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Mystery of the Magnetic Mine. (C. E. Milbury, Scientific American, Vol. 162, No. 3, March, 1940, pp. 156-7.) (76/1 U.S.A.)

Magnetic mines are of two types, the inert or shallow water type and the mobile or deep water type. Both types can be dropped into the sea from a height of 200 feet without a parachute, the detonator not becoming alive until the mine has been submerged for some time. The shallow water mine is laid in waters approximately 50 feet deep, whilst the deep water type will operate at depths up to 400 feet. Both types of mines normally rest on the bottom of the sea, and since neither cables nor anchors are required, the weight of the mine is not great and a medium size aircraft may carry a dozen or more.

The article describes, in very general terms, the magnetic relay which is effected by a ship passing in close proximity. In the case of the inert or shallow mine, the explosive is fired when the ship is immediately overhead. In the case of the mobile mine, the relay begins to operate with the ship at some distance. The first action of the relay is to cause the mine to rise by expelling water ballast by means of compressed air. When the mine has reached a depth of about 50 feet, the charge is fired. In each case the resultant pressure wave is liable to seriously injure the ship's bottom. The new type of mine thus does not operate by contact, but resembles rather a depth charge.

According to the author, the sweeping up of such mines will present considerable difficulties. Perhaps the best method of destroying such mines will be by dropping barrages of small depth charges from aircraft over suspected waterways.

Army Co-operation with Fixed and Rotary Wing Aircraft. (R. Maurer, La Science et La Vie, Vol. 57, No. 273, March, 1940, pp. 166-78.) (76/2 France.)

The term army co-operation is restricted by the author to short-range reconnaissance over objectives of the land armies, covering a region roughly corresponding to the zone of operation of the various corps. Since enemy territory need only be observed to a relatively small depth (10-15 km.), use of a light, cheap and unarmed aircraft has been proposed by some authorities. The low speed of such a machine would facilitate observation at altitude and landing on rough ground, while the low cost would favour employment of large numbers and facilitate training of observers. However, in practice, reconnaissance over land army objectives has to be carried out from relatively low altitudes, and the low-speed light observation plane then becomes an easy prey to enemy raiding fighters.

A special design combining a certain amount of armament with an excellent field of view and a large speed range is therefore required. Moreover, a reason-

able top speed performance is necessary and the machine must be a two or three-seater. Some of the characteristics of co-operation machines evolved by different countries are described (Westland Lysander, North American 047A, Caproni CA 134, Hanriot 510).

German types are the Henschel Hs 126 and the Fieseler Storch, the latter having the exceptional speed range of 4/1. Its top speed is rather low (130 m.p.h.), but it is, nevertheless, regarded by the author as the best solution of the problem so far. In theory the autogiro should provide an ideal observation machine, but it is practically defenceless against attacks from above and thus its field of application is very limited.

Determination of the Coefficient of Friction of Steel Rubbing on Steel at High Velocities. (G. Grotsch and E. Plake, Z.G.S.S., Vol. 35, No. 1, pp. 3-5, and No. 2, pp. 30-32.) (76/3 Germany.)

Experiments were carried out by the authors on smooth steel cylinders which were fired in smooth (unrifled) barrels at muzzle speeds varying between 100 and 700 m./sec.

The projectiles were of equal weight (5.3 gm.) and calibre (7.9 mm.), but differed in shape, one of them being solid whilst the other had the rear portion hollowed out, thus producing the equivalent of a thin-walled piston. The friction of the solid head is assumed to be the same as that of the undrilled cylinder. The difference in the friction of the two projectiles in the barrel is thus due to the piston walls being pressed outwards on to the barrel. By measuring the difference in muzzle velocity of the two projectiles for different explosive charges (gas pressures), values for the coefficient of friction can be deduced for a series of mean speeds in the barrel. It appears that the coefficient of friction, which under static conditions is of the order of 0.27 for steel on steel, undergoes a marked reduction with increase in rubbing speed. This is shown in the following table :—

V (rubbing speed). m./sec.	μ
0	0.27
100	0.05
500	0.03
1000	0.02
∞ (extrapolated)	0.019

These results can be explained by the fact that at high rubbing speeds there is insufficient time for the boundary layer to be destroyed, and interlocking of the surface molecules is considerably restricted. It is well known that the static friction of copper on steel is smaller than that of steel on steel and preliminary experiments with the same projectiles, but copper plated, have shown that the skirted cylinder has practically the same muzzle velocity as the solid projectile.

If the reduction of friction with speed shown in the above experiments is accepted, calculations on the spin of projectiles carried out with the static coefficient are in error, and new design possibilities arise.

The Transition from Subsonic to Supersonic Velocity in a Gas Flowing Through a Nozzle. (H. Gortler, Z.A.M.M., Vol. 19, No. 6, Dec., 1939, pp. 325-337.) (76/4 Germany.)

The mathematical methods employed for the investigation of a purely subsonic or supersonic flow give no information on mixed problems, where there is a transition from subsonic to supersonic or vice-versa. In this case the fundamental differential equation for the stream function changes from the elliptic to the hyperbolic type and the mathematical difficulties of the problem increase considerably. In the case of two dimensional flow, Th. Meyer gave a possible solution with a discontinuity stretching right across the throat of the nozzle (V.D.I. Research Paper, No. 62, 1908). A symmetrical solution, in which the

discontinuities are confined to two small regions in the neighbourhood of the throat was given later by G. I. Taylor in 1930 (R. and M. 1381). The author investigates possible analytical transitions from the symmetrical Taylor type to the unsymmetrical case treated by Meyer. It appears that such an analytical transition is only possible in the immediate neighbourhood of the axis and that in general shock waves must arise.

Construction of Wing Polars, Taking into Account Variation in Reynolds Number with Angle of Incidence and Altitude. (A. S. Kravets, Aeron. Eng., U.S.S.R., Vol. 13, No. 11, Nov., 1939, pp. 9-21.) (76/5 U.S.S.R.)

This investigation shows that in order to obtain more accurate flight data, aerodynamic calculations should be carried out on the basis of wing polars which have been corrected for the effect of variation in *Re* over all ranges of incidence and altitude.

For purposes of practical computation the following assumptions may be made:—

(*a*) The wing polar diagram is calculated for a mean altitude and correction is only made for variation in *Cy* value.

(*b*) When passing from the wind tunnel polar to actual flight conditions it is sufficient to recalculate the corresponding point of maximum velocity and to plot the flight polar at constant distance from the experimental curve displacement. The error for an atmospheric wind tunnel at $Cy < 0.45$ will be less than 6 per cent. of the profile drag. For a variable density wind tunnel the corresponding error will be of the order of 11 per cent. When $Cy > 0.5$ the value of the error in profile drag increases, but not very greatly.

Use of these assumptions can considerably simplify calculation.

The methods given in this paper for the construction of full-scale wing polars can also be employed for estimating the effect of variation in *Re* on friction drag.

Thermo-Convective Vortices in Air. Their Application to Meteorology. (D. Avsec, Pub. Sci. et Tech., No. 155, 1939, 214 pp.) (76/6 France.)

The present paper describes a study of thermo-convective vortices in a layer of air uniformly heated from below.

CONTENTS.

I.—Historical survey of general studies of convection.

II.—Vertical instability in layers of fluid and the inception of systemmatic movements.

III.—Description of the apparatus employed for production of thermo-convective vortices in a horizontal layer of air. Mode of operation.

IV.—Thermo-convective vortices in a stationary layer of air or one undergoing translatory motion; principal types and the mechanism of their development.

V.—Transformations between the main types. Intermediate forms of thermo-convective vortices.

VI.—Résumé of the theory of thermo-convective vortices.

VII.—Determination of the Rayleigh-Bénard criterion in certain particular cases.

VIII.—Dimensions of thermo-convective vortices.

IX.—Variation of the ratio λ/h for vortices in longitudinal bands, and their stability.

X.—Lines of flow.

XI.—Temperature distribution in a fluid layer containing cellular vortices.

XII.—Application of the theory of thermo-convective vortices to meteorology.

The Forces on a Plane Aerofoil in a Wind Tunnel of the Goettingen Type, with Special Reference to the Approximate Formula for the Lift. (S. Tomotika and H. Umemoto, Aer. Res. Inst., Tokio, No. 185, Nov., 1939.) (76/7 Japan.)

The paper is of interest in giving the full steps of the calculation by the method of conformal representation of the forces acting on flat plane of chord (width) $2a$ placed in a two dimensional jet of width D at infinity. If U = velocity at infinity, the lift L is given by the equation $L=\rho U^2 D \sin \alpha$, when α = deviation of jet at $-\infty$. (This result, of course, can also be obtained directly from the impulse theorem.) In the case of an unlimited stream, $L_0 = 2\pi a U^2 \rho \sin \beta$ where β = inclination of plate with x axis. We thus have

$$L/L_0 = (D/2\pi a)(\sin \alpha / \sin \beta).$$

It is thus possible to express L/L_0 as a function of $2a/D$ once the relationship between α and β is determined. It is found that the interference effects of the free boundaries of a finite jet cause a reduction in the lift for values of β between 5° and 15°, the effect being the greater the larger $2a/D$.

The effect of change in β over the range investigated is small and may be neglected if $2a/D < 0.2$, which is the usual case.

The authors deduce an approximate formula for L/L_0 as a function of $(2a/D)$ and β which, if $\beta = 0$ reduces to the well known equations of Glauert and Pistolesi (to the second order $2a/D$).

