ABSTRACTS FROM THE SCIENTIFIC AND TECHNICAL PRESS.

Issued by the
Directorates of Scientific Research and Technical Development, Air Ministry.
(Prepared by R.T.P.)

No. 70. AUGUST, 1939.

A New Anti-Aircraft Range Finder Training Device—Distance of Shell Burst from Target. (From the German.) (Rivista Aeronautica, Vol. 15, No. 5, May, 1939, pp. 331/334.) (70/1 Germany.)

The training device consists of two cine theodolites situated at the ends of a known base. Target and shell burst are photographed simultaneously on the two cine films which also show the altitude and azimuth of the corresponding telescope axis.

These films are transferred to a special electrical calculating machine which gives in a few seconds the space distance as well as the co-ordinates Δx, Δy, Δz of the shell burst relative to the target.

As the films can be rendered available very quickly, it is possible to inform the gun crew as to the accuracy of fire within a few minutes of other exercise.

The Penetration of Bombs and Projectiles (from the German). (La Technique Moderne, Vol. 31, No. 8, 15/4/39, p. 293.) (70/2 Germany.)

If reinforced concrete (compression strength 200 kg./cm.^{2}) is struck by a shell moving at 450 m./sec., the depth of penetration is five times the calibre of the shell, for shells between 75 and 420 mm. calibre.

The depth of penetration of thin cased bombs at a striking velocity of 300 m./sec. is given in the following table (same concrete as above).

Weight of Bomb (kg.)	Penetration (cm.)
50	45
100	55
300	80
1,000	125
1,800	150

For soft steel, the penetration is $\frac{1}{5}$ of the above, whilst for sand, the penetration is multiplied by 10.

Incendiary Bombs made of Electron (from the German). (La Technique Moderne, Vol. 31, No. 8, 15/4/39, p. 293.) (70/3 Germany.)

A large bombing aircraft can carry over 2,000 of these small incendiaries. They are dropped from special containers at the rate of 10 or 20 a time. On account of the light weight and shape of these bombs, the terminal velocity is low (80 m./sec.) and the dispersion large.

The nose of these bombs is very flat and stability is assured by a terminal rod 8 cm. long. The charge consists of thermite which will burn 40-50 sec. (without oxygen). The heat liberated melts the electron case which burns for 10-20 minutes. The pressure generated by the burning thermite may project portions of the molten casing for a distance of 17 m.

A bomber flying at 1,700 m. at a speed of 320 km./h. and discharging 20 bombs every second on a 15 per cent. built-up region will start a fire on every path of 20-25 $m.^2$ unless suitable measures of protection are taken, such as a steel plate 6 mm. thick, a single layer of sandbags (well compressed) or a layer of reinforced concrete 10 cm. thick.

Some Lessons of the Spanish War. (V. Usera, U.S. Naval Inst. Proc. Vol. 65, No. 437, July, 1939, pp. 969-972.) (70/4 U.S.A.)

The author served as a captain with the Spanish Government Forces and he attributes the ultimate success mainly to the better discipline of Franco's Force brought about mainly by a preponderance of efficiently trained officers and non-commissioned officers.

As regards aerial warfare, the author considers that even a poorly entrenched unit with inadequate anti-aircraft guns cannot be driven out by plane alone if the men are of average morale. The aeroplane, despite its definite limitation and lack of accuracy, is still, however, a new enough weapon to be terrifying even to seasoned soldiers. There is a tendency to stop fire and watch for the drama to follow. If the attacking infantry is well trained, this temporary lull can be taken advantage of to close up within assault distance and attack immediately the planes are withdrawn. The precious moments of temporary shock and demoralization are thus utilised fully. Although this appears obvious, the author experienced the greatest difficulty when leading an attack to prevent his men watching the supporting aircraft rather than carrying on the attack.

Lessons of the War in Spain. (Laurent-Eynac, L'Air, No. 473, 20/7/39, p. 445.) (70/5 France.)

In the past, exaggerated claims have been made in turn for each new weapon as it has been introduced. We need only mention the torpedo and the high explosive shell.

The issue of a war is decided by the correct combination of all weapons, and whilst the Spanish conflict was not decided by the air force alone, it is correct to say that it could not have been won without it.

The successful blockade of the Mediterranean coast has demonstrated that the seaplane can in many respects replace the submarine in the destruction of merchant shipping, whilst the active part played by assault planes in ground engagements shows how modern aircraft constitutes a new danger to the infantry and gives the effect of an artillery bombardment without being tied to fixed emplacements.

It is, however, in the penetration behind the lines that the air force introduces a new factor. In Spain this form of attack has not played a large role, mainly because at the start of this war, not sufficient aircraft were available on either side.

In a large scale continental war, however, it is certain that attacks by large quantities of aircraft, well trained and knowing exactly their objectives, would profoundly affect the early stages of mobilisation and thus possibly determine the issue. Suitable protection against such " lightning " strokes presents the first problem and the author regrets that more attention is not paid in his country to modern anti aircraft artillery (88, 37 and 20 mm. calibre) such as utilised by the Nationalist troops in Spain with great success.

Tendencies and Aims of Italian Aviation. (Gen. Valle, Les Ailes, No. 944, 20/7/39, p. 6.) (70/6 Italy.)

The Italian Under Secretary of State for Air, General Valle, in a speech to the Senate reiterates his faith in the decisive role which the aircraft will play in any future war. Neither the Army nor the Navy can dispense with help from the air. The air force, however, on its own can put the enemy into a desperate position if the material is good and handled resolutely. The fact that certain parts of Valencia, Barcelona and Madrid are still intact was entirely a question of policy. Moreover, the number of aircraft engaged was relatively small. Spain can give no conception of what would happen if the number of aircraft engaged were increased 50 fold and no quarter given.

According to General Valle the following should be the objectives of aerial attacks in the order of their vulnerability: (1) centres of population; (2) fuel stores; (3) factories; (4) merchant ships; (5) harbours; (6) warships; (7) aerodromes; (8) railways; (9) trenches.

In connection with fuel stores, the speaker stressed the point that 30,000 tons of petrol were set on fire in Valencia as the result of a single attack with 50 kg. bombs. According to him, the fuel stored in Italy is safe from any air attack.

A New German Gas-Operated Light Machine Gun "Knott-Bremse" 7.92 mm. Calibre. (W.T.M., Vol. 43, No. 7, July, 1939, pp. 289-293.) (70/7 Germany.)

Nearly 80 per cent. of all the governments have adopted gas operated machine guns, the remaining 20 per cent. utilising recoil operation. This choice appears to be mainly due to the easier manufacture of the gas operated gun, recoil operation only being adopted by states which possess a highly developed armament industry.

Gas operated guns usually tap the gas from a position in the barrel. In the "K.B." gun a special muzzle attachment is used, the gas for operating the gun thus being only utilised after the projectile has left the barrel. As a result the muzzle velocity is not affected. Specially bladed channels are provided for conducting the gas to the piston operating the breech, which constitutes the only moving element, the barrel being stationary (air cooled). The barrel is easily removed by means of a special handle, an exchange being recommended after 200-500 rounds depending on rate of fire.

