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Safeguarding Aerodromes from Aerial Attack. (Air Fleet News, U.S.S.R., Vol. 21, No. 12, December, 1938, pp. 34-6.) (68/1 U.S.S.R.)

An aerodrome is always detected if the enemy can actually watch the take-off or landing of aircraft or if tracks can be seen in the dewy grass or on snow. For this reason flying fields must be made to appear unsuitable by scattering light sand (*i.e.*, appearance of agricultural land) or simulating roads by burning away the grass in tracks. Artificial colouration (dyes) can also be employed.

Attention of the enemy can also be diverted by erecting mock buildings at some distance from the actual landing ground. The buildings can be made of derelict aircraft, empty fuel tanks, etc. Distinctive markings must also be provided to simulate landing instructions, in the hope that the enemy will attack the bait. The characteristic contours of aircraft standing in the open must be hidden by adding material (of the same colour as the ground) to the wing tips and tail surface. In winter unbroken snow surface is easily simulated by white ground sheets. In summer the presence of abundant vegetation also renders camouflage easier. In the absence of much vegetation, however, the difficulties are very great. Matters are complicated by the fact that the normal colouring of aircraft (intended to render them more difficult to detect when observed in the air) gives rise to increased contrast on the ground.

Some Remarks on Aerial Warfare. (H. von Rohden, Luftwehr, Vol. 6, No. 1, January, 1939, pp. 2-13.) (68/2 Germany.)

The mass utilisation of a new weapon has always produced far-reaching effects on the tactics of warfare, and the question naturally arises whether the air arm is now in a position to produce decisive results on its own. This is no doubt the case if one of the combatants disposes of great superiority in the air. It is doubtful, however, whether such a superiority will exist in future conflicts, which thus cannot be won in the air alone, but which will require co-operation of all methods of attack.

In this co-operation the air arm is destined to play an important role, especially in the early stages of a campaign. With a fleet, on the other hand, results can generally only be achieved by a blockade, the effect of which can be nullified over a period by the proper organisation of all resources of the blockaded country. The proper use of the air arm will call for great qualities in leadership, uniformly well trained crews, ample reserves in men and material and an efficient ground organisation (aerodromes, signals, A.A. artillery). The ground organisation

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especially requires the most careful study, as well as the grouping of the forces in depth and width. The author discusses at some length the relative advantage of a self-contained " air army " which can operate in a similar manner to the mixed brigades first introduced by Napoleon. One very important factor in air fighting is the weather and meteorology thus becomes a military science.

The Participation of Aircraft in Ground Fighting. (Gen. Maginel, Rev. Millit. Gen., Oct.-Nov., 1938, Luftwehr, Vol. 6, No. 4, April, 1939, pp. 134-144.) (68/3 France.)

Aircraft can operate either in the front line itself or on the lines of communication. In the case of modern troops provided with ample artillery, the author is of the opinion that participation in front line fighting will be extremely costly and only be justified in exceptional cases. The normal field of application of aircraft is the zone behind the front, and this requires fast medium-sized bombers of great manœuvrability.

The diving method of attack has received considerable attention. It has, however, the drawback of requiring special aircraft and highly trained crews. As an alternative the author favours low altitude horizontal attack. By making suitable use of the terrain, the aircraft can remain hidden up to the moment of attack and need only fear those machine guns which happen to be pointed along its flight path. In carrying out this attack the squadron would operate singly in rapid succession (so-called " chain " attack of the Italians) the formation reassembling after attack and returning on a different route. The greatest danger exists from enemy fighters attacking the formation when it is broken up. It is thus essential that the instant of attack be chosen correctly. Some war problems illustrating the author's theories are worked out in detail.

Reconnaissance from a Great Height. (W. Kusnjetzon, Krassnaja, Swjesda, April, 1938. Luftwehr, Vol. 6, No. 4, April, 1939, pp. 145-6.) (68/4 U.S.S.R.)

Experience in Spain and China has shown that reconnaissance aircraft operating at more than 16,000 feet are practically immune from fighter attack. To make full use of this fact, the aircraft must have a speed range from 100 to 300 m.p.h. and a service ceiling of 30,000 ft. If to this we add the requirement of an endurance of several hours we see that not only the design and equipment of such aircraft require considerable care but the crew is also subjected to great strain. Great attention must be paid to the health of pilot and observer and training in artificial low pressure chambers must alternate with frequent high altitude flights. A hole in the floor of the aircraft is essential for ground observation and the operation of the aerial camera must be simplified. At most one crew can only carry out two high altitude flights of 1½-2 hours per 24 hours, and it is therefore necessary that the observer be thoroughly familiar with the enemy's organisation so that no time is wasted. In many cases observation of the ground will only be possible through gaps in the clouds and this requires considerable experience. Contrary to expectation a ground haze is often transparent when looked through from a great height, but whenever possible high altitude reconnaissance should be carried out in the morning or evening. A rain storm often makes the air more transparent and in general the crew should be ready to carry out such work at the shortest notice.

The Utilisation of Aircraft in the Spotting and Destruction of Submarines. (Kolesnikow and Bessonow, Air Fleet News, U.S.S.R., July, 1938; Luftwehr, Vol. 6, No. 4, April, 1939, pp. 146-151.) (68/5 U.S.S.R.)

Under favourable conditions (sunlight, absence of wind, deep water) the maximum depth at which a submarine can be seen from an aircraft operating at 100 to 600 m. is about 15 m. This maximum depth corresponds to the case when the

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submarine is approximately vertically below the aircraft (sighting angle up to 20°). With a more oblique view this depth rapidly diminishes (5 m. at 60°). If the submarine is at the surface when spotted by the aircraft, and then dives, it is possible to calculate the conical surface on which the submarine must be situated, if its rate of submergence and under water speed is known. If at the same time the distance of the aircraft from the submarine when submersion started, is known, the dimension of the circular locus on the immersion cone when the aircraft passes the original position (disturbed water!) can be determined, and the bomb dropping adjusted accordingly. As an alternative, the aircraft describes a curve round the submarine, so as to maintain a constant sighting angle, and summons other aircraft or surface vessels in the neighbourhood to participate in the hunt. The author also gives some details of how to carry out a systematic search for suspected submarines over a given stretch of water, and the minimum number of aircraft required.

Lighting System for Air Raid Precautions. (Engineering, Vol. 147, No. 3827, 26th May, 1939, p. 620.) (68/6 Great Britain.)

The system involves two components—a sodium source fitted with an enveloping filter and a lacquer in the complementary colour of the emitted light, which is sprayed on to the windows, roof lights, etc. The lamp and filter produce a narrow band of monochromatic yellow light to which the lacquer is opaque, and it is claimed that their combined use does not allow any visible radiation to penetrate into the outside atmosphere. The lacquer is sprayed on to the outside of the glass, forming a matt surface which prevents light from outside sources being reflected on it, and yet allows sufficient daylight (10 per cent.) to pass for general machine work and assembly processes to be carried out on a normal day without recourse to artificial lighting.

Japanese Attacks on Chinese Aerodromes. (Faysulin, Krassnaja Swjesda, 6/1/39; Luftwehr, Vol. 6, No. 4, April, 1939, p. 153.) (68/7 U.S.S.R.)

The main attack is preceded by a surprise reconnaissance, the route adopted missing the larger centres of population, final course being only set in close proximity to the objective. The major part of the flight is carried out at great altitudes (5,000 m.) with descent to 3,000 m. at the target. The first part of the return journey is carried out at high speed into the direction of the sun. No bombs are dropped during this reconnaissance, which is carried out by single aircraft. The main attack is carried out subsequently, after the target has been carefully studied. The Chinese, on the other hand, seem to rely on staff information when planning their operations and thus combine reconnaissance and attack in one operation.

