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On the Subsonic Flow of a Compressible Fluid Past an Elliptic Cylinder. (I. Imai and T. Aihara, Aer. Res. Inst., Tokyo, Vol. 15, No. 194, Aug., 1940.) (86/1 Japan.)

In this paper a new method of treating the two-dimensional subsonic irrotational flow of compressible fluids is given, which consists essentially of making use of conjugate complex variables. In illustration of the method the flow past an elliptic cylinder in an arbitrary orientation with any circulation is considered, and the expression for the velocity potential correct to the order of M^2 is obtained, without recourse to any infinite series expansions. Further, an explicit formula is given for the velocity distribution on the surface of an elliptic cylinder, in the case of absence of circulation. Finally, as an addendum, the critical Mach numbers for the flow past elliptic cylinders with their major axes perpendicular to the undisturbed flow are calculated for a series of values of their fineness ratios.

Pressure Distribution Investigation of an N.A.C.A. 0009 Aerofoil with a 30 per cent. Chord Plain Flap and Three Tabs. (M. B. Ames and R. I. Sears, N.A.C.A. Tech. Note No. 759, May, 1940.) (86/2 U.S.A.)

Pressure distribution tests of an N.A.C.A. 0009 aerofoil with a 30 per cent. chord plain flap and three plain tabs, having chords 10, 20, and 30 per cent. of the flap chord, were made in the N.A.C.A. 4- by 6-foot vertical tunnel. The purpose of these tests was to continue an investigation to supply structural and aerodynamic section data that may be applied to the design of horizontal and vertical tail surfaces.

The results are presented as diagrams of resultant pressures and of resultant pressure increments for the aerofoil with the flap and the 20 per cent. chord tab. Increments of normal force and hinge moment coefficients for the aerofoil, the flap, and the three tabs are also given.

At all unstalled flap and tab deflections, the experimental distributions agree well with those calculated by an analytical method. The agreement is poor, however, when the stalled or the unstalled condition of the flap or the tab deflected alone was changed to an unstalled or stalled condition by the simultaneous deflection of both the flap and the tab. This poor agreement between the experimental and the calculated results is attributed to the fact that the coefficient increments for these critical conditions are not additive, as they must be to obtain good agreement.

In the application of these data for design purposes, it should be remembered that, for all cases, gaps were completely sealed, resulting in higher peak pressures at the hinge axes and in higher hinge moment and normal force coefficients than would have been obtained with unsealed gaps. It should also be noted that only the values of the normal force coefficients were corrected for tunnel effects.

Pressure Distribution Investigation of an N.A.C.A. 0009 *Aerofoil with an* 80 *per cent. Chord Plain Flap and Three Tabs.* (M. B. Ames and R. I. Sears, N.A.C.A. Tech. Note No. 761, May, 1940.) (86/3 U.S.A.)

Pressure distribution tests of an N.A.C.A. 0009 aerofoil with an 80 per cent. chord plain flap and three plain tabs, having chords of 10, 20, and 30 per cent. of the flap chord, were made in the N.A.C.A. 4- by 6-foot vertical tunnel. Section data suitable for application to the design of horizontal and vertical tail surfaces were obtained.

Resultant pressure diagrams for the aerofoil with the flap and the 20 per cent. chord tab are presented. Plots are also given of increments of normal force and hinge moment coefficients for the aerofoil, the flap, and the three tabs. A comparison of some characteristic slopes for the 30, the 50, and the 80 per cent. chord flaps, tested in the general investigation of plain flaps for control surfaces, is included. The data now presented complete the investigation of an N.A.C.A. 0009 aerofoil with a wide range of flaps and tabs. The results should be applicable to the design of any plain flap and tab combination likely to be used for horizontal or vertical tail surfaces. The incremental data are believed to be applicable to other conventional aerofoils of approximately the same shape and thickness. In applying the data it has to be remembered that they were obtained with hinged surfaces having completely sealed gaps and that only the values of the aerofoil normal force coefficient have been corrected for tunnel effects. Although the other coefficients are uncorrected they are believed to be conservative for application in stress analysis.

The Flow of a Compressible Fluid Past a Sphere. (C. Kaplan, N.A.C.A. Tech. Note No. 762, May, 1940.) (86/4 U.S.A.)

The flow of a compressible fluid past a sphere fixed in a uniform stream is calculated to the third order of approximation by means of the Janzen-Rayleigh method. The velocity and the pressure distributions over the surface of the sphere are computed and the terms involving the fourth power of the Mach number, neglected in Rayleigh's calculation, are shown to be of considerable importance as the local velocity of sound is approached on the sphere. The critical Mach number, that is, the value of the Mach number at which the maximum velocity of the fluid past the sphere is just equal to the local velocity of sound, is calculated for both the second and the third approximations and is found to be respectively, $M_{cr}=0.587$ and $M_{cr}=0.573$.

Wind Tunnel Investigation of Two Aerofoils with 25 *per cent. Chord Gwinn and Plain Flaps.* (M. B. Ames, N.A.C.A. Tech. Note No. 763, May, 1940.) 86/5 U.S.A.)

Aerodynamic force tests of an N.A.C.A. 23018 aerofoil with a Gwinn flap having a chord 25 per cent. of the over-all chord and of an N.A.C.A. 23015 aerofoil with a plain flap having a 25 per cent. chord were conducted in the N.A.C.A. 7- by 10-foot wind tunnel to determine the relative merits of the Gwinn and the plain flaps.

The tests indicated that, based on speed range ratios, the plain flap was more effective than the Gwinn flap. At small flap deflections, the plain flap had the lower drag coefficients at lift coefficient values less than 0.70. For lift coefficients greater than 0.70, however, the Gwinn flap at all downward flap deflections had the lower drag coefficients.

Experimental Results with Aerofoils Tested in the High Speed Tunnel at Guidonia. (A. Ferri, Atti di Guidonia, No. 17, Sept., 1939. Translation available as N.A.C.A. Tech. Memo., No. 946.) (86/6 Italy.)

The seven sections tested were made up of circular arcs or straight lines with sharp leading and trailing edges, the thickness ratio being of the order of 5 per cent. whilst the chord varied between 48 and 60 mm. Lift, drag and moment curves were determined in the Guidonia supersonic tunnel at Mach numbers 1.85 and 2.13 for four of the sections (span 60 cm.), pressure distribution being also measured for two of them. Optical flow investigations were carried out on the three remaining sections (span 40 cm.). The aerodynamic characteristics of all the seven aerofoils were also calculated theoretically. The following are some of the main conclusions drawn by the author:—

(1) The lift coefficient is practically a straight line function of the angle of attack up to very high values of the incidence ($\alpha \sim 28°$). The slope of this line is however very low and the maximum value of C_L at these angles is of the order of 0.8.

(2) For values of α in excess of $\pm 5°$, the resistance coefficient increases rapidly. Maximum C_L/C_R is obtained in the neighbourhood of 6°, the value being of the order of 5.

(3) The calculated lift coefficients are appreciably above the experimental values and the slope of the lift coefficient line is also greater.

(4) The calculated drag coefficients, although no allowance for friction is made, are in many cases above the experimental values.

(5) The integration of the experimental pressure distribution curves is in fair agreement with the measured lift.

(6) The deflection of the shock wave at the leading edge as measured from flow photographs is in satisfactory agreement with theory.

