ABSTRACTS FROM THE SCIENTIFIC AND TECHNICAL PRESS.

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

No. 69. JULY, 1939.

Machine Gun Defence Against Low Flying Aircraft. (Lieut.-Col. Malvani, Rivista di Fanteria, May and July-August, 1938. W.T.M., No. 8, August, 1938, p. 384, and No. 2, Feb., 1939, p. 94.) (69/1 Italy.)

The article is of interest since it gives details of the number of hits by rifle and machine gun fire suffered by Italian low flying aircraft operating in Abyssinia.

In view of the short time the aircraft is under fire, it is essential that the gun control be as simple as possible. Best results are obtained by putting up a barrage through which the attacking aircraft must fly in order to attack the target. The gunner must know when to open fire and the angular lead required. For training, the author recommends miniature ranges, the target being at a distance varying between 2.5 m. and 30 m. Size of target, speed of travel and speed of bullet are arranged to correspond to the actual case. It is essential that the fire burst be always in front of the aircraft, the elevation being corrected subsequently as required. If tracer ammunition is used, the sight is only used for the first burst. Mixing tracer and ordinary bullets is not recommended.

It must always be remembered that the aircraft will drop its bomb whilst still at some distance from the target and the barrage must be placed accordingly. In conclusion some results obtained with machine guns against towed targets are given. At a distance of 110 m., 12 hits were scored for a burst of 445 rounds.

The Problems of the Electro-Magnetic Gun. (E. Rogge, Z.G.S.S., Vol. 34, No. 5, May, 1939, pp. 132-5.) (69/2 Germany.)

The author investigates in general terms the design of an electromagnetic gun consisting of 10 coils placed in series (total length 20 m.). A muzzle velocity of 1500 m./sec. is aimed at, the shell weighing 20 kg. and having a diameter of 10 cm. It is estimated that about 14,000 kw. of electrical energy will be required, the maximum current being of the order of several hundred thousand amps.

One of the main difficulties in the design will be the realisation of a sufficiently small time constant for the magnetic coils.

A further difficulty arises from the fact that it is not possible to rotate the shell and hence the stability of the trajectory will be poor.

Summing up the author considers that there exists very little prospect of the electromagnetic gun ever becoming a practical proposition.

Maximum Speed of Projectile which can be Reached with Present-Day Explosives. (H. Langweiler, Zeitsch. f. Techn. Physik., Vol. 19, No. 11, 1938, pp. 416-421.) (69/3 Germany.)

The motion of the projectile along the barrel of the gun necessarily produces a pressure difference between the base of the projectile and the closed end of the gun. The limiting projectile speed is reached when the pressure on its base has dropped to zero, *i.e.*, the projectile is moving at molecular velocity. Thus even if the gun is infinitely long, the explosive converted instantaneously into gas, and the mass of the projectile infinitely small, the speed is finite and (according to the author's calculation) of the order of 2800 m./sec. for a nitro cellulose powder. The molecular speed is increased if the explosive detonates. In this case nitro cellulose would give a limit of 3800 m./sec., whilst theoretical speeds of the order of 6000-7000 m./sec. are indicated for some other explosives of higher heat content. The author confirmed his prediction for the case of nitro cellulose (surface treated to give maximum rate of burning) by actually measuring the muzzle velocity of a series of projectiles of gradually decreasing mass by three different methods (perforation of wire, high speed cinema, shock wave, *i.e.*, Mach Angle). All three methods agreed in giving a limiting speed of 2790 m./sec. for this explosive.

Merchant Marine Losses in the Spanish and Chinese Wars, Sept., 1936-Dec., 1938. (U.S. Nav. Inst. Proc., Vol. 65, No. 436, p. 920.) (69/4 Denmark.)

According to statistics of a Danish Insurance Company, taking both theatres of war together, 160 ships were damaged and 106 totally lost.

It is interesting to note that 96 per cent. of the damaged cases were due to air attack, the remainder being accounted for by guns from ship or shore batteries. Of the total losses, 50 per cent. were due to attack by aircraft.

The Audibility of Warning Sirens in the Presence of Street Noises. (P. Baron, Comp. Rend., Vol. 208, No. 22, 30/5/39, pp. 1714-15.) (69/5 France.)

Typical street noises were recorded on a gramophone disc and reproduced electrically in a sound insulated room. In the same room was also reproduced the note of a siren of constant pitch (400/sec.). The intensity of the sound emitted by the siren as well as the noise level of the street record could be adjusted over wide limits. The degree of audibility of the siren was judged by six observers and was expressed as the fraction of the total experimental time during which the siren was audible above the street noises, for a given intensity of both note and noise. The following principal conclusions were drawn:—

1. Audibility changed from 15 per cent. to 90 per cent., for an increase in signal strength of 17 decibels.
2. For constant audibility, the signal strength must vary as the mean intensity of the street noise.
3. For general warning (untrained public) an audibility of 90 per cent. is required, *i.e.*, the intensity of the signal must be of the same order as that of the noise level.
4. Audibility is increased by a continuous change in frequency of the siren (constant intensity). A change in intensity at constant frequency produces a smaller audibility than the normal siren.

The Air Force of the U.S.S.R. (Quoted from Deutsche Wehr. L'Air, No. 472, 1/7/39, p. 429.) (69/6 Germany.)

The modern aircraft material of the U.S.S.R. amounts to 5,000 aircraft, of which 3,000 are fighters and only 500 heavy bombers.

The remainder of the fighting force (a further 5,000 machines) is considered to be obsolete.

The Russian fighters have shown up well in Spain and China. It must, however, not be forgotten that they were probably manned by picked crews. It is certain that the rank and file are very much inferior.

The industry is in need of skilled workmen, and matters are rendered more difficult by the periodical " purges " of the higher posts. It is significant that not a single aircraft engine of Russian design rated at above 1,000 h.p. is in production. The majority of the engines utilised are of American or French design and built under licence.

Aeronautics and National Defence. (I. I. Sikorsky, Mech. Eng., Vol. 61, No. 7, July, 1939, pp. 523-524.) (69/7 U.S.A.)

The Air Arm is a relatively new weapon which has as yet not been tried out on a really large scale. It appears likely, however, that results obtainable under such conditions will bear no resemblance to what occurred in the 1914-18 war. If a large town were raided by relays of bombers, say at the rate of 50 an hour, operating day and night for weeks on end, there is no doubt that life and work would become intolerable. Assuming 500lb. bombs are used by the raiders, the 50 machines could carry about 400 bombs. If these are dropped in line at intervals of about 150 feet, a line of destruction over a mile long would be created across which neither fire brigade nor ambulances could proceed. A fresh line would be created every hour, the menace being entirely a question of the number of aircraft available for the attack.

The author estimates that Germany is producing 30-40 good warplanes a day and this output could be doubled in an emergency.

The Art of War—To-day and To-morrow. (H. Foertsch, Germany General Staff; Publishers, W. Andermann, Berlin, 1939.) (69/8 Germany.)

War has been defined as the carrying out of a national policy by forceful means (Clausewitz), and according to Bismarck, " The purpose of war is to obtain a peace which corresponds to the requirements of the national policy." Although in the past wars were often fought for much narrower reasons than the above, it is thought that in the future state policies as expressed in alliances will ultimately decide over war and peace.

To carry out a war with any chance of permanent success thus implies a clear national policy, *i.e.*, the politician is more important than the general. On the other hand the general must be thoroughly familiar with a variety of new weapons and be able to ring the changes depending on circumstances.

