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Investigations on Bomb Trajectories—Effect of Changes in Ballistic Coefficient Altitude, Angle and Velocity at Release on the Horizontal Trajectory (Range). (D. Borsani, L'Aerotecnica, Vol. 19, No. 6, June, 1939, pp. 678-684.) (73/1 Italy.)

Starting with the well known Siacci type of solution for the external ballistic problem, the author obtains a difference formula connecting Δx, Δy, $\Delta\phi$, ΔC^1, and ΔV, where

x = range.
y = altitude at release.
ϕ = angle of tangent to trajectory with horizon at release.
C^1 = " reduced " ballistic coefficient of bomb.
V = velocity at release.

From this formula, four factors (C_H, C_φ, C_{C^1} and C_V) are deduced which give respectively the percentage variation in range due to 1 per cent. change in altitude, ballistic coefficient and launching speed and due to a 1° change in ϕ.

The case of a 250 kg. bomb (ballistic coefficient 1.75, form coefficient 1) launched horizontally ($\phi=0$) at 120 m./sec. at various altitudes ranging from 1,000 to 5,000 m. is next considered. Over this range of height

C_H = approximately constant and = 0.46.
C_φ varies from 1.4 (at 1,000 m.) to 0.6 (5,000 m.).
C_{C^1} varies from 0.03 to 0.11.
C_V varies from 0.7 to 1.2.

From this it appears that in the case of horizontal bombing, a 1 per cent. change in launching speed gives approximately a 1 per cent. change in range. A 1 per cent. change in altitude at release gives approximately a $\frac{1}{2}$ per cent. change in range. A 1° error in horizontality at release gives 1.1 per cent. change in range. A 1 per cent. change in ballistic coefficient is negligible as regards range. A correct estimation of the launching angle is thus of the greatest importance, especially at low altitudes.

The factors C_H, C_φ, etc., developed above only apply for small changes in the characteristic values, they obviously cannot be applied to convert horizontal into dive-bombing data.

Such trajectories have to be calculated afresh, and this presents no great difficulty using the Siacci Method. Once the elements of such a trajectory are known, the effect of subsequent small changes in the characteristics can be

determined with the help of the C factors obtained above. Thus, in the case of dive bombing

$$C\phi = \{ 1.745 \cos (2\phi - \epsilon) \} / \{ \cos^2 \phi \cos \epsilon \tan w \}$$

where ϕ = angle of release.
w = angle of impact.
$\epsilon = \tan^{-1} y/x$.

The actual calculation is not carried out in the present paper, but the author hopes to return to the subject in a further issue.

ABSTRACTOR'S NOTE.—Similar difference formulæ to those developed by the author are given by Cranz "Lehrbuch der Ballistik," Vol. 1, p. 284. Complete tables for the Siacci solution are also given in an appendix to this volume.

Motor Fuel Supply for the French Air Force. (Flemmig, W. T. M., Vol. 43, No. 10, October, 1939, pp. 414-6.) (73/2 France.)

To assist the fuel requirements of the French Air Force it is proposed to erect four hydrogenation plants having a total yearly output of 230,000 tons of high octane aviation spirit. Two of them, of capacity 100,000 tons and 70,000 tons respectively are to be erected on the Atlantic coast and will employ fuel and gas oils exclusively as raw materials. The third plant, of 30,000 tons output to be erected on the Mediterranean coast, will also treat fuel and gas oils, but provision is to be made for treatment of brown coal if necessary. The fourth, of similar capacity, will be situated in the centre of France and is to employ bituminous coal as raw material.

The plan is not yet finally settled on account of the enormous costs of the plant. The present two experimental plants at Liévin and Bethune, each of 5,000 tons annual output, have together cost about 180 million francs, at the present rate of currency, and the cost of producing synthetic petrol is eight to ten times the import price.

Bombardment of the Battle Field. (Rev. de l'Arm. de l'Air, No. 118, Sept.-Oct., 1939, pp. 574-5.) (73/3 Japan.)

A Russian account is given of the technique employed by the Japanese in bombing battlefields. Individual dive bombing attack is carried out as follows:—

The aeroplane approaches obliquely at about 800-1,000 m., for easy observation, then turns sharply through 30-40° and dives on the objective at an angle of 60-70° down to an altitude of 400 m. The velocity which was originally of the order of 140 km./kr., increases to 300-340 km./kr. with the ordinary aircraft in use. The manœuvre is completed by escaping in a turn to left or right. When the bombardment is carried out by a patrol, the latter commences to perform curves at a distance of 10-12 km. from the object, at an initial altitude of 3,000-5,000 m., decreasing progressively to 1,200-1,500 m.; this is the period during which the objective is observed. Horizontal flight is then maintained during 10-15 sec., in order to get into position, and speed is reduced. At a signal from the patrol leader the machine dives and escapes by a turn.

The bombs employed for dive bombing are generally 100 kg. According to the Japanese, the methods employed by them have the advantages of simplicity of execution without specialised observers, precision in aiming and small vulnerability from A.A. fire.

The Military Importance of the Stereoautomatic Device for Evaluating Films of Anti-Aircraft Target Practice. (H. Brandli, Flugwehr und Technik, Vol. 1, No. 8, August, 1939, pp. 217-219.) (73/4 Switzerland.)

The shell bursts near a towed target are recorded simultaneously on two Askania cine theodolites placed at the ends of a known base. The stereoautomatic device enables the co-ordinates of the shell burst relative to the target

as well as the resultant distance of the explosion to be obtained very quickly. Thus the total time required to measure up ten bursts is of the order of eight minutes, including the developing of the film. It is thus possible for the gun crew to judge the accuracy of each shot whilst the circumstances of the firing are still fresh in their minds.

A direct comparison between the relative accuracy of manual gun control and that given by the " gamma " predictor gear is of interest. It appears that the " placing " of the shell burst by a single observer is very difficult and that in many cases the automatic predictor gear gives the better results.

The author is of the opinion that apart from training the rapid evaluation of firing films will be most useful in maintaining the high standard required by A.A. batteries in war time.

Main Considerations for the Selection of Military Pilots. (H. Meier-Muller, Plugwehrund Technik, Vol. 1, No. 8, August, 1939, pp. 221-223.) (73/5 Switzerland.)

According to the author, 70-80 per cent. of all flying accidents are due to errors of judgment of the pilot.

It is thus essential that the mental make-up of the pilot be such that quick decisions come to him naturally. Mental alertness, on the other hand, depends largely on physical conditions and the health of the pilot, *i.e.*, his ability to withstand the physical strain of modern high speed flying is thus of great importance.

Over and above these requirements, the military pilot must be amenable to discipline, courageous, and ready for any sacrifice.

The organic health and resistance to special flight conditions (acceleration, cold, lack of oxygen, etc.) of the candidate are tested relatively easily. Mental alertness and general psychological qualities as well as character and general suitability for leadership are factors which cannot be expressed numerically, and although most of the modern air forces have devised psychological tests, the results are only of value if interpreted by men of large experience.

It appears that the main difficulty is the youth of the military pilot. Speaking psychologically, the applicant is immature and undergoing rapid development. As a result a judgment in mental make-up may require subsequent revision.

Petroleum for Germany at War. (B. T. Brooks, Ind. and Eng. Chem. (News Ed.), Vol. 17, No. 21, 10/11/39, pp. 679-680.) (73/6 Germany.)

If Germany is able to secure the whole of Russia's exportable surplus of petroleum and a similar amount from Rumania she will have sufficient war supplies without drawing on the reserve of 35-40,000,000 barrels, which has been accumulated since 1934.

Germany's war requirements are estimated to be about 75,000,000 barrels per annum. Without Russian and Rumanian assistance she will be able to raise only about one-third of this quantity. No accurate figures are available for production of oil from coal.

As regards aviation fuel, production of high octane fuels is a matter of difficulty. The product from the Fischer-Tropsch process has a very low octane rating and it has to be cracked or reformed to produce good quality motor spirit. The Bergius product, however, has an octane rating of about 70 and the method of reforming naphthas by catalytic hydrogenation can give a product of 80-82 octane value without addition of lead.

About 20 per cent. of the German Air Force is estimated to operate on Diesel power. An unknown number of machines have been modified for using benzene blends, thus enabling them to use 4,500,000 barrels of benzene for aviation purposes. Fuel injection in place of a carburettor also allows a wider range of petrols to be used for aviation purposes.