(7) Both the pressure distribution measurements and flow photographs show distinct evidence of flow separation brought about by friction in the boundary layer. In the present state of our knowledge of gas dynamics, no aerofoil theory exists that takes viscous forces into account. Further researches on these lines are urgently needed.

A Simple Approximate Method for Obtaining the Spanwise Lift Distribution. (O. Schrenk, Luftwissen, Vol. 7, No. 4, April, 1940, pp. 118-120. Translation available as N.A.C.A. Tech. Memo., No. 948.) (86/7 Germany.)

The plausible assumption is made that the real lift distribution lies between an ideal distribution independent of wing shape and a distribution determined in a simple manner by the wing shape.

The ideal distribution is that of minimum induced drag and constant induced downwash velocity (*i.e*, elliptic distribution for the monoplane) whilst the distribution dependent on shape is proportional to αt at each point of the wing.

In the case of an untwisted monoplane wing, the semi-ellipse of equal area with the chord distribution curve is drawn and the required lift distribution is obtained by forming the arithmetical mean between the two curves. In the case of a twisted wing (including wings with aileron or flap deflection) the zero lift direction of the whole wing is first determined and for all further computations, both the angle of attack and the twist are measured from this direction, use being made of the formula

$$\frac{dA}{dx} = \tfrac{1}{2} q \frac{dc_a}{d\alpha} \alpha \left\{ t(x) + \frac{4}{\pi} \bar{t} \sqrt{1 - \left(\frac{x}{b/2}\right)^2} \right\} + \tfrac{1}{2} q \frac{dc_a}{d\alpha_\infty} \delta(x)\, t(x)$$

In the above $\delta(x)$ = angle between reference line of wing and local zero lift direction. $dc_a/d\alpha$ and $dc_a/d\alpha_\infty$ can generally be taken as constant along the span. The author gives a number of comparisons of lift distribution as calculated by the above approximate method with those obtained by the more accurate but much more laborious method of Multhopp, showing very good agreement. By the decomposition into an ideal, plan form and twist distribution, simple and time-saving relations may be set up for frequently repeated computations of bending moments, transverse forces and torsional moments along the span. The method can also be applied to certain cases when the usual method fails completely (monoplane with end plates).

On the Theory of Unsteady Planing and the Motion of a Wing with Vortex Separation. (L. Sedov, C.A.H.I. Report No. 252. Translation available as N.A.C.A. Tech Memo., No. 942.) (86/8 U.S.S.R.)

In a fundamental paper on the theory of planing (R.T.P. Translation No. 331) Wagner has shown that for small angles of attack, the lift force on a planing surface is equal to half the lift on a wing of the same profile (steady motion in both cases). The author shows that the more general planing problems, including unsteady motion, can also be most easily attacked by making use of the theory of thin wings together with that of waves of small amplitudes. In the study of unsteady motion, it is usually assumed that the forces at each instant coincide with those of a corresponding steady motion defined by the same geometric parameters (position and velocity of body). The errors involved in this assumption (hypothesis of stationary forces) are investigated by the author. In the particular case of unsteady planing of a flat plate, the resultant lift $\gamma = \gamma_1 + \gamma_2 + \gamma_3$ of which only γ_2 is given by the " stationary " hypothesis. The γ_1 term corresponds to the so-called " added mass " whilst γ_3 takes into account the effect of the horizontal velocity of the fluid on the free surface (absent in steady planing). All three forces act perpendicularly to the plate, γ_1 and γ_2 at the centre, and γ_3 at a distance from the leading edge equal to γ_4 of the wetted length. In the case of accelerated motion, the water may break away and γ_3 become negative. Adding the inertia effect to the lift force as calculated from the stationary hypothesis thus gives too great a value for the total lift, the reverse holding true for retarded motion.

The author concludes his paper by considering the case of the steady harmonic oscillations of a plate, the lift forces obtained by the general formula being compared with those obtained by the stationary hypothesis and those given by Perring and Glauert in R. and M. 1,493. These authors assume that the ratio n of the actual wetted length to the length under the surface level is equal to unity. Under these conditions the lift values given by Perring and Glauert agree with those given by the author using the " stationary " hypothesis. The values obtained by the more general formula differ however appreciably, depending on the type of oscillation considered.

Windshield Wipers. (Inter. Avia., No. 733, 28/10/40, p. 8.) (86/9 U.S.A.)

Rotating windshield wipers for aircraft have been in use with considerable success in the United States for some time. A device of this type, manufactured by the Air Associates Inc., has been described in Inter. Avia., No. 638. Meanwhile, the N.A.C.A. has carried out extensive tests with windshield wipers operating with de-icer fluids and heating installations as part of its programme to eliminate the icing hazard on aeroplanes (Technical Note, No. 754). It is now reported that the aircraft of American Airlines Inc. are being fitted with return stroke type wipers which for a maximum of 480 return strokes a minute require one-half of a horse-power. The spray of de-icer fluid as well as the wiper's speed can be regulated by the pilot; the functioning of the device is unaffected by high winds created by the aircraft at speeds of up to 250 m.p.h.

Diving Brakes on Ju 87. (Inter. Avia., No. 731, 12/10/40, p. 9.) (86/10 Germany.)

Unlike the arrangements known in the Italian and American dive bomber types which aim at a limitation of the diving speed by the use of normal, downward deflection split-type flaps mounted at a point of the chord which corresponds to the rear spar, or by split-type flaps deflecting symmetrically upwards and downwards, the air brakes of the Ju 87 are mounted on the underside of the wing just ahead of the front spar. A small portion of the elevator unit still lies in the turbulent zone of the brake; in order to reduce such disturbances, the flap does not continue right to the wing cover and its surface is interrupted by means of a slot. The inter-connection between the air brake and the landing flap is described in the Swedish patent No. 99,515 which has been taken out by the Junkers Aircraft and Engine Company. A patent protects:—" An aircraft with dive brakes arranged on the wings, characterised by the fact that in the operating mechanism of the landing flaps inter-connecting members are incorporated in a way that the angular motion of the landing flaps located in the flight direction at the rear of the diving brakes is diminished or made entirely impossible when the diving brakes are deflected." A development of the arrangement described is formed by the air brakes mounted on the Ju 88 twin-engined bomber. The " venetian blind " type of brake is several times larger than the brakes of the Ju 87; the positive mechanical connection with the landing flaps is retained; the axis of rotation, on the other hand, is located on the front spar, so that in normal flight the brake surface lies flush with the underside of the wing.

Spin Tests of a Low Wing Monoplane in Flight and in the Free Spinning Wind Tunnel. (O. Seidman and W. H. McAvoy, N.A.C.A. Tech. Note No. 769, July, 1940.) (86/14 U.S.A.)

Comparative full-scale and model spin tests were made with a low wing monoplane in order to extend the available information as to the utility of the free spinning wind tunnel as an aid in predicting full-scale spin characteristics.

For a given control disposition the model indicated steeper spins than were actually obtained with the aeroplane, the difference being most pronounced for spins with elevators up. Recovery characteristics for the model, on the whole, agreed with those for the aeroplane, but a disagreement was noted for the case of recovery with elevators held full up. Free spinning wind tunnel tests are a useful aid in estimating spin characteristics of aeroplanes, but it must be appreciated that model results can give only general indications of full-scale behaviour.

