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AIRCRAFT ENGINES, FUELS AND LUBRICANTS

I Fuels

Possible Developments in Engine Fuels. (W. Ostwald, *Der Motorwagen*, XXX., 20/10/27, p. 628.) (7711 Germany.)

The author reviews the various fuels at present in use. The Bergius and Fischer processes for producing synthetic fuels are mentioned. Producer gas directly produced from suitable coal appears to be a possible development for commercial vehicles.

Attention is called to a mixture of methyl alcohol and benzene much used on the Continent as a racing fuel.

Some Autoxidation Reactions of Petrols. (A. Graetz, *Ann. off. nat. comb. liquides* 3, 69-76 (1928), abstr. in *Chem. Abstr.*, XXII., 10/7/28, p. 2459.) (9247 France.)

From a brief critical review of work on the subject it is concluded that:—
(1) before any thermal dissociation reaction occurs there is autoxidation of the petrol which takes place mainly in the liquid phase at an optimum temperature of 120-160°; (2) the most readily autoxidisable hydrocarbons are the C₂H₄ hydrocarbons, the autoxidation of which can take place in two different ways to give either unstable and detonating compounds or stable compounds. The presence of a fairly large proportion of C₂H₄ hydrocarbons in petrol thus causes a more regular autoxidation of the paraffin hydrocarbons and leads to more stable or more easily hydrolysed products. Similarly, the anti-knock properties of terpenes are attributable to their regulation of autoxidation to produce more stable products; (3) the anti-knock properties of aromatic hydrocarbons are due to the stability of the peroxides which they form, but this stability renders them less suitable as catalysers in the autoxidation of the paraffins. They can combine directly with compounds containing double bonds, and act as re-agents, rather than as catalysers, and the oxides which they form are very easily hydrolysed. In order to produce a beneficial effect they must therefore be present in large proportions in petrol (50 per cent. and over); (4) ketones and aldehydes (particularly cyclohexanone and menthone) behave like C₂H₄ hydrocarbons; (5) the chief factors which destroy the peroxides formed by autoxidation are hydrolysis by H₂O and decomposition by high temperature.

The Blummer Cracking Process. (*Ind. & Eng. Chem.*, XX., 10/7/28, p. 6.) (9248 U.S.A.)

The process consists in the main of pumping crude oil under pressure into an autoclave filled with molten lead, pressures of the order of 35-40 atmospheres being employed. An experimental plant has been set up near Berlin and it is claimed that the process is cheaper in operation and safer in handling than any other.

The Composition of Benzol from Carburetted Water-Gas. (W. O. Voss, J. Soc. Chem. Ind., 23/9/27, p. 373.) (7628 U.S.A.)

The experiments described were carried out in the laboratories of the Gas Light and Coke Co.

Benzol derived from carburetted water-gas under correctly controlled conditions does not contain a large quantity of paraffin. It differs from coal-gas benzol in containing a larger proportion of unsaturated compounds which are difficult to remove. With adequate washing and distillation satisfactory benzol with high toluene content was obtained.

2 Lubricants

The Influence of Pressure on the Viscosity of Oil. (S. Kiesskat, Phys. Ber., VIII., 1/11/27, p. 1950, F.V.D.I., No. 291.) (7723 Germany.)

The experiments were carried out in the Technical High School of Karlsruhe, the pressure range was from 100 to 1,000 atmospheres and the temperature range between 20 and 80°C. The viscosity shows an increase with pressure which at room temperature may be of the order of six to twelve times between 100 and 1,000 atmospheres. At higher temperatures the effect of pressure is diminished.

Detrimental Properties of Lubricants in Use. (F. Frank and H. Selberg, Erdöl u. Teer, IV., 1928, pp. 215-217, abstr. in Chem. Abstr., XXII., 1928, p. 2460.) (9249 Germany.)

It is contended that the method advanced by Hackford ("Engineering and Boiler House Review," September, 1926, p. 152) is substantially the method of Haslam and Frohlich ("Chem. Abstr., XXI., p. 1345), according to which O₂ is passed through a large sample of the oil at 130-140°C. and the increasing acidity is determined at intervals. Hackford's results are not considered trustworthy and the authors have repeated the experiments. A number of oils of American and Russian origin were tested at 160°C., the increased acidity being determined after nine hours. The superiority of the Russian naphthenic oils was clearly demonstrated.

3 Thermodynamical Investigations: Dopes and Detonation

Detonation Theories in U.S.A. (Ind. & Eng. Chem., XIX., Oct., 1927, p. 1077.) (7648 U.S.A.)

Fuel research receives special attention in the United States, and in this brief review of a year's progress considerable space is given to detonation theories. It is stated that no universally valid theory has yet been advanced, although such powerful methods as ultra-violet spectroscopy, analysis of the gas mixture in the cylinder and experiments with pure fuel have been applied. A surprising result of the work has been the discovery that pure straight chain hydrocarbons of the type supposed to be the principal constituent of petrol caused much more violent knocking than petrol itself. On the other hand, some of the isomeric branch chain hydrocarbons of approximately the same boiling point act as powerful knock preventers.

It would thus seem that the accepted theory that petrol is made up of straight chain hydrocarbons is erroneous.

Liquid Fuels for Internal Combustion Engines. (B.P. 277326, 7/9/26, Geb. Avenarius, abstr. in Chem. Abstr., XXII., 1928, p. 2455.) (9250 Germany.)

Petrol or similar fuels are treated with "anti-knocking" agents comprising higher fatty acids or corresponding esters, aldehydes, ketones, lactones,

anhydrides or other derivatives which may be treated with halogens, nitrogen, oxygen or ozone or their mixtures, *e.g.*, there may be added 0.5 per cent. of liver or castor oil, triolein or ethyl or methyl oleate.

Ionisation in Methane-Oxygen and Acetylene-Oxygen Explosions., (S. W. Saunders, *Trans. Farad. Soc.*, XXIII., 1927, p. 256, abstr. in *Fuel in Sc. & Prac.*, VI., Oct., 1927, p. 476.) (7650 Great Britain.)

From a study of the ionisation during the explosion of mixtures of methane and oxygen, and of acetylene and oxygen, it is shown that the maximum electrical conductivity occurs when the hydrogen is burnt to water and the carbon to carbon dioxide in the case of the former mixtures and when the hydrogen is burnt to water and the carbon to carbon monoxide in the latter. The addition of 70 per cent. of nitrogen to the acetylene-oxygen mixtures lowers the maximum temperature of explosion sufficiently for the combustion of carbon monoxide to carbon dioxide in the mixtures giving the greatest electrical conductivity. The conclusion previously reached, that ionisation is a thermal and not a chemical effect, was confirmed, and it was shown that there is probably no connection between ionisation during explosion and the ignition temperature of the initial gaseous mixture.

Ionisation Potential of Methane. (E. Pietsch and G. Wilcke, *Z.f. Physik*, XLIII., 1927, p. 342, and *Z. Phys. Chem.*, CXXI., 1926, p. 127, abstr. in *Fuel in Sc. & Prac.*, VI., Oct., 1927, p. 476.) (7649 Germany.)

The authors have found by experiment the ionisation potential of methane to be 14.6 volts, which is in agreement with the value of 15 to 16 previously obtained by calculation from the heat of dissociation of methane. The heat of dissociation of the hydrogen molecule was calculated from the results, and found to be 106.7 large calories in agreement with Bodenstein and Jung.

Ionisation in Explosion of Carbon Monoxide and Oxygen. (S. W. Saunders and K. Sato, *Trans. Farad. Soc.*, XXIII., 1927, p. 248, abstr. in *Fuel in Sc. & Prac.*, VI., Oct., 1927, p. 476.) (7651 Great Britain.)

A study of the electrical conductivity of mixtures of dry carbon monoxide and oxygen exploded in a spherical bomb of two litres capacity confirms the view that ionisation in gaseous explosions is mainly thermal in character. The addition of hydrogen or water to dry carbon monoxide and oxygen mixtures increases the ionisation produced during the explosion. The conductivity of the gases produced during the explosion of these mixtures changes in a manner analogous to the velocity of propagation of the explosion wave. The duration of the ionisation in the explosion of dry carbon monoxide-oxygen mixtures is much greater than for the moist gases, this being in agreement with the slow development of pressure which occurs in explosions of dry carbon monoxide and oxygen in closed vessels.

Ionisation in Flames of Various Organic Substances. (J. A. J. Bennett, *Trans. Faraday Soc.*, XXIII., July, 1927, pp. 307-311, abstr. in *Sc. Abstr.*, XXX., 359, 25/11/27, p. 818.) (7863 Great Britain.)

Experiments are made to determine the correlation, if any, between the degree of ionisation of various substances in flames and the amount of detonation in an engine cylinder charged with fuels containing these substances. Flames of coal-gas, hexane, ether, alcohol, acetone, etc., are studied, and the effects of the introduction of a large number of substances, including carbonyls, organic oxides, halogens, and halogen compounds, organic nitrogen compounds and aldehydes, are noted. The tabulated results show that although contrary to the views of Wendt and Grimms, Charach, Mack and Boord, many "knock-inducers" increase and "anti-knocks" decrease the ionisation of flames, this

is not generally so. It is concluded that although ionisation accompanies detonation, as it does all flame phenomena, there is no simple relationship between them, and that ionisation is neither a cause nor an effect of detonation, but is mainly a temperature effect.

Experimental Studies on the Effect of Ethyl Gasoline and its Combustion Products. (R. R. Sayers, A. C. Fieldner, W. P. Yant and B. G. H. Thomas, Bureau of Mines, U.S.A. Ann. Rep., 1927, p. 447, abstr. in Chem. Abstr., XXII., 1928, p. 160.) (7857 U.S.A.)

The investigation is divided into three parts—the physical effects of exhaust gases from engines using ethyl gasoline, the effects of inhaled ethyl gasoline vapour, and the effect of ethyl gas when absorbed through the skin. The danger zone for concentration of lead dust was found to lie between .14 and 1.4 mg. per cubic metre of air. The skin absorption experiments showed that a daily dose of one cubic cm. causes a distinct storage of lead which could be decreased somewhat by washing with kerosene and soap within five minutes after application.

4 Heavy Oil Engines

High Grade Cast Iron Suitable for Diesel Engine Cylinders. (Dr. Schulz, Motorwagen, XXX., 20/10/27, p. 625.) (7712 Germany.)

Messrs. Sulzer have perfected a close grain product containing a large percentage of perlite, suitable for cylinder liners. Liners of this material show only a small fraction of the wear usually exhibited.

5 Torsional Vibration

The Angular Distortion of Crankshafts. (C. A. Norman and K. W. Stinson, J. Soc. Autom. Eng., XXIII., July, 1928, p. 83.) (9251 U.S.A.)

Many references are given, both English and German. As published experimental data on deflections are lacking, the authors obtained an engine with four crankshafts, having crank-arms with different cross-sections, and measured the deflections under static load.

Deflections in various parts are analysed and compared, and a formula is developed for the deflection in the long crank-arms.