Everything is at rest during the actual firing process and the muzzle attachment is shaped to act as a recoil brake. As a result the gun is very steady during operation and more than 20,000 rounds can be fired by one gunner without undue fatigue. The gun weighs 9 kg. and can fire up to 1,000 rounds per minute (muzzle velocity 750 m./sec.). Three photographs.

The Accuracy of A.A. Artillery. (W.T.M., Vol. 43, No. 7, July, 1939, p. 331.) (70/8 Italy.)

Experience in the Spanish war has shown that an average of 15 shots suffices to bring down aircraft operating at 4,000 m.

Errors in acoustical spotters are mainly due to insufficient training of the operators. In these instruments it does not pay to increase the base beyond 3 m. The range can be increased by electrical amplification.

Of great importance is proper training of the observer and in this connection special apparatus has been devised which enables the pupil to check the accuracy of his observations.

As is well known, the blind generally possess very acute hearing and this has led to their extensive enrolment for this kind of work in Italy.

Finally, the position of the acoustic spotter in relation to the nature of the surrounding terrain is of the greatest importance.

Experimental Investigation of the Translatory Motion of Vortex Rings in a Real Fluid. (C. H. Krutzsch, Ann. der Physik., Vol. 35, No. 6, July, 1939, pp. 497-523.) (70/9 Germany.)

The vortices were produced in a water tank by the controlled motion of a piston in a tube communicating with the tank.

The vortex was rendered visible by painting the edge of the tube with an alcoholic solution of various dyes. (Sodium fluorescine or malachite green). The colouring matter enters the boundary layer ultimately forming the vortex and very beautiful photographs were obtained by the author, either showing the complete ring from the front or a section of the ring under lateral illumination. In the latter case the colouring matter was applied to the top and bottom edge of the tube only. During its progress the original circular shape of the vortex develops indentations and finally breaks up. The main cause of this instability is the introduction of fresh material into the vortex from the outside fluid, whilst in the ideal case, the vortex consists permanently of the same fluid particles. The correctness of the interpretation is shown by photographing the motion of fluid particles through which the ring passes. The resultant instability follows from a complicated interaction of the forces due to viscosity, pressure and centrifugal action.

A more complete investigation of the velocity distribution in the vortex will form the subject of a subsequent paper.

Experimental Investigation of the Momentum Method for Determining Profile Drag. (H. J. Goett, N.A.C.A. Tech. Report No. 660, 1939.) (70/10 U.S.A.)

An experimental investigation has been carried out in the full scale wind tunnel to determine the accuracy of the Jones and Betz equations for computing profile drag from total and static pressure surveys in the wake. The surveys were made behind 6 × 36 foot aerofoils of N.A.C.A. 0009, 0012 and 0018 section at zero lift and behind N.A.C.A. 0012 at positive lifts. Various spanwise positions were used, the distance behind the aerofoils ranging from .05c to 3.0c. The following are the main conclusions:—

1. The Betz and Jones equations give practically identical results, and, since the latter gives rise to simpler computation, it is recommended.
2. The drag by the momentum method is practically independent of distance over the range investigated. This answers the point raised by Muttray (L.F.F. Vol. 14, pp. 371-372, Air Ministry Translation No. 500).
3. At zero lift the drag by the momentum method agrees with balance measurements within 2 per cent.

A direct comparison between drag results obtained by momentum and balance measurements of a lifting aerofoil is impossible because of failure of the momentum method near the tip, and the inclusion of induced drag in the balance results. If the induced drag is deduced from the balance tests, its difference from the momentum drag gives the tip drag. The author's experiments show that the difference increases from 1 per cent. at zero lift to 22 per cent. at $C_L = 1$. It is, however, not certain that the whole of this difference is due to tip effects.

The Growth of the Circulation of an Aerofoil Flying Through a Gust. (W. R. Sears and A. M. Kuethe, J. Aeron. Sci., Vol. 6, No. 9, July, 1939, pp. 376-378.) (70/11 U.S.A.)

The rate of increase of the circulation about the tip of a wing flying through a vertical gust has been determined experimentally by Kuethe (N.A.C.A. Tech. Note 685).

The same phenomenon has been investigated theoretically by von Kármán and Sears (Aerofoil theory for non-uniform motion, J. Aeron. Sci., Vol. 5, No. 10, pp. 379-390) and by Jones (N.A.C.A. Tech. Note. 682).

The authors carry out a comparison between theory and experiment and show that fairly good agreement exists with the Kármán-Sears two dimensional theory.

The measured growth of circulation is, however, less rapid than that predicted by Jones. Possible explanations of the discrepancy are:—

(i) Jones theory is based on a lifting line approximation which can be shown to over-estimate the effect for small values of t.

(ii) Kuethe's measured rise may be too small due to experimental errors known to be present.

The Two-Dimensional Hydrodynamical Theory of Moving Aerofoils (III). (R. M. Morris, Proc. Roy. Soc., Series A, Vol. 172, No. 949, 3/8/39, pp. 213-230.) (70/12 Great Britain.)

This paper follows two previous ones on the general hydrodynamical problem of the two-dimensional motion of a cylinder in inviscid incompressible fluid. The general formulæ obtained in these papers are here reduced for the special case of the Joukowski aerofoil, where the coefficients assume simple finite forms. The formulæ obtained are then applied to a determination of the lift, moment and centre of pressure in uniform rectilinear motion, and also to a discussion of the dynamics of the small oscillation about such rectilinear motion. A simple condition is then obtained for the stability of this rectilinear motion, showing the effects of thickness, camber and angle of attack on this important property of the aerofoil.

De Havilland Variable Pitch Airscrew (Part 4). (Machinery, 15/6/39, pp. 321-329) (Metropolitan Vickers Technical News Bulletin No. 666, 23/6/39, p. 1.) (70/13 Great Britain.)

This article concludes the series dealing with the production of the components for variable pitch air screws by Messrs. de Havilland Aircraft Co. Ltd. The grinding of the counterbore and of the cam sleeve is discussed and also the other operations on the cam sleeve such as drilling and milling of the cam slots. The next operation is cutting the teeth in the inner cam sleeve and broaching the slots in the spider. The collar at the root of the blade is moulded, after fabrication, from bakelite-impregnated discs and tape.

Illustrated with 14 photographs and two diagrams.

Flight Tests on the Range of the Kôken Long-Range Monoplane. (H. Kimura and T. Takatuki, Aer. Res. Inst., Tokyo, Report No. 175, May, 1939, pp. 129-148.) (70/14 Japan.)

The range, kilometres per kilogram of fuel, of the Kôken long-range monoplane was measured for several speeds in level flight at heights between 1,000 m. and 2,000 m. The total weight at the tests was from 5,000 kg. to 6,000 kg., *i.e.*, from 55 to 65 per cent. of the fully loaded weight.

The test results with undercarriage retracted agree fairly well with those calculated from the wind-tunnel test data for C_z/C_x and η and the bench test data for the fuel consumption, so we can estimate, by the extrapolation of the curve of the calculated results, the range at the most economical speed, which was not actually measured in the tests.

With undercarriage retracted, the Kôken long-range monoplane, fitted with the wooden propellers, can cruise distances of 3.9 and 3.3 km. per kg. of fuel at total weights of 5,000 and 6,000 kg. respectively and altitudes of 1,000-2,000 m.; when fitted with a variable-pitch propeller, 5 per cent. increase is obtained on the above figures of range.

