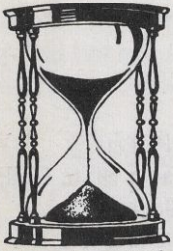
THE RHEOLOGY LEAFLET



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ONCE MORE; THE ANNUAL MEETING

Be sure to plan to attend the meeting at Pittsburgh, Pa. The tentative dates are December 27 and 28. Have you sent in the title of your paper to the Program Committee? The chairman is

H. R. Lillie
Research Division
Corning Glass Works
Corning, N. Y.

Better write him at once telling him that you hope to have a paper. Then start writing up that last bit of research on rheology, and, if you are an industrial man, start pushing for Company approval before it's too late.

It is planned to have a joint session one half-day with the Industrial and Engineering Chemistry division of the American Chemical Society. This joint session will consist of a symposium on Fluid Dynamics.

WE DO OUR BIT

The income of the American Institute of Physics is seasonal; during certain months of the year it is large, during other months it is vanishingly small. This is because the member societies make payments in lump sums at the time that dues are paid in. The expenses of the institute are more nearly constant month-by-month, because its publications come out at stated intervals. The result is that part of the year income exceeds expense. Then expense catches up and finally exceeds income for a few months, leaving a temporary deficit. This deficit then continues until the month when dues pour in to the member societies, and the member societies once more make large payments to the Institute. And so the whole cycle starts again. There would be obvious advantage in having a cushion fund to enable the institute to avoid these annually recurring temporary deficits. Such a fund, in the phraseology of a physicist, would not alter the shape

of the curve but would alter the absolute values of the ordinates, so that the curve could never go below the zero line.

The other founder societies of the Institute have agreed to increase their annual payments to the Institute in order to provide such a fund. They base their payments on the number of subscriptions to their respective journals. The Society of Rheology, having no journal of its own, makes use of the Journal of Applied Physics, which is sent monthly to all our regular members. This makes it hard for us to use the same basis for payments as the other founder societies. So your Executive Committee has voted a grant out of the Society treasury of forty cents a member per year for the current year and thirty cents per year thereafter for each regular and sustaining member. This approximates the rate paid by the other societies, and puts us in the position of having done our share. We understand that our action is satisfactory to the other founder societies.

ANNOUNCEMENT

We are happy to learn that our old friend, G. W. Scott-Blair, of the Rothamsted Experimental Station, England, is writing a book on applied rheology. The table of contents indicates that the book will give considerable space to the latest developments in laboratory rheological techniques, as applied in many different industries. A delightful preface has been written by Professor E. C. Bingham.

INDUSTRIAL RESEARCH

The purpose of an industrial research and development department is to enable the company to earn more money for its stockholders and its employees. This is done partly by developing new products to replace those lost by competition, changing customer demand, etc.; partly by developing new processes whereby a better product can be made at the same price, or an equally good product can be made at a cheaper price. This is the path of progress. Only by this path can wages be increased with respect to prices. Only by this path can we continue to stay solvent and still pay the constantly increasing tax bill, which in many corporations amounts to from $200 to $400 per employee. (For General Motors last year it was $444 per employee).

Shorter hours and higher pay are directly traceable to the work of scientists and engineers in our development laboratories. When hard times come, the laboratory should be the last place for retrenchment. An intelligently managed company will omit preferred dividends before it will cut its laboratory appropriation. Some of our largest and best known companies have followed this practice. One well known company reduces its sales force and increases its development staff when sales decrease. To reduce the appropriation for development in hard times, is like cancelling an insurance policy when you get sick.

ABSTRACTS AND BIBLIOGRAPHIES

(Thanks to J. H. Dillon and H. F. Wakefield)

Molecular Weight and Viscosity of Highly Polymerized Substances. A. Dobry, Kolloid-Z. **81,** 190-195. (1937).—It is found that for certain colloids (nitrocelluloses, polystyrols, etc.) in particular solvents, the courses of the p/c vs. c curves are not straight lines, so that an extrapolation of the molecular weight for lim c → o is only legitimate for measurements of concentrations below at least 0.1 per cent. The limiting values p/c for lim c → o are identical for a given substance in all solvents; the molecular weight so calculated is the true value which is independent of the solvent. The degree of dispersion of the colloidal particles in all solvents is the same at greater dilution, and the colloidal particle is for this reason a macro-molecule in dilute solution and not an associated micelle. The limiting value of the specific viscosity, $R_0=R_{c\to 0}=(\eta_0-\eta_0)/\eta_0 c$, deviates ±8 per cent at the most from the average value. An abnormally high solvation of the colloidal particles, which has been invoked for the explanation of the high viscosities of the highly polymerized substances, does not exist. The viscosimetric determination of the molecular weight, as carried out by Staudinger, is invalid, since different functions of one and the same substance give different viscosities although the molecular weight is the same. The method based on osmotic pressure appears to be the only method free from objection for the determination of the molecular weight of highly polymerized substances. (S. A.)