Mathematical Theory of Irrotational Translation Waves. (G. H. Keulegan and G. W. Patterson, Bur. Stan. J. Res., Vol. 24, No. 1, Jan., 1940, pp. 47-101.) (76/8 U.S.A.)

This paper is the first of a series dealing with the motion of flood waves and other waves of translation in open channels. The case treated is that of waves for which the forces of fluid friction are negligible with respect to the inertia and gravitational forces. The irrotational motion of a perfect liquid in a horizontal rectangular canal when the original surface is disturbed is investigated on the assumption that the horizontal velocity in a cross section is approximately uniform. The results are also applicable to motion in a canal of uniform slope containing water originally moving with a uniform velocity. Special emphasis is laid on disturbances which are propagated without change of form, and in these cases formulas are derived for the wave profile and velocity of propagation. Consideration is given to the maximum height of a wave of permanent form. Formulas have been compared with the available experimental data. Of special interest is the comparison of the shape of the undulations composing the head of an initial surge with the characteristics of the cnoidal wave.

Model Experiments in Flow-Channels Using Various Media. (W. Bardili, Phys. Zeit., Vol. 41, Nos. 3-4, 15/2/40, pp. 63-76.) (76/9 Germany.)

On the basis of the theory of similarity a calculation is made of the media which will require a small velocity of flow in order to obtain given values of Mach's and Reynolds numbers. In addition it is shown how the relative loss of flow channels (*e.g.*, with respect to air) can be calculated for various media, assuming that the same Reynolds or Mach's number, or even the same velocity, is to be reached. It was found that in order to reach a high Reynolds number with small losses the following relationship must hold:—

$$\mu^{*3}/\rho^{*2} = \mu\nu^2;$$

i.e., the product of viscosity and the square of the kinematic viscosity must be as small as possible. Thus, mercury and ether give approximately 100 per cent. smaller losses than air. The losses occurring on obtaining a given value of Mach's number, without taking into account any impulse losses, are approximately proportional to

$$(\mu^{*0.2})/(\rho^{*0.6} \cdot k^{*1.4}).$$

Therefore in this case heavy gases or vapours (ρ) of large compressibility (k) and small friction value (μ) are most suitable. For example, the losses obtained with iso-propane are half as great as with air. Finally, the lengths of channel, referred to air, required in order to reach a given Reynolds or Mach's number with equal loss are calculated.

Stability and Configuration of the Wakes Produced by Solid Bodies Moving Through Fluids. (S. H. Hollingdale, Phil. Mag., Vol. 29, No. 194, March, 1940, pp. 209-257.) (76/10 Great Britain.)

PART I.

The stability of certain types of " one-dimensional " steady flow in an unlimited viscous fluid has been investigated by the method of " small oscillations." The general result is obtained that the velocity of the oscillations (in the direction of motion of the main flow) is equal to the velocity of the main flow at the point of inflexion of the laminar velocity profile.

Two profiles of physical interest are considered in greater detail and approximate values obtained for the wave-length of the oscillations.

PART II.

Photographs have been obtained of the wakes produced by models (flat plates and symmetrical aerofoil sections at zero incidence) moving in a tank of water. Oscillations do not occur when the Reynolds number is less than 600 for the flat plate and 1,000 for the aerofoil section, and it is probable that the onset of instability can be considerably delayed by careful elimination of all " residual motions " of the water.

The velocity field in the laminar wake has been measured, and a comparison made with certain results of Goldstein and Fage. Good agreement is obtained, the divergence being appreciable at the edges of the wake due to the effect of the walls of the tank.

Measurements of the wave-length and wave-velocity have been made for various oscillating wakes, for a comparison with the conclusions of Part I. The agreement between theory and experiment is, on the whole, satisfactory, but the comparison is somewhat blunted owing to several difficulties in the interpretation of the theoretical results.

Some Aspects of Aero-Hangar Design. (A. M. Hamilton and E. B. Cocks, J. Inst. Civ. Engs., Vol. 13, No. 4, Feb., 1940, pp. 305-336.) (76/11 Great Britain.)

(1) In exposed aero-hangars, the wind pressure on the windward side is normally of less intensity than the wind suction on the roof, which has its highest values on the windward slope near the eaves, and diminishes towards the leeward eaves, with no sudden change at the ridge. There is normally no positive pressure on the roof.

(2) In designing a large aero-hangar, it is advisable to obtain a wind tunnel test report giving the pressure distribution.

(3) The tunnel tests indicate the wind forces on a closed-in structure, and they also give the values of the air pressures or suctions, which the covering of the shed, including windows and doors, should be able to resist in a wind of specified velocity. The tests indicate also the " emergency " pressures on the building structure should there be any opening in the covering.

(4) When a high wind blows through an open doorway or window into any closed building there is always a considerable uplift effect on the roof. Therefore, even in normal roof trusses of ordinary span and pitch the truss members should be capable of withstanding reversal of stress. The roof covering should always be adequately secured against uplift forces, and the hangar itself adequately anchored down.

(5) Winds from any direction lessen the dead load stresses except when there is a hole in the roof.

(6) The most stable form of light building construction is the lattice rib of as wide a box section as convenient; the cross section should be constant right to the foundation bases.

(7) The maximum bending moment in the rib for " hinged ends " is of the same order as that for " fixed ends."

(8) The roof ribs, as designed for an 80-mile per hour wind with a factor of safety of $1\frac{1}{2}$, are found to be adequate for small snow loads.

(9) For countries where the snow load may vary from 15 to 36 lb. per square foot, the ribs need be designed against this vertical loading only, and if continuous and capable of taking full reversals of stress, they will then be adequate for any wind.

(10) The box lattice rib has advantages, for service conditions which require stability under bombing and ease of repair if damaged, and also in its capacity as a girder to take reversals of stress due to wind uplift. Single girder ribs or simple roof trusses are not usually so well able to carry compression in the lower tie or chord.

Pressure-Distribution Measurements on a Rectangular Wing with a Partial Span Split Flap in Curved Flight. (F. G. Rokus, N.A.C.A. Tech. Note, No. 742, Dec., 1939.) (76/12 U.S.A.)

Pressure-distribution tests were made on the 32-foot whirling arm of the Daniel Guggenheim Airship Institute of a rectangular wing of N.A.C.A. 23012 section to determine the rolling and the yawing moment due to an angular velocity in yaw. The model was tested at 0° and 5° pitch; 0°, $\pm 5°$, and $\pm 10°$ yaw; and with no flap and with split flaps 25, 50 and 75 per cent. of the wing span and deflected 60°.

CONCLUSIONS.

1. The experimental rolling moment and yawing moment coefficients are in fairly close agreement with theoretical values.

2. The rolling moment coefficients are little affected by the angle of yaw within the range tested of $\pm 10°$.

3. Small variations in the normal force distribution, especially at the tips of the wing, have little effect on the resulting rolling moment coefficient.

4. The yawing moment coefficients exhibit considerable change due to the angle of yaw, especially on the model with a partial span flap. The coefficient increases as the wing model is yawed in a positive direction, and decreases as the wing model is yawed in the negative direction. The yawing moment coefficient for $-10°$ yaw reaches a slight negative value for the 25 per cent. and the 50 per cent. span flaps, the trend of the curves indicating larger negative coefficients for yaw angles beyond $-10°$.

5. The negative yawing moments for 25 per cent. and 50 per cent. span flaps at $-10°$ yaw angle are brought about, as is apparent from pressure distribution curves, by the somewhat higher pressure on the forward side of the flap near its tip on the inner portion of the span as compared with the outer portion, accompanied by a somewhat higher negative pressure at the rear of the flap on the inner portion of the span as against the outer portion.

Relative Performance with 87 and 100 Octane Fuel on Koolhoven Fk. 59 Two-Seater Reconnaissance Bomber (Mercury XV) Engine. (Flight, Vol. 37, No. 1626, 22/2/40, p. 180.) (76/13 Holland.)

The following comparative figures for the performance of the Koolhoven Fk 59 two-seater reconnaissance bomber biplane with Bristol Mercury XV engine show the advantages in performance arising from the use of 87 octane and 100 octane fuels.

	87 Octane.	100 Octane.
Maximum speed at 2,750 r.p.m.	236 m.p.h.	260 m.p.h.
Height for maximum speed	15,700 ft.	17,300 ft.
Cruising speed at 60 per cent. maximum power	192 m.p.h.	211 m.p.h.
At height of	15,700 ft.	17,300 ft.
Rate of climb at sea level	1,490 ft./min.	2,180 ft./min.
Rate of climb at 6,500 ft.	1,630 ft./min.	2,360 ft./min.
Rate of climb at 13,000 ft.	1,730 ft./min.	2,540 ft./min.
Rate of climb at 19,500 ft.	1,220 ft./min.	2,050 ft./min.
Time of climb to 6,500 ft.	4.2 min.	2.9 min.
Time of climb to 13,000 ft.	8.0 min.	5.6 min.
Time of climb to 19,500 ft.	12.3 min.	8.3 min.
Time of climb to 26,000 ft.	19.4 min.	12.2 min.
Service ceiling	31,800 ft.	35,700 ft.
Absolute ceiling	32,800 ft.	36,700 ft.
Range with 837 lb. fuel at cruising speed ...	621 miles	540 miles
At height of	15,700 ft.	17,350 ft.