Glass for A.R.P. Purposes. (Engineering, Vol. 148, No. 3,855, 1/12/39, p. 618.) (73/7 Great Britain.)

Some forms of glass offer considerable resistance to blast, the resistance of armour plate glass being five of six times that of ordinary polished plate glass of the same thickness. When shattered it breaks in small pieces which are neither large enough nor sharp enough to cause injury. Protection against splinters, though not against bullets, is afforded by $\frac{13}{16}$ in. Triplex-Armourplate, consisting of three layers of armourplate glass with intermediate layers of cellulose acetate. Toughened glass lenses when set in concrete will resist the blast from a 500 lb. high explosive bomb at a distance of 50 feet. The same lenses used in concrete roofs will also withstand the action of incendiary bombs. Vitrolite is suitable for the walls of decontamination chambers because it is non-absorbent and easily washed down.

Detonation of High Explosives in Shell and Bomb and its Effects. (D. D. Logan, British Medical Journal, No. 4,111, 21/10/39, pp. 816-819.) (73/8 Great Britain.)

Quite apart from the direct effect of concussion and splinters, the detonation of high explosives gives rise to large quantities of gas, the CO content of which increases rapidly if the detonation is imperfect. In confined spaces, therefore, casualties may arise due to gas poisoning, the ordinary gas mask affording no protection against CO. But quite apart from their poisonous nature, the gases liberated may form explosive mixtures with the air and in confined spaces (cellars, basements) there is a danger of a possible explosion which may persist for hours after the bombardment. It is therefore essential that only electric torches be used when examining cellars after a raid.

Organisation and Treatment of Air Raid Casualties. (J. Trueta, British Medical Journal, No. 4112, 28/10/39, 877-879.) (73/9 Spain.)

The principal recommendation of this Spanish surgeon (director of the department of surgery of one of the principal hospitals of Barcelona during the Civil War) is that all first aid posts separate from hospitals should be abandoned, as they delayed treatment and increased mortality. More than 30 per cent. of the patients needed operations and rapid admission to hospitals was their only chance; good organisation to ensure rapid transport to the hospital is essential. Arrived there, the patients are rapidly classified into five groups —

(i) Cases for immediate operation and could not be evacuated after treatment.
(ii) Immediate operation and subsequent evacuation.
(iii) Immediate non-operative treatment and no evacuation.
(iv) First aid followed by evacuation to base.
(v) First aid and sent home.

The lecturer made special reference to the type of injuries inflicted by small splinter bombs. These splinters travel mainly in a horizontal direction and are so small that the skin lesion is painless and without hæmorrhage. The internal damage done is, however, very considerable. Owing to the fact that many civilians had been recommended to lie prone during a raid, the splinters were frequently localised in the base of the skull.

On the Sinkage of a Ship at Low Speeds. (T. H. Havelock, Z.A.M.M., Vol. 19, No. 4, August, 1939, pp. 202-206.) (73/10 Great Britain.)

The immersed portion of the ship is assumed to be a semi-ellipsoid, the water surface being the xy plane. Potential flow about this ellipsoid is further assumed, the water surface remaining level. The author next calculates the reduction in the pressure in a vertical direction associated with this flow and deduces the corresponding increase in sinkage.

The results obtained are in agreement as to order of magnitude with those given by the empirical formula of Horn for full-scale ships.

In conclusion the author estimates the increase in the frictional resistance of a model due to sinkage.

On the Velocity Distribution in Turbulent Flow Through a Straight Pipe of Annular Cross Section. (I. Imai and S. Tomotika, Aer. Res. Inst., Tokyo Rept., No. 180, July, 1939.) (73/11 Japan.)

The distribution of mean velocity during the turbulent flow of fluid under pressure through a straight pipe of annular cross section is discussed theoretically on the basis of both the modified vorticity transport and the momentum transport theories of turbulent motion. It is assumed that the turbulence is isotropic and that the mixing length is proportional to the distance from the inner wall in the case of the inner region, whilst in the outer region it is proportional to the distance from the outer wall.

The calculated results are compared with the results of Mikrjukov's recent experiments and it is found that the modified vorticity transport theory gives results in better agreement with observation than does the momentum transport theory for turbulent flow through a straight pipe of annular cross section. A similar conclusion has been reached by Taylor for the case of turbulent flow through a straight circular pipe.

Note on the Effect of the Boundary Walls of a Stream upon the Circulation Round a Plane Aerofoil. (S. Tomotika, K. Tamada and Y. Saito, Aer. Res. Inst., Tokyo Rept., No. 182, August, 1939.) (73/12 Japan.)

The interference effect of the rigid boundaries of a stream upon the circulation round a plane aerofoil is dealt with for the case in which the aerofoil is placed in a semi-infinite stream bounded by a plane wall on the upper or lower side of the aerofoil and between two parallel rigid walls.

In each case it is found that the circulation is greatly affected, particularly when the distance of the aerofoil from the walls is of the order of the chord, or smaller than the chord.

Comparison of the curves for the circulation with the corresponding curves for the lift shows that the alteration in lift of the plain aerofoil due to the walls is mostly caused by the alteration in circulation round the aerofoil.

A critical discussion is made on the applicability of the usual method to the problems of the effect of wall interference on the aerodynamic properties of an aerofoil.

Wind Tunnel Investigation of the Effect of Yaw on Lateral Stability Characteristics, II. Rectangular N.A.C.A. 23012 Wing with a Circular Fuselage and a Fin. (M. J. Bamber and R. O. House, N.A.C.A. Tech. Note, No. 730, Sept., 1939.) (73/13 U.S.A.)

An N.A.C.A. 23012 rectangular wing with rounded tips was tested in combination with a fuselage of circular cross section at several angles of yaw in the N.A.C.A. 7 × 10 ft. wind tunnel. The model was tested as a high-wing, a mid-wing and a low-wing monoplane, each wing position being tested for two values of dihedral and with partial wing span flaps. Specimen graphs of the coefficients of rolling moment C_l^1, yawing moment C_n^1 and lateral force C_Y^1 are given for some of the combinations tested. The rate of change of the coefficients with angle of yaw, ψ', is given for the purpose of stability calculation.

The value of the effect of wing fuselage interference on $dC_l'/d\psi'$ changes sign as the wing moves down from the high to low position with respect to the fuselage, being zero at some intermediate position. In general $dC_l'/d\psi'$ is only slightly affected by wing fuselage interference for a given change in dihedral. Moving the wing from the low to the high position generally tends to increase the values

of $dC_l'/d\psi'$ and $dC_n'/d\psi'$ and to decrease the effectiveness of the fin with respect to $dC_l'/d\psi'$, $dC_n'/d\psi'$ and $dC_Y'/d\psi'$.

Flow Photographs Showing Ground Effect. (H. Muller, Forschung, Vol. 10, No. 5, Sept.-Oct., 1939, pp. 220-6.) (73/14 Germany.)

The ground surface forms a boundary condition in the problem of flow over an obstruction on the ground. In previous model experiments it was customary to reproduce this boundary condition by making the model with an exact counterpart (so-called mirror method), assuming the central plane of the new model to be the plane of symmetry of the flow, and thus acting as a substitute for the ground. However, this is incorrect, since the part of the ground in front of the obstruction gives rise to a friction boundary layer which causes the undisturbed flow to be deflected upwards, while the ground behind the obstruction cuts through the vortex path and neutralises the reciprocal influence of the vortices which detach themselves in pairs above and below, in the case of a duplicate model.

This effect is investigated by means of flow photographs taken both with duplicate models and with a ground plane. For obstacles which move over the ground, similarity between the flow conditions prevailing with a stationary model and with the full-scale object can only be achieved if the ground surface moves at the speed of flow. Pressure distribution measurements on a cylinder show that the critical Reynolds number is reduced by presence of a ground plate in front and bisecting the cylinder.

Different values of the resistance are obtained depending on whether the plate projects both to the front and rear or to the rear only. The latter arrangement gives the smallest resistance in the supercritical range of Reynolds number.

Turbulence, its Cause and Development. (F. Ahlborn, Z. ges. Naturwiss., Vol. 4, 1939, pp. 451-65. Zentralblatt fur Mechanik, Vol. 9, No. 2, 31/10/39, p. 80.) (73/15 Germany.)

