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Army Co-operation as the Main Objective of the Air Force. (Rev. de l'Arm. de l'Air, No. 102, Jan., 1938, pp. 3-6. Available as translation No. 673.) (58/1 France.)

The principal object of war is to destroy the armed forces of the enemy. In the air, however, the enemy may try to evade a large scale engagement and the problem is therefore to force him to give battle. One way of achieving this is to attack ground targets of such importance that the enemy air force must necessarily intervene. On account of the differences in effective range of various types of aircraft, it may, however, not pay the attacker to strike at an objective too far behind the lines purely from this point of view. Tactical conditions are, however, improved if the target is nearer home and the author points out that by choosing the front line itself as the objective of the attack, the enemy is forced to intervene and a major aerial battle results. In the words of the author, " the ground battle aspirates the air force " and co-operation with the army is thus the principal objective. This co-operation must, however, be understood in its broadest sense and not limited to artillery range finding or raking trenches with machine guns from the air. It is rather an overwhelming attack on head-quarters, railways, munition depots, rest camps, etc., all situated within or near the battle zone. Since no enemy territory is passed over, there is every chance of surprising the adversary and forcing him to intervene under what are to him unfavourable conditions.

The Training of the Aircraft Observer. (R. Thoumin, Rev. de l'Arm. de l'Air, No. 102, Jan., 1938, pp. 21-40. Available as Translation No. 498B.) (58/2 France.)

The aircraft observer has generally only a limited time available for studying the ground and it is therefore necessary that he concentrates his attention on essentials. He must know where to look and what to look for. It is extremely important that he should be able to form an opinion as to the appearance of the ground landscape to a soldier situated on the ground and he also must have sufficient training to appreciate the military possibilities of the territory over which he is flying. For this reason the author recommends a preliminary course in military geography so as to enable the observer to judge possible offensive and defensive positions and the particular manner in which certain territorial features will dominate others.

Once the possible positions of the enemy have been determined in this manner, the observer will look for definite evidence of enemy occupation. However well camouflaged, positions held by the enemy are bound to exhibit certain anomalies when viewed against the background of the normal landscape. In the words of the author: " The well trained observer will react almost automatically to such anomalies since they strike him like false notes in a symphony."

Obviously a considerable amount of flying experience is required to obtain this "automatic response," but much can be done by the careful study of selected aerial photographs. The author gives examples of such photographs, exhibiting various types of French scenery, and explains how by their means the observer is trained to look for essentials. It is hoped that by means of this kind of study the number of flying hours can be cut down.

The Training of the Air Force Officer. (Rev. de l'Arm. de l'Air, No. 102, Jan., 1938, pp. 85-6. Available as Translation No. 672.) (58/3 France.)

Although tactical instruction must necessarily be based on an official outlook, criticism by the student is invited and arrangements have been made for French officers to have official access to the Chief of the Air Staff as regards any suggestions concerning the employment of the Air Force.

The author is very keen to foster the spirit of team work amongst the students. The team should not be restricted to the officers of the same squadron doing similar work, but extend to civilians so as to cover a wide aspect (doctor, historian, engineer, artist, etc.).

In this way the outlook is widened and the critical faculty strengthened.

Lectures should be restricted as much as possible. Instead the officer should be induced to find out for himself and what is most important, put his thoughts on paper.

The author points out that at the Air Academie of Italy and Germany, both publicity and material rewards can be gained by the military author, whilst in France, only purely sporting achievements are rewarded.

World's Parachute Record (Delayed Opening). (P. Blu, l'Aeronautique, Vol. 20, No. 229, June, 1938, pp. 111-117.) (58/4 France.)

In March this year, the French parachutist J. Williams carried out a free drop of 11,175 m., the parachute opening 90 m. from the ground. The total time of descent amounted to 187 sec., the last 17 seconds corresponding to the functioning of the parachute. From the barograph records it appears that the rate of descent was practically constant at 75 m./sec. for the majority of the distance, slowing down to 40 m./sec. at an altitude of about 2,000 m. The terminal velocity was thus considerably less than the usually accepted figure for the human body (50 m./sec. at ground density and 80 m./sec. for a drop from 10,000 m.). The reason is that Williams had his arms extended. Medical examination of the parachutist showed no harmful after effects.

Previous to this record drop several practice jumps at lower altitudes were carried out and it is interesting to note that although the parachutist made every effort to land in the same region, and the meteorological conditions were similar the actual points of contact differed by 2-3 miles. From this it appears that the landing of parachute troops will require special sighting devices.

Control of Lighting in Buildings for A.A. Protection. (E. Bleser, Elektrotechnische Zeitschrift, Vol. 59, No. 13, 31/3/38, pp. 337-339.) (58/5 Germany.)

The author calls attention to a simple method of dimming the electric lights in a building by lowering the supply voltage.

In the case of alternating current supply, the voltage is easily lowered by a suitable transformer which is incorporated in the circuit by a master control in case of emergency. Preliminary trials will determine the decrease in supply voltage required (usually of the order of 25-45 per cent.).

In the case of direct current supply, the decrease in voltage has to be carried out by resistance and since in this case the actual drop will depend on the load, a hand adjustment will have to be provided.

The work carried out in buildings may necessitate the continuance of full illumination over restricted areas. These lamps will remain on the full supply

circuit and will be provided with tubular extension shades so as to concentrate the light in the required direction. If properly installed, ordinary sun blinds covering the windows will prevent any reflection to the outside of the building.

Italian Views on the German Air Force (from Ala d'Italia). (Inter. Avia., No. 561, 16/7/38, pp. 1-3.) (58/6 Italy.)

On March 1st, 1935, the German Air Force amounted to 250 machines. At the beginning of 1938 the estimated strength was 250 first line squadrons. Each squadron consists of nine aircraft supplemented by a first line reserve of three aircraft, a total of 3,000 aircraft, to which must be added 5,000 aircraft at schools, test centres and in air traffic, of which 700 can be used in front line service. The first line aircraft is of the following type:—

Type.	Designation.	Top Speed, m.p.h.	Range, miles.	Bombs, No.	Armament.
Bombers ...	Hc 111	310	930	4400	3 M.G.
	Ju 86	230	670	2200	3 M.G.
Dive Bombers	Hs 123	250	370	660	2 M.G.
	Hs 108	250	870	1100	1 M.G. and 1 cannon.
Fighters ...	Bf 109	310	370	—	3—4 M.G.
	Hc 112	302	685	130	4 M.G.
Reconnaissance	Do 17	300	930	1100	3 M.G.
	Hc 70	225	1300	660	2 M.G.
	Hs 122	175	600	—	2 M.G.

The author estimates the present annual output of the German industry at 5,000 aircraft, of which 50 per cent. are heavy types.

Cost of Training for Pilot's Licence and Cost of Practice Flight for Members of the N.S.F.K. (National Socialist Flying Corps). (Luftwissen, Vol. 5, No. 7, July, 1938, p. 246.) (58/7 Germany.)

The new regulations (April, 1938) have led to a considerable reduction in training cost, especially for the younger members of the N.S.F.K. Thus provided the applicant is below 23, physically fit, has not yet served in the army and has reached the required standard of preliminary training of the N.S.F.K. the following figures apply, on the understanding that the applicant will subsequently join the German Air Force:—

A2 Licence in 22 flying hours	RM. 200 (payable in instalments)
Every hour in excess	RM. 12
A1 Licence per hour training	RM. 15
A2-B1 ,, ,, ,, ...	RM. 15
B1-B2 ,, ,, ,, ...	RM. 18

PRACTICE FLIGHTS (ON CORRESPONDING AIRCRAFT) (REFRESHERS).

A2 Licence holder, per hour	RM. 12
K1 ,, ,, ,, ...	RM. 12
B1 ,, ,, ,, ...	RM. 12
B2 ,, ,, ,, ...	RM. 18

For older applicants who do not give an undertaking to serve in the Air Force, a sliding scale applies ranging from two to five times the above rates.

The training for pilot's licence can only be carried out at one of nine Government Civil Aviation Flying Schools. Practice flights can be carried out either from the above schools or any N.S.F.K. aerodrome.

The Italian Air Force Manœuvres at Furbara in Connection with Hitler's Visit. (Luftwehr, Vol. 5, No. 6, 18/7/38, pp. 216-218.) (58/8 Italy.)

