

BRITISH RHEOLOGISTS' CLUB

BULLETIN No. 17



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CLUB NOTES.

News of Members.

- MR. J. E. CAFFYN has been appointed Lecturer in Physics at the University of Durham.
- MR. P. T. CLARKE has joined the Staff of the New Zealand Co-operative Dairies at Hamilton, N.Z.
- MR. E. L. CROSSLEY has been appointed to the Chair of Dairying at the University of Reading.
- DR. A. T. GREEN has been appointed Hon. General Secretary of the British Ceramic Society.
- DR. R. E. LISHMUND has been appointed Senior Lecturer in Physics at the College of Technology, Leeds.
- DR. A. C. MERRINGTON was unfortunately one of the scientists injured in the recent explosion at the Guided Projectile Establishment. At the time of going to press, we are glad to report that he is making good progress. Dr. Merrington has written a book on Viscosity which will be awaited with interest by all working in this field.
- MR. J. BOWLER REED is now doing full time Research work at Imperial College, London.
- DR. MARKUS REINER has been appointed Research Professor at the Hebrew Technical College, Haifa, Palestine.
- MR. J. WILSON has been appointed Director of the British Rayon Research Association.

Future Meetings.

Our President, Professor J. B. Speakman, is organizing a meeting in Leeds, probably 19th and 20th March, on Textile Rheology. There will be speakers from the Club and from the Shirley Institute. Full particulars will be circulated to members as soon as possible.

A joint meeting with the British Glaciological Society and Institute of Metals will be held in London at some date in May on the Flow of Solids and especially of Snow, Ice and Metals. The principal speakers will be Dr. E. Orowan, F.R.S., and Dr. M. F. Perutz.

It is intended to hold a meeting in Cambridge during the summer at which biological aspects of rheology will be discussed.

Because of the International Congress on Rheology to be held in September in Scheveningen, Holland, the Club will not hold an Annual Conference in 1948. The Annual General Meeting will be held, probably in London, in October or early November. It is planned, on this occasion, to have a discussion on "Fracture."

International Rheology Conference.

The following information about the programme of the International Conference on Rheology has been received from Professor J. M. Burgers.

The general lectures will be as follows:

.....	Recent Developments in the Theory of Viscosity.
J. M. BURGERS (Delft) ...	Principles of Nomenclature.
F. R. EIRICH (Brooklyn, N.Y.) ...	Fundamental Experimental Methods.
CH. SADRON (Strassbourg) ...	Viscosité et propriétés des Solutions Macro-moléculaires.
M. P. VOLAROVICH (Moscow) ...	No answer as yet received.
M. REINER (Tel-Aviv) ...	Relations between Stress and Strain in Complicated Systems.
K. WEISSENBERG (Manchester) ...	Abnormal Flow Phenomena.
G. W. SCOTT BLAIR (Reading) ...	Psycho-physical Aspects of Rheology.
A. L. COPLEY (New York) ...	Rheological Problems in Biology.
R. HOUWINK (Delft) ...	Rheology in Industry.

Rubber Technology Conference, London, June 23rd—25th, 1948.

The Editor has been asked to notify members of this Conference at which it is hoped the Club will be represented. For particulars, please write to the Conference Secretary, Mr. J. F. Coleman, Institution of the Rubber Industry, 12 Whitehall, London, S.W.1.

Colloid Chemist Wanted.

Manufacturer of paper and board, in the Kent area, has a vacancy for an experienced colloidal chemist. Age preferably early thirties. Research experience in surface phenomena and related studies is required. The post is permanent and is of senior class. All enquiries will be treated confidentially.

Rheologists' Problems.

The Committee feels that a Correspondence Column in the *Bulletin* might be helpful to members. Members are therefore invited to write to the Editor putting any problems or questions which it is thought might evoke useful replies from other members, or offering any comments on rheological matters which might not be brought to members' attention through the usual channels of publication.

The Editor naturally retains the right to select suitable correspondence for insertion in the *Bulletin* either as received or in abbreviated form.

Missing Addresses.

The Hon. Secretary would be glad to have the addresses of the following members, whose correspondence has been returned through the dead-letter office:—

Dr. R. S. Collins, Mr. F. W. Draper, Mr. A. H. Snowden, Professor F. R. Winton and Mr. B. J. Brown.

New Members.

- Mr. N. F. Bilton, "Lansdowne," Cambridge Road, Southport, Lancs.
Dr. I. Holden, 50 Oakhill Close, Ashstead, Surrey.
Mr. F. J. Rigby, 86 Dallas Road, Lancaster.
Professor Dr. A. van Rossem, Director, Rubber Research Institute, T.N.O.,
67 Julianalaan, Delft, Holland.
Mr. G. Seligman, White Chester, Camp Road, London, S.W.19.
Professor J. B. Speakman, Department of Textile Industries, The University,
Leeds, 2.

Change of Address.

- Dr. J. A. Hetherington, Messrs. Oralite Co., Ltd., Thornton, Blackpool, Lancs.

From (American) Rheology Bulletin, 18, 3-4 (1947).

BRITISH RHEOLOGICAL NOMENCLATURE

A Letter to the Editor

Dear Sir,

In connection with Section 3 and the Appendix of the British report on rheological nomenclature published in the June issue of the Rheology Bulletin, we should like to present the following comments.

1. *Traction and Stress.* The adoption of a terminology which allows clear distinction between the force per unit area transmitted across a specified surface and the state of stress at a point is highly desirable. The terms "traction" and "stress" serve this purpose, but the fact that "traction" then covers tensile, compressive and shearing forces may create certain difficulties. An alternative procedure would be to reserve the term "stress" for the force per unit area transmitted across a specified surface and use the term "state of stress" or "stress tensor" when referring to the complete specification of the stresses transmitted across various surface elements through a specified point.

2. *Stress not a function of the material.* The statement in the first paragraph of Section 3 under the heading *Stress*, might be misinterpreted. Even for an elastic body in equilibrium, the stresses at a generic point are not solely determined by the forces applied to its surface, but may depend also on Poisson's ratio.

3. *Shear Stress.* In the second paragraph of Section 3 under the heading *Stress*, the term shear stress is used in rather a restricted sense to denote a state of simple shear (stress). This may cause confusion in so far as the term *shear stress* is customarily used to denote what, according to the present proposal, would be called *tangential traction*.

4. *Moduli.* In the definitions of Young's modulus and bulk modulus the denominators should read $\delta l/l$ and $\delta V/V$ respectively.

5. *Appendix.* The strain components given in the Appendix are not tensor components. It seems highly desirable to define the shear components ϵ_{xy} , etc., with the factor $\frac{1}{2}$ so that the quantities $\epsilon_{xx}, \dots, \epsilon_{xy}, \dots$, constitute the components of a tensor (strain tensor). If this seems desirable, the conventional strain components given in the Appendix might be denoted by $\epsilon_{xx}, \dots, \delta_{xy}, \dots$.

Sincerely yours,

(Signed) D. C. DRUCKER,

Associate Professor of Engineering.

Brown University,
Providence, R.I.

W. PRAGER,
Professor of Applied Mechanics.

RHEOLOGY ABSTRACTS

NOTE.—The initials following the Abstracts are those of the abstracting member, except for the following abbreviations for abstracts reproduced from other abstract journals by permission :—

B.R.R.A.	British Refractories Research Association.
I.D.I.B.	Industrial Diamond Information Bureau.
Nickel Bull.	Nickel Bulletin.
P.A.T.R.A.	Printing and Allied Trades' Research Association.
Sci. Abstr.	Science Abstracts.

739. **Applications of Starch Viscosity to the Paper Industry.**

W. G. BECHTEL and C. C. KESLER. *Paper Trade J.*, **125**, 35, 1947

Starch paste viscosity varies with rate of shear used in the test and with the previous treatment given to the sample. When any conventional viscometer is used, one serious problem is to avoid differences in conditions of cooking pastes; another is that a single viscosity test does not give complete information about starch flow properties. A new viscometer has been developed which makes a continuous automatic record of starch viscosity during cooking and cooling. The starch is cooked in the viscometer under controlled conditions.

The paste is stirred mechanically and is cooked at any desired temperature in a thermostatically controlled water bath. Evaporation of water from the paste during cooking is prevented by means of a condenser built in as a part of the tight fitting cover of the starch beaker. The stirring device is of special design to keep the entire paste thoroughly agitated so that it is smooth and free from lumps, and to remove the layer of pasted starch from the walls of the beaker. Measurement of viscosity is obtained as the torque in g-cm. against a propeller which stirs the centre of the paste. The stirrer is equipped with four speeds for the study of the effect of different rates of shear. The test may be continued for any desired length of time at any temperature up to the boiling point of the paste, and cooling curves can be made as well. Results of duplicate tests agree within narrow limits.

Typical curves are given showing the effects of changes in concentration, cooking temperature, time of cooking, pH and enzyme conversions. No constructional details of the instrument are given and it is not stated whether it is available commercially. Viscosities are expressed throughout in g-cm. torques and no conversion to fundamental units appears possible.

V.G.W.H. (see Abstr. 612).

740. **Upper Yield Point : Occurrence in Bending Tests and Signification.**

C. BENEDICKS and R. SKORSKI. *Nature*, **160**, 399, 1947.

Two examples of the occurrence of the upper yield point are described. It is shown that this is probably associated with the presence of a hard skeleton in the metal, e.g. cementite precipitated at grain boundaries. The upper yield point represents the rupture of this skeleton.

SCI. ABSTR.

