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Engineering Precautions (Air Raid) Committee. Effect of Blast. (Engineer, Vol. 147, No. 4332, 20/1/39, pp. 107-8.) (64/1 Great Britain.)

(1) Blast is a non-translational shock wave that is transmitted through the air to considerable distances from an exploding bomb. (2) Blast must be distinguished from the direct effect of the expanding gases, which involve pressures of much higher intensity and of different character, but effective only at short distances from the bomb. (3) A zone of expansion probably extends to a distance of about 25ft. for a charge which may be taken as representing a 500lb. bomb, and to a distance of about 65ft. for a charge of 1 ton of high explosive, representing a 3,000lb. bomb. (4) In the blast wave a phase of positive pressure is followed by a phase of negative pressure; the combined duration of the phases may range from about a hundredth of a second to a fifth of a second, according to the weight of the bomb. (5) The mean pressure in each phase of the blast wave is approximately in direct proportion to the reciprocal of the distance. (6) For targets of comparable static strength, those of higher frequency will in general be more easily ruptured by blast than those of lower frequency. (7) Of possible targets, windows may be subject to an equivalent static pressure of the same order as the momentary maximum intensity of blast, whilst walls and buildings may be subject to similar equivalent pressures if exposed to very heavy bombs.

Investigations on the following points bearing on the problem of blast are now in progress:—(*a*) The determination of the equivalent static pressure of the blast for different classes of targets. (*b*) Protective devices applicable to windows and glazing. (*c*) The magnitude of the pressure developed inside a shelter due to an external explosion.

Materials in Relation to A.R.P. (A. R. Astbury, Chem. and Ind., Vol. 58, No. 3, 21/1/39, pp. 41-5.) (64/2 Great Britain.)

(*a*) Reinforced concrete structures and steel-framed buildings, with fire-resisting roofs, floors, and walls, offer greater resistance to collapse and damage than other forms of structure. Buildings with load-bearing walls of brick or stone are liable to complete collapse. Buildings which are not fire resisting are liable to wholesale destruction. (*b*) Prolonged exposure to fire softens and disintegrates concrete whether used in reinforced concrete or as protection to steel framing. (*c*) The near effect of blast is to strip the concrete from the reinforcement which is left behind more or less intact. This effect may be also the result of overstressing of members due to falling debris. (*d*) Failure in reinforced concrete structures is likely to occur at the junctions between columns and beams, columns and footings, floor slabs, and supporting beams. (*e*) Cornices and heavy ornamental stonework are a serious danger to personnel in the streets. (*f*) Floors are often pierced by steel beams falling endways. (*g*) The value of strutting ceilings over refuges has not been fully demonstrated owing to the lack of materials for providing such support. (*h*) When casement mindows are open the glazing seems to suffer little from blast, but closed windows are damaged for about 150 to 200 yards from the explosion.

Development and Experimental Testing of Self-Contained Mathematical Expressions for Quantities in Internal Ballistics, Especially Those for Maximum Gas Pressure and Muzzle Velocity. (H. Langweiler, Z.G.S.S., Vol. 33, No. 10, 11, and 12, 1938, pp. 273-6, 305-9, 338-342.) (64/3 Germany.)

The author considers the problem of most favourable gun design for a given projectile (calibre and weight) and muzzle velocity.

Mathematical expressions for the following quantities are obtained:—

(*a*) Quantity of charge burnt when max. gas pressure is reached.
(*b*) Value of max. pressure.
(*c*) Gas pressure at end of combustion.
(*d*) Muzzle pressure.
(*e*) Distance moved by projectile when max. gas pressure is reached.
(*f*) Distance moved by projectile to the end of combustion.
(*g*) Velocity of projectile when max. gas pressure is reached.
(*h*) Velocity of projectile at end of combustion.
(*i*) Muzzle velocity of projectile.
(*k*) Time of combustion.
(*l*) Time for projectile to leave barrel.
(*m*) Efficiency.

The author shows how explosive constants obtained from pressure measurements on a certain gun can be applied to guns of different dimensions. The calibre range covered extends from the infantry rifle to about 6in.

Approximate Formulæ for the Ballistics of Oscillating Bombs. (H. Knobloch, Z.G.S.S., Vol. 33, No. 12, Dec., 1938, pp. 346-8.) (64/4 Germany.)

Formulæ and tables at present available for practical bomb ballistics are based on the assumption that the longitudinal axis of the bomb lies along the tangent to its path during fall, *i.e.*, that the c value for the bomb remains practically constant. This assumption is only fulfilled when the bombs are suspended horizontally in the aeroplane. With vertically suspended bombs, whose longitudinal axes lie at right angles to the tangent to the path of fall at the moment of release, oscillations occur, which are damped out after a few seconds. During this short time the c value varies from an initial high value to the smaller normal value corresponding to axial air flow.

Formulæ of the ballistics of oscillating bombs are deduced by dividing up this period of oscillation (not exceeding 5 secs.) into time intervals and considering the appropriate value of c for each interval. Constants occurring in the fundamental equations obtained can be determined experimentally in the manner described previously for horizontally suspended bombs (Knobloch, Beitrage gur Ballistik v. Techn. Phys., Leipzig, 1938) and the problem solved graphically. Of interest is the change ΔX in horizontal range X for a one degree change of incidence of the bomb for various values of the original incidence at release α.

For an aircraft flying at 4,000 m. at a speed of 100 m./sec. the author gives the following values:—

α (initial incidence of bomb).	ΔX.
90° (vertical release)	46 m.
60° (oblique release)	70 m.
0° (horizontal release)	16 m.

The Rôle of the Independent (Shore-Based) Air Force in Naval Warfare. (W. Gladisch, Marine Rundschau, Vol. 43, No. 12, Dec., 1938, pp. 887-897.) (64/5 Germany.)

According to the author, the independent air force by attacking all naval bases within reach will force the enemy fleet to seek shelter at a considerable distance. The resultant grouping of the fleet can be checked by long range reconnaissance flights and will be of the greatest strategical importance in the development of subsequent naval actions.

These duties are quite distinct from those of naval aircraft, which are nowadays recognised as an essential adjunct of every fleet, either in an offensive capacity (torpedo and bomb attack against surface vessels) or for short range reconnaissance.

Shore-based aircraft can also be used under certain circumstances to attack convoys or isolated merchant ships. Such duties, however, require very special training.

In conclusion the author urges the closest co-operation between the sea and air forces. The admirals and naval chiefs of staff especially should be fully conversant with general strategical and tactical air problems and not be satisfied with a slight acquaintance of the specialised problem of naval aircraft.

There is always a tendency to overrate the difficulties connected with new weapons.

What is wanted is a clear realisation of their possibilities. A surprise by new methods of attack always carries with it the element of success.

On the Transition from Laminar to Turbulent Flow in the Boundary Layer of a Sphere. (S. Tomotika and I. Imai, Aer. Res. Inst. Report, No. 167, August, 1938.) (64/6 Japan.)

The momentum integral equation for the boundary layer on the surface of a body of revolution is applied to the case of the boundary layer of a sphere placed in a uniform stream. The flow in the boundary layer is assumed to be laminar and also the quartic form is assumed for the velocity distribution in the layer. For the velocity distribution just outside the boundary layer, use is made of each of three actual distributions which have been obtained from distributions of normal pressure measured by Fage, at Reynolds numbers just within, near the middle of, and above, the critical range respectively, over which the drag coefficient of the sphere experiences a large fall.

The differential equation for determining the thickness of the laminar boundary layer is solved, in each case, by the method of graphical integration and thus various characteristic quantities for the layer are calculated.

The results indicate that the flow in the boundary layer is everywhere laminar up to the point of separation, in accordance with the result of Fage's observation.

When the Reynolds number of the stream lies near the middle of the critical range, the departure of the observed values of the intensity of skin friction from the calculated distribution of the intensity of laminar skin friction occurs at a point near the observed point of minimum normal pressure.