6 Mechanical and Heat Losses

The Calculation of Temperature Stresses in Tubes. (L. H. Barker, Engineering, CXXIV., 7/10/27, p. 443.) (7634 Great Britain.)

The author gives a series of alignment charts giving the values for

- (a) Maximum tangential stress.
- (b) Maximum longitudinal stress.
- (c) Maximum radial stress.
- (d) Tangential stress at the outside radius.
- (e) Longitudinal stress at the outside radius,

in terms of the temperature difference across the walls of the tube, the ratio of the diameter of the tube and a material constant.

Combustion Time in the Engine Cylinder and its Effect on Engine Performance. (C. F. Marvin, Jr., N.A.C.A. Report, No. 276.) (7887 U.S.A.)

A theoretical concept of a flame front which is assumed to advance radially from the point of ignition is presented, and calculations of the mass rate of combustion are based on the area and velocity of the flame front. From this rate

the mass which has been burned and the pressure at any instant during combustion are computed.

This process is then reversed in an effort to determine the actual rates of combustion and flame velocities from the pressures as recorded on indicator diagrams.

The effects of different rates of combustion on engine performance are then discussed and the importance of proper spark advance is emphasised.

7 Operation of Engines at High Altitudes

Effect of Altitudes on the Power of Aero Engines. (Akira Kobayashi, J. Soc. Mech. Eng., Tokyo, XXVIII., 1925, abstr. in Jap. J. of Eng., V.) (9252 Japan.)

A theory of height-control of carburation is given. Experimental data are required on which to base numerical applications of the conclusions.

Auto-Cooling Engines for High Altitudes. (L. Stipa, IV. International Air Congress, Rome, Oct., 1927.) (7875 Italy.)

The author makes a rapid examination of the superchargers, especially turbo-type, enumerating their inconveniences; he also deals with the so-called enlarged engine whose weight per horse-power would be 50 per cent. over the ordinary figure at the height of 6,500 metres, and 150 per cent. at the height of 12,000 metres—a very serious disadvantage. He touches on the requisites for carburation at high altitudes.

Drawings and calculations are given of an original design for a six-stroke engine with a chamber added to each cylinder. The mixture enters this chamber and returns to the cylinder for the second compression. With these two added phases regulation of the valve opening at various heights maintains constant power from zero to an altitude of 6,500 metres. From the thermal diagrams the engine will have a weight greater than normal at zero altitude but less beyond a certain altitude.

The chamber is concentric to the cylinder or even forms a constituent part of its jacket in such a manner as to do away with water-cooling, by cooling the engine with the mixture that circulates in the chamber. The thermal advantage is considerable.

He considers that the principle of six-strokes and of auto-cooling are of decisive importance.

(*Abstractor's note.*—This throws an interesting light on Italian aero engine research.)

8 Engine Design

The Idea of the Efficiency of Internal Combustion Engines. (W. T. David, Engineering, CXXIV., 16/9/27, p. 371.) (7633 Great Britain.)

This paper was read before Section G of the British Association at Leeds. The author puts forward the view that the specific heats as utilised by Messrs. Tizard and Pye are too high and that therefore the ideal efficiency calculated by them is too low. The main cause of this discrepancy is the incomplete combustion of the fuel at the moment of maximum pressure, chemical energy of the charge not having been completely converted into thermal energy. Internal combustion engines should therefore be still capable of perceptible improvements in efficiency.

Experimental Research on the Air Flow through Poppet Valves (Japanese). (Keikichi Tanaka and Toyoaki Chino, Research Inst., Tokyo Imp. Univ. 17 (1925), abstr. in Jap. J. of Eng., Vol. V.) (7946 Japan.)

With water, experimental researches upon this subject have been reported by many authorities. With air, however, the only investigation is that of the National Advisory Committee for Aeronautics in 1918.* As a problem of airplane engine design it is necessary to have more accurate information upon this subject.

In the present paper, being the first report, the authors describe (1) the apparatus of their experiments and the method of measurement of the air flow quantity; (2) one part of the flow characteristics of the poppet valve, *i.e.*, the relation between the valve lift, the pressure drop, the flow quantity and the coefficient of efflux; and (3) the comparison of these characteristics of three similar valves of different sizes.

* (*Abstractor's note.*—See F.V.D.I., No. 272; abstract reference No. 8.7/5885 on page 10 of Abstracts and Notices from the Scientific and Technical Press, No. 4.)

9 Anti-Freezing Compounds

Anti-Freeze Compounds. (Ind. & Eng. Chem., XIX., Oct., 1927, p. 1119.) (7627 U.S.A.)

The anti-freezing properties of methanol, ether-alcohol, glycerol, ethylene glycol are compared. The author favours the use of methanol. An extensive bibliography is attached.

AERODYNAMICS AND HYDRODYNAMICS

10 Aeroplane Performance

Analysis of Aeroplane Performance.—Results and Experiences in the Saxon Meeting. (H. Blenk, Z.F.M., XIX., 14/3/28, pp. 100-105.) (9255 Germany.)

From an analysis of the competitive performances, simple empirical formulæ are derived which give the relations between the weight per h.p. engine power and total weight between 20 and 500 h.p. The question of handicapping formulæ is raised and a warning is given against the danger of directing development along misleading lines.

11 Aeroplane Stability

Stability, Trim and Handling of Aeroplanes. (M. Roy, Rev. Gen. de l'Aeron., No. 8, 1928, pp. 7-124.) (9254 France.)

Part I.—A résumé of the experimental constants involved in statical equilibrium is given and the usual relations—developed for steady flight, under power or in a glide. The results are illustrated by metacentric curves.

Part II.—The equations of disturbed motion are developed on the usual lines and examples are drawn graphically showing the different types of instability.

A table shows how various types of instability arise as the discriminants change sign, thus classifying the types of instability.

Part III.—The handling of an aeroplane is discussed in its relation to the coefficients of stability. The result is put forward that the radius of gyration in pitching must lie between two fixed values and must have an optimum value. A numerical example is discussed at length.

Part IV.—The effect of atmospheric disturbance on the equilibrium of an aircraft is discussed in terms of the stability criteria and of the effective moment of the controls.

A summary of experimental measurements required in the laboratory is given and a scheme of calculations for routine design is added.

A short bibliography is given. The author succeeds in avoiding reference to British work.

12 Experimental Hydrodynamics

Eddies Produced by an Obstacle Immersed in a Fluid Stream. (G. Camichel, *Comp. Rend.*, CLXXXIV., 20/6/27.) (7882 France.)

The stable rows of alternate vortices (obtained mathematically by v. Karman) are obtained experimentally by the author with water and with a fluid of kinematic viscosity 5.3 times greater. The corresponding stream velocities were maintained in the ratio 1 : 5.3 and the corresponding periods were found to be also in the ratio 5 : 3.1, as expected, with a maximum error ± 3 per cent.

The linear dimensions were then altered in the ratio 2 : 1, and for water it was found that when the velocities were in this ratio the periods were in the inverse square ratio as expected. Thus Reynolds' criterion is sufficient in both instances. (Benard found Reynolds' criterion insufficient and v. Karman showed that surface tension and gravity were effective for vortices with their ends on the free surface on the small geometrical scale used by Benard.) A stroboscopic method of observing the angular velocity of vortex rings is described. It is based on the reflection of light from aluminium particles in given orientations and enables very rapid cycles to be measured.

The vibration of the cylindrical obstacle is suggested as a criterion of the critical velocity of flow, which produces resonance between the natural period of the cylinder and the shedding of vortices as observed by Rayleigh and others.

Influence of Vortices on Resistance of Solids Moving in a Liquid. (W. G. Bickley, *Proc. Roy. Soc. A.*, 119, 1/5/28, pp. 146-156.) (9255 Great Britain.)

The author discusses the resistance on a circular cylinder in two dimensions due to a system consisting of one or two trailing vortices, in the former case with equal and opposite circulation round the cylinder. The author makes a point of the fact that until the eddy or eddy pair are carried to a distance, they continue to affect the pressure distribution and the resistance. This consideration is irrelevant in the case of the v. Karman double row of vortices stretching to a distance. It is, however, of some interest in the case of the single eddy detached from a rotor under the special conditions of Prandtl's well-known experiment, where the lift on the rotor approaches its limiting value rapidly but not immediately, as the detached vortex is carried downstream. The mathematical presentation is interesting.

Application of the Theory of Similarity to Measurements of Flow. (A. Grunwald and E. Engel, *Z.V.D.I.*, LXXII., 26/5/28, pp. 699-702.) (9256 Germany.)

A large number of new experiments on the flow of water and steam through pipes of circular section and constant or varying diameter is collected. Four parameters are taken into account, the viscosity, the diameter at the point of measurement, a nozzle coefficient and the total quantity flowing.

The results are reduced to curves which are substantially universal, and extend and confirm previous work.

The Measurement of Pressure Through Tubes in Pressure Distribution Tests.
(P. E. Hemke, N.A.C.A. Report, No. 270.) (9257 U.S.A.)

Aluminium tubes of 3/16in. inside diameter in lengths from 20ft. to 226ft. and pressure maxima from 2in. to 14oin. of water were used.

Curves are constructed showing the time lag and pressure change. Empirical formulas are also given for computing time lag.

Analysis of pressure-distribution tests made on airplanes in flight shows that the recorded pressures are slightly higher than the pressures at the orifice and that the time lag is negligible. The apparent increase in pressure is usually within the experimental error, but in the case of the modern pursuit type of airplane the pressure increase may be 5 per cent. For pressure-distribution tests on airships the analysis shows that the time lag and pressure change may be neglected.

Measurement of Profile of a Circular Wave of Small Amplitude at the Surface of a Liquid. (J. Baurand, Comp. Rend., CLXXXVI., 25/6/28, pp. 1822-1823.) (9258 France.)

In view of the impossibility of obtaining direct photographs as with a parallel channel and rectilinear waves, point determinations, in time, are obtained by photography of an indicator on the surface and by other methods. The accuracy is stated to be within 1/80th of a millimetre.

Flow of Water in Rectangular Pipes. (S. J. Davies and C. M. White, Proc. Roy. Soc. A., 119, 1/5/28, pp. 92-107.) (9259 Great Britain.)

The aperture through which the water flows is 2.54 cm. wide, 4 cm. long, and from 0.054-0.0618 cm. deep. The conditions of flow are thus approximately two-dimensional. Two critical values were found for each depth, one at which instability of laminar flow appears and one at which it disappears. The effect of the "entering length" is well marked in the wider channels by the premature gradual departure of the resistance curves from the straight line representing the resistance for steady laminar flow; above transition range the resistance curve approximates to that for round pipes. Interesting results due to disturbances at entry are obtained and discussed.

The Determination of Profile Resistance in Flight by the Momentum Method.
(M. Schrenk, 102nd Rep. of the D.V.I., Berlin, L.L.F., II., Part I., 18/5/28, pp. 1-32.) (9260 Germany.)

