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Interpolation Method for the Calculation of Families of Trajectories and Their Variation with Changes in the Original Ballistic Values. (H. Athen, Z.A.M.M., Vol. 19, No. 6, Dec., 1939, pp. 366-371.) (77/1 Germany.)

For a given resistance function, the solution of the ballistic problem depends on the initial velocity and path inclination. In practice, the problem usually consists of determining a family of trajectories having a constant initial velocity V_0 and to investigate the changes produced by varying V_0 and the external ballistic factors. For this purpose it has been usual to calculate at least 6-8 trajectories for each elevation, and every variation in the ballistic constants introduces a further set of calculations. It is the purpose of the present paper to show how this amount of work can be very considerably cut down. In the new method only two or at the most three trajectories require complete calculation and the constants obtained in this manner suffice to determine the whole family including the effect of variations. The method is based on the well known Popoff solution of external ballistics in which the trajectory is expressed as a function of the original path inclination only. Knowing two trajectories, the family can be determined by interpolation. Amongst the effects of external change, the author gives special consideration to atmospheric changes in temperature with height.

The Development of the Machine Gun. (M. Runnebaum, W.T.M., Vol. 44, No. 2, Feb., 1940, pp. 25-32.) (77/2 Germany.)

The history of the Maxim gun and its use during the war, 1914-18, is reviewed.

After the 1914 war, every military state tried to obtain a reliable light machine gun weighing less than 20 lbs. For aircraft use the rate of fire has been increased to the order of 1,000 rounds per minute. Heavy automatic guns of 20-25 mm. calibre, firing explosive shells of 150 gm. for use against tanks, have also received great attention. The firing rate is of the order of 300 rounds per minute and the maximum range 6,000 m.

Machine guns can be classified into the following three groups depending on their principal design characteristics :—

I. Recoil operated with mobile barrel (Maxim and Bergmann).

II. Gas operated (Hotchkiss, Colt, Lewis). In this design, a portion of the explosion gases is tapped off to operate the mechanism.

III. Recoil operated with fixed barrel (Schwarzlose and Bergmann). The gas pressure acting on the base of the cartridge case pushes back the breech and operates the whole mechanism.

It will be noticed that a number of alternative solutions exist. The simplest gun is generally the best since it can be produced in quantity without excessive technical difficulties.

Unorthodox Guns and Projectiles. (P. Chaville, La Science et la Vie, Vol. 57, No. 274, April, 1940, pp. 316-324.) (77/3 France.)

A few of the proposals deserve attention.

Gun with Conical Barrel.—The object of a gradual reduction in calibre as the projectile leaves the gun is to ensure a high muzzle speed at moderate gas pressures. Applied to a 7.7 rifle, the diameter at the bottom of the rifling would be 9.2 mm. for a distance of 500 mm. from the breech. The diameter is then progressively reduced to 7.7 mm. at the muzzle. The bullet is provided with a central groove into which flows the excess metal of an obturator ring as the bore diminishes. It is known that Germany carried out experiments with such a weapon about 30 years ago.

The Electric Gun.—As is well known, an electric conductor in a magnetic field experiences a directing force. In this proposal, the shell consists of a steel arrow which bridges two parallel conductor rails, thus acting as a slider. The arrow is given a translatory motion by the superposition of an electric field. The device was tried by the French Government in the 1914 war and it is stated that speeds of the order of 200 m./sec. could be produced in a steel arrow weighing 50 gm.

Tunnel Projectiles.—Projectiles with a central passage for the air were tried in 1930. The object is to reduce air resistance, but the tests showed no advantage of this design.

Anti-Aircraft Projectiles, Releasing Wired Discs.—This device is obviously inspired by the old Baron gun, which was twin barrelled, two projectiles connected by a chain being fired simultaneously. In the modern version, a normal gun is used, the explosive shell containing a number of discs, each pair being connected by a coil of wire. A simple and more practical device consists of a single coil of wire of great length attached to a small parachute. It is interesting to note that the proposal for an aerial barrage dates back to 1917.

The Possibilities of the Rocket in War. (A. Ananoff, La Science et la Vie, Vol. 57, No. 274, April, 1940, pp. 451-460.) (77/4 France.)

After a brief review of the military history of the rocket, the author deals more specially with modern developments rendered possible by the introduction of liquid and gaseous fuels. The main advantage of the rocket as an offensive weapon is the fact that, being self-contained, it can be launched by means of a very flimsy cradle. The importance of this will be realised when it is remembered that a 6 in. field gun in firing position weighs over 13 tons and requires over one hour's work before it can be shifted. The chief difficulty, apart from corrosion of the nozzles, is to ensure adequate stability during prolonged flight.

Applied to aircraft bombs, the rocket should increase the terminal velocity and hence the destructive effect. It has also been proposed to neutralise the effect of the aircraft speed by applying a reaction to the bomb in the opposite direction. The bomb will now drop vertically and this should simplify the aim. By means of composite rockets, great altitudes could be reached and this is of interest in A.A. defence, since the limit of the usual artillery fire is reached at an altitude of 12,000 m. The rocket, not being subjected to the high pressures of a shell fired from a gun, can be easily adapted to a multitude of purposes, such as containing wires and parachutes or subsidiary grenades for aircraft attack. Finally, if aircraft speeds of the order of that of sound are required, the normal propeller drive will have to be replaced by rocket propulsion.

Fighter Aircraft of To-day and To-morrow. (R. Maurer, La Science et la Vie, Vol. 57, No. 274, April, 1940, pp. 401-423.) (77/5 France.)

In the present-day fighter, the low wing monoplane and the liquid-cooled engine have become practically the standard equipment. There exists, however, still some diversity in the armament question and a multiplicity of light calibre guns (eight machine guns on the Spitfire) is advocated by some, whilst others prefer fewer guns of heavier calibre. The latter alternative has the advantage of giving a better ballistic coefficient and therefore a longer range. It is true that up to now, air fighting to be effective has had to be carried out at ranges of the same order as in the 1914 war. As soon, however, as automatic sights for the heavier guns become available, the longer range weapon may prove superior. Departures from orthodox design, such as the American Bell P. 39 (engine behind pilot so as to improve view) and the Fokker D. 23 (engines in tandem, one behind and one in front of the pilot) have not yet been tried under war conditions. The twin fuselage Lockheed P. 38 appears to be too complicated for handling by a single pilot.

The weak spots of any design can only be revealed by experience in actual fighting. Victory will come to the nation which learns by experience and can adapt its production accordingly.

Future development, in its broad outlines can, however, be summarised very shortly; more horse-power and greater gunpower.

A New Method of Studying the Flow of the Water Along the Bottom of a Model of a Flying Boat Hull. (K. E. Ward, N.A.C.A. Tech. Note No. 749, Feb., 1940.) (77/6 U.S.A.)

A new method of studying the flow of the water along the bottom of a model of a flying boat hull is described. In this method, the model is fitted with a transparent bottom and is divided down the centre line by a bulkhead. The flow is observed and photographed through one-half of the model by means of the diffused illumination from a battery of lamps contained in the other half of the model. Photographs of the flow, particularly of the changes that occur when the step ventilates, are shown.

The results of the present investigation indicate that the method has considerable promise, chiefly in connection with motion picture studies.

The method should prove to be of use in conjunction with studies of bottom pressures by showing the movement of the peak pressure in landings, in rough water, and in porpoising.

Laminar Boundary Layer Phenomena on a Rotating Disc, with Special Reference to Change in Speed of Rotation (Starting and Stopping). (K. H. Thiriot, Z.A.M.M., Vol. 20, No. 1, Feb., 1940. pp. 1-12.) (77/7 Germany.)

The equations of a laminar boundary layer subjected to a centrifugal field of force are established and solved by the method of Blasius. The resultant streamlines are in the form of logarithmic spirals. The theoretical conclusions were checked by photographic records, using potassium permanganate crystals (0.3 to 0.5 mm. diameter) in water contained in a circular dish 900 mm. diameter.

The secondary flow phenomena observed under these conditions have some connections with certain meteorological phenomena (cyclones).

The Theory of the Annular Wing (Nozzle in Free Flow). (H. E. Dickmann, Ing. Archiv., Vol. 11, No. 1, Feb., 1940, pp. 36-52.) (77/8 Germany.)