The performance of the engine itself is also interesting :—

	87 Octane.	100 Octane.
Maximum output	830 h.p.	1,050 h.p.
Maximum power height	14,450 ft.	15,580 ft.
Maximum r.p.m.	2,750	2,750
Fuel consumption at cruising speed	242.5 lb./h.	308.5 lb./h.

Tests of a Gust-Alleviating Flap in the Gust Tunnel. (P. Donely and C. C. Shufflebarger, N.A.C.A. Tech. Note No. 745, Jan., 1940.) (76/14 U.S.A.)

Tests were made in the N.A.C.A. gust tunnel to determine the effectiveness of a long period dynamically overbalanced flap in reducing aeroplane accelerations due to atmospheric gusts. For two gust shapes, one gust velocity, one forward velocity, and one wing loading, a series of flights was made with the flap locked and was then repeated with the flap free to operate. The records obtained were evaluated by routine methods.

The results indicate that the flap reduced the maximum acceleration increment by 39 per cent. for a severe gust with a representative gust gradient distance of 8 chord lengths and that, for an extreme gust shape (a sharp-edge gust), the reduction was only 3 per cent. The results also indicate that the flap tended to reduce the longitudinal stability of the aeroplane. Computations made of the effectiveness and the action of the flap were in good agreement with the experimental results.

The Frequencies of Cantilever Wings in Beam and Torsional Vibrations. (C. P. Burgess, N.A.C.A. Tech. Note No. 746, Jan., 1940.) (76/15 U.S.A.)

Methods are described for calculating the period and frequency of vibration of cantilever wings and similar structures in which the weight and moment of inertia vary along the span. Both the beam and torsional frequencies may be calculated by these methods. The procedure is illustrated by examples.

It is shown that a surprisingly close approximation to the beam frequency may be obtained by a very brief calculation in which the curvature of the wing in vibration is assumed to be constant. A somewhat longer computation permits taking account of the true curvature of the beam by a series of successive approximations which are shown to be strongly convergent.

Analogous methods are applied to calculations of the torsional frequency. For the first approximation it is assumed that the angle of twist varies linearly along the semi-span. The true variation of the twist is computed by successive approximations which are strongly convergent, as in the case of beam vibrations.

Air Forces on Radial Air-Cooled Engine Cowling as Determined from Pressure Distribution Tests. (R. R. Higginbotham, Paper to S.A.E. Annual Meeting, 15-19/12/39. Available in R.T.P.) (76/16 U.S.A.)

Factors influencing engine cowl surface pressures are considered, and the results of pressure tests on one cowl model in the wind tunnel and on three representative cowl designs in flight are analysed. Some of the preliminary conclusions are as follows:—

1. Where the external airflow is essentially non-turbulent and the local velocities are below the speed of sound, and where the conductivity of the engine baffle combination is independent of air speed, the aerodynamic forces on an engine cowl without propeller are proportional to the dynamic pressure of the free air stream.

2. Where the local velocities in the external airflow exceed the speed of sound, the relation between air speed and surface pressures is not definitely known, but it is likely that the air loads are less severe above the critical speed.

3. Tests on R-1535 and " Wasp " engine cowls indicate that the aerodynamic forces are higher with power off than with power on.

4. For a given cowl the largest forces occur at the lowest conductivity of the engine baffle combination.

5. At positive angles of incidence of the thrust axis the unsymmetrical pressure distribution results in increase in aerodynamic load on the upper half of the cowl and decrease on the lower half, giving rise to an upward translational force and a pitching couple.

6. At positive angles of incidence, the combination of yaw at the horizontal sections and slipstream twist may also produce a lateral translational force and a horizontal couple.

7. The most severe cowl forces occur at the largest angle of incidence obtainable at maximum velocity.

Correlation of Wind Tunnel and Flight Test Results. (W. W. Symington, Paper to S.A.E. Annual Meeting, 15-19/12/39. Available in R.T.P.) (76/17 U.S.A.)

Accurate co-ordination of wind tunnel test results and results obtained in actual flight is the only available method for accurately predicting the performance of a new aircraft design. Wind tunnel results do not fully determine the actual performance in free flight, other variables which have to be considered are the Reynolds number, turbulence, surface conditions, slipstream, propeller, engine power and engine cooling drag. In general these factors, with the wind tunnel results, can be combined into three separate major variables, *i.e.*, engine power, propeller and drag. The engine power and propeller efficiency are important as a means of measuring flight test drag. Any one of these three variables may be adjusted after a flight test to arrive at the correct result. The real problem, however, is to predict the performance, and this can only be done correctly if the power, propeller efficiency and drag used in the calculations are the same as the corresponding values in the flight test after the plane has been built.

Aluminium Aircraft Fuel Tanks. (E. H. Dix and R. B. Mears, Paper to S.A.E. Annual Meeting, 15-19/12/39. Available in R.T.P.) (76/18 U.S.A.)

Aluminium fuel tanks, in use for many years, have generally given entirely satisfactory results. In isolated cases, however, pitting by corrosion has occurred, usually due to water contaminated with chlorides, bromides and heavy metal compounds lying in the bottom of the tank for a considerable time.

Corrosion is prevented by:—Suitable design to permit free drainage; selecting metals to avoid electrolytic action; preventing contamination of the fuel by water, rust or other heavy metal corrosion products prior to its entry into the fuel tank; applying protective coatings to the interior of the tank, such as an anodised layer,

subsequently impregnated with potassium bichromate, or by use of protective paints; use of corrosion inhibitors either in capsules inserted in the tanks or as an addition to the fuel; periodic cleaning of the tank interiors or flushing them with inhibited solutions.

Future Possibilities of the Autogiro (Civil and Military). (G. Favier, La Science et la Vie, Vol. 57, No. 273, March, 1940, pp. 179-186.) (76/19 France.)

The original Cierva autogiro was unmanageable on the ground, both during take-off and landing, due both to the high C.G. position and the gyroscopic couple of the rotor. In addition, any gust striking the machine during take-off run sets up violent rotor blade oscillations. Directional control on the ground is mainly by the tail wheel and it is thus essential that this wheel leaves the ground last during take-off and touches it first during landing. Even after touching the ground at low speed, the continued rotation of the rotor causes considerable lift and on the wind freshening the machine may rise again and very likely come to grief. These difficulties have now been overcome by providing a rotor blade incidence control mechanism, either automatic or under pilot control. It is possible both to land and take-off without any run on the ground, and since the blade incidence can be changed to give no lift, the machine is rendered much less sensitive to gust. Finally, a flap on the trailing edge of the rotor blade eliminates any danger of the blade incidence decreasing excessively during a steep dive and the autogiro is thus rendered automatically stable. (Lateral stability of the fuselage is assured by suitable arrangement of the tail surface.) By these two improvements the autogiro has been rendered safe both in the air and on the ground, and a great future is predicted for it. In civil aviation an obvious application will be as feeder aircraft between towns and outside aerodromes. In war, there are also a number of possible applications provided the machine is not exposed to actual air fighting. In the U.S.A., extensive use is being made of autogiros to replace observation balloons for artillery range finding. In these cases the autogiro can keep in telephonic communication with the ground by means of a cable, the tension of which is kept constant by means of an automatic winding drum.

Review of Some Messerschmitt Aircraft Patents (French and German). (L'Aéronautique, Vol. 22, No. 248, January, 1940, pp. 19-21.) (76/20 France.)

French Patent No. 779936.—Prevention of spin by a progressive thickening and rounding off of the wing nose, along the span, the central wing section having a pointed nose. As an alternative, the wing section is of normal shape along the span, but provided over the central section with a spoiler placed at the stagnation point.

French Patents 841781, 841976.—Boundary layer control by suction, an interconnection (channel) inside the wing providing a direct means of pressure equalisation between regions of low and high pressure respectively.

French Patent 808710.—Metallic fuselage without independent transverse frame members, the latter being formed by the sheet metal at one end of the cylindrical sections being turned inwards to form a circumferential lip or flange whilst the other end of the section is left unaltered. The fuselage is built up by riveting the plain ends on to the flanges, the latter being provided with cut outs for the wing spars.

German Patent 672053.—Wing fuselage attachment for low wing aircraft characterised by the fact that the compression forces at the foot of the wing spar are transmitted to a pyramidal structure, and are taken up partly by the fuselage spars and partly by frame members passing through the fuselage well to the rear of the wing span and connecting up with the other wing. The central section of the fuselage is thus kept quite clear. The same principle can also be applied to multi-spar wings.

French Patent 780664.—Lateral control for aircraft by means of wing spoilers placed near the tips, the deflection of which increases progressively along the span. This can be arranged either by sub-dividing the spoiler into sections which are deflected in succession, or the spoiler itself may be of a warped or twisted shape so as to produce the effect of variable incidence. The spoilers, working in a region of depression on the upper wing surface, have the tendency to open, and by providing suitable spring control, the action can be rendered automatic and excessive wing strain during a pull-out avoided.

French Patent 829768.—Ammunition feed for aircraft machine guns in the form of endless belts stored inside the wing.

Speed Control Device for the Propellers of a Twin-Propeller Aircraft. (Siemens-Schuckertwerke A.G.; D.R.P. 683,062, 30/10/39. Flugsport, Vol. 32, No. 2, 17/1/40, p. 79.) (76/21 Germany.)