Russian Experiments with Under-Water Wings for Ship propulsion. (A. N. Vladimirov, Soudostroienie, No. 7, 1938. Eng. Absts., Vol. 2, No. 3, Sect. 3, April, 1939, pp. 59-60.) (68/8 U.S.S.R.)

The stability of the horizontal motion of submerged wings and the effect of these on the propellers, are discussed. The author's conclusions indicate the complexity and difficulties of the problem of motion on the surface of the water by means of submerged wings. The greatest obstacle to a satisfactory solution of this problem is presented by cavitation, and it is considered that this will limit the possibility of utilising submerged wings for gliding boats to speeds of from 55 to 60 miles an hour. Above these speeds it is probable that the usual type of hydroplane will prove more efficient. The article contains a number of formulæ and equations and gives graphs and tables of values in connection with the various points discussed in it, and there are also a number of diagrams and illustrations of various types and sections of submerged wings.

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Reduction of Skin Friction on a Flat Plate Through Boundary Layer Control. (J. R. Weske, J. Aeron. Sci., Vol. 6, No. 7, May, 1939, pp. 289-291.) (68/9 U.S.A.)

The author carried out approximately two dimensional tests on the friction drag of a flat plate, air being emitted at low speeds from a slot placed near the leading edge, the original direction of the jet being at right angles to the tunnel wind. The nose part containing the slot could be supported separately, the following factors being measured:—

1. Aerodynamic force produced by the discharge slot due to air emission.
2. Effect of air jet on drag of plate placed in the wake of the jet.
3. Rate of disintegration of the surface of discontinuity between jet and free air stream.

Three series of test were carried out.

a. Nose slot fixed and plate on drag balance.
b. Plate fixed and nose slot on drag balance.
c. Both slot and plate on drag balance (combined drag).

The wind speed in the tunnel ranged from 40 to 90 feet/sec.

From the tests it appears that, disregarding the problem of the intake, for one h.p. spent at the slot in producing the jet, 1.3 h.p. are saved through decrease of skin friction of the flat plate and through negative drag of the slot.

Effect of Shock Waves. (N.A.C.A. Trade Conference.) (J. Aeron. Sci., Vol. 6, No. 7, May, 1939, p. 300.) (68/10 U.S.A.)

Investigation regarding the effects of shock waves at various points on a high-speed aeroplane have been carried out in the 8ft. 500 m.p.h. wind tunnel. These shock waves around local protuberances have been observed at flight speeds as low as 300 m.p.h.

With the usual blunt-nose N.A.C.A. cowling, for example, an aeroplane speed of 325 m.p.h. causes local flow speeds at the front curve of the cowling exceeding 710 m.p.h. This design of cowling is a very poor streamline form at 400 m.p.h., though an excellent one at 250. A new design of N.A.C.A. cowling delays the onset of shock waves and thus overcomes the difficulty.

New forms of windshields and propellers developed in these investigations to avoid the onset of shock waves are also discussed. With these new forms it will be possible to achieve top speeds in level flight exceeding 500 m.p.h. without the occurrence of the drag creating compression shock.

The Necessary Time and Fatigue Strength of Aircraft Wing Structure. (H. W. Kaul, Year Book of German Aeronautical Research, 1938, Vol. 1, pp. 274-288.) (68/11 Germany.)

Till relatively recent times, aircraft structures were designed to fulfil certain static strength requirements and the strength specifications of leading aeronautical countries showed general agreement. It is true that certain parts, such as wing roots and control surfaces were also designed to take into account fatigue limits, but this factor was not applied to the wing structure as a whole. In addition to fatigue strength, *i.e.*, the capacity to withstand a large number of load reversals, the aircraft wing structure may be subject to occasional overloads, especially in gusty air. It is obviously impracticable to design the wings so as to withstand such loads indefinitely, but a certain margin of safety must nevertheless be maintained. The measures adopted will obviously depend on the magnitude and frequency of the loads during the life of the aircraft and will vary with type of machine, purpose of employment and atmospheric conditions (gustiness). The author has subjected to statistical analysis a large number of data covering the wing stressing of six different civil aircraft ranging in weight from 2,000 to

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6,000 kg. At the same time the stress-frequency of application curves for three acrobatic aircraft were investigated. It is thus possible to state the probable number of times loads of a given magnitude will be applied to the wing structure over flying times ranging from 2,000-6,000 hrs. (life of aircraft depending on class) and the ground tests adjusted accordingly.

Aerodynamic Principles of Automatic Stabilisers. (F. Haus, Proc. Lilienthal Society, Oct., 1938, pp. 273-306. In course of translation.) (68/12 Germany.)

The object of the author is to show how far the classical theory of dynamic stability is of help in the special problems connected with stabilising appliances on aircraft. After showing how the general motion of an aircraft in space can be defined by nine variables, the author gives the results of flight tests during which these variables are recorded simultaneously, special attention being given to the recovery of the aircraft after having been subjected to a series of well-defined disturbances.

The object of the stabiliser is to improve this recovery. It is a mistake to attempt complete and instantaneous suppression of all variables, whatever the initial disturbance. The correct way is to destroy as quickly as possible only the most objectionable disturbances, leaving the others to be damped out naturally as a consequence of the motion of the aircraft. An aircraft flying at small incidence can always be made dynamically stable by suitable design. The trajectory of such an aircraft will, however, still possess certain objectionable features such as insufficient damping of the slow longitudinal oscillation and slow recovery from a lateral inclination. In addition there is always absence of course stability. The author concludes by showing how these defects can be remedied by the use of rationally designed stabilisers.

The Landing of Aeroplanes on Ice. (K. A. Moskatov, Air Fleet News, U.S.S.R., Vol. 21, No. 12, December, 1938, pp. 40-46.) (68/13 U.S.S.R.)

In the present paper a first approach is made towards the problem of landing of aeroplanes on ice, a review being given of the characteristics of ice and ice-covered aerodromes.

All the literature and research work, both Russian and foreign, has dealt with the problem of the quality, structure and strength of the ice, only fresh and artificial ice being investigated; very little work has been done on ice formed under natural conditions.

There has not so far been a single comparative investigation of the behaviour of the ice when landing an aeroplane on skis and on wheels on river—and sea—ice at different latitudes, *e.g.*, on the Baltic Sea and the Black Sea.

No accurate data is available for the variation in strength of ice according to the surrounding conditions in which it is formed and in relation to its salt content.

Individual observations made during voyages of ice breakers and other vessels in the Polar regions have shown that there are a number of other factors affecting ice formation and strength which will necessitate the working out of new coefficients. This applies to all the other ocean basins of the U.S.S.R.

Theory of Automatic Control of Aeroplanes. (H. K. Weiss, N.A.C.A. Tech. Note No. 700, April, 1939.) (68/14 U.S.A.)

Methods of automatically controlling the aeroplane are reviewed. Equations for the controlled motion including inertia effects of the control are developed and methods of investigating the stability of the resulting fifth and higher order equations are presented. The equations for longitudinal and lateral motion with both ideal and non-ideal controls are developed in dimensionless form in terms of control parameters based on simple dynamic tests of the isolated control unit.

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Wind Tunnel Tests of Several Forms of Fixed Wing Slot in Combination with a Slotted Flap on an N.A.C.A. 23012 Aerofoil. (M. J. Bamber, N.A.C.A. Tech. Note No. 702, April, 1939.) (68/15 U.S.A.)

Several forms of fixed wing slot in a large-chord N.A.C.A. 23012 aerofoil were tested in the closed-throat 7 by 10ft. wind tunnel. The aerofoil extended completely across the test section so that two-dimensional flow was approximated. The model was fitted with a full-span slotted flap having a chord 25.66 per cent. of the aerofoil chord. The slots extended over the entire wing span. The wing-slot location was varied along the chord and several variations of slot gap and width were tested at each location.