Over 300 aircraft took part in the manœuvres, an attack being staged on simulated harbour works and two ships at anchor.

The following types of aircraft participated :—

Bombers : Savoia S 81	}	Six regiments and two groups.
,, S 79		
Fiat Br 20		
Fighters : Fiat CR 32		Two groups.
Ground attack : Breda 65	}	One regiment.
AP 1	}	One group.
Reconnaissance : Romeo RO 37 ...	}	One group.
Cant Z 501		

(It appears that an Italian group consists of 16 aircraft, two groups forming a regiment.)

Altogether 98 tons of bombs were dropped in the 20 minutes the display lasted. Of special interest was a simulated bomb attack by fighters on bombers. The fighters crossed the path of the latter at an altitude of about 100 m., dropping their bombs so as to explode in the air immediately in front of the bombers. The explosion of these bombs was rendered visible by smoke puffs and it was noticed that in actual practice these bombs would either have destroyed the bombers or forced them to deviate from their course to such an extent that an effective attack on the ground target by the bomber would have been impossible.

A New Night Fire Control Apparatus for A.A. Artillery. (R. Schmitt, Luftwehr, Vol. 5, No. 6, 18/7/38, pp. 243-246.) (58/9 France.)

The article deals with the Sperry fire control system as described in the French patent No. 809,548.

Two listening posts X and Y (on a base of several kilometres) give the azimuth and elevation of the aircraft. These readings are transferred continuously to two small projectors (A and B) in the control apparatus and the intersection of the two light beams is found by raising or lowering a horizontal glass plate. A third projector C (corresponding to the A.A. gun) is then adjusted till its image on the glass plate coincides with the intersection of the beams A and B. By arranging so that A and B lie on the sides XC and YC of the triangle XYC, the elevation and azimuth of projector C is such that its line of prolongation would ultimately strike the aircraft spotted by the listening posts X and Y. In other words, the altitude of projector C gives the position of the gun for a straight line trajectory. The vertical adjustment of the glass plate corresponds to the height and the position of the spot on the plate gives the distance of the target. By following the motion of the spot of light it is easy to work out the speed and direction of displacement of the target and thus the usual gun corrections can be applied.

The advantage claimed for this method of fire control is the fact that no searchlights are required and the enemy will thus be subjected to A.A. fire without previous warning.

Several objections to this scheme naturally arise :—

(1) Errors in the original acoustic bearings.
(2) Size of apparatus (at least $2 \times 2 \times 1$ m.).
(3) In the case of an attack of several aircraft the acoustic detectors might not both be aimed at the same target.

High Explosive Shell (Artillery). (R. Meyer, Z.V.D.I., Vol. 82, No. 30, 23/7/38, pp. 879-883.) (58/10 Germany.)

After reviewing various types of shells, the author deals more explicitly with the fragmentation shell employed against ground personnel. On detonation, the casing of this type of shell breaks up into a large number of pieces which are projected over an egg-shaped area surrounding the point of impact. In order to achieve this object, careful attention must be given to the design and material employed. The steel must not be too tough, so as to avoid large splinters. On

the other hand, the casing must be strong enough not to burst in the gun. Addition of phosphorus (up to 0.1 per cent.) has been found beneficial and a properly designed 4-inch shell will produce on detonation at least 400 splinters weighing each at least 5 gm.

Safety in handling and the possibility of simple accurate mass production are the essentials of shell design. The usual process is by drawing square blocks fitted with a central hole. The drawing process has the advantage that the quality of the shell casing can be controlled. If suitable presses are not available, the ordinary machining processes may be employed.

Lately shell bodies made of cast steel have received attention. Although this construction is heavier and has thus to operate with a reduced filling of explosive, the splinter action of the cast steel is very good.

Principle and Test of the Mirror Type Pitot. (A. Klemin, J. Aeron. Sci., Vol. 5, No. 8, June, 1938, pp. 321-4.) (58/11 U.S.A.)

A considerable amount of experimental work, both in the wind tunnel and in full flight, has been carried out on the best location in which to place a pitot tube so that its readings may be correct at varying angles of attack in spite of wing interference. The literature of the subject is extensive and no entirely satisfactory position has been found even for the unflapped wing.

It occurred to the author that a pitot which would indicate correctly through a wide range of speeds, with approximate independence of its location, and independently of flap depression, might perhaps be achieved by placing the pitot in proximity to a small auxiliary aerofoil which would counteract the aerodynamic effects of the main wing. To this device the name mirror type pitot was applied, and the article gives a number of test results with this instrument.

It appears that the device, although not practicable as a service instrument on account of the size and aspect ratio of the mirror, will, nevertheless, prove useful in research and performance testing.

A Note on Some Accelerated Boundary Layer Velocity Profiles. (R. H. Mills, J. Aeron. Sci., Vol. 5, No. 8, June, 1938, pp. 325-7.) (58/12 U.S.A.)

The present paper deals with the two dimensional equations for the steady flow of a slightly viscous fluid over a flat plate.

The velocity profiles are assumed to be similar for all values of the abscissa x; and writing the velocities within the boundary layer as functions of $(Ry/Rx^{(p+1)/2})$, a separation of variables occurs for all flows whose velocity far from the surface of the plate, U, varies as A/x^p.

The velocity profiles are calculated for the case $p = 1/3$.

An asymptotic expression for the velocity profiles, with p arbitrary, is given. This expression indicates that the velocity profiles are of the type that would occur if the boundary layer were accelerated by injecting additional fluid into the flow.

An expression for the variation of the local coefficient of skin friction with Reynolds number is also given, that is $C_f = 2aR_x^{(p-1)/2}$.

Ship Stresses in Rough Water in the Light of Investigations Made upon the Motor Ship "San Francisco." (G. Schnadel, North East Coast Institution of Engineers and Shipbuilders, Transactions, Vol. 54 (Excerpt).) (58/13 Germany.)

The paper is of interest to the designer of flying boats since it gives for the first time correlative experiments on the shape of water waves, the impact forces on the hull, and the stresses set up in the ship structure.

Two methods were employed for the measurement of the waves:—

1. Photographic study with the Zeiss stereo camera.
2. A direct method by means of electric contact devices distributed over the hull.

The first method necessarily gives the shape and dimensions of the wave in the undisturbed water at some distance from the ship. In the second method, the water closes an electrical current which lights up a lamp. The various lamps are photographed on a rotating film and in this way the wave shape is reconstructed.

The forces on the hull are measured by the deflection of a certain number of diaphragms, the records being obtained by the well known D.V.L. scratch method. A similar method of recording is used for the internal strain gauges distributed over the structure of the ship.

It appears that the stresses in the ship are considerably affected by oscillation and impact (pounding). The author's measurements are mutually consistent and the importance of the work is recognised in the extensive discussion which concludes the article.

Pressure Losses for Fluid Flow in 90° Pipe Bends. (K. H. Beij, Bur. Stan. J. Res., Vol. 21, No. 1, July, 1938, pp. 1-18.) (58/14 U.S.A.)

Pressure losses were determined for nine 4-inch steel 90° pipe bends of radii from 6 to 80 inches. The results are discussed in relation to those found by previous investigators under comparable test conditions. For bends having radii of four pipe diameters or less, all the results which are discussed may be correlated on the basis of pipe roughness. Further data are needed to establish a working formula. No correlation could be obtained for the bends of larger radii. For such bends the maximum published values should be used in engineering work until more comprehensive data become available.

Theory of Two-Dimensional Potential Flow Round an Arbitrary Aerofoil. (H. Gebelein, Ing.-Arch., Vol. 9, No. 3, June, 1938, pp. 214/240.) (58/15 Germany.)

Three general theories concerning the potential flow round an aerofoil of arbitrary shape are discussed :—

(1) Method of conformal representation as laid down by Theodorsen and Garrick (N.A.C.A. Report No. 452).

(2) Generalisation of Birnbaum's theory for profiles of medium thickness (Z.A.M.M., Vol. 3, 1923, pp. 290, etc.).

(3) General investigation of the complex velocity function, making use of the relations first discussed by Weinig (Z.A.M.M., Vol. 9, 1929, p. 507; W.R.H., Vol. 14, 1933, p. 131; L.F.F., Vol. 12, 1935, p. 221).