Tyre Wear on Runways (*B. Pt. No.* 516,738). (Inter. Avia., No. 731, 12/10/40, p. 11.) (86/11 Great Britain.)

The use of artificial landing runways of concrete or with surface aggregates of asphaltic concrete, macadam, and so on, has resulted in a considerable reduction in the life of aircraft wheel tyres. Higher landing speeds, heavy tyre loads and lower tyre pressure further contribute to the decrease in tyre life. The additional tyre wear on hard, abrasive surfaces results mainly from the following factors :—Acceleration upon landing, deformation of the tyres in close taxying turns, slip due to the use of brakes, lateral tread scrubbing due to misalignment and lateral motion. The surmounting of the inertia of the wheels which at the moment of ground contact are stationary and which are brought up to the rotating speed corresponding to the taxying speed solely by ground friction, can add greatly to tyre wear in large aeroplanes. This type of wear is claimed to have been eliminated by a device for which Vickers-Armstrongs, Ltd., have been granted British Patent No. 516,738. The plan is to spin the wheels by means of wind cups on the wheels themselves or on the tyres.

Measurement of the Period of Natural Vibration of an Airscrew Blade. (J. Obata and Y. Yosida, Aer. Res. Inst., Tokyo, Vol. 15, No. 191, July, 1940.) (86/12 Japan.)

The results of previous studies by the authors in the electrical method of measuring small vibrations with the aid of a triode valve, together with its applications to the measurement of vibrations of airscrew blades, has been given in a previous report (No. 103).

Recently, in connection with the study of airscrew flutter, the need of accurate measurements of bending as well as of torsional vibrations of an airscrew blade arose, resulting in the application of the electrical method with very satisfactory results. At that time, certain improvements and developments were made on our former method, and are described in the present paper. These consisted chiefly in the provision of a set of suitable electric filters for sorting out different types of vibrations existing simultaneously and improvements in the design of the electrode.

Flight Investigation of Control Stick Vibration of the YG-1B Autogiro. (F. J. Bailey, N.A.C.A. Tech. Note No. 764, June, 1940.) (86/13 U.S.A.)

As a preliminary step in an investigation of control stick vibration in direct control autogiros, the periodic variations in the moments transmitted through the control system of a YG-1B autogiro were recorded in flight. The results of the measurements are presented in the form of coefficients of Fourier series expressing the varying part of the lateral and the longitudinal moments acting between rotor and fuselage at the control trunnions.

The most important component of the variation in stick force was found to have a frequency of three times the rotor speed and an amplitude that rose from negligible values at tip speed ratios below 0.20 to ± 5.2 pounds longitudinally and ± 3.2 pounds laterally at tip speed ratios of 0.35. Variations in stick force at all other frequencies were small in comparison with those at three times the rotor speed.

Transient Effects of the Wing Wake on the Horizontal Tail. (R. T. Jones and L. F. Fehlner, N.A.C.A. Tech. Note No. 771, August, 1940.) (86/15 U.S.A.)

A theoretical investigation is made of the effect of the wing wake on the lift of the horizontal tail surfaces. Expressions have been developed for this effect by taking into account the growth of wing circulation and wing wake, the time interval represented by the tail length and the development of lift by the tail. The tail surface was considered to be located directly in the wake where the effect is a maximum. The effect of tail length was investigated and it was found that the results obtained from computations covering a typical case could be extrapolated to take account of this factor in a satisfactory manner. The theory has been applied to a specific case to show the magnitude of the effect to be expected. It may also be extended to show the effects of vertical gusts. The lift of the tail surface due to interference from the wing during penetration of the gust may be calculated with the aid of curves given, provided that the variation in angle of attack of the wing is known. The lift independently developed by the action of the gust on the tail surface may be determined by the method described in N.A.C.A. Tech. Rept., No. 681. The two effects are additive.

Analysis of Wind Tunnel Data on Directional Stability and Control. (H. R. Pass, N.A.C.A. Tech. Note No. 775, Sept., 1940.) (86/16 U.S.A.)

Available wind tunnel data on static directional stability and control have been collected and studied. Methods based on these studies are given for evaluating the aerodynamic characteristics of vertical tail surfaces and their contribution to static directional stability and control. Special attention has been paid to the end-plate effect of the horizontal tail on the vertical tail and to the sidewash induced by the fuselage and the trailing vortex system from the wing. Methods based on limited data for fuselages and hulls, wings, and fuselage wing combinations are also given for estimating the contribution of the wing and the fuselage to directional stability.

This paper does not attempt to establish criteria for directional stability and control; rather, the emphasis is placed on providing some basis for design to specified criteria. An example applying the design methods has been included.

The Aileron as an Aid to Recovery from the Spin. (A. I. Neihouse, N.A.C.A. Tech. Note No. 776, Sept., 1940.) (86/17 U.S.A.)

As part of a general investigation by the N.A.C.A. of factors that affect the spin, the use of the aileron as an aid to recovery from the spin was studied. Tests of ten different models, covering a wide range of mass distribution, were made in the N.A.C.A. free-spinning tunnel to determine the effects of a large downward deflection of the outboard aileron and of normal angular deflections of the ailerons upon recovery characteristics.

The results indicate that the direction of aileron setting, with or against the spin, which will aid recovery from the spin depends upon the aeroplane weight distribution. For monoplanes and for biplanes with lower wing ailerons, ailerons with the spin will be favourable when the weight is distributed chiefly along the fuselage (single-engine aeroplanes) and ailerons against the spin will be favourable when the weight is distributed chiefly along the wings (multi-engine aeroplanes). Downward movement of the outboard aileron through a large angle will not always be effective in aiding recovery, the effectiveness of such a movement also being dependent upon the weight distribution of the aeroplane.

Notes on the Stalling of Vertical Tail Surfaces and on Fin Design. (F. L. Thompson and R. R. Gilruth, N.A.C.A. Tech. Note No. 778, October, 1940.) (86/18 U.S.A.)

The important aspects of the stalling of vertical tail surfaces, the type of instability encountered and the possibilities of its inadvertent occurrence are discussed on the basis of data accumulated in the N.A.C.A. flight research laboratory for the flying qualities of various aeroplanes. Flight tests of a twin-engine aeroplane in which the vertical fin area was increased are quoted to illustrate the influence of directional stability on the behaviour of an aeroplane when the tail stall takes place. Inadequate directional stability in certain modern designs appears to be due to the effect of refinement in fuselage shape and a general increase in wing loading. The properties and application of dorsal fins are discussed. In addition the chief factors regulating the requirements for conventional fin area are given, in which connection a simplified criterion for directional stability is presented. It is concluded that the directional instability at large angles of sideslip is associated with fin stalling, but that fin stalling does not necessarily produce instability. It is when the stalling condition can be produced by a smaller rudder angle than that at which the rudder tends to float with the fin stalled, that trouble occurs. It follows that a reduction in the rudder floating angle for the stalled condition, as well as an increase in the rudder angle required to produce the stalled condition, would be beneficial. In order further to clarify the problem and provide the proper quantitative basis for design, considerable research on the characteristics of various tail forms and on the flow conditions at the tail are needed.

Aerodynamic Heating and the Deflection of Drops by an Obstacle in an Air Stream in Relation to Aircraft Icing. (A. Kantrowitz, N.A.C.A. Tech. Note No. 779, Oct., 1940.) (86/19 U.S.A.)