The test results showed that by pulling down the undercarriage the range decreased about 20 per cent. over the weight and speed range tested accompanied by an appreciable decrease of the economical speed due to the shifting of the incidence angle of maximum lift-drag ratio to a higher value.

Assuming, from the wind tunnel tests, a propeller efficiency of 79 per cent., the maximum lift-drag ratio of the aircraft is of the order of 19.

Flight Tests of Retractable Ailerons on a Highly Tapered Wing. (J. W. Wetmore, N.A.C.A. Tech. Note, No. 714, June, 1939.) (70/15 U.S.A.)

A flight investigation was conducted to determine the lateral-control characteristics of retractable ailerons installed on a highly tapered wing. The effectiveness of the ailerons in producing roll was measured at various air speeds with full-span plain flaps both neutral and deflected 45°. The direction of the yawing moment created by the ailerons was also noted.

The lateral control provided by the retractable ailerons used in this investigation was approximately the same as that obtained with the plain ailerons of equal span with which the aeroplane was previously equipped. The amount of control available was found to be somewhat inadequate, apparently because of the rather short span of the ailerons (0.327 of the wing span). It is likely that, with an aileron span of from 0.50 to 0.60, a satisfactory degree of control would be obtained. With the full-span flaps deflected 45°, the rolling action of the ailerons was increased about 30 per cent. over that obtained with the flaps neutral at the same speed. The yawing moment produced by the ailerons was in the same sense as the rolling moment, *i.e.*, right roll was accompanied by right yaw. Lag in the response of the rolling action to control application was not large enough to be noticed by the pilots. No appreciable control force was apparent to the pilots, which was considered somewhat undesirable. Minor modifications in the design of the ailerons, however, would probably correct this fault.

Wind-Tunnel Investigation of an N.A.C.A. 23012 *Aerofoil with Two Arrangements of a Wide-Chord Slotted Flap.* (T. A. Harris, N.A.C.A. Tech. Note No. 715, June, 1939.) (70/16 U.S.A.)

An investigation has been made in the N.A.C.A. 7- by 10-foot wind tunnel of a large-chord N.A.C.A. 23012 aerofoil with several arrangements of a 40 per cent. chord slotted flap to determine the section aerodynamic characteristics of the aerofoil as affected by slot shape, flap location, and flap deflection. The flap positions for maximum lift, the polars for arrangements considered favourable for take-off and climb, and the complete section aerodynamic characteristics for selected optimum arrangements were determined. A discussion is given of the relative merits of the various arrangements. A comparison is made of slotted flaps of different chords on the N.A.C.A. 23012 aerofoil.

The best 40 per cent. chord slotted flap is only slightly superior to the 25 per cent. chord slotted flap from considerations of maximum lift coefficient and low drag for take-off and initial climb.

Makhonine Variable Wing Area Aircraft. (Inter Avia, No. 662, 21/7/39, p. 4.) (70/17 France.)

The Makhonine aircraft with variable wing area has resumed its tests at Villaconblay. The first trial flights have proved satisfactory; they included full extension and retraction of the wing (maximum wing area 355 sq. ft. = 33 m.², minimum 194 sq. ft. = 18 m.², hydraulic operation) and were made with a gross weight of 7,940lb. (3,600 kg.). Maximum permissible gross weight 11,020lb. (5,000 kg.). The modified aircraft is equipped with a Gnome 14 No. engine of 1,000 c.v. and a landing gear that partly retracts into the wing leading edge.

The Effect of Incomplete Partition (Ribs) on the Force Distribution in Single Spar Wings. (F. Reinitzhuber, L.F.F., Vol. 16, No. 7, 20/7/39, pp. 349-354.) (70/18 Germany.)

The author shows how the force distribution due to incomplete partitions in single spar wing structure can be determined with the help of the stress field

diagram. The special case of the incomplete partition being subjected to torsion (torque reaction of wing engines) is considered more fully. It appears that the forces are distributed fairly evenly over the cross-section of the wing, the results depending, however, markedly on the stiffness of the partitions and more especially on that of the flanges at the rear of the torsion nose of the wing.

By means of a number of simple assumptions, it is possible to reduce the number of statically indetermined factors and then reduce the labour involved without material sacrifice of accuracy. If the two incomplete partitions carrying the wing engines are subjected to equal moments, it is possible, by means of a simple statically indetermined calculation, to obtain a useful approximation for the couple transmitted by the rear section of the wing.

Aerodynamics of Rotary Wing Systems Provided with Rotor Blade Incidence Control. (A. Pfluger, L.F.F., Vol. 16, No. 7, 20/7/39, pp. 355-361.) (70/19 Germany.)

The author considers the type of rotor construction in which the blades undergo a change of incidence by a twist about the longitudinal axis, the control being linked in such a way to the vertical blade motion that an upward motion of the blade is accompanied by a reduction in incidence. Such types of rotary wing aircraft have been experimented with by Bregnet and Hafner. The case considered is that of steady horizontal flight under conditions of auto-rotation, the method employed being based on that of Wheatley (N.A.C.A. Rep. 487) and Sissingh (L.F.F., Vol. 15, p. 290).

The results are applied to the special case of a machine weighing 900 kg. and resembling in its leading characteristics the Standard Autogiro Type C.30. It appears that the new incidence control shows no marked advantages over the standard Cierva control, and the amplitude of the vertical blade oscillations is not reduced. It must, however, not be forgotten that the comparison as carried out by the author applies to steady horizontal flight. A mechanical blade incidence control profoundly affects the characteristics of flight (take-off, climb, &c.) and the possible benefits accruing on this score may well outweigh the additional complications.

Empennage Design with Single and Multiple Vertical Surfaces. (L. E. Root, J. Aeron. Sci., Vol. 6, No. 9, July, 1939, pp. 353-360.) (70/20 U.S.A.)

Wind-tunnel tests on models with flaps up have been analysed to obtain surface and control efficiencies for empennages with single and double vertical surfaces. On the basis of these efficiencies and constant static longitudinal stability with (1) constant static directional stability, or (2) constant rudder control, required areas for the DC-4 are compared for empennages with single and double vertical surfaces. Hinge moments for single and double rudders giving constant control are compared; and methods of hinge moment reduction are briefly discussed. The variation of ground clearance is shown with single, double, or triple vertical surfaces. Aerodynamic effects of such design variations as horizontal surface tips, rudder cutouts, vertical location of double vertical surfaces, and horizontal surface dihedral angle are mentioned.

Choice of vertical surface type for a particular design is governed by the fact that (1) for constant rudder control, the single vertical surface gives a relatively high value of static directional stability; double vertical surfaces, a relatively low value; and triple vertical surfaces, an intermediate value with minimum over-all aeroplane height, and that (2) for constant rudder control, the total empennage area with single or double vertical surfaces is approximately equal for all aspect ratios; for constant static directional stability, the total area is less with the single vertical surface.

Towards a Rational Method of Tail Plane Design. (A. Silverstein, J. Aeron. Sci., Vol. 6. No. 9, July, 1939, pp. 361-369.) (70/21 U.S.A.)

The framework of a method for the design of tail planes is outlined, and both the extent of the existing knowledge available for its application and the important omissions are discussed. The method differs from the existing one most particularly in that the separate variables that influence the tail performance are given greater individual attention.

