ABSTRACTS AND NOTICES FROM THE SCIENTIFIC AND TECHNICAL PRESS

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(*Prepared by R.T.P.*)

AIRCRAFT ENGINES, FUELS AND LUBRICANTS

1 Fuels

Cross Cracking Process (Engineering, 1.4.27). (8.512/5676 Great Britain.)

A paper on the Cross cracking process by Mr. F. Heron Rogers is discussed. Referring to the spirit obtained, it is stated that all cracked spirits had a peculiar odour; the Cross cracking process produced a spirit containing 47 per cent. naphthenes; 23 per cent. paraffins; 4.7 per cent. aromatics, and the compression ratio in engines can be raised from 4.5 to 6 without detonation.

2 Lubricants

A Study of Petroleum Lubricants (C. F. Mabery, Ind. & Eng. Chem., Vol. 19, No. 4, Apl., 1927). (8.41/5878 U.S.A.)

Commercial lubricants are defined by initial distillation, proportion distilled below 300°C., specific gravity and viscosity of the distilled products, and stability on a friction testing machine. The heaviest hydrocarbons of refinery distillation are separated and analysed.

Two oils subjected to heavy use, one on a truck and one on an aeroplane, were examined as to specific gravity, viscosity, and behaviour on a frictional bearing. The used oils were found to have undergone little deterioration. Oils with the same viscosity showed wide variations in frictional tests.

A series of medium-grade lubricants, viscosity 320 secs. at 38°C., gave a maximum difference of 12 secs. at 98°C., of 27 secs. at 54.4°C., and corresponding differences in results on the frictional bearing.

Lubrication (W. R. Ormandy, Engineering, 1.4.27, and Engineer, 1.4.27). (8.41/5677 Great Britain.)

These periodicals summarise a paper read by Dr. Ormandy before the Inst. of Mech. Engineers. The paper covered consideration of the uni-molecular nature of surface films, the surface energy of solids, spreading of solid surfaces, viscosity, volatility at flash point, and resistance to oxidisation. Connection between lubrication and "oiliness" is discussed, it being pointed out that no means have yet been devised for the measurement of "oiliness." It is stated that adhesion is probably the basis of the conception of oiliness and assumes enormous importance when the lubricating film thickness falls to an extremely low level. It is stated that the laws governing the frictional resistance in a bearing vary from the laws of solid friction for a very imperfectly lubricated surface, to the laws of viscous liquid flow when the lubrication is abundant.

Engineering states that recent investigations have demonstrated that the property of oiliness is dependent upon a number of variables. According to P. Woog, the dominating factors are:—

(1) Adhesion of the molecules at the inter-face resulting from residual affinity and orientation.
(2) The dimensions and shape of the molecules.
(3) The grouping of the molecules in the surface and adjacent layers.
(4) The molecular rigidity.

Lubricating Oils (Paper by A. G. Marshall & C. H. Barton read before the Inst. of Mech. Eng.; The Engineer, 8.4.27, and Engineering, 8.4.27). (8.41/5704 Great Britain.)

This paper puts forward views which differ considerably from those expressed by Dr. Ormandy in a recent paper before the Institution. The authors deal with "oiliness" as judged by the Deeley machine. The effect of "oiliness" in practice was examined by means of a special positive-testing machine, a single-cylinder engine without valves or sparking plugs with its crank driven by an external motor. The results showed no difference between straight mineral oil and an oil of the same viscosity combined with 10 per cent. or even 20 per cent. of fatty oil. A similar negative result was obtained by measuring the frictional h.p. of actual engines. It was concluded that "oiliness" measurements cannot be relied upon to indicate the general practical value of a lubricating oil.

The second criterion examined was the tendency of an oil to give carbon deposits. The laboratory tests devised to examine this tendency were not found to give any indication of the results to be expected in an engine. The authors examined the viscosity of oils, its variation with temperature, and the effect of such change on the lubrication of engines. It is concluded that the commonly accepted rule "the flatter the viscosity curve, the better the oil," is misleading in connection with questions of power and friction, and is incomplete in connection with the questions of starting effort.

In the discussion which followed, Dr. Ormandy believed that hundreds of examples could be given to show that oiliness did exist and that it was an important property of lubrication oils. He also maintained that the flatter the temperature viscosity curve, the better would be the oil as a lubricant.

Methods of Recovering Crankcase Oil (H. L. Kauffman, Oil and Gas Journal, 10.2.27; abstr. in J. Inst. of Pet. Technol., Vol. 13, No. 61, April, 1927). (8.44/5874 U.S.A.)

This paper contains descriptions of several processes in use for the recovery of crankcase oil. The Alton reclaimer, which is suitable for use on a small scale, subjects the oil to a straining, distilling and filtering process. The light impurities are removed by these means, but the recovered oil is inferior to that reclaimed by a process involving sulphuric acid treatment. The De La Vergne process involves the use of a washing powder with subsequent steaming to remove light fractions. The washing powder tends to emulsify certain types of oil. The apparatus for a similar process, the Miller, is given in detail.

In the General Electric method the oil is first clarified by the use of sodium silicate or a "dope" consisting of a mixture of acid manganese resinate and stearic acid. In order to remove the light fractions the oil is passed in a thin layer over electrically-heated plates. The process is continuous and the plant is designed for small scale work, but several units may easily be joined in order to increase the through-put of oil.

The De Laval process equipment consists of a receiving and treating tank, a centrifugal purifier, a pump for circulating and mixing, and a distilling unit. The oil is treated in the receiving tank with hot sodium phosphate solution.

Apparatus for removing water and breaking emulsions in steamship oils is also described. The process gives oil which may be re-used without further treatment, and the loss of oil during the operation is small.

In another process, after steaming to remove light fractions, all further impurities are removed by centrifuging.

Various facts are also given showing the present disposition of used oils (in America) and an estimation of the quantity of oil wasted yearly.

Critical Speeds Consequent on the Deformation of the Lubricant Layer (C. Hummel, F.V.D.I., No. 278, pp. 48). (8.4/5886 Germany.)

The mathematical theory of lubrication is summarised, the influence of heat being taken into account, by the methods of hydrodynamical theory. A dynamical theory of shaft oscillations in the bearing is then developed. Tests are then carried out in series and critical speeds are determined and shown in graphical charts. The results are interpreted as a graphical relation between a "bearing characteristic function" and the angular velocity, which divides the plane into stable and unstable regions. Two regions of instability are recognised, in the neighbourhood of the second of which the bearings rapidly heat and seize.

3 *Dopes and Detonation*

Autoxidation and antioxygenic action. Application to the mode of action of anti-detonants (C. Moureu, D. Dufraisse and R. Chaux, Compt. Rend., 1927, 184, 413-417; abstr. in British Chem. Abstr., 15.4.27). (8.514/5881 France.)

Autoxidation, or the union between an oxygen molecule and that of an autoxidisable substance to form a primary peroxide with absorption of energy, has been investigated at 160° for hydrocarbons and animal and vegetable oils. The paraffinic hydrocarbons show an autocatalytic autoxidation preceded by a period of induction which is suppressed by the addition of certain substances. The autoxidations of tetra-hydronaphthalene and of most animal and vegetable oils are higher than those of paraffin, but decahydronaphthalene, naphthalene and copra oil are less oxidisable. The formation of peroxides has been recognised in a number of petroleum fractions. The effects of various amounts of a number of organic compounds on the speed of absorption of oxygen have been noted in each of the above cases. Antidetonants act as antioxygens in the liquid rather than in the gaseous phase of the explosion mixture, and the formation of peroxides precedes all autoxidation. Antidetonants exert their effect by the prevention of the formation of peroxides, but an increase in the concentration of oxygen increases the intensity of peroxidation.

Detonation and Peroxide Formation (Letter from T. Midgley, Jr., Ind. & Eng. Chem., Vol. 19, No. 4, April, 1927). (8.514/5879 U.S.A.)

The letter states that, although the formation of organic peroxides may take place under conditions of low temperature partial oxidation, it is considered most improbable that these peroxides become concentrated in the nuclear drops during compression and ignite them simultaneously when the detonation temperature of the peroxide is reached. It is pointed out that fixed gases knock just as badly as do liquid fuels and there is no reason to believe that there are any liquid droplets in the combustion mixture when fired within the combustion chamber.