The N.A.C.A. has been conducting a programme to develop a method of using engine exhaust heat to prevent or to remove ice formations on aircraft. The chief object of this paper is to provide information that will be useful to persons attempting to apply this method.

Two subjects are included in the present investigation:—

1. The temperature rise of surfaces exposed to boundary layer friction has been studied. This natural temperature rise is expected materially to reduce the amount of heat required to keep a surface in high speed flight above the freezing temperature.
2. The paths of water drops in an air stream disturbed by the presence of a circular cylinder have been numerically calculated. The calculation of these paths leads to information on the percentage of the swept area cleared of drops by the circular cylinder. This information should be of assistance in estimating the heat required to overcome the supercooling of drops that strike the wing.

Measured Moments of Inertia of 32 Aeroplanes. (W. Gracey, N.A.C.A. Tech. Note No. 780, Oct., 1940.) (86/20 U.S.A.)

A compilation of the experimentally determined moments of inertia of 32 aeroplanes is presented. The measurements were obtained at the laboratories of the N.A.C.A. by means of a pendulum method. The aeroplanes tested are representative of several types of aircraft of gross weight less than 10,000 pounds.

The results are presented in coefficient as well as in dimensional form. An elementary analysis of the data disclosed the possibility of grouping the results according to wing type of the aeroplane, as low wing monoplanes, parasol and high wing monoplanes, and biplanes. The data are shown to provide a convenient means of rapidly estimating the moments of inertia of other aeroplanes. A three-view drawing of each of the 32 aeroplanes is included.

This note supersedes N.A.C.A. Technical Note No. 375.

Mathematical Analysis of Aircraft Intercooler Design. (U. T. Joyner, N.A.C.A. Technical Note No. 781, Oct., 1940.) (86/21 U.S.A.)

The dimensions of an aircraft intercooler of the cross flow type fulfilling a given set of design conditions is investigated mathematically, making use of published data on heat transfer and pressure drop. These design conditions are:—

(1) Total mass flow of engine air.
(2) Inlet temperatures of engine and cooling air.
(3) Required engine air temperature at cooler outlet.
(4) Characteristics of aircraft carrying cooler.
(5) Physical characteristics of cooling air.

The total power consumed by the intercooler (sum of power used in forcing cooling and engine air through the cooler and the power required to transport the cooler) is used as a criterion of merit.

The analysis is applied to the case of a 1,000 h.p. engine operating at 25,000 feet, flying speed 300 m.p.h. The engine air enters at 280°F. and leaves at 80°F., whilst the cooling air enters at –80°F.

The following table is for a series of mass flows of the cooling air, the dimensions of the cooler being adjusted in each case to produce the necessary heat flow.

M_c	H ft.	L_c ft.	L_e ft.	Intercooler volume cu. ft.	P_t lb./sq. ft.	Δp_c lb./sq. ft.	Δp_e h.p.
1.00	69.91	0.018	0.470	0.583	0.208	5.57	2.50
0.30	19.72	0.063	0.497	0.617	0.745	5.89	2.66
0.15	8.64	0.144	0.568	0.704	1.700	6.72	3.03
0.05	1.29	0.964	1.270	1.576	11.41	15.04	6.78
0.04	0.42	2.974	3.136	3.890	35.24	37.14	16.75

In the above table,

M_c = mass flow of cooling air in slugs per second (1 slug/sec. = 32 lb./sec.).
H = height of intercooler (ft.).
L_c = length of cooling air passage (ft.).
L_e = length of engine air passage (ft.).
Δp_c = pressure drop of cooling air (lb./sq. ft.).
Δp_e = pressure drop of engine air (lb./sq. ft.).
P_t = total power consumed (h.p.).

The design with M_c = 0.15 slugs/sec. (~ 2 lb./sec.) is suggested as forming the best compromise, the h.p. absorbed being of the order of 3.

Vibration Patterns of Propeller Blades. (G. S. Baker, Engineering, Vol. 150, No. 3,910, 20/12/40, pp. 484-486; No. 3,911, 27/12/40, pp. 518-9.) (86/22 Great Britain.)

The experiments were carried out on two-bladed model ship propellers, 1 foot in diameter, the relatively heavy boss being firmly secured to a massive iron plate. Seven models were tested, three being of symmetrical outline whilst the remaining four had skewed back blades. All the blades were made flat on the driving face which was in a horizontal plane when the model was secured to the base plate. Vibrations were excited by means of an electro magnet supplied with alternating current, the frequency of which could be varied over wide limits. Resonance was detected by the loudness of the note emitted and the vibration form determined by sand patterns. Two principal modes of vibration, *i.e.*, flexural and torsional were investigated. At very high frequencies a lateral vibration of the blade was also observed.

A large number of photographs showing these modes of vibration are given. For the particular models tested, the fundamental flexural vibration frequency (nodal line near hub) was of the order of 500/sec. whilst the fundamental torsional vibration (nodal line radiating outwards from hub to tip) had a frequency of about 1,500 vibrations/sec.

The second, third and fourth order flexural vibrations have frequency ratios of about 3.5, 7 and 10 respectively with regard to the primary. The second order torsional vibration has a frequency ratio of only 1.6. Higher torsionals are generally combined with bending vibrations and the resultant pattern is very complicated.

For a particular blade of parabolic outline and a straight thickness line from root to tip, the fundamental frequency f can be calculated and is given by the equations :—

$$\left.\begin{aligned} f_f &= (0.3\, t/l^2)\, r \sqrt{(gE/\rho)} \text{ (flexural)} \\ \text{and } f_t &= (1.0/b_r l)\, t_r \sqrt{(gN/\rho)} \text{ (torsional)} \end{aligned}\right\} \text{cycles/sec.}$$

where b_r and t_r are chord and thickness at root in inches.

l = free length of blade from root to tip.
ρ = density of material in lb./cub. in.
$g = 32 \times 12$.

The experimental results can be represented by similar equations given below.

$$f_f = 0.305\, (t_r/l^2)\, \{ (b_r/b_m)\, (t_m/t_r) \}^{\frac{1}{2}} \sqrt{(gE/\rho)}$$

$$f_t = 0.92\, (t_h/b_h l)\, (b_r/b_m) \sqrt{(gN/\rho)}$$

where b_h and t_h = breadth and maximum thickness of blade at $l/2$.

b_m and t_m = mean breadth and mean maximum thickness.

These formulæ can only be regarded as useful for blades with thin edges and rounded backs. Moreover, an allowance will also have to be made for the fact that the experimental blades were not twisted, *i.e.*, their flat lower surface was parallel to the bed plate for the whole span.

The author's experiments form part of an investigation on the troublesome vibrations accompanied by a " singing " tone occasionally met with in ships' propellers. In a particular case, the fundamental of the note emitted was of the order 180-300 cycles/sec. for an 18-foot propeller. The above equations show that both flexural and torsional frequencies vary inversely as l for similar propellers.

The corresponding frequency of the 1-foot model is thus of the order 3,000-5,000 vibrations/sec., *i.e.*, third and fourth order flexural.

Italian Experiments on Jet Propulsion. (Inter. Avia., No. 733, 28/10/40, p. 6.) (86/23 Italy.)