His responsibility has thus increased enormously. The chances of breaking off an engagement and the resultant alternative periods of rest and activity which characterised the 1914-18 war are not likely to occur to anything like the same extent in a future campaign. In other words the fighting will be much more continuous.

The length of the campaign will depend on the relative " morale " of the opponents including the civilian population and this introduces a new factor.

A " lightning " campaign is, however, not probable unless the Air Force reveals itself capable of producing unexpected results when employed on a large scale.

Further Development of a Boundary Layer Profile with a Given Pressure Distribution. (H. Gortler, Z.A.M.M., Vol. 19, No. 3, June, 1939, pp. 129-140.) (69/9 Germany.)

The author develops a method for the calculation of the down stream development of a laminar velocity profile of known shape, the pressure distribution in the fluid being given. The method, although cumbersome, is accurate up to the point

of separation and can be applied in a number of cases where the well-known Blasius method fails.

As a practical test the author investigates the case of a circular cylinder, his theoretical prediction being in satisfactory agreement with experiments.

Air Flow in the Boundary Layer of an Elliptic Cylinder. (G. B. Schubauer, N.A.C.A. Tech. Report No. 652, 1939.) (69/10 U.S.A.)

The boundary layer of an elliptic cylinder, of major and minor axes 11.78 and 3.98 inches respectively, was investigated in an air stream in which the turbulence could be varied. Conditions were arranged so that the flow was two-dimensional with the major axis of the ellipse parallel to the undisturbed stream. Speed distributions across the boundary layer were determined with a hot-wire anemometer at a number of positions about the surface for the lowest and highest intensities of turbulence, with the air speed in both cases sufficiently high to produce a turbulent boundary layer over the downstream part of the surface. The magnitude and the frequency of the speed fluctuations in the boundary layer were also measured by the use of the conventional type of hot-wire turbulence apparatus. Stream turbulence was found to affect both the nature of transition from laminar to turbulent flow in the layer and the position on the surface at which transition occurred.

Transition was then investigated in detail with stream turbulence of several different scales and intensities. It was found that the position of transition could be expressed as a function of the intensity divided by the fifth root of the scale.

New Methods of Calculation for Ventilators and Blowers of the Radial Type. (B. Eck, Schweizer Bauzeitung, Vol. 113, No. 4, 28/1/39, pp. 1-7.) (69/11 Germany.)

In the case of radial blowers it is possible to give optimum theoretical values for entry diameter, blade angle and blade width at entry.

The author determines the effect of practical tolerances in these dimensions, special attention being given to the permissible curvature of the leading edge of the blades.

The investigation is extended to cover radial blowers with blades possessing double curvature.

Some notes on propeller fans are added.

Lift Distribution on Wings Fitted with Lateral Disks. (W. Mangler, L.F.F., Vol. 16, No. 5, 20/5/39, pp. 219-228.) (69/12 Germany.)

The author calculates the lift distribution of a wing fitted with vertical plates and thus resembling the horizontal tail planes of certain machines fitted with twin rudders. The calculation is carried out for the case of minimum induced resistance, the plates, although symmetrical, being not necessarily situated at the ends of the span.

The work thus presents an extension of a previous report of the author (L.F.F., Vol. 14 (1937) pp. 564-569) available as Air Ministry Translation No. 623.

At a given angle of incidence, the total lift of the wing increases with increasing height of plates and reaches a maximum when the plates are at the ends of the span. The lateral forces and moments acting on the plates reach a maximum when the plates are attached to the end of the span, provided the plates project only along one wing surface. In the more general case where the plate projects both above and below the wing, maximum forces and moments on the plate occur when the latter are at some small distance from the ends.

The result obtained with end plates is extended to cover the case of the wing with bent-up wing tips.

Effect of Wing Load, Aspect Ratio and Load Distribution Along the Span on the Flight Performance. (B. Gothert, L.F.F., Vol. 16, No. 5, 20/5/39, pp. 229-276.) (69/13 Germany.)

The following are the main conclusions:—

(1) An increase in wing loading is mainly beneficial in the case of fast aircraft operating at moderate altitude.
(2) With the increasing utilisation of aerodynamically efficient aircraft the choice of optimum wing loading becomes more restricted.
(3) In the case of long range aircraft (small power loading) it is beneficial to combine increase of aspect ratio with increase in wing loading.
(4) The optimum wing loading for condition of climbing is the greater, the greater the power and aspect ratio and the smaller the height.
(5) The aircraft is most sensitive to a departure from the optimum wing loading at small values of the power/weight ratio.

De Havilland V.P. Airscrew, Pt. III. (Machinery, 8/6/39, pp. 289-295. Metropolitan-Vickers Tech. News Bull., No. 665, 16/6/39, p. 4.) (69/14 Great Britain.)

The production of the blades for the de Havilland variable-pitch airscrew is described in this article. The blades are produced in several types and sizes, the majority of them being made from aluminium alloy forgings. Aerodynamic considerations of their form and profile necessitates a considerable amount of handwork. Reduction in the amount of this handwork is effected by the use of highly specialised shaping and turning tools as fully described. Methods of testing, balancing, grinding and anodizing the blades are dealt with in some detail.

Illustrated with 13 photographs and three diagrams.

De Havilland V.P. Airscrew, Pt. II. (Machinery, 1/6/39, pp. 257-262. Metropolitan-Vickers Tech. News Bull., No. 664, 9/6/39, p. 4.) (69/15 Great Britain.)

The production of the spiders, barrels and cylinders for the 5,000-type variable pitch airscrew made by the de Havilland Aircraft Co. Ltd., has already been dealt with in two previous articles. This article deals with the production of the remaining components of this airscrew including the counterweight bracket, the blade bush, and the barrel support. The set-up for milling the profile and radial slots and the various grinding operations as well as the system of inspection and testing used are described in detail.

Illustrated with 11 photographs and three sketches.

An Approximate Spin Design Criterion for Monoplanes. (O. Seidman, C. J. Donlon, N.A.C.A. Tech. Note No. 711, June, 1939.) (69/16 U.S.A.)

In the present state of knowledge, no criterion is available that will infallibly predict the recovery characteristics of a new aeroplane design. It is possible, however, to formulate empirical criterions that are helpful in establishing the minimum design requirements for safety in spinning. It is believed that the tail damping-power factor (TDPF)* developed by the author is a simple practical method for rapidly estimating whether a new design is likely to comply with

* Tail damping-power factor (TDPF) = Unshielded rudder volume coefficient × tail damping ratio.

$$= \frac{\text{Unshielded rudder area} \times l}{S(b/2)} \times \frac{\text{Total fixed area below horizontal tail surface} \times L^2}{S(b/2)^2}$$

where l = distance of centroid of unshielded rudder area from C.G. of aircraft.
L = distance of centroid of fixed area below horizontal tail surfaces from C.G. of aircraft.
S = wing area.
$b/2$ = semi-span.

the minimum requirements for safety in spinning and it is recommended that no new monoplane design be constructed which possesses a TDPF of less than 0.00015. It should not be assumed, however, that a design which has a satisfactory TDPF will necessarily exhibit good recovery characteristics, as other factors not herein considered may influence the results.

General Aeroplane Performance. (W. C. Rockefeller, N.A.C.A. Tech. Report No. 654, 1939.) (69/17 U.S.A.)

Equations have been developed for the analysis of the performance of the ideal aeroplane, leading to an approximate physical interpretation of the performance problem. The basic sea-level aeroplane parameters have been generalised to altitude parameters and a new parameter has been introduced and physically interpreted.