Spectography and Internal Combustion Engine (A. Henne and G. L. Clark, Comptes Rendus, 184, 26; abstr. in Eng. Abstr. No. 31, April, 1927). (8.514/5872 France.)

Following Messrs. G. L. Clark and W. C. Thee, the authors, with more perfect apparatus, carried out spectroscopic observations of engine flames. A quartz window and prism were employed. By means of a valve, successive portions of the explosion could be isolated. Running normally, the four quarters of the explosion cycle were about equal in range and intensity, but when detonating the first quarter revealed a more intense spectrum, extending more towards the ultra-violet (2,360 A). Only the lines of water-vapour could be discerned with certainty. The second quarter was feeble, and the third and fourth quarters were as in normal running. Using four different antidetonants, namely, tetra-ethyl lead, iodine, aniline and ethylene, spectra analogous to those of

normal running were obtained. The principal conclusion reached is that with detonation there is a sudden liberation of energy in the first quarter of the explosion, and the function of the antidetonant is to ameliorate the violence of this effect. The fact that, when using tetra-ethyl lead, the lead lines appear only in the first quarter of the explosion leads to the view that these antidetonants, acting as catalysts, are effective chiefly in the initial phase of explosion. The authors observe, however, that no existing theory of antidetonants explains this general behaviour.

Ignition of Substances (A. Egerton and S. F. Gates, J. Inst. of Pet. Technol., Vol. 13, No. 61, April, 1927). (8.514/5863 Great Britain).

The following three articles by the same authors are included in the above journal :—

1. *Effect of metallic vapours on the ignition of substances.*

From this paper it is concluded that :—

(*a*) " Antiknocks," such as lead tetra-ethyl, raise the self-igniting temperature of certain combustible vapours.
(*b*) Lead volatilised or dispersed by means of an arc in nitrogen or argon has a comparable effect.
(*c*) The same method has been applied to test the effect of other metals.
(*d*) The metal atom in incipient oxidation is the seat of the action.
(*e*) The effect on the igniting temperature of various combustible substances has been tested. There appears to be very little effect on the igniting temperature of an alcohol, but a very pronounced effect on that of an aldehyde.
(*f*) The effect of the presence of the metal is to delay oxidation of the combustible substance.
(*g*) The decomposition and oxidation of " anti-knocks " have been investigated, and the existence of a class of volatile intermediate oxidation products has been indicated.

2. *The significance of igniting temperatures.*

(*a*) The ignition point of a substance is defined and its relation to " igniting temperature " discussed.
(*b*) The conditions affecting " igniting temperature " are investigated.
(*c*) Distinction is drawn between the surface reactions and the reactions in the body of the gas. The latter may lead to the establishment of ignition centres, unless dispersed by diffusive influences.
(*d*) The igniting temperatures of various substances are determined; aldehydes are found to ignite at lower temperatures than the corresponding alcohols and hydrocarbons. The effect of mixtures of certain combustible liquids is investigated.
(*e*) The igniting temperature of liquid drops is as a rule lower than that of the corresponding vapour.
(*f*) " Igniting temperatures " are shown to enhance differences in the ignition characteristics of combustible substances and to be related to their knocking characteristics in engines.

3. *Theories of antiknock action.*

(*a*) The main facts regarding antiknocks are summarised.
(*b*) Antiknocks are regarded as negative catalysts which react with and remove those substances which autocatalyse combustion.
(*c*) In the early stages of combustion peroxides are formed which act as autocatalysts. The importance of this in connection with the establishment of ignition centres is discussed.

(*d*) Metallic antiknocks form comparatively stable peroxides which react with and destroy the fuel peroxides and which are then regenerated.
(*e*) The importance of the relative stability of the various peroxides and of concentration of fuel and oxygen is demonstrated.
(*f*) The organic antiknocks are shown to exhibit similar behaviour, but themselves undergo combustion.
(*g*) It is shown how the slowing down of the initial processes of combustion by antiknocks leads to rise in "igniting temperature" and to prevention of "knocking."
(*h*) Other theories of antiknock action are mentioned and briefly discussed.

Pinking in Internal Combustion Engines (G. B. Maxwell, J. Inst. of Pet. Technol., Vol. 13, No. 61, April, 1927). (8.514/5864 Great Britain.)

This article, which is reprinted from "Fuel in Science and Practice," Vol. 6, No. 3, reviews the various theories regarding the cause of pinking; the detonation theory, the flame vibration theory, and the nuclear theory are considered. The various factors connected with engine design, fuel characteristics and inhibiting agents which affect detonation are discussed. It is concluded that further experimental evidence is required on certain points. The spontaneous ignition theory, as modified by Callendar's nuclear hypothesis, seems to fit the facts better than any other suggestion put forward. A more detailed examination of the oxygenated compounds formed during preliminary oxidation of paraffin hydrocarbons is required, since the formation of organic peroxides has not yet been definitely proved. The solution of titanous sulphate used to detect their presence is said by Engler to be a test for hydrogen peroxide, not for organic peroxides. The latter, however, form hydrogen perioxide in the presence of moisture by autoxidation, so that they react to titanous sulphate if not carefully purified. It would appear that the action of "knock inducers" on peroxide formation must also be investigated.

As a preliminary to engine experiments, the mode of combustion of fuel mists in a closed cylinder, at various initial temperatures and pressures, would repay photographic examination. The effect of preliminary "baking," and of a variety of "antiknock" substances and "knock inducers," could in this way be determined.

Antiknock Dopes (Dr. R. A. Weerman, J. Inst. of Pet. Technol., Vol. 13, No. 61, April, 1927). (8.514/5865 Holland.)

This article consists of a statement by the Laboratory of the Bataafsche Petroleum Maatschappij of Amsterdam, describing experiments carried out in 1925. These experiments show that there is a very great difference between the self-ignition temperature of the petrol with and without antiknock dope. A comprehensive list of the self-ignition temperatures of various compounds is given, from which it may be seen that those compounds which have a good antiknock effect also produce very considerable increase in the self-ignition temperature.

Detonation of Gaseous Mixtures of Acetylene and Pentane (A. Egerton and S. F. Gates, Proc. Roy. Soc., A.767, Vol. 114, 1.3.27). (8.514/5689 Great Britain.)

The article describes the experimental methods employed as the conditions for constancy of position of detonation, and the action of antiknocks on the position of detonation.

The conditions for detonation to occur in the same place in a tube of certain dimensions are investigated for acetylene and for pentane mixtures of definite

composition. It is concluded that detonation appears to take place slightly ahead of the combustion front.

The antiknock compounds—lead, tetra-ethyl and diethylselenide—were not found to affect the position of detonation at ordinary initial pressures and temperatures.

Detonation in Gaseous Mixtures at High Initial Pressures and Temperatures (A. Egerton and S. F. Gates, Proc. Roy. Soc., A.767, Vol. 114, 1.3.27). (8.514/5688 Great Britain.)

This paper extends the work referred to in the previous abstract.

Detonation in acetylene and in pentane mixtures at high initial temperatures (230°C.) and pressures (10 atmospheres) has been investigated photographically, using a steel tube fitted with glass windows. Increase of initial pressure engenders earlier detonation up to a certain limit, when further increase makes very little difference.

The effect of increase of initial temperature was also investigated. At a given initial pressure, rise of initial temperature appeared to render detonation slightly later.

Lead tetra-ethyl was not found to affect the position of detonation of the mixtures investigated at high pressure either at normal initial temperature or at 230°C.

Effects of Antiknock Materials on the Spontaneous Ignition Temperatures of Some Inflammable Liquids (Yoshio Tanaka and Yuzaburo, Procs. of Imp. Acad., Japan, 2,221; abstr. in Eng. Abstr., No. 31, April, 1927). (8.514/5871 Japan.)

The authors observed the effects of diethyl selenide, tetra-ethyl lead, aromatic amines and pyridine upon spontaneous ignition temperatures. They found that these appeared to act as catalysts. They suggest that the antidetonating action of lead ethide and other similar compounds cannot be explained by the elevation of the spontaneous ignition temperature.

4 Heavy Oil Engines

Some factors affecting the reproducibility of penetration and the cut-off of oil sprays for fuel injection engines (E. G. Beardsley, N.A.C.A. Report 258). (12.81/5813 U.S.A.)