The data are presented in the form of tables of important aerodynamic characteristics for each slot tested and as curves of section lift, profile-drag, and pitching-moment coefficients. The relative air velocity through the slot is given.

A slot as far back on the aerofoil as the 55 per cent. chord point, with the flap deflected 40°, was practically ineffective for increasing either the maximum lift coefficient or the angle of attack for maximum lift. A slot near the leading edge of the aerofoil, with the flap deflected 0°, increased the maximum lift coefficient by 0.65, the maximum angle of attack by 11°, and the minimum profile-drag coefficient by 0.012. With the flap deflected 40°, this nose slot increased the maximum lift coefficient by 0.40 and the maximum angle of attack by 10°.

Tests of an N.A.C.A. 23012 Aerofoil with a Slotted Deflector Flap. (R. O. House, N.A.C.A. Tech. Note No. 699, April, 1939.) (68/16 U.S.A.)

Section aerodynamic characteristics of a large-chord N.A.C.A. 23012 aerofoil with a slotted deflector flap were obtained in the N.A.C.A. 7 by 10ft. wind tunnel. The characteristics of an N.A.C.A. slotted flap and of a simple split flap are included for comparison.

The slotted deflector flap was found to have a somewhat lower maximum lift coefficient and somewhat higher drag at high lift coefficients than the N.A.C.A. slotted flap. At moderate lift coefficients, however, the drag of the slotted deflector flap was about the same as that of the N.A.C.A. slotted flap. The high drag of the open slot with the deflector flap neutral indicates that the slot should be closed for this condition.

Wind Tunnel Investigation of Ground Effect on Wings with Flaps. (I. G. Recant, N.A.C.A. Tech. Note No. 705, May, 1939.) (68/17 U.S.A.)

An investigation was conducted in the N.A.C.A. 7 by 10ft. wind tunnel to determine the effect of ground proximity on the aerodynamic characteristics of wings equipped with high-lift devices. A rectangular and a tapered wing were tested without flaps, with a split flap, and with a slotted flap. The ground was represented by a flat plate, completely spanning the tunnel and extending a considerable distance ahead and back of the model. The position of the plate was varied from one-half to three chord lengths below the wing.

The results are presented in the form of curves of absolute coefficients, showing the effect of the ground on lift, drag, and pitching moment. An appendix gives equations for calculating tunnel-wall corrections to be applied to ground effect tests conducted in rectangular tunnels when a plate is used to represent the ground.

The tests indicated that the ground effect on wings with flaps is a marked decrease in drag, a decrease in diving moment, and a substantial reduction in maximum lift.

Aircraft Accidents and Casualties in the U.S.A. for the Period 1928-1937. (Aeroplane, Vol. 56, No. 1462, 31/5/39, p. 709.) (68/18 U.S.A.)

For the whole ten years, the causes of accidents arrange themselves in the following order of importance:—

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38% Bad weather, bad terrain.
21% Pilot error.
17% Engine failure.
15% Structural failure (usually undercarriage).
4% Personal error other than pilot.
2% Handling qualities of aircraft.

The relative order of these factors does not vary very much for each of the years considered.

This seems to show that what has been gained by wireless navigational aids has been sacrificed by forcing the pilot to fly faster and more heavily loaded machines, requiring bigger and better aerodromes for landing. On the whole there has been, however, a marked improvement in safety. In 1928 the passenger miles per passenger fatality were of the order of two million. In 1937 this figure has increased to 12 million, and this is not all a result of higher speeds covering more ground between crashes.

Wind Tunnel Investigation of Effect of Yaw on Lateral Stability Characteristics. 1. Four N.A.C.A. 23012 Wings of Various Plan Forms with and without Dihedral. (M. J. Bamber and R. O. House, N.A.C.A. Tech. Note No. 703, 1939.) (68/19 U.S.A.)

Four N.A.C.A. 23012 wings were tested at several angles of yaw in the N.A.C.A. 7 by 10ft. wind tunnel. All the wings have rounded tips and, in plan form, one is rectangular and the others are tapered 3:1 with various amounts of sweep. Each wing was tested with two amounts of dihedral and with partial-span split flaps.

The coefficients of lift, drag, and pitching moment are given for all the models at zero yaw. The coefficients of rolling moment, yawing moment, and side force are given for the rectangular wing at all values of yaw tested. The rate of change in the coefficients with angle of yaw is given in convenient form of stability calculations.

Water Flow Lines About the Hull of a Seaplane. (N.A.C.A. Trade Conference.) (J. Aeron. Sci., Vol. 6, No. 7, May, 1939, p. 300.) (68/20 U.S.A.)

Investigations have been carried out in the N.A.C.A. towing tank over a period of years to determine the design factors that will allow seaplane floats of minimum resistance to be designed.

Investigations during the year have been made using a hull fitted with a glass bottom. On the under surface of the glass next to the water, long silk streamers have been placed. Illumination has been provided so that the character of the water flow over the hull can be observed from the beginning of the take-off to the point where the boat rises on the step, assumes a planing angle, and finally leaves the water. Motion pictures illustrated the character of the flow as affected by different design characteristics of the hull.

The streamers showed the details of the water flow near the hull and permitted a close study of the design factors, the correct application of which will lead to minimum resistance hulls. The above method, applied for the first time by the N.A.C.A., offers great promise for further improvements in the take-off and landing characteristics of seaplanes and flying boats.

Use of Hydrofoils for Assisting the Take-off of Large Seaplanes. (N.A.C.A. Trade Conference.) (J. Aeron. Sci., Vol. 6, No. 7, May, 1939, p. 300.) (68/21 U.S.A.)

Any large reduction in the air drag of conventional flying boat hulls usually results in poor performance on the water as landing and take-off gear.

A possible solution is the fitting of a special landing and take-off gear in the form of hydrofoils which will be retracted in flight and lowered for take-off and

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landing. The hydrofoils are generally similar to aerofoils but run submerged in the water. They develop large lift with small resistance and when suitably arranged beneath a streamline fuselage will lift it out of the water at very low speed and at the same time produce a water resistance of around one-half that of the planing hull that they replace. Thus marked improvement in flying boats should result from the use of an almost perfectly stream-lined fuselage for low air resistance and flotation, with retractable hydrofoils for landing and taking off.

Study of Recovery from Spin. (N.A.C.A. Trade Conference.) (J. Aeron. Sci., Vol. 6, No. 7, May, 1939, p. 301.) (68/22 U.S.A.)

During recent years the problem of spinning has been extensively investigated in the N.A.C.A. free-spinning wind tunnel and the results correlated with flight experience on a number of aeroplanes.

As a result of these investigations the committee has developed a criterion or design standard for aeroplane tails that will assure satisfactory recovery from spins. By a simple method, described and demonstrated in the free-spinning wind tunnel a designer can readily check his design of tail surfaces and determine whether or not it will guarantee prompt recovery from a spin. The development of this criterion is another step in improving the safety of military, commercial, and privately owned aeroplanes.

An Experimental Investigation on the Normal Acceleration of an Aeroplane Model in a Gust. (P. Donely, N.A.C.A. Tech. Note No. 706, May, 1939.) (68/23 U.S.A.)

In order to provide experimental data as a check of the theories used in the prediction of applied loads on aeroplanes due to atmospheric gusts, an investigation was made in the N.A.C.A. gust tunnel to determine the influence of the aeroplane wing loading, the forward velocity, the wing plan form, and the fuselage on the reaction of the aeroplane to a known gust. Tests were made for four values of gust velocity and for two gust gradients, namely, the sharp-edge gust and a gust rising linearly to full strength in a distance of several chord lengths.