The author investigates the case of a ring-shaped aerofoil (nozzle) immersed in a known field of flow. The problem is simplified by replacing an aerofoil of this type by a series of ring vortices on the skeleton line of the cross section. This leads to a non-linear integral equation of the first kind having elliptical

integrals as a core. These are expanded in a series of simpler core functions, the first of which is equivalent to a straight line vortex whilst succeeding terms allow for the curvature of the ring. By means of Fourier's series the problem finally reduces to an elementary system of m equations with m unknowns.

The special case where the skeleton of the aerofoil cross section is a straight line is solved as a simple example. It is shown that for the same resultant flow, the circulation round the ring-shaped aerofoil is considerably greater than that round a plain aerofoil of the same cross section. This is due to the fact that the induced velocity associated with a ring vortex falls off more rapidly with distance than is the case for a straight line vortex. In order to obtain a given velocity field, the distribution density of the vortices, *i.e.*, the circulation, must be greater in the case of the annular wing.

Lift and Moment of a Control Surface of Finite Thickness and Negligible Gap. (W. Weinberger, L.F.F., Vol. 17, No. 1, 20/1/40, pp. 3-11.) (77/9 Germany.)

The problem of the two-dimensional flow round control surfaces without gap has been investigated by Glauert for the case of vanishing profile thickness, using the method of line vortices. The results were, however, not in satisfactory agreement with practice and it was hoped by the D.V.L., that by introducing the thickness of the profile into the investigation, a better agreement would be achieved. The author investigated for two-dimensional potential flow the values of the lift moment, normal force on flap and moment of flap using such profiles as lend themselves easily to conformal representation on a circle, and assuming a linear theory as regards incidence and rudder deflection. It was found that the thickness of the profile reduced the coefficient of the flap moment appreciably and brought the results into much closer agreement with wind tunnel measurements. The effect of thickness was, however, negligible in the case of the calculated values for the remaining coefficients of the control surface.

The Velocity Field in the Neighbourhood of a Control Surface of Finite Thickness and Negligible Gap. (H. Menzel-Rogner, L.F.F., Vol. 17, No. 1, 20/1/40, pp. 11-17.) (77/10 Germany.)

The two-dimensional potential flow round an infinitely thin flapped wing can be calculated in a simple manner by using the Birnbaum method of equivalent line vortices. The author extends the case to a finite thickness by utilising the method of conformal representation, the control surface and flap being approximated to by a Joukowsky profile and a linear theory for incidence and flap deflection being assumed. The velocity distribution is calculated for a series of points extending to a distance of $4\frac{1}{2}$ chord lengths. Comparison with the corresponding case of an infinitely thin wing shows that the effect of the thickness diminishes rapidly with distance from profile and does not extend beyond two chord lengths.

Recently Keune (Yearbook of German Aeronautical Research, 1938, Vol. 1, pp. 3-26) has given an approximate method for the determination of the velocity field in potential flow round thick profiles. A comparison at a few check points shows satisfactory agreement with the results obtained by the author by the method of conformal representation.

Lift and Moment of a Flat Plate, Bent at a Short Angle with a Gap at the Corner. (H. Sohngen, L.F.F., Vol. 17, No. 1, 20/1/40, pp. 17-22.) (77/11 Germany.)

The author calculates the lift and moment coefficients as well as the pressure distribution of a simple form of symmetrical double wing, making use of the Birnbaum theory of the equivalent vortex surface. The system of integral equations is solved by a method discussed previously by the author (Math. Zeitschrift,

Vol. 45 (1939), pp. 245-264). The solutions are given in explicit form and an accurate linear theory of the flow angle is accepted. The coefficients of the lift and moment as well as the lever arm of the normal force on the flap at zero deflection are given in pictorial form for value of the ratio (chord of flap)/(total chord) of 0, 1/9, 2/9 and 3/9 respectively. From these figures intermediate values can be obtained by interpolation.

Lift and Moment of an Unsymmetrical Double Wing. (F. Losch, L.F.F., Vol. 17, No. 1, 20/1/40, pp. 22-31.) (77/12 Germany.)

The unsymmetrical double wing consists of two similar symmetrical Joukowsky-Betz profiles, the auxiliary wing being placed below and to the rear of the main surface. The two-dimensional potential flow is calculated by the approximate conformal representation of the field on the exterior of two circles. The pressure distribution on the wing system is calculated for a series of incidences and flap deflections. These distributions are utilised to obtain the coefficients of lift, moment, normal force on flap and flap moment in the linear range of incidence and flap deflection, the results being shown in a series of diagrams.

Flow Round Wings Accompanied by the Separation of Eddies. (C. Schmieden, L.F.F., Vol. 17, No. 2, 20/2/40, pp. 37-46.) (77/13 Germany.)

The flow round wings calculated by the usual method leads in the case of a finite trailing edge to a stagnation point at the rear edge due to the Kutta-Joukowsky condition of flow governing this region.

As a result the theoretical pressure distribution differs markedly from the experimental values in the neighbourhood of the trailing edge.

The author develops an alternative method of calculation in which the rear stagnation point no longer appears.

The stream leaves the rear edge tangentially on the pressure side and a similar tangential separation occurs on the suction side of the profile at a point slightly in front of the trailing edge. Both these limiting stream lines are formed by vortex sheets of equal and opposite circulation and enclose a " dead-water " region, the width of which diminishes to zero with increasing distance from the edge.

The flow in the immediate neighbourhood of the vortex sheet is parallel and of constant velocity and undergoes a sudden increase proportional to the vortex strength on passing through the sheet. The author shows that out of the multitude of possible flows for a given profile at a given incidence, only one flow characterised by a definite breakaway point in the suction side leads to the condition of constant speed along the trailing stream lines together with a dead water region which disappears at ∞. The calculation is carried out first explicitly for the simple case of a flat plate and then extended to a form of modified Joukowsky profiles which are amenable to simpler treatment.

The resultant force on the profile is finally calculated from the pressure distribution and leads to a pure lift force as required by theory.

Trigonometric Series Solution of the Prandtl Equation for Circulation. (K. Jaeckel, L.F.F., Vol. 17, No. 2, 20/2/40, pp. 47-53.) (77/14 Germany.)

The author demonstrates that the basic Prandtl equation for the finite wing in the form of an integral-differential equation is fundamentally no more limited in its application than the corresponding solution based on potential theory. By a suitable extension of the integral giving the induced velocity at the wing due to the presence of the vortex band, both methods of treatment are shown to cover the same range. The use of Fourier series for the evaluation of the Prandtl integral-differential equation is therefore also permissible in the case of a discontinuous distribution of angle of incidence or length of chord.

Intensity of Sound Emitted by Various Profiles Moving at High Speed. (W. Holle and E. Lubcke, L.F.F., Vol. 17, No. 2, Feb., 1940, pp. 56/58.) (77/15 Germany.)

The intensity of the sound due to rotation of various profiles over a large speed range was found to vary as the sixth to seventh power of the circumferential speed. Simultaneous experiment on the air friction losses showed that the latter increased as the 3.5th power of the speed. The sound conversion factor at circumferential speeds of 20-50 m. is as low as 10^{-8} or 10^{-9}, but increases to a multiple of 10^{-3} at 250 m./sec.

No satisfactory aerodynamic explanation of these phenomena has been found. A theory embracing all the known facts would be of great value so as to indicate methods of sound reduction.

New Researches on Profile Characteristics. (F. Riegels, Luftwissen, Vol. 6, No. 12, Dec., 1939, pp. 299-304.) (77/16 Germany.)

The author refers briefly to the theoretical methods now available for calculating the pressure distribution on a given profile. Strict accuracy is only possible in the case of certain families of profiles (Joukowsky, Kármán-Trefftz, Betz-Keune, Piercy), but thanks to the work of Theodorsen and others, the pressure distribution can be calculated with sufficient approximation for any arbitrary aerofoil.

The converse problem, *i.e.*, the construction of a profile having a given pressure distribution has also been attacked. If the new pressure distribution only differs slightly from that of a known profile, the method is relatively simple (Betz, L.F.F., Vol. 11, No. 1, 1934). The general case is complicated by the fact that the given pressure distribution must satisfy certain conditions in order to produce satisfactory profiles. In addition the determination of the imaginary part of the logarithmic derivation of the image function is not very accurate, especially in the neighbourhood of the stagnation point.

These difficulties have lately been overcome by Mangler, using a graphical evaluation of the Poisson Integral (1938 Yearbook of German Aeronautical Research, Vol. 1, p. 46). In the remainder of the article, the author deals with experimental work on maximum lift and profile resistance. Measurements of this type are sensitive to the amount of turbulence in the wind tunnel as well as to support interference effects. On applying suitable corrections for these factors, satisfactory agreement is obtained between the results of various laboratories.