This investigation was undertaken at the Langley Memorial Aeronautical Laboratory at Langley Field, Virginia, in connection with a general research on fuel-injection engines for aircraft. The purpose of the investigation was to determine the factors controlling reproducibility of spray penetration and secondary discharges after cut-off.

The development of single sprays from automatic injection valves was recorded by means of special high-speed photographic apparatus capable of taking 25 consecutive pictures of the moving spray at a rate of 4,000 per second. The effects of two types of injection valves, injection-valve tubing length, initial pressure in the injection-valve tube, speed of the injection control mechanism, and time of spray cut-off, on the reproducibility of spray penetration, and on secondary discharges, were investigated.

It was found that neither type of injection valve materially affected spray reproducibility. The initial pressure in the injection-valve tube controlled the reproducibility of spray penetrations. An increase in the initial pressure or in the length of the injection-valve tube slightly increased the spray penetration within the limits of this investigation. The speed of the injection control mechanism did not affect the penetration.

Analysis of the results indicates that secondary discharges were caused in this apparatus by pressure waves initiated by the rapid opening of the cut-off valve. The secondary discharges were eliminated in this investigation by increasing the length of the injection-valve tube.

Heavy Oil Engines for Aircraft (R. H. Ward, Aviation, Vol. 22, No. 16, 18.4.27). (12.81/5835 U.S.A.)

This article is an abstract of a paper prepared for the Oil Power National Conference (United States, 18th-23rd April, 1927). Several heavy oil engines are referred to, but all of them have been described elsewhere. The following details are given for the Attendu engine tested by the U.S. Navy Dept. with, it is understood, promising results. The engine was a two-cycle solid-injection two-cylinder model developing 85 b.h.p. at 1620 r.p.m.; better results are stated since to have been obtained; weight per b.h.p. has been reduced to 3.6 lbs. and fuel consumption to 0.5 lb. per b.h.p.

5 Carburation and Ignition

Aeroplane Carburation and Ignition (J. Soc. Autom. Eng., Vol. 20, No. 4, April, 1927). (8.92/5833 U.S.A.)

This article refers to a lecture by L. S. Hobbs and T. Z. Fagan before the Society of Automotive Engineers. The authors deal generally with the trend of aircraft curburettor design and with various types of magnetos for aircraft engines of eight, nine and twelve cyclinders, both V type and radial. A new type of spark plug cable now in the service is referred to. This spark plug is encased in a woven covering impregnated with a special preparation which is impervious to water, oil and kerosene, and which, by virtue of its dielectric qualities, materially lessens corona discharge. Wireless interference has been traced to the primary and secondary circuits of the ignition, and to eliminate this interference, spark plug cables are bunched and shielded with thin sheet steel and metallic braid, earthed to the engine at frequent intervals.

6 Test Engines

Variable Compression Engine for the Examination of Liquid Fuels (A. Oberle, Petr. Zeit., Jan. 10th, 1927; abstr. in J. Inst. Pet. Technol., Vol. 13, No. 61, April, 1927). (8.19/5873 Germany.)

A single-cylinder engine is described so arranged that by movement of the cylinder vertically the compression ratio can be varied, while running under full load, between 2 : 1 and 9 : 1, rated at 4 horse-power, 550 r.p.m. The power generated is absorbed in a lamp resistance. The method of examining petrols for their respective points of incipient detonation is outlined. Graphs are given showing the power output with increasing compression ratio when different petrols are used. The power output in each case attains a maximum, and the less easily a petrol detonates, the higher the maximum power output obtainable, other conditions being equal. Several indicator cards of explosions under detonating and non-detonating conditions are illustrated.

7 Heat Transfer

Heat Transfer in Internal Combustion Engines (Dr. Ing. W. Nusselt, F.V.D.I., No. 264, p. 79). (8.57/5890 Germany.)

Gas mixtures were exploded in a steel vessel of spherical internal surface water-cooled externally. The object of the experiment was to separate radiation and conduction taking into account reflection from the walls. Radiation of hot gases is discussed theoretically and applied to analyse the experimental results obtained from a mixture of CO and CO_2, but it is stated that the results are

applicable to other gases on the basis of comparison with the work of other authors.

The results are given in formulæ, tables and graphical representation.

Heat Transfer Alignment Charts (M. Roulleux, Chem. Eng., March, 1927; abstr. in J. Inst. Pet. Technol., Vol. 13, No. 61, April, 1927). (8.57/5889 Great Britain.)

In calculating the heat flow occurring when two liquids are separated by a solid wall it is necessary to know the mean temperature. This may be calculated from the known temperature conditions in the liquids, but the calculation is laborious. The object of the two charts given is to provide a graphical means of obtaining the mean temperature. The second chart may also be used to obtain the area of the heat transfer surface.

Distribution of Temperature and Heat Flow (Dr. Ing. G. Eichelberg, F.V.D.I., No. 263, p. 46). (8.57/5891 Germany.)

I. Prandtl's empirical relation is used in developing expressions for heat exchange between turbulent gas and cylinder wall.

II. Fourier's differential equations of conduction are used to determine the temperature distribution in the cylinder walls.

III. The stresses due to thermal expansion are discussed, for various simple geometrical forms, with methods of reducing the differential equations.

Substantially, the measurements give time average values, but a small variation is shown following the very large variation in gas temperature.

8 *Heat Dissipation by Means of Ribs*

(Prof. Dr. Ing. E. Schmidt, Z.V.D.I., No. 26, 26.6.26, and No. 28, 10.7.26). (8.36/5841 Germany.)

In this article the author has examined by calculation to what extent the capacity of ribs for dissipating heat depends on their shape and dimensions. It is shown that there are certain very definite rib profiles in which the quantity of material used for the ribs is smaller than with any other shape. With ribs on flat surfaces, the optimum profile is bounded by two parabolas with their apices meeting at the outer edge of the ribs. With circular ribs a parabolic curve is obtained. The optimum rib profiles, therefore, are of a shape somewhat resembling a hollow ground razor blade. As this shape is difficult to produce and the sharp edge is undesirable, ribs of uniform thickness and a rib with triangular profile are also examined.

9 *Flow of Exhaust Gases*

Configuration and Resistance of Flow of Exhaust Gases from Valves (Dr. Ing. E. Schrenk, F.V.D.I., No. 272, p. 62). 8.7/5885 Germany.)

A systematic series of experiments with exhaust valves of different sizes, shape and openings are tabulated, and a number of photographs are reproduced showing the actual exhaust flow.

The author does not consider that the body of observed facts is sufficient to establish mathematical expressions for these relations, but it is possible to draw valuable inferences about the design of valves for minimum resistance and back pressure, and by use of a diffuser to reconvert kinetic energy back into pressure head.

10 The Direct Measurement of Engine Power on an Airplane in Flight with a Hub Type Dynamometer

(W. D. Gove and M. W. Green, N.A.C.A. Report No. 252). (8.18/5840 U.S.A.)

This report describes tests made at the Langley Memorial Aeronautical Laboratory of the National Advisory Committee for Aeronautics to obtain direct measurements of engine power in flight. Tests were made with a Bendemann hub dynamometer installed on a modified DH-4 airplane, Liberty 12 engine, to determine the suitability of this apparatus.

This dynamometer unit, which was designed specially for use with a Liberty 12 engine, is a special propeller hub in which is incorporated a system of pistons and cylinders interposed between the propeller and the engine crankshaft. The torque and thrust forces are balanced by fluid pressures, which are recorded by instruments in the cockpit.

These tests have shown the suitability of this type of hub dynamometer for measurement of power in flight and for the determination of the torque and power coefficients of the propeller.

AERODYNAMICS AND HYDRODYNAMICS

11 Fluid Motion

The Head Resistance of a Model Rotating in an Air Flow (C. Wieselsberger, Phys. Zeit., No. 2, 15.1.27). (5.32/5665 Japan.)

These tests, carried out in the Aeronautical Institute of Tokio, were made with the object of determining whether the head resistance of a body changes if, in addition to its forward motion, the body simultaneously rotates at a constant angular velocity about an axis of symmetry parallel to its direction of motion. A bullet-shaped body, a cylinder and a circular disc were used in the experiments. The influence of rotation was found to be most marked in the case of a bullet-shaped model, the coefficient of resistance increasing to twice its original value at one speed of revolution. The relation between this increase of resistance and boundary layer phenomena is discussed.