The viscosities of suspensions and solutions. VIII. **Inertia effects of suspended spheres.** F. Eirich and O. Goldschmid; Kolloid-Z. **81,** 7-18 (1937); cf. C. A. **30,** 7997.—Viscosity measurements on suspensions of glass spheres of radius 0.016-0.0075 cm. in Hg (NO_3)$_2$—HNO_3 soln. agree with the modified Einstein equation (loc. cit) to within 6 per cent when measured in the Couette (rotating cylinder) app., but capillary viscometer measurements yield low results. The difference is shown to be due to measurements in turbulence of flow leading to the participation of an inertia factor in the capillary viscometer. (C. A.)

Binding of solvents by immobilization. F. Eirich and H. Mark and Trude Huber; Papier-Fabr. **35,** No. 27 (Fest u. Auslandsheft), Tech. T1. 251-8 (1937)—The rates of fall of a perforated glass sphere, an oblate ellipsoid, 2 tubes and 4 wire gauzes of various meshes, through a series of 5 machine oils of varying viscosities confirm hypotheses previously advanced by others regarding the immobilization of solvents in colloidal systems. There is a strong fixation of the liquid, and, as a result of calcns. it is concluded that a part of the solvent is bound in porous structures through purely hydrodynamic forces. The assumption of far-reaching mol. forces is unnecessary.

Dilatancy and its Relation to Thixotropy. H. Freudlich and H . Roder; Faraday Soc., Trans 34. pp. 308-316, Feb. 1938.—The dilatancy of aqueous suspensions of quartz and starch was quantitatively investigated by finding the speed of a sphere pulled through the mass with varying shearing stresses. The suspensions acted as normal viscous fluids at low rate of shear, but with increasing rate the resistance to motion became disproportionately greater, and the speed of the sphere reaches a limiting value. Dilatancy was observed only with a concentration range of the suspensions of 42-45 per cent. This does not agree with the view that dilatancy is due to a change from close to loose packing, and an alternative theory is put forward. Colloidal systems were also prepared which showed behavior similar to dilatancy. The nature of the suspension medium has a marked effect on the phenomenon. Suspensions of quartz or starch in polar liquids (H_2O, EtOH, glycerol) show dilatancy, but those in non-polar liquids (C_6H_6, CCl_4, etc.) were thixotropic.

A theory of liquid structure. Joseph Hirschfelder, David Stevenson and Henry Eyring; J. Chem. Phys. **5,** 896-912 (1937); cf. C. A. **30,** 4174; Newton and Eyring, C. A. **31,** 2888.—A simple model of the liquid is used to extend the equation of state previously obtained and to treat the process of fusion, viscous flow and binary liquid systems. The equation of state which applies to dense liquids is fitted to Happel's modification of Van der Waal's equation to give a single equation applicable over the entire range from gas to liquid. A liquid differs from a solid in that the surplus vol. in one part of the liquid becomes available in another part without an activation energy appreciable as compared to kT. This communal sharing of vol. gives rise to an entropy of fusion R modified, of course, if there are other structural changes. Other entropy changes arise from expansion, changes of vibrations into free rotations and from polymerization. Double mols. held together by Van der Waals' forces are considered quantitatively and used in the explanation of viscous flow and deviations of the equation of state at the crit. point. An explicit expression is given for the osmotic pressure of a binary liquid mixt. "Holes" are used to complete the analogy beteen crit. phenomena for a one-component system and crit. soln. phenomena of binary liquids. In binary liquids the presence of a lower crit. soln. temp. above which 2 phases exist results from H (or analogous) bonds or bridges between unlike mols. which prevent free rotation. The crit. mixing point coincides with the onset of free rotations which disrupt these bonds. (C. A.)