The deviations of the experimental points from the calculated distribution curve of the intensity of laminar skin friction become more conspicuous when the Reynolds number of the stream is above the critical range. It is then found that the transition from laminar to turbulent flow begins in front of the point of minimum pressure.

On the Stability of Vortex Sheets. (G. Petrov, Trans. C.A.H.I. (Moscow), No. 304, 1937.) (64/7 U.S.S.R.)

The paper discusses the stability of vortex sheets both infinitely thin and of a finite thickness in a perfect uniform fluid.

The bulk of the work is confined to the determination of the distance between isolated vortices formed during the disintegration of unstable vortex sheets.

The results obtained by Rayleigh on the stability of rectilinear sheets (the two-dimensional problem) are supplemented by a detailed analysis of the case of two parallel vortex sheets. It is shown that in this case unsymmetrical oscillations are dominating (*i.e.*, the process of development of unsymmetrical oscillations goes faster than that of symmetrical ones), which contributes to the fact that behind a bluff body an unsymmetrical vortex row is formed.

A study of propagation of small oscillations in a circular jet of a uniform incompressible fluid bound by an infinitely thin vortex sheet was accomplished. The analysis has shown the instability of such a flow for any disturbances.

The stability of "zonal" oscillations of a circular jet bound by a sheet of finite thickness is investigated.

In conclusion, several considerations are given concerning the possibility of applying the results of investigation to the determination of the structure of the wake.

Turbulent Boundary Layer of an Aerofoil. Part II. On the Resistance Law. (K. Fediaevsky, Trans. C.A.H.I. (Moscow), No. 316, 1937.) (64/8 U.S.S.R.)

The present investigation represents a continuation of the work described in Report No. 282 of the Joukovsky Central Institute of Aerohydrodynamics.

A new form of the power law of resistance is developed allowing the expression of the numerical coefficient in the resistance law for any exponent in terms of the critical Reynolds number of the laminar sublayer.

The polynomial interpolation of the square root of the value of the frictional stresses in a turbulent boundary layer leads to much simpler laws for the velocity distribution as compared with those given in the first part of this work. Assuming the Prandtl mixing path to be proportional to the distance from the wall, formulæ for the velocity distribution are obtained which in a particular case (without a pressure gradient and inertia forces) assume the Prandtl-Nikuradse form.

The use of this law of velocity distribution leads to a very simple law of friction resistance which represents the generalisation of the Kármán logarithmic law of resistance for the case of a two-dimensional boundary layer with a positive pressure gradient.

The new law also explains the results of Fage and Faulkner (Symmetrical Joukovsky profile) and of Doensch and Nikuradse (flat diffusors) in a more satisfactory manner than the logarithmic resistance law.

Turbulent Friction in the Boundary Layer of a Flat Plate in a Two-Dimensional Flow of Compressible Gas at High Speeds. (F. Frankl and V. Voishel, Trans. C.A.H.I. (Moscow), No. 321, 1937.) (64/9 U.S.S.R.)

The present article is confined to the investigation of the compressibility effect and heating of a flate plate placed in a two-dimensional flow of compressible gas on the turbulent friction coefficient in a boundary layer of an aerofoil and a wing radiator. The analysis is based on the Prandtl-Kármán theory of a turbulent boundary layer and the Stodola-Crocco theorem of a linear dependence between the total energy of the flow and its velocity.*† Formulæ are obtained for the velocity distribution and the friction law in a turbulent boundary layer taking into account the compressibility effect and the heat transfer.

It is found that with increase of the compressibility and adiabatic temperature corresponding to fully retarded flow, the friction coefficient c_f decreases.

* L. Crocco. "Sulla trasmissione del calore da una lamina piana a un fluido scorrente ad alta velocita." L'Aerotecnica.

† A. Stodola. "Zur Theorie des Wärmeübergangses von Flüssigkeiten oder Gasen an feste Wände." Schweiz. Bauzeitung, Bd. 88, No. 18, 1926.

The Consideration of the Viscosity Effect in the Kármán Turbulence Theory. (G. Gurjienko, Trans. C.A.H.I. (Moscow), No. 322, 1937.) (64/10 U.S.S.R.)

The purpose of the present work was to integrate the equations of a turbulent flow in a pipe according to the Kármán theory, taking into account the viscous friction effect.

The results indicate that the consideration of the viscous friction effect has but a slight effect on the velocity distribution even at low Reynolds numbers.

Thus the consideration of the viscous friction does not eliminate the principal defect of the classical theory of turbulence developed by Kármán, *i.e.*, the 25-30 per cent. discrepancy in the values of the so-called "universal constant of turbulence" for the resistance law and velocity distribution.

In our previous work on the Mattioli Turbulence Theory (G. Gurjienko, "Viscosity Effect on the Turbulent Flow in a Rectilinear Cylindrical Pipe with Smooth Walls," Trans. of Aerohydrodyn. Inst., No. 303, Moscow, 1936) in which the viscous friction was also considered, it was shown that the Mattioli theory is free from the above mentioned defect, *i.e.*, the value of the universal constant of turbulence in this theory is the same both for the resistance law and the velocity distribution law.

The superiority of the Mattioli theory over the Kármán theory is thus not due to the consideration of the viscous friction effect, but to the fact that the Mattioli theory is apparently based on a more perfect model of the turbulent exchange.

Effect of Profile Form on Frictional Resistance. Investigation of the Turbulent Boundary Layer in the Region of Breakaway. (L. E. Kalikman, Trans. C.A.H.I. (Moscow), No. 333, 1937, 79 pp.) (64/11 U.S.S.R.)

A method is given for calculating friction drag and for determining the position of breakaway of the turbulent boundary layer from a wing profile. The theoretical distribution of intensity of friction over the surface of the wing, obtained by calculating the turbulent boundary layer by this method, is in good agreement with the experimental distribution.

The relationship between friction drag and the shape of a wing profile is investigated by carrying out the calculations for two series of profiles of different relative thicknesses. It is shown that:—

(*a*) At high Reynolds numbers the friction drag of wing profiles (of ordinary relative thicknesses) depends relatively little on the shape of the profile.

(*b*) Of all the geometrical parameters of a symmetrical profile, only the relative thickness has any considerable influence.

Formulæ are given for determining the coefficient of friction drag of a normal, smooth, symmetrical profile at high Reynolds numbers.

The method proposed by F. G. Glass for converting profile drag coefficients to higher Reynolds numbers is analysed from the point of view of the results obtained.

The point of breakaway of the turbulent boundary layer, determined from the condition that the friction stress becomes zero, can be found by extrapolation to any required degree of accuracy.

In conclusion, a full theoretical investigation is made of the turbulent boundary layer in the region of breakaway.

An Analytical Method for Solving the Problem of Flow Around a Curved Arc with Breakaway of the Jet. (Y. E. Sekerj-Zenkovich, Trans. Cents. Aero-Hydrodyn. Inst., Moscow, No. 354, 1938, 52 pp.) (64/12 U.S.S.R.)

This paper deals with the problem of the structure of a plane-parallel flow of ideal non-viscous fluid around a given curved arc, when the jet breaks away according to the well-known system of Helmholtz-Kirchhoff. The purpose of

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the investigation is to obtain an analytical method for solving the problem of oblique impact for the general case of an arc of any type.

Firstly, the fundamental equation of the problem is solved analytically and the first approximate solution is calculated. The method is then applied to an arc of given shape, and approximate formulæ are deduced for determining the length of arc and its drag.

The formulæ obtained are applied to investigation of direct impact on particular types of arcs—arc of a circle, parabolic arc, arc of a cycloid.

Some Applications of Conformal Representation to Hydrodynamics. (Lavrentie, V., Proc. Joukowsky Academy of Military Aeronautics, 1935, No. 13, pp. 18-27.) (64/13 U.S.S.R.)

New methods involving the theory of conformal representation based on Koebe's theorem, are applied to the solution of certain hydrodynamic problems.

The author shows that by means of certain supplementary conditions, a wing whose contour is a circular arc can give the maximum lift.

A number of mathematical considerations relating to the principle of variation in conformal representation are analysed.