741. **A General Kinetic Theory of Liquids. III. Dynamical Properties.**

M. BORN and H. S. GREEN. *Proc. Roy. Soc. A*, **190**, 455, 1947.

The theory of liquids is here extended to liquids in motion. The connection between the macroscopic and microscopic properties is revealed by the derivation of a set of generalized hydrodynamical equations, of which the fundamental equations of hydrodynamics are a special case; the more general equations describe the mean

motion of clusters of molecules in the fluid. It is shown that the pressure tensor and energy-flux vector in a fluid consist of two parts, due to the thermal motion of the molecules and the intermolecular forces respectively, of which only the first is found in the kinetic theory of gases, but of which the second is dominant for the liquid state. A method is evolved for the study of those "normal" non-uniform states which relate to actual monatomic fluids in motion. It becomes apparent, as in the case of equilibrium, that there is a region of temperature and density where analytical singularities arise, closely associated with the process of condensation. Rigorous expressions for the coefficients of viscosity and thermal conduction are then derived which apply equally to the liquid and the gas. They consist of two parts due to the thermal motion and molecular forces respectively, of which the first is dominant for the gas, and the second for the liquid. By approximating to the rigorous formula, an expression for the viscosity of liquids is obtained, comparable with certain other formulae, previously proposed on quasi-empirical grounds, and giving good agreement with experiment. An integro-differential equation is derived for the determination of the distribution functions relating to the non-uniform state. A full discussion is given of the simplest case, and the velocity distribution in non-uniform liquids and gases examined.

SCI. ABSTR.

742. **A General Kinetic Theory of Liquids. IV. Quantum Mechanics of Fluids.**

M. BORN and H. S. GREEN. *Proc. Roy. Soc. A*, **191**, 168, 1947.

In this paper the classical theory of liquids developed in the first three parts of this series is translated into the quantum formalism. After the fundamental equations have been reformulated, it is shown that in the classical limit $\hbar = 0$, they go over into the corresponding classical equations. A quantized proof of the Boltzmann distribution law is given which is simpler and more direct than that of the Darwin-Fowler method. Then the equation of state is derived in a form which exhibits clearly the deviations from the classical law at very low temps. An approx. method of solution of the fundamental equations is developed in a form suitable for practical application. Finally, the quantum equations of motion and energy transport are obtained, and it is shown that they are formally identical with the classical "hydrodynamical equations." This enables a discussion of the viscosity and thermal conductivity of quantum liquids to be given which exposes clearly the alternative explanations of the abnormal properties of liquid He II.

SCI. ABSTR. (see Abstr. 679).

743. **A Dynamical Model of a Crystal Structure.**

SIR LAWRENCE BRAGG and J. F. NYE. *Proc. Roy. Soc. A*, **190**, 474, 1947.

The behaviour of a model of crystal structure is described where the atoms of the crystal are represented by gas bubbles from 2.0 to 0.1 mm. in diameter floating on the surface of a soap solution. These bubbles are sufficiently persistent for experiments lasting an hour or more; they can be made uniform in size, and they are held together either in a single layer on the surface or in a three-dimensional mass. The assemblages of bubbles show structures which have been supposed to exist in metals, and simulate effects which have been observed, such as grain boundaries, dislocations, slip, recrystallization, annealing, and strains caused by "foreign" atoms.

Separate grains show up in polycrystalline bubble rafts. It often happens that some "impurity" atoms, or bubbles, which are markedly larger or smaller than the average, are found in a polycrystalline raft, and when this is so a large proportion of them is situated at the grain boundaries. No diffusion of bubbles through the structure can take place, mutual adjustments of neighbours alone are possible.

The boundaries appear to readjust themselves by the growth of one crystal at the expense of another till they pass through the irregular atoms.

Photographs illustrate dislocations produced by deformation of polycrystalline rafts including a dislocation projecting from a grain boundary. The greater rigidity of rafts of smaller bubbles leads to longer dislocations. However, there is not a standard length of dislocation for each size. The length depends upon the nature of the strain in the crystal. The case of positive and negative dislocations on neighbouring rows is also illustrated where two bubbles take the place of one.

Examples are given of the simulation of recrystallization. The raft covering the surface of the solution was given a vigorous stirring and then left to adjust itself. Photographs were taken after definite time intervals. Another photograph shows the widespread effect of a bubble which is of the wrong size.

Reference is made to an experimental arrangement for demonstrating mechanical properties of the two-dimensional raft. When subjected to a shearing strain, the raft obeys Hooke's law up to the point where the elastic limit is reached. It then slips along some intermediate row by an amount equal to the width of one bubble. Some unpublished calculations are mentioned concerning the variation of potential energy with distance between centres.

An oblique view is shown of a three-dimensional assemblage with its resemblance to a polished and etched metal surface. An example of twinning is given, and dislocations in a three-dimensional structure subjected to a bending strain are shown.

R.S.

744. **New Results in the Study of Materials.**

H. BRANDENBERGER. *Schweiz. Bauztg.*, **65**, 509, 1947.

Steel, brass, copper, duralumin, etc., stressed in one direction at first flow only in that direction, setting up spatial and lattice stresses. Flow in all three main stress directions begins when the space stress has become equal to the maximum lattice stress, so a first and second flow boundary must be distinguished.

I.A. (abridged).

745. **Reply to "Remarks on Compressive and Tensile Strengths."**

P. W. BRIDGMAN, *J. Appl. Phys.*, **18**, 782, 1947.

Criticises the point of view presented by S. Thompson (Abstr. 820), and claims that this involves an unwarrantable and probably invalid extrapolation of the available experimental data.

L.R.G.T.

746. **The Rheological Properties of Matter under High Pressure.**

P. W. BRIDGMAN. *J. Colloid. Sci.*, **2**, 7, 1947.

With liquids viscosity increases with rising pressure at constant temperature, and the increase takes place in practically every case at an accelerated rate with increasing pressure. There is a close correlation between the magnitude of the effect of pressure on viscosity and the complication of the molecule. The effect of temperature combined with pressure is abnormal, however, the coefficient of viscosity becoming markedly greater with increasing pressure. Above the first few thousand kg./sq. cm. the increased molecular agitation due to increasing temperature has a specific effect in decreasing viscosity apart from the effect on volume. In these respects water is abnormal as for many of its other properties; between 0° and 25° C. the initial effect of increasing temperature is to decrease instead of increase viscosity, and at higher temperatures the increase with increasing pressure is abnormally low. With the concept of "manoeuvre space" it now is possible to reproduce measurements on viscosity up to 10,000 kg./sq. cm. with only small error. There exists a greater variety of phenomena for solids, corresponding to the greater range of kinds of deformation to which a solid is subjected. Von Mises theory states that a substance is in the plastic state if the function of the stresses $(X_x - Y_y)^2 +$

$(Y_y - Z_z)^2 + (Z_z - X_x)^2$ exceeds a critical value, otherwise it is in the elastic range, and there is a connection between the stresses and the rate at which strain varies with time, that is the rate of flow. It is recognized that the equations referred to are valid in a narrow range above the point of initial flow only. A tensile test under pressure may be vastly different from one at atmospheric pressure, as for example with the increase of ductility in mild steel, and strain-hardening, and certain substances such as limestone are brittle to tensile stresses at atmospheric pressure, but have a measurable degree of ductility imparted to them by high pressure. Hydrostatic pressure has an effect on flow under simple compressive stresses as well as under tensile stresses; glass may become enormously strong in compression, and with a single crystal sapphire, failure under simple compression took the forms of slip without fracture as in single crystals of ductile metal. Brinell hardness increases between 5 and 10% for a pressure increase of 10,000 kg./sq. cm. In the pressure range up to 50,000 kg./sq. cm. the shearing stress at which plastic flow occurs is a rising function of pressure. Internal fracture is confined almost exclusively to non-metallic substances which do not crystallize in the cubic system, and after internal fracture there may be cold welding, as occurs with borax glass and steel. With a plastic solid the shearing stress varies little with the velocity of shear. It would appear that the forces which are active during the plastic flow of a solid are configurational in character, depending on the relative location of atoms and molecules contracted with forces dynamic in origin which are concerned in the viscous motion of a liquid. B.R.R.A.

747. A Sensitive Recording Calorimetric Mass Flowmeter.

A. F. BROWN and H. KRONBERGER. *J. Sci. Instr.*, **24**, 151, 1947.

A laboratory flowmeter and a precision flowmeter are described which depend on the fact that the symmetry of the temperature distribution in the wall of a heated tube is disturbed when gas flows along the tube. The temperature difference at two points, one up-stream, one down-stream, is linearly related to the mass flow. In the precision flowmeter, this temperature difference is integrated over portions of the tube wall by winding platinum resistance coils on to the tube. The instrument is linear up to flow of 1×10^{-4} g. of hydrogen per sec. A simplified theory of the instrument is also given. J.E.C.

748. An Electron-Diffraction Study of the Heating of Straight-Chain Organic Films and its Application to Lubrication.

K. G. BRUMMAGE. *Proc. Roy. Soc. A*, **191**, 243, 1947.

Thin films of normal paraffins (*n*-tetratriacontane, *n*-triacontane, *n*-tetracosane), fatty acids (behenic acid, stearic acid, palmitic acid), and esters (cetyl palmitate, ethyl stearate, methyl stearate) have been examined by electron diffraction upon a variety of metal surfaces. The films were formed on metallographically polished specimens of aluminium, cadmium, copper, nickel, silver, mild steel, and stainless steel. The films were applied either by using the Langmuir-Blodgett method, or by direct deposition upon the metal from isohexane.

