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Penetration of Bombs. (Engineering Precautions Air Raid Committee Memorandum, No. 2, J. Inst. Civ. Eng., Vol 11, No. 5, March, 1939, pp. 30-44.) (66/1 Great Britain.)

The penetration of a bomb depends on—

1. The velocity of impact.
2. The sectional density of the bomb (lb./sq. in.).
3. The shape of bomb.
4. Nature of material penetrated.

The velocity of impact itself is a function of the height of drop and the sectional density. This density may vary from 0.5 (small incendiary bombs) to 15 lb./sq. in. for large heavy case bombs.

The following table gives representative values :—

Type of Bomb.	Height of fall (feet).	Impact velocity (feet/sec.)
Small incendiary ($\Omega \approxeq 0.5$)	10,000	400
	20,000	400
Heavy incendiary or small explosive ($\Omega \approxeq 2$) ...	10,000	600
	20,000	700
Medium case bomb (500-1,000lb.) ($\Omega \approxeq 5$) ...	10,000	750
	20,000	900
Large heavy case bomb ($\Omega \approxeq 15$)	10,000	900
	20,000	1,150
	40,000	1,500

Using the above data, the depth of penetration for unit sectional density is approximately as follows :—

Material.	Impact velocity.	Penetration in feet for unit sectional density.
Concrete (strength 2,800 lb./sq. in.)	400	0.2
	800	0.6
	1,200	0.9
Timber	400	1
	800	2.6
	1,200	4.2
Loose earth	400	2
	800	4.8
	1,200	5.5

Thus a small incendiary bomb (sectional density $\Omega = 0.5$) will penetrate 1 foot of earth or 0.1 foot of concrete if dropped from 20,000 feet.

A 500lb. bomb ($\Omega = 5$) dropped from the same height will penetrate 3 feet of concrete or 25 feet of earth.

A 2,000lb. bomb ($\Omega = 15$) might penetrate 75 feet of earth.

At very high speeds of impact, the resistance of sand or earth is greatly increased. The relative depth of penetration for bomb fragments (v = 5,000 feet/sec.) for earth and concrete is thus not 10/1 (as in the above table) but only of the order of 2-3/1.

The Effectiveness of Aerial Bombardment in Spain. (Les Ailes, No. 927, 23/3/39, p. 11.) (66/2 France.)

The author has discussed the effectiveness of aerial bombardment with various officers and men of the Republican forces which recently retreated into France.

The following are the principal conclusions:—

1. Complete demoralisation of the civilian population when exposed to high explosives. The heavy (500 kg.) bomb will cause the collapse of any building (blast) and rescue work will be rendered very difficult by the subsequent use of splinter bombs.
2. Complete demoralisation of troops in trenches subjected to heavy and continuous aerial bombardment. Even if the actual loss of life is relatively small, the troops are incapable of offering any resistance and the trench is taken without a shot being fired.
3. Troops in the open, especially mechanised columns on roads, are extremely vulnerable to machine gun attack from the air and to the effect of small splinter bombs.
4. The ordinary soldier as normally equipped is incapable of any effective reply to aerial attack.

Civil Defence (Methods of Adequate Protection Against Aerial Attack). (C. W. Glover, published by Chapman and Hall. Reviewed in Nature, No. 3,622, 1/4/39, pp. 537-8.) (66/3 Great Britain.)

The first part of the book deals with war gases and methods of protection. The second part considers the problem of buildings, trenches and shelters. Provided the walls of steel framed buildings are sufficiently thick (12in. ferro-concrete or 14in. of brick) the ground floor (if there is no basement) is recommended as the best level for a shelter, provided the floors above are capable of holding up any debris that may fall on them.

As regards trenches, the zig-zag type has been found in Spain to be preferable to the crenellated. If a roof is provided it should only be sufficiently strong to hold up splinters, since a roof proof against a direct hit is in most cases impracticable.

From a practical point of view small dispersed shelters are easier to construct and, generally speaking, not more than 50 people should be accommodated in one place.

The book ends with a description of the Home Office A.R.P. Organisation.

The Resistance of Concrete to High Explosives. (Engineering, Vol. 147, No. 3,820, 31/3/39, p. 386.) (66/4 Great Britain.)

The resistance of concrete to high explosives can be increased by the addition of granite dust to the aggregate. The mix recommended has the following composition:—

$2\frac{1}{4}$ parts $\frac{3}{16}$in. granite and sand.
$3\frac{3}{4}$ parts $\frac{3}{4}$in. to $\frac{1}{4}$in. granite.
1 part cement.

The water/cement ratio in the above is 0.53. Slabs made of this material, 2ft. by 2ft. by 6in. were subjected, after ageing, to the action of $\frac{1}{2}$oz. charge of

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Abelite placed in a central plugged hole of the slab, 1⅛in. diameter and 3¼in. deep. Similar tests were carried out on slabs of normal concrete.

The published photographs show the superiority of the granite mix, the greater cohesion of the latter being accounted for by the keying action of the sharp granite particles.

A Complete Plant for A.R.P. Emergency Power Generation. (Mechanical World and Engineering Record, 24/3/39, pp. 296-7. Metropolitan Vickers Technical News Bulletin, No. 654, 31/3/39, p. 3.) (66/5 Great Britain.)

The plant described has been installed at Portsmouth as a protection against interruption of production by the failure of the public electricity supply. The apparatus, housed under reinforced concrete, is driven by a 250 b.h.p. Petter "Superscavenge" Diesel engine. This is coupled to a single-bearing alternator with overhung exciter made by the English Electric Co. The unit runs at 500 r.p.m. and the generator is designed to have high efficiency at fractional loads. Voltage regulation is maintained by B.T.H. carbon-pile automatic regulator, and paper insulated armoured cable in an underground duct is employed throughout. The air compressor, exhaust cooling and emergency lighting systems are described.

Illustrated with two photographs.

The Training of Pilots in the National Socialist Flying Corps (N.S.F.K.) (O. R. Thomson, published by C. J. E. Volckmann, Berlin.) (66/6 Germany.)

The object of the N.S.F.K. is threefold:—

1. Create air-mindedness in the German people.
2. To provide pre-military training.
3. To coordinate sporting aviation in Germany.

The membership is voluntary, but limited to the following classes:—

1. Retired Air Force members who have had flying experience.
2. Civilians who have been trained as pilots or observers, balloon and glider pilots.
3. All members of the Air Section of the Hitler Youth organisation older than 18 years.
4. All members of the flying and gliding sections of the former D.L.V.

The N.S.F.K. is organised into 17 groups with headquarters distributed over the whole of Germany. These groups are further subdivided into smaller units so that practically every village can easily get into touch with the organisation.

The booklet under review deals mainly with the training for the A2 pilot's licence, which is usually obtained in 6-8 weeks (15-22 hours in the air). The description of the various control movements during take-off, landing and curvilinear flight are simply explained with the help of diagrams. The book certainly fulfils its object since most young readers will be tempted to try their own hand!

Circulation Measurements About the Tip of an Aerofoil During Flight Through a Gust. (A. M. Kuethe, N.A.C.A. Tech. Note No. 685, Feb., 1939.) (66/7 U.S.A.)