Mathematical Problems in the Dynamics of Gases. (F. Frankl, Proc. Joukovsky Academy of Military Aeronautics, 1935, No. 13, pp. 28-32.) (64/14 U.S.S.R.)

This paper deals with certain important mathematical problems connected with integration of the fundamental differential equation; and involves partial differential coefficients of the hyperbolic type for velocities greater than the velocity of sound, and partial differential coefficients of the elliptical type for velocities less than that of sound. The results obtained by the author and by other workers in elaborating these methods are analysed.

Approximate Integration of the Equation for the Boundary Layer by the Methods Employed in the Theory of Heat Transfer. (Leybenson, Proc. Joukovsky Academy of Military Aeronautics, 1935, No. 13, pp. 38-52.) (64/15 U.S.S.R.)

The author studies methods for approximate integration of the equation of the boundary layer, based on analogy with the problem of heat transfer.

The results are applied to the solution of the problem of breakaway of small streams of air from an arbitrary body situated in a current. The problem is studied for the cases of a plane surface, a circular or elliptical cylinder and a surface of revolution.

The position of the point of breakaway is determined theoretically for the elliptical cylinder and the surface of revolution.

Flight Analysis of a Sounding Rocket with Special Reference to Propulsion by Successive Impulses. (H. S. Tsien and F. J. Malina, J. Aer. Sci., Vol. 6, No. 2, Dec., 1938, pp. 50-8.) (64/16 U.S.A.)

In Part I of this paper an exact solution of the problem of determining the height reached by a body in vertical flight in vacuo propelled by successive impulses is presented. On the basis of this analysis it is concluded that a rocket propelled by successive impulses—the impulses being obtained, for example, from rapidly burning powder—can theoretically reach much greater heights than is possible by sounding balloons and, therefore, further experimental research is justified. In Part II the effect of the variation of the acceleration of gravity with height above sea level on the flight performance of a sounding rocket is analysed. For a 1,000-mile sounding rocket the decrease in gravitational pull accounts for a 25 per cent. increase in the maximum height reached over that calculated on the basis of a constant gravitational acceleration. In Part III the fundamental performance equation for flight of a sounding rocket in air is expressed in terms of dimensionless parameters and factors and their physical significance is discussed. Finally, in Part IV the theory of the preceding sections is applied to a specific case of a sounding rocket propelled by successive impulses which are supplied by a reloading type of powder rocket motor.

The Wave Resistance of a Ship's Propeller and Interaction with Wake and Waves Produced by the Ship. (J. E. Dickmann, Ing.-Arch., Vol. 9, No. 6, Dec., 1938, pp. 452-486.) (64/17 Germany.)

The velocity potential and the equivalent sink distribution for the inflow of an ideal propeller are calculated with the help of the fundamental hydrodynamic equations. The interaction between ship and propeller is then studied in detail, special consideration being given to the following aspects of the problem:—

(1) Increase of ship's resistance on account of the reduced pressure field in front of the propeller.

(2) Loss of energy due to the propeller producing surface waves.

(3) Interaction with the waves produced by the ship.

The following conclusions are reached:—

(1) In the case of normal cargo boats, the increase in the ship's resistance above that corresponding to towing may amount to 20 per cent.

(2) The energy loss due to surface waves generated by the propeller is generally small.

(3) The interaction of these propeller waves with the waves due to the ship proper may, however, produce very important results.

Whenever possible the propeller should be situated below a wave crest.

The Blade Design of Centrifugal Impellers. (A. Betz and I. Flugge-Lotz, Ing.-Arch., Vol. 9, No. 6, Dec., 1938, pp. 486-501.) (64/18 Germany.)

The author shows how to calculate the shape of the blade for a given distribution of the circulation along the radius both for the case of constant and decreasing blade width. The results show that a decrease in the blade width mainly affects the mean radial flow through the impeller. The new method proposed by the author fills the gap between the two well known limiting cases: Infinite number of blades (solved by the Eulerian method) and widely spaced blades (solved by the method of conformal representation).

So far only the optimum theoretical working condition has been investigated (no shock loss at entry).

In a subsequent paper the author will demonstrate how the wing theory can be applied to estimate the losses occurring when the flow departs from this condition.

On a Limiting Case of the Dimensional Unsteady Flow Round a Wing. (V. Borbely, Z.A.M.M., Vol. 18, No. 6, Dec., 1938, pp. 319-342.) (64/19 Germany.)

The case of two-dimensional flow round an oscillating wing has already been solved. The author considers first the case of a finite supporting line with an elliptical vortex distribution. The results are next extended to cover the case of a finite oscillating wing of relatively small chord and possessing elliptical vortex distribution. Approximate expressions for the flow in the neighbourhood of the wing and for the angle of attack are obtained.

On the Theory of Vortex Motion. (A. Kneschke, Z.A.M.M., Vol. 18, No. 6, Dec., 1938, pp. 343-376.) (64/20 Germany.)

The author considers the motion of isolated vortices in any simply connected two-dimensional region. A relation is obtained between the kinetic energy and the "orbit function" of Kirchhoff, and a conformal transformation function for the energy is given.

The equation of motion of the vortex can also be deduced directly by applying the method of variation to the energy function of the vortex system.

On the Measurement of Longitudinal and Lateral Velocity Variations in Turbulent Flow. (H. Reichardt, Z.A.M.M., Vol. 18, No. 6, Dec., 1938, pp. 358-361. Göttingen Mathematical Congress.) (64/21 Germany.)

The author is specially concerned with non-isotropic turbulence, in which both lateral and longitudinal velocity variations occur.

The velocity measurements are usually carried out with hot wire instruments and the author describes a three-wire unit, the parallel wires being placed at the corners of an equilateral triangle, one corner facing the mean flow direction. The distance between the wires is very small (of the order of 0.1 mm.) the wires themselves being 0.01 mm. diameter. The three-wire instrument utilises the velocity and temperature gradients in the wake of the leading wire and is especially suited for low mean air speeds (below 100 cm./sec.).

Practical results obtained in a small wind tunnel under these conditions are described.

Frequency Analysis of Turbulent Velocity Variations. (H. Motzfeld, Z.A.M.M., Vol. 18, No. 6, Dec., 1938, pp. 362-365. Göttingen Mathematical Congress.) (64/22 Germany.)

It is usual to record the velocity variations during turbulent flow by means of hot wire anemometers. By means of a suitable amplifying circuit, the final voltage at any instant is proportional to the velocity variation. Previous investigators have carried out a frequency analysis by applying the resultant voltage to an electrodynamometer preceded by a filter which only allows known frequencies to pass. In this way the turbulence spectrum is obtained by a step by step method.

The author has devised an alternative method in which the resultant amplified voltage is applied to a number (10) of tuned mechanical resonators (torsion pendulums). The spectrum is deduced from the response of these resonators. The results obtained are in good agreement with those given by the filter method.

The Calculation of Turbulent Separation of Flow. (F. Schultz-Grunow, Z.A.M.M., Vol. 18, No. 6, Dec., 1938, pp. 367. Göttingen Mathematical Congress.) (64/23 Germany.)

The motion in the two-dimensional boundary at a flat plate is of the form

$$u\partial u/\partial x + v\partial u/\partial y = U\delta U/\partial x + (1/\rho)(\partial\tau/\partial y)$$

where u and v are the velocities and x and y the co-ordinates respectively parallel and perpendicular to the well. U = velocity potential at outer edge of layer and τ = shear stress.

The author has analysed the experimental result of Gruschwitz on boundary layer flow and concludes that for

$$y/\delta \cong 0.15,\ v\partial u/\partial y \text{ is approximately equal to } (1/\rho)(\partial\tau/\partial y).$$

In other words, the equation of motion for a strip of this nature is given by

$$u\partial u/\partial x = U\partial U/\partial x$$

and at separation

$$U_2^2 = U_1^2 - u_1^2.$$

Wind Tunnel Measurements on Flat and Slightly Cambered Circular Plates. (M. Hansen, Z.A.M.M., Vol. 18, No. 6, Dec., 1938, pp. 368-370. Göttingen Mathematical Congress.) (64/24 Germany.)