The films gave diffraction patterns of the layer-line type. When such a film was heated, the bright parts of the pattern gradually became diffuse, and eventually disappeared. On allowing the specimen to cool, the diffraction pattern returned. The interpretation of the results is based on temperature disorientation of the films with the suggestion that the disorientation temperature was lowest for the monolayer and increased with thickness to a steady value which remained constant for films up to 100 molecular layers in thickness.

The disorientation temperatures are discussed in conjunction with observations made by Frewing and others with the Bowden-Leben apparatus. For metals which are easily corroded, such as copper, cadmium, and mild steel, the difference between

the disorientation temperature and the melting point of the film is appreciably higher for the fatty acids than for either the paraffins or the esters.

The reasons for the dependence of disorientation temperature upon film thickness, and of "thick-film" disorientation temperature upon film constitution and substrate metal are unknown.

R.S. (see Abstr. 583).

749. Andrade's Creep Law and the Flow of Zinc Crystals.

A. H. COTTRELL and V. AYTEKIN. *Nature*, **160**, 328, 1947.

Single Zn crystals were strained with a device to maintain uniform shear stress on the glide planes. The law $\gamma = \gamma_0 + \beta t^{\frac{1}{2}} + \chi t$ (γ = total shear at time t , γ_0 = instantaneous shear accompanying loading, β , χ = constants) was obeyed closely.

SCI. ABSTR.

750. The Evaluation of the Intrinsic Viscosity (as Intrinsic Flow Time) of G.R-S. in Benzene.

L. H. CRAGG, T. M. ROGERS and D. A. HENDERSON, *Can. J. Res.*, **25**, 333, 1947.

$[\eta]$ was determined by the use of the function $n(t_r^{1/n} - 1)/c$ based on the Baker equation; the value of n was taken as 8. $[t]$, the intrinsic flow time, was determined by linear extrapolation to zero concentration of the function $8(t_r^{\frac{1}{8}} - 1)/c$ by measurements on only one solution of a concentration such that $t_r = 1.8 \pm 0.4$. The authors found later (25, 351) that the function was independent of concentration up to 0.3% and that $[\eta]$ of normal G.R-S, in benzene was independent of temperature over the range 10° to 55° C. within experimental precision of $\pm \frac{1}{2}\%$. E.W.J.M.

751. On Creep and Relaxation.

B. CROSS. *J. Appl. Physics*, **18**, 212, 1947.

The creep and the relaxation function of linear systems, for which the principle of superposition is valid, are mutually connected in a simple way. This makes it possible to calculate the distribution function of relaxation times of stress and the distribution function of retardation times of strain, when the relaxation function or the creep function is given. It also allows a transformation formula to be established for the conversion of one distribution function into another. The results of the theory are applied to a detailed discussion of the relaxation process in a particular case.

B.R.R.A.

752. The Texture of Copper Wire drawn with Backpull.

J. F. H. CUSTERS. *Physica, 's Grav.*, **13**, 366, 1947.

The preferred orientations of Cu wire drawn in the normal way and with backpull respectively were investigated with X-rays. In the outer zones these orientations show distinct differences. In wire drawn with backpull the so-called conical fibre texture which predominates especially in the outer zones has developed less intensively than in wire drawn in the normal way. It is, however, still an open question whether properties like tensile strength are improved to a significant degree.

SCI. ABSTR.

753. Relationships between Specific Gravity of Cheese-Curd Particles, the Firmness of the Curd and the Body and Quality of Cheese.

(Die Auswirkung des spezifischen Gewichtes des Käsekorns auf die Festigkeit des Bruches sowie auf die Härte und Qualität des Käses.)

J. CZISZÁR. *Milchw. Forsch.*, **20**, 192, 1940.

The author has studied the properties of Ovarer Hungarian cheese-curd (a type of Tilsit) during the scalding process and in relation to the body of the finished cheese. Winkler's method of measuring the density of individual curd particles by dropping them into salt solutions (NaCl) of varying concentrations gives results which do not correlate with moisture content or with the subjectively judged "feel" of the curd. It is pointed out that the sinking of a lump of curd in salt solution is a

complex phenomenon, the smaller particles falling more quickly than the larger on account of their relatively greater surface and consequent more rapid withdrawal of water. Samples are therefore taken with a sieve-sampler so that the curd particles may be of comparatively uniform size.

None of the data correlates effectively with the body of the finished cheese. Over 200 curds were tested but there were no objective measures of consistency either for curd or cheese, nor is any statistical analysis quoted. G.W.S.B.

754. The Effect of Molecular Weight Distribution on the Reduced Viscosity-Concentration Coefficient.

W. E. DAVIS. *J. Amer. Chem. Soc.*, **69**, 1453, 1947.

Viscosity determinations with cellulose nitrate solutions using an Ostwald viscometer of the Cannon-Fenske type were made for four or five concentrations. From these data, values of $\log [\eta]$ and k of the equation $\log \eta_{sp}/c = \log [\eta] + k[\eta]c$ were determined by the method of least squares. Cases in which high values of the slope constant were obtained can reasonably be attributed to chemical heterogeneity of the samples. E.W.J.M.

755. On the Mechanism of Consolidation of Clayey Rocks.

N. I. DENISOV. *C.R. Acad. Sci. U.R.S.S.*, **53**, 343, 1946.

Sedimentation and consolidation of clayey rocks tend to reduce the free potential surface energy, and to attain the lowest energy level. The maximum effect of consolidation cannot be brought about unless the consolidation pressure is exerted under conditions of reduced friction between the particles in the absence of cohesion. During the formation of most clayey rocks, factors impeding consolidation were at work, and on this account they are considered to be in a state of "apparent" equilibrium between their porosity and the pressure applied. Tests on a paste and a specimen of undisturbed structure indicate that, with the same load applied, the porosity coefficient of the latter is generally higher, owing to the peptisation of a bottom sediment achieved by grinding, and by the fact that its particles are surrounded by water films, consolidation will occur under almost optimum conditions, and such a state may be considered closely to approach that of a true relationship between porosity and pressure. A comparison of values for a ground paste and a monolithic specimen made with a load exceeding that at which compression curves begin to diverge may be represented as a ratio which is the factor of the energy stability of rocks, $K = \epsilon_p/\epsilon_m$ where ϵ_p = the porosity of the ground paste and ϵ_m = the porosity of the monolith. The higher the value for K , the greater is the consolidation undergone by the rock. In clays cemented together with relatively water-resisting compounds, weakening of cohesion occurs slowly, and may become manifest only in zones of small thickness, mainly under the influence of shearing stress. The significance of these stresses is seen from the fact that the shearing strength value of clayey rocks is half the value of their compression strength, and their passage to the state of true relationship between porosity and pressure is possible chiefly in the process of landslide shifts. B.R.R.A. (see Abstr. 688).

756. Grip for Tensile Testing.

W. C. DILLON & Co., INC., and R. R. DILLON.

U.S.P. 2,419,711; *Bull. Inst. Paper Chem.*, **17**, 604, 1947.

A grip consists of a pair of holders and a base on which they are slidably mounted together with interchangeable jaws in the holders and a clamp band for coaction with the holders. The apparatus is apparently designed for testing metals. It may or may not have an application for testing of paper.

P.A.T.R.A. (see Abstr. 535).

757. Elastic Constants of Magnetite, Pyrite and Chromite.

M. S. DORAISWAMI. *Proc. Indian Acad. Sci. A*, **26**, 413, 1947.

Elastic constants of two specimens of magnetite from Holenarasipura in Mysore, four specimens of pyrite from Macherla in Guntur district, and one specimen of chromite from Kondapalle in Kistna district have been determined by the ultrasonic wedge method.

SCI. ABSTR.

758. The Relation between the Physical Properties and the Structure of Glass. I. Variations of the Physical Properties with Time.

R. W. DOUGLAS. *J. Soc. Glass Tech.*, **31**, 50 (T), 1947.

The X-ray diffraction patterns of liquids and glasses are compared; it is shown that the similarities between them enable a qualitative application to be made to glasses of Bernal's theoretical work on the liquid state. In this way a satisfactory account may be given of the time-variation of the physical properties of glasses in the temp. range for which their viscosity $> \sim 10^{13}$ poises, in terms of a random network structure involving no considerations of aggregation or association.

SCI. ABSTR.

759. The Relation between the Physical Properties and the Structure of Glass. II. Viscosity as a Function of Temperature.

R. W. DOUGLAS. *J. Soc. Glass Tech.*, **31**, 74 (T), 1947.

Log (viscosity of normal liquids) $\propto 1/T^\circ\text{A}$, but the viscosity of glass cannot be so expressed. It is shown that the viscosity-temp. relationship of glasses can be predicted from the assumptions of a random network structure which possesses an equilibrium configuration for each temp.

SCI. ABSTR.

760. Materials for Power Gas Turbines.

C. T. EVANS. *Trans. Amer. Soc. Mech. Engrs.*, **69**, 601, 1947.

The composition, creep, thermal expansion and stress-rupture relations for high-temperature alloys are given. Processing may be the most important factor in the performance of heat-resisting components. Machined bar stock, forgings, weldments, and castings are felt to be dependable in that order.

P.F.