Although the past ten years have already yielded promising results, the author is of the opinion that real progress in profile design, including boundary layer control, is only about to begin.

Principles, Practice and Progress of Noise Reduction in Aeroplanes. (A. London, N.A.C.A. Technical Note No. 748, Jan., 1940, pp. 1-66.) (77/17 U.S.A.)

Progress in noise reduction in aircraft has only been made possible by a full application of the principles of acoustics. The whole problem is reviewed:— Nature of sound and hearing; physical and physiological scales of noise measurement; sources of noise in aircraft, *e.g.*, propeller, engine and exhaust, aerodynamic and ventilation.

In order to obtain the maximum sound reduction in an aircraft cabin, the walls must be bad conductors of sound and the internal surface must have a high absorption coefficient. The same result can be obtained by emphasising either one or other of these two factors, the question of weight being of paramount importance. Both transmission and absorption are affected by frequency and to obtain a uniform reduction over a large range of frequency is difficult.

In the case of absorption, a satisfactory compromise can be effected by mounting a porous material on a membrane permitting vibration. Thus asbestos sprayed on metal lath and surface painted is satisfactory over the whole frequency range

from 128 to 4,096 vibrations/sec., the high frequency end being dealt with by the porous material, whilst the panel vibrations absorb the low frequency sound. As regards transmission of sound, the most important determinant of insulation efficiency of a homogeneous panel is its mass. This practically rules out solid structures and composite panels with intermediate air spaces are now generally used. These are designed so that the sound energy in the air space is absorbed and there is no elastic coupling between the solid walls via the air space. Thus the filler (hair felt, balsam wool, etc.) must be loosely distributed, which, under service operation, may cause its disintegration and compacting, to the great detriment of the sound insulation.

Rigorous Performance Prediction without Drudgery. (E. G. Reid, J. Roy. Aer. Soc., Vol. 44, No. 350, Feb., 1940, pp. 176-94.) (77/18 Great Britain.)

The principal departure which characterises the new method is the adaptation of Eiffel's logarithmic propeller chart to the construction of available power curves. The use of " indicated air speed " ($\sigma^{\frac{1}{4}} V$) and the analogous quantity " indicated power " ($\sigma^{\frac{1}{4}}$ h.p.) as co-ordinates causes a single curve to represent the power requirements for level flight at all altitudes. Other simplifications arising from the recognition of certain engine characteristics, utilisation of the unique properties of the Eiffel chart and development of a convenient method of evaluating the excess available power (from logarithmic curves) make it possible to eliminate a large portion of the labour previously required for rigorous performance prediction. The method is not only applicable to, but especially convenient in, the case of the constant speed propeller; moreover, it yields complete level flight and climb characteristics for altitudes below, as well as above, the critical altitudes of supercharged engines.

A Generalised Vortex Theory of the Screw Propeller and its Application. (H. Reissner, N.A.C.A. Tech. Note No. 750, Feb., 1940.) (77/19 U.S.A.)

The vortex theory as presented by the author in earlier papers has been extended to permit the solution of the following problems:—

(1) The investigation of the relation between thrust and torque distribution and energy loss as given by the induction of helical vortex sheets and by the parasite drag;

(2) The checking of the theorem of Betz of the rigidly behaving helical vortex sheet of minimum induced energy loss;

(3) The extension of the theory of the screw propeller of minimum energy loss for the inclusion of parasite drag distribution along the blades.

A simple system of diagrams has been developed to systematise the design of aeroplane propellers for a wide range of practical application. Several typical diagrams are presented to illustrate the method.

Damping Formulas and Experimental Values of Damping in Flutter Models. (R. P. Coleman, N.A.C.A. Tech. Note No. 751, Feb., 1940, 28 pp.) (77/20 U.S.A.)

In connection with an investigation of flutter carried out in the N.A.C.A. 8 ft. high-speed wind tunnel it was found necessary to determine the structural ramping in the models tested. The idea of equivalent viscous damping is reviewed and shown to be related to the structural damping coefficient g introduced in N.A.C.A. Tech. Note No. 685. The theory of normal modes is discussed and a number of methods for separating the motions associated with different modes are described. Equations are obtained for use in evaluating the damping parameters from experimental data. Experimental results of measurements of damping in several flutter models led to the following conclusions:—

1. In determining the damping of structures from the shape of the response curve obtained by applying an alternating load at one point of the structure,

use of the analysis for one degree of freedom is justified when: (*a*) the damping is small; (*b*) the points of applying the force and measuring the amplitudes are appropriate from considerations of disturbing normal modes; (*c*) only amplitudes close to the resonant peak are used to determine the non-dimensional damping parameter, δ.

2. When the normal functions for a structure are known, the damping in the different modes can be separately determined from the measured amplitudes at several points along the structure.

3. The measured values of δ for a homogeneous structure are approximately equal in the different modes of vibration.

Aeroplane Stability and Control from the Designer's Point of View. (O. C. Koppen, J. Aeron. Sci., Vol. 7, No. 4, Feb., 1940, pp. 135-40.) (77/21 U.S.A.)

PRINCIPAL CONCLUSIONS.

(1) From all points of view a large tail-length to wing-span ratio is desirable.

(2) All of the requirements for satisfactory controlled motion indicate the desirability of a large vertical tail. The only conflict is with the requirement for spiral stability of uncontrolled motion, which indicates the need for a small vertical tail.

(3) A minimum of dihedral angle is indicated for all cases except that of uncontrolled spiral motion. Except for the case of aileron controllability the use of a larger dihedral, than the minimum required for the proper direction of the rolling moment due to sideslip, is not as harmful to the controlled motion as is the use of a small vertical tail.

LONGITUDINAL REQUIREMENTS.

In the cases in which the centre of gravity has any effect, it appears to be desirable to meet the minimum requirement of the slope of the pitching moment curve with the centre of gravity as far back on the wing chord as possible. The maximum rearward location of the centre of gravity appears to be limited only by structural and performance considerations.

RESEARCH SUGGESTIONS.

Research in the direction of determining the pilot's control motion relative to the motion of an aeroplane while flying in rough air would be most helpful. In addition, data concerning the average pilot's control application lag as affected by the period of the motion, the control force, and the moment of inertia of the control system, should be determined.

The Application of Television to Wireless Controlled Aircraft. (P. Devaux, La Science et la Vie, Vol. 57, No. 274, April, 1940, pp. 371-376.) (77/22 France.)

Wireless controlled pilot-less aircraft have been in use for some time. A well known British type utilises a short wave receiver responding to six different wave lengths (two for direction, one for climb, one for horizontal flight, one for gliding and one for diving). The aircraft is normally stabilised by means of gyroscopes and the reception of the requisite code message on any one of the control wave lengths, the connecting links between the gyroscope and the servo motors operating the controls are suitably modified so as to bring about the required manœuvre. Several safety devices prevent dangerous flying altitudes. Thus a servo motor under aneroid control pulls the machine automatically out of a dive when approaching the ground. The control of such aircraft is from an emitting station on the ground, the pilot-less machine being under visual observation (relatively small distance). The control could, however, also be carried out from

a second aircraft carrying the necessary transmitter. The utility of a pilot-less aircraft would be enormously increased, if it could be fitted with a television apparatus by means of which an image of the field of view is transmitted to the home station. Two difficulties at once arise: the size and weight of the installation and the poor quality of long distance pictures taken in the open air. The latter defect could possibly be overcome by televising not the actual view but a series of photographs taken in quick succession. Such films can be developed and televised within three seconds of exposure and would have the additional advantage that material sensitive to the infra red could be employed (visibility in fog).

Flight Path and Control during the Longitudinal Motion of an Aircraft. (W. Richter, Ing. Archiv., Vol. 11, No. 1, Feb., 1940, pp. 24-36.) (77/23 Germany.)

The motion of an aircraft in a vertical plane under the action of gravity only is determined by the equations

$$\dot{v} = -g \sin \phi - k_w v^2$$
$$v\dot{\phi} = -g \cos \phi + k_a v^2$$

where

ϕ = inclination of flight path,
$k_a = \frac{1}{2} \gamma C_a (F/G)$,
$k_w = \frac{1}{2} \gamma C_w (F/G)$.