The Laws of Similitude Applied to the Flow of a Viscous Fluid (Engineering, 123, pp. 27-30, 7.1.27; abstr. in Sci. Abstr. B, Vol. 30, 25.3.27. Translation of a paper by Camichel read before the Soc. Franc. de Navigation Aerienne, Toulouse, July, 1925). (5.32/5680 France.)

The main theme of the paper is the use of the principle of dynamical similitude to investigate the flow behind an aeroplane or its portions by experiments on the flow past obstacles in a viscous liquid. The liquid contains suspended particles which are intermittently illuminated, and photographs enable the fluid velocity to be determined in both magnitude and direction. Examples of the photographs are given. By using different fluids the principles of similitude were experimentally verified; the flow round a plate perpendicular to the stream is discussed fully. At relatively great speeds there is a "wake" of "dead water"; at slower speeds the streamlines from the edges unite some distance downstream, the space between being occupied by two vortices; at still lower speeds the flow is laminar. Using different fluids, the speeds at which the flow is geometrically similar were found to agree with the law, and for junction at a specified distance downstream the streamlines were everywhere identical, and the distribution of velocities was that demanded by the laws of similitude.

Aerodynamical Theories Tested by the Principles of Rational Hydromechanics (M. E. Carafoli, L'Aerophile, 1-15.3.27, pp. 71-77). (5.32/5693 Germany.)

A brief synthesis of the work of Magnus, Rayleigh, Joukowsky and Prandtl in setting up a theory of viscous fluid motion round a body or wing. Excellent experimental illustrations of flow round a wing profile are reproduced from photographs obtained at the Institut Aerotechnique of Saint Cyr.

The writer concluded that the striking points of agreement justify the adoption of the theory until something nearer the facts is offered.

Theory of Mutual Influence of Wings and Body (J. Lennertz, Aachen, Z.F.M., 18.1.27, pp. 11-13). (5.32/5783 Germany.)

For mathematical treatment the body is taken as a sphere or an infinite cylinder. In the latter case the trailing eddies have "images" in the body the effects of which on the induced velocities are readily calculated. They produce an increase in the downward flow and in the induced resistance. The distribution of lift for minimum drag is calculated approximately by Fourier expansions and solution of an integral equation. The effect for aspect ratio 10 is sensibly the same as for infinite aspect ratio. Further analysis will be published in a dissertation.

The Problem of Turbulence in Flow between Parallel Walls (H. Lorenz, Phys. Zeit., 1.1.27, pp. 12-16). (5.32/5825 Germany.)

The exact differential equation for laminar motion is replaced by an empirical form for turbulent motion constructed from consideration of superposed cyclic flows, consisting of regular transverse eddies. The redistribution of energy in passing from one type of flow to the other is calculated on the basis of the various assumptions and a value of Reynolds's critical number is obtained. This is compared with Couette's experimental determination of the critical number for rotating cylinders and is found to be 18 per cent. higher. (Note.—The author does not refer to the complication of Couette's experiments by relatively great end effects, and does not refer to G. I. Taylor's complete experimental and mathematical solution of flow between long cylinders. Nor does he note that this type of instability cannot occur in motion between parallel planes.) With a different empirical distribution of velocities he obtains a value in agreement with Heisenberg in a paper read at Innsbruck, 1922. Further, in comparison with his own previous work on flow in tubes he again obtains good agreement with his new result.

Air Flow on Flat Plates (Prandtl and Betz, Ergebn. der Aerodyn. Versuchsanstalt zu Göttingen, 3rd issue, 1927, pp. 1-5). (5.32/5826 Germany.)

Tangential resistance of air flow on flat plates.

The empirical formulæ of Prandtl and von Karman in which the velocity varies as one-seventh power of the distance from the surface is applied to analyse the tangential friction on a flat plate. It is pointed out that near the leading edge there may be laminar flow, while beyond a certain critical point turbulent flow sets in. The resistance is therefore divided into two parts, one part due to the laminar flow near the leading edge and calculated by means of the solution of Blasius for Prandtl's differential equation. The second part of the resistance is calculated by means of the empirical formulæ referred to above. A graphical example is given showing the resistance varying according to the results from laminar flow at low Reynolds's numbers, according to the equation for complete turbulence at high Reynolds's numbers, and according to a composite equation for intermediate values of Reynolds's numbers.

Once the empirical equation for turbulent resistance is accepted, these results give a satisfactory analysis of an observed discontinuity in the resistance

coefficient and of the hitherto obscure result that above the critical value the resistance coefficient approached the straight line corresponding to the one-seventh power only asymptotically.

Cinematograph Examination of Plane Fluid Motion past Obstacles (A. Toussaint and E. Carafoli, Compt. Rend., 183, pp. 48-948, 22.11.26; abstr. in Sci. Abstr. A, Vol. 30, Pt. 4, 25.4.27). (5.32/5845 France.)

At small speeds vortices are formed near the point of division of the central streamline, and these move along the boundary. At greater speeds these disappear, but "dead water" begins to appear, and its boundaries become turbulent at some distance. At higher speeds alternate vortices are thrown off behind, and these enhance the effect of the wake. A stepped profile is found to diminish the effects of the stream disengaging from the boundary, which may explain the reason why stepped wing profiles give greater lift than smooth ones.

Flow and Drag Formulæ for Simple Quadrics (A. F. Zahm, N.A.C.A. Report No. 253). (5.23/5866 U.S.A.)

In this text are given the pressure distribution and resistance found by theory and experiment for simple quadrics fixed in an infinite uniform stream of practically incompressible fluid. The experimental values pertain to air and some liquids, especially water: the theoretical refer sometimes to perfect, again to viscid fluids. For the cases treated the concordance of theory and measurement is so close as to make a résume of results desirable. Incidentally, formulæ for the velocity at all points of the flow field are given, some being new forms for ready use derived in a previous paper. A summary is given. A list of symbols follows the text.

Theory of the Vortex (Joh Dejmek, Phys. Zeit., 1.3.27, pp. 196-198). 5.32/5694 Germany.)

A brief descriptive account is given of the formation of vortices by the rolling up of the boundary layer along the walls of a channel, and is illustrated by three photographs. Reference is made to the meteorological theory of the formation of cyclones at a surface of discontinuity.

12 Pressure Distribution Over Aerofoils

The Air Forces on a Systematic Series of Biplane and Triplane Cellule Models (Max. M. Munk, N.A.C.A. Report No. 256). (5.33/5868 U.S.A.)

The air forces on a systematic series of biplane and triplane cellule models measured in the atmospheric density tunnel of the Langley Memorial Aeronautical Laboratory are the subject of this report. The tests consist in the determination of the lift, drag and moment of each individual airfoil in each cellule, mostly with the same wing section.

The magnitude of the gap and of the stagger is systematically varied, not, however, the decalage, which is zero throughout the tests. Certain check tests with a second wing section make the tests more complete, and the conclusions more convincing.

The results give evidence that the present U.S. Army and Navy specifications for the relative lifts of biplanes are good. They furnish material for improving such specifications for the relative lifts of triplanes. A larger number of factors can now be prescribed to take care of different cases.

Pressure Distribution over a Wing and Tail Rib of a VE-7 and of a TS Airplane in Flight (J. W. Crowley, Jr., N.A.C.A. Report No. 257). (5.336/5869 U.S.A.)

This investigation was made by the National Advisory Committee for Aeronautics at Langley Field to determine the pressure distribution over a rib of the

wing and over a rib of the horizontal tail surface of an airplane in flight, and to obtain information as to the time correlation of the loads occurring on these ribs. Two airplanes, VE-7 and TS, were selected in order to obtain the information for a thin and a thick wing section. In each case the pressure distribution was recorded for the full range of angle of attack in level flight and throughout violent manœuvres. Particular attention was given to the high and low angle of attack conditions. The results show :—(*a*) that the present rib load specifications in use by the U.S. Army Air Corps and the Bureau of Aeronautics, Navy Dept., are in fair agreement with the loads actually occurring in flight, but could be slightly improved; (*b*) that there appears to be no definite sequence in which wing and tail surface ribs reach their respective maximum loads in different manœuvres; (*c*) that in accelerated flight, at air speeds less than or equal to 60 per cent. of the maximum speed, the accelerations measured agree very closely with the theoretically possible maximum accelerations. In manœuvres at higher air speeds the observed accelerations were smaller than those theoretically possible.