1. Control for an aircraft power plant consisting of at least two propellers, preferably driven from a common motor having counter-rotating parts, characterised by the fact that the driving shaft of each propeller, in addition to being connected to the actual motor, is also connected to an electric motor; the latter connection is such that the electric motor can serve either as a generator, for the purpose of reducing the speed of rotation of the appropriate shaft, or as a motor for the purpose of increasing it.

2. Drive as in claim 1, in which the shaft of each propeller is coupled to the rotor of a direct current motor, the two rotors are connected in series, and the excitation of these direct current motors can be adjusted by a governor so that the one motor acts as a generator and the other as a motor, as required.

3. Drive as claimed in 1 and 2, in which the common driving motor is a three-phase current motor.

Some New Investigations on Old Combustion Engine Problems (I). (G. Eichelberg, Engineering, Vol. 148, No. 3850, 27/10/39, pp. 463-466.) (76/22 Switzerland.)

In this first lecture, the author deals with the problem of heat transfer in engine cylinders. The experiments were carried out on large Diesel engines varying in bore from 280 to 600 mm. The heat transfer coefficient α (kilo calories/M^2/hour/°C.) between the metal and the cooling fluid is easily obtained from the known heat loss and the temperature difference between the surface and the fluid. The value of α increases with the rate of flow of the cooling fluid, the following being representative values:—

α	Rate of flow (Kg./M^2/hour).			
	2,000	5,000	10,000	25,000
Cylinder head	—	1,000	—	2,500
Liner	500	1,000	—	—
Piston (oil-cooled) ...	—	300	1,200	—

In the case of the heat transfer from the working medium (gas), to the walls, the heat transfer coefficient is found to vary very markedly during the cycle. The heat entering the surface at any instant is equal to

$$\lambda\,(\partial T/\partial x)7_{x=0}$$

and this must be equal to $\alpha\,(\theta - T)$, where

α = heat transfer coefficient between gas and wall.

θ = gas temperature at same instant.

T = wall surface temperature at same instant.

Assuming θ to be given by the indicator diagram, and

$$(\partial T/\partial x)7_{x=0}$$

to be determined experimentally, α can then be calculated. The following mean values (time basis) for α were obtained for the piston crown of a two-stroke engine at 300 r.p.m.:—

$$\alpha \text{ mean } \begin{cases} \text{(Full load)} = 300 \text{ kilo. cal./}M^2\text{/h./°C.} \\ \text{(Half load)} = 250 \quad ,, \quad ,, \\ \text{(Motoring)} = 200 \quad ,, \quad ,, \end{cases}$$

Wear of Diesel Engine Cylinders and Rings (with Discussion). (P. S. Lane, Trans. A.S.M.E., Vol. 62, No. 2, Feb., 1940, pp. 95-110.) (76/23 U.S.A.)

This paper considers wear mainly from the viewpoint of cylinder and ring materials, rather than from the design or operating angle. The types of iron used, though important factors, have received only limited attention in published data. Existing wear rates in medium and heavy duty Diesel and gas engines in various fields of service are reviewed, followed by several examples of cylinder wear as affected by the hardness and structure of the iron alloy. By means of laboratory wear tests, correlated with service experience, the nature and characteristics of the materials used in cylinders and rings are surveyed and discussed in detail, covering the effects of section size, hardness, analysis and structure. Initial engine wear, as influenced by bore finishes and wear-resistant or chemical surface treatments, is considered, together with the action of bi-metallic or composite rings, in retarding scuffing and overall wear rates. It is the author's opinion, which seems to be substantiated by the work reported in this paper, that in some cases a possible reduction in wear rates of 2 to 1 may be expected through proper balance of ring and cylinder structures. There is further evidence that with existing conditions, a reduction in cylinder wear of roughly 2 to 1 may be obtained through the use of bi-metallic and/or chemically treated rings. Thus, theoretically at least, there appear to be possibilities for an overall decrease in wear rates in the order of 4 to 1; that is, wear seems possible of reduction to one-fourth of existing averages. The *rôle* of corrosion in cylinder wear is not considered important.

Shortcomings of Mica as an Insulating Material in Aviation Spark Plugs. (V. Cronstedt, Paper at S.A.E. Annual Meeting, 15-19/1/1940.) (76/24 U.S.A.)

Between 80 and 90 per cent. of delays in American air transport are due to ignition troubles, and although these are not all due to spark plugs, maintenance records selected at random show a figure of 2,187 unscheduled plug replacements in about 60 engines during 5,350 flying hours. One disadvantage of mica as a spark plug insulator is its low heat conductivity, as a result of which a plug may become so cold under idling conditions that oil, petrol, moisture and deposits accumulate under the insulator and short-circuit the plug. Under full load the plug may become so hot that its materials are destroyed. At 1,000-1,200°F., mica is dehydrated, resulting in rapid deterioration of the plug. In order to reduce the maximum temperature of the nose of the central electrode, manufacturers have reduced the thickness of the mica tube to facilitate heat flow. This, however, leads to fragility and increases the electrical capacity of the secondary circuit. The thermal expansion of mica is less than half that of the central electrode (stainless steel), which tends to loosen the washers at high temperatures and enables carbon, oil, etc., to lodge between them.

Mica is liable to react with lead oxide formed by oxidation of the deposit formed on the exposed plug surface during combustion of leaded fuels. Any deposits of lead silicate formed in this way greatly change the thermal properties of the plug.

New Measurements on Diesel Engines and Their Effect on Development. (C. Zublin, W.R.H., Vol. 21, No. 4, 15/2/40, pp. 45-47.) (76/25 Switzerland.)

Experiments carried out on a single cylinder Sulzer two-stroke Diesel engine of 720 mm. bore and 1,250 mm. stroke comprised:—Temperature measurements over the cylinder head, piston and liner under various conditions of load; investiga-

tions of the deflection of the piston crown under loads and the distribution of gas pressure behind the piston rings; stress measurements on various parts of the engine frame under static loads (compressed air) and the deflection of the cylinder head under actual power conditions. Fuel characteristics were also investigated and it was found that the main effect on engine operation of a change in fuel occurred during light load. Indicator diagrams taken under such conditions are recommended as a ready means of classifying fuel oils.

The other main conclusions are:—

(1) At constant r.p.m. and scavenge, the engine temperatures rise rapidly with the B.M.E.P.

(2) At constant B.M.E.P. the temperatures rise with decrease in r.p.m.

(3) At constant r.p.m. and B.M.E.P., the engine temperatures remain practically constant over the scavenging range of 125 to 200 per cent. This shows that the scavenging of this engine is already very complete for relatively small air consumptions.

(4) The maximum deflection of the piston crown amounted to about 0.3 mm. and the deflection/crank angle diagram corresponds closely to that of the normal indicator diagram. From a comparison of this with the permanent deflection due to thermal expansion of the piston, it is deduced that the thermal stresses are about three times those due to gas pressure.

The Future of Safety Fuels in Spark Ignition Aircraft Engines. (F. C. Mock, Paper at S.A.E. National Aircraft Meeting, December, 1939.) (76/26 U.S.A.)

The various safety fuels have from 3-7 per cent. less heat value than standard petrols and must therefore be burnt very completely. The volatility of safety fuels is naturally low, but complete vaporisation only calls for 7.5 per cent. of the normal jacket loss and the exhaust gas residue in the engine contains about half the heat required for this purpose. The cooling effect of the vaporisation process should react favourably on engine design and render possible the utilisation of larger pistons and exhaust valves. (According to the N.A.C.A., best results are obtained with direct cylinder injection, spraying horizontally across the chamber and utilising a large valve overlap.)

Although a large amount of preliminary work has been done, the author estimates that a considerable time ($\sim 2\frac{1}{2}$ years) would be required before an aircraft engine of this type would be ready for flight tests. At the same time he is of the opinion that the safety fuel equipment would weigh at least 2-2½ times that of the standard fuel system. The fuel economy will certainly not be improved, and in view of the present craze for speed, the question arises whether these drawbacks are not too high a price to pay for reduction in fire hazard.

Data on Ethyl Gasoline Corrosion. (Goldowsky, Rept. No. 9, Bull. Soc. Royale des Ingénieurs et des Industriels, Brussels, 1939.) (76/27 Belgium.)

For successful corrosion tests all conditions should correspond to those of the metal's future use. Test samples should even be in the shape of the pieces studied, including rivets, solder, and other parts with which they are associated.

If a sample of light metallic alloy is placed in ethyl gasoline no corrosion occurs. However, it is found that tanks are always perforated at the bottom, never at the top. Water always enters when the tanks are filled. This water, accumulating at the bottom, is responsible for corrosion, which occurs only with light alloys. With rustless steel, the reverse phenomenon is found and only the parts bathed by gasoline are attacked.

Experiments show that gasoline loses its corrosive power in proportion to the duration of agitation and that the corrosive power of water increases. The phenomenon can be explained thus: The ethyl gasoline contains tetraethyl lead

and ethylene bromide. In the presence of water the ethylene bromide hydrolyses and produces a very corrosive acid medium.

Characteristics of Diesel Fuels Influencing Power and Economy. (A. J. Blackwood and G. H. Cloud, J.S.A.E., Vol. 46, No. 2, Feb., 1940, pp. 49-53.) (76/28 U.S.A.)

The only important properties of Diesel fuels which affect engine power and economy are calorific value, ignition quality and possibly viscosity. The present paper reports data obtained from an extended fuel research programme investigating the power and fuel economy obtained when using fuels differing in their physical and chemical characteristics. The main results arrived at are:—

1. Assuming complete combustion, fuel volatility affects the consumption per brake horse-power hour only indirectly, in so far as it is related to calorific value and ignition quality.