The aerodynamics of the circular plate were investigated theoretically by Kinner some time ago (Ing.-Arch., Vol. 8, Part I, 1937). The present paper deals with experimental measurements on the same subject, the plates being 40 cm. in diameter.

Speaking generally, agreement between theory and experiments is only satisfactory in the region of small lift coefficients.

The reasons for the discrepancies are discussed.

Laws of Turbulent Flow in Open Channels. (G. H. Keulegan, Bur. Stan. J. Res., Vol. 21, No. 6, Dec., 1938, pp. 707-41.) (64/25 U.S.A.)

The theoretical investigations of Prandtl and Kármán, and the experimental work of Nikuradse, have led to rational formulas for velocity distribution and hydraulic resistance for turbulent flow in circular pipes. With certain assumptions regarding the effects of secondary currents and of the free surface, and with the adoption of the hydraulic radius as the characteristic, similar rational formulas are deduced for open channels. The validity and the applications of these formulas are illustrated by a study of Bazin's experiment. In this study, the equivalent sand roughness of the channels used by Bazin are determined. The criterion for determining the conditions under which a channel with wooden plank surfaces is to be considered hydrodynamically wavy or hydrodynamically rough is also evaluated. The rational formulas with constants determined from Bazin's experiments are expressed in the form of power laws. It is shown that Manning's empirical formula is a good approximation to the rational formula for rough channels when the relative roughness is large.

Cavitation Characteristics of Centrifugal Pumps by Similarity Considerations. (G. F. Wislicenus, R. M. Watson and I. J. Karassik, Trans. A.S.M.E., Vol. 61, No. 1 (Sect. 1), January, 1939, pp. 17-24.) (64/26 U.S.A.)

Similarity considerations of hydraulic pumps and turbines can be obtained by comparing the known hydraulic performance of a given machine with the performance of other machines having geometrically similar waterways. The paper describes the application of this theory to the cavitation performance of centrifugal pumps and related machinery, and also introduces a characteristic parameter which, concerning cavitation performance, has properties similar to the specific speed with respect to other performance characteristics of such machines.

Lateral Stability of Aeroplanes at Unsymmetrical Propeller Thrust. (G. Scherbakov and F. Mamonov, C.A.H.I. Report No. 318, Moscow, 1937.) (64/27 U.S.S.R.)

After discussing several existing formulæ for the calculation of lateral stability, the author develops his own system of equations and obtains approximate solutions for the particular case of unsymmetrical thrust.

The theoretical data obtained in this manner are compared with the results of flight experiments. Flight methods and apparatus used are described and some foreign flight tests on stability briefly reviewed.

It appears that under condition of unsymmetrical propeller thrust (*e.g.*, only one of the two lateral engines working), the optimum attitude of the machine from the point of view of control is a bank together with a sideslip towards the working engine.

The optimum attitude for high speed flight will be discussed in a subsequent paper.

Effect of the Shape of a Wing on the Load Distribution Along the Span and on the Longitudinal Stability. (A. B. Risberg, Trans. C.A.H.I., Moscow, No. 335, 1937, 80 pp.) (64/28 U.S.S.R.)

The results of this research were intended to provide some of the aerodynamic fundamentals for new strength specifications. The paper comprises a theoretical investigation of how the two most important design factors—load distribution and moment of longitudinal stability—depend on the main wing parameters. The investigation was based on a variation of Lotz's method. The modified method is employed to solve a few problems relating to trapezoidal wings, *i.e.*, determination of the main circulation round a plane wing and the additional circulations due to dihedral, deflection of ailerons and twist.

Calculations and graphs are given for the distribution of aerodynamic load on trapeze wings both with and without a rectangular centre section; these enable the effects of the various wing parameters to be studied.

A simple method is given for calculating the circulation for a wing of any shape, either plane or with any degree of dihedral, by means of numerical integration. Formulæ are deduced for determining the longitudinal stability of a wing of any shape from the curves for distribution of the relative loads.

Graphs are given to show the effects of spar, taper, dihedral angle, dimensions of the centre section and arrow formation of the wing, on the moment of longitudinal stability.

The Negative Thrust and Torque of Several Full-Scale Propellers and Their Application to Various Flight Problems. (E. P. Hartmann and D. Biermann, N.A.C.A. Report No. 641, 1938.) (64/29 U.S.A.)

Negative thrust and torque data for 2-, 3- and 4-blade metal propellers having Clark Y and R.A.F. 6 aerofoil sections were obtained from tests in the N.A.C.A. 20-foot tunnel. The propellers were mounted in front of a radial engine nacelle and the blade angle settings covered in the tests ranged from 15° to 90°. One propeller was also tested at blade angle settings of 0°, 5° and 10°.

A considerable portion of the report deals with the various applications of the negative thrust and torque to flight problems. A controllable propeller is shown to have a number of interesting, and perhaps valuable, uses within the negative thrust and torque range of operation. A small amount of engine friction data is included to facilitate the application of the propeller data.

The Aerodynamic Drag of Five Models of Side Floats. N.A.C.A. Models 51-E, 51-F, 51-G, 51-H, and 51-J. (R. O. House, N.A.C.A. Tech. Note No. 680, Dec., 1938.) (64/30 U.S.A.)

The drag of five models of side floats was measured in the N.A.C.A. 7 by 10-foot wind tunnel. The most promising method of reducing the drag of floats indicated by these tests is lowering the angle at which the floats are rigged. The addition of a step to a float does not always increase the drag in the flying range, floats with steps sometimes having lower drag than similar floats without steps.

Making the bow chine no higher than necessary might result in a reduction in air drag because of the lower angle of pitch of the chines. Since side floats are used primarily to obtain lateral stability when the seaplane is operating on the water at slow speeds or at rest, greater consideration can be given to factors affecting aerodynamic drag than is possible for other types of floats and hulls.

Proposed Method for the Design of Bottom Plating for Flying Boat Hulls and Seaplane Floats. (S. D. Berman, J. Aer. Sci., Vol. 6, No. 2, Dec., 1938, pp. 64-7.) (64/31 U.S.A.)

A lack of complete data for designing the bottom plating of flying boat hulls and floats prompted the author to investigate the subject of stresses in the plating due to the normal pressures incurred while taking off or landing. In this undertaking, use was made of an approximate method of determining the stresses in thin plates given by Timoshenko. Since the dimensional requirements for adequate strength obtained by the author's application of Timoshenko's method are in close agreement with successful practice, the resulting design information is presented herewith in the hope that the designer will find it useful.

N.P.L. Researches on the Stability of Aircraft. (Engineering, Vol. 146, 4/11/38, pp. 527-8. Eng. Absts., Vol. 1, No. 11, Section 3, Dec., 1938, p. 203.) (64/32 Great Britain.)

Mathematically it has been shown that a model suspended at the end of a long rod can show the lateral stability characteristics of free flight under certain conditions as to correlation of mass, aerodynamic lift, and degrees of freedom. This method gives much quicker results than the laborious measurement of derivatives hitherto used. In a certain aircraft the loss of rolling moment with a highly tapered (4.4) wing was traced to body-wing interaction when the latter were in the low position, loss of stability not being due to the high taper as was thought at first. Wing-tip design to reduce undesirable rolling near stalling incidence is proving a difficult subject, wind tunnel research being very susceptible to scale effect in this instance. Slots are an effective remedy against wind dropping, but a design is being attempted which does not include them.

The Dynamic Stability of a Helicopter Fitted with Hinged Rotor Blades. (K. Hohenemser, Ing.-Arch., Vol. 9, No. 6, Dec., 1938, pp. 419-428.) (64/33 Germany.)

The author investigates the case of dynamic stability of a helicopter under hovering conditions. In the case of hinged blades perfect stability can in general not be obtained. It is, however, possible by means of certain design features (mass of rotating blades, inclination of rotor tip plane, aerodynamic moment about longitudinal axis of rotor blade, etc.) to increase the periodic time of self-induced oscillation of the helicopter and reduce the effect of the disturbance so that the aircraft is approximately in indifferent equilibrium. In the case of hinged blades, the gyroscopic effects of two rotors become additive, even if they rotate in opposite direction. A rotation of the helicopter about its axis is thus accompanied by a linear damping which is of the greatest importance for stability and control.