The measurements were made on full scale, and photographs are given of the installation on a Junker monoplane with a low set wing, and a B.M.W. IV. engine, model A.20. Two types of pitot tube were used; (1) a Prandtl type with spherical head of such a radius that the recorded pressure fell off as the cosine of the inclination between 0° and 20°, and (2) the Brabbee type showing no inclination effect up to 10° and only a 2 per cent. effect at 20°.

The hydrodynamical principles involved are discussed and the formulæ are transformed so that the coefficient of resistance is expressed in terms of effective head.

Thirteen different types of wing covering were used and ten different vertical positions of the pitot tube. In Figs. 12 to 24 the observed pressure differences for the different vertical positions are plotted against the pressure head at infinity multiplied by factors corresponding to the relative density and the inclination of the pitot head. After graphical reductions the distribution of pressure difference over the tail wash is obtained for the corresponding incidence. The results are given in Figs. 25-36. The effect of errors of observations is discussed.

The final results are given in Table III. and a discussion of the differences is given in detail. A bibliography with fifteen references is added.

New Experiments on the Air Resistance of Spheres. (O. Flachzbart, Phys. Zeit., XXVIII., 1927, pp. 461-468.) (6280 Germany.)

The author assembles a number of experimental results on spheres in Fig. 1 where the different curves show the same general characteristics but different positions of the critical points.

A general qualitative explanation is attempted with some success on the lines of Prandtl's recent methods. The author's systematic experiments with different types of mounting are given in illustration. It is shown fairly conclusively that where there is no sharp edge in the model (which would dominate the other effects) the type of flow is very sensitive near the critical velocity. In particular, any wire or rod upstream reduces the critical velocity and increases the final resistance.

Any attachment to the sphere except at the unavoidable rear dam-point may precipitate the breaking of the stream away from the surface.

Pre-existing turbulence in the stream, caused by grids and otherwise, also affects the critical velocity and the resistance.

On the basis of the last result the author states the Reynolds' criterion is insufficient, which is not a very happy way of saying that flows with and without previous disturbance cannot be treated as dynamically similar.

The author quotes Prandtl's suggestion that with mounting on a rod at the rear dam point a sphere could be used as a criterion of previous turbulence. Here again it seems that equality of the critical value of Vl/v , though a necessary condition is very far indeed from being a sufficient criterion of dynamical similarity.

Fluid Resistance to Moving Spheres. (R. G. Lunnon, Procs. Roy. Soc. A., CXVIII., A. 780, April, 1928, pp. 680-694.) (9261 Great Britain.)

Spheres of bronze, steel and lead were allowed to drop freely in water. The coefficients of resistance were obtained for Reynolds' numbers from 10^3 up to $10^{5.3}$ and agreed closely with Wieselberger's results obtained in the Göttingen wind tunnel, but less closely with others.

The general run of the curve shows that a formula of the form AV^n cannot hold over any great range of Reynolds' numbers up to $R=6$.

Systematic observations were further made of the wall effect on fall in tubes and the results are given graphically.

The physical conditions are discussed and the periodic formation and detachment of vortex rings is suggested as a possible type of motion. Reference is made to trailing spiral vortices observed by Ermisch at Aachen.

The smooth run of the curves is held by the author to exclude any abrupt change in the type of fluid motion.

Transference of Heat between Flowing Water and Pipes. (L. Schiller and Th. Burbach, Phys. Zeit., XXIX., 1/6/28, pp. 340-342.) (9262 Germany.)

Reference is made to the work of Reynolds, Prandtl, G. I. Taylor, v. Karman and others in determining the distribution of mean velocity along a radius. The uncertainty of the results is pointed out and a mean value selected, leading to a semi-empirical equation which is compared with experimental results; the agreement is not unsatisfactory.

13 Mathematical Hydrodynamics

(Physical) Homogeneity and Similitude in Aerodynamics. (A. Metral, Rev. Gen. de l'Aeron., 8, 1928, pp. 125-204.) (9263 France.)

A systematic examination is made of Buckingham's theory of dimensions. The advantages of non-dimensional variables is pointed out.

The general principle of replacing a system of differential equations involving dimensional physical quantities by a system in an equal or smaller number of non-dimensional ratios is discussed with an attempt at rigour.

In application to hydrodynamics examples are given illustrating the variety of fluid motions kinematically possible in the absence of a dynamical criterion. Experiments by fifteen observers on the resistance of spheres are assembled graphically and illustrate the need of a criterion for comparison.

The introduction of the speed of sound as a parameter in the equations of compressible fluid motion is discussed at length. The conditions for cavitation in a gas and in a fluid are compared. In discussing Benard's experiments on the double row of vortices shed by a cylinder, the necessity for introducing the surface tension is noted.

The argument is mathematical.

Resistance to a Barrier in the Shape of a Circular Arc. (L. Rosenhead, Proc. Roy. Soc., Jan., 1928, pp. 417 to 432. Note by Prof. Brodetsky, pp. 432-433.) (9264 Germany.)

A brief bibliography is given of developments of Levi-Civita's transformation of the part of the barrier in contact with the stream into a semi-circle. The present paper applies the method to a circular arc by a "direct" method involving successive approximations which converge rapidly. Interesting results are obtained as to the effect of camber and shift of centre of pressure.

At large angles of incidence the pressures on the pressure surface are a good representation of the physical facts. In the "deadwater" region there is little sign of agreement with observations. At small incidence the Joukowski transformation is more applicable.

Problems in Electrical Machine Design Involving Elliptic Functions. (R. T. Coe and H. W. Taylor, Phil. Mag., 34, July, 1928, pp. 100-145.) (9265 Great Britain.)

Elliptic functions are applied to determine the magnetic field across air gaps, the boundaries being pole faces and armature surfaces with slots.

The problems solved have hydrodynamical analogies.

Joukowski Profiles. (Der Flug, 2/3/28, pp. 116-117.) (9266 Austria.)

This short notice describes briefly the method for drawing a Joukowski profile by means of a mechanical device. Much of the work can be done with the aid of a device of great simplicity. This, however, does not make the work completely automatic. It is, however, stated that there is now being developed a wholly automatic device. This is driven by clockwork or by an electric motor. After it has been set for a certain wing width, thickness and arching parameter, it draws the Joukowski profile entirely by itself. Development work on this device is being carried out, for instance in Moscow, by the Central Aero-Hydrodynamical Institute.

(Vector) Expressions for Hydrodynamical Forces. (H. Hewer, Phys. Zeit., XXIX., 1928.) (9267 Germany.)

The author summarises the equations of viscous hydrodynamic in the notation of vector analysis, carries out the usual transformation, and obtains a number of formal expressions.

The result of projecting a spherical cap of zinc 30 cm. diameter and one-tenth diameter deep is given. Length of trajectory 40 m., height 15 m.

There is no perceptible relation between the description and the previous mathematical work.

The Theory of Fluid Motion and the Actual Motion. (Prof. Ahlborn, Phys. Zeit., XXIX., 1/1/28, pp. 30-41.) (9268 Germany.)

The author is known as a critic of Prandtl's views on the setting up of the velocity field and the consequent distribution of pressure.

He criticises the various efforts at explanation by Helmholtz, Lanchester and Prandtl, and attempts to formulate a new view. The initial motion is potential, but thereafter the inertia carries the fluid past sharp corners enclosing a mass of fluid which rounds off the contours of the obstacle. Such a mass of rotating fluid he calls picturesquely a "gyrom." The formation of "gyroms" takes place near streamline bodies as well as behind sharp edges. The cyclic motion sets up a diminution of pressure behind the body. On the whole the verbal descriptions, photographs and illustrations seem to fall well into line with Prandtl's views, in spite of the author's views to the contrary.

Effect of Compressibility on the Lift of an Aerofoil. (H. Glauert, Proc. Roy. Soc., A. 118, No. 729, pp. 113-119.) (9269 Great Britain.)

The equations of compressible inviscid fluid motion and the integrals defining circulation, lift and drag are written down in polar co-ordinates. Expansions for large values of r reduce to the field obtained by superposing a simple linear vortex field on a steady stream, with appropriate assumptions. The velocities are affected by the fraction $(1 - V^2/C^2)^{1/2} / (1 - V^2 \sin^2 \theta / C^2)^{1/2}$. The analysis used holds only for large values of r , but the result is assumed to hold for small values of r . The aerofoil profile has been replaced by a "fixed vortex line," and this in turn is replaced by a plane vortex sheet through a finite segment of the x -axis. The incidence is the angle between the stream and the x -axis, and is taken to be small so that $\sin^2 \theta$ is negligible. The assumed conditions now require the strength of the vortex sheet to be increased by $1 / (1 - V^2 / C^2)^{1/2}$ agreeing with a result of Prandtl cited by the author.

A further transformation in cartesian co-ordinates gives an equivalent system in an incompressible fluid, with an increase of chord in the ratio $1 / (1 - V^2 / C^2)^{1/2}$. Both results indicate an increase in the slope of the lift curve.

The lift curve derived by the inverse blade element method from experiments on a high-speed airscrew indicate an increase in the slope of the lift curve up to $V/C = 0.6$ and thereafter a falling back.

The author is therefore justified in inferring that the formula fails in this manner when $V/C \rightarrow 1$, but not in again quoting the test results as a surprisingly good confirmation of the "theory."

The Influence of the Curvature of Stream Lines on the Lift of Biplanes. (Göttingen Reports, III., Part I., No. 3, pp. 9-13.) (9270 Germany.)

It is assumed that the curvature of the streamlines due to one plane at the position of the other plane is equivalent to a change in the effective incidence equal to one-half of the angle subtended by the chord at the centre. Where the profile is also curved the difference $1/R - 1/R'$ is to be taken instead of l/R . On these lines semi-empirical formulæ are developed for the mutual interference of the planes and the results are found to be in good agreement with experiment.

14 Wing Profiles

Tests of Profiles. (Göttingen Reports, III., Part 3, No. 2, pages 33-59.) (9271 Germany.)

The results of measurement of coefficients of lift drag and moment are given for 64 profiles in which the curvature and thickness are varied systematically by groups.

The results are given graphically showing in each instance the calculated parabola of induced drag and a silhouette of the profile. The results are also given in tables.

The Joukowski Profile—Theory and Measurement of. (Göttingen Reports, III., Part I., No. 4 (Theory), pp. 13-16, Part III., No. 3 (Measurements), pp. 59-77.) (9272 Germany.)

In Report I., No. 4, Joukowski profiles are obtained by transformation of the form:—

$$w = z \div a^2/z$$

Thirty profiles were obtained from this formula by varying two parameters corresponding to thickness in curvature. The formulæ for lift and moment are quoted along with the elementary geometrical construction developed by v. Mises.

In Report III., No. 3, systematic measurements on the Joukowski profiles are recorded in polar diagrams and in numerical tables.

Measurements on Profiles at Negative Incidence. (Göttingen Reports, III., Part 3, No. 5, pp. 79-82.) (9273 Germany.)