The aerodynamic coefficients C_a and C_w are functions of the incidence α and are obtained from the polar diagram of the aircraft under consideration.

In a previous paper, the author has given a graphical solution of the above equations by employing certain nomographs on the assumption that α is a given function of the time. Knowing v and ϕ, both the trajectory and the necessary elevator operation can be determined. The method has now been generalised by the author so that the problem can be solved for the cases when $v = f(\phi)$, v = constant, ϕ = constant, or when either the flight path or the time variation of the elevator deflection are given. In conclusion, the adaptation of the nomographs to conditions of power flight (propeller thrust) is explained.

Measurement of the Forces Acting on Gliders in Towed Flight. (W. B. Klemperer, N.A.C.A. Tech. Note No. 753, Feb., 1940.) (77/24 U.S.A.)

The magnitude, the direction, and the fluctuations of tow forces exerted upon gliders by towing them aloft behind an automobile were measured under a variety of conditions covering a range from gentle to severe types of operation. For these tests, the glider towing force did not exceed 1.6 of the gross weight of the glider. V-G records obtained during the towed flight period as well as during the subsequent return glide to earth showed accelerations in the range from 3 *g.* to -1 g. The results of preliminary aeroplane tow tests are also presented.

An Investigation of the Prevention of Ice on the Aeroplane Windscreen. (L. A. Rodert, N.A.C.A. Tech. Note No. 754.) (77/25 U.S.A.)

An investigation of three methods for prevention and removal of ice on an aeroplane windscreen was carried out in the 7×3 ice tunnel of the N.A.C.A. Check experiments were carried out in flight. The methods involved:—

(1) Heat from an electric source,
(2) Heat from engine exhaust,
(3) Alcohol dispensing rotary blade wiper.

(1) Two panes of glass $\frac{1}{8}$ in. thick were mounted in a frame and separated by $\frac{1}{4}$ in. gap, which contained the heating wires. To aid the transmission of heat, a liquid dielectric (ethylene glycol) was used. Vision through this arrangement

was satisfactory and the wattage for the prevention of ice formation was of the order of 2 watts per square inch of glass surface.

(2) The air is heated by the engine exhaust and passes through the gap between the two glass panes at a speed of about 50 feet per second. The heat required to prevent ice formation is of the order of 900 B.T.U. per square foot per hour, the air entering the panel at 180°F. and leaving at about 150°F. No mention is made of the means adopted for forcing the hot air to circulate in the manner required.

(3) The rotary wiper covered a circle 10 in. diameter and rotated at 300-600 r.p.m. The alcohol consumption for the prevention of ice was of the order of half-gallon per hour, the minimum power required to operate the wiper being of the order of 100 watts.

The wiper dispensing alcohol has the advantage of dispersing raindrops as well as preventing ice formation and of being easily installed. A disadvantage is that it will not remove pre-formed ice nor deal with frost deposits on the cabin side.

The heat-air panel appears to be the most satisfactory solution. There are no moving parts and it uses exhaust gas energy which normally would be wasted.

A disadvantage of any method using heat alone is the inability to deal with unfrozen water drops on the outer surface.

For this reason a combined wiper and hot air system may ultimately be adopted. The existing practice of making part of the windscreen retractable or removable by the pilot will then become unnecessary.

Some Factors Controlling the Development of Electrical Ignition of Aero Engines. (G. E. Bairsto, J. Roy. Aer. Soc., Vol. 44, No. 350, Feb., 1940, pp. 119-175.) (77/26 Great Britain.)

After calling attention to the very onerous conditions under which the ignition system of an aero engine has to operate, the author deals in turn with the electrical characteristics of the modern magneto and coil. It appears that the latter by itself is cheaper to design and manufacture than the magneto and that the coil ignition system is generally easier to instal. Wireless interference is, however, more difficult to guard against and there appears a greater risk of fire on crash (spark or breaking primary circuit). The reliability of the system also suffers and for these reasons the magneto is still holding its own on aircraft, although it has been almost completely displaced in the modern motor car. The remainder of the paper deals with sparking plugs and ignition cables. Special reference is made to the new insulator made of sintered aluminium oxide and to the use of special metals (Ni and Pt-Ir) to reduce erosion of the electrodes. This latter phenomenon by itself limits the life of high duty plugs to about 100 hours.

According to the author, ignition systems, although already astonishingly reliable, require further development to meet the high temperature conditions which are becoming increasingly common on high duty power plants. Both the cables, windings and bearings will have to be improved before the aims of a longer maintenance free period can be achieved.

Predetermination of Aircraft Engine Cooling Requirements for Specific Flight Conditions. (K. Campbell, J. Aeron. Sci., Vol. 7, No. 4, Feb., 1940, pp. 141-7.) (77/27 U.S.A.)

For the past several years, the engine manufacturer has provided the designer with the equivalent orifice area of the engine baffle passages of his various models, which have been established by flow testing; and to facilitate the designer's calculations, direct reading charts relating to cowl exit gap size to baffle pressure drop and cooling drag for any indicated air speed and altitude have been provided.

Until recently, however, one link in the chain of rational cooling system design

procedure has been missing, namely, a quantitative readily workable correlation of the principal variables influencing engine cooling performance under stabilised conditions. This is required so that the aeroplane designer may select the " suitable " baffle pressure drop which he must provide under his assumed conditions of allowable maximum cylinder temperature, brake horse-power, r.p.m., specific fuel consumption, pressure altitude, and prevailing air temperature. The author provides such a correlation in direct reading chart form, for the aeroplane designer's convenience, and some important relations which become evident from its application to specific assumed conditions are briefly discussed.

Researches on Direct Injection in Internal Combustion Engines. (J. E. Tuscher, Pub. Sci. et Tech., B.S.T., No. 89, 1939, 93 pp.) (77/28 France.)

Information obtained from successive experiments, under strictly comparable conditions, using injection devices permitting variation of both injection time and injection pressure, shows that these two factors have a primary effect on the power developed and on the efficiency of a Diesel engine. Experiments carried out in two engines of different types show that the laws relating injection and combustion are general and are not influenced either by the shape of the combustion chamber or by a more or less strong turbulence in the combustion chamber. Study of retarded cycles, in which combustion takes place entirely during the expansion stroke, has provided a means for reducing the combustion speed and for increasing the concentration of the fuel/air mixture up to saturation, while maintaining a high thermal efficiency. Combination of short injection time and a retarded cycle will produce the greatest specific power from a Diesel engine, at the same time reducing fatigue of its parts. Feed of Diesel engines by injection pumps worked by the compression of the engine can easily achieve the high injection velocities required and permits rigorous control of the charge introduced into each cylinder. Avoidance of mechanical control of the pumps and pressure pipes simplifies the construction of direct-injection engines and improves their reliability in operation.

On the Effective Rigidity of Crankshafts Undergoing Torsional Vibrations. (J. Meyer, L.F.F., Vol. 17, No. 2, 20/2/40, pp. 54-55.) (77/29 Germany.)

Grammel (Ing. Arch., Vol. 4 (1933)) pointed out that a crankshaft may be twisted in two different ways, which he designated as torsions of the first and second kind respectively.

Torsion of the first kind arises if a couple is applied to one journal and balanced by an equivalent couple in another journal. The second kind of torsion arises if a single force is applied to the crankpin of one throw and balanced by a force on the crankpin of the next throw. Both calculation, taking into account bearing play, and experiment on single throws show that for the same applied moment the angular twist is greater in the first than in the second case, *i.e.*, a crank throw is apparently stiffer when the force is applied to the pin. This led Grammel to reject the usual method of determining effective rigidity of a crankshaft by applying a couple to one end whilst the other end is fixed. According to his argument the method must lead to an under-estimation of the natural frequency. Now practical experience has shown that the first two orders of frequencies, at any rate, are given in a satisfactory manner for crankshafts with four or more throws when the rigidity is estimated in the usual manner by applying a couple to one end of the shaft. The discrepancy between Grammel's investigation and practical experience has now been found to be due to secondary torsion effects always present in multi-throw shafts and neglected by Grammel. The usual method of obtaining the rigidity of the shaft can thus be retained and will give satisfactory value except for frequencies of a high order which are usually of no great importance.

New Designs for Piston Ring Grooves. (E. Mickel, Luftwissen, Vol. 6, No. 12, Dec., 1939, pp. 305-308.) (77/30 Germany.)