The performance analysis for actual aeroplanes has been obtained in terms of the equivalent ideal aeroplane in order that the charts developed for use in practical calculations will for the most part apply to any type of engine propeller combination and system of control, the only additional material required consisting of the actual engine and propeller curves for the propulsion unit.

Finally, a more exact method for the calculation of the climb characteristics for the constant speed controllable propeller is presented in the appendix. This method replaces the approximate method, contained in the main body of the paper, in cases where the approximate method is not sufficiently accurate.

An Introduction to Seaplane Porpoising. (A. Klemin, J. D. Pierson and E. M. Storer, J. Aeron. Sci., Vol. 6, No. 8, June, 1939, pp. 311-318.) (69/18 U.S.A.)

Seaplane porpoising may be defined as an oscillatory combination of pitching and vertical motion of increasing amplitude.

Whilst independent motions in rise and pitch are usually stable in themselves, cross-coupling may produce instability.

Porpoising occurs both in alighting and take-off, but is generally more dangerous in the latter case since conditions of constant speed and trim may persist over a relatively long period.

The best way to check porpoising is to alter the angle of trim and endeavour to get through the dangerous region as quickly as possible. It appears that a change in C.G. position is only of use in so far as it affects the ease with which the pilot can control trim.

Porpoising tests on a hull alone may be very deceptive since the aerodynamic damping of pitching oscillation by the horizontal tail plane is not included.

The derivatives controlling the motion of a hull depend on a complex relationship between shape and speed and the magnitude of the coupled derivatives on which porpoising depends is thus not often known with sufficient accuracy. If, however, a complete test of the hull is available, the authors show how to predict the effect of certain change such as beam loading and trim angle.

Some Structural Problems Pertaining to Pressurised Fuselages. (L. F. Engelhardt, J. Aeron. Sci., Vol. 6, No. 8, June, 1939, pp. 319-322.) (69/19 U.S.A.)

Loads due to pressurisation have certain peculiarities which distinguish them from flight or landing loads. The magnitudes of the imposed loads are very accurately known, and cannot with the provision of suitable safety valves, be appreciably exceeded.

Since the structure is subjected to its maximum probable imposed loads for a considerable portion of its service life, this being its normal operating condition, the pressure shell should have an appreciable allowance for fatigue, material creep, etc.

Normal allowance is ample for variations in material or fabrication and for uncertainties of analysis methods because it is so simple by means of a proof test to check the strength of the shell with an authentic representation of the loads due to pressurisation.

A practical design might use the following design load factors:—

(1) For a steady flight condition superimpose upon the loads due to normal unaccelerated flight those due to the maximum probable pressure differential, the latter to be multiplied by a constant which would provide for fatigue, creep of the material, and the excess pressure possible before the safety valves can open. This factor should probably be between 1.25 and 1.50. Both flight and pressure loads should then be multiplied by the conventional 1.50 for design purposes.

(2) For momentary accelerations the pressure loads without the factor for fatigue, etc., should be superimposed on the critical limit flight loads. As before, both flight and pressure loads should be multiplied by the factor 1.50 for design purposes.

A Comparison of Several Tapered Wings, Designed to Avoid Tip Stalling. (R. F. Anderson, N.A.C.A. Technical Note No. 713, June, 1939.) (69/20 U.S.A.)

Optimum proportions of tapered wings were investigated by a method that involved a comparison of wings designed to be aerodynamically equal. The conditions of aerodynamic equality were equality in stalling speed, in induced drag at a low speed, and in the total drag at cruising speed. After the wings were adjusted to aerodynamic equivalence, the weights of the wings were calculated as a convenient method of indicating the optimum wing. The aerodynamic characteristics were calculated from wing theory and test data for the aerofoil sections. Various combinations of washout, camber increase in the aerofoil sections from the centre to the tips, and sharp leading edges at the centre were used to bring about the desired equivalence of maximum lift and centre-stalling characteristics.

In the calculation of the weights of the wings, a simple type of spar structure was assumed that permitted an integration across the span to determine the web and the flange weights. The covering and the remaining weight were taken in proportion to the wing area. The total weights showed the wings with camber and washout to have the lowest weights and indicated the minimum for wings with a taper ratio between 1/2 and 1/3.

Tests of Two Full-Scale Propellers with Different Pitch Distributions at Blade Angles up to 60°. (D. Biermann and E. P. Hartmann, N.A.C.A. Tech. Report No. 658, 1939.) (69/21 U.S.A.)

Two three-blade 10-foot propellers were operated in front of a liquid-cooled engine nacelle. The propellers differed only in pitch distribution; one had normal distribution (nearly constant pitch for a blade angle of 15° at 0.75 radius), and the other had the pitch of the tip sections decreased with respect to that for the shank sections (blade angle of 35° for nearly constant pitch distribution). Propeller blade angles at 0.75 R from 15° to 60°, corresponding to design speeds up to 500 miles per hour, were investigated.

The results indicated that the propulsive efficiency at a blade angle of 60° was about 9 per cent. less than the maximum value of 86 per cent., which occurred at a blade angle of about 30°. The efficiency at a blade angle of 60° was increased about 7 per cent. by correcting for the effect of a spinner and, at a blade angle of 30°, about 3 per cent. The peak efficiencies for the propeller having the washed-out pitch distribution were slightly less than for the normal propeller, but the take-off efficiency was generally higher.

Supercharger Tests on Precombustion Chamber Diesel Engines. (E. Schmidt, Yearbook of German Aeronautical Research, 1938, Vol. 2, pp. 48-52.) (69/22 Germany.)

The majority of the experiments were carried out on two Daimler-Benz four-stroke Diesel locomotives normally rated at 300 and 400 h.p. respectively and fitted with exhaust driven superchargers of the Brown-Boveri type.

It appears that this type of engine is specially suited for supercharging, since the design is already characterised by low explosion temperatures. With increased boost, the ignition lag is reduced and there appears to be no difficulty in keeping the explosion pressure down to reasonable values by the simple process of altering the injection cam so as to reduce the initial rate of fuel injection. The author gives some examples of the importance of valve overlap and discusses the design of exhaust piping so as to ensure adequate scavenging.

The quantity of scavenge air required is much less than on a two-stroke engine. In the case of a locomotive normally rated at 300 h.p. and boosted to 450 h.p., the scavenge air only amounts to 24 per cent. of the total air consumption. Under these conditions, the induction pressure was of the order of 1.35 atm. abs., and the fuel consumption below 160 gm./b.h.p. hour.

It is stated that the altitude behaviour of the engine fitted with exhaust driven supercharger is very favourable and that an aircraft engine could be designed weighing not more than 0.7 kg./h.p.

Effect of Piston Ring Material on Running Time. (M. Kuhm, Yearbook of German Aeronautical Research, 1938, Vol. 2, pp. 87-96.) (69/23 Germany.)

The experiments were carried out on an air-cooled single cylinder engine of approximately 1 litre volume running at 3,000 r.p.m. (C.R. 6.35, b.h.p. 23). Four different kinds of piston ring material were employed, the principal criterion being the duration of run before seizure of ring in grooves. Two kinds of seizure have to be distinguished:—

(*a*) Caking of oil in ring groove after an appreciable running time—heavy oil supply. In this case ring material has but little effect and the elasticity of the " freed " ring is not seriously impaired.