Elasticity of Amorphous Bodies. P. Kobeko, E. Kuvshinskij and G. Gurevich; Techn. Phys., (U.S.S.R.) 4. 8. pp. 622-637, 1937. In English.—A notion is introduced of two components of reversible deformation: initial elastic or acoustic deformation and highly elastic deformation. Total mechanical deformation of amorphous bodies is

composed of three independent components: the elastic initial deformation, resilient highly-elastic deformation and inelastic plastic deformation. The initial modulus of shearing stresses in amorphous bodies is large. For phenol-phthalein, hard rubber and soft rubber it is equal to 2 x 10^4 kg./cm^2. and to 10 kg. cm. for rosin. The total modulus is many times less than the initial one. For soft rubber it is equal to 6 kg. cm ., for hard rubber—30 kg./cm^2., for phenol-phthalein—2500 kg. /cm^2. The setting-in time of highly elastic deformation drops very sharply with increasing temperature. Soft rubber and hard rubber are highly elastic at high temperatures as well as at low temperatures. Cooling produces only a drop in the velocity of setting-in of the highly-elastic deformation, but the limiting magnitude of deformation does not change. The hardening of soft rubber and hard rubber takes place not by jumps, but gradually as the temperature goes down, and is similar to the process of turning into glass of monomeric bodies. The manifestations of highly elastic properties may take place at greatly differing viscosities. In polymers the viscosity in the softening interval is very large compared with that of monomeric materials.

Efflux of gases through orifices—kinetic theory. B. V. Korin-Kroukovsky; J. Franklin Inst. **225,** 81-93 (1938).—Consideration of mol. motion on the principles of the kinetic theory of gases shows the possibility that a gas flowing through an orifice can expand without change of temp. and permits the formation of quant. relations that agree satisfactorily with test data. For small pressure differences the new expression for discharge becomes identical with Fliegner's formula. Reductions of temp. postulated by adiabatic formulas apply to the observer moving with the stream but no change of temp. is registered by a stationary observer. By a consideration of reduced number of collisions between mols. with reduction of the pressure ratio the adiabatic and new formulas can be extended to pressure ratios below the crit. value.

Production and Dissipation of Vorticity in a Turbulent Fluid. G. I. Taylor; Roy. Soc. Proc. 164A. pp. 152-3, Jan. 7, 1938.—When isotropic turbulence is set up in a fluid, e. g., by moving a grid of regularly spaced bars through it, the average vorticity decreases with time. This decrease is due to viscosity. Recently V. Karman has calculated the rate at which vorticity is destroyed by viscosity. His equation involves only quantities which can be measured in a wind tunnel by means of the hot wire technique. These quantities are now measured in one case, and the rate of decrease in the mean square of the vorticity is also measured. In this case it is proved that the rate of destruction of vorticity by viscosity is four times as great as the rate at which vorticity disappears. Vorticity therefore is necessarily being produced by extension of vortex filaments three times as fast

as it is disappearing. It seems that the stretching of vortex filaments must be regarded as the chief mechanical cause of the high rate of dissipation associated with turbulent motion.

RECENT PAPERS OF RHEOLOGICAL INTEREST ON RUBBER

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H. F. Church and H. A. Daynes; Trans. Inst. Rubber Ind. **13,** 96-108 (1937)—Investigation of the influence on impact strength of ebonite of dimension of test piece, notches and their dimensions, velocity of impact, fatigue, composition and degree of vulcanization.

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E. Guth; Kautschuk **13,** 201-9 (1937)—The influence of chain length and molecular uniformity on viscosity and tensile strength of natural and synthetic rubber.

H. Hintenberger and W. Neumann; Naturwissenschaften, Jan. 1, 1938. Stress strain curves and strength anomalies of rubber.

E. T. Lessig; Ind. Eng. Chem., Anal. Ed. **9,** 582-8 (1937)—Description of a new type of flexometer for studying the generation of heat and ensuing fatigue during high frequency compressive loadings.

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A. N. Puri; Nat. Acad. Sci., India, Proc. 7, I, pp. 45-51 (1937)—The Young's modulus of rubber is found to be higher when determined by dynamic than by static methods.

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RECENT PAPERS OF RHEOLOGICAL INTEREST ON PLASTIC BODIES

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Gino Bozza; Chimica e industria (Italy) **19,** 564-8 (1937)—Mathematical study of the flow of viscous fluids of varying viscosities, the results being applied to solutions of polystyrene in tetralin.

H. Kaneko and Y. Nakazawa; J. Agr. Chem. Soc. Japan **13,** 595-600 (1937)—A study of the relative viscosities of sols. of silk fibroin and fibroin components and the influence of sulfuric acid upon their viscosities.