For the purpose of calculating stresses in aerobatics measurements were made on eight profiles for negative incidences up to about -40° . The lift and moment coefficients are plotted against the drag coefficient. In two instances the measurements were made both with increasing and decreasing incidence and loops were found in the lift and moment curves, the different sides of the loops corresponding to the different types of flow obtained.

Measurements on a Profile from 0° to 360° Incidence. (Göttingen Reports, III., Part 3, No. 4, pp. 78, 79.) (9274 Germany.)

The measurements were carried out on Göttingen profile No. 420, and the value of lift, drag and moment are given in polar curves, and as functions of incidence.

The numerical values are tabulated.

15 Wing Profiles with Special Modifications

Distribution of Pressure over a Staggered Multiplane (Wing-Grid). (Göttingen Reports, III., Part 3, No. 16, pp. 132-138.) (9275 Germany.)

Five similar aerofoils were arranged between plane surfaces with different angles of stagger and of incidence. A graphical representation of the distribution of pressure over an isolated wing is given for three angles of incidence, 4.2° , 2.8° , 1.4° . Similar diagrams are given for the same three values of incidence, for three different angles of stagger, 16° , 22° , 29° , and for six different ratios of chord to gap. The method of measurement leads to very high values of pressure and lift as compared with the wing alone. The reason for this is explained. The numerical results are also given in tables.

Measurements on Profiles with Cut-Away Trailing Edges. (Göttingen Reports, III., Part 3, No. 6, pp. 82-86.) (9276 Germany.)

From profile of 200 mm. chord sections of the trailing edge were cut away by steps to 20 mm. This produced effectively eight different profiles. Lift, drag

and moment coefficients are given graphically and in tables. The polar curves, eight on the same diagram along with the parabola of induced resistance, show the deterioration of the wing slowly at first; then with increasing rapidity.

Measurements on Wings with Cut-Away Parts. (Göttingen Reports, III., Part 3, No. 8, pp. 92-94.) (9277 Germany.)

Seven different types of cut-away were tested:—

Leading edge:—

- I. Semi-circular cut-away 8 cm. diam.
- II. Large circular cut-away 12 cm. diam.

Trailing edge:—

- III. Segmental circular cut-away 20 cm. chord, 3.33 cm. rise.
- IV. Segmental circular cut-away 20 cm. chord, 6.67 cm. rise.
- Va. Semi-circular cut-away 20 cm. diam. rounded off.
- Vb. Semi-circular cut-away 20 cm. diam. not rounded off.

Central strip 10 cm. wide cut out.

Results are given in two polar diagrams and show that the cut-away of the leading edge has a much more serious effect than the cut-away in the trailing edge. The effects are comparable with that of the last case, central section completely cut away.

Experiments on Wings with Profiles Split Along the Chord. (Göttingen Reports, III., Part 3, No. 10, pp. 99-102.) (9278 Germany.)

The profile is split in two along a curved surface running from nose to trailing edge.

The two profiles thus formed are separated by a gap and are staggered according to the following scheme:—

Gap	0	7	20	50	80 mm.
Stagger	0	0	1	10	33 mm.

The results are given graphically and in tables for the biplane combination and for the upper part alone.

The object of this particular experiment is not stated.

The Effect of Roughness on Wings. (Göttingen Reports, III., Part 3, 13, pp. 112-114.) (9279 Germany.)

Various parts of the wing surface are roughened in six different ways according to the following scheme:—

- I. Pressure side rough.
- II. Suction side rough.
- III. Both sides rough.
- IV. Forward upper surface rough.
- V. Mid upper surface rough.
- VI. Trailing upper surface rough.

The results are given in two polars and seven tables, which show that the roughening of the forward part of the upper surface has the most serious effect in causing a breakdown of the flow accompanied by heavily increased resistance and much reduced lift. At low incidence the roughening of the whole surface has a heavy effect. Below the no-lift incidence the roughening of the under forward side is the most serious factor, as might be expected.

Preliminary Investigation of Boundary Layer Control by Means of Suction and Pressure with the U.S.A. 27 Airfoil. (E. G. Reid and M. J. Bamber, N.A.C.A. Technical Note No. 286.) (9280 U.S.A.)

The tests described in this report constitute a preliminary investigation of aerofoil boundary layer control as carried out in the atmospheric wind tunnel of the Langley Memorial Aeronautical Laboratory, from February to August, 1927.

Tests were made on a U.S.A. 27 aerofoil section with various slot shapes and combinations, and at various amounts of pressure or suction on the slots.

The lift of aerofoils can be increased by removing or by accelerating the boundary layer.

Removing the boundary layer by suction is more economical than to accelerate it by jet action. Gauze-covered suction slots apparently give the best results.

When not in operation, all suction slots tested had a detrimental effect upon the aerodynamic characteristics of the aerofoil which was not apparent with the backward-opening pressure slots.

Thick, blunt-nose aerofoils would seem to give best results with boundary layer control.

Detachment of Vortices and the Prevention Thereof. (Göttingen Reports, III., Section 2, pages 6-9.) (9281 Germany.)

Photographs are given showing the formation and detachment of vortices behind a fixed cylinder and of a single vortex behind a rotating cylinder. It is explained that the motion of the surface of the cylinder with the stream on the upper side prevents the accumulation of retarded boundary layer fluid, while the motion of the lower side of the cylinder against the stream intensifies the effect.

An example is also given diagrammatically of two cylinders in contact rotating so that their external sides travel with the fluid and prevent the formation of eddies.

Wings with Boundary Layer Sucked Away. (O. Schrenk, K.W.-G., L.F.F., II., Part 2, 11/6/28, pp. 49-62.) (9282 Germany.)

A brief historical note and bibliography are given.

It is remarked that the power required for sucking away the boundary layer, and the weight and cost of the apparatus required, must pay for themselves in increased lift and reduced resistance.

The following quantities must be determined experimentally:—lift, resistance, volume removed and work expended. To measure these quantities rapidly and accurately, various experimental difficulties have to be overcome. The details of the apparatus used are described.

In the experimental work a thick Joukowsky profile with end plates was used. The interior was divided into three compartments and the surface was pierced with rows of narrow slots, preferably parallel to the span; later it is stated that the form of the opening has no sensible effect. The remarkable results obtained are shown graphically. After correction for end effect the lift curve is brought into substantial coincidence with the theoretical curve of complete Joukowsky lift from 10° to 40° incidence.

Figures give graphically some of the more important results of a long series of investigations.

The values of lift, resistance and power coefficients are given graphically, and the power coefficient for the sucking away is given separately in a table.

As the incidence increases an increasing volume has to be sucked away from the boundary layer, but in each case when a certain volume sucked away

per second is reached the flow follows the profile closely and further expenditure of energy on sucking away the boundary layer is useless.

The important remark is made that on full sized wings the volume sucked away to produce a sufficient approximation to potential flow will probably be much less in proportion than for the model experiments here described.

The Improvement of Aerodynamic Characteristics by Mechanical Removal of the Boundary Layer. (Dr. A. Betz, German Patent No. 458428, Flugsport, 25/4/28, p. 95.) (9283 Germany.)

The author proposes to improve the lift of aeroplane wings for the efficiency of airscrews by removing the boundary layer from the surface of the wing or airscrew into the interior. For this purpose slots are placed at suitable intervals which communicate with an exhaustor through which the material in the boundary layer is passed away. The article gives constructional details for various types of wings.

Slotted Wings. (German Patent No. 454355, H. Helmbold, Flugsport, 11/4/28, p. 91.) (9284 Germany.)

This invention claims to obtain high lift coefficients and realise at the same time small drags over a large range of incidence of the slot. It is also stated that the effort required to operate the slot is small. The main claim of the patent is the following:—

Slotted wing characterised by the fact that the part preceding the slot, for instance the main wing and the part following the slot, for instance, aileron, are so shaped that the minimum distance of the slot remains unchanged as the inclination of the aileron alters.

The article shows several possible methods of construction.

Slotted Wings. (German Patent No. 456780, J. Knoll, Flugsport, April 11th, 1928. Patent Section page 91.) (9285 Germany.)

The invention concerns the constructions of a composite wing, the sub-sections being separated one from the other and thus forming slots. The suction side of the wing is furnished with a movable cover, adjustments of which produce variations of air flow through the wing.

Experiments on the Influence of the Body on a Low Set Wing. (H. Muttray, Report of the Aerodynamical Laboratory of the Kaiser Wilhelm-Gesellschaft, L.F.F., Part 2, 11/6/28, pp. 33-39.) 9286 Germany.)

A series of systematic experiments in a wind channel were carried out, with various positions and shapes of body, and with the body alone. The results are given in nine polar curves covering about thirty different arrangements.

Influence of Motor Housings on Wings. (Göttingen Reports, III., Part 3, No. 14, pp. 115-118.) (9287 Germany.)

Model motor engine housings of three different diameters, bluff forward surface and tapered trailing surface, were split horizontally in half and fitted to the wing according to the following scheme:—

- | | |
|----------|-----------------------|
| Housing. | Wing alone. |
| I. | With under half only. |
| II. | „ |
| IIa. | „ |
| III. | „ |

Housing.	Wing alone.
I.	With upper half only.
II.	„
IIa.	„
III.	„
Housing.	Wing alone.
I.	With complete housing.
II.	„
IIa.	„
III.	„

In the case IIa. the diameter is the same as in case II., but the forward surface is rounded off more gradually.

The results are given in three polar curves and thirteen tables. The upper half of the housing has a much more serious effect than the lower half. The adverse effects increase with the diameter. The rounding-off diminishes the adverse effect. In general, the adverse effects are due to the premature breaking away of the flow from the upper surface caused by the housing, especially the upper half.

Profile Resistance of Two Thin Profiles at Different Reynolds' Numbers.
(Göttingen Reports, III., Part 3, No. 7, pages 87-91.) (9288 Germany.)

In a previous abstract, No. 4, 28.6.27, Ref. 5.32/5826, Germany (Air flow over flat plates. Prandtl and Betz, *Ergbn. der Aerodyn. Versuchsantalt zu Göttingen*, 3rd issue, 1927, pp. 1-5, Section I.), the result was quoted that the flow along a plate might be partly laminar and partly turbulent, so that the resistance might lie along a transition curve between these types of flow. In Section 7 an application is made to the profile resistance of two thin profiles at different Reynolds' numbers. Data of extensive measurements are given and the curves of resistance against Reynolds' number show general similarity to the results for flat plates.

The Induced Resistance of Wings with End Plates. (Göttingen Reports, III., Part I., No. 5, pp. 17-18.) (9289 Germany.)

It is found that when end plates are fitted to the end of an aerofoil two trailing vortices of half strength are detached from each end plate, one at the top edge and one at the bottom edge. In this way the induced resistance is decreased from that of a monoplane to that of a biplane with the same span and lift and with a gap equal to the distance between the two parts of the divided vortex. The results are given in figures and in a table and confirm the equivalents to a biplane. Two formulæ are given as first and second approximations.