(*b*) Seizure in groove due to prior loss of elasticity, relatively short running time—small oil supply. This form of failure can be influenced by choice of material (type of cast iron).

Unfortunately ring materials capable of withstanding high working temperatures without serious loss of elasticity are not capable of forming good gas seals.

For this reason the author recommends composite rings, the outer member providing the seal and possessing good running-in qualities whilst the inner member is responsible for maintaining the contact pressure. The best running times on the test engine (150 hours) were obtained with a bimetal ring of bronze and cast iron of this type. With a very hard cast iron ring, on the other hand, seizure took place after as little as six hours.

The Load Distribution in a Roller Bearing Connecting Rod. (W. Hampp, Yearbook of German Aeronautical Research, 1938, Vol. 2, pp. 102-6.) (69/24 Germany.)

The load distribution in a roller bearing can be calculated on the supposition of complete rigidity and absence of clearance. In practice the distribution differs appreciably from this depending on how the load is transmitted to the bearing (deformation due to elasticity of the rod).

Thus we may have a few rollers only taking the whole load or the deformation of the outer ring may cause a more or less uniform distribution of the load over a large number of rollers. In the first case, experiment showed that the roller pressures were from 25-45 per cent. greater than in the theoretical case. Sharing the load over a large number of rollers has, however, the disadvantage that

localities which are theoretically unloaded now experience high pressures without effectively contributing to the load capacity of the bearing. Each single roller is loaded over a relatively long path which reduces the life and induces skidding and tilting of the roller. This difficulty can be overcome to some extent by suitable design of rod. Attempt should be made to equalise as much as possible the load distribution under tension and compression and the forces should be introduced tangentially by the rod so that the roller pressure at right angles to the load is kept as small as possible.

Problems in the Construction of Ball and Roller Bearings for Speed of Rotation Above 20,000 *r.p.m.* (H. Merkle, Yearbook of German Aeronautical Research, 1938, Vol. 2, pp. 107-109.) (69/25 Germany.)

The author deals shortly with the following aspects of the problem :—

1. Materials.
2. Manufacture.
3. Clearance.
4. Lubrication.
5. Installation.
6. Temperature.
7. Load carrying capacity.

Reference is made to reinforced synthetic resins as a suitable material for the cages of high speed blower bearings. Such cages are standard practice in the U.S.A.

Bearings up to 20 mm. bore and operating up to 30,000 r.p.m. can be lubricated satisfactorily with oil mist or spray. Larger bearings, however, must be pressure lubricated, a 25 mm. bearing requiring roughly 6 litres of oil per hour. Great care must be taken to prevent loss of oil to the outside. At the same time ample facilities must be given for the oil to leave the bearing, the exit pipe having at least ten times the section of the oil supply.

Properly designed bearings, carefully installed, have a life well in excess of 5,000 hours for bearing temperatures up to 130°C.

Experiments on Ball and Roller Bearings Under Conditions of High Speed and Small Oil Supply. (G. Getzlaff, Yearbook of German Aeronautical Research, 1938, Vol. 2, pp. 110-118.) (69/26 Germany.)

The author describes a testing machine on which 35 mm. bearings (bore) can be run at speeds of the order of 20,000 r.p.m. whilst the following factors were recorded :—

(1) Oil circulation through bearing and temperature of oil.
(2) Maximum temperature of outer bearing ring.
(3) Radial and axial load on bearing.
(4) Radial, axial and angular clearance of bearing.
(5) Power consumption of bearing.

The experiments show that the lubrication was most reliable and oil consumption least when the oil was introduced through a hole in the outer or inner ring of the bearing. In the case of roller bearings the oil circulation could be kept especially low (0.5 l/h and less).

The temperature of the bearing is mainly determined by the radial clearance. A satisfactory performance could always be achieved on shafts without overhang provided the radial clearance was of the order of 30 μ.

The axial load also increases the working temperature and it obviously pays to have oil of low viscosity.

Increasing the oil flow from 2 to 20 l/hour practically doubles the power consumption of the bearing.

Vibrations of Helical Valve Springs. (A. Hussmann, Yearbook of German Aeronautical Research, 1938, Vol. 2, pp. 119-133.) (69/27 Germany.)

Valve spring vibrations are forced vibrations induced by higher harmonics of the valve lifting cam. It is possible to determine the relative importance of the forcing impulses from a harmonic analysis of the cam profile if the elastic constants of the spring and the damping are known. Conversely, it is possible to design cam shapes such that no notable spring vibrations occur over a given speed range of the engine.

The successful employment of such cams presupposes that the valve clearance is maintained small (of the order of 0.3 mm.).

Investigations of the Causes of Breakage of Valve Springs. (R. Hunlich and W. Pungel, Yearbook of German Aeronautical Research, 1938, Vol. 2, pp. 134-140.) (69/28 Germany.)

Most of the breakages seem to be associated with surface defects (longitudinal grooves) produced during manufacture of the wire and aggravated by corrosion.

On deep etching, the broken wire often showed, in addition, peculiar notches of sharply defined saw tooth pattern. These notches are produced by fatigue when operating over a certain section of the Wohler curve, and their formation is apparently independent of the structure of the steel.

The author describes test results on 231 valve springs of which 136 broke. Of the total breakages only 23 showed no visible surface defects. Similarly of the 95 sound springs, 79 showed no surface defects.

New Knowledge on the Production and Testing of High Quality Steel Wires with Special Reference to Valve Spring Wire. (P. Kotzschke, Yearbook of German Aeronautical Research, 1938, Vol. 2, pp. 319-325.) (69/29 Germany.)

Till relatively recently, most of the spring wire used in Germany was imported either in the form of plain carbon or chrome-silicon steel. The object of the present investigation is to demonstrate that wire at least as good as the imported article is now made in Germany For this purpose 15 tons of carbon steel ingots of similar composition to the Swedish imported wire were distributed to four different rolling mills to produce wire of 6.75 mm. diameter. This wire then went to two different wire drawing firms, the diameter being reduced to 3.9 mm. After drawing, the wire was heat treated (oil bath) and tempered (lead bath) and finally ground to 3.6 mm. diameter.

The springs were finally coiled by two different spring manufacturers and then subjected to an extensive examination, including etching (surface defects), fatigue strength (on a special testing machine) and surface cracks (magnetic powder test). Several thousand springs, of which all the past manufacturing history was known, were tested and compared with the best foreign product.

The article concludes with a description of the surface treatment known in America as " shot blasting." This is similar to sand blasting except that the blasting material must be small (less than 0.5 mm. diameter) and slightly harder than the steel.

The resultant " cold working " of the wire surface increases the fatigue strength of the material, provided the blasting is carried out with sufficient care.

The Charging Process and Limits of Valve Operation in Four-Stroke Aero Engines. (F. R. Schmidt, L.F.F., Vol. 16, No. 5, 20/5/39, pp. 251-275.) (69/30 Germany.)

The Lilienthal Society offered a prize for the best paper on this subject. The winning contribution has not been published, but the present paper as well as the essay forming the subject of Abstract No. 69/31 were awarded consolation prizes.

It is obvious that further attempts at a reduction in the specific weight of four-stroke aero engines can only be successful if increased boost pressure is accompanied by a further increase in r.p.m. It is interesting to note that with a given engine, the maximum performance at any boost recurs at the same r.p.m. The relative flow losses are thus constant and the optimum speed of operation is entirely a question of valve passage design, provided of course that no mechanical trouble due to valve operation arises at the higher speeds. The author considers this side of the problem very fully and concludes that the present four-stroke mechanism with poppet valves will be able to deal with such further increase in r.p.m. as is likely to arise in the near future, bearing in mind that ultimately the possible speed increase is limited by the piston cooling, and that improvements in the latter are bound to be slow.