Birnbaum's original theory (2) referred to infinitely thin wings which could be replaced by a vortex sheet. This method presents many advantages and several attempts have been made to extend it to profiles of medium thickness, so far without success.

Theodorsen's original method in the limit when applied to infinitely thin profiles does not lead to the same system of equations as the theory of the lifting vortex surface and thus cannot be considered as a generalisation of Birnbaum's work.

The author develops a new approximate theory which overcomes this difficulty.

The relative merits of the methods discussed will be exemplified by a worked out example which will appear in a subsequent issue of Ing. Arch.

Heinkel Explosive Rivets. (Flugsport, Vol. 30, No. 5, 2/3/38, pp. 110-112.) (58/16 Germany.)

The shaft of the rivet is hollowed out and filled with a special explosive detonating at 130°C. This explosive is stable, non-poisonous and leaves no corrosive residue after firing.

No cap is fitted over the tubular end of the rivet and after inserting in the hole to be riveted, the charge is fired by pressing an electrically heated tool against

the head of the rivet. The heat travels down the shaft and the explosion takes place after 1-5 seconds, depending on size of rivet. The explosion is entirely local and forces out the tubular shaft thus holding the rivet.

The following advantages are claimed:—

(1) No assistant holding the rivet is required.

(2) No counter weight is required and riveting can therefore be carried out in localities of difficult access.

(3) The rivet is tight (85 per cent. of strength of normal rivet) and can be used for tanks and floats.

(4) The method is suited for all shapes and sizes of rivets in any material, provided the latter has an extension of at least 15 per cent. Steel rivets can be used.

(5) The explosive rivet is specially suited for repair work under conditions where time available is short and lack of facilities exist.

Effect of Propeller Slipstream on Wings and Tail Surfaces. (J. Stuper, L.F.F., Vol. 15, No. 4, 6/4/38, pp. 181-205. Available as Translation No. 674.) (58/17 Germany.)

The experiments were carried out on a wing of 80 cm. span and 20 cm. chord, the effect of the slipstream being investigated both as regards change in lift distribution of the wing and changes in speed and direction of inflow at the tail surfaces. For the preliminary work, the slipstream (20 cm. diameter) possessed no rotary component and the results show that the increase in lift is appreciably less than that predicted by the theory of Koning, the local effects depending appreciably on the angle of incidence. This may be partly due to boundary layer effects at the nozzle from which the slipstream issues or due to the finite wing span employed.

In the subsequent experiments the slipstream had a rotary component and it was noticed that the two halves into which the slipstream separates on striking the wing do not reunite behind the wing, but retain a lateral displacement in the direction of rotation. Measurements of lift distribution and moment were also made for the case when the propeller axis makes an angle with the wing chord. The separation of the flow at the wing is affected by the propeller slipstream, the region where the jet contour leaves the wing being specially sensitive. The presence of the rotary jet also causes large differences in the individual contribution of the various elements of the tail surface to the total tail moment.

Recent Research on the Improvement of the Aerodynamic Characteristics of Aircraft. (E. F. Relf, J. Roy. Aeron. Soc., Vol. 42, No. 330, June, 1938, pp. 513-535.) (58/18 Great Britain.)

Aircraft characteristics may be broadly classified into two groups: Those concerned with performance and those concerned with stability and control. In other words, improvements in economy and in safety cover practically the whole of present-day research.

As regards economy or performance, it is now generally recognised that skin friction sets a lower limit to the drag of high speed aircraft. If the point of transition is known (*i.e.*, the relative proportion of laminar and turbulent boundary layer), the skin friction drag can be calculated with fair accuracy provided the surface is sufficiently smooth. Present-day machines already approach within reasonable distance of this ideal and there is every hope that design will ultimately triumph over the admittedly great practical difficulties of providing aerodynamic smooth surfaces for the whole of the aircraft. As regards control or safety much more remains to be done and among the numerous problems the author singles out two: Lateral stability near the stall and the problem of wing flutter.

Lack of lateral stability near the stall results in " wing dropping " which is due to an asymmetric stalling of the wing tips.

It appears possible to cure this by adopting a suitable profile for the tips, but full scale tests have so far not been carried out.

Turning now to the flutter problem, the author expresses the fear that with further increase in speed the present design precautions may not be sufficient to prevent a recurrence of this trouble. For this reason the technique of flutter measurements has been improved and new methods for tackling the mathematics are being developed.

Interference and Interaction from the Designer's Point of View. (M. Watter, J. Aeron. Sci., Vol. 5, No. 8, June, 1938, pp. 300-7.) (58/19 U.S.A.)

This paper treats certain phases of the turbulence problem generally defined as interference. Means of suppressing or minimising interference are proposed and the geometry of design is analysed in the light of the effect of interference phenomena. The results of a few wind tunnel tests made in connection with this study are presented in order to show satisfactory experimental verification of the methods suggested, which cover such a wide range of problems, including wing, nacelle and fuselage shadows, fairings and stability. Fourteen references.

A Study of Available Flap Data. (R. C. Molloy, J. Aeron. Sci., Vol. 5, No. 8, June, 1938, pp. 308-12.) (58/20 U.S.A.)

An analysis of published data on flaps indicates that in spite of the number of tests made, the results of such tests are by no means complete or consistent. These inconsistencies can probably be charged to slight changes in flap design for the same type of flap, to differences in testing technique, and to the effects of scale and turbulence. In the case of $C_{L\max}$ for split flaps, and for other types also, this characteristic changes with aerofoil thickness, camber, and camber position, in addition to changing with the factors already mentioned.

More accurate comparative test data are needed to settle the question of the superiority of one type of flap over another. More data on slotted flaps would be particularly useful.

Characteristics other than $C_{L\max}$ should be investigated more fully, in order that the designer may weigh those factors which are important in the choice of a type of flap to aid in take-off, as well as in landing. The effects of wing design variables on the aerodynamic characteristics of the wing flap combinations need further investigation.

Special Problems Connected with the Take-off and Landing of Aircraft. (J. J. Green, J. Aeron. Sci., Vol. 5, No. 8, June, 1938, pp. 313-20.) (58/21 U.S.A.)

A theoretical analysis has been made of the effect of gradient, wind, and combinations thereof, on the take-off and landing of aeroplanes. Formulæ and charts are given which permit the determination of the length of the ground run for any given conditions providing that the performance on a level surface in still air is known.

From American experiments it appears that

$$\text{(take-off run against wind)/(take-off run in still air)} = (1 - v/V)^{1.8}$$

where v = velocity of wind.

V = take-off speed of aircraft.

A similar relationship holds for the take-off of seaplanes in the absence of current, except that the index is 2 instead of 1.8. The effect of wind alone is to alter the length of run rather than the time of take-off. The effect of current alone is to alter the time of take-off without having much effect on the length of run. The take-off of a seaplane is thus always shortest if it takes place against the wind, irrespective of current direction.

(See also J. J. Green, Can. J. Res., Vol. 16, 1938, Sect. A, pp. 1-16.)

Propeller Problems Imposed by Substratosphere Flight. (C. F. Baker, J.S.A.E., Vol. 42, No. 7, July, 1938, pp. 285-8.) (58/22 U.S.A.)

This paper points out that high power sub-stratosphere flight will require a close co-ordination of aeroplane, engine, and propeller designers in order to ensure the most efficient conversion of power. If this co-ordination is not done, substantial penalties in propeller performance will be obtained.

Sub-stratosphere flight with high powers will require propellers which are appreciably heavier that present ones. However, although weights will increase, it is expected that the upward trend in specific weights can be reduced.

The Transition Phase in the Take-off of an Aeroplane. (J. W. Wetmore, N.A.C.A. Report No. 628, 1938.) (58/23 U.S.A.)

An investigation was undertaken to determine the character and importance of the transition phase between the ground run and the steady climb in the take-off of an aeroplane. The information was obtained from a series of step by step integrations defining the motion of a Verville A.T. biplane (weight app. 2,000lb.) during actual take-off. Both normal and zoom take-off were considered. During the former, the pilot left the ground at speeds ranging from 3 to 15 miles per hour in excess of minimum level flying speed and to climb at the same speeds. During the " zoom " take-off, the speed at the instant of take-off is the same as before, but is reduced to practically minimum flying speed during the climb. For normal take-off, the best transition is realised at the lowest possible take-off speed. Zoom take-off is only of advantage if the machine is heavily loaded and has to clear a high obstacle (100ft.).