The successful flights of the Focke helicopter FW. 61 have shown that controlled stability is possible for rotors fitted with hinged blades.

The Theory of Guide Vanes Applied to the Propeller. (A. Betz, Ing.-Arch., Vol. 9, No. 6, Dec., 1938, pp. 435-452.) (64/34 Germany.)

The amount of rotary energy which can be abstracted from the propeller slipstream and converted into thrust depends markedly on the number of guide vanes fitted. At the same time the vanes must project considerably beyond the edge of the propeller slipstream in order to produce the greatest theoretical effect. As soon as the friction of the vanes is, however, considered, it pays to have shorter vanes fitted to a relatively large hub placed behind the propeller. In order to save introducing an extra hub, the guide vanes are best attached to suitable portions of the engine gondola which would in any case be subjected to the slipstream.

A general Tank Test of a Model of the Hull of the P3M-1 Flying Boat, including a Special Working Chart for the Determination of Hull Performance. (J. R. Dawson, N.A.C.A. Tech. Note No. 881, December, 1938.) (64/35 U.S.A.)

The results of a general tank test of a one-sixth full-size model of the hull of the P3M-1 flying boat (N.A.C.A. model 18) are given in non-dimensional form.

In addition to the usual curves, the results are presented in a new form that makes it possible to apply them more conveniently than in the forms previously used.

The resistance was compared with that of N.A.C.A. models 11-C and 26 (Sikorsky S-40) and was found to be generally less than the resistance of either.

Characteristics of a Deflector Plate Flap. (R. C. Molloy, Autom. Ind., Vol. 80, No. 3, 21/1/39, pp. 87-8.) (64/36 U.S.A.)

One form of this device consists of a simple slotted flap with a curved plate fixed to its leading edge which, with the flap in the undeflected position, nests in the slot and does not protrude into the airstream. With the flap deflected, the deflector plate forms an extension of the slot for directing the air over the flap. A slot door on the under surface of the aerofoil, operated in conjunction with the flap by suitable mechanism, is preferably used to reduce drag at high speeds. A considerable improvement in the maximum lift coefficient is claimed for the deflector—external aerofoil type—over either the conventional external aerofoil or the slotted type with deflector plate.

North Atlantic Flights by German Lufthansa during 1938. (Canadian Aviation, Vol. 11, No. 12, December, 1938, p. 16.) (64/37 Germany.)

The 28 scheduled trans-Atlantic flights covered the period July 21st-October 19th. The 13 return flights, Horta (Azores) and New York were made with three Ha. 139 seaplanes, each equipped with four Junkers Jumo 205 Diesel engines of 600 h.p. each.

The two non-stop flights, Berlin-New York and return were made by a Focke-Wulf F.W. 200 Condor (land plane) fitted with four B.M.W. 132 L. petrol engines of 750 h.p. each.

The flights Horta-New York and return were carried out at approximately weekly intervals.

From the time table it appears that the interval between successive flights by the same machine was a week or less on 18 occasions and amounted to a fortnight on five occasions. The crossing times were generally consistent within 10 per cent., the average time taken for Horta-New York being 15.5 hours, whilst the average return journey took 14 hours. This works out at 154 and 170 m.p.h. respectively.

The corresponding speeds on the Berlin-New York and return flights were 158 and 199 m.p.h. respectively.

Flight Research on the Problem of Vapour Lock. (N. F. Scudder, J. Aer. Sci., Vol. 6, No. 2, Dec., 1938, pp. 68-71.) (64/38 U.S.A.)

From the results of this investigation it is apparent that the relatively large amount of gas contained in solution becomes separated when the absolute pressure on the fuel is diminished by climbing to a high altitude if agitation, such as that from a fuel pump and relief by-pass, is present.

At moderate temperatures (15°F. above standard altitude temperatures) the dissolved gases are made up in large proportion of the constituents of air.

The elimination of most of the fittings and valves needed in a twin-engine aeroplane and the use of a large fuel line with " easy " bends did not noticeably improve the performance of the system. In the summer, fuel coolers gave some improvement, but in the winter none whatever.

The operation of carburettors in which mixture strength is controlled by means of float bowl suction is violently upset by the quantity of gas liberated from aviation fuel during a fast climb.

If a conventional pump is used, a vapour separator is necessary for proper operation of the type carburettor used during these tests. For operation to 26,000ft. the separator installed in the carburettor feed line gives perfect operation, and it is probably simpler, lighter, and more dependable than any system

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in which a pump without a relief valve is used because of the complexity and cost of the equipment necessary with such a system.

Engine and Fuel—Their Mutual Effect on Development of the Power Plant. Review of Papers presented at the Augsburg Meeting, V.D.I. (G. Leunig, Z.V.D.I., Vol. 82, 3/12/1938, pp. 1401-1409.) (64/39 Germany.)

As appears from the following selection, the papers covered a wide range of subjects :—

(1) Testing of liquid fuels for spark ignition and compression ignition engines.
(2) The utilisation of high boiling fuels for Diesel engines.
(3) Gas generators.
(4) Means of increasing the power output of engines operating on gas fuel.
(5) The coal dust engine.
(6) Mixture formation in spark ignition and Diesel engines.
(7) Limitation in r.p.m. and m.e.p.
(8) Ignition lag and Diesel knock.
(9) Development of the two-stroke engine.
(10) Spark ignition engines using petrol injection.
(11) Light weight construction of large industrial Diesel engines.
(12) Motor car engines for continual high power output.

As regards item 10, (Petrol injections in spark ignition engines) the lecturer referred to experiments carried out at the D.V.L. since 1930. Injection takes place into the combustion space during the induction stroke, using a normal Diesel injection pump. A special fuel nozzle of the pintle type is used, giving a rotating jet of wide expansion. Position of fuel nozzle as well as timing of the injection are of importance. Increase in maximum power output up to 17 per cent. was realised (increase in volumetric efficiency). Alternately, using weak mixtures, the fuel consumption can be reduced 16 per cent. below the best carburettor setting. In the case of multi-cylinder engines, there is a marked improvement in slow running and pick up.

Petrol Injection for Spark Ignition Engines. (A. Labarthe, L'Aero., Vol. 31, No. 1601, 3/2/39, p. 7.) (64/40 France.)

The petrol injection can be carried out either into the induction pipe or into the cylinder. In the latter case the fuel may either be injected during the induction or during the compression stroke.

Early experiments in America were confined to injection in the induction pipe. This is relatively easy to realise and even in its simplest form shows certain important advantages over the carburettor. Injection into the engine cylinder is more difficult, but has been applied with success to the German Jumo 211 engine. In this engine injection is carried out during the induction stroke, the pump plunger being pressure lubricated in order to avoid seizure. A similar method of injection has been employed by the author on a Ricardo single cylinder engine using a standard Bosch injection pump and adding 5 per cent. lubricating oil to the fuel. (Recently a special pump has been designed which will handle pure petrol.)

These experiments were reported on in 1937 (see Abstract No. 64/41 below) and are now being continued, the injection taking place during the compression stroke. This timing is the most difficult to realise in practice. It has, however, a number of theoretical advantages (reduction of detonation tendency, possibility of weak mixture utilisation by stratification, cold air scavenging during the induction stroke) which, added to the inherent advantage of fuel injection (perfect distribution, etc.) render the scheme very attractive and worthy of the most careful consideration.

Petrol Injection for Spark Ignition Engines. (A. Labarthe and A. Ponomareff, Comp. Rend., Vol. 204, 3/5/37, pp. 1316-1318.) (64/41 France.)

It is well known that the mixture formation in compression ignition engines is a complicated process, the actual ignition starting in certain zones in the combustion chamber depending on the engine load.