761. Stress-Strain Relations in Dinnerware Bodies.

J. O. EVERHART and M. LASSETTRE. *Ceram. Age*, **48**, 254, 1946; *Ohio Eng. Exp. Sta. News*, **18**, 18, 1946.

A vitreous whiteware bar fired to Orton cone 4 was loaded, and the small strains set up were measured by the SR-4 bonded metal electric strain gauge and Wheatstone bridge; results obtained indicated that the use of engineering formulae was valid. In all the dinnerware bodies studied, there was a large deformation immediately upon application of the load, and then the body continued to deform slowly for some time without additional stress being added. This creep was not pronounced for semi-vitreous specimens, and decreased with harder firing. In all specimens there was some permanent set on removal of the stress, but this decreased slowly with time. No relation between creep and time could be established. Specimens were approximately $\frac{1}{2} \times 1 \times 8$ in., and in each series one was fired to each of cones 3, 4, 7, 10 and 12. For purposes of testing, the bar was supported by knife-edges 5-in. apart, and loaded with weight increments of 8.85 lb. at 5-min. intervals. Readings for first loadings were erratic, suggesting residual internal stresses from cooling, so the bars were pre-stressed lightly several times before measuring. They suffered from fatigue, and it seems that the modulus of rupture, modulus of elasticity and creep are a function of time and load, instead of load alone. Modulus of elasticity increased with firing temperature, and going from semi-vitreous to vitreous ware, the proportional elastic limit became higher, and the creep and permanent set less.

B.R.R.A. (see Abstr. 617).

762. Generalized Mechanical Properties of Solid Bodies.

J. B. FRIEDMANN. *C.R. Acad. Sci. U.R.S.S.*, **55**, 817, 1947.

The author has investigated the relation between max. shear stress and the resultant strain according as to whether the material is in tension, torsion, or compression. For duralumin and high strength Al alloys the shearing strain is a function of shear stress only, but there are anomalies in the case of certain steels.

SCI. ABSTR.

763. Rheological Behaviour and Classification.

F. H. GARNER and A. H. NISSAN. *Nature*, **160**, 329, 1947.

Results of viscosity measurements by two different methods of a petrol solution of Al stearate are reported, one of which classes the solution as "Newtonian" and the other as "non-Newtonian." It is proposed that classifications should be made by "regimes" rather than by the bodies themselves. SCI. ABSTR. (see Abstr. 543).

764. Measurements of the Ethylene Viscosity at Pressures up to 1,000 atm. by the Oscillating Disc Method.

M. G. GONIKBERG and L. E. VERESHCHAGIN. *C.R. Acad. Sci. U.R.S.S.*, **55**, 801, 1947.

Values of $\eta \times 10^4$ determined at 24° C. at intervals of 100 atm. pressure are: 100, 3.90; 200, 5.50; 300, 6.81; 400, 7.82; 500, 8.62; 600, 9.40; 700, 10.16; 800, 10.94; 900, 11.71; 1,000, 12.43. The apparatus was calibrated by determination of the viscosity of N₂ at 25° C, at pressures of 100—400 atm. SCI. ABSTR.

765. An Improved Method for Measurement of Gel Strength and Data on Starch Gels.

W. J. HAMER. *J. Res. Nat. Bur. Stds.*, **39**, 29, 1947.

The author uses a modification of the Saare-Martens method involving the fracture of a gel by an embedded disc. The method described gives two properties of gels, the strength of the gel and an indication of its deformability. The gel strength and deformability of various starches and wheat flour at 25° are shewn in tabular and graphical form.

E.W.J.M.

766. A New Penetrometer for the Examination of Settled Paints.

A. HANCOCK and T. F. BROWN. *J. Oil Colour Chem. Assoc.*, **29**, 155, 1946.

An instrument is described which might have application in the examination of settled clay slips, although it is designed primarily for the study of settled paints. By its use, the relative hardness and packing of a paint cake at any level throughout its depth can be determined.

B.R.R.A.

767. On the One-Dimensional Theory of Steady Compressible Fluid Flow in Ducts with Friction and Heat Addition.

B. L. HICKS, D. J. MONTGOMERY and R. H. WASSERMAN, *J. Appl. Phys.*, **18**, 891, 1947.

Equations are derived for the steady flow of a compressible fluid, on the basis of a one-dimensional approximation. The question of the existence of one or more solutions to these equations under specified conditions is examined, and an interpretation of the phenomenon of "choking" is advanced.

L.R.G.T.

768. The Flow of Starch Pastes. A New Consistometer.

R. S. HIGGINBOTHAM. *J. Text. Inst.*, **38**, (T), 131, 1947.

The power required to stir pastes at constant speed is measured by a mechanical dynamometer. The relation between consistency (in terms of torque) and viscosity (determined in other forms of viscometers) is discussed.

E.W.J.M. (see Abstr. 464).

769. **The Theory of Combined Plastic and Elastic Deformation with Particular Reference to a Thick Tube under Internal Pressure.**

R. HILL, E. H. LEE and S. J. TUPPER. *Proc. Roy. Soc. A*, **191**, 278, 1947.

The relationship between stress and strain is represented on a plane diagram, the reduced stress-strain diagram, which facilitates discrimination between the elastic and plastic components of strain and aids considerably the solution of certain problems. The diagram can also be used to express the relationships governing the dissipation of energy during plastic flow under combined stresses. The theory is applied to the deformation of a long thick tube under internal pressure with zero longitudinal extension. The solution is compared with that based on the usual theory which neglects elastic strains in the plastic region, revealing an error which reaches a max. of $> 60\%$ in the longitudinal stress distribution. The significance of the differences between the two solutions is discussed in detail.

SCI. ABSTR. (see Abstr. 610).

770. **A Direct-Reading Differential Micromanometer.**

H. R. HINDLEY. *J. Sci. Instr.*, **24**, 295, 1947.

A differential manometer working on the inverted bell system is described with a sensitivity of at least 10^{-4} mm. of mercury over a range of 0—0.05 mm. of mercury.

J.E.C.

771. **Ultrasonic Measurements on Single Crystals.**

H. B. HUNTINGTON, *Phys. Rev.*, **72**, 321, 1947.

A pulse technique at 10 Mc/s has been used to measure acoustic velocity and attenuation of several alkali halides and Rochelle salt. Values for the elastic moduli of LiF, NaCl, KBr, and KI have been determined. The attenuation of the ultrasonic beam in these media is small. Corresponding measurements on the elastic moduli of Rochelle salt are reported. Under the assumption of plane wave transmission many of these moduli automatically correspond to those measured on foiled crystals by other methods. Attenuation is considerable in Rochelle salt, and appears to be excessively high for transmission involving the temperature-dependent c_{44} (foiled case). Where this modulus is involved marked effects have been observed from elastic bias and mechanical pressure. A complete set of elastic moduli has been obtained and used to calculate the corresponding values for the moduli of compliance.

SCI. ABSTR.

772. **Adsorption and Lubrication at Crystal Surfaces. Part I. On the Boundary Lubrication of Sodium Nitrate.**

E. HUTCHINSON and E. K. RIDEAL. *Trans. Faraday Soc.*, **43**, 435, 1947.

The frictional force was recorded between a crystal of either ammonium nitrate or sodium nitrate firmly clamped in an aluminium holder and the circular track wiped on to a steel flywheel with which the crystal was in frictional contact. The peripheral speeds ranged between 2 cm./min. and 12 cm./min. and the normal loads between 50 g. and 400 g. It is said that within this region of load and speed Amontons' law was found to hold.

Experiments with solutions in nitro-benzene of stearic acid, stearoxyacetic acid, ammonium stearate, ammonium oleate, cetyl alcohol, and nitro-octadecane showed a decrease of the coefficient of friction from a value of about 0.5 in the "dry" case to about 0.12 with increasing concentration of the solutions. The concentrations for which the coefficient of friction had decreased to about 0.12 were 3 mg./cm.³, 4 mg./cm.³, 2.5 mg./cm.³, 5 mg./cm.³, 6 mg./cm.³, and 4 mg./cm.³, respectively. With octadecyl cyanide a three-point approach towards a coefficient of friction of 0.12 was indicated with a concentration of 10 mg./cm.³, whereas with a solution of Wax XP 59 the asymptotic approach seemed to be towards a coefficient of friction of about 0.17.

The claim is made that the wearability of polymeric compounds is much higher than that of paraffin chain derivatives. R.S.

773. **On Adsorption and Lubrication at Crystal Surfaces. Part II. On the Adsorption of Paraffin Chain Compounds on Sodium Nitrate.**
E. HUTCHINSON. *Trans. Faraday Soc.*, **43**, 439, 1947.

2.5 g. of fine-grained powders of some 5000 cm.² per g. were placed in a stoppered tube, 5 cm.³ of solution added, and the mixture shaken for about an hour. By spreading similar volumes of solution before and after adsorption on a Langmuir trough the amount adsorbed on the powder was calculated from the force-area characteristic.

By a comparison of the fractional surface covering θ and the lowering of the coefficient of friction $\Delta\mu$ there seems to be a slight increase of $\Delta\mu$ (from 0.15 to 0.25) for an increase of θ from 0.1 to about 1. Incidentally, the asymptotic value of $\Delta\mu$ appears here to be 0.25. R.S.

774. **Adsorption and Lubrication at Crystal Surfaces. Part III. On Heats of Wetting and Adsorption on Ionic Crystals.**
E. HUTCHINSON. *Trans. Faraday Soc.*, **43**, 443, 1947.

A calorimeter with a sensitive resistance thermometer ("thermistor") was built for the measurement of the heats of wetting and adsorption on sodium fluoride of a number of liquids. R.S.

775. **Stability of Visco-Plastic Flow of a Circular Slab.**

A. YU ISHLINSKIĬ. *Prikl. Mat. Mekh.*, U.S.S.R., **7**, 405, 1943.

In a previous work by the same author, the stability of the visco-plastic flow in a circular cylinder under axial tension or compression was discussed. The present paper is concerned with the stability of the visco-plastic flow in a circular slab under the action of uniformly distributed normal stresses applied to the cylindrical surface of the slab. The general problem of the stability of visco-plastic flow was first discussed by A. A. Ilyushin. I.A.