The author sets out from the well-known fact that the conditions occurring in the inlet of tubes or channels are essential for formation of turbulence. He has therefore obtained pictures of the flow in a channel with various types of inlet opening. Since in the cases photographed, vortices are formed by a sharp-edged inlet, the author concludes that turbulence will occur at all velocities with this shape of inlet, which is contrary to the experimental evidence of other authors. In his theoretical considerations he also considers the turbulence of flow around bodies and maintains that vortex formation commences at the point of transition from excess pressure to under pressure; this does not agree with the measured results obtained with resistance bodies such as circular cylinders. The author bases his further statements on the assertion that the picture of turbulence is different if it gradually develops in wide channels at low velocity, and different again if it suddenly breaks out in full strength in narrow channels at large critical velocities. This statement violates Reynolds law of similarity, which can be regarded as fully confirmed, at least at sufficient distance from the inlet, at which the turbulent resistance laws were determined.

The Problem of the Longitudinal Motion of Aircraft Under the Action of Gravity Only. (W. Muller, Z.A.M.M., Vol. 19, No. 4, August, 1939, pp. 193-202.) (73/16 Germany.)

The motion of the C.G. of an aircraft in a vertical plane is determined by a system of two equations for the normal and tangential acceleration respectively. Using rectangular co-ordinates, we obtain

$$\ddot{x} = -vk_a(\epsilon\dot{x} + y)$$
$$\ddot{y} = -g - vk_a(\epsilon\dot{y} - x)$$

where k_a = of lift coefficient.
ϵ = mean gliding coefficient
v = velocity along trajectory.

By assuming that $vk = f(t)$, a known function of the time, the complex co-ordinate of the trajectory can be expressed in terms of ϵ and $f(t)$.

Integration is readily possible if $f(t)$ = constant. A diminution of $f(t)$ with time (either hyperbolically or linearly) is also amenable to methods of computation, although the latter case leads to the use of Fresnel integrals.

The author applies his results to the calculation of "loopings," the aircraft having an original $v_0 = 72$ m./sec. in each case, $f(t)$ being either constant or varying with time as discussed above, the value of $f(t)$ at $t = 0$ being however the same for all three loops.

It appears that in the simplified case of no resistance ($\epsilon = 0$) the three loops do not differ markedly except for the trajectory after the cusp, where the linear variation of $f(t)$ gives an appreciably lower trajectory.

In the presence of resistance ($\epsilon = 0.08$) the area of the cusp of the loop diminishes and the trajectory after the cusp is raised.

(For further details of the author's method, see also Ing. Arch., Vol. 9 (1938), p. 258, and Vol. 10 (1939), p. 63.)

The Expression of Certain Integrals Occurring in Wing Vibration Investigations by Means of Cylindrical Functions. (J. Bonder, Z.A.M.M., Vol. 19, No. 4, August, 1939, pp. 251-252.) (73/17 Germany.)

The following four definite integrals are of importance in the Wagner-Glauert theory of non-steady lift of a harmonically vibrating profile in a two-dimensional flow:—

$$\int_0^\infty \{ \sin 2kx/(x+x^2)^{\frac{1}{2}} \}\, dx; \int_0^\infty \{ \cos 2kx/(x+x^2)^{\frac{1}{2}} \}\, dx;$$

$$\int_0^\infty \{ (1+1/x)^{\frac{1}{2}} - 1 \} \sin 2kx\, dx;$$

$$\int_0^\infty \{ (1+1/x)^{\frac{1}{2}} - 1 \} \cos 2kx\, dx.$$

These integrals have been evaluated by Glauert for a few values of the parameter k using the method of series (R. & M. 1242).

Borbely and others have since shown that the integrals can be expressed in a closed form in terms of cylindrical functions. All proofs submitted so far are, however, rather lengthy and complicated.

The author shows that by making the fundamental substitution—

$$2x = \cos t - 1$$

the first two integrals of the above list at once take the form of Bessel and Neumann cylindrical functions of zero order. The remaining two integrals are similarly reducible to Neumann functions with very little extra trouble.

Tests in the Gust Tunnel of a Model of the XBM-1 Aeroplane. (P. Donely and C. C. Shufflebarger, N.A.C.A. Tech. Note No. 731, October, 1939.) (73/18 U.S.A.)

In connection with a general investigation of the loads imposed on aircraft structures by atmospheric gusts, a dynamically scaled model of the biplane XBM-1 has been tested in the gust tunnel with several types of gust.

The tests consisted of flights over the gust tunnel at fixed values of the forward velocity and of the average maximum gust velocity. A minimum of five flights

was made for each of the three gust gradients. Measurements were made of flight velocity, gust velocity, normal acceleration, vertical displacement and pitch.

Good agreement was obtained between the experimental results and the values calculated by means of the theory of unsteady lift of monoplanes for gust gradient distances up to 12 chord lengths. The calculations were based on the assumption that the wings of a biplane act independently in an unsteady flow, and the mean slope of the lift curves of the two wings and the mean chord of the cellule were used in conjunction with data on the unsteady lift of finite wings.

A Simple Method of Obtaining Span Load Distributions. (A. Sherman, N.A.C.A. Tech. Note No. 732, October, 1939.) (73/19 U.S.A.)

The proposed method for determining span load distributions of wings is based on the method of superposition. The first step is to determine a chord distribution which will correspond to an elliptical loading and the given distributions of angle of incidence and the lift-curve slope. The differences between this imaginary chord distribution and the actual one determine the smaller component loads to be added to the initial elliptical loading to produce a new span loading which more nearly satisfies the given problem. This procedure is repeated, but the successive series of additional component loads rapidly become zero.

The method should enable the span load distribution to be obtained by a straightforward arithmetical procedure. Charts have been included to assist in the calculations. It is noted that the interference loads induced at the tips of each additional component load must not be overlooked, and also that the accumulation of computing errors may become serious in problems requiring the addition of many series of component loads. At any stage in the process the accumulation of inaccuracies can be removed by a separate check of the associated induced angle distribution.

Tests in the Variable Density Wind Tunnel of the N.A.C.A. 23012 *Aerofoil with Plain and Split Flaps.* (I. H. Abbott and H. Greenberg, N.A.C.A. Tech. Rept. No. 661, 1939.) (73/20 U.S.A.)

Aerofoil section data for use in wing design have been determined for the N.A.C.A. 23012 aerofoil with plain and split flaps of 20 per cent. wing chord at an effective Reynolds number of about 8,000,000. The flap deflections covered a range of from 60° upwards to 75° downwards for the plain flap, and from zero to 90° downwards for the split flap. The angle of incidence range extended from below zero lift to beyond maximum lift for all conditions and was extended through negative maximum lift for most of the settings of the plain flap. As applied to this aerofoil section the split flap was superior to the plain flap in producing high maximum lift coefficients, in having slightly lower profile drag coefficients at the lift coefficients used in take-off, and in having smaller pitching moment coefficients for equal maximum lift coefficients. Both types were unsatisfactory in producing low profile drag coefficients at the lift coefficients used in take-off as compared with low drag slotted flaps.

Determination of the Profile Drag of an Aeroplane Wing in Flight at High Reynolds Numbers. (J. Bicknell, N.A.C.A. Tech. Report No. 667, 1939.) (73/21 U.S.A.)

Flight tests were made to compare the profile drag coefficient of a portion of the original surface of an all-metal aeroplane with that of a portion of the wing which had been made aerodynamically smooth and more nearly mechanically smooth than the original section. The test panel was sufficiently far removed from the slipstream to avoid interference, and tests were carried out over a range of velocities giving a maximum Reynolds number of 15,000,000. Tests were also made to determine the point of transition from laminar to turbulent boundary layer and to determine the velocity distribution along the upper surface of the

wing. The profile drag coefficients of the original and of the smooth wing portions were 0.0102 and 0.0068 respectively. Manufacturing irregularities in rivets, lap joints, etc., are thus responsible for a 50 per cent. increase in profile drag coefficient. The boundary layer surveys on the upper surface of the smooth wing showed that transition from laminar to turbulent boundary layer occurred at a position farther forward on the section tested than would have been expected on a true N.A.C.A. 2414 five section. Differences in the position of the transition point could easily account for the slight differences in the profile drag coefficients of the N.A.C.A. 2414 five section found in flight and in the D.V.L. and variable density wind tunnels. The boundary layer surveys showed that transition occurred at a short distance downstream from the point of minimum pressure.