Distribution of Pressure over Model of the Upper Wing and Aileron of a Fokker D-VII Airplane (A. J. Fairbanks, N.A.C.A. Report No. 254). 5.31/5706 U.S.A.)

This report describes tests made in the N.A.C.A. atmospheric wind tunnel for the purpose of determining the distribution of pressure over a model of the tapered portion of the upper wind and the aileron of a Fokker D-VII airplane. Normal pressures were measured simultaneously at 74 points distributed over the wing and aileron. Tests were made throughout the useful range of angles of attack with aileron setting ranging from $-20°$ to $+20°$. The results are presented graphically.

It was found that the pressure distribution along the chords is in general similar to that of thick tapered airfoils previously tested. The maximum resultant pressure recorded was five times the dynamic pressure. The distribution of the air load along the span may be assumed to be uniform for design purposes.

Aileron displacements affect the pressures forward to the leading edge of the wing and may increase the air load on the outer portion of the wing by a considerable amount. With the wing at large angles of attack the overhanging portion of the aileron creates usually a burbled flow and therefore a large drag. The balance reduces the control stick forces at small angles of attack for all aileron displacements. At large angles of attack it does this for small displacements only. With the airplane at its maximum speed, an angle of attack of 18°, and a down aileron displacement of 20°, the bending moment tending to break off the overhanging portion of the aileron will be greater than that caused by a uniform static load of 35 lbs. per sq. foot.

13 Gyroplanes and Rotors

Autogyro (Flugwoche, 28.3.27, No. 5/6, page 100). (17.3/5832 Germany.)

Referring to the accident to the 300 h.p. Hispano Suiza gyroplane, it is stated that similar constructions are being proceeded with in Germany.

14 Wall Interference in Closed Type Wind Tunnels

(G. J. Higgins, N.A.C.A. Tech. Note No. 256). (11.16/5674 U.S.A.)

A series of tests has been conducted by the National Advisory Committee for Aeronautics in the variable density wind tunnel on several airfoils of different sizes and sections to determine the effect of tunnel wall interference and to determine a correction which can be applied to reduce the error caused thereby. The use of several empirical corrections was attempted with little success. The Prandtl theoretical correction gives the best results and its use is recommended for correcting closed wind tunnel results to conditions of free air.

15 Tests on Free Models of New Types

(A. Lippisch, Rhon-Rossittengesellschaft, Z.F.M., 28.12.26, pp. 549-552). (5.323/5789 Germany.)

The principles of dynamical similarity are stated. The dimensions of a model are given with photographs in free flight, and examples of reductions.

16 Performance Tests and Reduction of Data

Performance Calculations of Aeroplanes without use of Polar Diagrams—74th Report of the D.V.L. (Martin Schrenk, Z.F.M., 14.4.27, pp. 158-159). (4.2/5827 Germany.)

An expression is developed for the falling off of engine power with height and the various quantities required are then calculated in terms of coefficients of lift, drag, airscrew efficiency, surface and loads.

A number of abacs (nomograms) are given to lighten the computations.

Cinematograph Records for Measurement of Performance (P. Raethjen, Z.F.M., 28.12.26, pp. 547-549). (4.2/5788 Germany.)

The method has been developed at the Rhon-Rossittengesellschaft e.V., where the investigation of the motions of the centre of gravity and of the motions of axes fixed in the aeroplane about the centre of gravity have been given special attention. Records of aeroplane position are taken through a transparent ruled screen (compare R.T.P. abstract 5.26/5534, Chaps. IV. and VII.) at a ground station, and at the same time records are taken in the aeroplane. Emphasis is laid on devoting extreme care to exact measurement, one complete set of readings accurately made and correctly reduced being worth a hundred doubtful results.

Formulæ for Starting of Landplanes (Hermann Blenk, 59th Report of the Deutsch. Versuchsanstalt fur Luftfahrt, Berlin, Z.F.M., 28.1.27, pp. 25-32). (4.2/5787 Germany.)

The length of starting run and initial rate of climb have limits set by the size of aerodromes and by the surrounding country. The usual methods of performance calculation are arranged in convenient form and graphical results are given of relations between length of run and total weight, surface loading, engine loading, angle of incidence and ground friction.

Aircraft Design and Equipment

17 Structures

Approximations for Column Effect in Airplane Wing Spars (E. P. Warner and Mac Short, N.A.C.A. Report 251). (5.21/5828 U.S.A.)

The significance attaching to "column effect" in airplane wing spars has been increasingly realised with the passage of time, but exact computations of the corrections to bending moment curves resulting from the existence of end loads are frequently omitted because of the additional labour involved in an analysis by rigorously correct methods. The present report, submitted for publication by the National Advisory Committee for Aeronautics, represents an attempt to provide for approximate column effect corrections that can be graphically or otherwise expressed so as to be applied with a minimum of labour. Curves are plotted giving approximate values of the correction factors for single and two bay trusses of varying proportions and with various relationships between axial and lateral loads. It is further shown from an analysis of those curves that rough but useful approximations can be obtained from Perry's formula for corrected bending moment, with the assumed distance between points of inflection arbitrarily modified in accordance with rules given in the report.

The discussion of general rules of variation of bending stress with axial load is accompanied by a study of the best distribution of the points of support along a spar for various conditions of loading.

Limits of Error in Approximate Formula for Resistance to Bending (Researches of the E.V. Fortschrittliche Verkehrstechnik. Otto Steinitz, Z.F.M., 14.2.27, pp. 67-69). (5.1/5785 Germany.)

Approximate methods by planimetry replace tedious calculations of the moments of irregular sections. Eight examples are given.

New Problems in Aeroplane Structure (*continued*). Lectures at Charlottenburg Technical High School, 1925-1926 (H. Reissner, Z.F.M., 14.4.27, pp. 153-158). (5.21/5846 Germany.)

Single span wings. Torsion of a built-up span. The differential equation is obtained and solved approximately and by the more exact methods of v. Mises, with a numerical example. Ratio of total stresses to pure bending stresses. Ratio of shear stress to pure torsional stresses.

Calculation of Aeroplane Structure with Strut Bracing (Karl Thalau, 71st Report of the Deutsch. Versuchsanstalt fur Luftfahrt E.V. Berlin-Aldershof, Z.F.M., 14.3.27, pp. 105-111). (5.21/5793 Germany.)

In continuation of the 64th Report, improved formulæ are developed for completely triangulated strut frame, *i.e.*, without wire bracing. Three worked-out examples are given. The results are stated to be in good agreement with those in the following abstract.

Calculation of Bracing Struts (Karl Ruhl, 2nd Report of the Design Office of the Albatross Aeroplane Works, Berlin, Z.F.M., 14.3.27, pp. 111-121). (5.21/5794 Germany.)

A more formal discussion of strut bracing. Two very completely worked-out examples are given.

18 Airscrews

Approximate Solution of the Problem of Commercial Airscrew Design (H. B. Helmbold, Z.F.M., 14.1.27, pp. 13-18). (5.41/5791 Germany.)

The circulation round an element is related to the lift and the induced velocities. An application of the calculus of variations gives the best distribution of lift along the blade. Integrations along the blade of four types determine thrust and torque. This applies to a lightly-loaded airscrew with many blades. Prandtl's corrections for a two-bladed airscrew are given in tabular form for the various parameters used. The course of the practical calculation is then summarised.

Micarta Airscrew in U.S.A. (Army & Navy Register, 12.2.27). (5.462/5703 U.S.A.)

The use of Micarta airscrews of the detachable blade type is stated to have been developed to the point at which they are ready for service. It is stated that this material appears preferable to aluminium alloy for horse-powers of about 200.

19 Aircraft Brakes

Sauzedde Brakes for Aircraft (W. Brennan, Aviation, Vol. 22, No. 16, 18.4.27). (5.55/5834 U.S.A.)