776. **Brittle Rupture of Plastic Material.**

F. K. T. VAN ITERSSEN. *Proc. K. Ned. Akad. Wet.*, **50**, 246, 1947.

The paper discusses theoretically the possibility of brittle explosive-like fracture in a plastic material such as mild steel. A photograph of brittle fracture in a mild steel girder is given. SCI. ABSTR. (see Abstr. 467, 468).

777. **Measurements on the Viscosity of Gas Mixtures.**

A. VAN IITERBEEK, O. VAN PAEMEL, and J. VAN LIERDE. *Physica, 's Grav.*, **13**, 88, 1947.

These measurements were carried out using the oscillating disc method. At ordinary pressure, mixtures of H₂ with He, Ne, O₂, N₂, and CO were investigated at room temp. and H₂-N₂ also at liquid air temp. Pure H₂, N₂, O₂, A, and He, and the mixtures H₂-N₂ and H₂-A were examined in the Knudsen region. It was found that the law $\eta' = \eta p / (p + c\eta/\sqrt{\rho})$ also applies to gas mixtures. η' = viscosity at pressure p , η = viscosity in the Poiseuille region, c = const. depending on the dimensions of the apparatus, ρ = density of the gas mixture at unit pressure.

SCI. ABSTR.

778. **Discussion of Mix and Forming Pressure in Dry Press Brick.**

A. W. JACKSON. *Brick Clay Rec.*, **109**, 70, 1946.

Bricks with up to 15% moisture may be made on a dry press, and the term is sometimes misleading. The materials used are clay, calcined clay and bats. Pure clay bricks crack at an extremely low pressure and have a very high shrinkage,

hence the need for non-plastic inclusions. Most bricks made on a press are pressed near to the cracking point. As the depth of clay in the mould box before pressing is almost twice that of the pressed bulk, nearly half the box is filled with air, which is compressed by the top plunger, and causes cracks when pressure is released. Of the methods developed to prevent this, the use of a vacuum of 24 in. of mercury has proved most successful. The passages to the vacuum tend to clog up, and the dies and plates are subject to more abrasion, but the higher forming pressures increase bulk density, crushing and transverse strengths, resistance to abrasion, and slag attack. Manufacturing and maintenance costs are increased, and resistance to thermal spalling is decreased. B.R.R.A.

779. The Measurement of Stiffness of Paper.

P. M. H. JACOBSEN. *Svensk Papperstidn*, **50**, 98, 1947.

The article is a résumé of a 54-page bulletin published by the A/S Nordisk Standard Saekke Selskab (Northern Standard Bag Co.), Copenhagen, Denmark. The possibility is discussed of using the formulae for the elasticity coefficient and the elastic curvature of a steel rod clamped at one end for the stiffness measurement of paper. The necessary modifications which are to be made in the formulae, as well as their validity range, are given. The elasticity coefficient is a material constant and thus is independent of the basis weight and the thickness of the paper. It is, however, sometimes of importance to know the bending movement of the paper, which is dependent upon the paper thickness. Formulae are given for its calculation. A simpler formula is obtained when the paper strip is clamped with the long dimension horizontal and the plane of the paper perpendicular to the base of the apparatus. The weight of the paper can then be disregarded. However, in this case a special apparatus has to be used for the bending, such as the one by Schöller-Cornely-Wiesdorf, which is a torsion-pendulum tester. P.A.T.R.A.

780. Statistical Properties of Networks of Flexible Chains.

H. M. JAMES. *J. Chem. Phys.*, **15**, 651, 1947.

A more complete mathematical development of the theory of rubber elasticity, from the standpoint of James and Guth (1943), is presented. L.R.G.T.

781. Theory of the Increase of Rigidity of Rubber during Cure.

H. M. JAMES and E. GUTH. *J. Chem. Phys.*, **15**, 669, 1947.

Previous theories have attempted to relate the modulus of elasticity of a rubber to the number of network chains. In the present paper this connection is critically examined, special attention being given to the detailed process of cross-linking of the individual molecules so as to form the vulcanised network.

L.R.G.T. (see Abstr. 74, 328, etc.).

782. A Theory of the Viscosity of Monomolecular Layers based on their Structure. I-II.

M. JOLY. *J. Phys. Radium (Sér. 8)*, **7**, 83, 112, 1946.

Part I gives a simple theory based on the work of Eyring to explain the viscosity of monomolecular films spread on aqueous solutions. This results from a consideration of the activation energy as a function of van der Waals' forces and a few simple hypotheses regarding the structure of the films and the equilibrium states of the molecules. The theoretical treatment is extended in Part II, where the effect of the H_2O molecules of the substrate is considered, leading, for cases of liquid and gaseous films, to an explanation of the observed increase of viscosity with increase of molecular area. The theory is applied to experimental results obtained for films of palmitic acid, oleic acid, and tricaprin. SCI. ABSTR.

783. **On the Viscosity of Liquid Helium in the Neighbourhood of the Lambda-Point.**

W. H. KEESOM and P. H. KEESOM. *Commun. K. Onnes Lab. Leiden (No. 260e)*. *Physica, 's Grav.*, **8**, 65, 1941.

The results of measurements between 2.12 and 2.43° K are given graphically. No discontinuity appears to occur. SCI. ABSTR.

784. **Waves in Elastic Tubes : Velocity of the Pulse Wave in large Arteries.**
A. L. KING. *J. Appl. Phys.*, **18**, 595, 1947.

An equation for waves in elastic tubes is developed and applied to cylindrical tubes with Hookean and with elastomeric walls. The former application yields the Moens-Korteweg formula, which has been found inadequate. The latter application leads to a rather complicated equation for the pulse-wave velocity. Values of pulse-wave velocities are computed for the thoracic aorta by means of the foregoing equation, and the results are compared with measured mean velocities for the entire aorta. A graphical analysis of this velocity equation can be applied to any large artery; and the method is illustrated by computing the pulse-wave velocity in the left common carotid. SCI. ABSTR. (see Abstr. 614).

785. **Formation of Diamond Impressions in Glass Surfaces**

W. KLEMM. *Glastechn. Ber.*, **19**, 386, 1941.

Tests were carried out using Zeiss microhardness tester. Photomicrographs of impressions in glass surfaces show that deformation through plastic flow without fracture is possible with glasses up to fairly high test loads. Only at high loads should brittleness limit be reached where radial tears appear. But even before appearance of radial fractures sort of ring-shaped tear is formed in impression. With special arrangement of apparatus observations during formation of impression could be made. Circular tears form in series during loading, and radial cracks appear as load is released. I.D.I.B.

786. **Proposed Experiments for Further Study of the Mechanism of Plastic Deformation.**

J. S. KOEHLER and F. SEITZ. *J. Appl. Mech.*, **14**, A 217, 1947.

A qualitative theory, assuming that plastic deformation is a result of the formation and motion of dislocations, is discussed and used to suggest experiments with single crystals including fine wires of spectroscopically pure metal at various temperatures. E.W.J.M.

787. **A New Falling Body Viscometer for Pressures up to 2,000 Atmospheres**

E. KUSS. *Naturwiss.*, **33**, 312, 1946.

The disadvantages of previous forms are reviewed. In the present apparatus the liquid under test comes into contact only with glass and Hg, and the times of fall, which are measured electrically, are accurate to ~ 0.5%. Some results on a synthetic oil and on nitrobenzene are given. SCI. ABSTR.

788. **Coagulation and Surface Losses in Disperse Systems in Still and Turbulent Air.**

G. O. LANGSTROTH and T. GILLESPIE. *Can. J. Res.*, **25**, 455, 1947.

The coagulation constant for ammonium chloride smokes in still air was found to be only slightly greater than the ideal Smoluchowski value. The increase in particulate volume ($1/n$) with time (t) may be represented by $1/n = 1/n_0 + kt$, where n denotes the number of particles per cc. at time t and n_0 the number at the beginning of the test.

A description was given of the manner in which the various constants increased with the degree of air motion. E.W.J.M.

789. **A Micro-Hardness Tester.**

H. LLOYD and R. JEFFREY. *J. Sci. Instr.*, **24**, 186, 1947.

A spring loaded pyramid diamond is fitted into a phosphor bronze body, threaded for standard microscope nose piece. The diamond is pressed into the metal surface by racking down a microscope, and the load is taken by the spring. When the spring takes up the load a light goes out and the indentation is measured with the microscope in the usual way. Examples of the reproducibility of the test and a comparison with other standard instruments are given. J.E.C.

790. **Limiting Thickness of Liquid Films. Relation between Viscosity and the Minimum Thickness of Liquid Films.**

A. MARCELIN. *C.R. Acad. Sci., Paris*, **225**, 225, 1947.

A drop of oil, of average viscosity, cannot be compressed between plane surfaces beyond a thickness of 1-2 μ , in general. If the critical pressure at this stage is exceeded the film between the surfaces is suddenly destroyed and the planes attain a state of pseudo-contact with intervening strato-films which behave like a perfect fluid so far as relative motion of the plane surfaces is concerned. Surface irregularities act as a primer to rupture of the film. Stability of the film is increased by an increase of viscosity of the oil and by increased polish of the surfaces. Experiments carried out with six mineral oils of the same origin (viscosities 3.7 to 3,500 stokes) show that the min. thickness of film, prior to rupture under pressure, $\propto \sim$ (viscosity of the oil)^{1/2}. SCI. ABSTR.