A Comparison of Valve Mechanisms (Poppet and Sleeve) as Regards Limiting Values of Compression Ratio, Mean Effective Pressure and Specific Fuel Consumption. (T. Hoock, L.F.F., Vol. 16, No. 5, 20/5/39, pp. 276-282.) (69/31 Germany.)

In the case of poppet valves, a high temperature of the exhaust valve cannot be avoided and this puts an upper limit to the compression ratio and amount of permissible boost (detonation of charge).

The author describes the Cross rotary valve mechanism and gives some results obtained on small cylinders (under 500 c.c.). In this case the temperature of the valve mechanism can be kept quite low and provided the mechanism can be adapted to larger cylinders without difficulty, it should be possible to run a three-litre cylinder at a compression ratio of 9/1 with 87 octane fuel, giving a specific fuel consumption of about 170 gm. per b.h.p. hour (0.38 lb.).

It is recommended that further experiments be carried out with this valve mechanism, which is considered to be in some respects more promising than the Burt sleeve developed by Bristols. (According to the author the Burt sleeve distorts since one side is permanently cooled by the fresh charge. As a result, this kind of sleeve valve engine is strictly limited as regards overload.)

Detonation and Combustion Chamber Design. (K. Zinner, A.T.Z., Vol. 42, No. 9, 15/5/39, pp. 251-9.) (69/32 Germany.)

The " rest gas " responsible for the phenomenon of engine detonation receives heat by adiabatic compression and transfer from the flame front. But the most important source of heat energy resides in the " rest gas " itself and is associated with preliminary reactions of the chain type. The shape of the combustion chamber and especially the plug position will affect the amount of " activation " of the unburnt charge. Thus if the flame path is long, the available time for activation of the residue increases and with it the chance of detonation, unless care is taken to thoroughly cool all pockets, etc. An increase in combustion speed reduces the time of activation, but on the other hand increases the heat transfer to the residue brought about by compression. Generally speaking, the reduction in activation time is more important and therefore a turbulent combustion chamber is anti-knock.

The general problem of the relative importance of activation time and heat transfer is, however, very complicated and heat transfer tests under engine conditions are urgently required.

Combustion Engines with Pneumatic Power Transmission. (H. G. Hammar, E. Johansson, Trans. Inst. Marine Eng., May, 1939, pp. 139-154. Metropolitan Vickers Tech. News Bull. No. 664, 9/6/39, p. 11.) (69/33 Great Britain.)

This article discusses the " Götaverken " system of power transmission which it is claimed has been successfully applied to the propulsion of several types of

ships. The system comprises two sections—the prime mover or generator, and the propulsive unit. The former is a combustion engine, whilst the latter can comprise either a turbine or a reciprocating engine. Transmission is carried out by a mixture of air and hot gases produced in the combustion engine. The many advantages claimed for this system of propulsion over Diesel and steam engine propulsion, and its thermodynamics, are fully discussed.

The main feature is a combination of the manœuvrability of the steam engine with the low fuel consumption of the Diesel.

Illustrated with 14 diagrams and sketches.

The Way to Increased Aeroplane Engine Power. (E. Vohrer, Luftwissen, Vol. 5, No. 10, October, 1938, pp. 357-67. Available as Translation T.M. 894.) (69/34 Germany.)

As recently as three years ago a high output engine was defined as one delivering 25 h.p. per litre. This figure has now been raised to at least 30 h.p. for continuous and nearly 40 h.p. per litre for discontinuous operation (take-off).

Better fuels, more efficient superchargers and higher boost pressures together with increase in r.p.m. are responsible for this improvement. The limit is not yet in sight, since peak outputs of the order of 100 h.p. per litre have already been obtained in the laboratory with spark ignition engines (water injection for cooling).

According to the author the most promising way of realising such high power outputs in practice would be by adopting the two-stroke principle possibly in conjunction with a sleeve valve mechanism.

As petrol injection is already extensively used on four-stroke engines, its application to the two-stroke engine would present no great difficulties.

Thin Oil Films. (W. Claypoole, Trans. A.S.M.E., Vol. 61, No. 4, May, 1939, pp. 323-33.) (69/35 U.S.A.)

A method is described for depositing very thin lubricating oil films of any specified thickness of the order of 10^{-7} in. on polished metal in connection with experiments on boundary friction. The oil to be deposited is converted into a highly dispersed fog consisting largely of positively charged particles. The oil is readily deposited on a negatively charged metal surface at a rate depending on the nature of the oil, the potential gradient at the metal surface, and the concentration of the oil particles in the fog. The rate of deposition is best determined by observation of the progressive change in the interference colour produced over a thickness range between 4×10^{-6} cm. and 30×10^{-6} cm. Comparison of colour with a standard stepped film of barium stearate laid down by the Langmuir and Blodgett technique gives a high degree of accuracy to the determination of film thickness.

Experiments have been made on the wearability of very thin oil films, and on the determination of the coefficient of static friction. An instrument is described which has been found especially suitable for this work. The author points out that a low value of the coefficient of static friction is a measure of the oiliness value of an oil metal combination.

Wear in Lubrication Problems. (L. M. Tichvinsky, Trans. A.S.M.E., Vol. 61, No. 4, May, 1939, pp. 335-46.) (69/36 U.S.A.)

Boundary or semi-fluid friction takes place in bearings of practically all rotating machines when they are started or brought to a standstill. This type of friction, lasting a short period of time, is usually accompanied by the wearing of the bearing surface, the journal surface, or both. Wear takes place also in the case of anti-friction bearings due to sliding, rolling, or combined sliding and rolling friction. Many other causes, such as misalignment, dirt, or inadequate lubrication, might be responsible for wearing of any type of bearing. This paper

deals with the methods which are employed to obtain the wear resistance of various metals, especially those used in the design of bearings.

A Comparison of Ignition Characteristics of Diesel Fuels as Determined in Engines and in a Constant-Volume Bomb. (R. F. Selden, N.A.C.A. Tech. Note No. 710, June, 1939.) (69/37 U.S.A.)

Ignition lag data have been obtained for seven fuels injected into heated, compressed air under conditions simulating those in a compression-ignition engine. The results of the bomb tests have been compared with similar engine data, and the differences between the two sets of results are explained in terms of the response of each fuel to variations in air density and temperature.

CONCLUSIONS.

1. The rating order for certain Diesel fuels, as indicated by the ignition lags in the bomb, may change with variations in either air temperature of density.

2. Usually, the lower the air temperature and density at which ignition takes place, the greater is the spread between the ignition lags of two fuels.

3. With the exception of the marine Diesel fuel, the rating order obtained with the bomb was the same as that with an engine.

The Ignition of Inflammable Gases by Hot Moving Particles. (S. Paterson, Phil. Mag., Vol. 28, No. 186, July, 1939, pp. 1-23.) (69/38 Great Britain.)

1. A survey of the literature of ignition by hot surface suggests that the speed of relative motion of gas and surface is a factor determining whether ignition takes place; it is further surmised that increase of speed results in decrease of igniting power.

2. An apparatus for examining the effect of speed when the surface is that of a small sphere is then described in detail.

3. The results obtained with this apparatus are given. They apply to coal-gas-air and may be summarised as follows:—

(*a*) There is a minimum ignition temperature, for a given size of sphere, below which ignition has not been obtained.