Inter. Avia., No. 694-95, pointed to the plans of Engineer Campini, of the Caproni group, which aimed at the realisation of a high level high speed aircraft with jet propulsion. On August 27th the first flight of such a design was effected from the Milan aerodrome of Forlanini in the presence of Divisionnaire-General Alberto Briganti, the Commander of No. 1 Air Zone. According to the " Popolo d'Italia," the machine is built entirely of metal, has a gross weight of about 8,800 lb., retractable landing gear and a pressure cabin. Piloted by Colonel de Bernardi, of the Caproni works, the machine, driven solely by the reaction of ejected gases, accomplished a flight of ten minutes' duration. The Italian source claims the first flight of this " rocket-drive aircraft " to be the prelude to a revolution in the design of aircraft and power plant installations, without, however, dealing in any detail with the work that has been accomplished to overcome the difficulties hitherto encountered in the construction of jet-propulsion aircraft; it is merely stated that the research work of Engineer Campini, extending over decades, has finally led to the development of a power plant whose efficiency is not below that of the engine airscrew combination even at conventional speeds.

A Method of Measuring Piston Temperatures. (B. Pinkel and E. J. Manganiello, N.A.C.A. Tech. Note No. 765, June, 1940.) (86/24 U.S.A.)

A method employing thermocouples to measure the temperatures of engine pistons operating at high speeds has been developed. The thermocouples installed on the moving piston are connected to a potentiometer outside the engine by means of pneumatically operated plungers. These make contact with the piston thermocouples for about ten crankshaft degrees at the bottom of the piston stroke. The equipment operates satisfactorily at engine speeds of 2,400 r.p.m. and shows promise of successful operation at higher speeds. The accuracy of measurement is unaffected by speed within the range tested and its dependence on percentage duration of contact may be obviated by the use of a sufficiently sensitive galvanometer for a balance indicator. Piston temperatures were measured in a liquid-cooled compression ignition engine and in an air-cooled spark ignition engine with fuel injection. In the latter case the increase in piston temperature with increased load and increase in head and barrel temperature indicates the pressing need for an investigation of possible means for reducing the operating temperatures of pistons.

A Study of the Air Movement in Two Aircraft Engine Cylinders. (D. W. Lee, N.A.C.A. Tech. Note No. 766, July, 1940.) (86/25 U.S.A.)

Studies were made of the air movements in the N.A.C.A. glass cylinder apparatus using cylinder heads similar to those on the Wright R-1820-G engine (I) and the Pratt and Whitney "Wasp" engine, as modified by the Eclipse Aviation Corporation to use fuel injection equipment (II). The air movements were made visible by mixing small feathers with the air; high speed motion pictures were taken of the feathers as they swirled about inside the glass cylinder. The test engine speeds were 350, 500 and 1,000 r.p.m. Motion pictures were also taken of gasoline sprays injected into the cylinder during the intake stroke. The air movement in the cylinder using cylinder head (I) was very turbulent during the intake stroke. During the second half of the intake stroke, a very slow rotation of the air about the cylinder axis began. The turbulence died out during the compression stroke, but the rotation continued at a reduced rate until the end of the cycle. The air movement in the cylinder when using head (II) took the form of a vertical loop during the intake and compression strokes; some turbulence was also present. The loop movement died out before the beginning of the expansion stroke, leaving only a slight turbulence. There appeared to be no difference in the time required for vapourisation of gasoline sprays injected into the cylinder when using the two types of head.

The Development of the Brown Boveri Axial Compressor. (Seippet, Brown Boveri Review, May, 1940, pp. 108-113.) (86-27 Great Britain.)

Some of the aerodynamic principles involved in the design of axial compressors are dealt with, and their influence upon blade shape discussed. Notes are added on the experimental development of the axial blower, and a review is made of the field of its application.

(Abstract supplied by Research Dept., Metropolitan-Vickers.)

Analysis of Cylinder Pressure Indicator Diagrams showing Effects of Mixture Strength and Spark Timing. (H. C. Gerrish and F. Voss, N.A.C.A. Tech. Note No. 772, Aug., 1940.) (86/26 U.S.A.)

An investigation was made to determine the effect of mixture strength and of normal as well as optimum spark timing on the combustion, on the cylinder temperature, and on the performance characteristics of an engine. A single cylinder test unit utilising an air-cooled cylinder and a carburettor and operating with gasoline having an octane rating of 92 was used. The investigation covered a range of fuel-air ratios from 0.053 to 0.118. Indicator diagrams and engine performance data were taken for each change in engine conditions.

Examination of the indicator diagrams shows that for fuel-air ratios less than and greater than 0.082 the rate and the amount of effective fuel burned decreased. For a fuel-air ratio of 0.118 the combustion efficiency was only 58 per cent. Advancing the spark timing increased the rate of pressure rise. This effect was more pronounced with leaner mixtures.

Italian High Speed Aeroplane Engines. (C. F. Bona, Paper presented to the Volta Conference, Oct., 1935. Translation available as N.A.C.A. Tech. Memo., No. 944.) (86/28 Italy.)

Some design particulars of the Fiat A.S.6 engine which gained the speed record over 3 km. for Italy in 1934 are given. This engine consists of two separate A.S.5 V engines placed in tandem, each driving its own propeller. The propellers are arranged concentrically in the nose of the front engine, the driving shafts (two tubes one inside the other) being located inside the V. One of these shafts is driven from the rear end of the front engine whilst the inside shaft is driven from the front of the rear engine. The two reduction gears are similar, but the crankshafts and therefore the propellers rotate in opposite directions. The lengths of the two shafts is thus practically the same (length of one engine) and no torsional difficulties were experienced. Since only one supercharger is fitted, which is driven by the rear engine whilst supplying compressed charge to both, the net h.p. transmitted by the rear engine differs by the negative work (200 h.p.) from that available at the propeller driven from the front engine. In order to ensure the same rotational speed the pitches of the two propellers are made slightly different. The original A.S.5 engines (12-cylinder V, 138 × 140 mm.; separate cylinders, welded steel jackets) developed about 1,000 h.p. at 3,200 r.p.m. and were not fitted with a supercharger. The two A.S.5 engines forming the new unit had certain parts stiffened and were boosted to intake pressure varying between 7 and 12 lb. per sq. in. Under these conditions the combined unit developed up to 3,000 h.p. at 3,300 r.p.m. The article deals mainly with various difficulties encountered whilst developing and testing, damage due to backfires being the principal source of trouble. This was partly due to faulty mixture distribution and partly to changes in ignition timing due to torsional oscillations of the drive. The fuel used had the following composition :—

Petrol	55%	+ 1.5 per cent. Tet. Ethyl Lead.
Ethyl alcohol ...	23%	
Benzol	22%	

The mixture was supplied by four down draught carburettors placed at the blower intake and distributed to the cylinders by a central pipe of relatively large capacity placed inside the V and provided with branches for every two cylinders.

Viscosity Characteristics of Lubricating Oils as Related to their Chemical Structure. (B. Yamaguchi, Aer. Res. Inst., Tokyo, Rept. No. 192, Aug., 1940. In Japanese.) (86/29 Japan.)