2. Most modern engines have fixed ignition timing and, on such engines, ignition quality is a major factor in determining volumetric fuel economy in the upper speed ranges. At lower engine speeds calorific value is the most important consideration.

3. Fuel viscosity in itself is not an important factor in determining the power obtained from a high speed Diesel engine, except in instances where worn injection equipment may make it undesirable to use a low viscosity fuel.

Fundamental Mechanical Aspects of Boundary Lubrication. (H. Blok, J.S.A.E., Vol. 46, No. 2, Feb., 1940, pp. 54-68.) (76/29 U.S.A.)

The physico-chemical aspects of boundary lubrication have already been investigated fairly thoroughly, but lack of information on the fundamental mechanical aspects is a great handicap in applying the physico-chemical results to the intelligent selection of lubricants and materials. On the assumption that pressure and temperature in the region of contact between the rubbing surfaces are the basic mechanical factors, it is shown that four main types of boundary lubrication should be distinguished:—

1. Low pressure and temperature boundary lubrication, or mild boundary lubrication.
2. High temperature boundary lubrication.
3. High pressure boundary lubrication.
4. High pressure and temperature boundary lubrication, or extreme boundary lubrication.

Up to now type 4 has been called " extreme pressure lubrication," but the term now proposed should be adopted, since in this region of boundary lubrication it is more the extreme temperatures than the extreme pressures which are decisive. Moreover, confusion with high pressure boundary lubrication (type 3) can then be avoided.

Phenomena characteristic of each of the four main types of boundary lubrication are discussed.

An appendix deals with frictional (*i.e.*, tangential) vibrations of rubbing surfaces.

Effect of Supercharging on the Comparative Evaluation of the Anti-Knock Properties of Fuels. (M. M. Maslenikov and G. E. Bliessnukov, Aeron. Eng., U.S.S.R., Vol. 13, No. 11, Nov., 1939, pp. 30-9.) (76/30 U.S.S.R.)

Experimental data obtained with a modified Waukesha fuel testing engine shows that when an engine is supercharged the knock tendency of various fuels does not alter to the same extent, since it depends on their chemical constitution; the anti-detonating effect of ethyl fluid apparently does not depend on induction pressure. Of the hydrocarbon groups constituting the fuels tested, the un-

saturateds show best anti-knock stability in the case of supercharging. Naphthenes and aromatics show approximately the same anti-knock stability—inferior to that of the unsaturateds, and the paraffins show the worst behaviour. Thus the results obtained by comparison of the anti-knock properties of fuels, which sharply differentiate the behaviour of paraffin—and unsaturated hydrocarbons, depend on the pressure of the air admitted to the engine.

Evaluation of the anti-knock properties of fuels by the C.F.R. engine method will characterise the value of the fuels for use in a supercharged engine only when there is a small difference between the contents of the fuels in paraffin and unsaturated compounds. For a larger difference a fuel of different octane rating will be required for use with supercharging; results of the present work show that this difference in octane rating may amount to four units.

Effect of Temperature on Lubricating Films. (D. Tabor, Nature, Vol. 145, No. 3669, 24/2/40, p. 308.) (76/31 Great Britain.)

The friction apparatus of Bowden and Leben has shown that when clean steel surfaces slide on one another, the motion is irregular, sticking alternating with slipping. This phenomenon persists in the presence of a non-polar lubricant such as medicinal paraffin oil, although the average value of the friction is reduced. Long chain fatty acids will produce continuous sliding which can also be produced if non-polar oils are heated (oxidised).

This oxidation becomes appreciable for most oils at temperatures above 150°C., and the change in friction characteristics is irreversible on subsequent cooling.

Recent work on some commercial oils giving continuous sliding at room temperatures has revealed a new effect. With these oils, stick-slips are produced when the oil is warmed to between 40 and 80°C., and the effect is reversible, provided the heating has not been sufficiently long to produce appreciable oxidation. It appears that this temperature effect is connected with the desorption or disorientation of the boundary lubricating film and the film is the more strongly absorbed the higher the critical temperature. Similar effects have also been noted with pure fatty acids.

Protective Greases for Aeroplane Engines. (V. A. Yakhlakov, Aviapromyschlennost, Nos. 7-8, 1939, pp. 9-24.) (76/32 U.S.S.R.)

The corrosion of inside surfaces of aero engines and the characteristics of various protective greases are discussed. Tests have been carried out with the two following greases for protecting the internal and external engine surfaces respectively:—

1. Butyl alcohol 10 per cent., aluminium stearate 10 per cent., triethanolamine 6.5 per cent., and lard 73.5 per cent.
2. Oil 98 per cent., triethanolamine oleate 1.5 and triethanolamine 0.5 per cent.

The tests were carried out on various metals and from the results obtained it is claimed that these greases are equal to those of the Ethyl Gasoline Corporation.

Stability of Crankcase Oils (with Discussion). (W. F. Weiland, Trans. A.S.M.E., Vol. 62, No. 2, Feb., 1940, pp. 125-132.) (76/33 U.S.A.)

In this paper the author attempts to answer two vital questions concerning lubricating oils, *i.e.*, performance and useful life. Oxidation and corrosion tendencies constitute the major elements in the deterioration of crankcase oils. The essential requirements for conducting oxidation tests are outlined in the paper and the procedure and results of tests are indicated. Observations on the behaviour of oils in service also offer a means for predicting oil performance. Acid vapour tests to determine oil breakdown are discussed and the results of corrosion studies detailed.

Physical Properties of Some Purified Aliphatic Hydrocarbons. (D. B. Brooks, F. L. Howard and H. C. Crafton, Jr., Bur. Stan. J. Res., Vol. 24, No. 1, Jan., 1940, pp. 33-45.) (76/34 U.S.A.)

In an investigation of the suitability of various paraffin hydrocarbons as constituents of aviation fuel, which is being conducted for the National Advisory Committee for Aeronautics, the Navy Bureau of Aeronautics, and the Army Air Corps, four olefin (di and trimethyl butanes) and seven paraffin hydrocarbons (di and trimethyl butanes, ethyl and trimethyl pentanes and *n*-heptanes) have been obtained in a state of high purity. Eight of these materials were synthesised, one was isolated from a commercial synthetic crude, and two were obtained from commercial sources. All were purified by distillation in automatically controlled fractionating columns of high efficiency.

The measured physical properties of these materials included freezing point, boiling point and its variation with pressure, refractive index and density and their variations with temperature.

Lead—Sensitivity of Motor Fuels and its Dependency on Chemical Composition. (O. Widmaier, Autom. Tech. Zeit., Vol. 43, No. 3, 10/2/40, pp. 63-8.) (76/35 Germany.)

The lead sensitivity of various motor fuels, *i.e.*, the extent to which their knock rating is increased by addition of tetra-ethyl lead, depends on their chemical composition. Paraffin hydrocarbons are most sensitive. Hydrocarbons which on account of their good anti-knock properties are blended with fuels of lower knock rating, respond in different degrees to addition of lead tetra-ethyl. Thus, for example, knock rating is increased to the greatest extent by addition of ethyl fluid to petrol containing isopropyl ether. Fuel mixtures containing iso-octane and iso-pentane are also very sensitive, but blends containing alcohol and benzol respond very little to addition of lead tetra-ethyl. In many cases the knock rating of leaded fuels can even be lowered by addition of alcohol. Lead deposits are formed during storage of leaded fuels, the formation being particularly influenced by light. During use, they also cause corrosion of the cylinder head and base of the piston. However, these disadvantages, which can be partly eliminated, are more than compensated by the greater power and reduced fuel consumption obtained with leaded fuels. It is not yet clear how they affect deterioration of the lubricating oil. (24 references.)

Friction Losses in Ship Propeller Shaft Bearings (Review of German and Dutch Experiments). (W.R.H., Vol. 21, No. 4, 15/2/40, pp. 39-45.) (76/36 Germany.)

The ship propeller shaft is usually supported on a number (11-17) of oil lubricated bearings placed between the thrust block (at engine end of shaft) and the stuffing gland at the propeller end. The friction losses in the oil lubricated bearings is generally assumed to be of the order of 0.3 per cent. of the i.h.p. per bearing, giving a 5-7 per cent. loss for this part of the shaft. These figures have been confirmed by German experiments in which the torsion of the shaft was measured immediately in front of the first bearing and between the last bearing and the stuffing box. The difference between these two readings gives the total friction torque, from which the friction as a percentage of the i.h.p. can be readily calculated. Recent Dutch experiments lead to considerably lower values ($\sim$ 1/10) and the discrepancy has led to an interesting discussion. In the Dutch tests the overall twist of the whole shaft was measured and the torque compared with the passing into the first section. As the German reviewer, however, points out, this method underestimates the true loss which, in the case of a uniformly graded friction drop along the shaft, amounts to twice the measured loss. Even with this multiplication, however, the Dutch friction losses are smaller than

those generally accepted, and must result either from errors in measurement or less strenuous conditions of the tests (shafts not deformed by motion of ship).

The Principle of Mechanical Similarity Applied to Lubricating Films. (A. A. Capocaccia, Ricerche di Ingegneria, Vol. 7, Sept.-Oct., 1939, pp. 158-62.) (76/37 Italy.)