Experimental results are presented in some cases to show their relation with certain theories, or to illustrate the general nature of a phenomenon. It is concluded that further extensive research is required before a complete design solution of the tail plane problem can be made.

Hydrodynamic and Aerodynamic Tests of a Family of Models of Seaplane Floats with Varying Angles of Dead Rise, N.A.C.A. Models 57-A, 57-B and 57-C. (J. B. Parkinson, R. E. Olson and R. O. House, N.A.C.A. Tech. Note. No. 716, July, 1939.) (70/22 U.S.A.)

Three models of V-bottom floats for twin-float seaplanes (N.A.C.A. models 57-A, 57-B and 57-C) having angles of dead rise of 20°, 25° and 30°, respectively, were tested in the N.A.C.A. tank and in the N.A.C.A. 7- by 10-foot wind tunnel.

CONCLUSIONS.

1. The effect of angle of dead rise on water resistance in the range from 20° to 30° was negligible up to and including the hump speed. At planing speeds the resistance increased with an increase in the angle of dead rise, a trend similar to that obtained with planing plates.

2. The height and the amount of spray at the hump speed tended to decrease with an increase in the angle of dead rise from 20° to 30°.

3. The aerodynamic drag increased slightly with an increase in the angle of dead rise from 20° to 30°.

4. For floats having the usual cross-sectional shape and load coefficients for minimum allowable surplus buoyancy, the length-beam ratio of the forebody should be approximately 4.0, or larger, to run cleanly at low speeds on the water. Too short and bluff a forebody will result in excessive spray and resistance at speeds below the hump speed.

5. Spray strips were an effective means of reducing spray at the high loadings employed with seaplane floats, but they caused high aerodynamic drag.

The Effects of Partial Span Slotted Flaps on the Aerodynamic Characteristics of a Rectangular and a Tapered N.A.C.A. 23012 Wing. (R. O. House, N.A.C.A. Tech. Note No. 719, July, 1939.) (70/23 U.S.A.)

An investigation was made in the N.A.C.A. 7- by 10-foot wind tunnel to determine the aerodynamic characteristics of tapered and rectangular wings with partial-span slotted flaps. Two N.A.C.A. 23012 aerofoils equipped with centre-section and tip-section flaps were tested.

The results showed that the changes in lift and drag due to changes in flap span for both rectangular and tapered wings having partial-span slotted flaps were similar to those for corresponding wings having partial-span split or plain flaps. For the two wings tested, higher values of maximum lift were obtained with centre-section slotted flaps than with tip-section slotted flaps of the same size. The highest values of lift-drag ratio at maximum lift for the rectangular wing were obtained with centre-section flaps and, for the tapered wing, with tip-section flaps. Centre-section flaps on the tapered wing gave higher values of drag at maximum lift than tip-section flaps; no great difference in drag at maximum lift was apparent for either centre-section or tip-section slotted flaps on the rectangular wing.

It should be borne in mind that the point along the span at which the stall begins may have an appreciable effect on the value of the maximum lift obtained in flight. If the tips stall first any further increase in angle of attack is limited, although it may be several degrees below the angle at which maximum lift is obtained in a wind tunnel. Consequently some of the values of the maximum lift coefficient given for the tapered wing and for the rectangular wing with centre-section flaps may be somewhat higher than those attainable in flight.

Axial Flow Superchargers. (A. Betz, Yearbook of German Aeronautical Research 1938, Vol. 2, pp. 183-186) (in course of translation.) (70/24 Germany.)

Axial type blowers have the advantage of small diameter and high efficiency. Their disadvantage is the constructional length, five impellers being required for a compression ratio of 2/1.

It is not possible to cut down the space occupied by the intermediate stationary guide vanes unless contrary rotating impellers are employed. Although such a type has proved successful on test employing two impellers, it is feared that the mechanical difficulties of extending this method drive to three or more impellers will rule out this construction for aircraft use.

The author has carried out a series of experiments with the object of improving the compression ratio per stage and in this way cutting down the number of impellers required. By very accurate manufacture of the blades and adopting special shapes it has been possible to improve the pressure ratio per stage by 20 per cent.

Further improvement along these lines appears very difficult, apparently due to complicated effects in the boundary layer under conditions of rotary air flow.

Another line of approach is to work deliberately in the supersonic region. Theory indicates that by this means a considerable increase in compression ratio should be possible. Experiments on these lines are still in a very preliminary state and the author is not in a position to report any definite results.

Aircraft Supercharger with Radial or Backward Curved Blades. (C. Pfleiderer, Yearbook of German Aeronautical Research, 1938, Vol. 2, pp. 187-195.) 70/25 Germany.)

As is well known, for a given peripheral speed, the theoretical compression head increases as the blade shape is changed from backward to forward curvature. On the other hand both efficiency and stability of operation suffer, and harmful effects due to attainment of supersonic air speeds are likely to arise.

In the case of the aircraft supercharger, the urgent requirements of small size and weight, however, require such high speeds of operation that the ultimate strength of the blade becomes the decisive factor, *i.e.*, the exit angle at the blade must be $\geq 90°$.

The author shows how the stability of operation can be improved by proper installation (*i.e.*, small pipe capacity on either side of blower) and how a properly designed vaneless diffuser overcomes supersonic difficulties.

Compared with the advantage of compactness and low weight, the drop in compression efficiency is not serious and it is thought that the radial vane will hold the field for single stage aircraft superchargers for some time to come.

Critical Oscillations in the Suction and Exhaust Pipes of Straight-Type Engines. (O. Lutz, L.F.F., Vol. 16, No. 3, 20/3/39, pp. 139-147) (Eng. Absts., Vol. 2, No. 6, Sect. 2, June, 1939, p. 71.) (70/26 Germany.)

The author describes a method of calculating the critical frequencies in lines of piping in which oscillations are set up at more than one point. He cites an earlier publication (Bulletin No. 3 of the Laboratory for Internal-Combustion Engines of Stuttgart Technical University, 1934), in which he discussed oscillations set

up at a single point of a line piping. He recapitulates briefly the procedure then adopted which was based upon the differential equations for the propagation of sound, and demonstrates that the oscillation phenomena resulting from the generation of waves at several points can be treated as oscillations in a number of open pipes, the resultant oscillation being obtained by superposition. He gives examples of the generation of oscillations by fluctuations of the flow-velocity at various points of a pipe-line, and investigates the influence of variations of the cross-section and of throttling. More complex systems of mains and branch lines will be discussed later.

Development Problems on Rotating Boiler-Turbines. (F. Huttner, Z.V.D.I., Vol. 83, No. 14, 8/4/39, pp. 397-404) (Eng. Absts., Vol. 2, No. 6, Sect. 2, June, 1939, p. 70.) (70/27 Germany.)

The author considers that the rotating steam-generator is a decisive step in the mechanical utilisation of heat, and that its association with a turbine opens up wide possibilities. He discusses the developments during the past 15 years and the lessons to be learned from them and asserts that the two main factors which afford scope for advancement are improved radiation from the furnace and improved conditions for the passage of conducted heat. He discusses the principle upon which the system is based, describes test-machines, and states that, despite a small depth of heating surface, the boiler efficiency was 80 per cent. at an exhaust-gas temperature of 150-250°C., whilst higher efficiency would have been possible with pre-heated air. Although the tests were on a small scale, he considers that they offer encouragement for development to larger powers. He discusses in detail the suitability for working with saturated steam, the thermal efficiency of the system, the improvement of the heating surface, and arrangements for gas-firing and oil-firing; he considers that the time is ripe for wider developments, but that these will entail a study of the problem of condensation.