Measurements on Wings with End Plates. (Göttingen Reports, III., Part III., No. 9, pp. 95-99.) (9290 Germany.)

Göttingen profile No. 535 with chord 30 cm. was fitted with elliptical or circular end plates with the following semi-diameters:—

	I	2	3	4	5	6
a.	30	15	30	45	30	45
b.	15	30	30	30	45	45

The results are given graphically and in tables, and show that the depth of the end plate, *i.e.*, the semi-diameter *b*, is the most important factor.

The Effect on Performance of a Cut-Away Centre Section. (T. Carroll, U.S. Technical Note No. 273.) (9291 U.S.A.)

The assumption is made that a skeleton or cut-away centre section is desirable for forward vision and the following work was done to determine the effect of such mutilation upon performance.

The aeroplane used was a Vought VE-7, and in addition to the cut-away centre section a system of end plates or fins was installed. Various conditions and combinations were investigated in level flight and in climb.

It is found that the greatest difference in the conditions investigated was a drop of 12.5 per cent. in a ten-minute climb, while the effect upon level speeds was negligible.

Acroplane Control. (A. Gymnich, Z.F.M., XIX., 14/3/28, pp. 97-100.) (9292 Germany.)

An elementary discussion of the theory and application of slots to prevent stalling.

Measurements on Wings with Flaps and Slots. (Göttingen Reports, III., Part III., No. 12, pp. 107-112.) (9293 Germany.)

The combination of wing and aileron flap separated by a slot is effectively a species of slotted wing with the slot about $\frac{1}{4}$ to $\frac{1}{3}$ chord from the trailing tip. Tests were carried out with six different settings of each of three flaps.

Three corresponding polar curves are given showing an increase of lift, drag and moment, along the same lines as for the Handley Page slot. The numerical results are of a similar nature to those for a slotted wing, but are aerodynamically less favourable. They are tabulated for the different cases.

Theoretical and Experimental Investigation of the Moment on Wings Produced by Ailerons. (E. Petersohn, K.W.G., L.F.F., II., Part 2, pp. 40-48.) (9294 Germany.)

The assumption is made that the distribution of circulation along the wing can be represented by a Fourier series and a number of formal mathematical results are worked out on this basis.

Experimental determinations are then made of the physical quantities involved and the results are given in polar curves of lift resistance and rolling moment for different settings of the ailerons. The numerical values are given in a table.

A comparison is made between the calculations of the various quantities made in a simple manner by Munk for a wing with an elliptical plan and the excellent agreement obtained is exhibited graphically.

In referring to Wieselsberger's application of Fourier series, it is remarked that in general eight terms should be taken, giving eight equations to determine the eight unknown coefficients.

Measurements on Three Elevators. (Göttingen Reports, III., Part 3, No. 11, pp. 102-107.) (9295 Germany.)

The chord of the profile is 250 mm., the length of the flap to the hinge is 65 mm., 91 mm., and 120 mm. respectively. Polar curves are given for three fixed flap settings, 0° , 10° and 20° .

A coefficient of moment about the tail pin is defined and measured for five values of the incidence of the fixed part, 0° , 6° , 12° , 13° and 18° , and for a change of flap setting from $+20^\circ$ to -20° .

The curves are then transformed to show the hinge moments as functions of incidence for different flap settings.

Forces and Moments Produced on a Wing by the Aileron. (C. Wieselsberger and P. Asano, Tokyo, Z.F.M., XIX., 14/7/28, pp. 289-293.) (9296 Germany.)

From selected experimental work curves are drawn representing the distribution of the change in lift over the span set up by the ailerons working in opposite directions and in the same direction. These are superposed on curves of elliptical lift distribution. The resulting moments are obtained by integration. The effect on the induced resistance is also calculated. The calculated results are shown in tables and diagrams.

16 Model Aeroplanes

Experiments on a Number of Model Aeroplanes. (Göttingen Reports, III., Part 3, No. 15, pp. 118-132.) (9297 Germany.)

The following models were tested:—

- (a) Vampyr glider.
- (b) Greif glider.
- (c) Tailless Weltensegler glider (Type V.E.I.).
- (d) Rohrbach twin-engine aeroplane.
- (e) Focke-Wulf commercial aeroplane with airscrew.

The results are given in polar curves and in tables.

In (a) the effect of a round body and of an angular body is compared with the polar for the wing alone.

Curves are given in (b) for the wing alone and for the rounded body with and without cut-away portion.

In (c) for the complete model and for the wings alone.

And in (d) for the wing alone, for the model without engines, and for the complete model.

The various effects are discussed in the light of the breaking away of the flow.

(e) The tests on the model with airscrew form an independent series, and are dealt with under airscrews.

Experiments with New Types of Aeroplane. (A. Lippisch, Z.F.M., XIX., 28/6/28, pp. 274-284.) (9298 Germany.)

Swept-back wings suitable for a tailless monoplane were investigated experimentally in the wind channel and polar curves obtained for different degrees of sweeping back. Profiles with constant centre of pressure were selected from American reports for comparison with Göttingen profile 459.

Further, a polar is given for a complete tailless model from measurements at Göttingen and a curve is given of the cube of the lift divided by square of resistance plotted against lift over resistance both theoretically and experimentally, with fair agreement. Diagrammatic sketches and photographs of glider and of model in flight are shown. It is suggested that the new type is suitable for giant aeroplane construction, but the arguments offered in support are very brief and general, and require the support of worked-out examples.

Preliminary Biplane Tests in the Variable Density Wind Tunnel. (J. M. Shoemaker, N.A.C.A. Technical Note, No. 289.) (9299 U.S.A.)

Biplane cellules using the N.A.C.A. M.6 airfoil section have been tested in the variable density wind tunnel of the National Advisory Committee for Aeronautics. Three cellules, differing only in the amount of stagger, were tested at two air densities, corresponding to pressures of one atmosphere and of twenty atmospheres. The range of angle of attack was from -2° to $+48^\circ$. The effect of stagger on the lift and drag, and on the shielding effect of the upper wing by the lower at high angles of attack, was determined.

17 Air Resistance Measurements

Air Resistance Measurements on Rolled Joists. (Göttingen Reports, III., Part 3, No. 20, pp. 151-156.) (9300 Germany.)

Joists of various section, L, T, I, and of various built-up forms are tested in wind at angles from 0° to 360° in the plane of the section. Both horizontal and normal forces are produced which vary in a highly irregular manner. The results are given graphically and in tables.

Air Resistance Measurements on Bridge Girders. (Göttingen Reports, III., Part 3, No. 19, pp. 146-151.) (9301 Germany.)

Five models are tested, a plate girder punched out and three built-up girders. The wind pressures are measured with different arrangements of the girders, singly, one behind the other, with the wind at right angles, and with oblique wind. The results are given graphically and in tables.

Air Resistance Measurements on Wind Screens. (Göttingen Reports, Vol. III., Part 3, No. 21, pp. 157-161.) (9302 Germany.)

Modern shunting yards in Germany make use of inclines for the purpose of moving waggons. It was found in a shunting yard at Bremen that the effect of unfavourable wind pressure reduced the run obtainable under the gravity, especially in the neighbourhood of a signal bridge.

Palisade wind screens were suggested to break the force of the wind while permitting visibility of the waggons.

Models were made with different size and spacing of the pales and a complete model of the signal bridge with the proposed system of wind screens was tested. The most effective type of pale and distribution of wind screen area obtained by the model tests was tried on full scale and gave substantial results anticipated.

Details of the tests on section of the screen are given in diagrams and in tables.

Wind Pressure Measurements on a Model Gasometer. (Göttingen Reports, III., Part 3, No. 18, pp. 144-146.) (9303 Germany.)

The model is cylindrical with a conical roof and with a small cupola. The distribution of pressure is measured for five points on a generating line three points on the sloping roof and two points on the cupola. Ten generating lines are selected round the semi-circle. The results are given graphically and in a table. Diagrams are also given showing the increase or decrease of pressure round two meridians in the planes parallel to the wind and at right angles to the wind.

Air Resistance measurements on High Speed Railway Carriages. (Göttingen Reports, III., Part 3, No. 22, pp. 161-164.) (9304 Germany.)

Models were made up of carriages with rounded noses and with faired casing over the wheels. Resistance was measured with and without the casing and with and without the rounded nose, and the results are given graphically. A channel was also made up to represent the walls of a tunnel and further tests were made. An approximate theory is developed for variation of resistance from the mouth of the tunnel to a point well inside the tunnel, and with the aid of the actual tests curves are made up showing the variation of the resistance as the carriage passes further into the tunnel. Three different widths of tunnel were employed. The results are given graphically.

18 Laboratory Equipment

Calibration of Wind Profiles. (Göttingen Reports, III., Part 3, No. 1, pp. 26-33.) (9305 Germany.)

A description is given of an optical micrometer gauge consisting of plane table with slide and cross slide, scales and an eye-piece with cross wires. The scales are divided into $1/10$ th of a millimeter, and $1/100$ ths of a mm. can be estimated.

In practice the figures are rounded off to the nearest half $1/10$ th mm. for purposes of tabulation.

About 145 profiles are tabulated, the ordinates of upper and lower surfaces being given for 17 different abscissæ; these comprise generally the profiles for which aerodynamical tests are given in the previous volumes or in Volume III.

Small Alternating Current Motor for Driving Model Airscrews.—Alternating Current Brakes. (Göttingen Reports, III., Part 2, Nos. 1 and 2, pp. 21-25.) (9306 Germany.)

Useful practical details are given for construction and running, with an account of the difficulties met and overcome. Curves of power and efficiency are given.

A squirrel-cage type of alternating current rotor combined with a speed counter is described and curves of braking effect are given for different electric currents, measured in amperes.

AIRCRAFT DESIGN AND EQUIPMENT**19 General Design**

Monoplane or Biplane. (C. H. Chatfield, J. Soc. Autom. Engineers, XXII., Jan., 1928, p. 49.) (7861 U.S.A.)

After pointing out that the rivalry between the monoplane and the biplane is of long standing, and that each must therefore have some advantages, the author proceeds to the consideration of the question at issue by comparing structural efficiency, aerodynamic characteristics, performance, and certain other features. In the discussion Mr. A. H. G. Fokker considered the biplane or triplane superior to the monoplane for pursuit planes on account of its greater manoeuvrability and higher factor of safety. For commercial craft, on the other hand, the monoplane lent itself more easily to all-metal construction, with reduction in cost. Eventually, profiles of sufficient section will be used to house the engine and auxiliaries inside the wing.

20 Structures

The Best Spacing of Spars in a Two-Spar Wing. (K. Haarmann, Z.F.M., XIX., 14/7/28, p. 298.) (9307 Germany.)

In German specifications of wing strength three conditions are considered in steady forward flight; (A) load forward, (B) load mean position, (C) load aft. By spacing the spars more widely the load in extreme cases is diminished. With Göttingen profile No. 593, curves are drawn showing the variation of load on the spars for different spacings. A numerical example is worked out.