Measurements were made of the circulation about the rectangular tip of a short-span aerofoil passing through an artificial gust of known velocity gradient. A Clark Y aerofoil of 30-centimetre chord was mounted on a whirling arm and moved at a velocity of 29 metres per second over a vertical gust with a velocity of nearly seven metres per second. Flow angles were measured with a hot-wire apparatus.

CONCLUSIONS.

1. During the first stages of the motion of a wing into a gust, the measurements indicate that the trailing vortices behind a wing of rectangular plan form are concentrated nearer to the wing tips than they are during flight.

2. For conventional plan forms, *i.e.*, with the chord constant or decreasing towards the tips, wing-tip loads in gusts do not exceed those experienced in steady flight at angles of attack equal to the maximum value reached in the gusts.

3. The rate at which the lift at the tips of a wing entering a gust is realised is in satisfactory agreement with that predicted on the basis of the two-dimensional theory of von Karman and Sears.

Large Wind Power Generators. (C. Martini, Elektrotechnik und Maschinenbau, 17/2/39, pp. 83-9. Metropolitan Vickers Tech. News Bulletin No. 652, 17/3/39, p. 9.) (66/8 Germany.)

The author makes a weight comparison of wind power generators according to the Honnef system, the weights being plotted as a function of the three variables: number of poles, air induction and diameter. Illustrated with six diagrams.

Tests of N.A.C.A. 0009, 0012 *and* 0018 *Aerofoils in the Full-Scale Tunnel.* (H. J. Goett, W. K. Bullivant, N.A.C.A. Tech. Report No. 647, 1938.) (66/9 U.S.A.)

An investigation was conducted in the N.A.C.A. full-scale wind tunnel to determine the aerodynamic characteristics of the N.A.C.A. 0009, 0012, and 0018 aerofoils, with the ultimate purpose of providing data to be used as a basis for comparison with other wind-tunnel data, mainly in the study of scale and turbulence effects. Three symmetrical 6- by 36-foot rectangular aerofoils were used. The Reynolds number range for minimum drag was from 1,800,000 to 7,000,000 and for maximum lift, from 1,700,000 to 4,500,000. The effect of rounded tips was determined for each of the aerofoils. Tests were also made of the N.A.C.A. 0012 aerofoil equipped with a 0.20*c* full-span split flap hinged at 0.80*c*. Tuft surveys were included to show the progressive breakdown of flow near maximum lift.

Momentum surveys were made in conjunction with force measurements at zero lift as an aid in converting force-test data to section coefficients.

Turbulence in the Boundary Layer. (H. L. Dryden, J. Aeron. Sci., Vol. 6, No. 3, January, 1939, pp. 85-105.) (66/10 U.S.A.)

It is well known that certain wind tunnel measurements are affected by the degree of turbulence of the wind stream. Thus the drag of a sphere may vary by a factor of 4, that of an airship by a factor of 2 and the maximum lift of an aerofoil by a factor of 1.3, depending on the turbulence of the air stream.

After discussing how both the intensity and the scale of the turbulence can be measured by means of special hot wire anemometers, the author considers the effect of turbulence of the air stream on an originally laminar boundary layer.

It is known that such a layer will become turbulent at a certain distance from the stagnation point of the flow, the position of this point of transition depending amongst other factors on the intensity and scale of the turbulence of the incident flow. Other possible factors include the Reynolds number, the pressure gradient, and curvature and roughness of the surface. The position of the separation point where the laminar boundary layer leaves the surface may also have an effect.

These various factors are being examined with a view to predicting the transition point on a given surface theoretically. Much more work will, however, be required before a satisfactory answer can be given in all cases.

The Correlation of Boundary Layer Transition Data. (J. Bricknell, J. Aeron. Sci., Vol. 6, No. 5, March, 1939, pp. 203-205.) (66/11 U.S.A.)

It is now generally admitted that the conditions leading to transition cannot be stated in terms of parameters based on local mean values.

The author attempts to provide a more satisfactory correlation based on the previous history of the laminer boundary layer and for this purpose introduces the concept of the equivalent flat plate, first suggested by von Doenhoff.

Applied to flight transition data on three aerofoil sections, the correlation is fairly satisfactory.

Since the mechanism of transition in turbulence-free air (*i.e.*, flight) is probably different from that existing in turbulent streams, the method in its present form must be considered as only of limited application.

Metal Aircraft Construction. (C. W. Vogelsang, Published by R. C. Schmidt, Berlin, 1938.) (66/12 Germany.)

After a brief survey of available materials, the author considers the following aspect of the problem in greater detail:—

(1) Deep Drawing and Pressed Profiles.
(2) Riveting and Riveting Machines.
(3) Welding of Light Alloys.
(4) Fuselage Construction.
(5) Undercart and Floats.
(6) Wing Construction.
(7) Corrosion Protection.

There are also some notes on inspection and series production. Most of the examples illustrated refer to German Practice (Junkers, Dornier, Focke-Wulf).

The book is mainly intended for engineering students as an introduction to more advanced study, and the author has succeeded in condensing a fair amount of practical information into the relatively small space of 160 pages. The absence of an index is a drawback.

The Aerodynamic Characteristics of Full-Scale Propellers having 2, 3 and 4 Blades of Clark Y and R.A.F. 6 Aerofoil Sections. (E. P. Hartmann and D. Biermann, N.A.C.A. Tech. Report No. 640, 1938.) (66/13 U.S.A.)

Aerodynamic tests were made of seven full-scale 10-foot-diameter propellers of recent design comprising three groups. The first group was composed of three propellers having Clark Y aerofoil sections and the second group was composed of three propellers having R.A.F. six aerofoil sections, the propellers of each group having two, three, and four blades. The third group was composed of two propellers, the two-blade propeller taken from the second group and another propeller having the same aerofoil section and number of blades but with the width and thickness 50 per cent. greater. The tests of these propellers reveal the effect of changes in solidity resulting either from increasing the number of blades or from increasing the blade width.

It was found that (1) increasing the solidity by adding blades had a lesser adverse effect than increasing it by increasing the blade width; (2) the loss in efficiency commonly conceived to be the result of increasing the number of blades was not fully realised, only about 2 per cent. difference in peak efficiency between a two-blade and a four-blade propeller being measured; and (3) an increase in solidity tended to delay the stall and to increase the efficiency in the take-off range.

Propeller design charts and methods of computing propeller thrust are included.

Tandem Air Propellers. (E. P. Lesley, N.A.C.A. Tech. Note No. 689, February, 1939.) (66/14 U.S.A.)

Tests of two-blade, adjustable-pitch, counter-rotating tandem model propellers, adjusted to absorb equal power at maximum efficiency, were made at Stanford University.

The characteristics, for 15°, 25°, 35°, and 45° pitch settings at 0.75 R of the forward propeller and for $8\frac{1}{2}$ per cent., 15 per cent., and 30 per cent. diameter spacings, were compared with those of two-blade and four-blade propellers of the same blade form.

The tests showed that the efficiency of the tandem propellers was from 0.5 per cent. to 4 per cent. greater than that of a four-blade propeller and, at the high blade-angle settings, not appreciably inferior to that of a two-blade propeller.

It was found that the rear tandem propeller should be set at a blade angle slightly less than that of the forward propeller to realise the condition of equal power at maximum efficiency. Under this condition the total power absorbed by the tandem propellers was from 3 per cent. to 9 per cent. more than that absorbed by the four-blade propeller and about twice that absorbed by a two-blade propeller.

