external shear stresses on vapour pressure is considered, although it is not necessary in the case of homogeneous gels, since the analysis is similar to that for the internal energy of expansion, and the effect of such stresses is required when dealing with more complex structures.

B.R.R.A.

BOOK REVIEWS.

Limits of Torsional Vibration Stress in Marine Oil-Engine Shafting.

S. F. DOREY. *Engineering*, (June 13, 1947. p. 509).

A consistent basis for the assessment of torsional vibration characteristics of marine propelling and auxiliary installations is advanced.

In view of the wide variations in damping, harmonic torques, etc., arising in different types of machinery, the accurate calculation of the true values of vibration stress are critical speeds in complex and the limits here recommended are confined to stress derived from actual measurement of vibration amplitudes. Also, the calculated values are nominal, referring to plain sections of the shaftings; stress raisers being neglected.

The author's recommendations are based on extensive experience gained by Lloyds' Register of Shipping in their investigations of torsional vibration stresses. At the time of writing, improved methods of stress calculation were still under extensive investigation.

Formulae for the determination of limiting vibration stress in crankshafts, screw shafts, intermediate shafts and thrust shafts, working under continuous operation, are given and discussed. Expressions facilitating the evaluation of recommended "barred" speed ranges for the one-node mode of vibration are also given. (A "barred" speed range is a range, extending over the "spread" of the resonance curve of a transient critical speed, which must not be used for continuous running if fatigue failure is to be forestalled).

The fitting of dampers is recommended on main and auxiliary engines, to deal with transient vibration stresses which would otherwise exceed the recommended limits. The correct adjustment of the dampers should be ensured torsigraphically. Calibration of tachometers of vessels to an exactness within $\pm 2\%$ of the true speed is also imperative to ensure effective engine control over restricted ranges of revolution.

M.W.T.

Practical Plastics Illustrated.

Edited by PAUL I. SMITH. *Odhams Press, Limited, London.*

The interaction between the advances in and the trends of the plastics industry, as regards both the satisfactory qualities of the finished products for their intended purposes, and the choice of raw materials to suit desired methods of fabrication, provides sufficient justification for this instructive volume which comprises an orderly series of articles contributed by 12 experts, each of whom has experienced in one or more specialized sub-divisions of modern practice. Additional justification could be claimed, nevertheless, in respect of the introductory chapters, dealing succinctly with the physical and chemical characteristics of plastic substances, and with the position of plastics among the world's industries, for they form a background against which the succeeding technological descriptions can be reviewed with enhanced clarity and realism. A somewhat similar objective underlies, no doubt, the useful survey of the qualities and performance demanded by standard specifications for plastics, and a critical account of the associated practices in mechanical and electrical testing. On this foundation, and with the help of a large number of excellent illustrations, Mr. Paul Smith's team of authors expound the technologies entailed in the design and manufacture of moulds; in moulding by the compression, injection and transfer methods; in extrusion operations by the use of dies; in "rubber bag" forming; in sheet production; and in the manufacture and fabrication of laminates and plastic-impregnated woods.

Engineering, 11/7/47.

The Compacting of Soil by Rolling and Vibration.

An interesting Editorial article in *Engineering* (July 4th, 1947) points out that "the heavy loads which have now to be carried by highways and particularly by airport runways, have resulted in recent years in increased attention being paid to the question of compacting the foundation soil."

The writer goes on to discuss the relative merits of different types of rolling for compacting. The modern sheep's foot roller has a drum 96 in. diameter and 10 ft. in length, and when filled with water and sand, exerts a foot print pressure ranging from 400-1,000 lb./in².

O. J. Porter, in a paper read before the American Road Builders' Association, points out that the tyres of heavy modern aeroplanes impose a load of from 7-8 tons/foot² on the runway pavement and that the total load on a single tyre is about half the weight of the largest American steam locomotive. He also states that "the first principle of soil compaction is that the material must be moistened to lubricate the particles to the point where a minimum amount of energy will be required to force the soil grains together."

As a general rule, the energy required to compact relatively impervious soils is said to vary roughly as the square of the thickness of the layer (rheologists will be reminded of Pokrovskii's earlier work). The importance of moisture content, which can sometimes be artificially controlled, and of the mechanic composition of the soil, is stressed. Moreover, compacting of the subgrade is often as important as that of the pavement itself.

At an airport at Santa Monica (Calif.), careful experiments were done in which strips of soil were compacted by different treatments. The results, which clearly indicated the most effective treatment for the soil in question, would not apply to other types of soil, and more general information would be needed if the relative advantages of the different methods are to be assessed for all types of soil.

For sandy soils, experiments at Princeton (Soil Mechanics Lab.) suggest that vibratory methods are superior to rollers. Much greater efficiency is obtained if vibration of the natural frequency of the system are used, and any type of spring, including pneumatic tyres, reduces the compacting vibratory forces.

Yet another method, tested at the Vicksburg Experimental Station, compacts the soil by the impact of heavy weights on the surface, e.g., a 2-4 ton steel weight with a 3 ft. square base was dropped from a height of 5 ft. on to the soil.

All these problems of soil compacting are of interest to the rheologist. Burmister's work (*see* Abstrs. 317, 366) is already well-known—but it has not perhaps been realized how wide and interesting a field of investigation awaits further study of these compacted soil problems.

G.W.S.B.