Buckling Strength of a Strut of Given Form. (A. P. Czerevkov, Z.F.M., XIX., 14/7/28, pp. 293-298.) (9308 Germany.)

The ordinates of the contour are expressed by multiple integrals, up to sextuple integrals. A numerical example is worked out for particular assumptions, involving Bessel functions.

21 *Airscrews*

Airscrew Efficiency. (A. Betz, Z.F.M., XIX., 20/8/28, pp. 171-177) (9309 Germany.)

The author summarises the principles of airscrew theory and extends the definition of thrust to the net thrust of an airscrew in the neighbourhood of a wing. Curves previously obtained experimentally in the laboratory are given graphically, and examples exhibit the method of applying the results to design, taking into account mutual interference with the wing. The main object of the paper is to clear up some rather delicate points in the definition of net resistance, net efficiency, etc., taking mutual interference into account.

Tests of Model Airscrew Mounted on Model Aeroplane. (Göttingen Reports, III., Part 3, No. 15, pp. 125-132.) (9310 Germany.)

The model two-bladed airscrew is taken from the U.S.A. Advisory Committee Report No. 141, along with the efficiency, thrust and torque coefficients.

Tests are made of the complete aeroplane model without airscrew, with airscrew blades vertical and with airscrew blades horizontal. In the latter case the adverse effect is sensibly greater in promoting the breakaway of the flow. Systematic tests are then carried out of the shaft thrust and the net drag or thrust of the aeroplane-cum-airscrew for different ratios of tip speed to aeroplane speed. The polar of the last defined quantity is given in the form of a family of curves.

From these it is possible to infer whether the net thrust h.p. available from the engine is greater or less than the required flying h.p. of the aeroplane.

The quantities involved require careful definition on account of the interference between airscrew and body. Various numerical results are given in tables.

Theory of Airscrews (Japanese). (Sandi Kawada, Research Inst., Tokyo, Imp. Univ., X., 1925, pp. 137-157, abstr. in Jap. J. of Eng., V.) (7944 Japan.)

The theory is based on the assumption that the number of blades of the airscrew is large.

Upon the analogy of the vortex theory of an aerofoil, together with the consideration of the momentum relation, the magnitude of so-called "inflow velocity" was obtained in a simple form. The profile resistance of the blades was also taken into consideration.

It was found that the difference between the effective angle of incidence and the apparent angle of incidence of blade element was a linear function of the circulation.

As an application, the distribution of circulation corresponding to the maximum efficiency was sought, using the calculus of variations, and in comparison with actual experiments good agreement is claimed.

The Effect of the Sperry Messenger Fuselage on the Air Flow at the Propeller Plane. (F. E. Weick, N.A.C.A. Technical Note, No. 274.) (9311 U.S.A.)

In order to study the effect of the fuselage, landing gear and engine on the air flow through the propeller, a survey was made in the plane of the Sperry Messenger propeller with the propeller removed. The tests were made in the 20-foot air stream of the propeller research tunnel of the National Advisory Committee for Aeronautics at Langley Field, Virginia. The variation of the velocity with distance from the centre in the propeller plane was found to be appreciable and well worth consideration in the design of propellers. It was

also found that the velocity through the propeller plane was affected by the presence of the engine, and that the velocity in front of the landing gear was lower than that at other points in the propeller plane having the same radius.

Wind Wheels (Multivane Windmills)—(a) *Theoretical Relations*, (b) *Experimental Results*. (Göttingen Reports, III., No. 6 (Theoretical), No. 17 (Experimental), pp. 19-20 and 139-144.) (9312 Germany.)

In Report No. 6 general considerations of momentum are discussed along the lines of Froude's theory, but with a decrease of velocity and increase of diameter behind the wind wheel. Coefficients of efficiency, thrust and torque are defined.

In Report No. 17 extensive experiments are described with variable number of blades, disc area factor and wind speed. In tables and curves the results are given and non-dimensional coefficients of lift, thrust and moment.

The most important economic factor for a wind wheel driven by the natural wind is the maximum power output for a given expenditure, irrespective of maximum efficiency, but for small wind wheels mounted on aeroplanes and driven by relative wind, maximum efficiency is the most important consideration.

Theory of the Lifting Screw. (O. Flachsbart, Z.F.M., XIX., 1928, pp. 177-183.) (9313 Germany.)

A very complete résumé of modern screw theory is given and the conditions of minimum power for a given lift are derived by integration over the blade, taking into account Prandtl's correction for tip effect. The lift over power characteristics are given graphically, and the wide difference between the results of design for maximum efficiency and for maximum lift over power are shown. As the result of worked-out examples, the author finds that 500 h.p. is sufficient to lift 3,000 kilograms (three tons) at 200 r.p.m. with a diameter of twelve metres, whereas with an airscrew designed for high efficiency 600 h.p. would be required.

22 Rocket Propulsion

Experiments with Rocket Propulsion on Model and Light Aeroplanes. (A. Lippisch and Fr. Stamer, Z.F.M., XIX., 28/6/28, pp. 270-274.) (9314 Germany.)

Sketches and photographs are given of the apparatus and of flights with details of the weight of combustible and time of burning.

INSTRUMENTS

23 Wireless

The Application of Short Wave Lengths. (C. L. L. Kollatz, Z.V.D.I., LXXII., 30/6/28, pp. 913-916.) (9315 Germany.)

From the formula for wave length it follows at once that induction coils of few turns and condensers of small capacity are required. Every device for reducing the energy losses in consequence of the high frequency must be employed. The resulting apparatus is sensitive and difficult to adjust.

Photographs and diagrams of the short wave installations at Nauen, Pittsburg, etc., are given.

Wave lengths below 40 metres give directional results. Wave lengths of 30 to 40 cm. are obtainable by the apparatus described.

Construction and Working of a New Oscillator with very Short Waves. (E. Pierret, Comp. Rend., CLXXXVI., 11/6/28, pp. 1601-1603.) (9316 France.)

A previous oscillator with two valves giving wave lengths of 14-18 cms. required for operating two valves absolutely identical, a condition difficult to satisfy.

A new apparatus has therefore been designed with a single triode valve and a copper strip of variable length. One end of the strip is insulated, the other end soldered to a disc of diameter equal to the half wave length. The positive pole of a battery of 300 volts is connected to the grid and to the strip at quarter of a wave length from the insulated end or to the strip itself.

A wave of 16.5 cm. length is obtained. A brief mathematical analysis is given leading to a calculated value of 11.7 cm. in comparison with the experimental value of 16.5 cm. The frequency of the oscillator is double that of the electronic oscillation, hence the short wave length obtained.

Theory of Wave Filters containing a Finite Number of Sections. (H. A. Wheeler and F. D. Murnaghan, Phil. Mag., No. 34, July, 1928, pp. 146-174.) (9317 Great Britain.)

Campbell's solution for an infinite loaded telephone line is developed for a finite line so that special conditions to avoid reflections from the ends are unnecessary. A graphical method of solution is obtained of completely general application. The analytical method originated by Rayleigh in connection with a loaded string, and developed by Pupin, gives solutions in determinant form. The relations between three ideal types and the practical results obtainable are exhibited graphically in three diagrams and exhibit to what extent the actual results fall short of the ideal.

On the Technics of Radio Apparatus on Board. (P. Zonta, IV. International Air Congress, Rome, Oct., 1927.) (7873 Italy.)

The author treats of radio apparatus on board different types of airships, describes their construction, working and disposition. He alludes to the radio sets driven by a screw deriving its motion from the forward movement of the aircraft, as well as to alternating current sets and antennæ, describing their advantages and disadvantages. Reference is made to different methods and a critical analysis is made of the types of sets and their characteristics as used by the Italian Air Force.

Finally, he treats of the peculiarities of apparatus on board, of their characteristics, and of the details of their accessory material. He concluded by asserting that the radio apparatus in use in the Italian Air Service is by far the most perfect to be found in actual use.

Laboratory Equipment and Research Work at the German Research Institute for Aeronautics (D.V.L.). (H. Fassbender, 88th Report of the D.V.L.-L.F.F., I., 4, 7/5/28, pp. 113-116.) (9319 Germany.)

The general outlay of the laboratory is given diagrammatically and photographs of a number of details are shown including a directional coil mounted on an aeroplane. Specifications of the main machinery equipment are also given. Special sections of the laboratory are devoted to researches on wireless generators, high vacuum production, directional apparatus, emission apparatus and short wave apparatus.

Application of Short Waves to Air Navigation.—Experiments between Berlin and Madrid. (K. Kruger and H. Plendl, 98th Report of the D.V.L.-L.F.F., I., 4, 7/5/28, pp. 126-131.) (9318 Germany.)

The author gives descriptions and diagrams of a crystal controlled transmitter used on board the aeroplanes. The experiments covered three wave lengths, 18 m., 28 m. and 48 m. To excite a pure undamped high frequency wave a crystal control transmitter of only one watt was used, coupled to a small amplifying tube and taking its energy from the receiver battery. A transmitter of higher power (300 watts for the ground apparatus, 30 watts for the aeroplane transmitter) was excited by an alternating current of 500 cycles per sec. raised to high voltage by a transformer. Further details of the ground installation at Berlin are given.

A scale of relative signal strength was established with degrees of audibility numbered 1-9 and tables are given of the results showing the variation with the time of day, with the distance and with the wave length. Under favourable conditions the degree of audibility was 7 at a distance of 1,700 km., but negative results were sometimes obtained, especially during the day.

The problem of dead zones arises and further experimental information is required.

The Advantages of Short Wave Transmission for Aeroplanes. (H. Fassbender, 98th Report of the D.V.L. Adlershof-L.F.F., I., 4, 7/5/28, pp. 121-125.) (9320 Germany.)

By the use of short waves, 15 m. to 50 m., it was found that fixed antennæ of sufficient length could be installed in aeroplanes. From the observations it is concluded that such fixed antennæ are the most suitable, and the comparatively poor results obtained in other countries are attributed to the use of flexible antennæ easily displaced by a gust of wind.

The results of transmission and reception on various flights are described. In particular a crystal controlled undamped transmitter with only 0.7 watts energy in the antennæ and a wave of 46 metres gave results exceeding all expectations, being perfectly audible throughout a stage of 135 km.

24 Engine Indicators

Electrical Indicator for High-Speed Internal Combustion Engines. (J. Obata, Engineering, CXXIV., 26/8/27, pp. 253-254, abstr. in Sc. Abstr., XXX., 359, 25/11/27, p. 533.) (7864 Japan.)

The indicator consists of a steel disc 5 cm. dia. × 2 mm. thick, which, together with a fixed insulated plate, forms a parallel plate condenser having a gap of about 2 mm. This condenser is used as the capacity in an oscillating valve circuit, pressure changes in the engine cylinder producing alterations in the anode current, which are recorded either by a string galvanometer or a Duddell oscillograph. Sensitiveness can be increased by reducing the gap, and the instrument is calibrated by air pressure and a standard pressure gauge. The calibration is liable to alteration by the use of one or more valves, and is also affected by temperature changes in the indicator; but this change of scale is of minor importance in internal combustion engine work. Typical records from motor-cycle engines running at speeds up to 3,000 r.p.m. are reproduced. Many physical complications are ignored.