791. **The Mechanical Properties of High Polymers.**

H. MARK. *Trans. Faraday Soc.*, **43**, 447, 1947.

A general survey of the effect of molecular constitution on the mechanical properties of polymers is presented. Among other things, consideration is given to the interpretation of the rubber-like, viscous, glassy and crystalline states. L.R.G.T.

792. **Studies in Friction II. Maximum Shear Strength of Solids in Relation to the Thermodynamics of Melting.**

M. E. MERCHANT. *Phys. Rev.*, **72**, 534, 1947.

(Abstract of a paper presented at the Montreal meeting of the American Physical Society). The previous treatment applied to "clean" metals in frictional contact is now studied for conditions of boundary lubrication (thin films of solids on friction surfaces). The maximum shear strength is related to the density, heat of fusion and melting point of the solid. The calculated values are compared with experimental data obtained by Bridgman and a fair degree of correlation is said to exist.

R.S. (see Abstr. 279).

793. **Metallurgical Considerations of Gas Turbines**

N. L. MOCHEL. *Trans. Amer. Soc. Mech. Engrs.*, **69**, 561, 1947.

The high temperatures involved in gas-turbine practice have created conditions under which customary materials-testing procedure does not provide the characteristic data which are required. New testing methods and equipment to accomplish the desired results on high-temperature resisting materials are discussed; particular applications in some detail. The quality of a given material was judged by the load that could be imposed, under a given temperature condition, that would result in no greater than an established maximum deformation, during the expected life of the material or unit. This stress-temperature-deformation relationship is represented by a square. The sides of the square can be altered, but unless the shape is preserved, i.e. departure from the "four-square principle," deterioration in the

service life occurs. Time (i.e. the useful service life) is made the abscissa of the square, while the allowable deformation is made the ordinate (useful dimensional status). An increase in the temperature of the material is represented by an appropriately scaled displacement of the side of the square which is parallel to the "deformation-axis," parallel to itself and in the direction towards the deformation axis. A trapezium then results. To restore optimum conditions it is then necessary to restore the square shape by a movement of the side parallel to the time axis, in the direction of the time axis. This movement represents (appropriately scaled) the necessary decrease in stress to achieve the optimum conditions, i.e. longest life at increased temperature. Stress here is meant to be interpreted in the wider sense of service conditions, taking into account corrosion, oxidation, shock, wear and other possible causes of the deterioration of the metal. P.F.

794. Rheological Experiments Carried out on Gruyère Cheese.

G. MOCQUOT, G. W. SCOTT BLAIR and M. BARON. *Dairy Industr.*, **12**, 966, 1947.

Rheological methods devised by Scott Blair *et al* for studying the manufacture of British cheese have now been applied to Gruyère. Two tests were especially studied, (1) superficial density in the scalding stage (see Abstr., **17**, 66, 117, 172, 262, 672) and (2) sphere-indentation hardness of finished cheese (see Abstr., **262**, 368, 672). In the former test the weight (W) of a test-cylinder of curd of controlled diameter is divided by the height (h), W/h being independent of W over a reasonable range in the case of Cheddar and Cheshire curd. For Gruyère curd, which is scalded at a higher temperature, the factor found to be independent of W is $W^{0.8}/h$. The hardness tester, used to determine both elastic and plastic components of the indentation, is as effective for Gruyère as for Cheddar and Cheshire. It facilitates prediction of the way the cheese will ripen, and gives an objective standard against which to compare graders' judgments. G.W.S.B.

795. Elastic Behaviour and Creep of Refractory Bricks under Tensile Compressive Loads.

L. E. MONG. *J. Res. Nat. Bur. Stand.*, **38**, 229, 1947.

Specimens were cut from nine brands of 9-in. refractories, including two high alumina, four fireclay, two siliceous, and one silica, and subjected to creep tests with either tensile or compressive stresses at 11 temperatures from 25° to 950° C. inclusive. Durations of tests were approximately 240 days. Small length changes, independent of stress direction, occurred at the lower temperatures. Lowest temperatures at which creep was significant were high alumina, 700° to 850° C.; fireclay 600° to 700° C.; siliceous and silica, 950° C. Creep results with compressive stresses could not be correlated with results with tensile stresses. At 950° C., specimens of different brands showed greatly different capacities to carry load. Repeated heatings caused growth of silica bricks. Moduli of elasticity at room temperature were determined before and after the various heat treatments, and resultant changes in moduli are recorded. The changes were large for silica bricks and small for the firebricks. B.R.R.A.

796. The Mechanical Degradation of Large Molecules.

W. J. MORRIS and R. SCHNURMANN. *Nature*, **160**, 674, 1947.

With mean rates of shear of the order 10^5 sec.^{-1} under laminar flow conditions, long chain molecules of molecular weights above 10^5 were broken down, yielding an exponential type of decay curve for the % permanent viscosity loss plotted as a function of the number of cycles of forcing the solution in individual drops through a jet. The mechanical degradation was assessed by the permanent viscosity loss, by the increase in the viscosity-temperature coefficient and by the displacement of the transition region from laminar to turbulent flow towards higher values of the

rate of shear. With a high pressure jet calculated to give rates of shear of the order 10^7 sec.^{-1} for Poiseuille flow, materials of molecular weight of 25,000 and less were broken down.

E.W.J.M.

797. The Delayed Elastic Effect in Silicate Glasses at Room Temperature.
J. B. MURGATROYD and R. F. R. SYKES. *J. Soc. Glass Tech.*, **31**, 17 (T), 1947.

The effect has been measured at 12°C . in vitreous silica, a boro-silicate glass and a sheet glass, using a torsion balance of high sensitivity with an optical lever. Expressing the delayed strain between 1 and 10^4 min. after loading as % of total strain, the following values were found: for vitreous silica, 0.12%, for "Wembley X-8," 0.55%, and for sheet glass, 1.2%. The empirical equation, $\text{strain} = a + b \log t$ (a and b being const. for a particular glass), was shown to hold to a close approx., although it does not express the results when very close to the limiting strain. It was demonstrated that the delayed elastic effect is reversible and regularly reproducible, and in all respects conforms with the assumption that glass consists of a truly elastic matrix containing inclusions of viscous components possessing a wide range of viscosities.

SCI. ABSTR.

798. The Relation between the Delayed Elastic Effect and the Decay of Strength of Silicate Glasses at Room Temperature.

J. B. MURGATROYD and R. F. R. SYKES. *J. Soc. Glass Tech.*, **31**, 36 (T), 1947.

A relationship is derived between breaking strength and the delayed strain which appears in glass under constant load, namely, $1/P_B = k\sigma + k'$ (P_B = breaking strength, σ = strain). P_B and σ were measured at durations of loading varying from 1 to 10^4 min. in vitreous silica, "X-8" glass and sheet glass and the results were in close agreement with the equation. This supports the assumption that stress concentrations arise locally in the elastic matrix of glasses where inclusions of a quasi-viscous component occur, and that these stress concentrations continue to increase as relaxation proceeds in the quasi-viscous component. An explanation is offered of the fact that $1/P_B \propto \log$ (duration of loading) + const. The effect of surface condition on the strength of glass is also discussed, and it is shown that the lack of decay of strength of glass under load after being heated *in vacuo* is compatible with the "viscous pocket" theory.

SCI. ABSTR. (see Abstr. 343).

799. An Indentation Method for Measuring Wear.

S. A. MCKEE. *J. Res. Nat. Bur. Stds.*, **39**, 155, 1947.

Minute indentations in the wearing surface (aircraft engine cylinders) by means of a four-sided diamond pyramid were made. As the material was worn, the dimensions of the marks changed.

E.W.J.M.

800. Viscosity Data and Relations of Normal and Iso-Paraffins.

G. W. NEDERBRAGT and J. W. M. BOELHOUWER. *Physica, 's Grav.*, **13**, 305, 1947.

The viscosities of seven paraffinic hydrocarbons with 16 or more C atoms are derived from the times of descent of a small needle of glass in a capillary filled with the liquid. The relation between viscosity and vapour pressure, length of molecule and branching are discussed.

SCI. ABSTR.

801. A Relation between the Theory of Bennewitz and Roetger for Internal friction and that of Päsler.

M. PÄSLER. *Z. Phys.*, **124**, 105, 1947.

It is shown that the equations developed by Päsler in considering the theory of internal friction bear a relation to the fundamental differential equations developed by Bennewitz and Roetger. From the expanded equations of motion of an oscillator and the generalized heat conduction equation, one arrives at a differential

equation for the displacement vector, after eliminating the excess temp. arising from the deformation of the oscillator. The additional elasticity modulus ϵ introduced by B. and R. is shown to be expressible in terms of material constants which can be determined by experiment. Similarly the compensating coeff. $\gamma \propto$ the heat conductivity of the oscillator. The quantities ϵ and γ can be treated in terms of an electrical analogy and so evaluated.

SCI. ABSTR.

802. Helical Flow of Liquids in Pipes with Circular Cross-Section.

B. A. PISHKIN. *Bull. Acad. Sci. U.R.S.S., Dep. Tech. Sci.*, 53, 1947.

The differential equations of current motion are formulated. A simplified contemporary theory which assumes equal kinetic energies of the circular and longitudinal flows is criticized, and a general mathematical treatment of the problem is presented. A universal nomograph is constructed, which yields information on relevant characteristics such as min. and max. velocities, vector angle betw. longitudinal and total flow and the ratio of kinetic energies.

SCI. ABSTR.