In recent years it has been appreciated that the life of a highly stressed part depends not only on the material utilised but also on the design. It is now well known that sharp corners or edges should be avoided. Nevertheless, piston ring grooves have retained up to now a rigid rectangular shape with sharp corners. It is true that the projecting bands are generally only subjected to small loads and should therefore stand up to their work in spite of the unfavourable shape. As a matter of fact, fatigue fracture of the bands have been relatively rare up to now. With the modern tendency of utilising shorter pistons, combined with increase in the power output of the engine, it is to be feared that breakages will become more frequent unless steps are taken to remedy the faulty design of the ring groove. The author has designed a special machine by means of which both the ultimate and fatigue strength of the piston band can be tested and the effect of change in ring groove shape investigated. If the corner or neck of the groove has constant curvature, the maximum stress concentration occurs near the point of juncture of the circular corner with the band, and this stress concentration is the smaller, the greater the radius of curvature. A large uniform radius, however, reduces the available ring space. For this reason the author recommends increasing the curvature of the neck beyond the critical point, *i.e.*, making the junction of the band with the back of the ring groove sharper. This entails machining the ring groove with a special tool, ground to two different radii. In this way the ring space is practically unchanged whilst the fatigue strength of the band is the same as that of the groove of uniform radius.

The Ageing of Lubricating Oil for Diesel Engines. (H. L. Matthijsen J. Inst. Petrol., Vol. 26, No. 196, Feb., 1940, pp. 72-89.) (77/31 Great Britain.)

(1) The catalytic effect of all the relevant metals, with which the lubricating oil comes into contact in the Maybach Diesel engine on the ageing at 230°C. of a paraffin base oil A, has been examined in the oxidation instrument designed by A. Mollinger (centrifugal oil spray).

All the ferrous metals stimulate ageing more or less.

The non-ferrous metals have no catalytic effect, or a negative one.

(2) From investigations into the effect of the addition of copper as very fine turnings to a paraffin base oil (A) and to a naphthene base oil (B) during ageing progressively from 100°C. to 230°C., it appears that the catalytic effect of copper is very different in the case of the two lubricating oils.

With the paraffin base oil the catalytic effect up to 180°C. is clearly but weakly positive, whereas above 180°C. copper strongly represses the ageing.

There is only a slight catalytic effect over the whole range of temperature with the naphthene base oil.

The Investigation of Rapidly Changing Mechanical Stresses with the Cathode Ray Oscillograph. (S. L. de Bruin, Philips Technical Review, Jan., 1940, pp. 26-8.) (77/32 Great Britain.)

The cathode ray oscillograph has been adapted to measuring extremely small changes in shape in mechanical structures, and these are assumed proportional to the stresses. The deformations are transmitted to an electrical resistance of which one end is fixed to the specimen. The electrical resistance is a piece of flexible insulating material upon which a line is drawn with a suspension of powdered charcoal. The terminal contacts are of silver, and for small vibrations the resistance varies directly with the change in length. A potential varying with the resistance is transmitted to the plates of the oscillograph. The article discusses the sensitivity of the apparatus, its calibration for absolute measurement

and the limits of the deformation for linear variation of the resistance. (Abstract supplied by Metropolitan Vickers Research Department.)

Spring Joints in the Construction of Measuring Instruments. (H. Stabe, Z.V.D.I., Vol. 83, No. 45, 11/11/39, pp. 1189-96.) (77/33 Germany.)

By comparison with point, spindle and knife edge bearings, wires and bands, which are subjected to bending and torsion by the forces to be measured, offer the advantage of considerably smaller internal friction, and therefore greater sensitivity. The reliability and transportability of such instruments is also important. The disadvantage, that the angular deflection is limited and the spring joints are subjected to directional force can be avoided by balancing the forces to be measured against forces in the springs. Examples are given, and illustrated by sketches, of the use of the spring joints in acoustics (tuning forks, strings), mechanics (spring balances and dynamometers, pendulum and balanced suspensions, torsion balances, balance wheels, membranes, tube corrugated tube and leaf springs, etc.), and in electro-technology (band suspension of galvanometer coils, vibration galvanometers, oscillographs, electrometers with metallised quartz fibres, electro-magnetic measuring instruments with spiral spring suspension). Brief reference is made to the properties required of the materials of the springs, calculation of the latter (effect of shape and of cross section), their mounting and damping.

Measurement of the Thickness of Non-Magnetic Layers. (W. Redepenning, Z.V.D.I., Vol. 83, No. 38, 23/9/39, p. 1071.) (77/34 Germany.)

An instrument has been designed as follows:—A measuring knob, which is pressed firmly on to the layer to be measured, contains a coil through which alternating current passes and an iron core. When this is brought near to a piece of iron the impedance of the coil increases to an extent depending on the proximity of the external iron. Thus, after suitable calibration the impedance of the coil serves as a measure of the distance between the pole shoe of the coil and the surface of the iron part, *i.e.*, as a measure of the thickness of the surface layer. This measurement is made in the usual way by a bridge connection and the thickness read off on an electrical measuring instrument graduated in μ. All parts necessary for the measurement are enclosed in a special casing and separate measuring knobs are provided for use on plain and curved surfaces. By suitable adjustment of the sensitivity of the instrument any thickness of layer can be measured to an accuracy of ± 1-2 per cent.

Measurement of Impact Strains by a Carbon Strip Extensometer. (R. Fanning and W. V. Bassett, J. App. Mech., Vol. 7, No. 1, March, 1940, pp. A24-8.) (77/35 U.S.A.)

A method of experimentally ascertaining the actual stress time curve in a mechanical part subjected to an impact blow is described. The apparatus consists of a resistance strain gauge in conjunction with a high speed recording oscillograph, the combination being sufficiently rapid in response to record strain variations occurring within a few micro seconds. Consequently, the strain during impact are recorded with sufficient accuracy for detailed analysis.

Longitudinal strain waves in long bars striking end to end have been subjected to theoretical analysis and have served as a subject for testing of the apparatus. The theory is reviewed in this paper, and computed results based thereon are compared with experimental data. The agreement is shown to be satisfactory, the form being as predicted and the magnitude within a few per cent. of the computed value.

The strain waves and refections occurring in this simple case are surprisingly complex. An investigation of other impact problems by this method such as the

correlation of standard impact tests of materials, might well yield information of considerable value.

The Polishing, Plating and Anodising of the Aluminium Light Alloys. (E. E. Halls, Metallurgia, Feb., 1940, pp. 123-6.) (77/36 Great Britain.)

A description is given of the physical and chemical properties of aluminium and its light alloys, in so far as these affect the general machining and electro-plating of these metals. The final stages of polishing and the use of lacquers are dealt with in detail. Regarding electro-plating, the importance of each operation is explained, and how a sound surface may be obtained which shall give some protection against mechanical maltreatment and corrosion. The review given of anodising extends over pre-cleaning, the choice of suitable electrolytes for different alloys, impurities, pigmenting and the nature of the final film, with a recommendation as to the best selection of these actions for resistance to corrosion. (Abstract supplied by Metropolitan Vickers Research Department.)

Modern Precision Grinding Methods. (R. Brule, Airc. Eng., Feb., 1940, pp. 49-55; translated from Rev. Techn. Hispano Suiza, No. 5, July, 1939.) (77/37 Great Britain.)

For production of components requiring extreme precision in manufacture, grinding wheels are replacing other tools. The nature of the agglomerant, the abrasive, shape of the workpiece and speed of revolution are considered in turn. Particular attention is paid to methods of supporting the work piece for various grinding cuts, including the case of shaped grinders. Details of thread cutting by these tools are given, together with a method by which the accuracy may be checked while the operation is in progress.

The application of grinding to the elastic watertight joint of the cylinders of Hispano-Suiza liquid-cooled engines is described. (Abstract supplied by Metropolitan Vickers Research Department.)

Elastic Theory Involving Finite Displacements (Part II). R. Kappus, Z.A.M.M., Vol. 19, No. 6, Dec., 1939, pp. 344-361.) (77/38 Germany.)

The general theory developed in Part I is applied to problems of stability of rods, plates and shells.

The special case of the buckling of a tube under torsion is treated by the energetic criterium, and a physical interpretation is given of some of the terms in the resulting differential equations, which throws a light on the problem of resistance to buckling.

Speaking generally, it appears that small terms involving the moment balance at the element must be retained, but that those depending on complete isotropy of the material may be neglected when evaluating the equations.