N. Legrain; Rev. gen. mat. plastiques **13,** 123-9 (1937)—The viscosity of ethyl cellulose may be decreased either by modification of structure or by molecular degradation. Acidity or basicity exerts an important effect but various acids may have a specific action.

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A. A. Morozov and A. V. Pamfilov; J. Gen. Chem. (U.S.S.R.) **7,** 2154-66 (1937)—Non-Newtonian solutions of nitrocellulose decrease in viscosity on aging by a change in internal structure and not from depolymerization.
Z. A. Rogovin and M. Ioffe; J. Gen. Chem. (U.S.S.R.) **7,** 2167-74 (1937); cf. C. A. **31,** 32605—The abnormal viscosity of concd, aq. solns. of acetylcellulose was found to be caused by small amts. of highly sapond. lower acetyl fractions in the sample of ester.
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S. P. Zel'din; Org. Chem. Ind. (U.S.S.R.) **4,** 275-8 (1937)—Effect of electrolytes and hydrolysis upon the viscosity of casein solutions.

RHEOLOGY IN THE PETROLEUM INDUSTRY

H. A. Everett; S. A. E. Journal **41,** 531-44T (1937)—Pressure-temp.-viscosity curves for 3 oils, up to 50,000 lbs. per sq. in. and 210° F., show that differences in apparent oiliness may be due merely to differences in the effect of pressure on viscosity. A comprehensive discussion by 13 different authors indicates the uncertainty in present knowledge of the true nature of oiliness.
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The viscosity data on eleven lubricating oils tested under pressure are collected and reduced to the same units.

R. E. Hersh; Natl. Petroleum News **28,** No. 45, 30-2, 34-6, 38-40 (1936)—The effect of different solvents used in extraction processes upon the viscosity index and other properties of the extracted oils.

Mircea Jordachescu; Ann. combustible liquides 12, 511-49, 735-75 (1937)—The fluid behavior and colloidal nature of oils at low temps. are reviewed, with 46 references. Characteristic properties of all oils studied at temps. near the pour point are: plasticity, shown by change in viscosity, η, with time and with pressure; thixotropy; and appearance of turbidity.

Raymond Lautie; Bull. soc. chim. (5), **4,** 2071-6 (1937)—Some const. characteristics of homologous org. series are derived from different formulas covering one or more phys. properties such as d., η, and surface tension. In the analysis of aviation gasoline some constants of homologous organic series are derived from the properties of density, viscosity and surface tension.

A. W. Ralston, E. J. Hoffman and E. S. Stephens; Natl. Petroleum News **29,** No. 44, R-288-90 (1937)—Film-forming materials are added to lubricating oil and the variations in temperature rise are noted during frictional test.

L. S. Reid and R. L. Huntington; 1 Am. Inst. Mining Met. Engrs., Tech. Pub. No. **873,** 14 pp. (1938)—Flow of oil and gas mixtures thru unconsolidated sand.

A. R. Rescorla, F. L. Carnahan and M. R. Fenske; Ind. Eng. Chem., Anal. Ed. **9,** 574-6 (1937)—Data are presented for 4 lubricating oils tested in 4 and 6 cylinder motors for 24-hr. periods, showing that increases in viscosity, sludge content and carbon residue, are, in many instances, accompanied by a development of acidity.

Tentative viscosity-temperature charts for liquid petroleum products. Am. Soc. Testing Materials, A. S. T. M. Designation D341-37T; Am. Standards Assoc. A. S. A. No. : Z11.39-1937; 4 pp.

R. L. Smith and K. M. Watson; Ind. Eng. Chem. **29,** 1408-14 (1937) —Relation between boiling points and viscosity of hydrocarbon mixtures.

C. E. Zwahl; S. A. E. Journal **41,** 555-65T (1937)—Chem. analyses and properties are reported for about 100 different hypoid lubricants.

THE RHEOLOGY OF CERAMIC MATERIALS

A. Appen; Uspekhi Khim. **6,** 662-89 (1937)—Phys. properties as a function of chem. compn. in both the molten and the solid state are discussed for various silicate and borate glasses. A. concludes that glasslike properties are the result of three-dimensional "polymerization" leading to very complex structures in addition to results of the

type of valence bonds, coordination valence and the nature of the cation. Glasses cannot be regarded simply as mixts. of mols.

M. Bonnot; Usine **46,** No. 38, 35 (1937)—A brief description of the app. used and principles involved for detg. the phys. and mech. properties of refractories.