The Determination of the Product of Inertia of Aircraft Control Surfaces. (A.C.I.C., No. 711, 15/9/38.) (66/15 U.S.A.)

The product of inertia is defined and its physical significance discussed.

Three methods for determining the product of inertia experimentally are discussed. These are as follows: first, by calculations based on the experimental determinations of the moments of inertia about three axes lying in the same plane, two of which are mutually perpendicular; second, by measuring the torque produced by a definite angular acceleration; and third, by the use of auxiliary balance weights to reduce the product of inertia to zero. In connection with the first method, an original scheme for locating the third axis so as to reduce the effect of unavoidable experimental errors is developed theoretically, which, when applied to an actual case, reduced the maximum possible error in the final result from 105 per cent. to less than 7 per cent.

Tests on Experimental Flotation Compartment Test Specimens. (A.C.I.C., No. 712, 15/9/38.) (66/16 U.S.A.)

Flotation compartments can be made watertight and airtight if the type of structure is adaptable to being sealed with tape impregnated with sealing compound. The technique of assembly and experience of mechanics in fabricating this type of structure contributes materially in making tight joints.

A reasonable test pressure is one-half pound per square inch.

A sealing compound should be one with which cotton tape can be impregnated and which will not become hard and flake off due to age.

The rivet spacing should be close enough to prevent flexing or working of the sheets in the seam.

A packing gland type of fitting is satisfactory for use on vent tubes and conduits which pass through the flotation compartments.

Operating Safety and Requirements of the Modern Transport. (W. B. Oswald, J. Aeron. Sci., Vol. 6, No. 4, Feb., 1939, pp. 127-36.) (66/17 U.S.A.)

Four principal emergencies occurring during operation of transport aeroplanes are investigated: (1) power plant failure during take-off; (2) power plant failure during normal flight; (3) misjudged landing with climb-out from the field, and (4) adverse operating conditions at low efficiency, such as with an irregular load of ice. Landing speed and control at low speed are also studied.

Four engines are desirable for safe all-year operation of long and medium-range aeroplanes because of the large reserve of power after propulsive unit failure. The two-engine aeroplane seems suitable for short-range operation where, with small fuel load, a good payload can be maintained without exceeding safe loading.

The tricycle landing gear has exceptional stability on the ground, hence contributes both to fool-proof take-off and landing, particularly under adverse conditions. Greater load can be landed in shorter distance with the tricycle gear, hence it adds safety and efficiency to an aeroplane.

Calculation of the Induced Efficiency of Heavily Loaded Propellers having Infinite Number of Blades. (F. Lösch, L.F.F., Vol. 15, No. 7, 6/7/38, pp. 321-5. Available as Translation T.M. 884.) (66/18 Germany.)

Based on a suggestion made by L. Prandtl, the present report contains an approximate method of computing the induced efficiency of heavily loaded propellers in suitable form for extension to finite number of blades, and a comparison of the results obtained by this simple method with the data of the Betz-Helmbold theory for heavily loaded propellers. It is found that—quite apart from the accord in the limiting case of light loading—good agreement obtains for relatively low as for relatively high coefficients of advance. A direct calculation of the (c_s, η_i) curves by the two methods affords excellent agreement up to $\eta_i = 0.5$, even for coefficients of advance in the neighbourhood of 0.5, 1, 2.

The Induced Efficiency of Optimum Propellers having a Finite Number of Blades. (K. N. Kramer, L.F.F., Vol. 15, No. 7, 6/7/38, pp. 326-333. Available as translation T.M. No. 884.) (66/19 Germany.)

The highest possible induced efficiency η_i for free-running propellers can be computed on the assumption of optimum circulation distribution and vanishing profile drag. This induced efficiency is thus a measure of the quality of constructed propellers and plays a similar role to the induced drag of a wing with elliptic lift distribution when considering the energy balance of an aeroplane.

The author determines the functional relationships between propeller load coefficient λ_s and λ_1 and η_i (partly by exact calculation and in part by interpolation) for 2, 3, 4, 6, and 8-bladed propellers for any value of the coefficient of advance λ.

The results are incorporated in a series of graphs from which η_i can be read off in λ, x_s and the number of blades ζ are given.

The following is an example:—

$x_s = .09$; $\lambda = .45$.

ζ	η_i
2	·93
3	·945
6	·955
8	.960
∞	·965

The axial efficiency η_a under the given conditions $= .978$.

The difference between η_a and η_i is a measure of the losses due to rotation of slipstream and finite blade number.

American Verdict on Large Four-Engined Civil Aircraft. (G. E. Marque, Inter. Avia., No. 630, 28/3/39, p. 1-3.) (66/20 U.S.A.)

The principal characteristics of the aircraft types reviewed are given in the following table:—

Type.	D.C.-3.	C.W.-20.	B. 307-S.	D.C. 4.
Weight (empty)	16,300	24,000	31,000	46,000 lb.
Cost (complete)	117,500	225,000	337,000	450,000 $.
Useful load	8,100	12,000	14,000	19,000 lb.
Total cost per lb. of useful load	14.50	18.75	24.07	23.67 $.
Engine	2 Wright	2 Wright	4 Wright	4 P. & W.
Take-off power per engine ...	1,100	1,600	1,100	1,400 h.p.
Cruising speed	182	205	215	210 m.p.h.
Maximum range (65 per cent. power, no wind)	1,650	1,700	1,520	1,870 m.
Payload at maximum range	2,325	5,000	5,070	5,110 lb.
Load factor to cover direct flying costs for round trip Chicago-New York (1,450 miles)	37%	32%	41%	37%

From the above the author concludes that a twin-engined aircraft of the type Curtiss Wright C.W.20 is the most economical solution.

Junkers Fully Automatic V.P. Airscrew. (Inter. Avia., No. 631, 31/3/39, p. 6.) (66/21 Germany.)

A hydraulic motor is fixed to the front of the hub; according to the direction of the oil flow, it acts through a gear either in one or the other direction on the driving worm, which engages with the worm wheel on the blade root and rotates the blade. The direction of the oil flow is controlled by a piston which is moved from one side by a centrifugal governor and from the other side by a spring. By adjusting the tension of the spring, the engine speed can be set within a wide range. The airscrew provides also for full feathering position which is effected by cutting out the governor and allowing the hydraulic motor to run in the direction of coarse pitch until the blades reach the limit stop.

The Centenary of the Birth of Count Zeppelin. (E. Breithaupt, Luftwissen, Vol. 5, No. 7, July, 1938, pp. 235-238.) (66/22 Germany.)

The following table gives the structural weights in gm. per cubic metre of gas for a number of zeppelin airships:—

	Type, Date, Capacity.			
Structural Elements.	LZ. 62 (1916). (56,000 M^3).	L.59 (1917). (68,000 M^3).	LZ. 127 (1930). (112,000 M^3).	LZ. 129 (1935). (200,000 M^3).
Frame including cover and ballonets (installed)	423.1	293.9	363.1	392.3
Engine	142.9	79.3	101.1	79.8
Tanks	21.7	18.0	30.8	16.0
Equipment including accommodation for crew	43.2	16.7	45.3	46.3
Special fittings for passengers or load carrying	6.4	—	25.0	56.5

It will be noted that in spite of a fourfold increase in size (gas capacity) since 1916, the unit weight of the frame and gas fittings has decreased slightly. The main improvement has been in the weight and specific consumption of the power plant.