The results of the investigation indicate that the formulæ given in a 1937 S.A.E. paper by R. V. Rhode entitled " Gust Loads on Aeroplanes " predict the qualitative effect of gust velocity, forward velocity, wing loading, wing plan form, and gust gradient on the acceleration increment in a satisfactory manner. The quantitative agreement is also good for aeroplanes of normal proportions when the fuselage is neglected in the computations; *i.e.*, when the wing area, intercepted by the fuselage, is included as a part of the wing. Although the agreement between computed and test results remained good for aspect ratios as low as 2.0, there is an indication in Technical Note No. 682 that, in some cases, the influence of the finite span may require more careful consideration.

The investigation also shows that the value of maximum lift coefficient for steady flow does not limit the acceleration increment in a gust.

A Simplified Method for the Calculation of Aerofoil Pressure Distribution. (H. J. Allen, N.A.C.A. Tech. Note No. 708, May, 1939.) (68/24 U.S.A.)

A method is presented for the rapid calculation of the pressure distribution over an aerofoil section when the normal force distribution and the pressure distribution over the " base profile " (*i.e.*, the profile of the same aerofoil were the camber line straight and the resulting aerofoil at zero angle of attack) are known. This note is intended as a supplement to N.A.C.A. Reports Nos. 631 and 634, wherein methods are presented for the calculation of the normal force distribution over plain and flapped aerofoils, respectively, but not of the pressures on the individual surfaces.

Base-profile pressure-coefficient distributions for the usual N.A.C.A. family of aerofoils, which are also suitable for several other commonly employed aerofoils,

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are included in tabular form. With those tabulated base-profile pressures and the computed normal force distributions, pressure distributions adequate for most engineering purposes can be obtained.

Determination of the High Altitude Performance of Aero Engines on the Basis of Performance Measurements Made Under Ground Conditions. (J. Zeyns and H. Caroselli, Year Book of German Aeronautical Research, 1938, Vol. 2, pp. 7-15. In course of translation.) (68/25 Germany.)

A knowledge of the altitude performance of aero-engines is becoming of increasing importance as operational heights are tending upwards. Since high altitude test benches are not generally available and are moreover expensive as well as cumbersome, numerous attempts have been made to calculate the altitude performance from ground tests by applying certain correction factors. The well-known Brooks formula utilises three factors f_1, f_2 and f_3. The first factor f_1 allows for the increase in the supercharger pressure ratio with decrease in the blower intake temperature with altitude. The factor f_2 gives the power increase with reduction of intake temperature whilst the last factor f_3 allows for the increase in power due to the exhaust back pressure being less than the induction pressure. The Brooks formula gives fair results for altitudes near the supercharged height. If the engine is operating above the supercharger height, the Brooks values are too low. Discrepancies also occur if the engine has appreciable overlap in the valve timing. The author develops new expression for the value of the factors f_1, f_2 and f_3 which take into account any valve overlap and applies the correction to the i.h.p. instead of the b.h.p. of the engine (i.h.p. is obtained from motoring tests at the same throttle opening). It appears from the examples (comparison of prediction and high altitude test bench results) that the new formulæ are in satisfactory agreement with experiment.

Methods of Improving the Fuel Consumption of Four-Stroke Spark Ignition Engines. (F. A. F. Schmidt, Year Book of German Aeronautical Research, 1938, Vol. 2, pp. 33-6. In course of translation.) (68/26 Germany.)

It is well known that the fuel economy at a given compression ratio reaches a maximum at an excess air coefficient of about $\lambda = 1.10$. By using two spark plugs, one which gives a normal single spark whilst the second produces a series of sparks, it is possible to extend the weak mixture range to $\lambda = 1.25$, provided the ignition timing is suitably advanced and the distribution characteristics of the engine favourable. Representative consumption figures are as follows:—

Max. power mixture	$\lambda = .90$	260 gm./b.h.p. hour.
Max. economy (normal 2 plugs)	$\lambda = 1.10$	220 gm./b.h.p. hour.
Max. economy (2 plugs, one giving a series of sparks) ...	$\lambda = 1.25$	210 gm./b.h.p. hour.

The author points out the important effect on performance of scavenging the exhaust residue in the case of supercharging. By using a weak mixture with valve overlap it is possible to obtain the same power as with a richer mixture without overlap. The engine runs cooler when scavenged and the specific fuel consumption (with weak mixture) is improved.

Investigation of the Altitude Behaviour of a Precombustion Chamber Diesel Engine. (R. Dull, Year Book of German Aeronautical Research, 1938, Vol. 2, pp. 37-40.) (68/27 Germany.)

Experiments were carried out on the high altitude test bench of the D.V.L. on a single-cylinder water cooled precombustion chamber Diesel engine of unspecified design (compression ratio 14/1). The intake to the engine was throttled

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but not cooled to altitude value, the exhaust being evacuated to maintain pressure balance across the engine. The tests were carried out both at constant excess air coefficient λ and at constant exhaust temperature, the injection timing being advanced to give maximum power for each throttle position. As is well known, the ignition lag of a Diesel increases with decrease in density of charge and this cannot be completely corrected by an increase in the injection advance. As a result the engine runs increasingly rough (knocks) as the intake is progressively throttled and cuts out completely at a density = .36 ground level value.

Although with constant exhaust temperature (620°C.) the power does not fall off as fast as the density (the engine at .5 density still gives .6 of the ground level b.h.p.) the specific fuel consumption is increased from 210 gm. to 240 gm./b.h.p. hour over this range.

Experiments with the Lanova Aircraft Diesel. (K. Lohner, Year Book of German Aeronautical Research, 1938, Vol. 2, pp. 41-3.) (68/28 Germany.)

In the Lanova Diesel the fuel is injected horizontally across the main combustion chamber and enters the throat of a subsidiary combustion chamber (10-20 per cent. of the clearance volume). This chamber is only cooled indirectly and under load assumes a high temperature (600°C.).

Ignition starts in the subsidiary chamber and the resultant explosion causes a pressure difference and discharge into the main combustion chamber where the combustion is completed. Piezo-electric indicator diagrams demonstrate this function of the chamber and also show that the combustion pressure in the main cylinder seldom exceeds 50 atmospheres, whilst the ignition pressure in the chamber is above 100 atmospheres. Adapting the Lanova principle to aircraft use presents certain difficulties, since the engine is sensitive to the temperature of the subsidiary chamber and the temperature rises very markedly under supercharged conditions. Initial ignition in the main cylinder must be avoided as otherwise very harsh running results. The difficulty was overcome by adopting a form of pilot injection, *i.e.*, the main fuel is sprayed into the flame issuing from the subsidiary chamber after a prior injection of a small quantity of fuels. It is stated that this procedure also overcomes starting difficulties.

Relative Fin Area of Some Air-Cooled Engines. (Les Ailes, No. 934, 11/5/39, p. 7.) (68/29 France.)

Engine.	Stroke Volume (litres)	No. of Cyl.	Take-off Power.	Fin Area/St. Head.	Fin Area/St. Cyl.	Vol. (m^2/l) Total.	Fin Area/ h.p. per cyl. m^2/h.p.
Wright Cyclone G.R. 1820	29.85	9	850	.370	.155	.525	.0184
Wright Cyclone G. 100 ...	29.85	9	1100	.435	.168	.603	.0164
Bristol Pegasus 18 ...	29.10	9	980	.387	.195	.582	.0172
Bramo Fafnir	26.8	9	950	—	—	.661	.0187
B.M.W. 132	27.7	9	880	—	—	.602	.0190
Napier Rapier	8.86	16	340	.272	.203	.475	.0123
Argus As 410	12.0	12	450	.389	.264	.653	.0175

Intermittent Flow Coefficients of a Poppet Valve. (C. D. Waldron, N.A.C.A. Tech. Note No. 701, April, 1939.) (68/30 U.S.A.)