(*b*) For temperatures above this minimum, ignition is regularly observed, provided that the speed does not exceed a critical value.

(*c*) This critical speed is a function of the temperature; it increases as the temperature is increased, according to a roughly linear relation.

(*d*) The slope of the temperature critical speed characteristic decreases (*i.e.*, the critical speed for any given temperature increases) as the richness of the mixture is increased from its value at the lower explosive limit.

(*e*) The characteristics for fused silica ("quartz") spheres rise more steeply than those for platinum spheres of the same size, but the minimum ignition temperature is the same as before, and shows the same constancy with varying mixture strength.

(*f*) The platinum spheres are found to improve their igniting power with use.

(*g*) The initial temperature of the mixture appears to have no effect (over a range of 200°C.) on the minimum igniting temperature of a platinum sphere (2 mm.).

An Electro-Magnetic Indicator and Knock Meter. (J. Ratzke, Yearbook of German Aeronautical Research, 1938, Vol. 2, pp. 368-372.) (69/39 Germany.)

The principle of this instrument is similar to that of the electric extensometer described by the author in the 1937 Yearbook (Vol. 2, pp. 278-282). An alternating current bridge is fed with a high carrier frequency (of the order of 50,000/sec.) which becomes modulated depending on the motion of a soft iron armature moving in an inductive circuit. The armature is attached to a non-

magnetic diaphragm screwed into the combustion space, the whole recording unit having the outside dimensions of a normal sparking plug. For knock recording, the inductive circuit is simplified, one of the coils only being utilised. This coil is supplied with direct current and the resultant alternating p.d. produced by the motion of the armature when the engine knocks is recorded. The amplifying circuit is arranged so as to respond to the time variation of the p.d., *i.e.*, the final record corresponds to d^2p/dt^2.

Examples or records obtained on the C.F.R. engine under various conditions of operation show satisfactory working of the instrument as a knock meter.

Pulsating Air Velocity Measurements. (N. P. Bailey, Trans. A.S.M.E., Vol. 61, No. 4, May, 1939, pp. 301-8.) (69/40 U.S.A.)

This paper includes an analysis of the weaknesses of three methods of air velocity measurement, that is, (1) the hot wire anemometer, (2) the Thomas or Callendar meter, and (3) nozzles, orifices, or pitot tubes used with liquid manometers, and the author points out that all these methods give unreliable results when the air flow is pulsating. After analysing the influence of damping capacities the author describes a modified proportional flowmeter in which the pressure change of a nozzle, orifice, or pitot tube produces an air velocity through a small orifice which is always proportional to the instantaneous velocity of the main air flow; therefore, by measuring volumetrically the air that passes through the small orifice, the average velocity of the main air flow can be determined. Included in the paper are test results obtained with this meter on a $3\frac{1}{4} \times 4\frac{1}{2}$ in. single cylinder C.F.R. engine.

Effect of Pulsations on Orifice Meters. (S. R. Beitler, Trans. A.S.M.E., Vol. 61, No. 4, May, 1939, pp. 309-314.) (69/41 U.S.A.)

The paper describes three test set-ups made for investigating the effects of pulsations on orifice flow meters. Arrangements are described for subjecting meters to pulsations from either the inlet or outlet side and determining the error in measurement.

The work so far is admittedly preliminary, but the results show the extent and seriousness of the problem and point the way for further research which is of vital interest to the measurement industry.

Corrosion on Electrical Measuring Instruments. (F. Lieneweg, E.T.Z., 25/5/39, pp. 621-3. Metropolitan Vickers Tech. News Bull., No. 663, 2/6/39, p. 2.) (69/42 Germany.)

The author discusses the effect on electrical measuring instruments and measuring probes of corrosion which not only has a destructive effect on the material, but also affects the accuracy and reliability of measurement (corrosion due to electric current, leakage currents, precipitation of sulphur from rubber, frictional corrosion on steel points). He indicates remedies against the effects of such corrosion. Illustrated with three photographs.

Collector Ring Films (Formation and Influence). (V. P. Hessler, R. H. Savage, General Electric Review, May, 1939, pp. 192-7. Metropolitan Vickers Tech. News Bull., No. 663, 2/6/39, p. 10.) (69/43 Great Britain.)

The purpose of this article is to show something of the formation, nature and influence of corrosion film on sliding contact metallic surfaces. Most of the wide variation of resistance with current at the brush-ring contact is attributed to film formation, since a film-free ring exhibits essentially a constant resistance. Copper tarnish is only partially protective and corrosion may take place slowly through the oxide lattice. The existence and nature of the film can be determined by various physical and chemical means, but in an oxide layer on copper,

dielectric properties are so marked that resistance measurements are highly efficacious. The apparatus necessary to make such measurements and the author's interpretations of the results are given in detail.

Illustrated with one photograph and eight graphs.

Altitude Effects on an Uncompensated Rate-of-Climb Meter. (G. V. Schliestett, J. Aeron. Sci., Vol. 6, No. 8, June, 1939, pp. 323-8.) (69/44 U.S.A.)

The response of an uncompensated climb indicator to a sudden change in rate of climb and the accuracy of the indicated vertical speed during steady flight are treated as functions of altitude. Results of theory, laboratory tests, and flight tests are shown by non-dimensional curves. Agreement of the results is satisfactory. The observed flight responses of a climb indicator after sudden changes from level flight to actual climbs of 750, 1,050, and 2,150 ft. per min. are shown by curves of indicated and of actual rates of climb against time. Expressed in terms of non-dimensional quantities, these three curves are identical within the accuracy of flight tests.

The only compensation in this instrument is that which counteracts the effect of temperature on the properties of the materials in the pressure gauge. The air chamber is thermally insulated. The capillary is a glass tube that is not compensated in any way.

Some Notes on the Schuler Principle—the 84 Minutes Pendulum. (K. L. Stellmacher, Z.A.M.M., Vol. 19, No. 3, June, 1939, pp. 154-165.) (69/45 Germany.)

Schuler has shown that it is possible to compensate pendulum appliances against the effect of acceleration by utilising the change in the direction of gravity. This has led to the design of gyro-pendulums with an oscillation period of 84 minutes (*i.e.*, reduced length equal to the radius of the earth).

Schuler's principle has been very successfully applied in the gyro-compass. The proof given by him, however, is only valid if the accelerations act for a relatively short time. The author shows that this restriction is not necessary, provided the damping is sufficiently small. In the presence of finite damping, complete compensation against acceleration is not possible. There exists, however, an optimum period for which the effect of acceleration is least. This period is greater than 84 minutes if damping is present.

Some Studies on Wire Drawing. (M. Goto, H. Tanaka, Tokyo Aer. Res. Inst., No. 174, April, 1939, pp. 92-128.) (69/46 Japan.)

(1) When annealed wire which shows no sign of orientation is once drawn, it becomes oriented or fibrous. As it undergoes further drawings the degree of orientation is more pronounced. The rate of increase is not marked in the early stages of draft, but it becomes strikingly evident in the advanced stages.

(2) The fibrous nature of the wire increases as the centre of the wire is approached. At the extreme surface no sign of orientation is observed.

(3) If the draft per one pass is heavier, the wire becomes more fibrous provided it is carefully drawn.

(4) The more the lubricant diminishes the friction of a die, the more fibrous the wire becomes, that is, good lubrication imparts to the wire high degree of orientation.

(5) If the drawing speed is kept low the structure of the wire becomes more fibrous.