Parachute for Fast Aeroplanes. (American Aviation, Vol. 3, No. 10, 15/10/39, p. 12.) (73/22 U.S.A.)

A new Italian parachute, Salvator D.39, has been designed to resist violent shocks submitted when the jumper leaves a fast military plane. In the device, a canopy has been constructed with an elastic hole in its summit which dilates when the canopy opens, so that the shock is reduced. When speed is stabilised the hole closes gradually until normal braking is realised. The auxiliary extracting parachute is of silk and is provided with a spring which causes it to open in any position. The parachute's total weight is about 17½ lbs.

Calculation of a Steady Turn. (E. V. Ostoslavsky, Aeron. Eng., U.S.S.R., Vol. 13, No. 9, Sept., 1939, pp. 24-43.) (73/23 U.S.S.R.)

By a steady turn is understood one in the horizontal plane at constant angular velocity, constant velocity along the path, constant angle of incidence and constant angle of bank. The mechanics of this manœuvre are quite simple and calculation presents no difficulty, but in the greater majority of cases there is found to be considerable discrepancy between calculated results and actual flying data. The radius of the actual turn is smaller than the calculated value. The present paper attempts to explain the causes of this discrepancy and proposes a more accurate method of calculation.

Numerical results given show the importance of correct choice of initial data, in particular the necessity for correcting the polar curve of the model aeroplane for the effect of re-number, not only in the region of $C_{x\ min}$ as is usually done in aerodynamic calculations, but also in the region of $C_{y\ max}$; the effect of propeller interference must also be taken into account.

Until full and reliable data are obtained by experiment, correction of the polar for change in $C_{y\ max}$ when converting to the re-number corresponding to natural conditions may be made in future by the method described. The slipstream effect may be calculated by the method proposed by V. S. Vedron and the present author. For convenience in calculation a graph is given for determining the requisite coefficient for single-turn and four-engined aircraft.

Aviation on the Ground; Factors Determining the Design of Military Landing Grounds. (Rev. de l'Arm. de l'Air, No. 118, Sept.-Oct., 1939, pp. 483-7.) (73/24 France.)

In order to present minimum vulnerability towards air attack, landing grounds must be designed to have the smallest possible total surface. This requirement leads to the system of tracks, arranged in such a way as to avoid focal points. The system of radiating tracks proposed by Ssegedi is thus eliminated. Natural camouflage (trees, houses) should be left between the runways. The arrangement adopted should also permit:—(1) Normal departing of all the aircraft constituting a tactical unit, either simultaneously or within a short time interval; this can be achieved by take-off in file or simultaneous departure in two or three directions, subsequently assembling in the air; (2) sudden evacuation in case of

attack; (3) rapid removal of any aeroplane which has landed in difficulties, this gives the need for having the tracks in a closed circuit; (4) minimum requirements of men and vehicles for servicing purposes.

The Modern Twin-Fin Tail. (B. S. Shenstone, Aircraft Engineering, Vol. 11, No. 130, Dec., 1939, pp. 442-3.) (73/25 Great Britain.)

Part II. Fins inset from the tips. Curves for induced drag for different fin arrangements plotted from theoretical calculations lead to the following conclusions:—(1) End plate fins are better than inset fins, as far as their effect on tailplane efficiency is concerned. As long as inset fins are outside the half semi-span position the efficiency is considerably higher than that of a single-fin tail, but if the fins are inside the half semi-span position they are hardly better than a single fin. (2) It makes no practical difference to tailplane efficiency whether the fins are all above, below, or symmetrically disposed. (3) The side loads for zero rudder angle, as in the case of end-plate fins, are least for symmetrically arranged inset fins.

Part III. Tail or wings with dihedral.

Conclusions:—(1) Dihedral increases wing efficiency by reducing the induced drag, but to such a small extent for ordinary dihedrals as to be entirely negligible. (2) The effect of splaying out the fins is to decrease the efficiency of the tailplane in comparison with that having fins at 90°.

Sparking Plugs and Octane Rating. (Fuel, Vol. 18, No. 11, Nov., 1939, pp. 318-19.) (73/26 Great Britain.)

F. Fisher and H. Pohl have carried out tests with an I.G. knock testing engine to determine the effect of sparking plug design and material on knocking. The plugs tested had three electrodes of ample section machined from the body proper, thereby eliminating welded or riveted joints, to take full advantage of the high heat conductivity of the metals used. With copper as a body and electrode material, the octane rating of the fuel in use was improved from 54.7, observed with a standard plug to 58.5. This plug gave satisfactory service during the two hours of test. Similar results were obtained with a mica plug equipped with copper electrodes, the improvement in octane number amounting to 2.6 units. With brass electrodes the effect was less, whilst aluminium and lead had no effect.

Detection of Loose Metal in Aircraft Lubricating Systems. (Engineer, Vol. 168, No. 4377, 1/12/39, p. 543.) (73/27 Great Britain.)

One arrangement of the device consists of a grating of metal rods set in the pipe-line, alternate rods being connected with one pole of the electric generator and, via a warning light, with the opposite pole. The warning light is set in the cockpit of the machine and any metal fragments too large to pass through the grating complete the circuit and switch the light on. Fine metallic particles produced in normal engine operation are passed without the warning being given. An alternative arrangement whereby a special plug performs the same function as the grating is also described. The device is the invention of M. Van Os, of the Royal Dutch Air Lines, and the article states that at least twelve cases of engine failure in flight have been averted by warnings given by it.

Modern Aero Engines and Their Performance Characteristics. (E. Vohrer, Luftwissen, Vol. 6, Nos. 9 and 10, Sept. and Oct., 1939, pp. 255-62, 274-7.) (73/28 Germany.)

The present state of aero engine development is reviewed and at the same time the limits within which the performance figures vary are indicated. The following results are arrived at:—

For cylinders of over 1.5 litres the power per litre reaches 40 h.p.; for cylinders below 1 litre the figure is 58 h.p. The most powerful engines do not have the

highest power per litre since they are limited by low speed of revolution. High output per unit volume can only be attained by high speed of revolution in conjunction with decrease in the cylinder dimensions. The peak value for the piston velocity lies at 16 m./sec.; most frequently the value is 12-14 m./sec. with stroke-bore ratios between 1.09 and 1.13. The maximum mean effective pressure is 14.3 kg./cm.^{2}, values of 12-13 kg./cm.^{2} being common for modern supercharged engines; on going over from 87 octane fuel to 100 octane fuel these figures are increased by 30 per cent. For the power loading of the pistons values between 0.35 and 0.68 h.p./cm.^{2} are obtained. The increase in power with altitude (supercharge pressure and engine speed constant) varies between 3 and 4.75 per kilometre altitude. With one exception (Bristol "Pegasus" XXIII) there is no engine in existence weighing less than 0.5 h.p./kg., if the weight of the cooler is taken into account in the case of liquid-cooled engines. The weights per unit of swept volume vary between 14 and 28 kg./l. With modern liquid-cooled engines it has already been possible to reduce the cross-section of the engine group to 1,750 h.p./m.^{2}.

Vapour Phase Cooling for Internal Combustion Engines. (J. H. Wallace and R. A. Newton, Oil Gas J., Vol. 38, No. 17, 7/9/39, p. 58.) (73/29 U.S.A.)

A new method of engine cooling termed vapour phase cooling, involves the use of a liquid at or near its boiling point. Tests on a typical cylinder showed that irrespective of the average temperature of the jacket water, the water in the upper jackets and heads is at boiling point while 10-15 times the normal water flow would be required to keep the metal temperatures to within 20°F. of that of the water. High jacket temperatures reduce liner distortion, increase mechanical efficiency by up to 10 per cent., but have little effect on thermal or volumetric efficiency while reducing moisture condensation in the cylinder. The ideal jacket water temperature is obviously near boiling point, but this cannot be maintained in normal systems. The vapour phase cooling system which has now been developed consists essentially of a flash chamber in which the jacket water is circulated and from which steam-free water is returned by pump to the jacket. The circulation rate is approximately 0.4 gall./min. per b.h.p. and is sufficient to maintain a difference of not more than 20°F. The advantages of the system are enumerated. Results of practical tests indicate an improvement in the condition of the engine and of the lubricating oil after installation of these systems.

Production of Fuel Oil from Sewage Sludge (from the Japanese). (S. Sibata, Fuel, Vol. 18, No. 11, November, 1939, p. 318.) (73/30 Japan.)