Flow coefficients were determined for the inlet valve of a modern air-cooled cylinder during operation of the valve. The cylinder head with valves was mounted on a large tank that could be evacuated. Operating the valve with a rotating cam allowed air to flow through the valve into the evacuated tank. The change of pressure in the tank was a measure of the amount of air flowing through the valve in a given number of cycles. The flow coefficients were determined from the pressure across the valve, the quantity of air flowing, and the valve-lift curve. Coefficients were measured with lifts of 0.1 to 0.6 inch and speeds of 130 to 1,200 r.p.m.

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CONCLUSIONS.

1. Flow coefficients measured with steady-flow conditions can be applied to intermittent-flow conditions with no correction for valve-opening speed.

2. The over-all flow coefficient of a valve with any lift curve can be accurately computed by the method described if the flow coefficients of a similar valve are known at values of lift of 0.1, 0.2, 0.3 inch, and so on.

3. When a valve seat has a well-rounded approach, flow coefficients above 1.00 can be obtained if the flow area is computed from the inside-seat diameter.

The Combustion Gas Turbine, Its History, Development and Prospects. (A. Meyer, Proc. Inst. Mech. Eng., May, 1939, pp. 197-212. Metropolitan-Vickers Tech. News Bull. No. 661, 19/5/39, p. 10.) (68/31 Great Britain.)

Inventors appear to have been at work on the gas turbine since 1791, the original attractions of the proposal being its simplicity and the elimination of the reciprocating motion of the early steam engines. The efficiency attainable under present conditions is 17-18 per cent., but this would be increased to 23 per cent. if the gas inlet temperature could be raised from 1,000 to 1,300°F. The proposed new fields of application of the gas turbine include locomotive and marine propulsion, blast furnace plants, and the power supply for wind tunnels. Illustrated with 18 diagrams and three photographs.

The Study of Air Flow in an Engine Cylinder. (D. W. Lee, N.A.C.A. Tech. Reports No. 653, 1939.) (68/32 U.S.A.)

A four-stroke-cycle test engine was equipped with a glass cylinder and the air movements within it were studied while the engine was being motored. Different types of air flow were produced by using shrouded intake valves in various arrangements and by altering the shape of the intake-air passage in the cylinder head. The air movements were made visible by mixing feathers with the entering air, and high-speed motion pictures were taken of them so that the air currents might be studied in detail and their velocities measured. Motion pictures were also taken of petrol sprays injected into the cylinder on the intake stroke.

The photographs showed that a wide variety of induced air movements could be created in the cylinder; the movements always persisted throughout the compression stroke; and the only type of movement that persisted until the end of the cycle was rotation about the cylinder axis. The velocities of the air currents were approximately proportional to the engine speed and had about the same value whether the flow was orderly or turbulent. Orderly air movements greatly aided the distribution of the sprays about the cylinder.

Dimensional Analysis and the Performance of Centrifugal Pumps and Fans. (J. Jennings, Engineer, Vol. 167, No. 4349, 19/5/39, pp. 614-5.) (68/33 Great Britain.)

The following are considered to be some of the advantages of dimensional analysis applied to pumps:—

1. The characteristic curves are directly comparable with one another with regard to the effect of differences of design independent of slight differences of size and speed.

2. The curves have the same scales for consistent English or metric units.

3. The effect of viscosity and roughness can be investigated independently of other variable quantities.

4. The pump and fan similarity laws are embodied in the curves and need not be considered separately.

5. The relation between experiments on models and on the operation of full-scale machines can be examined easily.

6. The operation of pumps with fluids of varying density and viscosity may be more easily forecast.

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Knock in Otto Cycle Engines. (H. Weinhart, L.F.F., Vol. 16, No. 2, 20/2/39, pp. 74-83. Eng. Absts., Vol. 2, No. 4, Section 2, April, 1939, p. 43.) (68/34 Germany.)

The author reviews the progress of research on the " knocking " of internal-combustion engines, and the alternative theories according to which the phenomenon is due either to " pressure-ignition " in the residual charge, or to the impact on the cylinder-walls of a " detonation-wave " in the residual charge. He describes experiments carried out on a cylindrical pressure-vessel and also on an aircraft engine in which records were taken to establish whether or not the respective characteristic phenomena postulated by the rival theories occurred solely in association with " knocking." These are the formation of directionally-determined pressure waves, as determined by pressure measurements; the abrupt increase to a maximum of the electric current in the recording plugs employed in ionisation tests; and flame velocities exceeding considerably those associated with normal combustion. The pressure measurements were made by the piezo-electric method, whilst the ionisation method in conjunction with cathode-ray oscillograph recording was used to ascertain the combustion velocities.

The author concludes that the variation of the ionisation current caused by gas mixtures detonating in a pressure vessel differs fundamentally from that observed in a " knocking " motor; it can thus be asserted that in the latter no " detonation wave " is formed. He considers that, so far as the tests permit conclusions to be drawn, they indicate spontaneous ignition of the residuary charge due to its compression as the cause of the " knocking " phenomenon.

Measurement of the Flow Velocities in the Cylinder of an Externally Driven Aircraft Engine. (H. Wenger, L.F.F., Vol. 16, No. 2, 20/2/39, pp. 62-73. Eng. Absts., Vol. 2, No. 4, Section 2, April, 1939, p. 43.) (68/35 Germany.)

The author presents the results of researches on the flow velocities in the cylinder of an externally-driven experimental single-cylinder aircraft engine of 160 mm. (6.3in.) bore and 190 mm. (7.5in.) stroke. The tests were made at high speeds—500-1,800 r.p.m.—by the heated wire method due to J. Ulsamer (Diss. Techn. Hochschules, Munchen, 1932), which permits measurements to be made even if the velocity and the temperature vary rapidly and within wide limits during one revolution. The author discusses the principles upon which this method is based, and describes the apparatus used. The tests covered the influence upon the air velocity of the rate of revolution, the setting of the carburettor, the cooling-water temperature, and the compression-ratio. The results indicated that, generally speaking, the variation of the flow-velocity during a revolution was of uniform character. It attained a maximum during the suction phase, decreased during the compression phase, and increased again during the expansion and scavenging phases. In order to assess the influence of the rate of revolution and of the carburettor setting, the mean speeds for the various phases, as well as for the whole revolution, were determined and plotted separately.

Vibration of Radial Aircraft Engines. (Part I.) (G. P. Bentley, J. Aeron. Sci., Vol. 6, No. 7, May, 1939, pp. 278-83.) (68/36 U.S.A.)

A complete theoretical study of gas and inertia vibration forcing functions in 7 and 9-cylinder single row and 14 and 18-cylinder twin row radial aircraft engines with articulated connecting rods is outlined qualitatively in part I, and the results presented in mathematical terms in chart form.

In part II (to be published) engine vibration in an unrestrained engine mounting arrangement is outlined theoretically and charts provided to permit calculation of free engine vibration in all degrees of freedom. All theoretical work in parts I and II was verified by full-scale tests on two 9-cylinder and two 14-cylinder engines, operating under conditions of negligible restraint, and by full flight

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vibration surveys on two aeroplane engine installations of the same freely mounted test engines. Plots are included comparing the test results with the theoretical work both on the ground and in the air.

Dynamic Strength Characteristics of Light Alloys at Low Temperatures. (K. Bungardt, Year Book of German Aeronautical Research, 1938, Vol. 1, pp. 529-531.) (68/37 Germany.)

Both for aluminium and magnesium alloys the fatigue strength under bending increases with decreases in temperature (+20°C. to −65°C.).