It is shown that no clear relationship exists between chemical structure and viscosity index (Viscositatspolhöhe) of high molecular weight hydrocarbons, but that the viscosity temperature coefficient for liquids of equal viscosity is a function only of chemical structure. For a number of synthetic high molecular weight hydrocarbons the viscosity temperature coefficients, at the respective temperatures at which all the liquids have a viscosity of 100 centistokes, have been calculated by means of Walther's viscosity temperature equation. It was found that the

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calculated coefficients are always definitely related to chemical structure. It is concluded that the greater the " degree of entanglement " of a hydrocarbon molecule, defined by the size of cyclic nuclei or the length of paraffinic side chains in conjunction with the size and allocation of branched chains in the molecule, the smaller is the value of the viscosity temperature coefficient (or " structure viscosity index," $-[(dv/dt)\, v=100 \text{ c.s.} + 5] \times 100$). A criterion for grading the viscosity characteristics of hydrocarbons is provided both by the values of viscosity and " structure viscosity index." For compounds of comparable viscosities, the viscosity characteristics are better the smaller the structure viscosity index. The molecular structure necessary to give optimum viscosity characteristics is discussed and it is shown that the beneficial effect of addition of agents such as paratone to commercial lubricants can be reasonably explained by the idea of " structure viscosity index."

The Effects of Engine Speed and Mixture Temperature on the Knocking Characteristics of Several Fuels. (D. W. Lee, N.A.C.A. Tech. Note No. 767, July, 1940.) (86/30 U.S.A.)

Six 100 octane and two 87 octane aviation engine fuels were tested in a modified C.F.R. variable compression engine at 1,500, 2,000, and 2,500 r.p.m. The mixture temperature was raised from 50° to 300°F. in approximately 50° steps and, at each temperature, the compression ratio was adjusted to give incipient knock as shown by a cathode ray indicator. The results are presented in tabular form.

The results are analysed on the assumption that the conditions which determine whether a given fuel will knock are the maximum values of density and temperature reached by the burning gases. A maximum permissible density factor, proportional to the maximum density of the burning gases just prior to incipient knock,. and the temperature of the gases at that time were computed for each of the test conditions. Values of the density factor were plotted against the corresponding end gas temperatures for the three engine speeds and also against engine speed for several end gas temperatures.

The maximum permissible density factor varied only slightly with engine speed, but decreased rapidly with an increase in the end gas temperature. The effect of changing the mixture temperature was different for fuels of different types. The results emphasise the desirability of determining the anti-knock values of fuels over a wide range of engine and intake air conditions rather than at a single set of conditions.

Correlation of Knocking Characteristics of Fuels in an Engine having a Hemispherical Combustion Chamber. (A. M. Rothrock and A. E. Biermann, N.A.C.A. Tech. Note No. 768, July, 1940.) (86/31 U.S.A.)

Data are presented to show the effects of inlet air pressure, inlet air temperature, and compression ratio on the maximum permissible performance obtained with a cylinder having a hemispherical dome combustion chamber. The five aircraft engine fuels used have octane numbers varying from 90 to 100 plus 2 *ml* of tetraethyl lead per gallon. The data were obtained on a $5\frac{1}{4}$-inch by $4\frac{3}{4}$-inch liquid-cooled engine operating at 2,500 r.p.m. The compression ratio was varied from 6.0 to 8.9. The inlet air temperature was varied from 110° to 310°F. For each set of conditions, the inlet air pressure was increased until audible knock occurred and then reduced two inches of mercury before data were recorded. The results for each fuel can be correlated by plotting the calculated end gas density factor against the calculated end gas temperature. Measurements of spark plug electrode temperatures showed that, with two spark plugs, cutting off the switch to one spark plug lowered the electrode temperature of that plug from a value of 1,365°F. to a value of 957°F. The results indicate that the surface temperatures of combustion chamber areas which become new sources of ignition markedly increase after ignition commences.

Ionisation in the Knock Zone of an Internal Combustion Engine. (C. E. Hastings, N.A.C.A. Tech. Note No. 774, Sept., 1940.) (86/32 U.S.A.)

The ionisation in the knock zone of an internal combustion engine was investigated. A suspected correlation between the intensity of knock and the degree of ionisation was verified and an oscillation in the degree of ionisation corresponding in frequency to the knock vibrations in the cylinder pressure was observed. Under suitable conditions the ionisation gap may be used to indicate knock.

Universal Compass Checking Bench. (Inter. Avia., No. 728, 19/9/40, pp. 3-4.) (86/33 Germany.)

For the periodical checking of direct reading and tele-compasses the Askania Werke A.G., Berlin-Friedenau, has developed a universal checking bench which permits the control of all compass models of up to 6.23 in. (160 mm.) diameter. During the checking process the surrounding magnetic fields and the position of the compasses are altered and the following properties tested:—Time required for re-setting after a 90 deg. deviation, angle of inversion and period of semi-oscillations, hunting, pivot friction and maximum permissible compass-rose inclination. In tele-compasses the setting precision at full directing force is also checked. The design of the checking bench is as follows:—

A rotatable axle carries a gear ring; three pedestals on the ring take the compass to be checked. The gear ring is rotated either by a hand crank or a synchronous motor. Three magnet coils connected to a 12-volt D.C. circuit serve to modify the magnetic fields. The synchronous motor driving the gear ring is provided with a gear box selected in such a way that the ring rotates through 360 degrees in one, two or three minutes, respectively. The spacing of the motor from the compass is large enough to eliminate all magnetic influence. A photo shows the mounting of a conventional direct-reading compass on the bench. The accessories such as the course element, vacuum pump, suction meter, and differential manometer are needed for the checking of tele-compasses.

Tensor Gauge. (Inter. Avia., No. 731, 12/10/40, p. 12.) (86/34 U.S.A.)

With the introduction of the all-metal monocoque type of construction in the aircraft industry, it was found necessary to develop a method of determining in a simple way the complete state of strain and stress in continuous sheets or thin plates under the influence of loads in the aeroplanes. The conventional experimental procedure consists of applying linear strain gauges in different directions during three successively repeated load cycles. The technical difficulties of repeating the test load cycle with exactly the same load distribution are well known. The efforts to develop a handy instrument which permits simultaneous measurement of stresses in three directions on certain points of the fuselage monocoque, at inaccessible junctions, etc., have led to the design of the Tensor gauge. The instrument is fastened to the specimen surface by a single central suction cup; three measuring cones, entirely independent of each other and forming the corners of an equilateral triangle, engage the specimen in a circular diameter of 30 mm. Each of the three movable legs is guided precisely radially; their movements are translated with imperceptible friction to a microscopic index reticule, the position of which is made readable by means of magnifying lenses. A strain of 1/10,000, which in aluminium corresponds to a linear stress of approximately 1,000 lb. per sq. in., appears as one scale division; the total range amply covers any test requirements within the yield limits of the structural material.

Dynamical Stability of a Column Under Periodic Longitudinal Forces. (I. Utida and K. Sezawa, Aer. Res. Inst., Tokyo, Vol. 15, No. 193, Aug., 1940.) (86/35 Japan.)

Although there is a number of frequencies at which the vibration becomes unstable (resonance), the mode of vibration of the column is generally of the fundamental mode, *i.e.*, the ratio of the natural to the exciting frequency is of the order ½, 2/2, 3/2, etc.

Although the periodic vibration of the column in the unstable or resonance condition is almost of sine form, the same form tends to change increasingly with increase in the order of resonances. It is likely that the wave form of the vibration of the column in the frequency intermediate between two neighbouring unstable conditions, contains both types of waves in these unstable conditions.