This braking device, which is described and illustrated, consists of a triple-laced wire wheel and brake combined. The wheel has three rows of spokes at the hub, laced in a manner which allows all spokes to be equal length, thus reducing the list of replacement parts. By having all of the spokes of equal

length, the inventor claims to have made the strain on each row equal. In lacing the wheel, the spokes are crossed, allowing the brakes to be placed closer to the centre of the hub, thus distributing the braking reaction more uniformly and allowing more efficient streamlining.

20 *The Prevention of Fire in Aircraft*

(Marcel Ducout, L'Aerophile, 1.15.26.) (16.12/5707 France.)

The author enumerates the best methods of preventing fire in aircraft as follows :—

(1) The installation of long piping leading the flame, resulting from back firing, outside the aircraft.

(2) The mounting of the petrol tanks near the undercarriage where they can be easily slipped and are a long way from the engine.

(3) Protection of the exhaust manifolds by concentric fireproof tubes of asbestos and aluminium.

(4) Piping brazed and not tin-soldered, and carefully arranged joints.

(5) Insulation of the electric plant.

(6) Engine with low vibrations.

(7) The mounting of a good automatic extinguisher.

(8) The use of a fuel which is non-inflammable outside the engine.

21 *Design of Seaplane Floats and Flying Boat Hulls*

(H. Herrmann, Jahrbuch der Wissenschaftlichen Gesellschaft fur Luftfahrt, 1926). (5.341/5702 Germany.)

A graphical representation is given of the water resistance at various speeds and with various loadings. A graphical method, developed by Madellung, is given, comparing resistances of various floats and hulls. The relationship between model and full scale experiments is discussed, and a useful table based on dimensional relationships is included in the discussion. The taking-off characteristics are discussed particularly in relation to the size and position of the step. The article concludes with some constructional considerations. Numerous illustrations of English, American and German flying boats and seaplanes are included.

22 *Parachutes*

Veenstra Parachute (La Conquete de l'Air, No. 3, 1.3.27). 16.11/5830 Belgium.)

This parachute has a diameter of 26ft. and weighs 0.13 lb./sq. in. A frame on the principle of a spider's web, actuated by a spring, facilitates the opening of the parachute. The hook is of special design on the snaphook principle with the addition of a ring which, on the shock of opening, slips over the open ends of the hook and locks the hook by screwing on. The parachute is carried in a cylindrical container. The parachute has been successfully tested from 1,000ft.

INSTRUMENTS

23 *Photography*

Distortion of Some Typical Photographic Objectives (A. H. Bennett, J. Opt. Soc. Am., and Rev. Sc. Instr., Vol. 14, No. 3, March, 1927). (14.2/5842 U.S.A.)

In connection with an examination of lenses to be used in airplane topographical mapping, a careful study has been made of the distortion of a large number of high-grade commercial photographic objectives. The apparatus designed for the measurement of distortion for infinite or finite object distance is described. The data show the distortion of the symmetrical anastigmat when the object is at an infinite distance, and also at unit magnification. At unit magnification, with a symmetrical lens, there should be no distortion, but tests of nominally symmetrical anastigmats show sufficient distortion to affect the performance of

the lens. This distortion arises from lack of complete symmetry in the lens construction. Data for the distortion of the unsymmetrical anastigmat (Tessar type) are presented. The results show that rather large variations exist among individual lenses of nominally the same construction. The case in which the axis of the lens is bent, a result of slight prismatic action of the system, is discussed, and a method for determining the magnitude of tilt is described.

The Compensation of Distortion in Objectives for Airplane Photography (I. C. Gardner and A. H. Bennett, Opt. Soc. Am. and Rev. Sci. Inst., Vol. 14, No. 3, March, 1927). (14.2/5843 U.S.A.)

Lenses to be used in taking airplane photographs for topographic surveying must be substantially free from distortion. It is difficult to find objectives satisfactory in this respect and it is shown that in many cases the distortion can be compensated by a plane parallel plate used as an additional component of the lens. The effect of the plane parallel is generally not detrimental to the correction of the other aberrations of the objective. Experimental work is reported which justifies these conclusions.

Spectral Filters (K. S. Gibson, J. Opt. Soc. Am. and Rev. Sc. Inst., 13, pp. 267-280, September, 1926; abstr. in Sc. Abstr. A., Vol. 30, 25.3.27). (14.241/5682 U.S.A.)

This is a compilation, with bibliography, of data relating to filters for the ultra-violet, visible and infra-red regions. As a rule only those filters are considered which have a relatively sharp transition between the regions of free transmission and sharp absorption.

Rectification of Aerial Survey Photographs (M. N. MacLeod, Proc. Opt. Conv., Part II., pp. 653-661, and disc., 662, 1926; abstr. in Sci. Abstr. A, Vol. 30, 25.3.27). (14.31/5683 Great Britain.)

The author discusses the geometrical and mathematical principles underlying a projection method of rectification. It is first necessary to determine the tilt of the camera at the instant when any given photograph was taken, and a simple form of apparatus for doing this is described and illustrated. This apparatus gives the height and tilt, and it is then possible by a simple form of projection apparatus to rectify the photograph. The method is first described with reference to a survey of flat ground, but the application of the method to hilly country is also given, and the use of the " camera plastica " for the determination of ground heights is described.

24 Navigation

Navigation of Aircraft (H. Junkers, English Patent No. 264842). 6.35/5666 Germany.)

For navigating aircraft so as to direct a straight course towards an object on the ground, an apparatus is described in which actual pictures of the compass and of the ground below are produced optically. The observed direction of displacement of the ground is transferred to the compass image, and the aircraft is steered so that this direction coincides with the desired course.

The Mengden Automatic Course Recorder (P. Grenier, L'Aeronautique, No. 92, Jan., 1927). (6.35/5653 France.)

This article describes and explains the method of using M. Mengden's automatic course recorder (auto-estimographe) which constantly indicates to the pilot his position by dead reckoning, and automatically records the aircraft's course on the chart.

25 Measurement of Air Speed

Theory of the Vane Anemometer (E. Ower, Phil. Mag., 2, pp. 881-900, Nov., 1926; abstr. in Sc. Abstr. A, Vol. 30, Pt. 4, 25.4.27). (6.382/5844 Great Britain.)

The writer urges that the vane anemometer, when used to measure speeds for which it has been designed and calibrated, can give very accurate results, and is thoroughly reliable. The calibration curve is sensibly straight, except for small speeds where the friction of the instrument has a marked effect. After obtaining the general equations of motion, the author examines the effects of variations of wind speed and air density. The effect of fluctuations ordinarily met with is less than one per cent.; the effect of air density is much more at low than at high speeds, and should be taken into account in accurate work; the effect of a wind speed varying across the vane circle is shown to be small.

Measurement of Static Pressure (C. J. Fechheimer, Am. Soc. Mech. E.; abstr. in Eng. Abstr., No. 31, April, 1927). (6.38/5882 U.S.A.)

The author describes an instrument for measuring static pressures in air flow determinations. This consists of two concentric tubes, closed at one end; the outer tube is $\frac{1}{4}$in. dia. and the inner tube $\frac{1}{8}$in. dia.; a small cylindrical radial connection is provided between the tubes near the closed end. In a plane at right angles to the axis of the tubes, and at an angle of $78\frac{1}{2}°$ to each other, two small holes are drilled radially, one through the radial connection between the tubes, thus communicating with the interior of the inner tube, and the other through the outer tube only, thus communicating with the annular space between the tubes. At the open end of the inner tube this annular space is closed, and near this end a hole is drilled in the outer tube and a short radial tube is inserted to provide means of connecting the annular space to two manometers, one connected between the annular space and the inner tube, and the other connected to the annular space only. In order to measure the static pressure at any section of an air duct through which air is flowing, the instrument is passed through a small hole in the air duct and is held at right angles to the direction of flow and with the two radial holes towards the impact side. The instrument is then turned slightly on its axis until the reading of the manometer connected between the annular space and the inner tube is zero. In this position the direction of flow bisects the angle between the two radial holes, and the reading of the second manometer gives the static pressure.

26 An Altitude Indicator for Aircraft

(La Nature, No. 2754, 5.2.27.) (6.336/5640 U.S.A. and Germany.)