Reference is made to the new silk fabric for the ballonets (the use of this material increased the lift of LZ.130 by 4 tons) and water recovery. In the case of normal Diesel fuels, the exhaust contains sulphuric acid (corrosion!). This difficulty was overcome by utilising Kogasin fuel, a by-product Fischer-Tropsch synthetic fuel process.

The Landing Impact of Aircraft Floats. (C. Schmieden, Ing. Arch., Vol. 10, No. 1, Feb., 1939, pp. 1-13.) (66/23 Germany.)

Previous investigation on landing impact of floats assumed two dimensional flow, *i.e.*, the float is infinitely long. The author investigates the effect of having a finite float length and in order to reduce the mathematical difficulties a float shape is assumed such that the pressure surface is in the form of an ellipse, which remains of constant shape (but increasing size) during the impact process.

The results are given in the form of non-dimensional co-efficients, the two-dimensional impact case being also given for comparison.

It appears that the maximum value of the impact force occurs appreciably earlier in the case of the finite float.

The Controlled Curvilinear Horizontal Flight of an Aircraft. (E. Mettler, Ing. Arch., Vol. 9, No. 5, Oct., 1938, pp. 327-343.) (66/24 Germany.)

The author assumes a path for the C.G. of the aircraft and calculates the necessary control motions from the six fundamental equations of motion. The investigation is limited to normal attitudes of flight (in stalled and moderately fast rates of turn), the flight path being horizontal throughout.

Two flight paths are studied in detail. The first corresponds to a relatively sharp turn through 40°, both initial and final path being straight. During this manœuvre the change in speed is negligible. The second path corresponds to the change from straight line motion to steady circular flight, during which there occurs an appreciable drop in speed. The results of the investigation are given in the form of graphs which give the motions of the aileron, elevator and rudder respectively plotted on a basis of length of flight path.

As would be expected, the ailerons and rudder are reversed in the flight path position corresponding to the centre of the turn (case I), whilst the elevator reaches its maximum deflection at approximately the same position. All controls are at zero at the beginning and end of the turn. In case II (continuous turn), aileron and rudder, after an initial deflection, both soon return to approximately zero the curve being flown at a constant elevator deflection. These results naturally depend on the type of flight path and aircraft assumed.

The Effect of Propeller Slipstream on the Aerodynamic Characteristics of a Wing. (J. Kampe de Ferret and A. Fauguet, G.R.A. Tech. Note No. 2, Les Ailes, No. 929, 6/4/39, p. 7.) (66/25 France.)

The report deals with wind tunnel tests on a model of 1.25 m. span and .25 m. chord. The two-bladed propeller had a diameter of 200 mm. and was driven by a high-speed electric motor mounted inside the fuselage. The experiments were carried out in the large wind tunnel at Lille at a constant air speed of 25 m./sec. and showed that the no-lift incidence was unaffected by the operation of the propeller. The maximum lift coefficient, however, increased from 1.2 to 1.32

The propeller retards the break away of the flow over the central wing section and also has a profound influence on the downwash.

Due to the spiral motion of the air this angle of downwash differs on the two sides of the vertical tail plane and thus calls for a corresponding difference in trim of the horizontal control surfaces.

It is interesting to note that the drag of the stationary propeller is least with the axis of the propeller parallel to the leading edge of the wing.

The Charging Process in a High Speed Single Cylinder Four-Stroke Engine. (B. Reynolds, H. Schecter and E. S. Taylor, N.A.C.A. Tech. Note No. 675, Feb., 1939.) (66/26 U.S.A.)

The experiments were carried out on a Wasp, jr. aircraft engine cylinder, $5\frac{3}{16}$in. bore and $5\frac{1}{2}$in. stroke, compression ratio 6.5, the speed of operation ranging from 1,500 to 2,600 r.p.m. No inlet or exhaust pipes were fitted, the fuel being injected directly into the inlet port by means of a Bosch high-speed injector pump. The air consumption was estimated from the indicated m.e.p. (brake and motoring), a relationship having been obtained previously for this engine when fitted with an inlet pipe and Roots displacement meter. Indicator diagrams were taken with the M.I.T. balance pressure indicator, which had been modified to increase its accuracy.

The following conclusions were drawn:—

1. Pressure drop in the valve is responsible for an extremely small part of the volumetric deficiency on the cylinder tested, even at 2,380ft. per minute mean piston speed.
2. The rise in temperature of the charge coming through the inlet valve and in the cylinder before inlet closing is responsible for a relatively large volumetric deficiency.
3. It is possible to calculate the pressure drop in the valve with good accuracy.
4. The friction of the air in the valve port is responsible for most of the pressure drop.

It is recommended that further study on this problem be directed particularly toward a study of the heat transfer process.

Comparative Performance of Engines Using a Carburettor, Manifold Injection and Cylinder Injection. (O. W. Schey and J. D. Clark, N.A.C.A. Tech. Note No. 688, Feb., 1939.) (66/27 U.S.A.)

The comparative performance was determined of engines using three methods of mixing the fuel and the air: the use of a carburettor, manifold injection, and cylinder injection. The tests were made of a single-cylinder engine with a Wright 1820-G air-cooled cylinder.

Each method of mixing the fuel and the air was investigated over a range of fuel-air ratios from 0.10 to the limit of stable operation and at engine speeds of 1,500 and 1,900 r.p.m. The comparative performance with a fuel-air ratio of 0.08 was investigated for speeds from 1,300 to 1,900 r.p.m.

The results show that the power obtained with each method closely followed the volumetric efficiency; the power was, therefore, the highest with cylinder injection because this method had less manifold restriction. The difference amounted to 7 per cent. at 1,900 r.p.m. The values of minimum specific fuel consumption obtained with each method of mixing of fuel and air were the same. For the same engine and cooling conditions, the cylinder temperatures are the same regardless of the method used for mixing the fuel and the air.

Additional advantages of cylinder injection are:—

1. Possibility of using safety fuel.
2. Possibility of scavenging.
3. Perfect distribution on in-line engines.

Non-Magnetic Oil Engines. (Engineer, Vol. 167, No. 4343, 7/4/39, p. 434.) (66/28 Great Britain.)

The propelling engines on the Admiralty magnetic survey vessel " Research " weigh 370 cwt. and do not contain more than 250lb. of magnetic material. The crankshaft and layshafts are made of manganese-nickel-chrome steel, which is practically non-magnetic. The forgings for these shafts cost about 20 times as much as standard high tensile steel!

The bed plate is a bronze alloy and the flywheel of solid bronze.

The cylinder head and crankcase are of aluminium bronze, centrifugally cast Ni-resist iron (non-magnetic is used for the cylinder liners, the aluminium cylinder being cast around them).

The engine is of the single acting two-stroke type and develops 160 b.h.p. at 375 r.p.m.

Aircraft Engine Power Estimation from Intake Manifold Density. (T. W. Rhines and P. W. Schipper, J. Aeron. Sci., Vol. 6, No. 3, January, 1939, pp. 106-13.) (66/29 U.S.A.)