The increase (approximately 20 per cent.) is especially marked in the case of Al-Cu-Mg alloys, Al-Mg alloy containing 4.68 per cent. Mg, and Mg-Mn alloys.

The impact strength (notch test) also increases by 15-20 per cent. with reduction in temperature from +20°C. to −65°C. except for an Al-Mg alloy containing 7 per cent. Mg, a Mg-Al alloy containing 7 per cent. Al, and a Mg-Mn alloy containing 2 per cent. of Mn.

For these three alloys reduction of temperature has a very slight detrimental effect.

Slow-Ageing Light Alloys and Their Use as Riveting Materials. (K. Matthaes, Year Book of German Aeronautical Research, 1938, Vol. 1, pp. 504-510.) (68/38 Germany.)

The duralumin rivets used up to now in aircraft construction have the following composition:—

Cu	3·7-4·7%
Mg	·4-1 %
Sc	·1- ·7%
Mn	·3- ·7%
Fe + Ti	<·5%
Zn	<·1%
Al	rest.

This material (fully hardened) has a great shear strength (27 kg/mm²) but is liable to crack, especially if high-speed riveting machines are employed. The rivets must, therefore, be used before the ageing has fully developed, *i.e.*, within 2½ hours if stored at 20° after heat treatment. This period can be appreciably lengthened by cold storage of the rivets (ice box). This method is, however, inconvenient and expensive. The Heinkel works have lately produced a new alloy for which the age hardening only begins to develop after 20 hours storage at 20°C. The final Brinell hardness of this new alloy (German pat. applied for) is 100 kg/mm² (against 120 of the original Dural rivets). The shear strength of the worked rivet is practically the same as before. The composition of the new material is as follows:—

Cu ...	2.09%
Mg ...	2.09%
Sc ...	·78%
Mn ...	·55%
Fe ...	·47%
Al ...	rest.

It is stated that the corrosion resistance is satisfactory.

Construction of Welded Structural Parts. (W. Rethel, Year Book of German Aeronautical Research, 1938, Vol. 1, pp. 495-500.) (68/39 Germany.)

The great advantage of welding is the possibility of constructing hollow and therefore stiff parts. In the case of mass production the constituent sheet elements can be pressed, bent or cut to the requisite size with great accuracy by means of automatic tools. The parts are then assembled in formers, the only

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skilled work being the final welding of the assembly. With suitable material and gas a good weld can always be obtained by a welder of average skill, provided the part is so designed that simple welds can be employed. It must be possible for the edges of the weld to warm up equally, concave corners should be avoided, and in case of large flat pieces, with welds near the edges, it is essential that an edge or groove be provided at a distance from the weld of 20 d (d = thickness of plate) in order to prevent buckling.

If these precautions are borne in mind, it is possible to build up structural parts which can be utilised without requiring any subsequent straightening and re-setting. Photographs show various welded aircraft components illustrating design features discussed (float fittings, wing fittings, spar joints, etc.). Of interest is a completely welded wing with 17 intermediate ribs.

The Effect of Cu, Mg and Si Content on the Properties of Al-Cu-Mg Alloys. (M. Hansen, Year Book of German Aeronautical Research, 1938, Vol. 1, pp. 501-3.) (68-40 Germany.)

Considerable quantities of Cu-Mg-Al alloys are utilised in the German aircraft industry and the problem arose how to save the copper consumption without diminishing the strength characteristics of the alloy.

After investigating a large number of alloys, the author concludes that the two standard aircraft alloys containing 4 per cent. Cu, 0.6 per cent. Mg and 4 per cent. Cu, 0.9 per cent. Mg respectively can be replaced by alloys containing 3 per cent. Cu, 1.5 per cent. Mg and 3.5 per cent. Cu, 1.5 per cent. Mg without any deterioration in Brinell hardness, tensile strength and yield point. In these alloys the original Mn and Si content was unaltered.

The silicon content is very important since it concerns the age hardening of the alloy at elevated temperatures. The process is very complicated since the effect depends on the quenching temperature as well as on the ageing temperature. Experiments are still in progress, but it appears that a high silicon content ($\sim$ 1 per cent.) may be beneficial.

Cladding with Ultra Pure Aluminium (99.99 *per cent.*). (P. Brenner, Year Book of German Aeronautical Research, 1938, Vol. 1, pp. 515-516.) (68/41 Germany.)

The usual material used for cladding in Germany (Specification No. 3,116) is an Al-Mg-Si alloy containing 99.5 per cent. Al.

Although this material withstands immersion in sea water for years without any ill effects, a certain amount of surface corrosion took place on aircraft. The surface attacked is very thin and there is no measurable reduction in material strength. The appearance, especially on transport machines is, however, very unsightly and the deposit may have an effect on the speed (boundary layer). Although the corrosion may be prevented by painting, this entails an appreciable increase in weight and also prevents the smooth polished surface finish so important for high speed work.

The author shows that the trouble can be completely overcome by substituting ultra pure aluminium (99.9 per cent.) for the alloy specification 3,116 utilised so far. The resultant drop in strength of the cladded article is very small and can be easily allowed for by a slightly stronger core. As this material is easily scratched, it must be protected by a hard varnish during assembly, the varnish being dissolved off on completion of the structure.

Flush Riveting—Considerations for Quantity Production. (D. R. Berlin and P. F. Rossmann, Aero Digest, Vol. 34, No. 5, May, 1939, pp. 54-61.) (68/42 U.S.A.)

The Curtiss-Wright Corporation initiated early in 1937 a flush riveting development project in connection with production engineering and tooling preparations

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The present paper gives a summary of the basic development and the problem of tooling production. Its considerations are based on a production of 100 aircraft. The total number of rivets in the typical aircraft under consideration amount to approximately 45,000, of which 30,000 are external. For direct comparison ⅛in. brazier head and flush rivets only are considered. For flush riveting, the height of the A.N. 425 rivet was reduced and special attention given to the following :—

1. The hole pior to press countersinking is drilled to size.
2. Choice of countersinking die angle.
3. Chamfering of inner edge of extrusions and formed stringers prior to press countersinking.
4. Use of a lubricant on the press countersinking punches and dies.

As a result of the investigation it is concluded that flush riveting costs approximately 30 per cent. more than present brazier riveting for all constructions of panel and fuselage riveting.

Theory of Fatigue of Metals. (E. Growan, Proc. Roy. Soc., Series A, Vol. 171, No. 944, 1/5/39, pp. 79-105.) (68/43 Great Britain.)

The present theory of fatigue is based upon the fact that plastic deformation is not homogeneous. The stress acting upon a plastic inhomogeneity that is embedded in elastic surroundings is a function of its plastic strain, diminishing with increasing strain. This fact, with the assumption that the plastic spot is subject to strain hardening of the usual kind, leads to the existence of safe and unsafe ranges. The derived dependence of the safe range upon the mean stress of the cycle is the same as that deduced by McAdam from empirical data. The relation between the stress range and the number of cycles after which a crack is formed, as calculated from the theory, is in accord with the typical $\log S - \log N$ curves given by experiments. Conclusions from the theory about fatigue endurance at elevated temperatures, about the correlation between fatigue endurance and strength, about mechanical hysteresis, etc., are confirmed by experience.

The "Pack" Method for Compressive Tests of Thin Specimens of Materials Used in Thin Wall Structures. (C. S. Aitchison and L. B. Tuckerman, N.A.C.A. Report No. 649, 1939.) (68/44 U.S.A.)

The strength of modern lightweight thin wall structures is generally limited by the strength of the compression members. An adequate design of these members requires a knowledge of the compressive stress-strain graph of the thin wall material. The "pack" method was developed to meet this case.