In the case of spark ignition engines, matters are still further complicated by the fact that the combustion must always start at a fixed point: the sparking plug. It is thus essential that the proper mixture be at this exact locality at the instant the spark passes. There are two methods of ensuring this: Injection into the induction pipe and injection into the cylinder. The author utilised the latter method, injection being carried out either during the induction or during the compression stroke. The former method is favoured by the authors although the latter, if functioning properly, has the greater tendency to reduce detonation.

The experiment was carried out on a single cylinder unit developing 10 h.p. at 3,000 r.p.m. when fitted with a carburettor. The fuel injection produced an increase in h.p. over the whole speed range (1,500-3,000 r.p.m.) compared with the carburettor performance, the improvement varying between 12 and 17 per cent. At the same time a reduction in specific fuel consumption of the order of 7 per cent. could be realised under certain conditions. The great advantages of petrol injection are: Better distribution, better slow running and pick up, reduced fire and ice dangers.

Testing of Air-Cooled Aero Engines. (K. Madsen, E.T.Z., 2/2/39, pp. 121-5. Metropolitan Vickers Tech. News Bulletin No. 647, 10/2/39, p. 7.) (64/42 Germany.)

The author describes an installation for the testing of aero engines which employs two rigidly coupled three-phase asynchronous machines. The large six-pole machine has a rating of 1,200 brake h.p. at 1,050 r.p.m. and takes over the main load during braking; the smaller machine is a 12/6 pole, pole-changing type for starting and heating up the aero engine. By connecting the two machines together it is possible, in the six-pole connection, to raise the total output from 1,400 to 2,400 brake h.p. continuously between 1,050 and 1,750 r.p.m. The author also gives details of the cooling equipment, the control plant, protective apparatus, high speed braking system, and in conclusion discusses the economy of the measuring installation.

Illustrated with four diagrams and two photographs.

Research on the Mechanism of Knock. (A. Kochling, Z.V.D.I., Vol. 82, 24/9/38, pp. 1126-1134. Eng. Absts., Vol. 1, No. 10, Section 3, Nov., 1938, pp. 188-9.) (64/43 Germany.)

The mixture to be investigated was exploded electrically in the usual way in a cylindrical bomb 84 cm. long and 20 cm. in diameter after drying, pressure being measured by piezo-electric voltage generated in a quartz crystal, which was fed to an oscillograph via an amplifier, knock resonance being measured simultaneously, accuracy being 6-10 per cent. Curves are given for mixtures of (methane + air) and (propane + air) at 20°, (pentane + air) at 30°, (benzole + air) and (toluol + air) at 80°, for an initial pressure of 2.5 atm., showing the maximum amplitude of oscillation k_{max} plotted against the air ratio λ between 0.5 and 1.5. A certain correlation with the actual engine experience appears, provided that one compares not the peak value of k_{max}, but the values at $\lambda = 0.85$ customary in actual running. The unexpected conclusion is drawn that chemical constitution (and physical properties closely allied) appears to have little effect on detonation. Values of k_{max}, mean velocity of combustion $= v$, and maximum pressure attained π, are plotted for benzol $- O_2 - N_2$ mixtures of constant calorific value up to 50 per cent. O_2; the second and third quantities show smooth curves, but the maximum amplitude shows a marked narrow peak of 4.3 at a little below the O_2

content of the atmosphere. According to other investigators a knocking mixture burns smoothly when the N_2 is replaced by a noble gas; it appears that a definite rate of combustion is required for knocking oscillation. Of 30 different fuels investigated all had approximately the same velocity of combustion with the exception of H_2, C_2H_2, CS_2 and CO, which all show anomalous knocking properties.

The Use of Liquefied Ammonia as a Motor Fuel in France. (G. Benoist, Revue des Carburants Français, Vol. 1, No. 8-9, August-September, 1938, pp. 349-354.) (64/44 France.)

Liquefied ammonia is obtained synthetically from atmospheric nitrogen and hydrogen. The latter is extracted from coken oven or water gas or produced electrolytically. Electrolysis is favoured by the author in view of the excess hydro-electric power available in France. Roughly speaking, 1.2 kg. of liquefied ammonia are equivalent to 1 litre of petrol. Assuming an energy consumption of 13 kilowatt hours per kg. of ammonia, the equivalent of 250,000 tons of petrol should become available without extending present plants. When used in the engine the ammonia gas is first passed over a catalysor which decomposes about 5 per cent. of the gas into H_2. This acts as a primer in the subsequent combustion.

It is stated that the power output is practically the same as that obtained with petrol, the weight of the container being about 0.6 kg. per h.p. hour.

Carburettor Icing. (R. Sanders, J.S.A.E., Vol. 44, No. 1, Jan., 1939, p. 14.) (64/45 U.S.A.)

Heating the carburettor intake promotes detonation and this, together with the resultant reduction in volumetric efficiency, may lead to a serious drop in power.

The amount of heat required under icing conditions may be reduced by adopting the following precautions:—

(1) Use as weak a mixture as possible.
(2) Maintain full cruising power.
(3) Maintain as high a cruising altitude as possible.

Improvements in Diesel Engine Lubricating Oils. (U. B. Bray, C. C. Moore and D. R. Merrill, J.S.A.E., Vol. 44, No. 1, Jan., 1939, pp. 35-42.) (64/46 U.S.A.)

Improvements in design and performance of Diesel engines, together with a more widespread usage of the smaller-sized higher speed Diesel engines, have emphasised the inadequacy of ordinary straight mineral oils for this type of service. Marked progress has been made in overcoming the deficiencies of straight mineral oils through the use of soap type addition agents. Several brands of this general type of compounded oils are now available to Diesel engine operators. The properties exhibited by the soap compounded oils include:—(1) Detergency, which aids in preventing ring sticking; (2) high film strength, which reduces the danger of scuffing, scratching, or galling under adverse or severe conditions; (3) high degree of oiliness, which reduces wear under normal operating conditions; (4) low carbon-forming tendency; and (5) adequate crank-case stability, which promotes cleanliness of the engine and continuance of efficient lubrication.

Torque Measurements in Flight. (J. Salez, Pub. Sci. et Tech. du Ministere de l'Air, B.S.T., No. 82.) (64-47 France.)

The torque-meter consists of a Farman reduction gear in which the front (propeller) crown wheel instead of being clamped to the casing is able to undergo a small rotation. This rotation is prevented by the action of four plungers under oil pressure. The pressure required to " float " this gear wheel is thus a measure of the torque transmitted. After calibration on the ground (which revealed an accuracy of the order of ±1 per cent.) the flight experiments were carried out on Potez 541 fitted with two Gnome-Rhone 14 K drs engines (800 h.p. each at 4,000 m.). During these tests the induction pressure was kept constant at 735 mm. up to 4,350 m. (full throttle). Above this altitude, the induction pressure gradually decreased to 650 mm. at 5,300 m. (maximum altitude of tests); the full throttle h.p. as measured with the torque meter was compared with the value calculated from the equation

$$W_a/W_o=[1+0.00035\ (760-H_a)]\ (515/500)+t_a$$

when

W_a = h.p. at altitude.
W_o = h.p. on ground.
H_a = atmospheric pressure at altitude (mm. of *Hg*).
t_a = temperature at altitude °C.

Agreement was satisfactory up to 3,600 m. Beyond this altitude, the actual h.p. was appreciably greater, the supercharged height being 4,350 m. instead of 3,600 m. as estimated from throttling tests on the ground. The author attributes the difference to the compression ratio of the blower increasing with altitude (due to reduction in intake temperature) and to the ramming effect due to the speed of the aircraft.

An Instrument for the Measurement of Anomalous Viscosity. (C. F. Goodeve, J. Sci. Inst., Vol. 16, No. 1, January, 1939, pp. 19-27.) (64/48 Great Britain.)

A new form of viscometer is described in which the fluid is placed in a rotating container with a conical inner surface. A viscous drag is imparted to a coaxially suspended or pivoted inner cone, and the torque produced measured by means of a torsion wire or spring. The rate of shear is altered by a movement of one of the cones relative to the other along the axis, thus altering the separation between the moving surfaces. The instrument is especially designed for the measurement of anomalous viscosities. Very high rates of shear may be obtained without the occurrence of turbulent flow.