The error in the calculation of air-borne distance of take-off by neglecting the transition phase varies from +4 per cent. (heavy load) to −4 per cent. (light load) for normal take-off. For zoom take-off the error is considerably greater.

The ground effect reduces the air-borne distance to attain a height of 100 feet by 5 per cent. (light load) and 8 per cent. (heavy load) respectively.

The Icing Problem on Aircraft. (A. Mirlés, Pub. Sci. et Tech. du Ministere de l'Air, B.S.T., No. 78, April, 1938.) (58/24 France.)

In order to study the problem of icing, an experimental station was established at the summit of the Puy de Dome (1,460 m.).

In this locality a wind of the order of 40 m./sec. is quite frequent and the high moisture content of the air together with the low winter temperature enable the formation of ice deposits to be studied under natural conditions. Certain experiments were also carried out in the propeller slipstream of an aero engine mounted in the open. After discussing the meteorological conditions favouring ice formation, experiments on the icing up of bodies of various shapes are described. As is well known, the deposits concentrate on wires and sharp edges and gradually build up in the direction facing the wind. In the case of aerofoils the leading edge is most subject to attack. Certain methods of de-icing depending on supplying heat electrically to the danger zones are described and it is pointed out that, once the ice has formed, much more energy has to be supplied for its removal than is required to prevent a deposit from forming. This shows the importance of an adequate warning device which has been developed by the author by placing a wire mesh over the intake of a venturi. By comparing the readings of two such instruments, one with and the other without a grid, an accurate warning of the possibility of ice formation is given before any marked deposits occur on the wings.

In addition to some good photographs, the article also contains an interesting summary of icing troubles experienced by civil aviation pilots.

Income and Subsidies of Various European Air Lines. (L'Aerophile, Vol. 46, No. 7, July, 1938, p. 163.) (58/25 ——.)

Company.	Year.	Subsidy.	Total Receipts, including Subsidy.	Subsidy, % Total.
Imperial Airways...	1934	£543,694	£1,197,809	45·4%
,, ,, ...	1935	£561,556	£1,425,167	39·4%
,, ,, ...	1936	£426,595	£1,539,065	27·7%
,, ,, ...	1937	£381,767	£1,604,061	23·8%
Air France ...	1934	Frs. 163,405,167 (£1,315,555)	Frs. 219,390,442 (£1,766,286)	74·48%
,, ...	1935	Frs. 161,553,925 (£1,300,619)	Frs. 220,385,737 (£1,774,305)	73·31%
,, ...	1936	Frs. 154,865,873 (£1,246,807)	Frs. 235,952,747 (£1,899,626)	65·63%
Deutsche Lufthansa	1934	Rm. 20,649,903 (£1,010,764)	Rm. 40,542,988 (£1,766,286)	50·93%
,, ,,	1935	Rm. 19,656,115 (£962,120)	Rm. 45,525,259 (£2,228,333)	43·18%
,, ,,	1936	Rm. 21,212,643 (£1,038,308)	Rm. 50,050,082 (£2,449,833)	42·38%
Sabena	1935	Frs. 12,605,499 (£72,031)	Frs. 35,026,450 (£200,151)	35·99%
,, ...	1936	Frs. 14,428,232 (£82,447)	Frs. 42,022,408 (£240,129)	34·33%
Ala Littoria ...	1934-1935	Lire 49,696,300 (£537,478)	Lire 55,822,011 (£603,742)	89·02%
,, ...	1935-1936	Lire 65,983,140 (£713,640)	Lire 97,327,982 (£1,052,650)	67·79%
K.L.M.	1934	Fl. 367,662 (£40,851)	Fl. 5,832,357 (£648,040)	6·3%
,, ...	1935	Fl. 548,000 (£60,888)	Fl. 6,653,706 (£748,189)	8·14%
,, ...	1936	Fl. 526,653 (£58,517)	Fl. 7,317,568 (£813,063)	7·19%
,, ...	1937	Fl. 548,000 (£60,888)	Fl. 9,248,000 (£1,027,800)	5·93%

Simplified Propeller Calculations. (I. H. Driggs, J. Aeron. Sci., Vol. 5, No. 9, July, 1938, pp. 337-344.) (58/26 U.S.A.)

The method of equivalent wing polars first suggested by Doepp (L.F.F., Vol. 13, No. 2, pp. 46-56) is very useful for determining the best propeller to fit any aeroplane design conditions. In its original form, however, no account is taken of the Goldstein blade interference factor (R. and M., No. 1674) and this may introduce appreciable errors in the induced power losses at high lift values for the blades.

The author has applied the necessary corrections, but comparison with experiment is rendered difficult by the absence of suitable model experiments. It appears that propeller tests run under any conditions other than those to be used in flight may lead to erroneous results and further work is urgently required. The author's formulæ lead to the following main conclusions:—

(1) The power lost in the slipstream is a fixed quantity and need not be considered when comparing various propeller designs.

(2) The static thrust per unit power increases with a decrease in tip speed.

(3) The tip speed for greatest efficiency is equal to the velocity of advance in the same units.

Formulæ for the Performance of Spark Ignition Engines at Altitude. (L. Auer, Z.V.D.I., Vol. 82, No. 27, 2/7/38, pp. 789-793.) (58/27 Germany.)

A number of formulæ are available by means of which the performance of an aircraft engine at altitude can be calculated provided the power output under a set of standard conditions is known. These formulæ are empirical and based on such test figures under altitude conditions as are available. Since power measurement at altitude is very difficult and only very few test benches reproducing altitude conditions on the ground are available, the formulæ in use at the present time cannot lay any claim to great accuracy. They are, however, useful in forming a basis of comparison. Unfortunately, the responsible authorities in different countries have so far not yet agreed on an international method of representation and the aircraft engineer is thus confronted by various formulæ (American, French, English and Russian) which all lead to different numerical results. These formulæ are defined by the author and their application to unsupercharged and supercharged engines is explained.

The subject requires more elucidation by actual measurements in flight.

Propeller Factors Tending to Limit Aircraft Engine Powers. (G. T. Lampton, J.S.A.E., Vol. 42, No. 7, July, 1938, pp. 289-92.) (58/28 U.S.A.)

There is a strong trend towards increasing aeroplane gross weights inasmuch as larger sizes simultaneously result in structural economy and aerodynamic improvement. The concurrent demand for larger power plants may be limited by the propeller since, at constant tip speed and velocity, its weight is proportional to the 3/2 power of the horse-power.

By assuming a specific engine weight curve for increasing powers and adding the propeller weight, specific weight curves for the power plant group are obtained. These curves show minima in the vicinity of 2,500 and 6,000 h.p. for 250 and 450 m.h.p. design speeds, respectively, at sea level. Multi-blade propellers and very high design speeds tend to reduce the weight penalty, and the author concludes that the ultimate limit to engine power is not yet in sight.

Aerodynamic Considerations Affecting Propellers for Large Engines. (G. W. Brady, J.S.A.E., Vol. 42, No. 7, July, 1938, pp. 293-300.) (58/29 U.S.A.)

From the aerodynamic standpoint, propellers for engines of several times present powers will operate just as efficiently as those for smaller powers. For long-range aircraft operating at altitudes of 20,000 to 30,000ft., three-blade propellers increased somewhat in diameter over what in current practice are definitely indicated although, for medium range types, the diameters of present practice scaled up by the square root of the take-off power ratio appear satisfactory.

As alternatives to the increased diameters for the long range high altitude aircraft, the three-blade propeller of about 15 per cent. small diameter with a two-speed reduction gear will give equal range but a poorer take-off, or the four-blade propeller of the same diameter as the smaller three-blade design will give almost equal range without a two-speed reduction gear and slightly poorer take-off.

The importance of pitch distribution designed for operating speeds is indicated, as is the necessity for keeping blade shank sections faired when exposed to the airstream, particularly in liquid-cooled installations. Propellers which can be feathered in case of power plant failures are considered essential to long range aircraft from the standpoint of safety and increased performance on the remaining engines.