The U.S. Army Air Corps and the Junkers Company are stated to have evolved independently electric devices for the determination of the height of an aircraft above the ground. Metal plates connected by a wire are mounted on the bottom wing tips. The two plates constitute one plate of a condenser, the other plate being the earth. The air between constitutes the di-electric. The capacity of this condenser is very low and increases as the aircraft approaches the ground. If the condenser is connected in an oscillating circuit, these variations in capacity can be used to produce a signal when the aircraft is within a short distance from the ground, so that the pilot is warned and can take action accordingly.

27 Lighting Equipment

Lighting of Air Routes (General Electric Co. Prelim. Bulletin G.E.A.216). (6.62/5705 U.S.A.)

This bulletin, which is well illustrated, describes the lighting equipment used on the U.S. Air Mail Service. The equipment dealt with includes 24in. Beacon, 4in. × 7in. Beacon, Boundary, Light fittings, Obstruction lights, Field lights, Flood lights and Anchor lights.

28 Flowmeters

Ewing Ball and Tube Flowmeter (J. H. Awbery and E. Griffiths, Procs. Roy. Soc. Edin., Vol. 47, Part I., page 1). (6.51/5894 Great Britain.)

The article describes the principle of the flowmeter and refers to the two most usual modes of motion of the ball; one in which it is quite steady in the tube, and one in which it chatters and vibrates from side to side of the tube. Calibration curves are given for these steady and turbulent motions of the ball in vertical tubes. The effect of inclining the tube is discussed, and curves are given showing the results of experiments with various fluids and spheres in a tube inclined at 45°.

An application of the dimensional theory to this flowmeter is developed.

The Metering of Fluids (H. Moren Brown, Ind. Chem., March, 1927; abstr. in J. Inst. Pet. Technol., Vol. 13, No. 61, April, 1927). (6.51/5888 Great Britain.)

This is a comprehensive survey of the methods available for the measurement of fluid velocity. An electrical method for estimating the flow when an orifice type of flowmeter is used is described. In outline the pressure difference is used to make a mercury column short-circuit a number of resistances which are placed in one arm of a Wheatstone's bridge. The flow may be observed from a galvanometer swing or a recording instrument may be used.

29 Oxygen Apparatus

Explosion of Liquid Oxygen Cylinders (Supplement to the Engineer, 29.4.27). (19.12/5829 Great Britain.)

The article refers to the explosion of an oxygen cylinder described in Le Genie Civil for 5th March, 1927. In discussing the failure, M. Fremont insists on the insufficiency of the ordinary hydraulic pressure test as applied to gas cylinders. In the case of a brittle steel containing numerous inclusions, the hydraulic test would show nothing and would give rise to a false sense of security, while the real danger lies in the development of creeping cracks within the steel.

It is considered that a test for brittleness applied to the steel, and especially a micro-ageing test, would afford a degree of security far greater than that offered by the hydraulic pressure test.

30 Hairsprings

Notes on the Manufacture and Properties of Hairsprings (H. Moore and S. Beckinsale; paper read before the Inst. of Metals and abstr. in Chemical News, 25.3.27). (6.731/5664 Great Britain.)

The function and essential properties of hairsprings and control springs are discussed. The respective merits and disadvantages of steels, ferrous alloys (*e.g.*, Elinvar) and non-ferrous metals and alloys as hairspring materials are indicated. To raise the elastic limit to the required degree, hardening by heat-treatment or by cold-working is necessary, but all hardening operations are liable to produce a state of imperfect elasticity detrimental to the spring. The use of low-temperature heat-treatments to restore elasticity after cold-working (drawing, rolling, and the coiling of the spring) is described. Steel hairsprings are subject to corrosion, but Elinvar is highly resistant. Some details of the manufacture of phosphor-bronze and other hairsprings are given, and the selection of material for hairsprings required to have a low electrical resistance is discussed.

MATERIALS

31 Characteristics of Metals (Ferrous and Non-Ferrous)

Metals for Service at High Temperatures (H. J. French, Chem. and Metal Eng., 33, pp. 591-595, October, 1926; extract of paper read before the Am. Chem. Soc., Washington, October, 1926). (10.17/5681 U.S.A.)

The chemical compositions are given of a large number of alloys which have been found suitable for the most severe service at high temperatures. High tungsten-chromium steels retain a relatively high degree of hardness up to 1400°F. as well as strength, but scale rather heavily. The low carbon, high chromium steels are more resistant to scaling, but soften at the higher temperatures. High chromium steels appear to be suitable for resisting stresses and erosion in steam and gas turbines. Aluminium, although very resistant to hydrogen sulphide at high temperatures, is very soft and can carry but little load at about 480°F. and higher. The nickel-chromium-iron alloys (60 per cent. nickel, 12 per cent. chromium) have been used with success in the production of ammonia. The addition of hardening elements such as carbon or tungsten to these alloys increases their temperature hardness and strength, but also reduces their malleability, so that there are greater possibilities in castings rather than in the wrought metal for the most severe requirements.

Intercrystalline Corrosion of Metals (H. S. Rawdon, Ind. and Eng. Chem., Vol. 19, No. 5). (10.27/5876 U.S.A.)

This article, which is well illustrated, consists of a review of the information available on the intercrystalline corrosion of various metals. When due to corrosion alone, this phenomenon can usually be related to some structural features peculiar to the metal under observation and to its composition. In a few cases, however, such as the corrosion embrittlement of pure lead, a relationship of this kind has not been established, and in the embrittlement of duralumin the evidence is said to be largely indirect.

In general, any practical remedy for the trouble must be along one of two lines. The stress acting on the metal, whether internal or externally applied, may be reduced considerably below the yield point of the metal. Most of the short-time laboratory tests have shown that in order to produce failure within a reasonable time in the laboratory the metal must be stressed close to its yield point. The practical solution of the problem of corrosion cracking in wrought brasses and other copper alloys has been along this line. The other method is to reduce the corrosive attack either by protective coatings, as in the case of duralumin, or by preventing so far as possible the formation and accumulation of the corrosive solution, as in the treatment for the prevention of "caustic embrittlement" of boiler plate. There appears also to be a possible third solution applicable in certain cases, which depends upon a change in the structural conditions in the alloy, particularly as related to the grain boundaries, by suitable heat-treatment or possibly other processes.

Electrolytic Coatings for Aluminium and Light Alloys: their Adhesion and Resistance to Corrosion by Sea Water (J. Cournot and J. Bary, Compt. Rend., No. 19, 8.11.26). (10.27/5849 France.)

The authors have investigated electrolytic deposits of cadmium and cobalt and chromium on aluminium and duralumin after a preliminary coating of copper. The direct coating of aluminium with cadmium was also obtained. The compositions of the electrolytic baths and the conditions of the deposits at the conclusion of the experiments are given.

The degree of corrosion on aluminium and duralumin for various platings are described. In certain instances an interesting hardening of the surface due to the deposit was observed: the factors producing this phenomenon include both the characteristics of electrolysis and the specific hardness of the metal deposit.

Test of Alloy Steels for Strength and Hardness (D. Meyer and M. Sayffert, F.V.D.I., No. 247, pp. 38). (10.12/5884 Germany.)

Sixty-three special steels were supplied covering a large variety of composition and heat treatment. Forty-eight micro-photographs record the grained structure. Ordinary yield tests were made. A method of test of strength under repeated blows and a method of test of hardness by pressing a hard steel sphere into the material are described.

The figures are tabulated to show the relation between the test results. A large number of graphical records show the properties of different steels, the effects of treatment, and the relations between the results of different tests.

Relation between Rockwell and Brinell Numbers (S. N. Petrenke, Bur. St. Tech. Paper, No. 334). (10.11/5696 U.S.A.)

Comparative Rockwell and Brinell tests were made on a great variety of ferrous and non-ferrous metals.

The theoretical relationships between the Brinell and the Rockwell numbers may be expressed by the equations

$$\text{Brinell number} = \text{constant}/130 - \text{Rockwell ball number.}$$
$$\text{Brinell number} = \text{constant}/(100 - \text{Rockwell cone number})^2.$$

The experimental values of Brinell and Rockwell numbers were inserted into these equations and the constants determined. These theoretical equations with the experimentally determined constants may be used to estimate, within an error of plus or minus 10 per cent. the Brinell number from the Rockwell number.