S. Sibata, in the Journal of the Fuel Society of Japan for April, 1939, describes experiments on the production of fuel oil from sewage sludges. He claims to have obtained fuel oil by retorting the digested residues of sewage solids, the amount being equivalent to 9 to 12 per cent. of the retorted material. Similar treatment of undigested raw activated sludge resulted in an oil yield of about 17.5 per cent. of the material treated. The oil obtained was rich in oxygen and nitrogen, its unsaturated and aromatic hydrocarbon contents were high, and its gasoline fraction was greater than that of ordinary natural petroleum. The quality of the oil could be considerably improved by hydrogenation, whereby the nitrogen was removed as ammonia, the oxygen as water and the unsaturated hydrocarbons converted into saturated compounds.

It is pointed out that, although retorting of the raw activated sludge yields about 17 per cent. of fuel oil as compared with a smaller amount from digested sludge, digestion is essential because of the offensive odour and because during digestion, which is carried out by allowing the sludges to ferment in a tank for 20 to 30 days, methane is evolved which is used for retort heating. The retort is of the rotary type, its inside temperature being 450 deg. Cent.

A New Anti-Knock Agent for Motor Fuel. Substitute for Tetra-Ethyl Lead. (E. Belani, Chemiker Zeitung, No. 37, 10/5/39.) (73/31 Germany.)

Furfurol ($C_5H_4O_2$) is obtained from a few petroleums and from many waste products, *e.g.*, grain distilleries products, wood carbonisation liquors, etc. The latest method of production is from sawdust or oat husks, which yield 11 per cent. furfurol.

It is itself non-explosive but extends the explosion limits of compressed gases in both directions. It imparts increased knock stability to motor fuels and by promoting complete combustion gives considerable economy in fuel consumption. Carbon and tar deposits on sparking plugs are reduced so that ignition is more reliable and the running of the engine more smooth, thereby reducing stresses in the moving parts. Furfurol also has a certain lubricating effect and its high flame point reduces the danger of carburettor fires. Many large American companies, such as the Texas Gulf Company, are already using large quantities of furfurol as an anti-knock, thereby reaching knock-ratings of 99. Addition of furfurol does not reduce lead sensitivity. As a substitute for tetra-ethyl lead the Standard Oil Co. is using a mixture of metal carbonyls such as Fe $(Co)_4$, Fe $(CO)_5$, Fe $(CO)_6$, Co $(CO)_3$, Co $(CO)_4$, Ni $(CO)_4$, Mo $(CO)_6$, with furfurol and amines.

Furfurol is also added to lubricating oils in small quantities to improve their properties.

Hydrogen as a Motor Fuel. (M. Oehmichen, Autom. Tech. Zeit., Vol. 42, No. 21, 10/11/39, pp. 573-6.) (73/32 Germany.)

Water with addition of NaOH, is electrolised under pressure by means of direct current, the pressure being up to several hundred atmospheres. The gas thus obtained is considerably cleaner and contains less moisture than that obtained by other methods.

Bomb experiments on the effect of preliminary compression on combustion of hydrogen-air mixtures appear to show that under engine conditions the velocity of combustion will be about 100 m./sec. Assuming that the flame front runs at right angles to the cylinder axis from the centrally situated ignition point, then for a cylinder of 100 mm. diameter the mixture will be burnt through in about 1/2,000 sec., which corresponds to 3° of crank angle if the engine speed is 1,000 rev./min. At a calorific value of 711 kcal./m.^{3} (corresponding to an air excess number $\lambda = 1.0$), a rough allowance for heat losses gives a pressure rise of about 50 atm., *i.e.*, about 16.7 atm. per degree crank angle. This compares favourably with many Diesel engines.

The conclusion to be drawn from bomb experiments is that hydrogen appears to be a difficult fuel to deal with. The large extent of the ignition range indicates that careful adjustment of the mixture will be necessary, as too great dilution will give too slow burning accompanied by high heat losses. Researches on the use of hydrogen as an engine fuel are reviewed with special reference to the Erren hydrogen engine.

Measurement of Anti-Knock Values in Otto Engines. (R. Schutz, Deutsche Kraftfahrtforsch., No. 31, 1939, 22 pp. Chem. Absts., Vol. 33, 1939, p. 8971.) (73/33 Germany.)

A critical discussion is given of the factors affecting determination of engine knock by the bouncing pin method, based on experiments with commercially available indicators and one designed by the author. In the latter an electromagnetic induction coil mounted on the bouncing pin serves for recording the velocity of the pin. Generally, the bouncing pin indicator readings are adversely affected by the natural oscillation of the membrane, burned contact points and the natural oscillation of the contact springs. The values measured depend not only on the rate of pressure rise, but also usually on the final combustion pres-

sure and rate of expansion. None of these three factors being directly correlated to the knocking process it is unlikely that knock intensity can be correctly determined with the bouncing pin. Regardless of whether a " knocking oscillation " is revealed in the pressure diagram or not, knock frequencies can be determined from the vibrations of the engine by the use of amplifier circuits; however, only average values of knock intensity can be obtained in this way. Determination of the knock centre in the combustion chamber by means of the quartz window device or of the flame velocity by the ionisation method gives valuable information on the combustion process. Measurement of the spark advance angle at incipient knock serves the same purpose, but only average values should be considered.

Chemistry of Aircraft Lubricating Oils. (C. M. Larson, Oil Gas J., Vol. 37, No. 39, 1939, pp. 46, 48, 67-8. Chem. Absts., Vol. 33, 1939, p. 8974.) (73/34 U.S.A.)

The Saybolt universal viscosity of aircraft lubricating oils at the inlet should be less than 2,800 sec. for normal take-off, 6,000 sec. for emergency take-off and for operation 500-110 sec. Viscosity characteristics of the oils used by transport airlines, the navy and the army are given. Addition agents such as paratone and acrylic ester are being used in some cases to improve viscosity index. The navy work factor (U.S. Bureau of Eng. Bull. N. and Eng., 31, 1937) and the U.S. army oxidation test (Mo 29 LA, March 1, F-5) are used to determine stability to oxidation and sludge formation. Carbon residue is used to determine degree of refining. Iron salts picked up by the oil accelerate oxidation. Phosphates are being tried as anti-oxidants. Oil sludge analysis is a poor index for ring sticking, deposits, etc. Full-scale 50-hour endurance tests, using a scoring method (briefly described), are recommended by one engine manufacturer. Neutralisation number is not a reliable index of corrosiveness because values between laboratories vary by 300 per cent. Of the oiliness agents, including ketones, esters and phosphates, the ketones are effective, phosphates tend to combine with lead from the fuel and deposit salts in ring grooves and on exhaust valve stems, while with unleaded fuels deposits of H_3PO_4 are found. Oiliness agents can be tested only in flight.

The Friction Between Metals in the Presence of Lubricants. (G. M. Panchenkov and K. V. Konstantinova, J. Techn. Phys., U.S.S.R., Vol. 9, 1939, pp. 537-44. Chem Absts., Vol. 33, 1939, p. 8975.) (73/35 U.S.S.R.)

The coefficient of static friction μ between polished metals lubricated by mineral oils is lowered by cyclohexanol, cetyl alcohol and oleic, palmitic and stearic acids. Increasing the quantity added up to 2-3 per cent. decreases the static friction, while additions of α-naphthylamine or octyl alcohol give a minimum value of μ at 1-1.5 per cent. At a constant concentration of the addition agent is higher the smaller the viscosity of the mineral oil. The lowering of μ produced by these additions varies according to the nature of the metal (steel, iron, brass, etc.). The effect of the additions on μ is different from their influence on the interfacial tension between oil and water.

Peroxides and Detonation in Internal Combustion Engines. (A. S. Sokolik, Acta Physiocochim, U.S.S.R., Vol. 9, 1938, pp. 593-620. Chem. Absts., Vol. 33, 1939, p. 9586.) (73/36 U.S.S.R.)

The nuclear idea of the peroxide theory is no longer tenable. Peroxides which are formed during compression, are primary oxidation products and furnish active centres for the subsequent oxidation of the hydrocarbon by a chain reaction mechanism. Detonation is caused by sudden variation in the kinetic properties during the very short delay period and subsequent explosion wave. For detonation to occur, a certain concentration of peroxides must be reached immediately before ignition of the last portion of the charge. The maximum concentration

of peroxides very nearly coincides with the appearance of the cold flame; the concentration of aldehydes increases for some time thereafter, coinciding with the dissociation of peroxides. Experimental results show that detonation decreases both through slowing down the original oxidation reaction and also through its premature development and consequent degradation of the detonating properties of the mixture as a result of premature dissociation of peroxides. The oxidation of di-isopropyl ether is discussed as an example of the latter type, and the effects of preheating and of engine speed are mentioned. Cracked gasolines show less anti-knock properties when preheated than do straight run gasolines of the same octane number.