New Methods of Measuring Liquids. (Th. Schiel, Siemens Zeitschrift, Dec., 1938, pp. 506-15. Metropolitan Vickers Tech. News Bulletin No. 643, 13/1/39, p. 10.) (64/49 Germany.)

Apparatus for liquid measurement can be classified under two main types, viz., volume meters for continuous metering in units of volume (drum, piston and turbine meters) and through flow meters which indicate the through flow in units of volume per unit of time (pressure difference and float meters). The author describes these various types. Illustrated with 11 photographs and 10 diagrams.

Creep Rates and Recovery at High Temperatures. (H. Zschokke, Brown Boveri Review, Dec., 1938, pp. 247-61. Metropolitan Vickers Tech. News Bulletin, No. 645, 27/1/39, p. 1.) (64/50 Switzerland.)

The author discusses the influence of alloying, heat treatment and deformation on the creep limit and the extent to which the evaluation of the results depends on the method employed, showing the unreliability of extrapolation of results over a very long period. He shows the influence on the resultant creep elongation of the recovery of the steel when service is intermittent, by means of creep tests with interspersed periods of relief under both constant maintained temperature and falling temperature. He explains the recovery by consideration of the mechanism of deformation of the grain boundaries and crystals.

Illustrated with 15 diagrams and three tables.

The Working of Wrought Copper and Brass. (Machinist, 21/1/39, pp. 1101-2. Metropolitan Vickers Tech. News Bulletin No. 645, 27/1/39, p. 9.) (64/51 U.S.A.)

In this general review of modern practice in the working of copper and brass, the different forms of the materials and their mechanical properties are first discussed. The working of the metals is next reviewed, the article giving the approved methods of all processes such as hot and cold working, annealing, machining, drilling, reaming, tapping, grinding, cleaning, soldering and welding. Information as to the typical applications and physical characteristics of the various forms of the materials is also given in tabular form. Illustrated with six diagrams and seven tables.

The Effective Width of Curved Sheet After Buckling. (W. A. Wenzek, L.F.F., Vol. 15, No. 7, 6/7/38, pp. 340-4. Available as Translation T.M. 880.) (64/52 Germany.)

In stiffened shells under compression the carrying capacity of the buckled sheet between stiffeners can be accounted for by the introduction of an "effective width." The sheet is replaced by two assumedly buckling resistant sheet strips of such width $2\ b_R$, that their carrying capacity under a stress equivalent to the shortening at the sheet edge is the same as that of the buckled sheet panel. For sheets rigidly built in at the side this stress is equal to the edge stress of the sheet.

$$p_R \cdot 2\ b_R = p_m \cdot t$$

where t = width of sheet and p_m = mean stress.

The present report contains a description of experiments made for the purpose of ascertaining the effective width of circularly curved sheet under pure flexural stress.

A relation for the effective width of curved sheets is established. Comparisons with similar tests made by the D.V.L. show good agreement.

Application and Testing of Transparent Plastics Used in Aircraft Construction. (K. Riechers and J. Olms, Luftwissen, Vol. 5, No. 6, June, 1938, pp. 197-202. Available as Translation T.M. 881.) (64/53 Germany.)

The article deals with the mechanical and physical properties of four representative transparent plastic resins: Cellulose nitrate, cellulose acetate, polymer mixtures and polyacrylic esters.

After a short description of the method of manufacture, the standard D.V.L. tests on safety glass and transparent plastics are described.

These cover the following points:—

1. Optical tests.
2. Falling ball test.
3. Weathering.
4. Bending stress.

One of the difficulties of installing transparent plastic sheets in aircraft is the large coefficient of thermal expansion of the materials. A plastic sheet 1 m. long will thus shrink 5 mm. for a drop in temperature of 40°C., a similar length of aluminium only contracting 1 mm. The mounting adopted must therefore be capable of allowing a slip of this order.

Modern Manufacturing Equipment of the Ernst Heinkel Aeroplane Works. (A. Thormann and H. Jockisch, L.F.F., Vol. 15, Nos. 1 and 2, January, 1938, pp. 83-90. Available as Translation T.M. 882.) (64/54 Germany.)

This report contains a description of new methods of fabrication, new equipment, and special tools, with a view to supplying data for design from economical points of view, as well as to stimulate the interest of other factories in improved shop methods.

The following aspects of the problem are considered:—

1. Method and tools for changing the sectional shape of light alloy and steel tubes.
2. Skin riveting.
3. Automatic strip insertion for drawing sheet sections.
4. Panel beating tool (silent).
5. Beam strap milling machine.
6. Drilling and countersinking tools for mounting standard parts.
7. Tools for creasing thin sheet.

On the Luders-Hartman Lines of Slip at the Yield Point. (E. Reuss, Z.A.M.M., Vol. 18, No. 6, Dec., 1938, pp. 347-357.) (64/55 Germany.)

The author considers the formation of slip surfaces in an elastic body at the yield point. These lines of slip can be rendered visible by etching the surface and are known as Luders-Hartman lines.

As a typical example, the case of an elastic cylinder is investigated and it is shown that regions of plastic flow must exist, which by Castigliano's principle, are portions of planes parallel to the axis of the cylinder. The stress distribution of the material and especially the discontinuity at the slip surface may be calculated by means of a logarithmic potential.

Relaxation Methods Applied to Problems Relating to Elastic Stability and Vibrations. (K. N. E. Bradfield, D. G. Christopherson and R. V. Southwell, Proc. Roy. Soc., Series A, Vol. 169, No. 938, pp. 289-316.) (64/56 Great Britain.)

Preceding papers in this series have been concerned with unique solutions; this paper deals with problems such that a complete solution would define an infinite number of configurations, all satisfying the governing equations and the terminal conditions, but each associated with some particular value of a critical loading or frequency (the "characteristic number" or "Eigenwert"). The strut and vibrating rod (of non-uniform section) have been chosen for detailed treatment as the simplest examples, respectively, of elastic stability and vibrations; but the principles as distinct from the details of the relaxation treatment are quite general, and they provide a new method of attack on problems which are at once difficult and important.

In both problems relaxation methods appear capable of determining, with more than sufficient accuracy for practical purposes (when dimensions, etc., are not known exactly), not only characteristic numbers but also the mode associated with each. (The modes are not determined by the well-known method of Lord Rayleigh.)

Noise from Propellers with Symmetrical Sections at Zero Blade Angle. II. (A. F. Deming, N.A.C.A. Tech. Note No. 679, Dec., 1938.) (64/57 U.S.A.)

In a previous paper (Technical Note No. 605), a theory was developed that required an empirical relation to calculate sound pressures for the higher harmonics. Further investigation indicated that the modified theory agrees with experiment and that the empirical relation was due to an interference phenomenon peculiar to the test arrangement used.

Comparison is made between the test results for a two-blade arrangement and the theory. The comparison is made for sound pressures in the plane of the revolving blades for varying values of tip velocity. Comparison is also made at constant tip velocity for all values of azimuth angle 1.

A further check is made between the theory and the experimental results for the fundamental of a four-blade arrangement with blades of the same dimensions as those used in the two-blade arrangement.

CONCLUSIONS.

1. The theory gives the sound pressure with fair accuracy for the purpose for the first five harmonics of a two-blade arrangement with symmetrical sections exerting zero thrust for values of V_0/c up to 0.80.

2. The effect of blade thickness of propellers alone in producing noise is small except for low angles of attack.

3. The derived relationships give a good approximation to the polar distribution of the rotation noise for the first four harmonics.

Electric Model Tests for Solving Heat Flow Problems. (F. Bruckmayer, Archiv für Warmewirtschaft, January, 1939, pp. 23-5. Metropolitan Vickers Tech. News Bulletin No. 644, 20/1/39, p. 9.) (64/58 Germany.)