The method of dimensional analysis is used to establish a series of relationships expressing the frictional resistance, film thickness, dynamic coefficient of friction, moment, and energy wasted in terms of the non-dimensional ratio (surface × pressure)/(velocity × viscosity). It is shown that when any two of the quantities velocity, viscosity or pressure are kept constant and the third or any one of the other characteristic quantities is varied, the ratio between two values of any characteristic is some whole power (positive or negative) of the above ratio. The general theory is applied to special cases such as sliding and rolling friction, and it is shown to be applicable to the important problem of determining the physical qualities of a lubricant which will give satisfactory results under given mechanical conditions.

(From Science Abstr. " B," Vol. 43, No. 506, 25/2/40, p. 49.)

Low Lead-Silver Alloys for Bearings. (R. W. Dayton, Metals and Alloys, Vol. 10, 1939, pp. 306-10, 324.) (76/38 Great Britain.)

Alloys containing > 3.5 per cent. lead are very resistant to seizure. A corrosion test on specimens rotating in aërated oil containing 1 per cent. of oleic acid at $\sim 160°$ showed complete resistance and an increased seizure-resistance of the specimens. Addition of lead is shown to improve the mechanical properties of silver. Photomicrographs of cast and annealed alloys are given; intergranular cracking is observed in the latter when lead is excessive (4.68 per cent.). Electrodeposition of the Pb-Ag alloy on to the steel backing (from a silver cyanide bath containing lead acetate) is very satisfactory. Preliminary bearing tests made on such plated specimens gave very promising results. The application of bearing alloys with 3-4 per cent. lead in aeroplane engines is indicated.

(From Brit. Chem. Abstr. " B," Vol. 59, No. 1, Jan., 1940, p. 46.)

Plastic Flow in Metals. (H. W. Swift, Metal Industry, 2/2/40, pp. 127-130.) (76/39 Great Britain.)

The various factors involved in the phenomenon of plastic flow and the present state of knowledge on the subject are discussed. Conditions which cause elastic breakdown, plastic flow, and fracture, are mentioned, and the importance of treating these three phenomena as entirely distinct and independent, is stressed. The relationship between stress and strain under plastic conditions is discussed, and also the phenomenon of strain hardening. Note is made of the fact that plastic strain is a function of time, as well as a function of stress, and is also dependent on the previous strain history of the material; the problem of correlating the stress and strain circle diagram under various conditions of combined stress is considered.

(Abstract supplied by Met. Vickers Research Department.)

On the Design of Shell Bodies of Revolution Possessing Constant Strength in all Directions when Subject to a Constant External or Internal Pressure. (F. Tolke, Z.A.M.M., Vol. 19, No. 6, Dec., 1939, pp. 338-343.) (76/40 Germany.)

Shell bodies of revolution of constant strength under a given type of loading (gravity, gas pressure, etc.) are becoming of increasing interest from the point of view of aircraft structures. The theory of such structures is rather involved and necessitates a step by step graphical or numerical integration of the corre-

sponding differential equations. It is thus difficult to obtain general relationships and as a first attempt to classify the subject, the author limits himself to the consideration of shell structures of revolution under constant external or internal pressure. In this case the differential equations can be integrated directly by means of elliptic functions (Legendre Normal Integrals) if the shell is free from bending stresses, *i.e.*, becomes the equivalent of a membrane. The geometrical form of the generating curves is discussed and tables are given showing the variation in the constant stress with wall thickness shape and pressure.

It is thus possible to choose a shape which will ensure the best utilisation of the material under given conditions.

Local Instability of Columns with I-, Z-, Channel, and Rectangular Tube Sections. (E. Z. Stowell and E. E. Lundquist, N.A.C.A. Tech. Note No. 743, Dec., 1939.) (76/41 U.S.A.)

Charts are presented for the coefficients in the formulas for the critical compressive stress at which cross-sectional distortion begins in thin wall columns of I-, Z-, channel, and rectangular tube sections. The energy method of Timoshenko was used in the theoretical calculations required for the construction of the charts. The deflection equations were carefully selected to give good accuracy.

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

Study of an Apparatus for Studying the Ageing of Cellulose Varnishes by Light. (J. Grard, Pub. Sci. et Tech., No. B.S.T. 88, 1939, 11 pp.) (76/42 France.)

Numerous researches have shown the predominant effect of light in causing deterioration of cellulosic coverings of aircraft surfaces, and thus a light exposure test appears fundamental in investigating ageing of cellulose products. Mercury arc lamps have previously been used for this purpose, but the radiation from this type of lamp is not comparable with solar radiation. The difficulties associated with use of " Sunlamps," due to the variation in radiation intensity produced on a plane surface and caused by the shape of the light source itself, have been overcome by using two lamps in conjunction with a cylindrical reflector of ellipsoidal cross-section, arranged in such a manner as to give a concentration of intensity on the second focal line of the reflector. Application of the apparatus, which is described in detail, to the study of nitro-cellulose and aceto-cellulose films shows that the latter have a considerably higher resistance to the radiation from " daylight " lamps, a result in agreement with practical experience.

It is considered that the apparatus represents a considerable improvement on current practice.

Aeroplane Dopes. Relation of Tautening and Weathering Qualities to Composition. (F. W. Rheinhart and G. M. Kline, Ind. and Eng. Chem. (Industrial Ed.), Vol. 32, No. 2, Feb., 1940, pp. 185-193.) (76/43 U.S.A.)

In a previous report on developing a fire-resistant aeroplane dope to replace the hazardous cellulose nitrate product, formulæ for experimental dopes for application to fabric-covered test panels were selected on the basis of the effect of plastic, plasticiser, solvent, and diluent components on the shrinkage and flexibility of dope films. This report describes the exposure tests of these experimental dopes and discusses the relation between the tautness and weathering properties of the doped fabrics and the composition of the dope.

Evidence is presented to show that the hydroxyl content of cellulose mixed esters is especially critical in determining their suitability for use in aeroplane dopes. Solvent combinations and plasticisers which yield optimum tautness, resistance to slackening in wet weather, and least variation in tautness during

exposure are indicated for various cellulose derivatives. A close correlation is shown to exist between the properties of the unsupported films and the behaviour of doped fabrics; a considerable saving thus results in time, labour, and materials in evaluating new compounds and formulæ.

Spot Welding of Light Alloys (from a Publication Issued by Philips Industrial (Philips Lamps, Ltd.)). (Engineer, Vol. 169, No. 4389, 23/2/40, pp. 189-90.) (76/44 Great Britain.)

The difficulties of welding light alloys arise from the fact that they are good conductors of heat, of low melting point and easily liable to corrosion when heated. The structure of some light alloys alters above a certain temperature and special heat treatment is necessary to restore the normal condition. Moreover, after long exposure to air, light alloys become coated with a thin film of oxide which has a variable resistance value. This film should be removed by pickling in suitable acid shortly before welding. The main conclusions of the present report are:—(1) Light alloys must be welded with high electrode pressures to obtain regularity and to avoid rapid deterioration of the electrodes; (2) the quantity of heat supplied to the weld must be carefully controlled, this can only be done with an electronic interrupter or by an efficient storage device; (3) storage condenser machines are very convenient in operation, since their charge is automatically limited by the peak voltage of the supply; (4) welding at very high speeds offers no advantage and can cause metal projection between the parts. On the other hand, unduly long current time increases the power consumption and leads to distortion of the work; (5) the condenser method has the advantage that the discharge time can be controlled without use of a resistance and thus without lessening efficiency. The discharge curve can be made to extend over 1/10 ~ 1/50 seconds, and these times seem to be the most favourable.

The Combined Bending-Tension Test for Metals. (E. Mohr, Z.V.D.I., Vol. 84, No. 3, 20/1/40, pp. 49-52.) (76/45 Germany.)

This test is usually applied by bending small test pieces of equal dimensions (sheets, bands or wires) backwards and forwards over rollers, through a small angle, with simultaneous application of a static load, until breakage occurs. The test is carried out on several samples under different loads and a curve plotted showing number of bendings required for breakage against the static stress. These curves show a turning point; the stress corresponding to this point, the bending-tension strength, appears to give a value characterising the alternating bending fatigue strength. In evaluating experimental data the experimental conditions (diameter of rollers, thickness of specimen, angular bending deflection) must be stated since these affect the results. A bending-tension test can be carried out in about two hours, which gives the method particular value.

Complete bending-tension curves, plotted over the whole stress, range from zero up to breaking stress, give valuable information regarding the resistance to deformation and deformability of a material under alternating stressing, and regarding the uniformity of its structure.

Experimental data obtained with various alloys are analysed and discussed.

Micro Tearing Machine for the Photomicrographic and Microcinematographic Examination of Materials. (T. Pöschl, Arch. Eisenhüttenw., Vol. 13, 1939, pp. 189-92.) (76/46 Germany.)

A small, but very strongly constructed machine for tensile tests is described. This is particularly suitable for enabling phenomena at and beyond the flow limit, and the flow of materials itself, to be observed in detail. A continuous observation of the changes in fine structure, due to mechanical stresses and impacts is also possible. Numerous micrographs taken during a bending test are reproduced.

Measurement of the Permeability of Rubber to Various Gases. (A. S. Carpenter and D. F. Twiss, Ind. and Eng. Chem. (Analytical Ed.), Vol. 12, No. 2, 15/2/40, pp. 99-108.) (76/47 U.S.A.)