Nomographic Study of the Viscosity of Lubricating Oils as a Function of Temperature. (J. Groff, Ann. soc. belge etude petrole, Vol. 3, No. 12, 1939, pp. 27-31. Chem. Absts., Vol. 33, 1939, p. 9614.) (73/37 Belgium.)

It is shown how to construct nomograms representing:—(1) The viscosity temperature characteristics of an oil in the various conventional viscosity scales to enable an easy conversion; (2) the Dean and Davis viscosity indexes of oils of different S.A.E. viscosities; (3) the Saybolt viscosity ratio; or (4) the circulation coefficient, *i.e.*, the priming ability of the oils in a pump. The latter nomogram also shows the optimum viscosity index of mixtures of two or three oils, provided that no complex molecular association takes place. Viscosity changes due to crankcase dilution, etc., can likewise be evaluated from this nomogram.

Gasoline Engine Combustion. (H. Rabezzana, S. Kalmar and A. Candelise, Autom. Ind., Vol. 81, No. 10, 15/11/39, pp. 534-42.) (73/38 U.S.A.)

Engine combustion is analysed by treating separately the two simultaneous phenomena of burning and expansion of the reaction zone. Small elements of volume burn at constant volume, then expand into both the previously burned and the still unburned portion of the mixture until pressure equilibrium is reached. As the reaction progresses each element burns under different conditions of pressure, temperature and chamber volume. The time taken for a given linear flame displacement in space is determined by the reaction velocity—the linear rate at which the flame travels with respect to the unburned gas. The relationship between flame velocity and reaction velocity is deduced and a method given for predetermining the pressure-time characteristics of a combustion chamber design. Analysis of pressure and flame records obtained in various types of combustion chambers and under various conditions shows the effect of such factors as mixture ratio, induction and compression turbulence, spark advance, chamber contour, etc., etc., on reaction velocity. It is shown that the duration of the entire combustion cycle, depending mainly on the reaction velocity, controls the peak pressure and also detonation. Hence, for given fuel-air mixtures, there is a definite relationship between the maximum pressure obtainable without detonation and the time elapsed from ignition. The initial stage of combustion is the most sensitive towards the various factors which affect reaction velocity.

An Audio-Frequency Spectrometer. (R. K. Hellman, Instruments, Oct., 1939, pp. 277-9. Met. Vick. Tech. News Bull., No. 684, 10/11/39, p. 6.) (73/39 Great Britain.)

An electric wave analyser, permitting instantaneous measurement of the amplitudes of any frequency components present in a complex sound or electric wave, is described. Since all the components to be analysed are made visible simultaneously, the spectrum of the wave to be analysed is shown as in optical technique. Although the frequency range of the device is immaterial, its design makes it particularly suitable for audio and supersonic frequencies.

The Electron Raster Microscope. (R. Kompfner, Electrotecnica, Nov., 1939, pp. 635-7. Met. Vick. Tech. News Bull., No. 685, 17/11/39, p. 9.) (73/40 Great Britain.)

The limitations of the conventional electron microscope are due to lens aberrations and geometrical considerations. Further, it is essential to insert the object to be examined into the vacuum tube by means of an airlock. This necessitates keeping vacuum pumps and H.T. equipment going and critical adjustments of th. focal length of the coils. It is claimed that the electron Raster microscope overcomes these difficulties. The principle of the microscope is as follows:—A thin electron beam is made to scan the object in a " Raster " as in television. The electrons pass through the object and holder and impinge on a collecting electrode and are converted into current impulses. These impulses are amplified and reproduced on the fluorescent screen of a cathode ray tube whose electron beam is made to move in synchronism with the electron pencil in the microscope.

An Instrument for Estimating Tautness of Doped Fabrics on Aircraft. (G. M. Kline and H. F. Schiefer, N.A.C.A. Tech. Note No. 729, Sept., 1939.) (73/41 U.S.A.)

The linear deflections of doped fabrics under a given load are used as criteria for comparing the tautness of various panels. The usual type of tautness meter employs weights for loading, and can be used only on approximately horizontal surfaces. This prevents its use on many parts of aircraft. A spring-loaded tautness meter has therefore been developed which can be used in both horizontal and vertical positions. Results of tests made on the fabric coverings of various aeroplanes are reported and discussed. It is concluded that the actual deflection of the fabric under the arbitrary 1 lb. load, irrespective of the distance between ribs, is a more reliable criterion of the tautness on the assumption of a linear relation between deflection and spacing. A desirable limit to the maximum deflection under a 1 lb. load as measured by the method described is 0.100 inch.

Dynamic Balancing. (J. Craig Jones, Aircraft Production, Vol. I, No. 14, December, 1939, pp. 484-6.) (73/42 Great Britain.)

Having discussed the theory of balancing and the most common methods for determining out-of-balance, the Olsen " E.O." type balancing machine is described. This works on an entirely new principle and is capable of handling exceptionally small parts. The machine is made in several sizes, the smallest size being capable of handling parts weighing a maximum of 5 lb. and a minimum of 5 ozs. This type of balancing machine is capable of denoting the amount and position of out-of-balance weight by either mechanical or electrical means.

The Buckling Strength of Circular Symmetrically Stepped Plates. (F. A. Willers, Z.A.M.M., Vol. 19, No. 4, August, 1939, pp. 206-210.) (73/43 Germany.)

Starting with an expression for the potential energy of the buckled plate, the author develops the differential equations for buckling under radial compression, the edge of the plate being either fixed or allowed to rotate.

Under these conditions, a vertical plate may buckle as a whole either to the left or right, or the buckling may occur along nodal lines, partly to the left and partly to the right. The smallest buckling load corresponds to the first case, as would be expected.

The author next considers the case of a singly stepped plate, the increase in plate thickness being 100 per cent. at the step. The reinforcement is assumed to start at the centre of the plate and the buckling loads corresponding to a gradual increase in the diameter of the step are calculated. Similar calculations are carried out when the increase in thickness starts at the edge instead of the

middle. In either case both clamped and a free edge (bending) is considered.

It appears that an increase in " stepped " thickness spreading from the outer edge towards the centre produces always a smaller buckling load than if the same weight of material were spread uniformly over the disc.

If the reinforcing step starts, however, at the centre the buckling load for the supported plate is appreciably greater than if the same material is spread uniformly over the disc.

Small Oscillations of a Rope Suspended with Considerable Sag. (H. Seitter, Z.A.M.M., Vol. 19, No. 4, August, 1939, pp. 211-215.) (73/44 Germany.)

The rope of a given length $2 S_0$ is assumed to be perfectly flexible, inextensible and without weight. It is suspended without friction at two supports in the same horizontal plane a distance $2 x_0$ apart so that it assumes a symmetrical shape under the action of a vertical load q per unit length.

The author investigates the frequency of small symmetrical oscillations about the equilibrium of a system of this nature. With sufficient sag, the frequency is determined completely by the geometry of the system. Thus it suffices to know either S_0 and q or S_0 and X_0. In a particular case, where $\begin{cases} 2 x_0 = 200 \text{ cm.} \\ 2 s_0 = 209.4 \text{ cm.} \end{cases}$ the fundamental frequency is 2.81 vibrations/sec.

Resonance Vibrations of a System Subjected to Vectorial Forcing Impulses. (G. Heinrich, Z.A.M.M., Vol. 19, No. 4, August, 1939, pp. 216-223.) (73/45 Germany.)

In practice, cases of vibration often arise in which the forcing impulses alter their direction according to a definite law. As an example we may take the transverse vibrations of a flywheel interposed between two crank throws. Each working stroke produces an impulse of varying amount, but constant direction with reference to a stationary observer. If the system of co-ordinates, however, is attached to the flywheel, the impulse vector will undergo a regular rotation, provided the flywheel is turning uniformly.