A method of estimating engine power output in flight by means of calibrations based on the density of the fuel-air mixture in the intake pipe is described. Comparison of this method with the conventional manifold-pressure calibration is made, and test data taken with a torque indicator in flight are used to indicate the relative accuracies of the two methods. The comparison shows that there is little to choose between the two methods at the present stage of development of the newer one. However, improvement of the density method through advances in test technique is probable, because its basis is fundamentally sound. The manifold-pressure method is not on such a firm basis, so further advances with it are unlikely.

A Wear and Lubricant Testing Machine, Developed by the Timken Roller Bearing Company. (Metal Industry, 24/3/39, pp. 347-8. Metropolitan Vickers Technical News Bulletin, No. 654, 31/3/39, p. 6.) (66/30 Great Britain.)

Details are given of the construction, operation and testing procedure of a machine developed for testing lubricants and bearing metals. It consists of a lever system mounted on universal knife edges, by which a load can be accurately transmitted to a metal test piece revolving in a ground metal cup. The test piece is drawn through a reduction gear by an electric motor and rotates at any chosen speed. Lubricant is maintained at a given temperature and flows at a calibrated rate over the test pieces. For lubricant testing, the condition of the surfaces after the test is noted. For material testing, the lost metal is measured by weight. Modifications allow the testing of the lubricating qualities of greases to be undertaken. Illustrated with one photograph.

Compressed or Liquefied Gas Fuel for Small River Craft. (Soudostroienie, No. 4, 1938. Eng. Absts., Vol. 2, No. 1, Section 3, Feb., 1939, pp. 9-10.) (66/31 U.S.S.R.)

The condensable gases (propane, butane and their compounds) are obtained by reworking naphtha and coal and are also found in the form of naphtha gas in various oil fields. They are usually stored at a relatively low pressure (15-20 atmospheres).

The compressible gases (natural, illuminating, and producer gas) require much higher pressures (of the order of 200 atmospheres).

The great advantage of gas fuel is that it requires no modification to a carburettor engine so that liquid fuels can be used when available.

The National Research Department of the U.S.S.R. claim the following benefits for gas fuels:—

(1) The engine is started more easily, especially at low temperature.
(2) Greater flexibility.
(3) Cleaner engine and no oil dilution.

In addition to supply stations on shore, a number of floating stations have been provided from which the boats may refuel.

The Ignition Lag in the Diesel Engine. (K. Neumann, Forschung, Vol. 10, No. 1, Jan.-Feb., 1939, pp. 2-14.) (66/32 Germany.)

The mixture formation in the combustion chamber of a Diesel engine depends on the atomisation and vapourisation of the injected fuel.

The author investigates mathematically the variation in size and number of drops during the period of the ignition lag, both in the absence and in the presence of vapourisation. A quantitative estimate of the proportion of fuel mist and fuel vapour is carried out and it is concluded that the lag period is mainly governed by the time necessary to vapourise a certain proportion of the fuel.

Ignition Lag and Propagation of Combustion in the Direct Injection Diesel Engine. (L. Herele, Forschung, Vol. 10, No. 1, Jan.-Feb., 1939, pp. 15-27.) (66/33 Germany.)

The experiments were carried out on a three-cylinder two-stroke Krupp Diesel, developing 75 h.p. at 500 r.p.m. The engine was operated under full load conditions, both the ignition lag and the propagation of combustion being measured by the ionisation method, using 36 special point electrodes placed inside the combustion space of one cylinder. It appears that ignition starts almost simultaneously at various isolated regions in the confines of the fuel jet, which do not occupy a fixed position for successive explosions. The combustion is not propagated along the jet but spreads out laterally, conforming to local turbulence variations.

The irregularities in the spread of the combustion revealed by the ionisation method are confirmed by observations of the radiation emitted through a window in the combustion chamber.

On the other hand the indicator diagrams show that the beginning of the rapid pressure rise associated with the combustion occurs at the same part of the stroke with great regularity.

Measurement of the Thickness of Metal Plates from One Side. (A. G. Warren, J. Inst. Elec. Eng., Vol. 84, No. 505, January, 1939, pp. 91-5.) (66/34 Great Britain.)

The method described here is a conductivity method which does not depend upon any previous knowledge of the specific conductivity of the material. Although the actual measurements made depend upon the conductivity, this quantity is automatically eliminated during computation and the essential relationships used are purely geometrical and do not depend upon the physical properties of the material (imagined homogeneous.)

When corrosion is general the problem is simply that of determining the thickness of the plate at a number of places after it has been in use for some time. The apparatus employed may also be used in a search for local corrosion pits, which are not uncommon in some structures.

The theory of the method when applied to an extensive plate is given. Only a brief indication of the theory underlying the application to plates of limited area is here published, but curves are given enabling the method to be applied in practice.

Static Pressure Recorder. (J. Kampé de Feriét and G. Rollin, G.R.A. Note Technique, No. 1, January, 1939.) (66/35 France.)

Two sets of pressure orifices are placed on a hollow sphere, 60 mm. diameter, in such a way that the indication of either set alone is independent of the direction of the relative wind over a large range of incidence.

The orifices are connected together through calibrated passages inside the sphere, the true static pressure being tapped off at an intermediate point.

In the particular instrument, one orifice is placed at the end of a tube fixed centrally and longitudinally in the throat of Venturi, piercing the sphere along a diameter. The second set of orifices is placed over the rear surface of the sphere and is connected to a common pressure chamber which communicates with the total pressure pipe.

From the calibration curves it appears that the static pressure as read from a suitable intermediate point is practically independent of wind direction over the range $\pm 25°$.

Abstractors Note:—The principle of this instrument appears to be very similar to the method advocated by Kiel (L.F.F. Vol. 15, No. 12, 10/12/38, pp. 583-597, Air Ministry Abstract 63/12).

Relation of Camera Error to Photogrammetric Mapping. (I. C. Gardner, Bur. Stan. J. Res., Vol. 22, No. 2, February, 1939, pp. 209-38.) (66/36 U.S.A.)

A portion of the errors in a map constructed from aeroplane photographs arises from differences between the actual performance of the aeroplane camera and the postulated performance as defined by the calibration constants. The different sources of errors of this nature are enumerated and equations are derived showing the relation between errors in the calibration constants of the camera and the resulting errors in the map.

Equations are given for errors in the map arising from incorrect value of the calibrated focal length, distortion, and incorrect location of the principal point. Other sources of error in the camera, such as failure of the film to lie in a plane, the character of performance of the shutter, and imperfect filters are considered and their effects upon the image evaluated.

Constant Speed Control Theory. (H. K. Weiss, J. Aeron. Sci., Vol. 6, No. 4, Feb., 1939, pp. 147-52.) (66/37 U.S.A.)

The general theory of the constant speed control is reviewed for an " error " and " rate-of-change of error " control applied to a system possessing inertia but no damping or inherent speed stability. It is shown that the most satisfactory control is one which has a high natural frequency, small inertia, and little or no Coulomb friction. Viscous damping is shown to have a less detrimental effect on the response of the control than control inertia, and the general conclusion is drawn that stability of the motion is secured by viscous damping in the control, while good performance is obtained by keeping the inertia of the control small.

Torque Meter for Aircraft Models Fitted with Propellers. (R. Silber and Ad. Oudart, Pub. Sci. et Tech. B.S.T., No. 84, 1939.) (66/38 France.)