The elimination of terms before the final stages of the investigation is, however, always dangerous since, although the terms may appear to be negligibly small compared with others which are retained, these latter terms may finally cancel out and the correct answer will thus depend on the very terms which had been neglected.

Heat Treatment of Steel by High Frequency Currents. (G. Babat and M. Losinsky, J. Inst. Elec. Engs., Vol. 86, No. 518, Feb., 1940, pp. 161-8.) (77/39 Great Britain.)

There has recently been a great increase in the use of high frequency currents for heat treatment of metals, in such processes as surface hardening, cementation and alloying, welding, hot machining, and zonal tempering. The paper deals chiefly with surface hardening.

After giving an account of the advantages of the process and an estimate of the power requirements, the authors deal with the design of the heating coil in relation to the shape of the specimen, and describe a " model " method whereby the distribution of the electro-magnetic field in the system may be investigated.

Curves are plotted from the authors' experimental results to show the distribution of temperature and current density over the specimen, and the variation of the power absorbed, during the heating period.

The effect of frequency upon the depth of penetration of eddy currents in steel is examined, and consideration is given to the relation between the depth of penetration and the shape of the surface being treated.

Results obtained from the application of the high frequency method to the hardening of tools and gears are discussed.

On the Natural Frequencies of Vibrating Systems. (R. V. Southwell, Proc. Roy. Soc., Vol. 174, No. 959, 8/3/40, pp. 433-457.) (77/40 Great Britain.)

On the basis of a theorem due to Lord Rayleigh and relating to the effect on the natural frequencies of an added mass, methods are developed whereby lower limits can be imposed upon the frequencies of a specified system. Since upper limits can be imposed on the basis of " Rayleigh's principle," information so obtained is for practical purposes of equal value with an exact solution.

The methods can be applied as an extension of the " relaxation " technique, and it is then that their value is revealed most clearly. In this paper attention is confined to continuous systems governed by differential equations, and for these a method is developed whereby specially close estimates of the fundamental frequency can be made if desired.

The concluding section of the paper is concerned with the resolution of a paradox presented by Lord Rayleigh's theorem regarding the effect of a constraint.

As is well known, the natural transverse frequencies of a uniform bar with both ends completely free are higher than if the bar is simply supported. The effect of constraint is thus to lower the frequency in this case in apparent contradiction to Rayleigh's second theorem. Closer investigation of this particular case shows, however, that the relations imposed by momentum conditions in the case of the free bar have the same effect as the relations imposed by clamps prohibiting terminal slopes. The degrees of freedom are thus not reduced and Rayleigh's second theorem does not apply.

An Investigation of Sheet Stiffener Panels Subjected to Compression Loads with Particular Reference to Torsionally Weak Stiffeners. (L. G. Dunn, N.A.C.A. Tech. Note No. 752, Feb., 1940, 39 pp.) (77/41 U.S.A.)

PART I.—Methods are developed for calculating :—

(*a*) The buckling stress of a plate in which the edges parallel to the applied end load are elastically supported and the other two sides are simply supported. The elastic edge support corresponds to the restraining moments induced by the stiffener on the buckling of the sheet.

(*b*) The maximum wave amplitude of the buckled sheet as a function of the stiffener stress and the buckling stress of the sheet. Preliminary work done on theoretical calculation of the stiffener stresses is given in Appendix A.

PART II.—Experimental results are given for tests on 183 panel specimens of 24 ST aluminium alloy of three different thicknesses, stiffened by bulb angles of twelve different shapes, spaced at 4 and 5 inches. Bulb angles from 3 to 27½ inches long were tested as pin-end columns. The experimental data are presented as stress-strain and column curves and in tabular form and compared with theoretical results.

The scope of the tests was insufficient to formulate general design criteria, but the results are presented as a guide for design and an indication of the type of theoretical and experimental work needed.

Effect of Pressing Conditions and Composition on the Properties of Laminated Synthetic-Resin Pressed Plastics. (W. Kuch, Z.V.D.I., Vol. 83, No. 52, 30/12/39, pp. 1309-16.) (77/42 Germany.)

The optimum pressing conditions for production of high grade laminated materials with a binder of phenolformaldehyde resin have been determined. With wood as filler the optimum resin content is about 10 per cent. (referred to the weight of the final material); with cellulose strips it is 26-33 per cent., and with strips of fabric 33-38 per cent. In the case of synthetic resin compressed wood use of pressures higher than 200 kg./cm.^{2} causes destruction of the structure. Production of cellulose and fabric-filled materials of small deformability necessitates use of highest possible compression pressures. Urea resins show advantages as binders for compressed wood. Laminated materials prepared with polyvinyl chloride have low strength and high sensitivity towards moisture. The large deformability of fabric-filled materials can be reduced by hardening the fabric under tension or by pre-treatment. By using a special fabric in this way it is possible to prepare a compressed material for which the strength value, referred to weight, is equal to that of steel. By simultaneous use of several fillers (wood, cellulose, and strips of fabric) materials with improved properties may be prepared. The mechanical properties of these materials may be suitably judged on the basis of micro-photographs of their structure.

Corrugated Panels Under Combined Compression and Shear Load. (P. A. Sanderson and J. R. Fischel, J. Aeron. Sci., Vol. 7, No. 4, Feb., 1940, pp. 148-153.) (77/43 U.S.A.)

An investigation was conducted on a semi-monocoque box beam to determine the combined stress interaction curve for a corrugation skin type of construction under combined compression and shear load. The investigation included the determination of initial buckling stresses and a comparison of measured stresses with computed stresses on the box beam.

The interaction curve presented is most closely represented by the expression $R_c + R_s^{1.7} = 1$ where R is the appropriate stress ratio. Curves of effective width of skin versus corrugation stress, initial buckling stresses for several skin thicknesses, as well as the combined stress interaction curve are included.

It is probable that the addition of shear stresses to compression stresses in structures of this type lowers the effective width of skin acting with the stiffeners, but no proof of this is available. However, many investigators have noted that a very small amount of shear load changes the buckles in the skin from pure compression waves to prevailing buckles of the shear (diagonal tension) type, and the observations made during these tests agree. At any rate, shear stresses do lower the initial buckling stresses, but quantitative data are not available.

Contribution to the Study of Dissolution Potentials. (N. Goldowski, Pub. Sci. et Tech., No. 158, 1939, 102 pp.) (77/44 France.)

Corrosion phenomena depend not only on the metal in question, but also on the attacking medium, and corrosion of a metal can thus be studied only in presence of an absolutely defined medium. The metal dissolves as positive ions, and this dissolution of electric charges creates a difference in potential between the solid surface and the liquid bath, and the corresponding electrical field then brings about equilibrium in the diffusion of the ions; the equilibrium potential difference must thus have a definite value if the constitution of the solid surface and that of the bath are perfectly definite and if capable of measurement, this can be used to characterise the solubility of the metal in the bath considered. But it is only possible to measure the total difference in potential between the electrode studied and a reference electrode in contact with the same electrolyte. This quantity is defined as the dissolution potential, and it has been measured, using a normal calomel electrode as the reference electrode. It has been found

to depend on the surface layer of the metal, the conditions of formation of which have been studied. Some examples of variation in potential, disclosed by the coloriscopic method, led to an experimental study which enabled a relationship to be set up between the curves for potential as a function of time and susceptibility to corrosion of certain light alloys. The report concludes with a study of applications of the method, in particular a study of the variation in potential for steel with temperature of heat treatment.

Effect of Plastic Deformation on the Age Hardening of Duralumin. (R. W. Lindsay and J. T. Norton, Trans. Amer. Inst. Min. Metall. Eng., Vol. 133, 1939, pp. 111-9.) (77/45 U.S.A.)

The behaviour of commercial aluminium. (1) Aged in the normal way; (2) aged after cold-working; and (3) cold-worked after normal ageing, was compared on the basis of measurements of hardness, electrical conductivity and X-ray investigations. The samples were heat treated for one hour at 515° and quenched in water. Ageing took place in constant temperature baths at 25, 100, 190 and 300° (duration up to one week). After definite time intervals the samples were taken from the baths, investigated at 25°, and then given further ageing treatment in the baths. Mechanical deformation was obtained by taking original test bars of ½ in. diameter, cutting down to various diameters and then drawing with a draw plate to the same final diameter. The experimental results, in particular the hardness curves, show that the normal process of ageing takes place in three overlapping stages. At 25° a lattice disturbance occurs (increase in hardness and resistance). No change is observed in the position or breadth of the X-ray lines. The second stage begins at 100°—another increase in hardness, but slight decrease in electrical resistance. The third stage, clearly noticeable at 190° is characterised by general structural change (increase in hardness, with decreasing electrical resistance and increasing lattice parameter). At 300° the process takes place so quickly that the first and second stages can no longer be clearly observed. A lattice disturbance, similar to that of the first stage of ageing, can be obtained by mechanical deformation, but this mechanical disturbance is not identical with the spontaneous lattice disturbance due to ageing; mechanical deformation causes broadening of the X-ray lines. The general structural change takes place in the deformed samples at the same temperatures and in the same manner as in the undeformed samples. Deformation of age-hardened samples causes simple mechanical disturbance of the lattice.