Electric Testing Installations for the Development of Aero Engines. (E. Lotterle, Metropolitan Vickers Tech. News Bulletin, No. 619, 15/7/38, p. 8. E.T.Z., 7/7/38, pp. 709-14.) (58/30 Germany.)

The author describes examples of the application of electrical engineering in testing installations used in the development of aero engines. He deals in par-

ticular with testing installations for single cylinder engines, and for engines intended for high altitudes, for superchargers and for aero engine accessories. In conclusion, he briefly discusses electric converter stations for the larger testing installations. Illustrated with four diagrams and two photographs.

Principles Involved in the Cooling of a Finned and Baffled Cylinder. (M. J. Brevoort, N.A.C.A. Tech. Note No. 655, June, 1938.) (58/31 U.S.A.)

The author points out that the fin passage baffle of an air-cooled engine cylinder corresponds to a number of pipes in parallel. Assuming the wall temperature constant, the total heat transfer to the air entering the pipe at a given temperature can be calculated in terms of the dimensions of the pipe, the heat transfer coefficient, the mean speed through the pipe and the physical constants of the air. Since the heat transfer coefficient is known in terms of velocity and pipe dimensions whilst the velocity itself can be expressed in terms of pressure drop over the length of pipe, the total heat transfer can be expressed in terms of pressure drop, temperature difference of inlet air and pipe dimensions. Plotting these relations, the author shows that for fixed values of the pressure drop and temperature difference (air intake/wall) the heat transfer per unit intake area reaches a maximum for a certain l/d ratio (l=length of passage, d=hydraulic diameter). Moreover, at this optimum value of l/d, the heat transfer per unit frontal area is practically the same for any value of d. In other words, the " optimum " fin spacing mentioned in some previous researches is entirely due to the air passage having been of constant length in these experiments. Equivalent results can be obtained with other fin spacings if the baffle length is adjusted accordingly.

Buchi Turbo Charging. (Metropolitan Vickers Tech. News Bulletin, No. 620, 22/7/38, p. 7. Oil Engine, July, 1938, pp. 72-3.) (58/32 ——.)

This article gives data on the exhaust gas turbo charging method of pressure charging obtained from recent tests of a number of engines of widely differing types fitted with equipment of Buchi design. The results show the modern standards of performance attained with this system. Illustrated with one photograph and two diagrams.

Catalytic Combustion of Gases on Metals. (W. Davies, Engineering, 27/5/38, pp. 587-9. Eng. Absts., Vol. 1, No. 5, Section 3, June, 1938, p. 49.) (58/33 Great Britain.)

Pt and Ni wires 0.001in. in diameter were stretched within a cast iron cylinder one cubic foot in capacity, connected to vacuum pump, gas cylinders and gauge, the voltages across an ammeter shunt and rheostat being measured. Temperature was calculated from resistance, and rate of combustion by plotting temperature against power input. Results are given for air containing small percentages of H_2, CO and methane. With 1 per cent. H_2, reaction began very sharply at 200°C. With CO, combustion does not begin till about 400°C. For CO and H_2 rates of combustion at first increase and then decrease, the curves being parabolic about 1,200°C. The possibility of heating fine wires in an explosive mixture to above its ignition point is probably due to the intense thermal gradient—100°C. or more in a distance equal to the mean free path. In small amounts methane does not react below a wire temperature of 800°C. A small percentage of acetylene suppressed combustion of hydrogen, *e.g.*, 1 per cent. acetylene raised the explosion temperature of a 30 : 70 H_2 : air mixture from 280° to 600°C. The results agree well with recent theories of catalysis.

The Two-Stage Auto-Ignition of Hydrocarbons and " Knock." (G. P. Kane, Proc. Roy. Soc., Series A, Vol. 167, No. 928, 7/7/38, pp. 62-80.) (58/34 Great Britain.)

Previous investigations into the spontaneous ignition under pressure of the higher paraffins and olefins containing more than three carbon atoms have shown

that in the temperature range between ca. 270 and 400°C., ignition occurs by a two-stage process preceded by an induction lag t_1 before the formation of a cool flame and a second lag t_2 before the subsequent ignition of the cool flame products; increasing pressure shortens both these lags, and although kinetic relationships have been developed it has not been possible adequately to test them hitherto, owing to the extreme violence of the ignitions at pressures much above the minimum ignition pressure.

An optical recording manometer is described whereby it has been possible to measure t_1 and t_2 at pressures up to 15 atm. with an accuracy of 1/100 sec.

With propane t_2 decreases more rapidly than t_1 with increasing initial pressure, and at a critical pressure (about 8 atm.) the two-stage is replaced by a single stage process; the induction lag then decreases very rapidly with pressure. With propylene, where the induction lags are much greater, no such transition had occurred at pressures up to 12 atm.

The bearing of these results, both on the nature of the kinetic processes operative and on the problem of " knock," is briefly discussed, the latter phenomenon being attributed to the propagation of an explosion flame through a fuel air mixture in a state of enhanced chemical activity.

Limit of Detonation of Mixtures of Hydrocarbons with Air. (V. M. Rifin and A. Sovolik, Fuel, Vol. 17, No. 7, July, 1938, p. 224.) (58/35 U.S.S.R.)

The purpose of the experiments discussed in this paper was to study the formation of the detonation wave as regards its bearing on the phenomenon of pinking in internal combustion engines. The two problems of chief interest were: (1) The ability of hydrocarbon air mixtures to produce the explosive wave spontaneously; and (2) to sustain the propagation of a shock wave initiated from an external source. Experiments in a 30 m. long tube showed that a spontaneous production of the explosion wave was impossible in the mixtures of ethyl ether, of pentane, and of fractions of petroleum ether (35 to 39 deg.), with air at normal pressure and temperature, and ignition by a discharge from a high power condenser. In every case extinction was observed at a distance of less than 10 m. from the spark. For hydrocarbon air mixtures corresponding to the actual mixture in a petrol engine, the propagation of the explosion wave is possible only within the narrow limits of concentrations approximating to the stoichiometrical one. The same hydrocarbon air mixtures, containing 4 to 5 per cent. of CO_2—hence more similar to the actual mixture in an engine—are not capable of detonation. This is considered as proving that detonation in an engine is governed entirely by " chemical sensitisation " of the mixture during compression.

Diesel Deposits as Influenced by Fuels and Operating Conditions. (J. R. MacGregor and W. V. Hanley, J.S.A.E., Vol. 42, No. 7, July, 1938, pp. 272-80.) (58/36 U.S.A.)

Fuel deposition and ring sticking tests are described which were performed on several single cylinder and multi-cylinder service Diesel engines in the laboratory.

The development of an accelerated test method is outlined with special reference to the effects of engine variables on deposition. Decrease in load, speed, or jacket temperature or increase in altitude were found to increase fuel deposition. Increase in running time increases the exhaust deposits linearly but, within the combustion chamber, equilibrium deposition was reached in a few hours of operation.

Marked differences were found among fuels in the single cylinder test engine after 24 hours of operation under the accelerated conditions. Fuels doped with different types of cetane number improvers indicated that ignition quality is a factor in fuel deposition under certain operating conditions in some engines.

The results of the tests in one of the single cylinder engines were compared with the results obtained in the other engines. Although they correlate closely with the relative fuel deposition in certain of these engines, they were not indica-

tive of the results obtained in other engines which are relatively insensitive to fuel differences.

The tests demonstrated that the engine designer has much greater control over the quantity of fuel deposits formed than has either the fuel refiner or the engine operator.

Chemical Structure and Viscosity Characteristics of Lubricating Oils. (B. Yamaguchi, Aer. Res. Inst., Tokio, Report No. 162, April, 1938.) (58/37 Japan.)

As a continuation of the writer's previous paper, the present work contains the results of studies on the relation between the chemical structure and the viscosity association of high molecular weight hydrocarbons, such as those present in lubricating oil fractions. An equation expressing the relation in lubricating oils between viscosity association and viscosity temperature coefficient has been established, and, in order to study their viscosity association in relation to their chemical structure, calculations of viscosity association have been made with the aid of the equation for a number of high molecular weight hydrocarbons whose viscosity temperature coefficients and chemical structure are known. Finally, interesting conclusions have been drawn for these hydrocarbons in connection with the effect of chemical structure on the viscosity temperature coefficient.