803. Deformation of Metals during Single and Repeated Tensile Impact.

J. A. POPE. *J. Iron Steel Inst.*, 157, 31, 1947.

The falling-tup type of machine was used, an adjustable stop being fitted to the machine so that either a single impact could be split up into a number of stages or repeated impact tests could be carried out with constant velocity of deformation. The mode and spread of deformation was examined by microscopic examination, by Vickers hardness tests, and by measuring the change in diameter of the specimen at various points. Lowmoor iron and mild steel were tested. A general theory expressed in dimensionless groups is developed to explain the mode of deformation. The theory agrees well with experiment. The spread of deformation along the specimen during impact was fundamentally different from that for static deformation. Hardness tests taken along the centre and edge of deformed steel and iron specimens showed that the increase in hardness at the centre of the specimen was larger than that at the edge by a greater amount in impact than in static tests. Tests on brass specimens showed no such hardness variation. It was found that impact-percentage-elongation/static-percentage-elongation is a function of the gauge length of the specimen and is not a fundamental property of the metal.

SCI. ABSTR.

804. Stresses in Glass-to-Metal Bead Seals at Room Temperature.

G. D. REDSTON and J. E. STANWORTH. *J. Soc. Glass Tech.*, 30, 201 (T), 1946.

A photo-elastic study has been made of the distribution of the retardations due to axial stresses and due to radial and hoop stresses in bead seals. Seals of varying glass-metal radius ratio, b/a were tested. The observed distributions of retardation agreed substantially with those derived from the mathematical theory. Direct determinations of axial stress, however, became unreliable with seals of high glass/metal radius ratio, and also with short seals. Brief reference is made to practical applications of photo-elastic measurements on bead seals.

SCI. ABSTR. (see Abstr. 588).

805. Lubrication and Lubricants.

R. E. REYNOLDS. *Forward*, pp. 6, 35, July 1947.

A general discussion is given of the theory of lubrication and the composition of lubricants and their application.

P.A.T.R.A.

806. The Fall of Rain.

E. G. RICHARDSON. *Proc. Univ. Durham Philos. Soc.*, 10, 394, 1947.

The theory of the fall of single raindrops under the combined effects of gravity and evaporation is discussed and relationships between size of drop and height above ground level derived. Experiments on the free falling of drops and their loss of

mass *en route* are described and the results examined in the light of the theory. The possibility of using such methods to deduce rates of evaporation is also considered.

AUTHOR'S ABSTR.

807. A Gauge for Measuring Compression Force.

P. H. RINKEL, *J. Sci. Instr.*, **24**, 298, 1947.

The gauge consists of two double supported beams whose end deflections are measured when an unknown load is applied centrally. J.E.C.

808. The Straining of Constructions consisting of Elastico-Viscous Elements.

A. R. RZHANIZYN. *C.R. Acad. Sci. U.R.S.S.*, **52**, 25, 1946.

A material is said to be elastico-viscous when the relation between the strain, ϵ , and the stress, σ , is expressed by $nH\dot{\epsilon} + E\epsilon = \sigma + n\dot{\sigma}$, where H is the instantaneous modulus of elasticity, E the final modulus, and n the relaxation time. Most building materials (e.g. wood, concrete) satisfy this relation. The problem of an elastico-viscous rod losing stability under compression is studied. Formulae for the max. deflection are obtained when the compressive force $<$ its critical value. The equations of vibration of an elastico-viscous body are given and a formula for the amplitude of forced vibrations is obtained. SCI. ABSTR.

809. The Time Effect in the Fracture of Glass and other Materials.

E. SAIBEL. *J. Chem. Phys.*, **15**, 760, 1947.

810. Speed of Propagation of a Fracture Crack in Metals.

E. SAIBEL. *Phys. Rev.*, **72**, 534, 1947.

(Abstract of a paper presented at the Montreal meeting of the American Physical Society.) Relating fracture to the melting phenomenon and employing the Eyring theory of the liquid state, the rate of formation of the "hole" structure is calculated from chemical reaction rate theory. The material before fracture is regarded as the reactant, and the holes as the product of the reaction. The speed of fracture of a mild steel plate at room temperature, under a tensile stress, works out to be about 75,000 in./sec. R.S.

811. Dispersants from Sulphate Liquor.

J. R. SALVESEN and W. C. BROWNING. *Chem. Industr.*, **61**, 232, 1947.

The use is suggested of lignosulphonates from sulphite waste liquor as dispersing agents for solids. These materials are shown to compare favourably with existing products, and are studied here with relation to aqueous dispersions of carbon, calcium carbonate, sulphur, and clay. F.H.

812. Brinell Hardness versus Machining Index as a Criterion of Machinability.

G. SCHLESINGER. *Machinery (Lond.)*, **91**, 122, 1947.

There is no published table which accurately relates Brinell hardness figures to cutting speeds for different materials. Cutting speed together with specific cutting resistance of material determines tool life. Results of tool life tests on steels of varying hardness and of cutting resistance tests are given. I.D.I.B.

813. Precipitation-Hardened Alloys for Gas-Turbine Service.

H. SCOTT and R. B. GORDON. *Trans. Amer. Soc. Mech. Engrs.*, **69**, 583, 1947.

The metallurgical and rheological properties of precipitation-hardened, heat-resisting, alloys are considered—in particular the relation of tensile properties to hardness, of yield-strength to ductility, of tensile-strength to temperature, of creep to ductility. P.F.

814. The Role of Psychophysics in Rheology.

G. W. SCOTT BLAIR. *J. Colloid Sci.*, **2**, 21, 1947.

The observable phenomena in the science of deformation and flow are strains. For simple elastic bodies a state of stress is inferred proportional to the observed strain, or is related to the behaviour of the casual agent under subsequent dynamic conditions. In the psychophysical experiments concerned the main preoccupation has been with constant stress conditions under which σ/t changes are observed, and for convenience a Newtonian time definition is used, although in the straining of complex bodies this does not lead to a whole-number differential equation. In judging σ/t changes subjectively by handling, spontaneous judgments do not depend on a Newtonian time analysis, yet if enough data are amassed excellent agreement is reached between the values of material constants calculated from purely psychophysical experiments and the integrated Γ -function equation. Complex entities useful for comparing rheological properties may be described as associated groups of quasi-properties which describe a process and not an equilibrium state.

B.R.R.A.

815. Strength of Quartz Glass.

A. SMEKAL. *Z. Phys.*, **114**, 448, 1939.

Useful conclusions regarding properties and strength of glass cannot be drawn from determinations of tensile strength without determining influence of the rate of stretching on the value of the breaking strength and on the fracture picture.

I.D.I.B.

816. Paper as a Visco-Elastic Body.

B. STEENBERG. *Svensk Papperstidning*, **50**, 217, 1947.

Substances composed of macromolecules show, generally, elasto-viscous properties, i.e. they behave like solid bodies (elasticity) and simultaneously as liquids (flow). The fact that the results in paper testing are dependent on time shows that paper also possesses flow properties. After a short survey of elasticity and hydrodynamics from a physico-chemical viewpoint, the terminology for elasto-viscous processes and basic mathematical laws for creep are discussed. A load on a visco-elastic body causes not only an immediate deformation, but also a creep. When the load is removed part of the deformation vanishes immediately, and creep commences to recover slowly. However, often this recovery is incomplete and a certain deformation of the material remains. In subsequent, equally great or lesser loading, the existing deformation does not increase; the material is mechanically conditioned. The practical importance of relaxation of stress is dealt with. Much work was done in order to produce mechanical models which picture the properties of elasto-viscous substances. The elastic elements are modelled as spiral springs and the flow elements as loose pistons in cylinders, which are filled with liquids of different viscosities. Various coupling possibilities are dealt with and the weaknesses of older theories, which are based on Newton's laws, are discussed. For investigating the extent of the presence of elasto-viscous properties in the paper dealt with a chain scale was used, which permits either a constant loading speed or a constant elongation speed for loading the paper. The rate of loading can be as low as 0.5 g. per second and of strain 0.2 μ per second. The length of the sample strip can be varied from 2 mm. to 500 mm. An automatic registering scale is used, operated by a vacuum photocell. At first the extent to which the form of the working diagram for paper is dependent on the loading programme is shown. Not only the location of the breaking point, but also the form of the working diagram is dependent on the moisture content. Bone-dry papers show, in certain cases, diagrams with marked flow limits. The form of the working diagram for paper shows for some complicated loading sequences, a remarkable similarity to the corresponding diagram for viscose fibres, even though the paper can only be stretched by 15%. Paper shows primary and also secondary creep, and the effect of mechanical conditioning is considerable. The

great differences in the primary working diagram for strips, which were cut from the various directions in the paper, are related to the tensions in the paper during fabrication. The pull in the machine direction causes a great mechanical conditioning in this direction. Also in the cross direction certain tensions arise in the paper. These vary greatly and are greatest in the middle of the machine. The effect of this on the paper is important. The phenomena of creep and relaxation in paper are demonstrated by examples. It was verified, that in general the Boltzmann's superposition principle is valid also for paper. A mechanically conditioned paper may be elongated repeatedly without damaging the structure. The elongation conditions then are reversible up to 75% of the breaking load. The investigations show that the working diagram for paper is well reproducible, and that important knowledge of the properties of paper may be obtained by repeated thorough studies.

P.A.T.R.A.

817. **Large Strains and Displacements in Stress-Strain Problems.**

K. H. SWAINGER. *Nature*, **160**, 399, 1947.

A short account is given of a theory giving the relationship between the stresses and any finite values of displacement and strains in a loaded structure. "True" strain is defined as (stretched-initial length)/(stretched length) and can never > 1 ; "true" stress = load/(actual cross-section). The generalized theory includes post-yield stresses, non-orthogonal co-ordinates and anisotropic bodies.