The Influence of Injection-Timing on the Delay-Period in a Compression-Ignition Engine. (J. Riffkin, Engineering, Vol. 147, No. 3826, 12/5/39, pp. 552-553) (Eng. Absts., Vol. 2, No. 6, Sect. 2, June, 1939, p. 70.) (70/28 Great Britain.)

Tests were made on a single-cylinder four-stroke-cycle open-combustion-chamber compression-ignition engine provided with a special injection system to enable the injection-timing to be varied over a wide range while the engine was in operation. Three different fuel oils were supplied in turn, and engine performance data, including measurements of the delay period, were recorded for each change of injection-timing. The author concludes that the timing of injection influenced the value of the delay-period, and that the prevailing temperature in the combustion chamber at the instant of fuel-injection was probably the chief controlling factor.

Hydraulic Starter for Oil and Petrol Engines. (The Oil Engine, Vol. 6, No. 72, April, 1939, p. 366) (Eng. Absts., Vol. 2, No. 5, Section 3, June, 1939, p. 109.) (70/29 Great Britain.)

The Berger starter, made by a Paris firm holding the manufacturing rights for France and the U.K., is primarily intended for aircraft engines. The smallest model weighs 7.2lb., and will deal with engines of from 60 to 200 b.h.p., whilst the larger model weighing 15.9lb. is suitable for engines up to 1,600 b.h.p. There are two intermediate sizes. The power medium employed is hydraulic; oil is supplied by a small-bore pump driven by an electric motor, by the engine itself, or by hand. The pump feeds an accumulator, which contains air at high pressure; this air provides a form of spring loading on the oil, which operates on the starter pistons at a pressure up to 3,550lb./in.^{2}. The body of the device contains two pistons with helical-toothed racks actuating the pinion which drives

the engine crankshaft through dog clutches. The pistons are returned, after each working stroke, by springs to the outer ends of cylinders.

Improvements in Aeroplane Engines. (R. Combes, Bull. Soc. Enc. Industr., Nat. Paris, April, 1939, pp. 221-243) (Eng. Absts., Vol. 2, No. 6, Sect. 2, June, 1939, p. 70.) (70/30 France.)

The author reviews briefly the progress made in the performances of aeroplane engines, and examines, from the experimenter's point of view, the means whereby the present high standard has been attained and the directions in which further progress may be expected in the near future. He considers that recent progress has been due chiefly to three main causes, namely: (1) conditions of reception representing more closely the needs of actual service; (2) greater attention to efficient cooling; (3) improvements in carburants. The provision of short time supercharge tests permitted increased power for taking off to be obtained by increasing the admission pressure, and the utilisation to the greatest advantage of richer mixtures and higher speeds of rotation; it also led to reduced fuel consumption in cruising by reducing the maximum power at which such low specific consumptions were permissible. By permitting the use of weaker mixtures without risk of knocking, improvements in cooling—and also improvements in carburants—contributed not only to reduction of fuel consumption in cruising, but also to improved characteristics in climbing. The author considers that further improvement in the performance of existing types of engines may be achieved by reduction of losses of head, increased efficiency of compressors, and better adaption of the compressor to the engine, the ideal being a compressor working at optimum efficiency for all rates of air-supply required by the engine. Recent experiments bearing on the problem are described.

Gas Turbine Developments. (S. A. Tucker, Power, June, 1939, pp. 58-61. Metropolitan Vickers Technical News Bulletin, No. 666, 23/6/39, p. 6.) (70/31 U.S.A.)

This article gives a brief account of the development of the gas turbine in the U.S.A. during the past few years. Descriptions of 11 by-product gas turbine sets at present in course of production by Messrs. Brown-Boveri and Allis-Chalmers are included, and, also, details of a number of such sets in operation for several years past. The advantages and limitations of such turbines are outlined.

Illustrated with one photograph and five diagrams.

Atomisation of Oil by Small Pressure-Atomising Nozzles (Domestic Oil Burners). (E. B. Glendenning, A. R. Black, L. H. Ventres and W. A. Sullivan, Trans. A.S.M.E., Vol. 61, No. 5, July, 1939, pp. 373-381.) (70/32 U.S.A.)

1. One of the most important characteristics of an oil from the standpoint of atomisation is viscosity. Viscosity influences nozzle capacity, angle of spray, degree of atomisation, character of flame, and efficiency of combustion. Since the viscosity of the oil at atomising temperature is of first importance, the viscosity-temperature characteristics of an oil must be taken into consideration.

2. Nozzle design has an important bearing on the character of the spray and the sensitivity of the nozzle to variations in the atomising pressure and the viscosity of the oil. This calls for careful balancing of the sizes of the slots, vortex chamber and orifice to produce the desired tangential and axial velocities at the exit of the nozzle.

3. Of particular importance for efficient combustion is the placement of the combustion air as it conforms with the shape and nature of the oil spray.

4. Efficiency of combustion and economy of heating with oil in domestic pressure-atomising burners depends largely upon the selection of a nozzle having

the proper atomising characteristics, the correct aerodynamic design of the burner, and the use of an oil of correct and uniform viscosity.

Combustion Gas Turbine. (A. Meyer, Machinery Market, 21/7/39, pp. 21-22. Metropolitan Vickers Technical News Bulletin, No. 671, 28/7/39, p. 3.) (70/33 Great Britain.)

In this first of a series of articles, the author traces the history of the turbine, and the problems that confronted the early inventors, such as cooling and simplification of design. The first gas turbine to be designed was Stolze's hot air turbine in 1872, although its trials did not take place until 1900-1904. A description of the mechanism of turbines of this type is given. Due to the low efficiency of these early types, Holzworth developed the explosion type, and the article proceeds to describe its method of working. The history of this type of turbine is traced down to the present day and the part played by Brown-Boveri in its development.

Illustrated with three diagrams and two graphs.

Gland Seals. (K. Trutnovsky, Z.V.D.I., 22/7/39, pp. 857-858. Metropolitan Vickers Technical News Bulletin, No. 671, 28/7/39, p. 9.) (70/34 Germany.)

It is pointed out that in machines in which metallic surfaces having relative motion separate spaces subject to varying pressures and high temperatures, *e.g.*, cylinders of thermal prime movers, great difficulty is often experienced in achieving satisfactory lubrication and wear of the sealing parts. In these cases the use of contract-free gland seals is advantageous. In particular the author considers the fundamental differences in the behaviour of the smooth gap and the labyrinth gland, the influence of the modification of characteristic dimensions on the inertia of the labyrinth gland and makes a comparison of gland seals.

Illustrated with eight diagrams.

Poppet Valve Dynamics. (E. H. Olmstead and E. S. Taylor, J. Aeron. Sci., Vol. 6, No. 9, July, 1939, pp. 370-375.) (70/35 U.S.A.)