Aircraft Fuels of High Octane Rate. (W. H. Hubner and G. Egloff, Oil and Jes. Journal, Vol. 36, No. 46, 31/3/38, pp. 103-112.) (58/38 U.S.A.)

The following table shows the rapid increase in the use of high octane fuels in the U.S.A. :—

Rating.	Per cent. distribution of U.S. Army Air Corps fuel requirements for the years—						
	1938	1937	1936	1935	1934	1933	1932
100	90	29	14	2	—	—	—
92	7	68	83	95	96	53	—
87	—	—	—	—	—	40	—
58-65	3	3	3	3	4	7	14

At the present time the total annual consumption of aircraft fuel in the U.S.A. is roughly 100×10^6 gallons, 40 per cent. of which is for military use. There has also been an increase in the octane rating of civil aircraft fuel from an octane number 83 in 1935 to 89 at the present moment. The author discusses the composition of such high grade fuels and describes the test methods employed for determining the octane rating. At the present moment there exists unfortunately three different test methods the results differing appreciably according to the technique adopted, especially in the higher range of rating. Extensive standardisation tests are, however, in progress at the moment both in the U.S.A. and in certain European countries with the object of determining a universal method for the octane range 87-100. In this connection it is also hoped that the fuel volatility requirements will be standardised. The large number of grade and specifications existing at the present moment are considered both troublesome and wasteful and every effort should be made to reduce their number to the minimum. It is suggested that the following four grades should cover all aircraft requirements :—Rating 73, unleaded; rating 80, 1 cc. tel./gallon; rating 90, 4 cc. tel./gallon; rating 100, 4 cc. tel./gallon.

Tests of a $7 \times 10\frac{1}{2}$-inch Bearing at 3,600 r.p.m (L. M. Tichvinsky, Trans. A.S.M.E., Vol. 60, No. 5, July, 1938, pp. 393-7.) (58/39 U.S.A.)

This paper deals with the first stage of the test of a $7 \times 10\frac{1}{2}$in. bearing at 3,600 r.p.m. of the journal.

It is shown that in gradually bringing such a bearing to full loading its performance as a guide bearing at zero and small loads changes to the performance of a power bearing at high loads. At small loads the losses are produced in the nearly uniform circumferential clearance, while at high loading the predominant

part of the losses is produced in the carrying oil film. The relative distribution of losses in the carrying oil film, reliefs, and upper clearance is represented graphically as a function of load and pressure on the basis of theoretical calculations.

Northerly Turning Error of the Magnetic Compass for Aircraft. (C. S. Draper, W. H. Cook and W. McKay, J. Aeron. Sci., Vol. 5, No. 9, July, 1938, pp. 345-354.) (58/40 U.S.A.)

Northerly turning error in the conventional magnetic compass is produced by accelerations during turns. The mechanism of these errors is completely described throughout the turn and a method is pointed out for minimising the effects in practice. This procedure involves the use of bank angles less than a critical value which varies with magnetic latitude. A mathematical study is made of improvements possible in compass performance by changing the dynamic coefficients of the instrument. The results show that (1) the error may theoretically be eliminated by using a sufficiently long undamped period of the card about the normal axis and (2) increases in damping forces cannot eliminate turning errors.

Stratosphere Balloon Altitude Comparison of Barometric and Photogrammetric Measurements. (W. G. Brombacher and M. R. Houseman, J. Aeron. Sci., Vol. 5, No. 9, July, 1938, pp. 355-9.) (58/41 U.S.A.)

Considering the 1934 flight results for 32 comparisons in the range from 42,000 to 62,000ft. above sea level, the average difference between the altitudes calculated by the barometric and photogrammetric methods was 0.7 per cent. without regard to sign. On the average the barometric altitude was 30ft. higher than the photogrammetric.

For the 1935 flight, for 60 comparisons in the range from 59,000 to 72,000ft. above sea level, the average difference was 0.36 per cent. without regard to sign and the barometric altitude was 93ft. lower on the average. The altitudes obtained by vertical angle measurement and the other two methods were also in satisfactory agreement.

Measurement of Engine Power in Flight. (O. W. Schey, J. Aeron. Sci., Vol. 5, No. 9, July, 1938, pp. 364-7.) (58/42 U.S.A.)

The N.A.C.A. has recently completed the development of a torque meter for measuring and recording engine torque during flight. The instrument operates on the hydraulic principle with photographic recording. Three specially designed diaphragms form part of the hydraulic system and are interposed between the propeller and the crankshaft so that the force between these two elements, when applied to the diaphragms, creates a pressure on the hydraulic system. A measuring diaphragm transmits the pressure to a moving film by means of a light beam and mirrors.

Considerable difficulty was experienced at first with failure of the torque cell diaphragm. This was traced to torsional vibration of the engine and overcome by fitting a dynamic balancer.

From the records obtained for fixed throttle operation between 0 and 15,000 feet, it appears that the b.h.p. as measured agreed within 2 per cent. with that predicted on the assumption that the engine power varied directly as the manifold pressure and inversely as the square root of the absolute temperature. The engine employed was an air-cooled radial of approximately 450 h.p. and tests with other types will be required before this agreement may be accepted as general.

Highest Frequency of Torsional Vibration. (G. G. McDonald, Engineer, 13/5/38, pp. 542-4. Eng. Absts., Vol. 1, No. 5, Section 3, June, 1938, p. 59.) (58/43 Great Britain.)

In certain very high speed systems destructive stresses may be set up through coincidence of one of the lower impulse harmonics and the highest frequency of

natural vibration. The author has devised a simple graphical method for locating nodes in an idealised system comprising a number of rigid mass moments of inertia spaced in any manner along an inertialess shaft of uniform torsional elasticity. A system with m masses gives $(m-1)$ nodes if " free-free," $m-$ if " fixed-free," and $(m+1)$ if " fixed-fixed." The conception is developed from a geometrical standpoint for a single mass " fixed-free," four mass " free-free," three mass " fixed-free " and six mass " free-free " systems, and it is explained how it can be applied to the case of axial vibrations of masses on a rod. In a further contribution (" The Engineer," 27th May, 1938, p. 592) the author discusses an analogous optical construction suggested by Dick (" The Engineer," 11th March, 1938, pp. 267-268).

On the Problem of Stress Distribution in Wide Flanged Box Beams. (E. Reissner, J. Aeron. Sci., Vol. 5, No. 8, June, 1938, pp. 295-9.) (58/44 U.S.A.)

The structural analysis of monocoque and semi-monocoque structures, such as stressed skin wings, presents a number of complicated questions. One of these has to do with the fact that in a hollow wide flanged box beam, as such a wing may be considered, the stress distribution deviates appreciably from that in an ordinary " beam " even when its walls are so stiff that no local instabilities occur in the skin.

This paper contains a contribution to this problem which is often called the problem of " shear lag." In Section I, some general statements concerning this problem of stress distribution are discussed, some of which have been made previously by different authors. In Section II a quantitative theory of the stress distribution in rectangular corrugated box beams is developed which is both simple and quite rigorous. It permits solving problems for corrugated beams, which, for beams consisting of flat sheets, are mathematically very complicated and have not so far been solved. In those cases where the analysis of the flat sheet beam is feasible, the corresponding problem for the corrugated beam admits of a much simpler solution.

Resistance Welding Plant for Stainless Steels. (Metropolitan Vickers Tech. News Bulletin, No. 620, 22/7/38, p. 6. Welding Industry, July, 1938, pp. 210-12.) (58/45 Great Britain.)

This description of a resistance welding installation recently completed by the Soudvre Electrique Languepin consists mostly of details of the Budd type control apparatus and the special types of tongs designed by Languepin. A device for warning the operator of an inadequate or an excessive value of the time current product is also described. The installation is intended for welding austenitic stainless work-hardening high resistance steels.

Illustrated with six photographs.

X-Ray as an Aid in the Manufacture of Aluminium Castings. (G. E. Stoll and A. T. Ruppe, Metropolitan Vickers Tech. News Bulletin, No. 620, 22/7/38, p. 6. Trans. American Soc. Metals, June, 1938, pp. 801-15.) (58/46 U.S.A.)