The casing of the electric motor driving the propeller is mounted on ball bearings and the torque reaction is measured by the twist of a spiral spring. The fuselage of the model is fitted with a small illuminated window, the twist being read by means of a telescope placed outside the air current.

The model has a span of the order of 1 m., the electric motor having a diameter of 5 cm. and a length of 17 cm. The power output is of the order of 150 watts, the speed range being 5,000-15,000 r.p.m.

The torque meter measures torques between .01 + .04 kgm. with an accuracy of the order of .5 per cent. at .02 kgm.

On the Effect of the Density of the Air upon the Pitot Static Tube Coefficient. (T. Sasaki and K. Hattori, Aeron. Research Inst., Tokyo, Report No. 173, February, 1939.) (66/39 Japan.)

The calibration was carried out in the low temperature and low pressure wind tunnel at speeds ranging from 27 m./sec. to 71 m./sec. at various air densities from 1.285 kg./m.^{3} to .392 kg./m.^{3}.

The reference standard was a windmill previously calibrated on a rail track vehicle (operating in a long closed tunnel) and on a whirling arm placed inside the low density tunnel. It appears that the constant $K = \alpha p/\rho v^2$ of the pitot decreases roughly 4 per cent. as the air density is decreased over the range stated above.

Flight Altitude Control. (C. H. Colvin, J. Aeron. Sci., Vol. 6, No. 5, March, 1939, pp. 206-210.) (66/40 U.S.A.)

Maintenance of clearance between individual aeroplanes and the ground respectively can be ensured by the following rules:—

(1) While on a given route section, all pilots must keep the barometric scales of their altimeters set to the same Kollsman number (altimeter sea level pressure) as transmitted by the station controlling that route section.
(2) Except in emergencies, pilots must fly at the odd or even thousand foot altitudes presented by the C.A.R., as indicated by their altimeters. A permissible minimum altitude is prescribed for each flight level. At lower temperatures the pilot must go to the next higher level.
(3) In emergencies the pilot must not fly at a lower indicated altitude than is provided by "dead line" altitude/temperature chart for the route section utilised.

The advantages of this system of altitude control are:—

(1) The same instruments and methods are used for maintaining vertical separation of aeroplanes as for maintaining ground clearance.
(2) No instrument equipment is required in addition to that now regularly carried.
(3) The barometric scale of the altimeter is always set to the correct values for landing at the control airport.

The General Theory of Relaxation Applied to Linear Systems. (G. Temple, Proc. Roy. Soc., Series A, Vol. 169, No. 939, 7/3/39, pp. 476-500.) (66/41 Great Britain.)

The author gives a general account of the application of relaxation methods to the solution of linear equations. Southwell's original method for linear algebraic equations in a finite number of unknown variables has been the inspiration of the whole investigation. By replacing his method of successive relaxation by a method of steepest descents it has been possible to attack linear operational equations, linear integral equations, and linear differential equations. In each case the new methods give successive approximations which converge to the accurate solution of the problem. Two outstanding problems must be left for future investigation—the numerical solution of particular problems of physics and engineering, and the extension of the methods to non-linear equations.

Light Ray Control for Machine Tools. (Machinery, 9/3/39, pp. 713-7. Metropolitan Vickers Technical News Bulletin No. 652, 17/3/39, p. 3.) (66/42 Great Britain.)

The employment is described of a photo-electric circuit to control the sequence of operations in the drilling and reaming of oil reservoir holes in main bearing journals of A.E.C. engine crankshafts. The machine, which is in effect two two-spindle vertical machines mounted side by side on a common base, was designed specifically for this operation, and both it and the control gear are fully described. Illustrated with four photographs and four diagrams.

Some Recent Developments in Resistance Welding Equipment in America. (G. R. Ward, Welding Industry, March, 1939, pp. 82-90. Metropolitan Vickers Tech. News Bulletin, No. 652, 17/3/39, p. 5.) (66/43 U.S.A.)

Developments considered in this article comprise equipments which produce faster and more efficient welding than the plant they supersede. The first of these developments is an improved type of multiple spot welder, in which the entire group of electrodes is brought into the pressure position simultaneously. A small machine for making a single row of 20 spots (having the advantages of simplicity, high welding tip life, and small transformer capacity) and a combination machine for welding wide strips of stock together before pickling are described. Rapid flash welding of aluminium wheel rims, a composite machine for motor car body construction, an installation for the spot welding of heavy plate, and an improved continuous tube welder are also fully detailed. The performance figures of each machine are included. Illustrated with 10 photographs.

The Manufacture of Composite Metals by Carbon Arc Welding. (R. E. Kinkead, Mech. World, 10/3/39, pp. 246-7. Metropolitan Vickers Tech. News Bulletin, No. 652, 17/3/39, p. 5.) (66/44 U.S.A.)

The usefulness of composite metals is a function of the quality of the bond between the component parts. The new process described is designed to work on ingots, slabs, or billets which are then processed by normal steelworks methods. In the experimental equipment employed, a Lincoln Tornado carbon arc head is mounted on the tool carriage of a planer. A furnace mounted on the bed is provided for preheating the slab. The head is rocked transversely to the direction of the planer travel to give uniform heat distribution and depth of alloy penetration. Excellent bond results are claimed for the method. Illustrated with three photographs.

Elastic Properties of Cast Iron. (A. I. Krynitsky and C. M. Saeger, Jr., Bur. Stan. J. Res., Vol. 22, No. 2, February, 1939, pp. 191-207.) (66/45 U.S.A.)

An optical method for measuring the deflection of cast-iron transverse-test bars during loading and up to the breaking strength has been developed. Transverse strength properties were determined on test bars made from three types of cast iron heated to the maximum temperatures of 1,400°, 1,500°, 1,600°, and 1,700°C. Test bars were vertically cast bottom-poured in green-sand moulds at 100°, 150°, 200°, and 250°C. above the liquidous temperature. Total, plastic, and elastic deflection; modulus of rupture; modulus of relative elasticity; and total, plastic, and elastic resilience were determined and the microstructure of the test bars was examined.

The results of the transverse tests indicate that the initial portion of the elastic deflection curve is a straight line, but at approximately half of the breaking load the curve inclines towards the deflection axis. For all bars of iron A the points of inflection occurred at loads between 1,400 and 1,800 pounds, for irons B and C the limiting value lay between 1,200 and 1,400 pounds. Because of the curvature of the elastic deflection curves, a value for the relative modulus of elasticity, computed from the data for any point on the initial linear portion of the curve, is approximately 1,000,000 pounds greater than a similar value computed from the load and deflection at the point of rupture.

The Intercrystalline Corrosion of Some Aluminium Alloys. (J. D. Grogan and R. J. Pleasance, Engineer, Vol. 167, No. 4341, 24/3/39, p. 385.) (66/46 Great Britain.)

The intercrystalline failure under static stress of the aluminium alloy containing 3 per cent. copper and 20 per cent. zinc and of kindred alloys in the form of wrought heat-treated strip and the influence of heat treatment on the sensitivity of the alloys to such failure are examined. It is shown that the sensitivity increases with the quantity of zinc in solid solution. Attention is drawn to the similarity of failure in air to that in salt solution. The influence of heat treatment on this type of failure in thin strip "Y" alloy and 4 per cent. copper-aluminium alloy is examined. It is found that material rapidly cooled from the solution treatment temperature by quenching in cold water is free from inter-crystalline attack when submitted to sea-water spray, and that in this case corrosion is not influenced by the imposition of static tensional stress on the material during exposure. Material more slowly cooled, *e.g.*, in air, is susceptible to inter-crystalline corrosion, which is markedly stimulated by the imposition of static stress.