The author considers the general case of a body with rotational symmetry capable of vibrating with the same frequency about any axis passing through a certain point O on the axis of symmetry and perpendicular to the latter. The body itself is assumed to be rigid, the vibrations being made possible by the introduction of suitable spring forces. The forcing of these vibrations is due to rotary impulse, the vectors of which are all contained in a plane passing through O and perpendicular to the axis of symmetry. The conditions of resonance are examined for the two cases of discreet and continuous forcing impulses respectively.

On the Frequency of Flexural Vibrations of a Rotating Propeller Blade. (K. Sezawa and I. Utida, Aer. Res. Inst., Tokyo Rept., No. 181, August, 1939.) (73/46 Japan.)

The methods of calculation usually applied in determining the frequency of vibration of a blade in rotation are not satisfactory from the theoretical point of view. An exact method for calculating frequency is proposed, but since the calculation is extremely complex the problem is restricted to the case in which the blade has a uniform cross-section. Calculated results show that for the frequency of vibration of any higher order than the first harmonic the coefficient denoting the effect of speed of rotation on the frequency of vibration must be increased enormously over that previously employed. On the other hand, the frequency of the fundamental vibration does not differ much, whatever method of calculation is employed.

Experimental Study of Torsional Column Failure. (A. S. Niles, N.A.C.A. Tech. Note No. 733, Oct., 1939.) (73/47 U.S.A.)

Compression tests have been carried out on thirty-three open channels (dimensions $2 \times 2 \times 0.1$ in.) of 24 ST. aluminium alloy in order to test the validity of the theoretical formulæ for torsional failure developed by E. E. Lundquist of the N.A.C.A. The results obtained for the critical loads and the positions of the twist axis were sufficiently near to those given by the formulæ to establish the substantial validity of the latter. The differences between the observed and computed results were small enough to be accounted for by small and mostly unavoidable differences between the test conditions and those assumed in deducing the formulæ. Some data were obtained from the shorter specimens regarding the growth of buckles which resulted in local buckling failure.

The formulæ for torsional failure deduced by the Lundquist procedure may be employed with confidence by designers provided that formulæ based on suitable boundary conditions are selected. The importance of torsional failure of open sections is shown by the fact that the critical loads of the specimens which failed torsionally were far below those indicated by the usual column formulæ.

Investigation of the Impact Bending Strength of Synthetic Resins. (W. Kuntze and R. Nitsche, Kunststoffe, Vol. 29, No. 2, 1939, pp. 33-41.) (73/48 Germany.)

These investigations were carried out for the V.D.I. on mouldable phenol resins (with and without fillers or reinforcing materials) and on mouldable urea resins, and are to be used as a basis for specifications for testing the impact bending strength of synthetic resins. The pendulum impact test machine used gave a maximum loading of 10 mkg., and other series of experiments were also carried out at maximum loadings of 1.5 and 0.4 mkg. The impact weights were from 0.8 to 8 kg., the impact velocities from 0.5 to 9 m./sec. The materials were tested in the usual form of a prismatic bar ($120 \times 15 \times 10$ mm.^{3}). It was found that:—The impact work increases with impact velocity but is almost independent of impact mass. With increasing impact velocity the relative values for the velocity dependency and the amount of scattering decrease, but the absolute values increase. Fibrous and stratified reinforcing materials lead to greater values for the impact work. The fractures are characteristic for each type of material, independent of the velocity or impact weight which has produced fracture. On the other hand, pictures of the structure of a synthetic resin give practically no basis for judging its strength properties.

Effect of Internal Stresses on the Resistance of Materials Towards Splintering and Wear. (N. Sawin, Werkstattstechn, Vol. 33, No. 12, 1939, pp. 301-4.) (73/49 Germany.)

Any kind of chipping or shaving treatment is accompanied by thermal effects and permanent deformations, thereby causing inherent stresses in the machined part which are greatest at the treated surface. Surface smoothing by rolling also causes stresses in a material, which reduce its resistance towards cutting, grinding and wear. This was proved by an abrasion test on the Skoda-Sawin machine using a Widia abrasion disc. Roughening at low cutting velocity in the unhardened state, as well as ordinary grinding after annealing, considerably reduce the resistance towards abrasion with the Widia disc, although there is very little effect on hardness. Twenty per cent. reductions in the relative work required for abrasion were quite common in the case of steels which had previously been subjected to a shaving treatment. These working stresses can be removed to a considerable extent by annealing and very careful polishing, which again gives a corresponding increase in the abrasion resistance and in the work required for cutting and grinding.

The Anodic Protection of Magnesium. (J. Frasch, Métaux et Corrosion, Vol. 14, 1939, pp. 83-96. Chem. Absts., Vol. 33, No. 20, 20/10/39, p. 8121.) (73/50 U.S.A.)

The formation of an oxide film by anodic oxidation does not protect magnesium from corrosion, but the film can serve as a base for paint. Silicate, aluminate and phosphate coatings prevent corrosion to some extent, but they are too thin and porous. Better protection is obtained by electrolytic production of chromium or manganese oxides on the surface of the magnesium, using alternating current, followed by reduction of the oxides with hydrogen. Solutions of manganese carbonate and of potassium permanganate in chromic acid were used to test the anodic protection of magnesium. An oxide film of 4-5 μ offers sufficient protection. To obtain a uniform deposit the surface of the metal must be thoroughly degreased and descaled before the anodic treatment. Best results were obtained by letting the hydrogen over-voltage reach the maximum before closing the circuit, which takes 1-4 min. The oxides formed on magnesium by the anodic treatment are dehydrated by immersion for 5 min. in paraffin at 190°. Salt spray test of anodically treated magnesium alloys shows a corrosion resistance lasting two months for sheets of 1.8 per cent. Mn alloy, one month for sheets containing 6 per cent. Al, 1 per cent. Zn and 0.4 Mn, four weeks for forged alloy containing 3 per cent. Al, 1 per cent. Zn, and 0.4 per cent Mn, and three weeks for forged alloy containing 8.5 per cent. Al, 0.5 per cent. Zn and 0.4 per cent. Mn.

The Properties of Light Metal Welds. (P. Brenner, Metal Ind., 10/11/39, pp. 405-8. Met. Vick. Tech. News Bull., No. 685, 17/11/39, p. 4.) (73/51 Great Britain.)

A survey is made of the corrosion resistance and other properties of certain light metals after gas butt welding. The materials used in the tests were, pure aluminium, aluminium-manganese, aluminium-magnesium-manganese, aluminium-magnesium-silicon and aluminium-copper-magnesium alloys, and in each case a butt weld on 1.5 mm. sheet was made. The method adopted for corrosion resistance tests was the stirring test of Din 4853, using a 3 per cent. sodium chloride solution containing 0.1 per cent. hydrogen peroxide. At various intervals of time several test pieces were withdrawn from the solutions for determination of the decrease in tensile strength and for detailed metallographic examination. The results of the tests show that greatest resistance to corrosion is exhibited by pure aluminium, aluminium-manganese and aluminium-magnesium-manganese alloys, both in the welded and unwelded condition.

Isopachic Stress Patterns. (M. M. Frocht, J. Appl. Physics, Vol. 10, 1939, pp. 248-57.) (73/52 U.S.A.)

In optical stress investigations the term isopachics is used to denote the lines of constant alteration in thickness, which, assuming Hook's law to hold, also represent the lines of constant total stress (as determined graphically from the isoclines and isochromatics). The author determines the isopachics by the interference lines method. The present paper describes further experimental development of the method and gives an accurate description of the experimental arrangement. A coloured light is used (mercury vapour lamp) which, after passing through a condensing lens, is reflected at 45° from a glass plate and falls on a special interferometer prism; the light reflected from the latter reaches the air space between the prism and the model (breadth of the air space proportional to the change in thickness) and is finally reflected again at the polished surface of the model. The author used steel for the test model and obtains satisfactory results in the case of a diametrically-loaded circular ring disc.

Recovery Recrystallisation and Creep Behaviour of a Few, Cold-Worked, Austenitic Materials. (H. Cornelius, Metallwirtsch, Vol. 18, 1939, pp. 399-403, 419-21.) (73/53 Japan.)