This paper deals with the application of radiography to the examination and control of foundry procedure. The effect of change in positions of risers, pin-hole trouble, inspection and reduction of manufacturing costs are discussed in so far as they are affected by X-ray examinations. Finally the authors give some details of X-ray operation costs.

Illustrated with 12 photographs and one diagram.

Thermal Expansion and the Effect of Heat Treatment on the Growth Density and Structure of Some Heat Resisting Alloys. (P. Hidnert, Bur. Stan. J. Res., Vol. 20, No. 6, June, 1938, pp. 809-23.) (58/47 U.S.A.)

Coefficients of linear expansion for various temperature ranges between 20 and

1,000°C. were obtained on some new heat resisting alloys: An iron-chromium-aluminium alloy and three iron-chromium-aluminium-cobalt alloys. No polymorphic transition was observed in these alloys between 20 and 1,000°C. The alloys exhibited growth (0.82 to 2.81 per cent.) after various heat treatments at temperatures up to 1,400°C. Additional heat treatments would probably cause additional growth. The densities of the mechanically worked iron-chromium-aluminium alloy and iron-chromium-aluminium-cobalt alloys increased 1.12 to 2.50 per cent. as a result of various heat treatments to 1,400°C. Well marked grain growth occurred in the heat-resisting alloys as a result of various heat treatments at elevated temperatures.

Research on Materials and Modern Design. (A. Thum, Engineering, No. 3,785, 29/7/38, pp. 143-146.) (58/48 Germany.)

In certain classes of engineering, such as aeronautics, the weight of material making up the structure is of paramount importance.

It is now being realised that by a better understanding of fundamental principles, a considerable saving in weight is also possible for other types of engineering structures. Reduction in weight does not only lead to a direct reduction in cost, but the finished product may be definitely superior. Now a structure may be subjected to a variety of loads such as dead loads, fluctuating loads, starting impacts, applied deformation and non-uniform heating.

Even if the load is known, the resultant stresses in the structural elements can only be calculated for parts of relatively simple shape. The ultimate aim of the designer to utilise his material to the utmost at every point is thus very difficult to realise. Of great importance is the allowance for overload and this is intimately connected with the number of times such overloads are likely to occur during the normal life of the structure. The author shows how for certain materials, shapes and methods of stressing, overloads may be harmless and will not lead to a reduction in fatigue strength provided they do not occur too frequently. An interesting example of modern lines of development is furnished by the cast crankshaft. Here the better shape possible with casting more than makes up for the reduction in tensile strength of the material, the latter being only justified if a very much more expensive design is used.

Similarly, modern transmission shafts for motor cars are no longer made of extensively heat treated material, but instead a certain amount of plasticity is allowed so that under overload conditions, flow can take place over the whole length of the shaft.

Compression Struts with Non-Progressively Variable Moment of Inertia. (B. Radomski, L.F.F., Vol. 14, No. 9, 20/9/37, pp. 438-443. Available as Translation T.M. 861.) (58/49 U.S.A.)

The buckling failure conditions for a bar with non-progressively variable moment of inertia J_n, although constant over length l_n, are developed.

For two cases: (1) Bar consisting of two lengths l_1 and l_2 with J_1 and J_2; (2) bar consisting of three lengths l_1, l_2 and again l_1, with J_1, J_2 and again J_1 (symmetrical with respect to centre), graphs are plotted for different ratios $J_1 : J_2$ over $l_1 : l_2$, showing a mean moment of inertia J_m, with the aid of which the buckling strength P_k of the bar with sudden variations of the moment of inertia can be represented in the Euler form.

Load Tests on a Stiffened Circular Cylindrical Shell. (E. Schapitz and G. Krumling, L.F.F., Vol. 14, No. 12, 20/12/37, pp. 593-606. Available as Translation T.M. 864.) (58/50 U.S.A.)

For the purpose of checking and supplementing the theoretical computations carried out by the D.V.L. on the force distribution in cylindrical shells, tests are described whereby the stress distribution may be determined in a stiffened circular cylindrical shell loaded longitudinally at four symmetrically situated points. Of

particular importance are the cases investigated of groups of bending and arching or convexing forces, respectively. From the stress measurements on the longitudinal stiffeners, the shear stresses and the bulkhead ring stresses in the skin can be evaluated. These measurements showed that the " simple shear field " used in theoretical computations, in which all normal stresses in the skin are neglected, must be extended by the addition of the transverse or circumferential stresses (denoted by O_y) if the bulkhead rings are not riveted to the skin. The effect of buckling of the skin on the reduction of the stress disturbance within the load range investigated appeared to be slight. If the direct attachment to the skin of all of the bulkheads is loosened, the stress disturbance is reduced at a somewhat slower rate along the cylinder than is the case when the first two bulkheads are attached to the skin.

Investigation of Stress Conditions in a Full-Size Welded Branch Connection. (F. L. Everett, A. McCutchan, Trans. A.S.M.E., Vol. 60, No. 5, July, 1938, pp. 399-410.) (58/51 U.S.A.)

This paper presents the results of an investigation of stress conditions in an 8in. diam. 0.500in. wall test manifold having a full size welded branch connection. Stresses were determined from strain gauge measurements on the outer surface of the manifold at some 50 stations in the vicinity of the welded juncture of header and branch. High stresses were found to exist on the outer surface at the flat portion on the side of the manifold. No evidence of high stress was found on the outer surface of either the unreinforced or reinforced manifold in the vicinity of the crotch, although high stresses were deduced analytically as probably existing in the inside wall at this location in the unreinforced manifold.

It is concluded that the ring type of reinforcement described will develop the full strength of the pipe.

The Fatigue Strength of Hollow Crank Pins (Effect of Reinforced Oil Hole). (H. Cornelius and F. Bollenrath, Z.V.D.I., Vol. 82, No. 30, 23/7/38, p. 885.) (58/52 Germany.)

Two types of crank pins were experimented with. In the normal type, a cylindrical hole of constant diameter traverses the whole length of the pin, the oil passage to the connecting rod being in the form of a transverse hole in the wall. In the reinforced type, a ring of metal is left in the neighbourhood of the oil hole, the crank pin being bored out from the two ends separately. Experiments show that the fatigue strength under torsion is increased 26-33 per cent. by leaving the bridge of metal to reinforce the oil hole.

Using this type of pin, further experiments were carried out on the effect of double-duro hardening on the fatigue strength. In this process the metal is heated in an acetylene flame and then quenched in water.

The double-duro hardening generally led to a considerable reduction in the fatigue strength. Only if the original heat treatment was such as to produce a relatively soft pin did the acetylene hardening show a small beneficial effect.

Polar Diagrams for the Solution of Deflections of Axially Loaded Beams. (J. D. Akerman and B. C. Stephen, J. Aeron. Sci., Vol. 5, No. 9, July, 1938, pp. 360-3.) (58/53 U.S.A.)

Since polar moment diagrams give the shear, moment or solution for deflection at any point along the beam, the exact nature of stresses along the whole span is known and no approximations are involved. In the process of solving analytically a person is tempted to use assumed or average values.

Since it is a simple problem to draw a polar moment diagram using the exact moments of inertia, its use is recommended to avoid possible errors.

On the Influence of a Resonator upon the Field of Sound. (K. Sato and K. Kubo, Aer. Res. Inst., Tokio, Report No. 163, April, 1938.) (58/54 Japan.)

The ray of sound is projected on to a Helmholtz resonator and the sound field in its neighbourhood is investigated in detail.

When the resonator is out of tune, its presence causes a slight effect on the sound field. When the resonator is in action it absorbs the energy of sound from the surrounding field, a part being re-radiated as a spherical wave.

Luminous Enamels. (Z.V.D.I., Vol. 82, No. 30, 23/7/38, p. 884.) (58/55 Germany.)

Luminous enamels are now available which resemble ordinary enamels in that they are weather proof and can be cleaned like ordinary enamels. After previous exposure to light, they continue to glow in the dark for several hours.

The luminous enamels do not depend on radio-active substances, the phosphorescence being produced by the additions of a powdered zinc/sulphur/phosphorus compound to the ordinary paint prior to the normal stoving process (800°C.).

The luminous enamels are comparatively cheap and are receiving extensive application in anti-aircraft defence schemes (air raid shelters and sign posts).