Raymond A. Heindl and Wm. L. Pendergast; J. Research Natl. Bur. Standard **19,** 365-66 (1937) (Research Paper No. 1030)—The plastic and elastic deformations of 17 brands of fire-clay brick were measured.

Takeo Kanno; J. Japan. Ceram. Assoc. 45, 209-12 (1937)—Modulus of elasticity and modulus of rupture of electrical porcelain as affected by its composition and method of preparation.

C. Major Lampman; Bull. Am. Ceram. Soc. **17,** 12-16 (1930)—The flow of glazes on horizontal surfaces is influenced principally by surface tension whereas on inclined surfaces viscosity is of most importance.

F. H. Norton; J. Am. Ceram. Soc. **21,** 33-6 (1938)—Construction and operating details are given for an app. which uses the principle of rapidly twisting a tubular test specimen and recording the stress-strain diagram on a smoked glass. At least 3 properties must be used to express workability of clay, viz., yield point, max. strength and deformation at the breaking point. The rate of twisting has an important influence on the stress-strain curve. The slope of the elastic portion is profoundly influenced and the max. extension is increased with increasing rate of shear. The resistance to plastic flow increases with the rate of shear, but the decrease in modulus of elasticity and increase in max. tension require explanation.

RHEOLOGY OF THE METALS

Relaxation Methods Applied to Engineering Problems, Part II. Basic Theory, with Applications to Surveying and to Electrical Networks, and an Extension to Gyrostatic System. A. N. Black and R. V. Southwell; Roy. Soc., Proc. 164A. pp. 447-467. Feb. 18, 1938—The aim of the present paper is four-fold, viz., (1) to prove that relaxation methods, applied systematically to problems of elastic equilibrium, give solutions which converge steadily towards exact results; and hence, by analogy, (2) to show that they are applicable to any "minimal" problem, e. g., the adjustment of errors according to the method of least squares; (3) to notice, as particular examples, the adjustment of errors in level or triangulation surveys, and the partition of electric current in non-inductive networks of conductors; and (4) to discuss the more difficult problem of an inductive network carrying alternating current. This serves as a simple illustration of systems which are governed by equations containing "gyrostatic" or "non-energetic" terms, and which for that reason do not present minimal problems of the usual kind.

Hydrodynamic Analogy for Shearing Stress Distribution in Bending. M. A. Biot; J. of Applied Physics, 9. pp. 39-43, Jan. 1938—It is shown here that the shearing stress distribution in the combined shear and bending is represented with practical accuracy by the distribution of velocity in the flow of a perfect fluid over the area of the cross-section. This flow is produced by a linear distribution of sources above the neutral axis and of sinks below the neutral axis, the intensity of these sources and sinks being proportional to the distance to the neutral axis. For hollow beams the additional condition must be added that the circulation of the velocities is zero around each hole of the cross-section. The analogy which is rigorous for a material of zero Poisson ratio, holds within a small correction for the general case.

Surface tension and viscosity phenomena in tin-plate manufacture. Bruce Chalmers; Trans. Faraday Soc. **33,** 1167-76 (1937)—Applications of surface tension and viscosity theory are mathematically evaluated and discussed with respect to: the appearance of normal pores in terms of stability of the catenoid film, the appearance of potential pores and grease lines in terms of the stability of one liquid film on another, the rate of draining of liquid Sn under gravity in terms of viscosity.

X-ray diffraction studies of distortion in metals. Geo. L. Clark and Merton M. Beckwith; Trans. Am. Soc. Metals **25,** 1207-24 (1937)—Specimens consisting of both single crystals and polycryst. aggregates of Al were subjected to deformation by measured tension in successive steps and X-ray diffraction patterns made for each state of specimen. For a single-crystal specimen the first change in Laue spots is a shadow appearing below the interference from the (111) planes. The successive changes in the diffraction interferences support the theory that the distortion in a single crystal is bending, followed by fragmentation, with subsequent preferred orientation of the crystal fragments. The series of patterns for polycryst. Al show that the mechanism of distortion is the same for an aggregate of small crystals as for a single crystal.

Frequencies and Nodal Systems of Circular Plates
R. C. Colwell and H. C. Hardy; Phil. Mag. 24, pp. 1041-1055, Dec., 1937.—Values of the numerical constant in the frequency formula are given for up to 10 nodal diameters and 6 nodal circles, for a circular plate with a free edge. The radii of the nodal circles were also calculated, and compared with experiment.