Experimental as well as mathematical result show that the resonance or instability condition depends on the magnitude of the vibrating forces applied. If the forces were not great, it would be impossible for the resonance or unstable condition to occur, from which it follows that the phenomena resemble those of resonance vibration with respect to the vibrational frequency and those of buckling with respect to the magnitude of the applied forces.

Some Experiments on the Forced Vibration of Varying Period. (K. Sezawa and W. Watanabe, Aer. Res. Inst., Tokyo, Vol. 15, No. 195, Aug., 1940.) (86/36 Japan.)

The resonance condition of an elastic bar under forces with frequency increasing or decreasing linearly with time, was investigated experimentally. The vibration of the same bar was excited electro-magnetically, the intensity of the force being constant for every vibration through the whole range of the varying frequency. A magnetic damper was added to the bar for ascertaining the effect of viscous damping on the resonance amplitude in the case of varying frequency.

Let dN/dt be the absolute speed of change of frequency and k the logarithmic decrement of free vibration in the case of dN/dt being zero. When k was not very large, the resonance amplitude diminished enormously with increase in dN/dt. On the other hand, when k was fairly large, no appreciable change in resonance amplitude occurred for different dN/dt. Although the resistance arising from viscous damping was operative in forced vibration as well as in free vibration, that due to change of cycle manifested itself only in the case of forced vibration. Furthermore, although the resonance amplitude was nearly the same provided the absolute values of dN/dt were given, there was some time lag in reaching the maximum amplitude. This feature was pronounced particularly in the case of large k. It was possible to construct empirical formulæ indicating the resonance amplitudes for any case of dN/dt.

The Lateral Stability of Equal Flanged Aluminium Alloy I Beams Subjected to Pure Bending. (C. Dumont and H. N. Hill, N.A.C.A. Tech. Note No. 770, Aug., 1940.) (86/37 U.S.A.)

Equal flanged beams of a special extruded I section of 27 ST aluminium alloy were tested in pure bending. Complete end fixity was not attained. Loading was continued until a definite maximum value had been reached. Tensile tests were made on specimens cut from the flanges and the web of each beam. Compressive stress-strain characteristics were determined by pack compression tests on specimens cut from the flanges.

The critical stress at which equal flanged aluminium I beams subjected to pure bending become unstable may be determined from the equation

$$S_{cr} = (E_R/E) \{ 19{,}800{,}000/(KL)^2 Z \} \sqrt{\{ I_1 [J (KL)^2 + 6.58\, I_1 h^2] \}}.$$

In both the elastic and the plastic ranges of the material the values of critical stress calculated by means of the foregoing equation were in good agreement with the values computed from experimentally determined critical bending moments.

Approximate values of critical stress, as determined by the equivalent slenderness ratio method, were about 20 per cent. lower than the values obtained experimentally, when buckling occurred at stresses near the yield strength of the material.

Values of critical load determined by Southwell plots of the load deflection data were in good agreement with the experimentally determined values of critical load. This agreement demonstrates the applicability of the method to the case of lateral buckling of beams.

Chart for Critical Compressive Strength of Flat Rectangular Plates. (H. N. Hill, N.A.C.A. Tech. Note No. 773, August, 1940.) (86/38 U.S.A.)

The theoretical stress at which a rectangular flat plate will buckle elastically, when uniformly compressed in one direction, can be expressed :—

$$\sigma_{cr} = K \{ E/(1-\mu^2) \} (t/b)^2$$

where σ_{cr} = critical stress at which buckling occurs, lb./sq. in.

E = modulus of elasticity of the material, lb./sq. in.

μ = Poisson's ratio for the material.

t = thickness of plates, inches.

b = width of plate, normal to direction of compression, inches.

K = a coefficient depending on the ratio of length to width of the plate (l/b), the conditions of restraint at the edges of the plate, and in some cases on Poisson's ratio.

A chart is now presented for the coefficient K, the curves given applying to various combinations of fixed, simply supported and free edges. The curves demonstrate the importance of the condition of restraint of the loaded edges in determining the buckling stress of rectangular flat plates having L/b ratios less than 3.

Magnesium Alloys in Aircraft. Details of American Practice. (N. E. Woldman, Metal Industry, Vol. 57, No. 24, 13/12/40, pp. 465-8.) (86/40 U.S.A.)

Magnesium alloys can be produced in the following forms :—(i) Castings : sand cast, permanent mould and die cast. (ii) Forgings : hammer and press forgings. (iii) Wrought : extrusions, sheets, plates and bars. The constitution and physical properties of the casting, forging and wrought alloys are discussed. Not all of them are susceptible to heat treatment. The latter, which is a solution treatment, with or without an ageing treatment, produces the optimum physical properties. The solution treatment consists in heating the parts to 650-720°F. for a sufficient time (16-20 hours) until the insoluble constituents go into solution and then air cooling. This treatment increases the strength and ductility to maximum toughness. When followed by ageing for 12-16 hours at 340-400, the tensile strength and hardness are further increased with a sacrifice in ductility. Magnesium alloys, while possessing good tensile and fatigue properties are very notch-sensitive. Hence notches, scratches, sharp corners must be avoided, also cavities, in which moisture can accumulate and cause corrosion. Electrolytic corrosion in contact with brass and steel is prevented by plating with cadmium. Mg alloys can safely be used at low temperatures, but are not recommended for resistance to wear. Salt water corrosion is prevented by an anti-corrosive treatment known as chrome pickle (Na_2CrO_4 + Conc. HNO_3 + water). This produces a yellow porous coating of chromates which has definite anti-corrosive properties, and at the same time provides a good base for painting.

Non-Destructive Production Tests for Steel Tubing. (Steel, 21/10/40, pp. 38-40 and 75.) (86/39 Great Britain.)

A test for defects in tubing which is entirely independent of the magnetic properties of the tube has been developed by Sperry Products Inc. The detector equipment for production inspection work described in this article is provided with alternative automatic or manual control. An energising coil is employed which induces current in a circular direction in the tube, and a search coil picks out defects. The searching unit output is amplified by electronic equipment and operates visual signals and a motor relay controlling the passage of the tube through the detector.

(Abstract supplied by Research Dept., Metropolitan-Vickers.)

Tests on Lead Bronze Bearings in the D.V.L. Bearing Testing Machine. (G. Fischer, L.F.F., Vol. 16, No. 7, 20/7/39, pp. 370-383. Translation available as N.A.C.A. Tech. Memo., No. 943.) (86/41 Germany.)

The tests were carried out on 12 lead bronze bearings supplied by five manufacturers, the lead content varying between 20 and 40 per cent.

All the bearings had a steel shell backing, the actual bronze deposit (cast on) being about 0.5 mm. thick. Similar tests on light alloy bearing metals are described by the same author in L.F.F., Vol. 16, No. 1, pp. 1-13 (R.T.P. Translation No. 1,092).

The original D.V.L. bearing testing machine is described in an article by O. Heyer (L.F.F., Vol. 14, No. 1, 20/1/37, pp. 14-25). In this machine the bearing rotates about a fixed shaft, whilst a variable load in a fixed direction can be applied to the outside of the bearing by means of an ingenious toggle mechanism. In this way the force distribution over the bearing surface can be made to approach that existing in an engine under load. All the bearings tested were 60 mm. inside diameter, approximately 0.5 mm. thick and the width of running surface 25 mm. The rubbing speed was 5 m./sec. and the temperature of the shaft at a point near the oil film was kept at 120°C. by adjusting the oil circulation. Friction force are not measured by this machine, which is entirely intended to permit rapid examination of the bearing for marks of wear or injury. A safety cut-out device is, however, provided which stops the machine should the power absorbed increase by more than 50 per cent.