25 Optics

Loss of Light in Photographic Objectives. (Z.V.D.I., LXXII., 7/7/28, p. 965.) (9321 Germany.)

A new process has been developed by the German Government Cinematograph Laboratory for comparing the absorption of various photographic

objectives. A table of experimental results is given. It is pointed out that modern objectives of large aperture, owing to their complicated structure, are not so fast as would be expected from purely geometrical consideration.

MATERIALS

26 *General Properties of Materials*

The Molecular Theory of the Mechanical Strength of Crystals. (A. Smekal, Z.V.D.I., LXXII., 19/5/28, p. 667.) (9322 Germany.)

By means of X-ray analysis the molecular structure of crystals is well known and certain mechanical properties should be capable of theoretical evaluation. Tests on crystals show values which depart considerably from such calculations. It is probable that the crystals met with in practice are not perfect, but contain small regions of instability. By these means it is possible to account for the difference between theory and practice as well as for plastic flow and conditions arising when certain substances are at "work." The article has very complete bibliography of the subject.

Two-Dimensional Problems in Elasticity. M. Sandowsky, Z.f.A.M.u.M., VIII., 2, April, 1928, pp. 107-121.) (9323 Germany.)

The author's abstract states that the first part gives a systematic statement and discussion of the "plane" problem, with respect to the solution of periodic displacements. Certain difficulties of definition, arising from the distinction between plane stress and plane strain, are examined and ambiguities are removed by exact definitions and statements. Much of this is not new (see Love's *Elasticity*) but some detail results, and the explicit solution of certain boundary conditions are claimed as new. The second part attacks the problem of a screw deformation with the Z-axis as the screw axis, which is reduced to ordinary simultaneous differential equations, and integrated by development in series, in the manner of Bessel's differential equations which they resemble. Where the solutions are regular at the axis, the initial terms and the recursion formulæ are obtained explicitly.

Conformal transformations involving elliptic functions, developed by Fuchs and Hopf in the aerodynamics of the biplane, find an application in the problem of two supports on a yielding surface.

A Model illustrating a Kinetic Theory of Solids. (L. Prandtl, Z.f.A.M.u.M., VIII., 2, April, 1928, pp. 85-106.) (9324 Germany.)

Stress across a surface, producing strain, is regarded as a displacement of molecules from their mean position of equilibrium and of minimum (statistical mean) energy. The displacement sets up out-of-balance molecular forces which are purely elastic provided no molecule is permanently displaced from one position of equilibrium to another.

Simplifying assumptions are made in the first place for a single displaceable molecule with one degree of freedom subjected to an "elastic" constraint in its own "surface of molecules" and to a force set up by the adjacent "surface of molecules" varying as the simple sine when the two surfaces shear over each other.

An ingenious model of a single molecule illustrates the conception and produces a stress-strain diagram mechanically. Where the molecule passes from one state of equilibrium to another a simplified hysteresis loop is obtained satisfying Madelung's relations. The conception is then extended to a large number of molecules and statistical mean values are obtained. Particular

simplifying assumptions disappear and probability integrals take their place, justifying the assumption *à posteriori*.

In the course of the analysis a number of interesting integrals were evaluated by Tollmien.

Time and temperature effects are also discussed, and the phenomena of creeping, annealing and initial stress are reproduced by the expressions obtained. There is some similarity of idea with Professor C. F. Jenkin's model, *Aeronautical Journal*, Vol. XXVII., 1927, pp. 89-104.

The Dependence of the Mechanical Properties of Castings on Casting Technique. (G. Schreiber, *Z. Metallk.*, X., Nov., 1927, p. 456.) (7713 Germany.)

The author examined the constancy of the mechanical properties of a series of metals in the form of castings. For this purpose a large number of castings were prepared under apparently identical conditions and test pieces cut from similar parts of the castings.

Variations in tensile strength were especially marked in the case of certain aluminium alloys, the difference between maximum and minimum tensile strengths being of the order of 200 per cent. Ordinary cast iron showed variations of the order of 100 per cent. The experiments indicate the necessity of co-operation between the casting specialist and the designer.

Internal Strains in Metal. (G. Sachs, *Z.V.D.I.*, LXXI., 22/10/27, p. 1511.) (7660 Germany.)

The author has investigated the so-called season cracking exhibited by brass and copper alloys when subjected to cold working. The cracking is due to the presence of internal stresses, the magnitude and distribution of which have been investigated by the author. Considerable space is given to the discussion of the Bauschinger effect. The final conclusion reached is that considerable advance will have to be made in our knowledge of the structure of atoms and crystals before this effect can be explained. It is especially difficult to account for the improvement in mechanical qualities of certain alloys on storing and for the small resistance towards slip and cleavage shown by many crystals.

The Connection between Ultimate Tensile Strength and the Resistance to Shear. (P. Ludwik, *Z.V.D.I.*, LXXI., 29/10/27, p. 1532.) (9325 Germany.)

The author demonstrates that the resistance to shear as well as the resistance to tensile stress determines the behaviour of the material when subjected to any complicated form of stressing. Further researches in this direction are required for a satisfactory mechanics of deformed bodies. A lengthy bibliography is given.

27 Light Alloys—Physical Characteristics

Light and Ultra-Light Alloys in the Temperature Range of Work in Aviation Material. (Grard, IV. International Air Congress, Rome, Oct., 1927.) (7891 Italy.)

An inquiry is proposed as to the temperature range in which it is possible to use light alloys based on magnesium and aluminium.

A table is given showing the mechanical characteristics (resistance, toughness) of different alloys, light as well as ultra-light, followed by a detailed study of the thermal conductivity range of the same alloys in the 0°-200°.

From the results thus obtained from the point of view of resistance and toughness as well as of density and thermal conductivity, the choice from the alloys experimented on is indicated.

In a table are collected mechanical and physical data of selected alloys.

A method for the finding of the thermal conductivity of metals is appended.

Notes on Elektron and its Use. (N. Bonaretti, IV. International Air Congress, Rome, Oct., 1927.) (7894 Italy.)

Some notes on the recent history of the principal light metal alloys. Credit is due to Germany for the discovery of elektron, which is obtained from binary, ternary and quaternary alloys of magnesium.

This new product was introduced into Italy five years ago, and the firm Isotta Fraschini was the first industrial concern to use it. The alloy of elektron, used on the preparation of castings is quarternary, known by the mark A.Z.F., and is composed of 92.5 per cent. Mg., 4 per cent. of Al., 3 per cent. of Zn., 0.5 per cent. of Mn. Production, chemical and physical properties, etc., are discussed.

Difficulties which prevent its wider adoption in industry are discounted and the metal is stated to be adapted for many widely differing uses.

The use of elektron is recommended in aeronautical construction, several German firms having made entire machines of it.

28 Steel

Heat-Resisting and Non-Corroding Steels. (S. A. Main, J. Inst. Aeron. Eng., I., Aug., 1927.) (7630 Great Britain.)

The author deals fully with the various types of "Era" and "Hecta" steels made by Messrs. Hadfield. These steels contain relatively large quantities of chromium and nickel, the iron content varying between 50 per cent. and 70 per cent. The steels have received extensive application in turbine blading, cupola and internal combustion exhaust valves.

29 Corrosion and Corrosion Preventives

Surface Treatment of Aluminium by the Jyrotka Process. (Aluminium, 30/6/28, p. 5.) (9326 Germany.)

The process consists in obtaining a galvanic deposit on the surface of the aluminium by immersing the latter in a chemical bath kept at moderate temperature.

The process is automatic and the cost small. The application of an external current is necessary only when very thick deposits are required. The process in its simplest form improves the appearance and gives good protection against atmospheric corrosion. Additional paint or varnish adheres more strongly to the treated surface. The process is also applicable to magnesium alloys of the elektron class.

Nature of Film Produced by Anodic Oxidation of Aluminium. (H. Sutton and J. W. W. Willstrop, Chemistry & Industry, XLVI., 28/10/27, p. 818.) (7878 Great Britain.)

Samples of anodically treated aluminium were heated in dry hydrogen chloride at 300-320°; the metallic aluminium volatilised and the surface film was left unchanged. The films isolated from commercial aluminium contained small quantities of elementary silicon and were usually grey, owing to traces of carbon. The films obtained were from 0.74 u. to 2.10 u. thick, being from two to six times as thick as those produced by heating aluminium at 600° in oxygen for 80 hours (cf. Pilling and Bebbworth, B., 1923, 359A) and from 100 to 300 times as thick as the atmospheric corrosion films of Vernon (2nd Report Atmospheric Corrosion Research Committee). From the volume of gas evolved by heating in vacuo at 1,200° the film is shown to consist of oxide and not hydroxide.

Protection of Aluminium and its Alloys against Corrosion. (H. Sutton and A. J. Sidery, Chemistry & Industry, XLVI., 28/10/27, p. 818.) (7881 Great Britain.)

Samples of aluminium and aluminium alloys were treated by different protective processes and their resistance to corrosion by sea-water was determined by wet and dry and spray tests. The anodic oxidation process gave considerable protection, especially when followed by the application of grease. Good protection was also obtained by means of zinc and cadmium deposits .0005in. thick. Whilst the increase in weight caused by the anodic process is negligible, the zinc and cadmium plating results in an increase in weight of about $\frac{3}{4}$ oz./per sq. ft.

Corrosion Experiments with Light Alloys. (M. H. Kraemer, Z.V.D.I., LXXI., 29/10/27, p. 1538.) (7757 Germany.)

In order to obtain a reliable estimate of the effect of corrosion the author submits a test piece to both tensile and extension tests. Corrosion becomes evident by its effect on the extension, and diminution in the extension of the test piece under given load is a sensitive test for the extent of the corrosion which may be so slight as to escape ordinary tests based on the appearance of the specimen. The corrosion itself is initiated by exposing the specimen to a spray of salt water whilst subjected to the light of a mercury lamp for a definite period.

On the Protection of Iron by Use of Cadmium—Use of the Eutectic Alloy Cadmium—Zinc for the Coating of Steel Wires for High-Resistance Cables. (G. Montelucci, IV. International Air Congress, Rome, Oct., 1927.) (7889 Italy.)

Steel wires for high resistance aeroplane cables are protected from corrosion by passing them through a zinc bath.

Owing to the relatively high fusion-point of zinc (419°) the steel undergoes a change in character which lowers the resistance.

Tin is unsuitable because it is electronegative in regard to iron. Cadmium, next in the scale of elements to iron and electropositive with regard to iron because of its low fusion-point (321°) and its general qualities, is the most suitable protection.

An alloy of 83 parts of cadmium with 17 of zinc (electric alloy) has a much lower fusion-point (263°), and a fusion bath gives excellent protection and does not exercise any thermal influence. Steel wires thus coated maintain their strength.