In the "pack" test an odd number of specimens are assembled into a relatively stable pack, like a "pack of cards." Additional lateral stability is obtained from lateral supports between the external sheet faces of the pack and outside reactions. Studies have been made of the reproducibility of the test results by testing packs taken from sheets of aluminium alloy 17 ST and steel. The largest spread in yield strength was about 2 per cent. Tests were also made to determine whether the results from packs were like those obtained from compact solid specimens. The results indicated that the method of transverse support had no appreciable effect on the yield strength. The largest difference between a pack and a solid specimen was 1.60 per cent.

Bearing Metals for High Speed Engines. (Foundry Trade Journal, Vol. 60, No. 1177, 9/9/39, p. 209. Eng. Absts., Vol. 2, No. 3, Sect. 3, April, 1939, pp. 67-68.) (68/45 Great Britain.)

The severe conditions under which modern internal combustion engines function has led to the development of new bearing metals as alternatives to white metal. These new alloys are known respectively as copper-lead, cadmium base, hardened lead and silver bearing alloys. The first two of this list are chiefly used

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in the U.S.A., whilst hardened lead is favoured in Germany. Copper-lead alloys are subject to fatigue cracking which can be remedied by the addition of tin. Unfortunately the resultant alloy is subject to seizure when overstressed. Cadmium base alloys (cadmium with small additions of nickel, or tin and silver) have high fatigue value but are subject to corrosion by hot oil. Hardened lead contains 1-2 per cent. of tin together with small additions of other elements (calcium, cadmium, arsenic, copper, etc.). Except for corrosion, it is superior to white metal.

Silver or silver rich alloys present the latest development for bearing metals. Whilst possessing a better seizure resistance than any of the alloys listed above, silver is difficult to bond and behaves erratically, probably due to lack of "oiliness." Attempts to overcome this difficulty by proper choice of alloy constituents or by oil "doping" are still in progress.

Some Notes on the Numerical Solution of Shear-Lag and Mathematically Related Problems. (P. Kuhn, N.A.C.A. Tech. Notes No. 704, 1939.) (68/46 U.S.A.)

The analysis of box beams with shear deformation of the flanges can be reduced to the solution of a differential equation. The same equation is met in other problems of stress analysis. No analytical solutions of this equation can be given for practical cases, and numerical methods of evaluation must be used. Available methods are briefly discussed. Two numerical examples show the application of the step-by-step method of integration to shear-lag problems.

New Photo-Elastic Method for Three-Dimensional Stress Investigations. (R. Weller, Mech. Eng., Vol. 61, No. 6, June, 1939, p. 469.) (68/47 U.S.A.)

Three dimensional photo-elastic investigations have been carried out previously by treating the plastic model at an elevated temperature and then cooling. The cold material is then sliced in any direction and investigated as in the two-dimensional case. The method obviously depends on the fact that the cold material retains the stress pattern after slicing.

In the new method, the stressed plastic model is investigated directly by a beam of light focused on any interior part. To prevent any disturbing effects at the surface of the model, the latter is immersed in an oil bath of the same optical properties.

Under these conditions the light entering the model is scattered laterally by an amount depending on the internal strain conditions and the resultant pattern is utilised for stress investigations.

The new method has the following advantages:—

(1) The model is not destroyed by mechanical cutting and can therefore be used repeatedly.
(2) Heating and cooling is no longer necessary and uncertainty of constancy of physical factors is removed.
(3) Differential fringe patterns may be observed when taking account of any initial stresses.
(4) Stress direction and principal values are obtained by rotating the model during observation and a complex analysis is not required.
(5) Intermediate check points can be obtained by loading and unloading tests.

New Developments in the Riveting and Welding of Light Alloys. (E. V. Rajakovics, Z. Metallk., Vol. 31, No. 5, May, 1939, pp. 137-140.) (68/48 Germany.)

The author discusses the new alloy duralumin 681 H which can be used for rivets in its fully hardened state (without previous heating and ice storage). This material, moreover, possesses a greater shear strength due to the cold

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working (10 per cent.) after riveting, whilst the standard rivet (Dural 681 A) deteriorates slightly (4 per cent.).

Since the new material requires no previous heat treatment it is specially suited for explosive rivets.

Special reference is made to the Weibel system of electric welding for thin light metal sheets (0.2 to 1.5 mm. thick).

The welding tool consists of two carbon electrodes placed at an acute angle embracing the butt joint of the plate. Alternating current at 6 v. is used and thus no arc is formed.

The process gives excellent results for wrought Al alloys (such as dural), but suffers from the fact that the carbon electrodes burn away rather rapidly.

It is hoped to overcome this difficulty by proper choice of electrode material.

On the Rib Stiffness Required for Box Beams. (E. E. Lundquist, J. Aeron. Sci., Vol. 6, No. 7, May, 1939, pp. 269-77.) (68/49 U.S.A.)

In the design of stressed skin wings, it is common practice to assume that the shear webs and ribs are equivalent to rigid supports. As an idealised example of this problem the flat compression flange of a symmetrical box beam is regarded as a plate supported by transverse ribs and subjected to edge compression. A general theory for the stiffness required of the ribs to be equivalent to rigid supports is given. In addition, an approximate theory and a conservative theory for the rib stiffness are also given. The greater part of the paper is devoted to a design problem which shows in detail how to apply each theory.

A Method of Determining End Fixity. (W L. Howland, J. Aeron. Sci., Vol. 6, No. 7, May, 1939, pp. 284-8.) (68/50 U.S.A.)

One of the important factors in the design of a compression member is its end fixity, since, as long as the slenderness ratio of a member is reasonably large, the load-carrying ability of the member is directly proportional to its end fixity. It is unfortunate that the few cases in which the end fixity is definitely known (theoretically) seldom occur in practice. The commonly known theoretical cases are: Pin-ended columns where the end fixity coefficient is 1.0, built-in ends where the end fixity is 4.0, and the case of one fixed end and the other pin-ended which has an end fixity of 2.04. These three cases never actually occur in practice, since in pin-ended columns there is always some friction present, and built-in ends are not infinitely rigid. In a few cases of elastically built-in columns, the end fixity can be calculated theoretically, but in general the designer of an aeroplane does not know the conditions of the ends of his members accurately enough to be able to use these means. Until the present time the designer has had to estimate the end fixity of various panels or columns because he could not take into account the effect of clips, eccentric loading, flexibility of ribs, bulkheads, or edge restraints.

It is the object of this paper to present a method whereby the actual end fixity of a member on an aeroplane or in a test assembly can be determined experimentally without failing the member.

A Semi-Graphical Method for Analysing Strains Measured on Three or Four Gauge Lines Intersecting at 45°. (H. N. Hill, N.A.C.A. Tech. Note No. 709, May, 1939.) (68/51 U.S.A.)

The determination of the state of stress at a point in a plane, from strain measurements made on intersecting gauge lines, is not an exceptionally difficult problem, the solution being based on the generally well-known bi-axial relationships between stress and strain.

The method described by the author is essentially graphical, but does require a small amount of arithmetical manipulation. To the best of the author's knowledge, this treatment constitutes an entirely new procedure for determining

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stresses from strains measured on gauge lines intersecting at 45°. The method is thought to have some advantages in simplicity and directness over both of these previously mentioned.

A Method for Indicating Speeds of Rotation. (G. Morris and R. S. Silver, J. Sci. Inst., Vol. 16, No. 5, May, 1939, pp. 149-50.) (68/52 Great Britain.)

A method of indicating speed of rotation is described in which the frequency of the current generated by the rotation of a small bar of iron or mild steel, attached to the rotor and in the field of an electro-magnet, is measured by a vibration galvanometer adjusted to resonance with a multiple of the required rate of revolution.

The Utilisation of Sound Films for Harmonic Analysis. (L. W. Pollek, Z. Instrum., Vol. 59, No. 5, May, 1939, pp. 208-210.) (68/53 Germany.)