It has been found that if wire acquires a more fibrous structure, its mechanical properties, such as tensile and torsion strength are improved.

Thermal and Electrical Conductivities of Some Magnesium Alloys. (R. W. Powell, Phil. Mag., Vol. 27, No. 185 (Seventh Series), June, 1939, pp. 677-686.) (69/47 Great Britain.)

Results are given for the thermal and electrical conductivities of eight magnesium alloys at temperatures of 50°, 150° and 250°C. It is shown that these results can be represented to within 3.5 per cent. by the equation $K=0.526\times10^{-8}\,\rho T+0.027$, where K is the thermal conductivity expressed in gram calories per square cm. per second for 1 cm. thickness and 1°C. difference in temperature, σ is the electrical conductivity expressed in reciprocal ohms per cm. cube, and T is the absolute temperature. An analysis is then made of existing data for the conductivities of magnesium and magnesium alloys, from which it is concluded that the equation $K=0.516\times10^{-8}\,\rho T+0.022$ can be used to give an approximate value for the thermal conductivities of such metals.

A Note on the Nature of Sliding Friction. (J. J. Bikerman, E. K. Rideal, Phil. Mag., Vol. 27, No. 185 (Seventh Series), June, 1939, pp. 687-92.) (69/48 Great Britain.)

If sliding friction is due to cohesion, "welding," or plastic flow, the value of the coefficient of friction must depend on the previous overloading of the surfaces in contact. As this after-effect cannot be detected for hard surfaces, the friction between hard surfaces cannot be due to the above-mentioned effects. On the other hand, Coulomb's theory ascribing friction to a lifting of the slider over irregularities finds a semi-quantitative confirmation in the absolute value of the coefficients of friction.

Bearing Pressures and Cracks. (H. M. Westergaard, J. App. Mech., Vol. 6, No. 2, June, 1939, pp. 49-53.) (69/49 U.S.A.)

Two solids are examined which, before loading, are in contact along a row of evenly spaced lines in a horizontal plane. Between these lines the surfaces have a separation defined by a nearly flat cosine wave. A uniform pressure on top of the upper solid creates contact over an area consisting of a row of strips, reduces the separation of the solids between the strips, and creates contact pressures with vertical rises in the diagram of pressure at the edges of the strips. At a greater load the width of the strip becomes equal to the wave length, and the contact is complete. At still greater loads the stresses increase as if the two solids were one. The procedure by which this problem is solved is demonstrated first by showing its easy application to some well-known cases, especially Hertz's problem of circular cylinders in contact.

The Forces Required for Rolling Steel Strip Under Tension. (A. Nadai, J. App. Mech., Vol. 6, No. 2, June, 1939, pp. 54-62.) (69/50 U.S.A.)

In the continuous mills which have been installed during the last ten years, wide strips of steel are being rolled hot or cold. While the sheets are reduced under the lateral pressure of the rolls, tensile stresses are set up in the rolled strips. The influence of front or of back tension on the roll pressures is investigated and a theory developed for the rolling process considering tension.

The localised compression of wide sheets or strips under simultaneous application of tensile stresses is discussed under various conditions of surface friction, such as solid friction, uniform surface shearing stresses or a resistance to slipping proportional to the relative velocity of slip. Simultaneous pulling reduces considerably the pressures otherwise required for deforming metal through concentrated compression.

The theory of the rolling of wide sheets is discussed with particular reference to the influence of front and of back tension upon the rolling pressures and the results of such computations are shown in several examples. Treatment of the

equations aims at a simplified use of certain variables and parameters which are needed in such computations.

Numerical and Graphical Method of Solving Two-Dimensional Stress Problems. (H. Poritsky, H. D. Snively, C. R. Wylie, Jr., J. App. Mech., Vol. 6, No. 2, June, 1939, pp. 63-6.) (69/51 U.S.A.)

In developing their numerical and graphical method for solving two-dimensional stress problems, the authors use a tension member with a semi-circular notch as an example. The procedure actually has, however, a wide range of application. Comparison of the calculated results and those obtained from photoelasticity shows close agreement. The maximum value of the stress in the plate used as an example obtained by this method is 3.25. This compares with a maximum of 3.20 obtained photo-elastically by Wahl and Beeuwkes and a maximum of 3.05 obtained in the same manner by M. M. Frocht.

A Method of Calculating Energy Losses During Impact. (C. Zener and H. Feshbach, J. App. Mech., Vol. 6, No. 2, June, 1939, pp. 67-70.) (69/52 U.S.A.)

When an elastic sphere collides with another perfectly elastic body, part of the initial kinetic energy is lost in starting elastic waves in the two bodies. The author develops an approximate analytical method for this calculation which is applicable even when the greater part of the energy is dissipated.

The powerfulness of the method is illustrated by a complete survey of the problem of impact of spheres with beams fixed at each end. Graphs are constructed showing the variation of the coefficient of restitution with the length of the beam and the mass of the sphere is kept constant. The coefficient of restitution has a minimum for a certain optimal beam length, and is independent of the beam length for values greater than twice the optimal length. The coefficient is a minimum when the period of the fundamental mode of vibration is approximately equal to 2.4 times the time of contact.

The method is also applied to the impact of spheres with large thin plates. The semi-empirical formula of Raman is derived.

Calculation of Stresses within the Boundary of Photo-elastic Models. (R. Weller and G. H. Shortley, J. App. Mech., Vol. 6, No. 2, June, 1939, pp. 71-8.) (69/53 U.S.A.)

A method is proposed for the determination of the internal stresses in a two-dimensional system from data furnished by a photoelastic analysis. The method involves the numerical integration of the Laplace-difference equation over a region with known boundary values by the iteration of a set of improvement formulæ. The underlying theory is discussed briefly, reference being made to a more mathematical treatment appearing in another paper by the authors. New procedures for increasing the speed and accuracy of such computations are described and application is made to a typical photoelastic study. In this the complete system of internal stresses is computed, using the data obtained from the usual fringe photograph, without recourse to isoclinic lines, or other supplementary experimental measurements. The method is also applicable to other problems of potential theory which involve the vanishing of the Laplacian. These include electric fields, steady-state heat conduction, shapes of membranes, and problems in hydrodynamics and gravitation.

Creep, Elastic Hysteresis, and Damping in Bakelite Under Torsion. (H. Leaderman, J. App. Mech., Vol. 6, No. 2, June, 1939, pp. 79-85.) (69/54 U.S.A.)

The creep in torsion of various forms of bakelite under constant load and the creep recovery on removal of load is found to follow closely the superposition

principle or " memory law " of Boltzmann. If the previous maximum strain is exceeded, an additional plastic flow takes place which is not at any rate immediately recoverable.

A function of the elapsed time called the " equivalent time " is introduced in order to analyze the creep and creep recovery when the loading history is complex.

A method is developed for calculating the stress-strain loop due to creep for step-by-step cyclic loading. Results of cyclic-loading tests reveal the presence of a true elastic-hysteresis loop in addition to the loop due to creep.

The specific damping capacity in torsion at a given stress, calculated from the measured creep and elastic-hysteresis loop, is shown to agree fairly well with the damping measured directly.

The Propagation of a Pulse in the Atmosphere. (C. L. Pekeris, Proc. Roy. Soc., Vol. 171, No. 947, 7/7/39, pp. 434-449.) (69/55 Great Britain.)