Since the recovery temperatures of austenitic materials lie very high, during the course of studies of heat-stable materials for parts of internal combustion engines subjected to stress at high temperature (*e.g.*, valves), attention has been paid at the D.V.L. to the possibility of improving the creep behaviour of austenitic materials by cold working. Information regarding the possible alteration in strength properties during fatigue stressing was obtained by carrying out tension tests at room temperature before and after the fatigue test. The test materials were :—

1. A Cr-Ni steel with additions of W, Ta and Nb.
2. A carbon-containing Cr Ni Fe Ti alloy.
3. A Ni Co Cr Fe W alloy.

RESULTS.—Cold stretching gives an improvement in creep properties up to a definite temperature of fatigue stressing. However, above this temperature the creep behaviour of the cold-stretched material is worse than that of the soft-annealed material. The extent to which the creep behaviour of austenitic materials can be influenced by cold working, as well as temperature limit up to which the treatment has a beneficial effect, has to be determined experimentally for each individual case. The lowering of the recovery temperature, due to tension stress, was not shown clearly in any of the present experiments. As regards static strength properties, particularly from the point of view of deformability, the cold-worked materials are not more unfavourably affected by fatigue stressing at high temperature than the unworked material.

Contact Corrosion of Pure Aluminium with Various Metals, in Particular Stainless Steel. (W. Geller, Korrosion u. Metallsch., Vol. 15, No. 9, 1939, pp. 298-304.) (73/54 Germany.)

Results of experiments carried out with sheet metal samples to determine the contact corrosion of pure aluminium in conjunction with stainless steel, copper and iron, show that steels of low nickel content or free from nickel behave in practically the same way as the high nickel content 18/8 Cr-Ni steel, the contact effect is many times smaller by comparison with copper or iron. Measurements of potential made after various corrosion periods showed that the aluminium-stainless steel elements can be very strongly polarised, but in absence of current high potential differences can occur. Therefore insulation of the metals is always to be recommended, particularly when subjected to the continuous action of liquid. Contact corrosion and polarisation depend strongly on the prevailing conditions. Corrosion phenomena due to the effects of cracks are considerably increased by contact currents.

On the Combined Effect of Cold Working and Hardening at Room Temperature on Aluminium-Copper-Magnesium Alloys. (H. Kostron, Zeit fur Metallkunde, Vol. 31, No. 11, November, 1939, pp. 329, pp. 329-334.) (73/55 Germany.)

It is known that cold working carried out immediately after quenching accelerates the subsequent hardening of aluminium-copper-magnesium alloys at room temperature, but reduces the amount of hardening. An attempt is made to explain this as due to the fact that cold working favours the hardening process and therefore allows it to take place more completely, but at the same time it lowers the efficiency of the hardening process, because the latter takes place predominantly in the worked material, at the parts which have already been hardened by cold working. Apart from this change in the efficiency of the method, cold working also appears to cause an alteration in the mechanism of hardening; determinations of the grid constants show that demixing of the supersaturated

solid solution occurs. These conclusions are strengthened by observations of the subsequent hardening which follows repeated working of a material which after quenching, has been worked to a different degree and then hardened; in this case it is found that hardening of the material takes place more completely the greater the preliminary working; the reduction in the degree of hardening can thus only be explained by the deterioration in efficiency. Experimental results obtained by K. L. Dreyer can also be explained by a change in efficiency of this type or by the assumption that after cold working more stable hardening conditions are realised than after normal hardening at room temperature.

Torsion and Flexure. (C. Gurney, Aircraft Engineering, Vol. 11, No. 130, Dec., 1939, pp. 437-440.) (73/56 Great Britain.)

Solutions for flexure of a thin blade, and torsion of a thin-walled tube have been obtained without the use of stress functions—compatibility being introduced as a geometric condition. The shear deflection of a thin blade is shown to be the same as the deflection obtained by assuming a uniform shear distribution across the depth of the section—a conclusion different from that drawn in a well known text book. If axial warping is prevented at the root section it can be shown that the deflection will be less than that given in this paper. The Bredt formula and the first terms of Duncan's series approximation for torsion of thin walled tubes are obtained by a method similar to that used for flexure. Solutions for flexure of plate web girders and thin-walled tubes are not given here, but they can be obtained by a process identical with that used for flexure of the blade.

Thermoflux Method for Measuring Thickness of a Plate. (Fuel, Vol. 18, No. 11, Nov., 1939, p. 318.) (73/57 Great Britain.)

In the maintenance of boilers and other pressure vessels it is frequently desirable to measure the thickness of the plates in order to determine the extent to which corrosion has taken place. Direct measurement is often impossible, and the drilling of test holes is obviously undesirable. The Thermoflux method of testing is based on the variation of the thermal conductivity of steel plates with the thickness. Heat is generated in the plate by applying an alternating current magnetic yoke to the outer surface and a thermocouple is applied to the plate between the legs of the yoke. The rise in temperature indicated by the couple after a definite time interval is a function of the thickness and magnetic properties of the plate. With boiler plates of normal composition the variation in magnetic properties is slight, so that with the aid of calibration charts the thickness of the plate can readily be estimated with an accuracy of ± 5 per cent. Scale up to 0.002 in. in thickness beneath the poles of the magnet is not important, but the thermocouple must be in contact with clean metal.

Corrections are necessary if the instrument is used in the vicinity of abrupt changes of section, but still water in contact with the inner surface of the plate does not affect the consistency of the readings, although an appropriate calibration of the instrument is required.

Metal Photographic Film. (Fuel, Vol. 18, No. 11, Nov., 1939, p. 318.) (73/58 Great Britain.)

Several announcements have recently been published concerning the use of metallic materials as supports for photographic emulsions in place of paper or celluloid. Mining and metallurgy (September, 1939) states that in the U.S.A. the backing material is to be an alloy containing 92 per cent. of aluminium with a standard thickness, for normal use, of 0.004 in. The metal will be available in rolls up to 36 in. wide and in sheets up to 8 by 10 ft. The weight will be the same as ordinary acetate or nitrate film or double weight paper and the cost will be lower. Several advantages are claimed for the metal-backed emulsions,

Processing can be more rapid, since solutions will not penetrate the base and washing is therefore facilitated, whilst drying can be accelerated by the use of temperatures up to 400 deg. Fahr. Since the metal film will neither shrink nor stretch during processing, it should be of particular value when it is necessary to take precise measurements from a photographic record as in aerial mapping, spectography, and in the recording of transient phenomena.

In the projection of metal base cinematograph films it is necessary to use reflected light from both picture and sound track, but this is said to present little difficulty, as the film is non-inflammable and the intensity of the source of light can safely be increased to the necessary value. Economy in film may be obtained by using both sides of the film, and by a suitable arrangement of the sequences of a multi-reel film it should be possible to avoid re-winding.

Metal film is also suited to very high speed photography, as the film can be run at speeds which would result in the tearing of a cellulose base.

Sigal, the High Grade German Protective Paint Pigmented with Aluminium-Silicon. (F. Kipping, Metallges. Periodic Rev., Vol. 14, 1939, pp. 27-31. Chem Absts., Vol. 33, 1939, p. 9012.) (73/59 Germany.)

" Sigal " is the name of a rust-inhibiting pigment based on the corrosion-resistant properties of Al-Si alloy. It consists essentially of the eutectic alloy 87 per cent. Al, 13 per cent. Si with the addition of elementary Si; the whole is ground to a fine powder in a ball mill with air separation so that no residue is left on a sieve of 16,000 mesh/sq. cm. The film is very elastic, the elasticity increasing with increasing substitution of resinous material for linseed oil; it is superior to a film of red lead + white lead + linseed oil. Sigal priming coats are made up without addition of oil, while finishing coats contain up to 5.8 per cent. linseed only. Favourable results of almost eight years' observation on outdoor structures are described.

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. Z.A., London, W.C.2, and will be supplied 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.
	THEORY OF WARFARE.
981 Malvani, M.	*Machine Gun Defence Against Low-Flying Aircraft.* (Rassegna di Culture Militare-Rivista di Fanteria, Vol. 1, No. 6, June, 1938, pp. 293-299, and No. 7-8, July-August, 1938, pp. 341-355.)
988 Bachofner, Capt. ...	*Bomb Ballistics.* (Flugwehr-und Technik, Vol. 1, No. 5, May, 1939, pp. 136-138; No. 6, June, 1939, pp. 148-151; No. 7, July, 1939, pp. 178-9.)
	MATERIALS AND ELASTICITY.
954 Köller, H.	*Effect of Alterations in Stiffness on the Force Distribution in Statistically Indeterminate Frameworks.* (Jahrbuch der deutschen Luftfahrtforschung, 1938, Vol. 1, pp. 444-51.)