Plastic properties of high-chromium and of chromium-manganese-silicon steels. N. M. Danil'chenko; Teoriya i Prakt. Met No. **10,** 60-70 (1937)).—Discussion of the cold deformation and of subsequent heat treatment upon the plastic properties of steels.

Slip bands on mercury single crystals. K. M. Greenland; Proc. Roy. Soc. (London) **A163,** 28-34 (1937).—Slip bands on single-crystal wires of Hg at -60° were detd. Stretching a wire, previously unstrained, shows slip band approx. elliptical, wavy and branched near the ends of the major axes. If the band is slightly bent, plane bands which multiply in no. with extension are produced. Torsional strain produces close elliptical band; when followed by stretching, imperfectly elliptical bands appear. Bands formed by pure tension indicate surface gliding on the surfaces made up of glide elements having a common glide direction. The crystal surface behaves as an elastic skin with no break at the slip bands.

A continuous hardness test: Periodic hardness fluctuations. Edward G. Herbert; Metallurgia **16,** 184-6 (1937).—In a continuous hardness-testing machine designed by H. a loaded ball free to rotate is run over the specimen. With the aid of an optical lever hardness is recorded as a function of time. Tests on an Al alloy undergoing age hardening showed that periodic fluctuations were super-imposed on the general increase in hardness. In another machine used for hardened steels a diamond with a hemispherical tip was loaded and run over the specimen. Hardness at different times was detd. by measuring the width of the groove with a microscope. Periodic fluctuations were found in hardened steels.

E. J. Janitsky; Trans. Am. Soc. Metals 25, 1149-65 (1937).—A math. development of a formula for the conversion of the elongation percentage obtained on a tensile specimen of any practical diam. and guage length to the percentage which would be obtained on a specimen of standard dimensions.

The problem of the temperature coefficient of tensile creep rate. J. J. Kanter; Am. Inst. Mining Met. Engrs., Inst. Metals Div., Tech. Pub. No. **863,** 20 pp. (1937).—Creep investigators have made extensive studies to det. the interrelation of stress, temp. and the tensile creep rates of metals. It has been suggested that at small stresses the secondary or const. creep rates obey a simple viscous law. Based upon this suggestion, departure from pure viscosity as stress increases may be expressed mathematically as a consequence of reversibly altered viscosity or "flowability" in the same sense that temp. change reversibly alters viscosity.

Deflection of Thin Rectangular Plates Clamped at the Edges and Uniformly Loaded. B. C. Laws; Phil. Mag., 24, pp. 1072-1082, Dec. 1937.—Mainly on account of the consequence of the stretching of the deflected plate, it is expected that theory will give a maximum deflection in excess of the experimental value.

Mechanical properties of some tin bronzes. H. Lepp; Intern. Tin Research Development Council, Tech. Pub. D, No. **3,** 11 pp. (1937). —Changes in tin content influence tensile strength, elastic limit and elongation. As tin content is increased, cold working results in increased hardness and tensile strength.

Electrical Analogy as an Auxiliary Method of Photo elasticity. L. Malavard; Comptes Rendus, 206. pp. 38-39, Jan. 4, 1938.—The possibility, and some indication of the nature, of an electrical method, dependent on determination of equipotential lines under definite conditions, of determinig the sum of the two principal stresses in a plane elastic problem (the difference between these stresses being detremined photoelastically) is discussed.

Fluid Motion Devoid of Acceleration. E. Merlin; Comptes Rendus, 205. pp. 1128-1130, Dec. 6, 1937.—The motion of fluid, each particle of which retains its respective initial density and moves with constant velocity, both in magnitude and direction, is discussed. The motion of the fluid is derived by establishing a correspondence between points on an indicatrix surface, I, of constant velocity and lines on a congruence, G. of plane lines which move as though they were rigid.

Report of the research committee on fatigue of metals. Nomenclature for various ranges in stress in fatigue. H. F. Moore, et al. Proc. Am. Soc. Testing Materials **37,** Pt. I, 157-63 (1937).

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Experiments on the temporal progress of tension, elongation and elongating velocity in the tensile test, in particular at the elastic limit. A. Pomp and A. Krisch. Mitt. Kaiser-Wilhelm Inst. Eisenforsch. Dusseldorf, **19,** 187-98 (1937).— The object of the expts. was to check the shape of the tensile test curve at the elastic limit to ultimate strength by loading the sample by weights directly instead of in a machine.

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