The rate at which a gas passes through a sheet of rubberlike material and the rate at which a gas is absorbed by a block of the material are both dependent upon the same factors, solubility and diffusion constant. The magnitude of these factors can be measured by absorption experiments carried out under specified conditions and the results can be used to assess the permeability of the material in sheet form. Experimental methods and suitable apparatus are described for following absorption and the manner of interpreting the results in terms of permeability is given. Besides such advantages as accurate temperature control, convenient size and ease of handling of the apparatus, the small size of the test piece, and the elimination of the difficulty of producing uniform thin sheets free from pinholes, the method has the advantage that both factors, solubility and diffusion constant, can be assessed independently; this is not normally possible with direct permeation measurements. Some experimental results are tabulated.

Electric Spot and Seam Welding of Light Alloys. (C. Haase, Z.V.D.I., Vol. 84, No. 6, 10/2/40, pp. 89-96.) (76/48 Germany.)

Electric welding of light alloys still presents difficulties, mainly because the much lower electric resistance of the light alloy prevents the seam being maintained at the requisite temperature unless very much greater current densities are employed (30,000 to 45,000 amps). These currents can only be maintained for a very short time (~ $\frac{1}{5}$ sec.), otherwise the material undergoes structural changes and the electrode is affected. The current control can be carried out purely electrically by means of valves (thyratrons), or mechanically by means of a special cascade transformer. The latter method is more robust and requires less skilled attention. A single one of these modern transformers will operate simultaneously four spot welding or two seam welding machines, which reduces operative costs and produces a more favourable electric loan on the supply system.

The electrode pressure must also be adjustable to suit the work in hand (~ 100 to 300 kg.) and after the optimum values of these three factors have been determined, the electric circuit and welding machine must be able to work over relatively long periods under these conditions to ensure consistency of the weld.

The experiments described show how these factors vary for sheet metals of different thicknesses and composition as well as the resulting fatigue strength of the weld. Both ultimate and fatigue strength of such welded structures compare favourably with standard riveting. A welded fuselage can be completed in half to quarter of the time required for riveting. This new method of construction will require certain changes in design, but its obvious advantages ensure the future of welded light alloy structure as soon as the data on strength characteristics are complete.

Superpressed Plywood, Bonded with Thermosetting Synthetic Resin Adhesives. (R. K. Bernhard, T. D. Perry and E. G. Stern, Mech. Eng., Vol. 62, No. 3, March, 1940, pp. 189-95.) (76/49 U.S.A.)

A series of tests has been carried out to determine the most effective means for manufacturing superpressed plywood, using common species of wood and a synthetic resin of the phenol-formaldehyde type. This type was selected on account of its proved durability under many conditions. The effects of the following major variables were studied:—Thickness of veneer layers $\frac{1}{8}$ to 1/48 in.; common species of wood such as birch, yellow poplar and red gum; increasing pressures 200-1,500 lb./sq. in.; number of layers of resin film, 1-3; number of cross layers, alternate, every fifth and every tenth. The results showed that:—(1) Veneer thickness affects strength of superpressed plywood considerably.

(2) Birch plywood is much stronger than poplar or gum plywood when manufactured under a pressure of 500 lb./sq. in. (3) Poplar and birch superpressed plywood have similar high strength values when manufactured at about 1,500 lb./sq. in. The strength increment for the same materials varies between 66 and 127 per cent. for plywood made under 200 and 1,500 lb./sq. in. respectively. (4) The amount of synthetic resin influences the strength of the bond. (5) The arrangement of cross layers affects the strength data to such an extent that this factor should be considered in designing for specific purposes. (6) The strength of superpressed plywood increases in direct proportion to its density. (7) The strength of superpressed plywood may be adapted to its proposed function, because its strength can be determined with a fair degree of accuracy.

The Effect of Range of Stress on the Torsional Fatigue Strength of Steel. (J. O. Smith, Univ. Illinois Eng. Expt. Station Bull., No. 316, 1939, 38 pp.) (76/50 U.S.A.)

The effect of range of stress on the torsional fatigue strength of steel containing the following constituents: Carbon 0.37 per cent., Mn. 0.75 per cent., PO. 17 per cent., S 0.030 per cent., Si 0.178 per cent., Ni 1.33 per cent., Cr 0.65 per cent., was investigated. The influence of a notch, hole, fillet, keyway, or other type of " stress raiser " on the shearing endurance limit was determined. The formulæ for computing the endurance limit for any range of stress in torsional shear are discussed and classified.

(From Sci. Absts. " B," Vol. 43, No. 506, 25/2/40, p. 54.)

Fatigue Tests of Connection Angles. (W. M. Wilson and J. V. Coombe, Univ. Illinois Eng. Expt. Station Bull., No. 317, 1939, 24 pp.) (76/51 U.S.A.)

The fatigue strength, that is, the maximum stress to which the part may be subjected 2,000,000 times without failure, was determined for a number of angle parts and riveted parts. The specimens were tested on a cycle in which the total load on the specimen varied from zero to a maximum tension. The fatigue strength of rivets was obtained as the quotient by dividing the total external load that produced the failure in 2,000,000 cycles by the nominal area of the section of all tension rivets. Diagrams are given showing the methods of computing flexural stress and deflection, and deflection of angles due to load causing tension in rivets.

(From Sci. Absts. " B," Vol. 43, No. 506, 25/2/40, p. 54.)

An Improved Electric Hygrometer. (F. W. Dunmore, Bur. Stan. J. Res., Vol. 23, No. 6, Dec., 1939, pp. 701-14.) (76/52 U.S.A.)

The psychrometer and hair hygrometer are common means of determining the moisture content of air. There are, however, many circumstances to which these are not well adapted, especially in the measurement of upper air humidities by means of the radio sonde, where marked and sudden changes of humidity are encountered.

This paper describes a type of electric hygrometer which better fulfils the above requirements. It covers improvements made in an earlier type of electric hygrometer previously described by the author. The improved unit consists of an 0.01 inch wall aluminium tube $1\frac{11}{16}$ inches long coated with polystyrene resin and wound with a bifilar winding comprising 20 turns (of each wire) per inch of No. 38 AWG bare palladium wire. The unit is then coated with a thin film of partially hydrolysed polyvinyl acetate with the addition of a small amount of lithium chloride, the amount depending upon the humidity range to be covered by the unit. The electric resistance of the film between the two coils is a function of humidity.

The thin walled aluminium tube enables the unit to assume quickly the temperature of the air, as it must if measuring relative humidity. The use of palladium

wire eliminated a continuous ageing effect or increase in resistance caused by a film which continued to form on the surface of all other wires previously used. The polystyrene resin forms an excellent water resistant surface of high electric resistance for the wire and water sensitive film. This construction eliminated hysteresis effects previously experienced, caused by the adsorption of water by glass and other materials used as bases.

A calibration of a three-element unit used in the radio sonde circuit serves as an example of measurements over temperature range from $+30°$ to $-60°$C.

Electric hygrometer units have been made which have not varied more than two or three per cent. over a period of several months.

Corrugated Metal Diaphragms for Aircraft Pressure Measuring Instruments. (W. A. Wildhack and V. H. Goerke, N.A.C.A. Tech. Note No. 738, Nov., 1939.) (76/53 U.S.A.)

A large number of corrugated diaphragms of beryllium copper, phosphor bronze, and Z-nickel, having geometrically similar outlines, but of various diameters and thicknesses, were formed by hydraulic pressing. The apparatus and the technique used in the manufacture, the testing, and the heat treatment are described.

The shape of the diaphragms was such that the central deflections were nearly proportional to the differential pressures up to deflections of 2 per cent. of the diameter. The pressure deflection characteristics of the various diaphragms were correlated with the thickness, the diameter, and the elastic properties by dimensional analysis to obtain formulas and charts applicable to the design of similar diaphragms. The formula

$$FX/PD = 2.25 \times 10^5 \cdot \{ (t \times 10^3)/D \}^{-1.52}$$

holds for values of $(t \times 10^3)/D$ over the range from 1 to 4. Outside this range, the exponent is larger. In the formula, t, D, and X refer to the thickness, the diameter and the central deflection of the diaphragm, respectively; P refers to the differential pressure causing the deflection X; and F, a function of the elastic moduli, has the values 18.9, 17.5, and 28.4×10^6 pounds per square inch for beryllium copper, phosphor bronze, and Z-nickel, respectively.

For comparison, some data are presented for flat diaphragms and for corrugated diaphragms differing slightly from the standard design. The use of the experimental results in the selection or the design of corrugated diaphragms is briefly discussed.

The Development of Electrical Strain Gauges. (A. V. de Forest and H. Leaderman, N.A.C.A. Tech. Note No. 744, Jan., 1940, 37 pp.) (76/54 U.S.A.)

The design, construction and properties of an electrical resistance strain gauge consisting of fine wires moulded into a laminated plastic are described. These gauges have dimensions of about 3 in. $\times \frac{3}{8}$ in. $\times$ 0.010 in., and temperature compensation is effected by having wires with positive and negative temperature coefficients of resistance arranged in series or in parallel. At present the results obtained are not always reproducible, possibly due to overheating of the wires, overstraining of the wires on cooling, imperfect cementing of the wires in the gauge or of the gauge itself. The sources of these errors are under investigation, and when the correct conditions have been established it is proposed to make jigs for the production of temperature compensated gauges of about 250 ohms resistance for use on impact work. Short gauge length gauges for work on stress concentrations are also being considered.