Local Instability of Symmetrical Rectangular Tubes Under Axial Compression. (E. E. Lundquist, N.A.C.A. Tech. Note No. 686, Feb., 1939.) (66/47 U.S.A.)

A chart is presented for the coefficient in the formula for the critical compressive stress at which cross-sectional distortion begins in a thin-wall tube of rectangular section symmetrical about its two principal axes. The energy method of Timoshenko was used in the theoretical calculations required for the construction of the chart. The deflection equation used in this method was selected to give good accuracy. The exact values given by solution of the differential equation were calculated for a number of cases and it was found that the energy solution was correct to within a fraction of 1 per cent.

The calculation of the critical compressive stress at stresses above the elastic range is also discussed. In order to demonstrate the use of the formulas and the chart in engineering calculations, several illustrative problems are included.

Loads Imposed on Intermediate Frames of Stiffened Shells. (P. Kuhn, N.A.C.A. Tech. Note No. 687, Feb., 1939.) (66/48 U.S.A.)

The loads imposed on intermediate frames by the curvature of the longitudinals and by the diagonal tension effects are treated. A new empirical method is proposed for analysing diagonal tension effects. The basic formulas of the pure diagonal tension theory are used, and the part of the total shear S carried by diagonal tension is assumed to be given by the expression:—

$$S_{DT}=S\ (1-\tau_0/\tau)^n$$

where τ_0 is the critical shear stress, τ the total (nominal) shear stress, and $n=3-\sigma/\tau$ where σ is the stress in the intermediate frame. Numerical examples illustrate all cases treated.

Metallic Materials for Thermocouples. (A. Schulze, Wärme, 25/2/39, pp. 127-9. Metropolitan Vickers Tech. News Bulletin, No. 653, 24/3/39, p. 3.) (66/49 Germany.)

The author discusses metallic materials suitable for thermocouples. He deals first with the rare metals (platinum, rhodium, rhenium, iridium, etc.), and then with other metals and alloys (constantan, copper, silver, nickel, etc.). He indicates in particular the progress achieved in the field of the rare metal materials and, in the case of the second class of metals, shows the optimum attainable in regard to magnitude and sensitivity of the thermocouple electromotive force. Illustrated with three diagrams.

The Deep-Drawing of Light Alloys for Aircraft Construction. (E. J. Ritter, Luftwissen, Vol. 5, No. 7, July, 1938, pp. 249-255.) (66/50 Germany.)

After discussing the mechanical processes accompanying deep-drawing, the author examines the available light alloys as regards their suitability to this treatment. For this purpose a figure of merit has been developed which can be expressed in the form $m = d/D$

where D = diameter of original plate,
d = diameter of cup after drawing.

Representative values are $m = .6$ and $.8$ for the first and second drawing respectively.

It appears that modern light alloy plates (with the exception of pure aluminium) are seldom consistent and each plate should, therefore, be examined for its deep drawing qualities before the work is started.

After describing special test machines for this purpose, the author briefly discusses the various types of presses in use. In the case of relatively small production, very simple wood dies can often be employed.

Interesting photographs of examples of work turned out by the Junkers firm are given and a bibliography on the subject concludes the article.

Surface Hardness and Type of Wear (Lead Preferable to Stellite in Certain Cases). (Engineer, Vol. 167, No. 4343, 7/4/39, p. 433.) (66/51 Great Britain.)

When making feather dusters the feathers are drawn through a metal ring to regiment the quills. The tiny protective scales on the feathers wear out the ring in time, and this wear could not be prevented by using very hard rings made of stellite or carboloy. It is clear that hardness as measured by penetration of a steel ball bears no relation to the hardness as measured by the depth of groove of a diamond cutter. Prediction of wear under unusual conditions is thus impossible. In the present case the difficulty was overcome by utilising a lead ring. This material stands up indefinitely under these particular conditions, the metal apparently flowing backwards and forwards under the action of the feather scales. In the case of the harder material, however, minute particles of the metal break off.

The Influence of Internal Stresses on the Resistance of Metal to Cutting and Wear. (N. N. Sawin, Machinery, 23/3/39, pp. 802-5. Metropolitan Vickers Technical News Bulletin, No. 654, 31/3/39, p. 5.) (66/52 Great Britain.)

The article gives the results of extensive tests which tend to show that the cutting of metal requires less energy if internal stresses are present as a result of previous treatment, than under precisely similar conditions with such stresses removed by annealing. The mechanical work expended in cutting, with a given feed, on standard untempered material was compared with that taken in the cutting of previously tempered steel. Abrasive wear in the material is shown to occur more rapidly if surface stresses exist. Abrasive tests on various types of steel by the Skoda-Sawin wear testing machine, in conjunction with heat treatment, are fully detailed and the results correlated by graphical means. Illustrated with six diagrams.

Monocoque Fuselage Circular Ring Analysis. (B. F. Ruffner, J. Aeron. Sci., Vol. 6, No. 3, January, 1939, pp. 114-6.) (66/53 U.S.A.)

A method of solving for stresses in a uniform circular ring loaded with concentrated loads which are held in equilibrium by the distributed reactions in the fuselage is described. Formulæ giving the shear, direct force, and bending moments in a ring loaded with a pair of symmetrically placed concentrated loads are derived. It is indicated how these formulæ may be applied to cases where several pairs of symmetrically placed concentrated loads are acting.

Materials for Aeroplane Construction. (J. B. Johnson, J. Aeron. Sci., Vol. 6, No. 5, March, 1939, pp. 185-202.) (66/54 U.S.A.)

There are no materials used in aircraft construction which are not adaptable to other fields of engineering. Speaking generally, high tensile steels are preferable for elements subjected to tensile loads only and low density alloys are comparable to steel for structural elements subjected to flexural loads where there is no restriction on dimensions or form.

The majority of failures on aircraft are, however, produced by fatigue and it appears in this connection that the basic fatigue limit is of secondary importance compared with amplitude and frequency control effected by correct combination of structural rigidity and plasticity. For this reason direct vibration tests on built-up assemblies simulating practical conditions are becoming more general.

The author reviews the various aircraft materials in use at the moment. Only two new materials have recently become available: Compressed (impregnated) wood and synthetic resins.

The former is already receiving a wide application in the construction of propeller blades. Too little is as yet known about the fatigue limits of synthetic resins (*i.e.*, plastics) to forecast their possible application for primary structural components. For minor fittings and also in the form of transparent sheet a useful field of application is, however, already assured.

Combating Corrosion in Design and Construction. (R. S. Barnaby, J. Aeron. Sci., Vol. 6, No. 5, March, 1939, pp. 211-15.) (66/55 U.S.A.)

A study of the maintenance of large aluminium alloy flying boats makes it clear that corrosion is still a major problem. This corrosion is not general, but in isolated spots and associated with unsealed crevices, undrained pockets, and dissimilar materials. If a reasonable service life is to be obtained, corrosion prevention must start on the drafting board and continue throughout the design and construction of the aeroplane. The rules are:—(1) fill the crevices; (2) drain the pockets; (3) keep dissimilar materials apart.