Measurements of the motion of a pushrod-operated poppet valve at normal operating speed showed considerable deviation from the motion at low speed. Jumping was observed at a speed very much lower than the speed which would be predicted by the usual analysis. The observed discrepancy is attributed to flexibility in the operating mechanism. A mathematical analysis is presented which takes account of flexibility and gives a reasonable check on the observed motion. The effect of speed, valve spring pressure and cam form was investigated by means of a mechanical model. Special cam forms for eliminating jumping at a single speed are suggested.

The Influence of Directed Air Flow on Combustion in a Spark-Ignition Engine. (A. M. Rothrock and R. C. Spencer, N.A.C.A. Tech. Report No. 657, 1939.) (70/36 U.S.A.)

The N.A.C.A. combustion apparatus consists of a 5×7 single-cylinder test engine with a large glass window in the head to permit the combustion to be studied photographically. The engine is motored at the required speed and is then fired once by injecting and igniting a single charge of fuel. The air movement in the cylinder was regulated by using shrouded inlet valves and by fairing the inlet passage. Rates of combustion were determined at different inlet-air velocities with the engine speed maintained constant and at different engine speeds with the inlet-air velocity maintained approximately constant.

The rate of combustion increased when the engine speed was doubled without changing the inlet-air velocity; the observed increase was about the same as

the increase in the rate of combustion obtained by doubling the inlet-air velocity without changing the engine speed.

Certain types of directed air movement gave great improvement in the reproducibility of the explosions from cycle to cycle, provided that other variables were controlled.

Directing the inlet air past the injection valve during injection increased the rate of burning.

Liquid Ammonia as a Motor Fuel. (La Science et la Vie, No. 265, July, 1939, pp. 51-52.) (70/37 France.)

The liquid ammonia is vaporised and then passes over a catalyst which causes between 5-10 per cent. of the vapour to be decomposed into hydrogen. This hydrogen acts as a primer to the combustion.

According to the Phillips Petroleum Corporation, a 6 per cent. addition of liquid ammonia to ordinary petrol raises the permissible compression ratio appreciably.

Moreover the lead susceptibility of the petrol is markedly increased in the presence of ammonia.

The Hydrodynamic Theory of Detonation. (H. Langweiler, Zeit. Technische Physik, Vol. 19, No. 9, 1938, pp. 271-283.) (Available as Translation T.M.899.) (70/38 Germany.)

The author derives equations containing only directly measurable constants for the quantities involved in the hydrodynamic theory of detonation. The stable detonation speed, D_s, is revealed as having the lowest possible value in the case of positive material velocity, by finding the minimum of the Du curve (u denotes the speed of the gases of combustion). A study of the conditions of energy and the disclosure of a rarefaction front travelling at a lower speed behind the detonation front; its velocity is computed. The latent energy of the explosive passes into the steadily growing detonation zone—the region between the detonation front and the rarefaction front. The conclusions lead to a new definition of the concept of shattering power. The calculations are based on the behaviour of trinitrotoluene.

The Knocking Characteristics of Fuels in Relation to Maximum Permissible Performance of Aircraft Engines. (A. M. Rothrock and A. E. Bierman, N.A.C.A. Tech. Report No. 655, 1939.) (70/39 U.S.A.)

The results presented in this report show that, by a determination of the knocking characteristics of a fuel in an engine as a function of the highest permissible inlet-air density at any inlet-air temperature, data obtained at one compression ratio or at one inlet-air pressure are applicable to a series of inlet-air pressures and compression ratios at the different inlet-air temperatures tested.

Analysis of the more important engine factors affecting knock leads to the conclusion that the most important independent variables in any one engine are the inlet-mixture density and temperature and the mixture ratio.

The data show that preignition must be treated separately from knock if the fuels are to be adequately rated in the engine. In the case of knock, the maximum permissible performance increases with speed for a constant spark advance; whereas, with preignition, the indication is that the maximum permissible performance decreases with engine speed.

The Constitution and Application of Thermo-Electric Instruments. (L. B. Lambert, Eng. and Boiler-House Review, July, 1938, pp. 38-42. Metropolitan Vickers Tech. News Bulletin, No. 669, 14/7/39, p. 1.) (70/40 Great Britain.)

The article deals with the large range of pyrometric instruments now available and their application in the boiler house, turbine room, and other fields.

The author describes the principles of the thermo-electric couple and the various difficulties encountered in its use. He then deals with methods by which these difficulties are overcome. He also mentions the most suitable metals and alloys used in these instruments and the reasons for their suitability.

Illustrated with three photographs and five diagrams.

The Vectorscope. (G. Dashefsky, Trans. A.S.M.E., Vol. 61, No. 5, July, 1939, pp. 403-414.) (70/41 U.S.A.)

This paper describes a new instrument capable of rapidly summing up a number of vectors. The machine consists of a disk, mounted in gimbals in the manner of a nautical compass, on which are placed weights representing the vectors to be added. A spot of light on the screen indicates directly the resultant vector and its direction, as well as its horizontal and vertical components.

The mathematical principle is developed and the instrument is shown to be suitable for studying crankshaft arrangements with respect to unbalanced moments and torsional vibration. The suitability of any firing order for any crankshaft configuration may be ascertained simply and quickly.

It is shown that the instrument is inherently adapted to making harmonic analyses of periodic functions and the theory of this application is discussed. Results by this method of analysis compare favourably with other methods.

X-Ray Determination of the Notch-Factor of Notched Rods. (H. Krachter, Z. Metallk., April, 1939, pp. 114-115. Eng. Absts., Vol. 2, No. 6, Sect. 1, June, 1939, p. 50.) (70/42 Germany.)

The author observes that a knowledge of the increase of stress across the cross-section, especially of notched rods, is of considerable practical importance in structural engineering. The most important factor is the form or notch-factor, α_k, which is the ratio of the maximum stress σ_{max}, to the nominal stress, σ_n. In notched rods, this can be obtained only by approximate calculation or by the use of models. The author has applied X-rays to determine this factor by a difference method. First, by means of vertical radiation, the sum of the longitudinal and circumferential stresses $(\sigma_l + \sigma_u)$ was measured by the method of Wever and Moller, and then the circumferential stress, σ_u, alone was measured by oblique radiation at 45° by Glocker's method; then $\sigma_k = \frac{(\sigma_l + \sigma_u) - \sigma_u}{\sigma_n}$. The notch-factor was plotted against the notch-depth, and the resulting curve indicated that, as the notch-depth increases, the notch-factor increases up to a critical value of the notch-depth, and thereafter decreases.

Recent Welding Developments in the U.S.A. R. M. Gooderham, Welding Ind., June, 1939, pp. 164-170. Metropolitan Vickers Technical News Bulletin No. 666, 23/6/39, p. 5.) (70/43 U.S.A.)

The following article presents a general survey of the progress of welding in the United States during the past year. Reasons for the greatly increased use of welding are given. Various fields of application are detailed, such as the motor car industry, shipbuilding, structural welding and machine fabrication and indications given of future developments in these industries. Investigations into weld strengths by various methods are reviewed, as also the establishing of proper welding technique, symbols, procedure and preparation of materials, etc.

Illustrated with nine photographs.

New Resistance Material "Novokonstant." (E.T.Z., 15/6/39, pp. 729-730. Metropolitan Vickers Technical News Bulletin No. 666, 23/6/39, p. 8.) (70/44 Germany.)