It is shown that in a composite atmosphere, such as was assumed in a previous paper in connection with the theory of atmospheric tides, a surface pulse would excite waves of the first and second modes of oscillation, the amplitude of the former being greater than that of the latter by a factor varying from 2.4 to 2.9. This factor would tend to increase on account of dispersion. Some records of the atmospheric wave which was caused by the Krakatoa eruption of 1883 are discussed with a view to identifying the wave of the second mode. There are indications of this wave in the first passage and, to a lesser degree, in the second passage. The energy of these waves is estimated to be of the order of 10^{24} ergs. In the appendix is given the distribution with height of the vertical velocities in the two modes of oscillation of a model atmosphere. At heights of the order of 100 km., these velocities are found to be in phase with the surface pressure for both modes.

A Preliminary Study of the Prevention of Ice on Aircraft by the Use of Engine Exhaust Heat. (L. A. Rodert, N.A.C.A. Technical Note No. 712, June, 1939.) (69/56 U.S.A.)

An investigation was made in the N.A.C.A. ice tunnel at air temperatures from 20° to 28°F. and at a velocity of 80 miles per hour to determine whether ice formations on a model wing could be prevented by the use of the heat from the engine-exhaust gas. Various spanwise duct systems were tested in a 6-foot-chord N.A.C.A. 23012 wing model.

The formation of ice over the entire wing chord was prevented by the direct heating of the forward 10 per cent. of the wing by hot air, which was passed through leading-edge ducts. Under dry conditions, enough heat to maintain the temperature of the forward 10 per cent. of the wing at about 200°F. above that of the ambient air was required for the prevention of ice formation. The air temperature in the ducts that was necessary to produce these skin temperatures varied from 360° to 834°F.; the corresponding air velocities in the duct were 152 and 45 feet per second.

Ice formations at the leading edge were locally prevented by air that passed over the interior of the wing surface at a velocity of 30 feet per second and a temperature of 122°F.

Existing data indicate that sufficient exhaust heat is available; the problem is, therefore, to determine how this heat can be utilized to the best advantage or, in other words, the problem is one of distribution.

Report of the French Committee on Ice Formation on Aircraft. (Pub. Sci. et Tech. du Min. de l'Air, B.S.T. No. 85, 1939.) (69/57 France.)

This Bulletin, published in March, 1939, covers the Committee's findings of May, 1938.

As is well known, ice deposits on the wings and control surfaces are dangerous since they have a critical effect on the performance of the aircraft. It is obvious that under these conditions full engine power is of special importance and for this reason both the carburettor and propeller must be protected from any possible ice effect. This part of the problem is relatively simple and any failure on this account can only be attributed to carelessness.

As regards methods of overcoming wing icing, matters are more complicated and no completely satisfactory solution is known so far. The Goodrich mechanical deicer is satisfactory as regards the nose, but cannot be applied to slots and flaps without considerable complication.

The Committee seem to consider that a thermal method of getting rid of the ice is promising and in this connection seem to favour the electrical production of the necessary heat.

The obvious utilisation of the waste exhaust heat of the engine for this purpose is considered to be impracticable (see Abstract No. 69/56 for American experiments with exhaust heat deicers).

Detection of Turbulence of a Liquid by Means of Polarisation. (E. A. Hanser and D. R. Dewey, Ind. and Eng. Chem., Ind. Ed., Vol. 31, No. 6, June, 1939, p. 786.) (69/58 U.S.A.)

The use of transparent plastics in the construction of models for hydraulic research work is receiving increasing attention. Up to recently turbulent zones of flow in such systems were rendered visible by the addition of dyes to the liquid.

As an alternative the phenomenon of double refraction of colloidal dispersions can be utilised and has proved very useful especially at low rates of flow.

Anisometric particles will always tend to orientate themselves with one axis parallel to the direction of flow and this orientation is readily detected by placing the transparent container between crossed polaroid films and illuminating with strong diffuse light. Highly diluted water dispersions of natural bentonite have proved very suitable for such work. Such dispersions are prepared by fractionating in a supercentrifuge, the particles utilised being less than 50 m.μ. The mixture is practically clear to the eye and exhibits pronounced birefringence at low rates of flow for temperatures up to the boiling point of water.

Resolving Power and Distribution of Typical Aeroplane Camera Lenses. (F. E. Washer, Bur. Stan. J. Res., Vol. 22, No. 6, June, 1939, pp. 729-746.) (69/59 U.S.A.)

Tabulations are given of the resolving power and distortion of a number of aeroplane-camera lenses of the type most commonly used in recent air-mapping projects. Since the image plane of best average definition does not necessarily coincide with the image plane yielding best definition on the axis of the lens, the method of selecting the image plane of best average definition and its use in connection with the determination of the equivalent focal length are described. The manner of the variation of the resolving power across the field is characteristic of the type of lens.

Standardisation of the Luminous Transmission Scale Used in the Specification of Railroad Signal Glasses. (K. S. Gibson, G. W. Haupt, Bur. Stan. J. Res., Vol. 22, No. 6, June, 1939, pp. 627-649.) (69/60 U.S.A.)

This is the first of several papers dealing with the development and description of the signal-glass specifications formulated by the signal section of the Association of American Railroads in 1935 and 1938. The present paper gives the spectral transmissions of the basic standards—red, yellow, green, blue, purple, and lunar-white glasses—on which the AAR scale of luminous transmission is based, and defines that scale in fundamental, absolute units. Comparison is made with the scales defined in the 1908 and 1918 signal glass specifications.

Experiments on the Variation of the Electrical Resistance of Wires when Under Tension. (E. Czerlinsky, Yearbook of German Aeronautical Research, Vol. 2, 1938, pp. 377-380.) (69/61 Germany.)

Measuring devices which depend on the variation of the electrical characteristics of a circuit are well known. These variations may affect the induction, capacity or resistance. As regards the latter method of control, the pressure response of the carbon pile resistance is well known. The author investigates the variation in resistance of metallic conductors when under tension. This change consists of two parts, namely a portion which can be calculated from the change in shape of the wire under load and a remainder which depends on a change in the specific resistance of the material with load.

If the electrical resistance is to be utilised for recording the tension of the wire, it is important that the change in resistance be relatively large, that the temperature coefficient be small and that the change in specific resistanee with load be small. Of the various materials tested, it appears that constantan is most suitable for the purpose in view. The load resistance curve for nickel is peculiar in that the resistance first diminishes and then increases with increasing tension. The behaviour can be explained in terms of progressive orientation of the magnetic nickel molecules (magneto striction).

Electrical Model Experiments for the Solution of Heat Transfer Problems. (F. Bruckmayer, Z.V.D.I., Vol. 83, No. 10, 11/3/39, p. 316.) (69/62 Germany.)

The similarity between temperature fields and those of electric potential can be used for the solution of heat flow problems by measuring the electric resistance of thin tin foil having the section of the conducting substance. This resistance, measured in the direction of the heat flow, is compared with that of a rectangular calibrating strip, and gives the " form " factor for the thermal resistance of the section. The author found good agreement between the measurements and calculations for various simple geometrical shapes.

The method can also be employed for tracing the isotherms of insulators.

Blind Landing System. (Inter. Avia., No. 654-5, 27/6/39, pp. 10-11.) (69/63 U.S.A.)

Invented by Edward N. Dingley of the Navy Department, the device consists of an electrically magnetized cable buried beneath the main runway of the field. The deflection of a magnetic needle on the plane's instrument board shows the location of the plane with relation to the runway. The magnetic field is said to extend for a distance of 9,000ft. from any point on the runway.