The True Velocity of Sound in Air. (H. O. Kneser, Ann. d. Physik, Vol. 34, No. 7, April, 1939, pp. 661-668.) (66/56 Germany.)

The author reviews the more accurate recent velocity determinations and points out that certain discrepancies can be accounted for by the roughness of the surface along which the sound is propagated. This effect becomes especially marked if the distance from the wall is of the same order as its wavelength. The most probable value for the true velocity of sound (determined from frequency and wavelength, *i.e.*, $V = n\lambda$) appears to be $331.60 \pm .05$ m. for dry air at 0°C. and zero CO_2 content.

Over woodland the apparent speed under otherwise similar conditions may be as low as 330.67 m.

Problems of Periodic Heat Transfer with Special Reference to Reciprocating Engines. (H. Pfriem, Forschung, Vol. 10, No. 1, January-February, 1939, pp. 27-40.) (66/57 Germany.)

Heat transfer from a gas to a wall is largely a question of conduction through the boundary layer. This transfer takes time and as a result there exists a phase displacement between gas and wall temperature if the former undergoes periodic variations. The author proposes a new definition for the heat transfer coefficient which takes this time lag into account and applies this concept to the study of four fundamental cases:—

1. Steady flow of gas in a heat-insulated tube, the gas experiencing a periodic temperature variation at the inlet.
2. Periodic flow at constant temperature of gas core.
3. Effect of combustion at constant pressure on heat transfer.
4. Effect of pressure changes on heat transfer.

The heat transfer in an engine cylinder is a combination of the above four cases and thus necessarily very complex. It is, however, hoped that theoretical studies of this nature will ultimately lead to methods of heat flow control which would be extremely valuable during the take-off of heavily loaded aircraft engines.

The Measurement of Rapidly Changing Cylinder Wall Temperatures. (A. Meier, Forschung, Vol. 10, No. 1, January-February, 1939, pp. 41-54.) (66/58 Germany.)

Cylinder wall temperatures have so far been measured with thermocouples. This method suffers from the drawback that the couple can only be placed at some distance from the wall. The measured temperature field has, therefore, to be corrected for damping and phase displacement and this together with the small value of the original thermal E.M.F.'s renders the final estimate rather uncertain. Pfriem has developed a resistance thermometer consisting of a thin layer of gold deposited on the end of a plug which is inserted in the cylinder and terminates flush with the inside wall. The thickness of the layer is of the order of 2×10^{-3} mm. and its temperature lag is negligible. The sensitivity of the circuit adopted is about 100 times that of the usual thermocouple circuit (*i.e.*, $de/dt = 6 \times 10^{-3} V/°C.$ against $.05 \times 10^{-3} V/°C.$).

Oscillograph records can thus be taken without previous amplification.

Carbon deposits on the wall reduce the temperature variation very materially. Thus in the case of a small two-stroke engine operating at 2,000 r.p.m. the cyclic wall temperature jump amounted to over 10°C. with the engine freshly cleaned. After 20 hours this fluctuation was reduced to less than 5°C. with a corresponding reduction in mean wall temperature from 200°C. to 190°C.

A Sense Finding Device for Use with Spaced Aerial Direction Finders. (R. A. Fereday, J. Inst. Elec. Eng., Vol. 84, No. 505, January, 1939, pp. 96-100.) (66/59 Great Britain.)

A simple method is described for the rapid determination at a receiver of the sense of the direction of arrival of radiation from any transmitting station. A radio bearing of the station is taken in the usual manner with a four-aerial Adcock direction-finding system, and a second observation of minimum received signal is made after certain modifications to the electrical connections between the aerials have been effected by switching. The two observations are sufficient to determine without the usual ambiguity of 180° the bearing of the transmitting station at the receiver. The method is particularly suitable for use on high frequencies and with the visual type of receiver incorporating a cathode-ray tube.

A Terrain Clearance Indicator. (L. Espenschied and R. C. Newhouse, J. Aeron. Sci., Vol. 6, No. 4, Feb., 1939, pp. 137-41.) (66/60 U.S.A.)

The method used in the present instrument is extremely simple in theory. A radio transmitter is provided on the aeroplane which sends toward the earth a signal, the frequency of which changes at a definite rate with respect to time. The signal is reflected by the earth and returns as an echo after a time delay equal to twice the height, divided by the velocity of propagation. During this interval the frequency of the transmitter has changed and now differs from that of the echo by an amount equal to the product of the rate of change of frequency and the time of transit. The reflected wave is combined in the plane receiver with some of the out-going wave energy and the difference or " beat " frequency is measured by a frequency meter. Since the reading of the meter is that of the " beat " frequency, it is proportional to the time delay of the echo and, hence, to height and thus can be calibrated directly in feet.

Television Principle Applied to Blind Landing by the R.C.A. (Inter. Avia., No. 631, 31/3/39, p. 1.) (66/61 U.S.A.)

As the aircraft approaches the field an image is transmitted revealing to the pilot the name of the field, the direction of the wind, the barometer and other information. This image is picked up by the receiver and made visible on part of the television screen. In the vicinity of the landing field the aircraft runs into the reach of the short wave transmitter. The latter transmits a beam focused like the light of a searchlight. This beam is elevated and swung around until it hits the aircraft circling the field, and is picked up by the latter's receiver. The beam comprises radio impulses which are automatically varied in frequency to correspond with the angle along which a safe landing is to be made.

The receiver on the aircraft is so adjusted that it picks up those radio impulses whose frequency corresponds to the desired gliding angle of the aircraft. The reception of these impulses is also transmitted to the television screen in the form of a series of oblique lines of the same angle as the gliding beam. The lines remain constantly visible as long as the aircraft remains on the proper glide patch; should it stray from it their angles vary correspondingly and they fade at the same time, disappearing altogether in the case of greater deviations.

" Klystron " Ultra-High Frequency Generator Applied to Blind Landing Beams (Horn Projector). (Inter. Avia., No. 631, 31/3/39, pp. 2-3.) (66/62 U.S.A.)

A beam of electrons representing a constant current is sent through two metal containers acting as resonators and known as Rhumbatrons. In the first Rhumbatron is an oscillating electric field, parallel to the stream and of such strength as to change the speeds of the electrons by appreciable fraction, accelerating some and slowing down others. After passing through the first Rhumbatron the accelerated electrons begin to overtake those with decreased speeds ahead of them. This motion groups the electron into bunches separated by relatively empty spaces. In the second Rhumbatron—which contains a synchronously oscillating electric field—a considerable fraction of the power of the arriving electron bunches is converted into power of high frequency oscillations.

The first Rhumbatron of the Klystron is called the " buncher," the second the " catcher." The name Klystron comes from the Greek verb " klyzo " denoting the breaking of waves on a beach. The originally not seriously intended " Rhumbatron " was retained as the scientific name in view of its likeness to the Greek word " rhumba " for rhythm in motion.

The Klystron acts as:—an amplifier if the buncher is driven by an external source of power such as a receiving antenna; as an oscillator if the buncher is coupled to the catcher; and as a regenerative amplifier if the buncher is driven by power from both these sources.