Abstract from an article in Phys. Zeit. (1939), p. 357, describing tests carried out in the National Physical and Technical Institute on a new resistance material

called " Novokonstant." This is a copper-manganese alloy containing 82.5 per cent. Cu, 4 per cent. Al, 1.5 per cent. Fe and 12 per cent. Mn. The electrical behaviour of the material as a whole indicates its suitability for precision resistances. Details are given among other things of the relation between the electrical resistance of " Novokonstant " (and its temperature coefficient) and the temperature, the relation between the resistance temperature curve and the ageing curve, etc.

Illustrated with two diagrams and one photograph.

The Column Strength of Two Extruded Aluminium-Alloy H-Sections. (W. R. Osgood and M. Holt, N.A.C.A. Tech Report No. 656, 1939.) (70/45 U.S.A.)

Extruded aluminium-alloy members of various cross-sections are used in aircraft as compression members either singly or as stiffeners for aluminium-alloy sheet. In order to design such members, it is necessary to know their column strength, or, in the case of stiffeners, the value of the double modulus, which is best obtained for practical purposes from column tests.

Column tests made on two extruded H-sections are described, and column formulæ and formulæ for the ratio of the double modulus to Young's modulus, based on the tests, are given.

Experiments with D.V.L. Bearing Testing Machine on Lead Bronze Bearings Cast on Steel Shells. (G Fischer, L.F.F., Vol. 16, No. 7, 20/7/39, pp. 370-383.) (70/46 Germany.)

Although research with light alloy bearings has been very active, such materials are not yet considered suitable for the highly stressed aero-engine bearings. As a result, lead bronze bearings are still standard practice although their manufacture is complicated. The normal casting procedure has been to immerse the steel shell for a considerable time in the molten alloy, after which it is rapidly quenched. This ensures good adhesion, but is apt to make the lead distribution throughout the mass non uniform (gravity diffusion in the bath). In this connection it may be advantageous to produce the melt in an electric furnace of the high frequency coreless induction type. Another suggested line of development consists in using separate castings for the bearing and supporting shell, the junction being subsequently produced by means of a third alloy of high diffusion.

The author describes tests on 12 lead bronze bearings supplied by five firms. The load capacity of the bearings was determined as well as their behaviour on duration runs both with steady and alternating load. The results show the importance of uniform good lead distribution and the harmful effect of impurities (chiefly iron). In a number of cases the early formation of cracks has been traced to stresses introduced during manufacture.

Radiography in Iron and Steel Founding. (F. W. Rowe, Foundry Trade Journal 20/7/39, pp. 43-47. Metropolitan Vickers Technical News Bulletin, No. 671, 28/7/39, p. 4.) (70/47 Great Britain.)

Particulars in the manipulation of both X-ray and gamma-ray apparatus are given and the relative merits of both types are discussed. The cost of film, developing, film holders, etc., does not differ greatly. Gamma-ray practice offers marked advantages in the way of operating expense, as the operator may go about other work during exposure. Several examples of work encountered in the use of radiography are given.

Illustrated with 16 radiographs and one diagram.

The Lower Limiting Crystallite Size and Internal Strains in Some Cold Worked Metals. (W. A. Wood, Proc. Roy. Soc. Series A, Vol. 172, No. 949, 3/8/29, pp. 231-241.) (70/48 Great Britain.)

An X-Ray examination has been made of the changes in crystalline structure during the progressive cold working of pure Cu, Ag, Ni, Al, Mo and Fe. It is shown that the grains are dispersed into a fundamental unit (crystallite) characterised by a lower limiting size ranging from 10^{-4} cm. for Al to 0.7×10^{-5} cm. for Cu. This size is deduced from the broadening of appropriate diffraction lines. It is further shown, in the general case of copper, that on continued cold working the diffraction lines broaden to a maximum and then diminish in width to a definite value, the two processes alternating on further working. At the same time, the lattice dimensions of the crystallites change, having an expanded value when the line is most diffuse and a contracted value when the line breadth decreases. These changes are measured and indicate that the condition of the cold worked metal is marked by two extremes, (i) a comparatively stable state with a contracted lattice and minimum line broadening giving the lower limiting crystallite size, and (ii) a less stable state characterised by an expanded lattice and an abnormally diffuse line breadth which represents the extent and nature of the distortion transmitted to and retained by the metallic lattice during continued deformation.

The Friction of Clean Metals and the Influence of Adsorbed Gases. The Temperature Coefficient of Friction. F. P. Bowden and T. P. Hughes, Proc. Roy. Soc., Series A, Vol. 172, No. 949, 3/8/39, pp. 263-279.) (70/49 Great Britain.)

A method is described for measuring the kinetic friction between metal surfaces which have been freed from the oxide and surface films which are normally present. The removal of the films has a profound effect and the kinetic friction between the outgassed metals may be 20 times greater than that observed for the same metals cleaned in air.

The addition of a trace of oxygen to the clean metal causes an immediate reduction in the friction. Adsorbed hydrogen and nitrogen have little or no effect. Although the friction is reduced by a single film it is clear that polymolecular layers are necessary before a substance can act as an effective boundary lubricant for moving surfaces.

The temperature coefficient of friction between clean metals was determined over a wide temperature range. Most of the metals investigated show a small but regular decrease in the kinetic friction as the temperature rises. If the temperature causes excessive softening of the metal the friction may rise to a high value.

The Mechanism of Sliding on Ice and Snow. (F. P. Bowden and T. P. Hughes, Proc. Roy. Soc., Series A, Vol. 172, No. 949, 3/8/39, pp. 280-297.) (70/50 Great Britain.)

Experimental studies of the friction on ice surfaces have shown that the low frictions observed at temperatures near the melting point were due to lubrication by a thin water film at the points of contact between the sliding surfaces. The coefficient of kinetic friction was found to be independent of the load, apparent area of contact, and speed of sliding over a certain range. When the temperature of the ice was decreased the friction rose markedly as the water film became more difficult to form. Using ski of various materials, it was observed that the friction depended very largely on the thermal conductivity of the ski. This result suggested that frictional heating played a large part in melting a water film during sliding; it had been previously considered that pressure melting was alone responsible for the formation of this water film.

Experiments with miniature and real ski on snow surfaces showed that the same general laws were obeyed as on ice surfaces. The higher frictions obtained on snow were attributed to the extra work done in displacing and compressing the snow crystals.

Stress-Optical Investigation on a Square Plate Fitted with a Central Square Hole. (A. Schreyer, Forschung, Vol. 10, No. 4, July-August, 1939, pp. 157-164.) 70/51 Germany.)

The experiments are in excellent agreement with previous theoretical investigation of the author. This applies especially to the complicated phenomena arising at the internal corners.

It is confirmed that in the case of multi-connected regions where the forces acting on the inner edges are in equilibrium the resulting stress distribution is independent of the lateral contraction.

Stress distribution obtained by optical means can therefore be applied directly to other materials.

It appears that a good approximation to the stress distribution at the edge (position of zero and maximum stress) can be obtained from a study of the isochromatic lines alone without reference to the isoclinics.

This is of importance in the case of complicated multi-connected regions which are not amenable to mathematical treatment.