The Behaviour of Thin-Walled Tubes Under Internal Pressure. (R. Moufang, Z.A.M.M., Vol. 20, No. 1, Feb., 1940, pp. 24-37.) (77/46 Germany.)

The author investigates the stress and deformation of a thin-walled circular tube under hydrostatic pressure on the assumption that both the ends and the external surface of the tube have no forces acting on them. It is further assumed that the plastic deformation is independent of time, and that, therefore, the equations of Mises as well as the strain-hardening law of Schmidt can be applied, the volume remaining constant.

In the case of linear strain-hardening, the stresses and deformations are expressed explicitly. In this case the stresses (but not the deformations) are found to be independent of the strain-hardening to a first approximation.

Strength Properties of Light Metal Screws. (F. Bollenrath, H. Cornelius and W. Siedenburg, Z.V.D.I., Vol. 83, No. 44, 4/11/39, pp. 1169-73.) (77/47 Germany.)

Light metal screws, which give considerable weight economy by comparison with steel screws, also assist in reducing corrosion and thermal stresses when used in assembling light metal parts. So far they have hardly been used at all, since insufficient data has been available regarding their properties. A compara-

tive investigation has therefore been made of the strength properties of light metal and steel screws under static and alternating stress and of their behaviour on tightening and loosening. The light metal screws, of ordinary commercial sizes, were made from a ductile alloy of the Al-Cu-Mg class and from an alloy of the same class with addition of lead, comparison being made with unalloyed steel screws of equal yield ratio. The strength tests comprised determination of tensile strength, fatigue bending strength and fatigue tension strength (no load reversal), full data for which are given. Results showed that chromium plating and electrolytic oxidation are not advisable, but that light metal screws are practically equivalent to the corresponding steel screws. For fatigue stressing, however, a lower initial stress should be chosen.

Smooth Skin Riveting in German Aircraft Construction. (W. Pleines, Z.V.D.I., Vol. 83, No. 37, 16/9/39, pp. 1037-1041; No. 38, 23/9/39, pp. 1057-1060.) (77/48 Germany.)

The importance of a smooth skin in modern high speed aircraft necessitates special attention being paid to the riveting. A number of N.A.C.A. and British reports on the effect of rivet heads on minimum profile resistance of the wing as well as their effect on the water resistance of flat plates are reviewed by the author.

For this reason flush rivets have been employed by German aircraft constructors for some time for the whole of the wing surface and for at least the front one-third of the fuselage.

An additional reason for such rivets is the recently discovered fact that the icing up of wings is greatly facilitated by the presence of protuberances such as rivet heads.

Flush riveting can be either of the normal countersunk type in which the rivet head fits, the plates remaining flat, or a certain amount of deformation of the material is produced in the neighbourhood of the rivet shaft during the process of insertion so as to make room for the rivet head, when the rivet is hammered. The latter process is used in Germany as it is more suitable for thin skins, the countersinking of which by drilling would be difficult. The rivet is generally introduced from the outside, as the reverse procedure requires the use of special mushroom rivets and more skill on the part of the operator. The tools are generally pneumatic and operate on the so-called indirect principle, *i.e.*, the blows act on the rivet head whilst the actual closing up of the shaft is due to the inertia mass held by hand. In order to prevent injury to the material, especially in the case of anodised sheets, it is customary to surround the die with a cushion of plastic material such as aluminium.

A Theoretical Investigation of Plastic Torsion in an I-beam. (D. G. Christopherson, J. App. Mech., Vol. 7, No. 1, March, 1940, pp. A1-4.) (77/49 U.S.A.)

The distribution of stress in an I-beam in torsion is investigated by a method of successive approximation, and the regions of initial yielding are determined for several values of the angle of twist. Formulas are given for elaborating the methods of Southwell (1) and of Shortley and Weller (2) in order to facilitate this determination.

The value of the stress concentration factor in the fillets is found to agree well with results obtained by soap film tests, and regions of plastic flow approximate closely to those observed by McGregor and Hrones (3) by the use of the etching method.

Stress Concentration Factors Around a Central Circular Hole in a Plate Loaded Through Pin in the Hole. (M. M. Frocht and H. N. Hill, J. App. Mech., Vol. 7, No. 1, March, 1940, pp. A5-9.) (77/50 U.S.A.)

This paper deals with factors of stress concentrations in plates of finite width with central circular holes loaded through pins or rivets. Two sets of results are

presented, one from oversize aluminium specimens in which the stresses were determined from strain-gauge measurements, the other, from photo-elastic tests with small bakelite models. The two investigations were conceived and executed independently. The tests involving the use of strain gauges were made at aluminium research laboratories and the photo-elastic tests were made at the Photo-elastic Laboratory of the Carnegie Institute of Technology.

While most of the tests involved plates loaded through a single pin in a hole on the longitudinal centre line of the plate, several tests were made on plates loaded through two pins symmetrically situated about the centre line of the plate. Numerical values for the stress concentration factor k are given for ratios of hole diameter to width of plate ($2r/D$) ranging from 0.086 to 0.76.

The Distribution of Load on the Threads of Screws. (J. N. Goodier, J. App. Mech., Vol. 7, No. 1, March, 1940, pp. A10-16.) (77/51 U.S.A.)

The distribution of load on the threads of screws and the types of deformation affecting it have been investigated by means of extensometer measurements made on the outside of the nut. The types of deformation characteristic of concentrations of load on different parts of the thread were found by using a bolt carrying only a single turn of thread. At low loads the deformations of nuts with complete bolts closely resemble the effects of the artificial concentration of load on the base part of the thread, whereas there are marked contrasts with the effects of loads concentrated at the middle or at the free end. At higher loads a more uniform distribution is indicated. Similar conclusions follow from the application of an approximate method for deducing the distribution from the deformation measurements.

It is shown that the distribution is governed by (*a*) stretch and compression in bolt and nut, respectively, which are primarily responsible for concentration at the base; and (*b*) by bending of the thread, circumferential stretch (at the base), and contraction (near the free end) of the nut wall, which have comparable effects in reducing the concentration.

Deformation and Fatigue of Metallic Materials as Detected by X-Rays. (F. Regler, Forschungsarb. Metallkunde Rontgenmetallog., No. 26, 1939, 98 pp.) (77/52 Germany.)

Deformation of metals causes both peripheral and radial broadening of X-ray diffraction spots. A number of examples of peripheral broadening brought about by cold deformation and fatigue are shown. With moderate reductions the spots tend to merge to form lines and with increasing reduction the well known fibre structures result. The significance of radial broadening is discussed. Measurements of this indicate that radial line width tends to a maximum which characterises the material; this is termed the " fracture line width." This was 6.30 mm. for pure iron and as high as 7.80 for some alloy steels. On fractured specimens the line width rises slowly to a maximum at the point of fracture. On notched specimens the width increases abruptly at the notch. The maximum of the line width on materials subjected to fatigue but not fracture was found to indicate where fracture would ultimately occur. Measurement of the line width in and near welds indicated positions of stress concentration. Several practical applications of radial broadening of X-ray lines are given and detailed directions for X-ray study of fatigue damage are given. (From Chem. Absts., Vol. 34, No. 6, 1940, p. 1598.)

Forging and Stamping of Aeroplane Propeller Blades from Magnesium Alloys of High Strength. (S. M. Voronov and L. Y. Shpolyanski, Avia Promyshlennost, No. 2, 1939, pp. 24-33.) (77/53 U.S.S.R.)