SCI. ABSTR. (see Abstr. 651, 652)

818. **Nomographic Representation of the Elastic Contact Conditions between Steel Pivot and Sapphire Jewel.**

G. F. TAGG. *J. Sci. Instr.*, **24**, 244, 1947.

Hertz' theory of elastic contact between spherical surfaces is used to obtain nomograms relating radius of pivot, load, maximum pressure, radius of circle of contact, frictional torque and the ratio of pivot radius to jewel radius for both static and impact conditions.

J.E.C.

819. **A Relationship between Viscosity, Density, and Vapour Pressure of Liquids.**

L. H. THOMAS. *J. Chem. Soc.*, 822, 1947.

An equation is proposed connecting the fluidity (ϕ) and the density (d) of a liquid with vapour pressure, and a comparison made of $\phi\sqrt{d}$ at corresponding pressures. The value of $\phi\sqrt{d}$ at the same reduced pressure is approximately a constant for all non-associated non-symmetrical substances. The significance of this constant is discussed.

SCI. ABSTR. (see Abstr. 657).

820. **Remarks on Compressive and Tensile Strengths.**

S. THOMPSON. *J. Appl. Phys.*, **18**, 781, 1947.

This note bears on a paper by Bridgman (*J. Appl. Phys.*, **18**, 246, 1947) dealing with the strength of materials in the presence of large hydrostatic pressures. Attention is drawn to an observation by Föppe that the breaking strength under one-dimensional and two-dimensional compressive stresses are equal. On this is based a theory which leads to a quantitative relationship between tensile and compressive breaking stresses, including the effects of superposed hydrostatic pressure.

L.R.G.T. (cf. Bridgman, Abstr. 745).

821. **Ink Consistency Tester.**

THWING-ALBERT INSTRUMENT CO. *Instruments* **20**, 304, 1947.

The new model C-46 Inkometer for measuring effective consistency of lithographic and printing inks, embodies an ink-film dynamometer; a delicately balanced pendulum involving a hollow brass roller and a composition roller is first "zeroed" without ink; an ink sample of standard volume is applied to the rollers; the resistance

is measured by a sliding weight on a scale beam. Standard temperature is maintained by circulating water from a thermo-regulated bath through the hollow brass roller. Composition rollers may be coated with whatever material is used on the ink rollers of presses. Press speeds are also simulated: Model C-46 produces speeds of 400, 1,200 and 2,000 r.p.m., or peripheral speeds of 314, 942 and 1,570 f.p.m.

P.A.T.R.A.

822. Atomic Vacancy and the Viscosity of Grain Boundaries in Metals.
T'ING-SUI KÊ. *Phys. Rev.*, **72**, 534, 1947.

(Abstract of a paper presented at the Montreal meeting of the American Physical Society.) Internal friction measurements on 99.991 aluminium specimens of similar grain size have shown that the grain boundary viscosity is lower in a specimen subjected to a heavier plastic deformation prior to recrystallization. It has also been found that the conditions corresponding to a smaller grain boundary viscosity in this metal are conditions that favour grain growth. The assumption is made that holes are created during plastic deformation and that these holes "migrate" to the grain boundaries during later heat treatment. Hence, the heavier the previous deformation, the greater will be the hole density at the grain boundary, and thus the lower the grain boundary viscosity. Also, it favours grain growth on account of the associated increase of surface energy.

R.S. (see Abstr. 658).

823. Viscosity of Linseed Stand Oil at High Shearing Stresses.

D. TOLLENAAR and H. BOLTHOF. *Ind. Eng. Chem.*, **38**, 851, 1946.

Stand oils as used in paints, printing inks and lacquers, obtained by heating linseed oil possess colloid properties which are manifested by a decrease in viscosity with increasing shearing stress. This decrease is the result of deformation and consequent alignment of colloid particles. The decrease in viscosity of mixtures is greater when the average particle size of one component differs more widely from the average particle size of the other component. The measurements were carried out in a capillary viscometer over the shearing stress range of 10^3 to 10^6 dynes per sq. cm.

P.A.T.R.A.

824. The Measurement of Double and Triple Correlation Derivatives in Isotropic Turbulence.

A. A. TOWNSEND. *Proc. Camb. Phil. Soc.*, **43**, 560, 1947.

By electrical analysis of the output from a hot-wire anemometer, it is possible to measure rapidly and accurately all the quantities appearing in the theoretical equations for the decay of isotropic turbulence. The technique for these measurements is described, and possible extensions and limitations of the method are discussed. Measurements have been made of the second and fourth derivatives of the longitudinal double-velocity correlation at the origin, the third derivative of the longitudinal triple-velocity correlation at the origin, the statistical distribution in time of the velocity fluctuations, and the integral scale of turbulence. SCI. ABSTR.

825. Elastic and Plastic Bending of Beams.

TSUN KUEI WANG. *J. Aero Sci., U.S.A.*, **14**, 422, 1947.

As well as a presentation of a method of analysing fibre stresses of beams, this paper includes the full effect of non-linear stress-strain characteristics of materials throughout the elastic and plastic range of bending. A stress-strain formula is also recommended for use when calculating integrals involved in the stress and moment equations.

I.A. (abridged).

826. Tensile Stress as a Factor in Fern Phyllotaxis.

C. W. WARDLOW. *Nature*, **160**, 678, 1947.

From anatomical investigations of the development of leaf primordia in the

broad shield fern it appears that during growth each primordium sets up tangential tensile stress in the apical meristem above its axil ; the next primordium to be formed arises in that region of the apical cone in which tensile stress is minimal.

E.W.J.M.

827. **"Structure" in Liquids and the Relation between the Parameters of the Arrhenius Equation for Reactions in the Condensed Phase.**

C. E. WARING and P. BECHER. *J. Chem. Phys.*, **15**, 488, 1947.

On the basis of the liquid state being quasi-crystalline, a modification of the transition state theory leads to a simple equation for the temp.-dependence of the fluidity, which involves a characteristic frequency of molecular vibration. The parameters of the fluidity equation are shown to have a linear correlation for certain liquids. The quasi-crystalline picture is then extended to a simple collision theory of uni- and bimolecular reactions in solution, and it is shown that the known correlation of the parameters of the Arrhenius equation arises from the fluidity correlation.

SCI. ABSTR.

828. **The Optical Investigation of Fluid Flow.**

R. WELLER. *J. Appl. Mech.*, **14**, A103, 1947.

The methods of photo-elastic stress analysis can be carried over to the study of the flow of fluids by making use of the double refraction developed in viscous shear. The effect is referred to as the "photoviscous effect." Suitable liquids are tabulated, the method of calibration is described, and qualitative results are shown for a few simple conditions obtained in an experimental liquid tunnel.

SCI. ABSTR.

829. **A Direct Reading Electrical Strain Meter.**

F. C. WIDDIS. *J. Sci. Instr.*, **24**, 302, 1947.

The out-of-balance voltage of a Wheatstone bridge is recorded on a galvanometer following a linear law. The bridge has two strain gauges, one gauge to compensate for temperature changes. By adjusting the potential applied to the bridge, the deflection can be made proportional to strain for all gauges.

J.E.C.

830. **Some Observations on the Behaviour of Water in Ceramic Materials.**

W. O. WILLIAMSON. *Trans. Brit. Ceram. Soc.*, **46**, 77, 1947.

Current opinions on the nature of the clay-water relationship are critically reviewed and difficulties in accepting the idea that the adsorbed water has the structure of ordinary ice are outlined. The association between water and non-plastics is discussed ; implications in the literature that such materials are not solvated cannot be sustained. Attention is directed to the work of von Buzágh on inter-particle forces. If his findings can be validly extended to plastic clay, they suggest that long-range attractive forces exist in this system and accompany a resistance to approach arising from the lyospheres round the particles. For a typical earthenware body in the plastic state a relationship is established between moisture content and dry porosity ; this is explicable in terms of a varying degree of particle orientation. Differences in moisture content produced by compression or centrifuging of unconfined specimens are related to Reynolds' dilatancy. This dilatancy is manifested by the non-plastic content of the body, but is not obvious in the ball and china clays. Short-term ageing of certain test-pieces in saturated air does not yield a more even distribution of water even where aqueous migration occurs. The relationship mentioned above suggests that a completely homogeneous moisture content may be unobtainable. The backlash phenomenon of Macey is more widely prevalent than is commonly supposed ; it is reported in ball clay, china clay, flint, Cornish stone, felspar, earthenware, bone china and brick clays. In earthenware, the portion of the test-piece undergoing alternating tension and compression becomes more hydrous from the operation of Reynolds' dilatancy ; this

increased moisture content does not appear consistently in ball and china clays. The cause of backlash is discussed, and a brief comment is made on the warping and cracking of clayware in the light of the foregoing work. B.R.R.A.

831. **Specific Studies pertaining to Tool Wear, Chip Characteristics, and Surface Finish of Free-Cutting Steels.**

G. P. WITTEMAN. *Trans. Amer. Soc., Mech. Engrs.*, **63**, 643, 1947.

Variables affecting machinability are very numerous, complicating control of machining properties. Specific cases are given, illustrating how increases in hardening elements will affect machinability. Studies of chip-sizes and characteristics, supplemented by colour photographs, give information on machining properties and tool wear. A flow chart, depicting schematically the factors affecting machinability, is shown. P.F.

Erratum.

From *Bulletin* No. 14, Abstr. No. 522.—Page number should read 25.