Use of Lubricating greases for the Preservation of Metals. (M. V. Borodulin, Trans. State Inst. Applied Chem. (Moscow), 1927, 5, pp. 53-58, abstr. in Chem. Abstr., XXII., 1928, p. 2460.) (9327 Russia.)

The most desired characteristic of preservative oil is good adhesiveness, *i.e.*, absorbability of the oil by the surface of the metal; this is a more important factor than viscosity. Soap, which is usually introduced in these oils to neutralise the effect of free acids, does not prevent the action of atmospheric oxygen on the metals and even has a tendency to facilitate it.

30 Glass

"Kinon" Safety Glass. (Motor, XV., Aug., 1927, p. 72.) (7462 Germany.)

"Kinon" glass, invented by Herr Kinon, is made up of two glass plates with a layer of celluloid between, the whole being compressed in a hydraulic press after special treatment. The original transparency of the glass is not impaired by the process; "Kinon" glass has undergone the most violent tests

without splintering and is used by the Deutsche Luft Hansa on all their aeroplanes.

31 Fabrics

Resistance of Silk Fabrics to Light. (Silk (N.Y.), XIX., 1926, p. 45, abstr. in J. Text. Inst., XVIII., Oct., 1927.) (7885 U.S.A.)

The action of light may cause the complete destruction of silk fabrics.. In the course of experiments, which are very scantily related, it was found that silk, when soaked for $1\frac{3}{4}$ hours in 1 per cent. tannin at 79°C ., washed in hot and cold water and then dried, withstood an exposure to light for 400 hours without losing its elasticity, and retained 93 per cent. of its original strength.

MISCELLANEOUS

32 Airships

Development of Rigid Airships. (Lecture by Dr. Ing. Schwengler, published in Motorwagen, XXX., p. 761.) (7853 Germany.)

The Lecturer pointed out the advantage of supplying the engines of the airship with gaseous fuel of a density as near as possible equal to that of air. It was stated that a new airship under construction by the Zeppelin Works will have engines specially designed for gas burning. The Lecturer had taken out patents for a special type of triangular ring girder with a gas bag inside and claimed a saving in structural weight of from 10 to 15 per cent.

33 Meteorology

Size of Particles in Fog. (Dr. Owens, J. of the Roy. Soc. Arts, LXXIII., 27/3/25.) (7871 Great Britain.)

Dr. Owens gives figures for sizes of particles during a London fog and in a white country fog. He explains that the two types of fog are essentially different.

Reduction to Sea Level, by Means of Graphic-Mechanical Processes, of the Atmospheric Pressure. (G. Elliot, IV. International Air Congress, Rome, Oct., 1927.) (7905 Italy.)

The operation of reducing the atmospheric pressure to that of sea level is based on an approximate formula for the variation of pressure with height. The success of the method depends on observational knowledge of the lapse rate.

Self-Electrification of Internal Combustion Engines—Gradient of Electric Potential near an Airship. (A. Wigand, Z.F.M., XIX., 28/2/28, pp. 77-86.) (9328 Germany.)

The author, with T. Schlonka (Ann. der Phys., Vol. LXXV., 1924, p.279, and Z.F.M., XV., 1924, pp. 153 and 185), noticed that engines, excluding the rotary types which were not examined, show a sensible, positive, self-charging effect in flight as well as on the ground, while the exhaust gases show a negative electrification.

The sign of the electrification is sensitive to changes in the composition of the exhaust, and by regulating the temperature and thereby the composition of the escaping gases it may be possible to have a neutral exhaust.

Details are given of the apparatus employed for measuring the potential gradient near the skin of an airship.

It was possible to discharge a self-charge by equalisers sufficiently to prevent danger of sparking in an airship, but not so as to measure easily or accurately the potential gradient outwards from the aircraft.

Tests on an engine in flight show a gradient of from 1,000 V/M to 2,000 V/M , 10 to 20 times the gradient in the air near the ground, which is about 100 V/M , and at 15,000 metres height, 25 V/M . The airship L.Z.126, of 76,000 M^3 was available for extended tests and the electrical potential gradient was found to vary from 150 V/M on a second flight.

The author does not find any unavoidable risk of sparking in a dirigible from self-charging by the engines.

34 Acoustics

Demonstration of a "Doppler Effect" in Acoustics. (J. Zenneck, Phys. Zeit., XXIX., 1/6/28, pp. 343-344.) (9329 Germany.)

A sound wave of frequency 1,000 per sec., is reflected from a moving pendulum to a microphone receiver coupled with an oscillograph and the interference of the direct wave with the wave reflected from the moving pendulum is recorded optically.

Ultra-Sonics. (Prof. R. Boyle, Science Progress, XXIII., July, 1928, pp. 75-105.) (9330 Great Britain.)

A concise exposition is given of the work on sound-ranging since 1912. The main physical principles were anticipated mathematically by Rayleigh and later by Richardson through optical analogies. The piezo-electric properties of quartz are in most general application both for emission and reception.

Beam transmission is feasible and telephony is practicable by controlled wave trains in a manner analogous to wireless telephony.

The most important application is that of sound ranging. So far submarine sound ranging has received exclusive attention.

A bibliography gives 43 references.

The Measurement of Sound Absorption in a Room. (V. O. Knudsen, Phil. Mag., 33, June, 1928, pp. 1240-1257.) (9331 Great Britain.)

The author starts with the assumption, based on standard experiments, that the rate of decay of a sound wave in a closed room has a logarithmic decrement of the form $vat/4V$, where v is the velocity of sound, V is the volume of the room, and a is a surface to be determined experimentally. The measurement may be made either by oscillogram measurements or by determining by ear the time required for the sound to be reduced to a known fraction of an initial steady value. The conditions of the experiment are varied by opening the windows, etc. Various methods are discussed critically and preference is given to instrumental methods. A table gives comparative values for two selected methods and the difference is shown to be of an average order of two or three per cent., while in another table, a similar comparison is made, with about the same order of difference. In conclusion, the advantages and difficulties of the oscillograph method are discussed. The principal difficulty arises from the irregularity of the sound waves actually reaching the oscillograph which thus separates effects which are averaged by the ear. It is suggested that an improved technique of "mixing" the sound so as to distribute the average intensity more uniformly through the room will get over the difficulties of the oscillogram method.

On the Coefficient of Sound Absorption Measured by the Reverberation Method.
(E. T. Paris, D.Sc. London, Edinburgh and Dublin, Philosophical Magazine and Journal of Science, March, 1928, V., No. 29.) (9332 Great Britain.)

A formula is deduced from the reverberation theory by means of which the reverberation co-efficient of absorption of a material can be calculated if the co-efficient for plane waves is known for all angles of incidence between 0 and $\frac{1}{2}$. In the case of certain porous substances the reverberation co-efficient can be found if the acoustical admittance per unit area is known. It is shown that in general the reverberation co-efficient differs from the co-efficient at normal incidence. Some numerical values for an ideal porous substance are given by way of illustrating the results obtained.

Measurement of Noise in Aircraft. (H. Fassbender and K. Kruger, 96th Report of the D.V.L.-L.F.F., I., Part 4, 7/5/28, pp. 117-120) (9333 Germany.)

A descriptive account is given of the elementary physical principles involved. These find application in the audiometer designed by Barkhausen and constructed by Siemens. The intensity is graduated in steps increasing by powers of 2 from $38 \cdot 10^{-12}$ ergs to $2^{28} \cdot 10^{-12} \times 38$ ergs. Numbering the stages from 1-15, the degree of noise can be represented by a single number.

Tables 4, 5 and 6 give the intensity of noise on this scale, and these were found to lie between stages 9 and 15, with the exception of the Dornier-Merkur-B.M.W.6, which was greater than the 15th stage.

The strength and direction of the wind make differences as large as two stages (16-fold).

On increasing the revolutions of a B.M.W.4 from 500 r.p.m. to 1,200 r.p.m., the noise energy increased from stage 9 to stage 13. The difference in noise outside and inside the cabin was as much as four stages, that is in the ratio of $1/2^8$.

Simple Method of Finding the Sound-Absorbing Power of Building Material.
(G. Heimburger, Phys. Rev. XXXI., Feb., 1928, pp. 275-282, abstr. in Sc. Abstr., Section A—Physics, 25/5/28, p. 389.) (9334 Germany.)

An accurate method of comparing the absorbing powers of building materials is described. As in Taylor's method, a Rayleigh disc is used to examine the standing waves inside a tube, one end of which is closed by the test material. The main feature of the method is the comparison of the values of the maximum sound intensity in the standing waves when the end of the tube is closed first by a hard material and then by the material under test. The results are accurately reproducible. The following values of the absorption co-efficient at a pitch of 295 were obtained:—Commercial Celotex 7/16in. not perforated, 0.17; acoustical Celotex, $\frac{7}{8}$ in. perforated side exposed, 0.34; J.M.Asbestos Akoustikos felt, $\frac{1}{2}$ in. thick, one layer, 0.15; two layers, 0.43; J.M.Akoustikos felt, 1in. thick (older type), 0.13; Akoustolith, 1in. thick, tile, 0.15; Rumford tile 1in. thick, 0.22.

35 Ballistics

Theory of Internal Ballistics, Based on a Pressure Index Relation of Burning.
(C. A. Clemmow, Phil. Trans. Roy. Soc. A., Vol. 237, 9/2/28, pp. 345-382.) (9335 Great Britain.)

The problem is divided into two parts; the first part covers the period of the burning of the propellant and the second part the period after the propellant is burned. Empirical relations are assumed for the rate of burning and these lead to differential equations which are reduced to a simplified non-linear form and integrated numerically. From these the pressure and the travel of the shot

during burning may be calculated. Thereafter an adiabatic expansion is assumed and the remainder of the trajectory inside the gun may be calculated. It only remains to introduce corrections for band friction.

36 *Effect of Height on Pilots*

Physiological Effects of Height on Pilots. (Kwanichi Tanaka, Aeronautical Research Institute, Tokyo University, Report No. 37, March, 1928.) (9336 Japan.)

Acknowledgement is made to Professor Dreyer, Pathological Laboratory, Oxford, to Prof. Spearman, University College, London, and the Wing-Commander Flack, R.A.F.

The low pressure chamber at Oxford University was used to produce conditions equivalent to heights up to 24,000 feet. Excess of oxygen could be supplied. The tests comprised the effect on rapidity of mental reaction, handwriting, memory, muscular strength, etc., and both descending and ascending graphs were drawn. More positive physiological effects such as nausea, sickness, and even fainting were observed. A height of about 5,000 metres appears to be critical. The actual figures recorded are contained in an appendix. A list of 14 references is given.

37 *Radiation Chemistry*

Radiation Chemistry. (Ind. & Eng. Chem., XX., 10/7/28, p. 5.) (9337 U.S.A.)

The main principles of radiation chemistry are discussed according to the types of rays employed, wave or corpuscular. It has been found possible to carry out a large number of polymerizations, as well as several syntheses. Of special interest is the polymerization of the Isoprene family to rubber.