The curve to be analysed is photographed a suitable number of times on a continuous film band, so that the area below the curve is black on the film.

The band is passed at constant speed through a normal sound reproducing camera and the variation in photo-electric E.M.F. is analysed into its harmonic constituents by means of a standard wave analyser. This consists of a super-heterodyne valve voltmeter of adjustable sensitivity responding to a single frequency lying within the range 20-16,000 periods.

The proposed method gives the amplitude of the fundamental and that of its harmonics in a simple manner, and is very useful when a large number of curves have to be investigated.

The method is so far not suitable for determining relative phase displacements.

Portable Apparatus for the Accurate Analysis of Gaseous Fuel, Mine Gases, Gases of Combustion or Engine Exhaust Gases. (A. Schmidt, Gluckauf, Vol. 75, 4/3/39, pp. 198-203. Eng. Absts., Vol. 2, No. 4, Sect. 4, April, 1939, p. 26.) (68/54 Germany.)

In the quantitative gas analysis by means of the apparatus described, the composition of the mixture is determined from the difference in pressure registered after ignition of the gas and absorption by a reagent. A high degree of precision is attainable as a result of certain minor factors being taken into consideration in the experimental procedure. For example, very small quantities of the absorption liquid may be used owing to the adoption of mercury as the seal for confining the gas, as well as for indicating the pressure. The necessary corrections to be made for variations of temperature during the analysis are given in a table, which indicates the influence of these variations upon the pressure. The two-standard methods of gas analysis, namely, the volumetric and the manometric systems, are compared as regards their respective accuracy, and sources of error are discussed.

The "Maximeter." (Retel, J. R., and Tchang-Te-Lou, Sci. et Industr. (Mecanique), Vol. 23, Jan.-Feb., 1939, pp. 47-9. Eng. Absts., Vol. 2, No. 4, Section 2, April, 1939, pp. 54-5.) (68/55 France.)

The "maximeter" is designed to record the maximum pressure occurring in the cylinder of an internal combustion engine. The indicator fixed to the engine carries a membrane, one face of which is in communication with the cylinder; to the other face a neutral gas is supplied, the pressure of which may be controlled and measured. When the pressure in the cylinder exceeds that of the neutral gas the membrane lifts and breaks an electric circuit, this inducing a secondary current which illuminates an indicating neon lamp. By varying the pressure of the neutral gas, and noting its pressure when the indicator lamp just begins to function, the maximum pressure in the cylinder can be determined with precision. The authors describe the apparatus required for a single cylinder

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and for a multi-cylinder engine, and reproduce curves showing data obtained by the instrument. These indicate the possible utility of the device in experimental and routine testing and also in determining the causes of break down or inefficiency in engines.

The Artificial Dissipation of Fog. (D. Brunt, J. Sci. Inst., Vol. 16, No. 5, May, 1939, pp. 137-140.) (68/56 Great Britain.)

The chemical method of fog dissipation depends on removing part of the water vapour in the air by means of $CaCl_2$. The equilibrium between the vapour pressure on the surface of the suspended water drops and the surrounding air is then upset and the water drops evaporate.

The author estimates that to clear a space of 100 m. wide in a fog 100 m. deep drifting at 1 m./sec. will require about 200 litres of saturated $CaCl_2$ solution per minute, the fog being at a temperature of 5°C. At 15°C., the quantity of liquid required will be nearly doubled.

The water deposited will be highly corrosive and this together with the fact that pipe lines will have to be erected at a considerable distance from the ground (since it is not feasible to spray the liquid upwards for any distance) renders the chemical method scarcely applicable to aerodromes.

The author considers heating the fog until the water drops evaporate, a more likely solution. According to his figures, to clear a space 100 m. wide in a fog 100 m. deep drifting at 1 m./sec. will require a heat expenditure of 36 therms per minute, which is equivalent to the combustion of 20 gallons of paraffin per minute. Such a solution is clearly feasible. It should, however, be noted that neither the thermal method nor any other method yet suggested appears to offer a solution of the problems of clearing a fog in calm conditions.

Aircraft Icing Problems. (N.A.C.A. Trade Conference.) (J. Aeron. Sci., Vol. 6, No. 7, May, 1939, p. 301.) (68/57 U.S.A.)

The N.A.C.A. has been, for the past few years, conducting investigations on devices and systems for reducing the tendencies toward ice formation on the various parts of aircraft. These investigations are, for the most part, conducted in flight on an aeroplane especially equipped for the purpose, although some have recently been run in a special, refrigerated wind tunnel.

The aeroplane used in the icing investigations is provided with a spray apparatus mounted ahead of the part on which the de-icing system is to be investigated. By flying the aeroplane at sufficient altitude to reach freezing temperatures, icing conditions can be simulated with the spray system all the year round, and the investigation is not restricted to the winter months.

The equipment shown dealt with methods for keeping the windshield clear of ice to insure clear vision for the pilot while navigating and landing in bad weather conditions. One method consists in using two sheets of thick glass with a liquid between and an electrical heating element located in the liquid. In this way the heat is much more effectively transmitted to the outer surface of the windshield and the danger of cracking the glass by excessive local heating is avoided. Another method of providing heat is to pass air that has been heated by the engine exhaust between the two plates of glass.

The Theory of Crystal Rectifiers. (N. F. Mott, Proc. Roy. Soc., Series A, Vol. 171, No. 944, 1/5/39, pp. 27-38.) (68/58 Great Britain.)

The existing theories of the action of crystal rectifiers assume that between the semi-conductor and the metal there is a potential barrier which the electrons penetrate by the tunnel effect. It is shown that this theory gives rectification in the opposite direction to that observed. An alternative theory is proposed; the nature of the potential barrier is discussed and is assumed that the electrons have to be thermally excited so that they go over the barrier, instead of through it. Good agreement with experiment is observed.

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Precipitation—Static Interference on Aircraft and at Ground Stations. (H. M. Hucke, Proc. Inst. Rad. Eng., Vol. 27, No. 5, May, 1939, pp. 301-316.) (68/59 U.S.A.)

The effect of precipitation static on aircraft reception is described and a history of previous work on the subject given. The results of an expedition assembled by the United Air Lines for a study of the subject are described under a series of chapter headings. The meteorological conditions producing the static areas were explored by flights through them and the theory of their formation is discussed. Flight tests of all known types of antistatic antennas were made in bad weather areas and their effectiveness compared. A theory that the interference results from corona produced on the plane structure was developed and tested by mounting the plane on insulators and charging it to 100,000 volts with all radio equipment and personnel on board. A method for reducing the corona was developed as a result and proved by flight tests. A study of the electro-magnetic radiation from corona discharges was made with a synthetic static generator and the operation of the metallically shielded anti-static loop antennas explained and its limitations established. A commercial form of plane discharge system was developed and its advantages and limitations are described. The application of the aircraft results to ground radio reception is discussed.

Heavy Current Installation of the Airship "Graf Zeppelin." (E. Hilligardt, Siemens Zeitschrift, April, 1939, pp. 172-7. Metropolitan Vickers Tech. News Bulletin, No. 662, 26/5/39, p. 6.) (68/60 Germany.)

The author points out that a feature of the supply is that it consists entirely of three-phase current, and indicates the advantages of this system, *e.g.*, freedom from radio disturbances, simpler design of motors with squirrel-cage rotors, saving in weight of 18 per cent. as compared with d.c. Current is generated by two Diesel electric generating sets (four-cylinder Diesel engine coupled to a 22 k.v.a. 220 v. 50-cycle three-phase generator). Details are also given concerning the exciter, emergency lighting, electrically operated pumps and the electrically operated rudder equipment. Illustrated with eight photographs and three diagrams.

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