Only two of the bearings carried out satisfactorily the specified endurance run of 100 hours at a static load of 250 kg./cm.^{2}. (In these tests the toggle mechanism is clamped.) Apparently running conditions under dynamic load are less onerous, since the oil film can reform itself during the low pressure periods.

It appears that the main difficulty is to ensure a uniform, fine globular lead distribution in the original casting. It is well known that such a desirable grain structure requires a low pouring temperature and fast quenching. Unfortunately this reduces the bonding to the steel shell backing. The use of a high frequency electric furnace for the melting seems to improve grain structure (eddy currents?).

Active research for some alloying component producing the same result has not yet given any satisfactory results and the possibility of fastening the bronze to the steel shell by some alternative method to casting is also receiving attention (A. Blankenfeld, Z. für Metallkunde. Vol. 31, No. 2, 1939, pp. 31-45).

New Equipment for Testing the Fatigue Strength of Riveted and Welded Joints. (W. Müller, Schweizer Archiv, No. 10, 1937. N.A.C.A. Tech. Memo., No. 947, July, 1940.) (86/42 Germany.)

In fatigue testing of joints the stress applied should be sufficient to produce failure within 1-14 days. To obtain a sinusoidal variation in alternating bending stress, the vibrations being in rhythm with the natural frequency of the test body, the simplest method is to form the joint into an oscillating pendulum on which the maximum amplitude is preserved by synchronous application of exciter forces. This has been achieved by attaching the joint by flanges and bolts to a fixed base plate. The upper part of the joint carries a flywheel mass which oscillates during the test and gives a steady motion. The vibration amplitude is maintained by a system of two magnets, operating in opposite phase, which alternately pull two pole pieces downwards. The latter are situated on opposite sides of the pendulum and attached to wires which pull the vibrating part of the joint to left or right. The electric oscillator is operated by two current impulses out of phase by one-half vibration period, produced by rectifier tubes. The arrangement is fully described. The number of vibrations up to failure is determined by a counting mechanism with an automatic stopping device. Tests made on 65 riveted and welded joints indicate that the testing machine can operate without serious disturbance for more than 3,500 hours. Light alloy joints of double U section with an inertia moment of 10.6 $cm.^4$ can be maintained at a frequency of 9-11 vibrations per second, and a maximum bending stress of 7-10 $kg./mm.^2$ in vibration.

Buckling Tests with a Spar-Rib Grill. (J. Weinhold, L.F.F., Vol. 17, No. 3, 20/3/40, pp. 78-81. Translation available as N.A.C.A. Tech. Memo., No. 950.) (86/43 Germany.)

The author has investigated the buckling loads of grills under certain simple conditions in two previous papers. The present paper deals with a more practical case, the experimental grill having dissimilar spars, 8 mm. wide, 100 mm. deep and 3,250 mm. long. The ribs are eight in number, 7×7 mm. and 1,000 mm. long. Both spars and ribs are made of selected pine wood. The loads are applied in the form of equal bending moments at both spar ends, as compression in the line connecting the joints and in the spar centre line as a uniformly distributed spar weight. The evaluation formula is derived from the energy equation as before, allowances being made for the dissimilarity of the spars, the variation in rib rigidity and the load due to spar weight and is valid for a deflection following a half wave.

Comparison with experiment is satisfactory, an effect due to the finite aspect ratio of the test spars is not apparent. For smaller compressive forces and greater end moments the coefficients of the formula should be computed again for further deflection forms in order to find further buckling conditions, which of course yield lower loads at the stability limit.

Improved Type of Radio Sonde. (Inter. Avia., No. 728, 19/9/40, p. 4.) (86/44 Italy.)

An improved type of radio sonde has been taken into operation by the meteorological service of the Italian Air Force about a month ago; the new sondes report by wireless the temperature, the static pressure and the degree of moisture registered. They are designated "Italia," are used by the "Centrale Assistenza Volo dell'Aeroporto Littorio-Roma" and weigh, including the transmitter, batteries, antenna, etc., 1.44 lb.; they have an average rate of climb of 11 ft./sec. and a ceiling of about 98,000 ft. The temperature measuring range extends over as much as 70 deg. Centigrade; the values measured are transmitted automatically to the ground station every 30 secs.; the range of the transmitter varies from 62 to 125 miles. Upon reception of each signal the ground station checks the position of the sounding balloon which enables a simultaneous determination of wind speed and direction at different altitudes to be made.

LIST OF SELECTED TRANSLATIONS.

NOTE.—Applications for the loan of copies of translations mentioned below should be addressed to the Secretary (R.T.P.), Ministry of Aircraft Production, and copies will be loaned as far as availability of stocks permits. 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.

THEORY AND PRACTICE OF WARFARE.

TRANSLATION NUMBER AND AUTHOR.		TITLE AND REFERENCE.
1130	Baasch, H.	*A Contribution to the Question of Estimating the Efficiency of Light Anti-Aircraft Guns with Special Reference to their Gun-laying Devices.* (Flugwehr und-Technik, Vol. 2, No. 8, Aug., 1940, pp. 176-7.)
1133	Grötsch, G. ... ... Plake, E.	*Determination of the Coefficients of Friction of Steel on Steel at High Velocities.* (Z.G.S.S., Vol. 35, No. 1, Jan., 1940, pp. 3-5; No. 2, Feb., 1940, pp. 30-32.) (R.D. Translation No. 898.)

AERO- AND HYDRODYNAMICS.

1115	Ferri, A.	*Some Experimental Results Obtained on Wing Profiles in the Guidonia Supersonic Wind Tunnel.* (Atti di Guidonia, No. 17, 20/9/39.)
1131	Campini, S.	*An Analysis of the Theory of the Campini Jet Propulsion System.* (L'Aerotecnica, Vol. 18, No. 1, Jan., 1938, pp. 18-63.)

MATERIALS.

1128	Sudinin, V. A.... ...	*Wing Vibration in Relation to Engine Masses and Elasticity of the Supports.* (Aeron. Eng., U.S.S.R., Vol. 13, No. 5, May, 1939. pp. 95-7.)

Translation Number and Author.		Title and Reference.
1132	Zeerleder, A. von ...	*Recent Developments in the Riveting of Light Metals in Aircraft Construction.* (Flugwehr und-Technik, Vol. 2, No. 5-6, May-June, 1940, pp. 120-3.)
1134	Hollbach, O.	*Aircraft Materials. A. Steels.* (Deutscher Flugzeugbau, Export Handbook of the German Aircraft Industry, 1939, pp. 173-5.)
		Miscellaneous.
1129	Spetzler, A.	*The Mechanism of Pocket Watches.* (Z.V.D.I., Vol. 84, No. 21, 25/5/40, pp. 355-8.)
1135	Diringshofen, H. von... Hartmann, H.	*The Physiological Effects of CO at High Altitudes.* (L.F.F., Vol. 12, No. 4, 30/7/35, pp. 121-3.)