Magnesium alloys containing 4.5-5 per cent. Al, 0.5-0.6 per cent. Zn and 0.3-0.5 per cent. Mn are much less easily forged than alloys of the type Dow F. The maximum deformation occurring during forging should not be greater than

20-25 per cent. to prevent destruction of the material. The alloy has a narrower temperature interval of forging than alloys of the Dow type containing 4-4.5 per cent. Al. The recommended temperature interval 330-350°. The stamped blades of the Al-Zn-Mn alloy should be heat treated by either of the following methods:— (i) Heating at 350-400° for 6-12 hours followed by air cooling; (ii) heating at 420° for 2 hours followed by 12 hours ageing at 200°.

Protective Enamel Finishes for Magnesium Base Alloys. (E. E. Halls, Products Finishing, Vol. 4, No. 3, 1939, pp. 42-6.) (77/54 U.S.A.)

Since magnesium is strongly electro-positive, the enamelling and painting of its alloys is difficult and it is necessary to convert the surface into an inert layer by any one of a number of aqueous pre-treatment processes, mostly having a chromate base. Tables are given showing the behaviour of enamelled magnesium alloys in a salt spray atmosphere, in hot and cold humid atmospheres and under weathering; data are given for the alloy composition and the characteristics of the primers and enamels used on the test specimens. All types of exposure tests show the advantages of using chromate pre-treatment or a special primer, in particular of a chromate primer with or without chromate pre-treatment. Appreciable advantages can be obtained by using an ordinary red oxide variety of primer, but the benefit is not so great as with the zinc chromate type. The data given show that satisfactory results are obtainable without departing from normal commercial practice. The groundwork is provided by an aqueous chromate pre-treatment and a synthetic zinc chromate primer. The usual commercial finishing coats are then applied.

A Buna Fabric Gasket Free from Asbestos. (K. Diehl, Autom. Tech. Zeit., Vol. 43, No. 5, 10/3/40, pp. 123-4.) (77/55 Germany.)

Use of asbestos containing materials for packing is not now desirable in Germany from the point of view of the raw material situation. A new type of gasket has therefore been developed from synthetic rubber (Buna). The latter differs from natural rubber in not being liable to soften at high temperature; on the contrary, it is much more inclined to stiffen (due to cyclisation) and therefore can withstand higher temperatures, in the capacity of a packing material, than can natural rubber. The main problem has been to find a suitable filler. The new gaskets have steel inserts, preferably consisting of two layers of metal wire fabric, vulcanised into the synthetic rubber. The meshes of these wire fabrics do not run parallel, but one is displaced by 45°, thereby ensuring high strength. Owing to the elastic nature of the rubber surface the new gaskets fit very closely; they are practically unaffected by heat, not liable to formation of a graphite layer, stable towards hot water, hot oil, glycol, petrol, leaded petrol, various acids, alkalis and organic solvents.

Reciprocity Failure of Photographic Materials at Short Exposure Times. (W. F. Berg, Proc. Roy. Soc., Vol. 174, No. 959, 8/3/40, pp. 559-68.) (77/56 Great Britain.)

Experiments at very high intensities and at various temperatures show that for sufficiently short exposures reciprocity failure disappears. The bend-over point in the reciprocity failure curve is shown to be connected with the mobility and concentration of the interstitial $Ag+$ ions, and below room temperature varies with temperature as the mobility. These results provide further confirmation that the latent image is formed by the aggregation and neutralisation of silver ions on sensitivity specks.

New High Temperature X-Ray Camera. (E. C. Ellwood, J. Inst. Metals, March, 1940, pp. 87-96.) (77/57 Great Britain.)

The camera is designed to study the constitution of aluminium-zinc alloys at temperatures above 275°C. The X-ray tube used is of the demountable, hot-

cathode, continuously evacuated type with an output of 25 m.a. at 50 kv., using copper radiation. To prevent oxidation, the specimen is sealed in a thin silica container; this is placed in a hole drilled in a steel rod, the rod being adjustable from a rotating head. Heating is carried out entirely by radiation from two similar china clay alumina pots placed mouth to mouth with a 2 mm. gap between, the pots being heated by the electric resistance method using bright-ray wire. The film is held to a detachable film carrier which can be removed without disturbing the position or temperature of the camera. (Abstract supplied by Metropolitan Vickers Research Department.)

Heat Transfer in Vibrating Gases. (R. Sinn, Z.V.D.I., Vol. 83, No. 45, 11/11/39, pp. 1197-9.) (77/58 Germany.)

Measurements of heat transfer in vibrating gases were made by a new method depending on compressing a gas, and giving vibratory motion to the piston during compression. From the measured pressure distribution, it is possible to calculate the quantity of heat given up to the wall during compression. These quantities were compared with the corresponding values for heat transfer to the wall during compression without vibration. Experimental results show that when the vibration amplitude of the gas is sufficiently large the heat transfer may be a multiple of the value for a stationary gas. The results are employed to explain the increased heat transfer and associated decrease in power internal combustion engines during knocking.

Measurement of Stagnation Temperature. (W. Wimmer, Ing. Archiv., Vol. 11, No. 1, Feb., 1940, pp. 1-23.) (77/59 Germany.)

If we attempt to measure the temperature of a flowing gas by introducing a thermometer, the flow is naturally disturbed and the temperature will vary depending on the shape of the instrument. At the stagnation point, the flow is brought to rest and if the compression is carried out without loss, the temperature at this point will exceed the static or undisturbed temperature by a definite amount corresponding to the compression work. Thus if

T_w = static temperature of undisturbed flow at velocity W_o.
T_{st} = stagnation temperature.
$T_w = T_{st} - (A \cdot W_o^2)/(2gC_p)$.

Since the last term can be calculated, T_w follows from the measured stagnation temperature. Various shapes of thermometers were investigated by the author, the best result being obtained if the thermocouple was placed a small distance ahead of the theoretical stagnation point. Under these conditions fresh hot air is continually brought into contact with the couple and a higher temperature is indicated than at the stagnation point itself where the heat loss is not compensated (zero flow). By employing a sphere, the error in the recorded stagnation temperature is not more than 1-2 per cent. at high flow rates.

The author investigated arrangements of this type of various dimensions and by applying the laws of similarity to the heat balance, a correction for heat loss is obtained which can be applied to any given thermometer.

The Behaviour of a Long Period Physical Pendulum of One Degree of Freedom and Unresponsive to Acceleration when Moving in a Circular Orbit of Small Radius. (E. Schmid, L.F.F., Vol. 17, No. 1, 20/1/40, pp. 32-36.) (77/60 Germany.)

The case of the so-called 84 min. pendulum which does not respond to acceleration has been treated in a previous report by the author (Yearbook of German Aeronautical Research, 1938, Vol. 3, pp. 6-9) (Air Ministry Translation Nos. 905 and 906).

The author points out in the present paper that for a physical pendulum of great effective length, the variation of the force of gravity along the length must be

considered. This not only affects the period, but also the stability of the vertical as a position of equilibrium.

If the axis of rotation of such a pendulum of one degree of freedom is guided to be tangential to a circular orbit, stability is only obtained in the vertical pendulum position if the diameter of the orbit exceeds a certain value, depending on the velocity of translation in the orbit. For smaller values of the radius, there are two positions of equilibrium, neither of which agree with the vertical. If the orbit is sufficiently large or the time of rotation sufficiently long, a second stable vertical position arises, in which finally (with zero orbit velocity) the centre of mass is vertically above the point of support. The two periodic times at zero orbit velocity and small amplitude are 42.2 and 59.7 min. respectively, depending on whether the centre of mass is below or above the point of support.

LIST OF SELECTED TRANSLATIONS.

NOTE.—Applications for the loan of copies of translations mentioned below should be addressed to the Under-Secretary of State (R.T.P.), Air Ministry, Dept. ZA, London, W.C.2, and will be loaned 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.
983	Kalikman, L. E. ...	*Effect of Profile Form on Friction Drag. Investigation of the Turbulent Boundary Layer in the Region of Breakaway.* (C.A.H.I. (Moscow), Report No. 333, 1937.)
993	Lazzarino, L. ...	*Investigations on Airscrews for High-Speed Aircraft.* (L'Aerotecnica, Vol. 19, No. 7, July, 1939, pp. 760-780.)
995	Vladomiroff, A. N....	*The Approximate Hydrodynamic Calculation of an Underwater Wing of Finite Span.* (C.A.H.I. (Moscow), Report No. 311, 1937.)
1016	Kosberg, S. A. ...	*Lubrication of High Pressure Petrol Injection Pumps.* (Aeron. Eng., U.S.S.R., Vol. 13, No. 2, Feb., 1939, pp. 56-60.)