The Effect of Continuous Weathering on Light Metal Alloys Used in Aircraft. (W. Mutchler, N.A.C.A. Report, No. 663, 1939.) 70/52 U.S.A.)

An investigation of the corrosion of light metal alloys used in aircraft was begun at the National Bureau of Standards in 1925, and has for its purpose the study of the causes of corrosion in aluminium-rich and magnesium-rich alloys together with the development of methods for its prevention.

The results, obtained in an extensive series of laboratory and weather-exposure tests, reveal the relative durability of a number of commercially available materials and the extent to which the application of various surface coatings of oxide alone and with paint coatings afforded additional protection. The paper may be considered as a supplement to N.A.C.A. Report No. 490.

A Method of Estimating the Critical Buckling Load of Structural Members. (E. E. Lundquist, N.A.C.A. Tech. Note No. 717, July, 1939.) (70/53 U.S.A.)

The relation between load on the structure and rotation of a joint can be used to estimate the lowest critical load, after the equation for neutral stability has been tested for three assumed critical loads, each of which is less than the lowest critical load.

The solutions of six problems are included to illustrate the method. Four of these problems are concerned with members that lie in the elastic (long-column) range. The remainder deal with members in the short column range.

When all the members are in compression, the calculation over-estimates the critical load. The region of good agreement cannot be stated generally. Transition from over to under-estimation is likely to occur when the size, axial load or number of tension members, is small relative to the compression members.

The method of estimating the critical load should always be regarded as a tool to aid in finding the lowest load that satisfies the equations for neutral stability. This lowest load is the calculated critical load for the problem.

Resistance of Transparent Plastics to Impact. (B. M. Axilrod and G. M. Kline, N.A.C.A. Tech. Note No. 718, July, 1939.) (70/54 U.S.A.)

The problem of developing a windshield for aircraft which will withstand the effect of bird impact during flight is difficult. If a 4lb. bird is involved, an

impact energy of the order of 10,000 foot lbs. may have to be dissipated (relative speed 400 feet/sec.). The present report gives the results of a comparative study of the impact strength of various types of transparent plastics with particular reference to their ability to withstand impacts with relatively soft bodies, such as a shot filled sponge rubber ball. A 4lb. ball travelling at 400 feet/sec. could not be stopped by plastic materials up to ½in. thick or glass products up to 1.2in. thick.

Four ⅛in. sheets of cellulose acetate bolted together and a sheet of tempered glass 1.2in. were also broken when struck by a 3in. ball travelling at 300 feet/sec. (normal impact), but withstood the impact when inclined at 45°.

Improvements and Experience in Radio Soundings. (H. Diamond, W. S. Hinman, A. H. Mears and C. Harmantas, J. Aeron. Sci., Vol. 6, No. 9, July, 1939, pp. 379-383.) (70/55 U.S.A.)

Further improvements of the radio sonde developed at the National Bureau of Standards for the U.S. Navy Department are described. The improvements were directed to facilitate the mass production of the instrument while retaining its accuracy and simplicity. An analysis, based on data of the U.S. Weather Bureau, of the performance of the improved instrument in routine use at six Weather Bureau and one Navy Department aerological stations is presented. A quantitative evaluation of the accuracy of the radio sonde observations is included. The radio sonde system has provided a continuous sequence of upper-air observations to much greater heights and with greater regularity and reliability than the aeroplane method of sounding hitherto employed. Plans of the Weather Bureau and the Navy Department call for routine use of the instrument described at about 35 aerological stations, during the fiscal year 1940.

Graphical Determination of the Coefficient of Heat Transfer for Banks of Tubes. (J. Böhm, Wärme, 1/7/39, pp. 425-431. Metropolitan Vickers Tech. News Bull., No. 669, 14/7/39, p. 8.) (70/56 Germany.)

After reviewing the present state of knowledge of the transfer of heat from gases to banks of tubes, the author develops a graphical method which, with the aid of a nomogram, enables the coefficient of heat transfer to be rapidly and reliably determined. He gives examples which show how the influence of modifications can be clearly observed with the help of the nomogram.

Illustrated with 13 diagrams.

Temperature Distribution in Circular Discs. (E. Beck, Forschung, July-August, 1939, pp. 165-169. Metropolitan Vickers Technical News Bulletin, No. 671, 28/7/39, p. 8.) (70/57 Germany.)

For a circular disc of equal thickness the author develops the differential equation for heat conduction, whose solution reproduces the temperature field in the disc. The theory is then extended to discs of arbitrary cross-section, and the method is also applied to a turbine disc. It is found that, in consequence of the dissipation of heat at the disc, the temperature declines considerably from the foot of the blade to the middle of the disc. Corresponding temperature stresses are set up, which may in no case be disregarded during the design of the disc. The importance of a knowledge of the temperature distribution is stressed especially in those cases in which artificial cooling of the turbine rotor at the disc is used.

Illustrated with three diagrams.

The Production of Ultra-High-Frequency Oscillations by Means of Diodes. (F. B. Llewellyn, A. E. Bowen, Bell Telephones Pubs., No. B.1143, 1939, pp. 1-12.) (70/58 U.S.A.)

The general problem of obtaining oscillations by the use of diodes with critical electron transit time is outlined. Some of the properties of a 10 cm. oscillator

tested experimentally are included. Extraneous losses were reduced when the oscillator was enclosed within a wave guide.

Narrow Band Transmission System for Animated Line Images. (A. M. Skellett, Bell Telephone Pubs., No. B.1136, 1939, pp. 1-7.) (70/59 U.S.A.)

A method of transmission and reproduction of line images is described which utilizes a cathode-ray tube for reproduction, the spot of which is made to trace out the line image 20 or more times a second. In an experimental test a drawing of a woman's head was reproduced with an equivalent total band width of approximately 2,600 cycles. This was made up of two bands, each 1,300 cycles wide for the potentials to the two sets of cathode-ray deflector plates. Analysis of a more complex image, such as that of an animated cartoon shows that such material could be transmitted and reproduced by this method within a total band width of 10,000 cycles.

Means are described for transcribing from drawing or animated cartoon film into recordings (similar to sound recordings) from which the potentials for transmission and subsequent operation of the cathode-ray tube may be obtained.

Radio Telephone System for Harbour and Coastal Services. (C. N. Anderson and H. M. Pruden, Bell Telephone Publications B.1147, pp. 1-22.) (70/60 U.S.A.)

Radio telephone service with harbour and coastal vessels is now being given through coastal stations in the vicinities of seven large harbours on the Atlantic and Pacific coasts with additional stations planned. The system is designed to be as simple as possible from both the technical and operating standpoints on both ship and shore.

Recent developments in the shore-station design eliminates all manipulations of the controls by the technical operator. This is made possible principally because of crystal-controlled frequencies on shore and ship, a " vogad " which keeps the transmitting volume of the above subscriber constant, and a " codan " incorporated in the shore radio receiver which will operate on signal carrier but is highly discriminatory against noise.

A signalling system permits the traffic operator to call in an individual boat by dialling the assigned code which rings a bell on the particular boat called. The ship calls the shore station by turning on the transmitter. The radio signal operates the codan in the shore receiver, which, in turn, lights a signal lamp in the traffic switchboard.

Gradually the system has been taking on more and more the aspects of wire telephone systems.