The author describes a method for the solution of heat flow problems by means of comparative electrical measurements on models. An imitation of the particular part is cut out of thin metal foil (tinfoil), current being supplied by means of copper bars to the parts of the model which represent the heat-conducting surfaces; the electrical conductivity of this two-dimensional model is determined from the current flow and voltage drop. Tests on tubes, hollow stones and girders, are described and it is suggested that the method may render possible more accurate determination of the heat losses or temperature course in the case of fittings, flanges, machine parts, etc.

Illustrated with five photographs and four diagrams.

Visual Examination of Temperature Fields by Means of Temperature-Sensitive Coloured Paints. (F. Penzig, Z.V.D.I., Vol. 83, No. 3, 21/1/39, pp. 69-74.) (64/59 Germany.)

The idea of using substances which change colour with change in temperature as indicators is not new. The difficulty is to obtain materials which give permanent records on subsequent cooling and which are at the same time sensitive and accurate. The problem was solved by the Oppau Research Laboratory of the I.G. by the use of certain metallic salts which change their composition at certain critical temperatures (evolving water, CO_2, ammonia, etc.), this break up being accompanied by a characteristic change in colour. Over 300 combinations of salts were investigated before the final 12 indicators were evolved. These cover a range from 30°C. to over 400°C., the accuracy of the record being generally of the order of ± 5°C. The work is being extended to cover temperatures up to 650°C.

The paint is made by mixing finely divided resin with the powdered salt and adding alcohol to obtain the required consistency. The thickness of the applied layer is of the order of 0.05 mm. and is negligible in heat transfer experiments. The method of colour indication has been successfully applied to the study of temperature distribution on aircraft engine cylinders, and examples in the form of colour photographs are given in the article.

Other possible applications are briefly discussed.

Application of the Harvard Meteorograph to a Study of Icing Conditions. (K. O. Lange, J. Aer. Sci., Vol. 6, No. 2, Dec., 1938, pp. 59-63.) (64/60 U.S.A.)

Routine radio soundings since December, 1936, have yielded cases in which ice formation greatly affected the ascensional rate of the balloons. In several instances they were forced into a rapid descent of several thousand feet before the ice melted off. From the changes of the rate of ascension, the amount of ice formation can be computed, *i.e.*, radio soundings indicate the existence and amount of icing in the atmosphere.

Present samples of such radio soundings indicate the formation of an amount of ice of the order of magnitude of one kilogramme. It formed suddenly and occurred in layer of a steep temperature lapse rate at temperatures slightly above *the freezing point and at relative humidities of less than 100 per cent. Rapid* formation of large quantities of ice near the temperature of the freezing point can be explained only if the way in which the heat of fusion is extracted can be determined. The radio meteorograph records show that the air was not saturated, allowing rapid evaporation of part of the cloud or rain drops after they hit the balloon. The amount of heat absorbed by this process is sufficient to change considerable amounts of liquid water into ice in a relatively short time. The observational material presented in this paper indicates that relative humidities of less than 100 per cent. are a pre-requisite for dangerous ice formation.

Blue Hill Observatory proposes to conduct a systematic study of the mechanics of ice formation by means of successive radio soundings on days when the regular early morning ascents show icing and by expansion of the rime studies on Mount Washington.

Instructional Films on the Subject of Conformal Representation. (H. Heinrich, Z.A.M.M., Vol. 18, No. 6, Dec., 1938, p. 366. Göttingen Mathematical Congress.) (64/61 Germany.)

Two films have so far been prepared, dealing respectively with the image function $w=\frac{1}{2}$ and $w=z+1/z$ (Joukowsky transformation), whilst a third film deals with the correlated streamlines round image circle and wing profile. The correlated curves are drawn with pencil on tracing paper, divided into small corresponding sections and inked in progressively. During this process the paper is illuminated from below and photographed from above. As neither paper nor camera are shifted between successive exposures, no difficulty in accurate superposition arises.

The Nature of Sliding and the Analysis of Friction. (F. P. Bowden and L. Leben, Proc. Roy. Soc., Series A, Vol. 169, No. 938, 7th February, 1939, pp. 371-391.) (64/62 Great Britain.)

A detailed analysis of the kinetic friction between moving metals shows that the frictional force does not remain constant during sliding. Sliding is not a continuous process; the motion proceeds in jerks and large and violent fluctuations occur in the friction. In the case of dissimilar metals the top surface sticks to the bottom one and moves with it until, as a result of the gradually increasing pull, a sudden and very rapid slip occurs. The process is then repeated indefinitely. A simultaneous measurement of the surface temperature shows that this too is fluctuating and, at the instant of slip, there is a sudden temperature "flash."

The exact behaviour depends upon the relative physical properties of the metals, particularly on the melting point, and there is evidence that three distinct types of sliding may occur. The experiments suggest that friction is due to a welding together of the metals at the local points of contact. These metallic junctions are large compared with the dimensions of a molecule and when they are broken the metal is distorted to a considerable depth.

Even if the surfaces are lubricated with mineral oils or other lubricants an intermittent clutching and breaking away of the surfaces occurs and the behaviour may be essentially the same. Certain long chain fatty acids may prevent stick-slip and allow continuous sliding to take place.

Area of Contact Between Stationary and Between Moving Surfaces. (F. P. Bowden and D. Tabor, Proc. Roy. Soc., Series A, Vol. 169, No. 938, 7th February, 1939, pp. 391-413.) (64/63 Great Britain.)

An estimate of the real area of contact between stationary and between moving and metal surfaces has been made by electrical and by visual means. Experiments with stationary surfaces show that the area of intimate contact is very small. It varies with the pressure, but for flat steel surfaces it may be less than one ten-thousandth of the apparent area. The real area of contact is not greatly affected by the size, shape and degree of roughness of the surface; it depends mainly on the pressure. The general behaviour is consistent with the view that the surfaces are held apart by small irregularities. This means that even with lightly loaded surfaces the local pressure may be sufficiently great to cause steel to flow plastically. This conclusion is supported by the observed relation between the pressure and the electrical conductance.

Measurements made with moving surfaces show that the area of contact is not constant, but is fluctuating rapidly during sliding. A detailed analysis shows a remarkable correlation between these fluctuations and the frictional and temperature changes described in an earlier paper. It is clear that an intermittent clutching and breaking away of the surfaces is taking place and the results support the view that metallic junctions between the metals are being rapidly formed and broken.

The conductance measurements show that even if the metals are lubricated with mineral oils and other lubricants, metallic contact may still occur through the film of lubricant.

LIST OF SELECTED TRANSLATIONS.

NOTE.—Applications for the supply of copies of translations mentioned below should be addressed to the Under-Secretary of State (R.T.P.), Berkeley Square House, W.1, and will be supplied, free of charge, as far as availability of stocks permit. Suggestions concerning new translations will be considered in relation to general interest and facilities available.

Lists of selected translations have appeared in this publication since September, 1938.

TRANSLATION NUMBER AND AUTHOR.	TITLE AND JOURNAL.
	AERODYNAMICS AND HYDRODYNAMICS.
X20 Birnbaum, W. ...	*The Two-Dimensional Problem of the Beating Wing.* (Z.A.M.M., Vol. 4, 1924.)
828 Meissner, W. ...	*Measurement of the Temperature of High Speed Gas Flow.* (Forschung, Vol. 9, No. 5, Sept.-Oct., 1938, pp. 213-8.)
830 Possio, C.	*Aerodynamic Forces on an Oscillating Profile in a Compressible Fluid at Sub-Sonic Speed.* (Volume Commemorativo del XXV Annuale del Laboratorio di Aeronautica de R. Politecnico di Torino, 1938, pp. 152-169.)
	AIRCRAFT.
805 Nemchinov, V. ...	*Choice of Optimum Altitude and Régime of Flight.* (Civil Aviation, U.S.S.R., Vol. 8, No. 6, June, 1938, pp. 15-18.)
816 Langheinrich, M. ...	*Load Specifications as Affected by Experience Obtained by the Lufthansa with Float Seaplanes.* (Jahrbuch der Deutschen Luftfahrtforschung, Vol. 1, 1938, pp. 339-41.)