The methods of moulding wires into plastic materials are described.

The programme of future work in this field consists in the standardisation and quantity production of wire type resistance strain gauges and development of cold cementing methods and methods of instrumentation suitable for use in the field.

Sensitive Aneroid Diaphragm Capsule with No Deflection Above a Selected Pressure. (W. G. Brombacher, V. H. Goerke and F. Cordero, Bur. Stan. J. Res., Vol. 24, No. 1, Jan., 1940, pp. 31-32.) (76/55 U.S.A.)

A sensitive diaphragm capsule has been designed in which the two corrugated diaphragms nest into each other at external air pressures above a desired value. Evacuated capsules of this type have particular application in measuring pressure with radio sondes of the Diamond-Hinman-Dunmore type, where the deflection of the contact arm is fixed. At the ground level the diaphragms are designed to nest into each other and deflection does not begin until the air pressure is reduced to the value called the cut-off pressure. Several elements of two capsules each were constructed with a cut-off pressure of 140 millibars. When installed in a radio sonde in place of the usual type, which is responsive over the entire range of pressures, a sevenfold increase in sensitivity in pressure measurement was obtained at altitudes above 46,000 feet.

Flightray (Blind Flying and Landing Indicator). (Inter. Avia., No. 699, 27/2/40, pp. 1-5.) (76/56 U.S.A.)

This instrument (Sperry Gyroscope Co.) shows the readings of four navigational instruments simultaneously as an optical pattern on the fluorescent screen of a cathode ray tube. The instruments are:—I. Artificial horizon shown by a straight line, up and down motion of which means dive or climb, whilst a tilt indicates banking. II. Directional gyro turn about the vertical axis is shown by deviation of a short vertical line on the upper part of the screen. III. Radio compass (or localiser path): A small circle of light is able to travel all over the screen; its central position indicates " on path " conditions and deflection to left or right shows deviation from the radio compass heading. Up or down deflection shows change in altitude or deviation from the glide path in blind approach. IV. Air speed indicator: A small horizontal line rises across the screen with increase in speed. A black mark on the lower half of the screen acts as a stall warning indicator.

A miniature aeroplane is silhouetted in the centre of the screen and the real aircraft is kept to normal altitude, position and heading by ensuring that the luminous circle surrounds the fuselage of the silhouette and the horizontal lines coincide with the span. Each of the master instruments thus " televised " is fitted with a special pick-up transforming the deviation of the pointer into a differential alternating voltage, which, after rectification and amplification, deflects the corresponding optical pattern in the cathode ray tube. The four patterns are seen simultaneously without flicker.

The " Flightray " has been undergoing development since 1937 and several units will shortly be available for extensive service trials.

Note on the Distributions of Temperature and Vapour Pressure Around a Horizontal Wet Cylinder. (R. W. Powell, Phil. Mag., Vol. 29, No. 194, March, 1940, pp. 274-284.) (76/57 Great Britain.)

Experiments are described in which unventilated thermocouple psychrometers are used to determine the temperature and vapour pressure distributions above, below, and to one side of the wet surface of a horizontal cylinder. The presence of a convection current passing over the surface in a downwards direction is revealed when the surface is cooled to a temperature well below that of the air. When the surface temperature is raised, a temperature is reached at which very little movement of the air occurs. Under the conditions of the present experiment this occurred when the surface temperature was just over 1°C. below the temperature of the surroundings. With further increase in surface temperature the convection currents change to an upward direction. It is shown that the rate of evaporation falls to a minimum value in the region of little air movement, and, on the assumption that the whole of the moisture loss takes place by diffusion,

the experimental data for the vapour pressure gradients near the wet surface are seen to lead to values of the correct order of magnitude for the coefficient of diffusion of water vapour into air.

Noise Analysis. A New Laboratory for Noise Investigation. (C. A. Mason, B.T.H. Act., Vol. 15, Nov.-Dec., 1939, pp. 205-11.) (76/58 Great Britain.)

The object of the laboratory is to enable consistent and accurate noise measurements to be made on all classes of electrical products, so that the behaviour of the equipment on site may be predicted by measurements taken before despatch. Important factors are the use of a non-reverberant room or echoless chamber, an isolated base for the machine, and an enclosure which excludes external noises. The building is described; the test-room has its walls and ceiling lined with four inches of glass wool with an air space behind. When a machine is under test, personnel and apparatus, except the microphones, are evacuated, and measurements are made in an adjoining room. The use of subjective and objective instruments for the measurement of equivalent loudness is discussed. The objective meter is preferred, but readings are frequently checked by subjective methods. The instruments used, and analyses of noises, are described and illustrated.

(From Sci. Absts. " B," Vol. 43, No. 506, 25/2/40, p. 88.)

Propeller Rotation Noise Due to Torque and Thrust. (A. F. Deming, N.A.C.A. Tech. Note No. 747, Jan., 1940.) (76/59 U.S.A.)

Sound pressures of the first four harmonics of rotation noise from a full scale two-blade propeller were measured and are compared with values calculated from theory. The comparison is made (1) for the space distribution with constant tip speed, and (2) for fixed space angles with variable tip speed.

CONCLUSIONS.

1. The theory gives values of total power radiated in the first four harmonics within four decibels of experimental values.

2. This study shows that the experimental results are in reasonably good agreement with Gutin's theory. The agreement is particularly good for the lower harmonics, in regard to both magnitude and distribution.

3. For the fourth harmonic, the results differ by as much as eight decibels. This disagreement might be due to disregard of the thickness effect, which, in general, should be greater for the higher harmonics.

4. It has been shown that the power output in rotation noise increases as the $6+5/3\ qn$ power of the tip speed, where

q = order of harmonic,
n = number of propeller blades.

Free Space Propagation Measurements at 75 Megacycles. (G. L. Haller, J. Frank. Inst., Vol. 229, No. 2, Feb., 1940, pp. 165-80.) (76/60 U.S.A.)

In studying the radiation characteristics of aircraft antennas, employing the principle of similitude with scale models, a major problem has been to devise a system of free space propagation measurements in order to eliminate errors caused by proximity to the ground. The ground errors appear in two forms. The first is the actual distortion of the field in both amplitude and phase, and the other is the unequal attenuation of the horizontal and vertical electrical fields. As an aircraft antenna is rather complex and may be made up of both horizontal and vertical components, any unequal attenuation may give a false representation of the true radiation pattern. The original work was done at a frequency of 75 megacycles and at a height of approximately one-half wavelength (2 meters) and serious errors were noted. This paper details the preliminary study and

some of results of a tower system which was built to make free space measurements with little error due to ground effects.

40 *cm. Waves for Aviation.* (Electronics, Vol. 12, Nov., 1939, pp. 12-15.) (76/61 Great Britain.)

Signals of 700 mc./s., modulated at 150 and 90 c./s., respectively, are directed in fan-shaped beams from two horns 26 ft. long. The overlapping signal field provides a glide path for the landing of aircraft. The test described was made with a sender in which the output power of the oscillator was about 1 W. at 700 mc./s. The heterodyne receiver, which produces full-scale output for an input of only 15 μV., employs in the first detector stage a diode which develops the third harmonic of the oscillator frequency (230 mc./s.). Three tuned circuits are connected in series with the diode, tuned to frequencies 700, 230, and 10 mc./s., respectively, 10 mc./s. being the intermediate frequency. Subsequent stages of amplification, which are more conventional, are described. Noise and motor-boating are avoided by the inclusion of resistance-capacitance band-pass couplings, permitting only frequencies from 50 to 400 c./s. to appear in the output. The apparatus has been successfully tested with aircraft.

(From Sci. Absts. " B," Vol. 43, No. 506, 25/2/40, p. 82.)

LIST OF SELECTED TRANSLATIONS.

NOTE.—Applications for the loan of copies of translations mentioned below should be addressed to the Under-Secretary of State (R.T.P.), Air Ministry, Dept. Z.A., London, W.C.2, and will be loaned as far as availability of stocks permit. Suggestions concerning new translations will be considered in relation to general interest and facilities available.

Lists of selected translations have appeared in this publication since September, 1938.

TRANSLATION NUMBER AND AUTHOR.		TITLE AND JOURNAL.
989	Schultz-Grunow, F. ...	*Predetermination of the Separation Point in Turbulent Flow.* (L.F.F., Vol. 16, No. 8, 30/8/39, pp. 425-8.)
1007	Stanke, P.	*External Disturbance of the Path of a Projectile.* (W.T.M., Vol. 42, No. 12, Dec., 1938, pp. 560-9; Vol. 43, No. 1, Jan., 1939, pp. 35-44; No. 2, Feb., 1939, pp. 63-9.)
1008	Seifert, A.	*Comparison of Terms Relative to the Performance of Aero Engines, Employed in Various Countries.* (Luftwissen, Vol. 6, No. 8, August, 1939, pp. 238-241.)
1009	Schmierschalski, H. ...	*Action of Several Propellers on One Shaft.* (W.R.H., Vol. 20, No. 17, 1/9/39, pp. 278-9.)
1010	—	*High Altitude Flying.* (La Guerre Aérienne, Vol. 5, No. 164, 20/11/39.)
1012	Stieglitz, A.	*The Effect of Pendular Masses on Torsional Vibrations.* (Yearbook of German Aeronautical Research, Vol. 2, 1938, pp. 164-178.)