Application of the Phase Integral Method to the Analysis of the Diffraction and Refraction of Wireless Waves Round the Earth. (T. L. Eckersley and G. Millington, Phil. Trans. Roy. Soc., Series A, Vol. 237, No. 778, 10/6/38, pp. 273-309.) (58/56 Great Britain.)

The phase integral theory leads to the complete form of the solution for points on the surface of the earth, and presents the analysis in a form which exhibits clearly the physical nature of the problem. In addition, it extends the solution to points above the surface of the earth, and to the case where air refraction is present as an important factor. While the solutions are not general in the sense of applying to any point in space, however far from the earth or near to the transmitter, they provide a complete basis for calculating all the cases of practical importance. In particular the theory has been applied to the preparation of a set of ground curves for various wave lengths from 2 to 2,000 m., and of a set of height-gain curves for the range 2-10 m. It has also provided the necessary material for calculating the probable effects of air refraction.

Brushes of Electric Machines. (P. Szereszewski, Metropolitan Vickers Tech. News Bulletin, No. 619, 15/7/38, p. 7. R.G.E., 9/7/38, pp. 35-42.) (58/57 France.)

The author reviews a number of recent articles concerning the operation of rubbing contacts used on the brushes and commutators of electrical machines. He considers the mechanism of the contact between brush and commutator, the voltage drop and finally the wear of brushes, rings and commutators. He investigates the influence of pressure, hygroscopic state and speed on this wear taking as a basis the results obtained by various investigators. Illustrated with seven diagrams.

Radio Direction Finding on Wave Lengths Between Six and Ten Metres. (R. L. Smith-Rose and H. G. Hopkins, J. Inst. Elec. Eng., Vol. 83, No. 499, 20/7/38, pp. 87-97.) (58/58 Great Britain.)

The authors describe the development of simple experimental direction finders for wave lengths between 6 and 10 metres, and their use in an investigation of the accuracy of direction finding on these wave lengths. It is shown that the inherent accuracy of the instruments is well within the limits of $\pm 2°$, while their sensitivity is sufficient for observation on an experimental 50 watt transmitter at

ranges up to 22 miles over flat ground. Bearings have also been taken on signals emanating from London television transmitters, blind landing beacons, and also from commercial and amateur transmitting stations some 3,000 miles away.

A brief study has been made of the behaviour of the loop direction finder when horizontally polarised waves are emitted at the transmitting station. It is shown that the errors experienced in this case can be almost entirely eliminated by the use of a rotating spaced vertical aerial arrangement in place of the loop. The evidence resulting from the use of this Adcock type of direction finder indicates that the errors with the loop set are due to the reception of horizontally polarised waves.

The Measurement of the Lateral Deviation of Radio Waves by Means of a Spaced Loop Direction Finder. (R. H. Barfield, J. Inst. Elec. Eng., Vol. 83, No. 499, 20/7/38, pp. 98-110.) (58/59 Great Britain.)

The paper gives an account of some systematic measurements of the lateral deviations of wireless waves received at Slough from various short wave transmitters over a period of several months. The measurements were made by means of a spaced aerial direction finder of the four fixed loop type, and the first part of the paper is devoted to a description of the apparatus, together with an account of its performance in respect of instrumental accuracy, pick-up factor, and other characteristics.

The results obtained show that the variations in bearings which arise from instrumental causes do not exceed about 2°, and are usually of the order of 1°. The records demonstrate that lateral deviation occurs for the above cases to an extent which depends on the range and type of the reflected waves observed. Deviations of 10° to 20° were recorded from the more distant stations, while in the case of Dorchester, distant 160 kilometres, the deviations were as much as 50° on occasions. From a study of these observations it is concluded that the effective points of reflection at the ionosphere may be as much as 50-100 km. out of the great circle path.

A Radio Control System for Model Aircraft. (L. A. Weiss, The Aero Modeller, Vol. III, No. 33, August, 1938, pp. 447-451.) (58/60 Great Britain.)

The aircraft receiver weighs about 6lbs. and is intended for a relatively large engine-driven model of 14ft. span.

The emitting station sends out a continuous train of 6 m. waves which can be modulated at will at seven different audio frequencies in the neighbourhood of 200 cycles per sec. The required modulation is produced by a vibrating reed and the receiving circuit is such that the corresponding reed possessing the modulation frequency is set in resonant vibration. This closes a relay circuit which in its turn operates a small electric motor to move the controls. The seven reeds provided suffice for the operation of the elevator (2), aileron (2), rudder (2) and ignition (1). Some details of the electrical circuits are given.

Flight tests have so far not been carried out.

Some Fundamental Factors in the Design of Permanent Magnets. (Post Office Engineering Dept., Library Circular, Vol. 15, No. 5, 1938, Informative Summary No. 19, pp. 1-6; Post Office Research Station, Dollis Hill, London, N.W.2.) (58/61 Great Britain.)

The simple requirements of magnet design are formulated and the significance of the quantities involved is discussed by consideration of the demagnetisation curve of a magnetic material. The pertinent properties of some alloys are given in the following table:—

Magnetic Property.	Alnico	Alni	35 % Cobalt Steel.	15 % Cobalt Steel.	3 % Cobalt Steel.	6 % Tungsten Steel.
Remanence ...	7,500	5,500	9,000	8,000	7,200	10,500
Coercive force ...	500	500	255	195	135	65
BH_{max}	18×10^5	12×10^5	10×10^5	6×10^5	4×10^5	3×10^5
H at BH_{max} ...	380	320	155	120	90	45
B at BH_{max} ...	4,700	3,800	6,000	5,100	4,500	7,100

In order that the flux density shall be reasonably high, the demagnetising force H_d must be appreciably less than the coercive force H_c. In the case of the older alloys, such as tungsten steel with a coercive force of 65 c.g.s. units, the maximum value of demagnetising field which can be allowed to develop without a serious reduction in flux density is limited to a fraction of this value. In the case of the newer alloys with coercive forces of 500, demagnetising fields of the order of ten times those allowable in tungsten steel can be developed without serious reduction of flux density, and in consequence very much shorter magnets of the newer materials can be used without serious demagnetisation.

A Direct Reading Radio Wave (Reflection Type) Absolute Altimeter for Aircraft. (S. Matsuo, Proc. Inst. Rad. Eng., Vol. 26, No. 7, July, 1938, pp. 848-858.) (58/62 Japan.)

A frequency modulated radio wave is emitted from the plane and the beat frequency resulting from the combination of direct and ground reflected wave is measured. This beat frequency depends directly on the altitude and can be recorded as such by a pointer reading.

The wave length employed was 50 cm. with a modulative frequency of 25 cycles/sec.

Ground calibration tests with this instrument are described for distances ranging from 4 to 160 m. (waves emitted horizontally and reflected from a vertical obstacle).

It appears that the accuracy is ample for navigational purposes, the power consumption being of the order of 2 watt.

No weights are given.

The Graphical Solution of Ordinary Differential Equations. (V. A. Bailey and J. M. Somerville, Phil. Mag., Vol. 26, No. 173, July, 1938, pp. 1-31.) (58/63 Great Britain.)

It is shown how a number of simple and inexpensive graphical devices may be applied to the solution of a large class of ordinary differential equations such as are frequently met with in applied mathematics. The relatively high cost of machines like Bush's differential analyser leaves room for such graphical methods when an accuracy of the order of 1 per cent. is sufficient. The treatment is general and emphasis is laid on the method of attack rather than on the solution of particular equations. In a subsequent paper, the application of these methods to particular equations of importance in various branches of applied mathematics will be given in greater detail.

On Bi-Partitional Functions. (P. V. Sukhatme, Phil. Trans. Roy. Soc., Series A, Vol. 237, No. 780, 10/6/38, pp. 375-409.) (58/64 Great Britain.)

The transformation formulæ of symmetric functions involve arithmetical functions, each of which depends from two partitions of the same partible number. Of these bi-partitional functions twelve may be recognised as fundamental. Some of these have been previously studied individually, and in the present paper an attempt is made to set out systematically their mutual relationships and, with respect to each, their connections with distributions in plano and with the combinatorial problems of which they afford solutions. Particular attention is given to the practical evaluation of these functions for the partitions of numbers up to about twenty, with a view to their use in the simplification of heavy algebraic transformations.