Stainless Steel (Iron Age, Vol. 118, No. 19). (10.12/5667 U.S.A.)

The properties of certain low carbon chromium-iron alloys, commonly known as stainless steels, are discussed. The article describes tests carried out to determine the suitability of these alloys if used in the construction of fuel and oil tanks for aircraft. The article includes a comprehensive table giving the mechanical and corrosion properties of a number of stainless steels.

Magnetic Permeability of Iron and Magnetite in High Frequency Alternating Fields (G. R. Wait, Phys. Rev., Vol. 29, No. 4). (10.16/5697 Great Britain.)

Relative values of the permeability of cast iron filings, iron wires and iron powder in high frequency magnetic fields. Wwedensky and Theodortschik have found the magnetic permeability of iron, steel and nickel in alternating fields to be abnormally large in certain frequency bands (at about 100 metres for iron) and nearly normal in other regions. The general appearance of the phenomenon suggested the existence, in the material, of resonators corresponding to these frequencies. Two experimental methods have been followed in the present investigation, one the resonance method and the other the heterodyne method. Both utilised, in principle, the measurement of the change in inductance of a coil due to the introduction of the sample of material into it. The results are in disagreement with those of Wwedensky and Theodortschik and with those of Kralovec. No anomalous change in permeability was found at any frequency.

32 X-Ray Testing of Metals

Rotation Method of X-Ray Crystallography (J. D. Bernal, Procs. Roy. Soc. 113, pp. 117-160, 1.11.1926—abstr. in Sc. Abstr. A., Vol. 30, Pt. 4, 25.4.27). (10.63/5838 England.)

An important paper giving the first account in English of general methods of interpretation of X-ray, single crystal, rotation photographs. The Ewald

reciprocal lattice and the geometrical law of this lattice corresponding to the Bragg law of X-ray diffraction in crystals are discussed; the interaction of the reciprocal lattice with homogeneous X-rays is analysed; the determination of the size of the true unit cell, and the determination of the indices of the crystal plane from the position of the reflected ray upon the photographic plate or filter are explained; and the requirements of a spectrometer, with which reliable results can be obtained, are stated. A special feature of the paper is the number of transparent charts which very considerably reduce the numerical calculations normally required.

The Application of Rontgen Rays to the Testing of Materials (G. Sachs, Z.V.D.I., 70, 1634-1640, 1926—abstr. in Chem. Abstr., Vol. 21, No. 6, 20.3.27). (10.63/5839 Germany.)

This is a discussion of the principles of X-ray reflection from crystal lattices, and a description of the methods of application of these principles to the examination of metallic substances, either for crystal structure or as a means of determining chemical composition. Characteristic rontgenographs are shown, and several types of apparatus are described and illustrated.

33 *Welding*

Tests in Connection with Gas and Metal Arc-Welding as applied to Aircraft Construction (H. B. Hird, Am. Soc. Nav. Eng.—abstr. in Eng. Abstr., No. 31, April, 1927). (10.18/5867 U.S.A.)

The tests were carried out on plain steel tubes, steel tubes arranged as branches and steel sheets made from mild, chrome-vanadium, nickel and chrome-molybdenum steels. The tubes ranged from $\frac{3}{4}$in. to $1\frac{1}{2}$in. dia. and from 17 to 22 gauge. The heat treatment applied after drawing and before welding is not described. The author states that the thermal effect of gas and metal arc-welding decreases the ultimate strength of all classes of steel by about 20 per cent. for both gas and metal arc-welds. The reduction is about 28 per cent. if the head is ground off, but this may be due to a reduction in cross section during grinding. Unannealed gas and metal arc deposits of weld metal or branches welded to a tube tend to stiffen the tube locally, counteracting to some extent the thermal effect of welding. The thermal effect of an unsymmetrical deposit of weld metal on a tube does not affect the ultimate strength of a tube to a greater extent than a symmetrical deposit. The metal arc-welding of tubes directly to another tube of similar size and gauge is not satisfactory when the branches are subject to a high tensile stress, as the main tube is liable to split at half its ultimate tensile strength. In order to obtain a tee-joint having a high tensile strength at right angles to the tube to which the branch is welded, it is necessary to reinforce the tube with a gusset plate of sheet metal through the tube and extending into the branches. Mild, nickel and chrome-molybdenum steel tubing can be welded satisfactorily by either process if the gauge is not less than 20. Metal arc-welding is as satisfactory as gas welding for aeroplane construction, and has the advantage that warping is much less than with gas welding. Arc-welding machines should have an open circuit voltage of 55 volts, with a current range of 10-18 amp. by increments of 2 amp.

Welding in Aeroplane Construction. A Fundamental Investigation (A. Rechtlich and M. Schrenk, 69th Report of the Deutsch. Versuchsanstalt, Berlin, Z.F.M., 28.1.27, pp. 41-47). (10.22/5786 Germany.)

Distrust of welding in the past was due to lack of uniformity in application. A brief mention is made of hydrogen. The acetylene flame is analysed and the effect of various chemical substances is discussed (C. Si, Mn, P, S, Ni, Al, Cr). In Part II. systematic tests are laid down for laboratory and workshop. Numerous references to other papers are given.

34 Glass

New Resistant Glass (Ind. and Eng. Chem., Vol. 19, No. 5, May, 1927). (10.51/5877 Germany.)

A glass that is said to withstand pressure, heat and acids better than any yet known is being processed successfully in Germany. It was first used for the manufacture of glass tube water gauges and glass bars. The newest tubes produced by this method will sustain a cold water pressure of 20, 45, 65, 80 and 100 atmos.

35 Fabrics

Standard Methods of Applying Fabric to Aerofoils (C. J. Cleary—McCook Field "Slipstream," Ohio, Vol. 8, No. 2). (10.41/5639 U.S.A.)

The article describes and illustrates methods of applying the main fabric, reinforcing tape, lacing cord and surface tape. The general requirements relating to moisture content and the protection of metal parts is discussed.

The Absorption of Water by Cotton Mercerised with and without Tension (A. R. Urquhart, J. Text. Inst., 1927, Vol. 18, No. 2, pp. 155-72—abstr. by L.I.R.A.). (10.41/5855 Great Britain.)

In previous work with loose cotton it was found that the curve showing the relation between the hygroscopicity of mercerised cotton and the concentration of the mercerising solution were of similar form to those representing the swelling of cotton hairs in solutions of sodium hydroxide. This result has been confirmed in the present research on yarns mercerised with and without tension, the differences observed being explainable in terms of the effects of tension. It is also found that the changes in the absorptive capacity of cotton brought about by mercerisation are very similar for all the varieties of cotton examined. The applied tension acts in opposition to the swelling forces, so that the absorptive capacity of cotton mercerised with tension is considerably less than that of cotton mercerised loose. Some figures for technically mercerised materials are given for comparison with those of the laboratory preparations.

Testing of Yarns (American Dye-Stuff Reporter, 1927, 16, 7-14—abstr. by B.C.I.R.A.). (10.41/5708 U.S.A.)

This paper refers to a lecture on the practical application of physical tests to determine the effects of chemical or other treatments on yarns. The measurement of the length of a sample of yarn, the requisite number of tests and the effect of the moisture content of the samples are discussed with reference to actual examples. On the question of strength measurements the author is of the opinion that continuous load extension curves are unnecessary for ordinary comparative results and he himself uses, in conjunction with a Baer single thread tester, sliding wedges of board arranged to arrest the motion of the falling weight at any desired position, extra hooks being applied to take skeins of the full length or such skeins doubled. Elongations are recorded as units of length.

Substitute for Gold Beaters Skin (Aviation, Vol. 22, No. 18, page 928). (12.63/5824 U.S.A.)

A new fabric is said to have been developed which is lighter in weight and of lower permeability than the gold beaters skin fabric. The raw materials are available in unlimited quantities and the cost of manufacture is less than that of gold beaters skin. It is stated that the production of this fabric has passed the laboratory stage and samples have been made successfully on factory scale. The manufacture of full-size experimental gas cell is in progress.

36 Woods

Collected Tests on Timber.—Material Testing Laboratory, Technical High School, Stuttgart (R. Baumann, F.V.D.I., No. 231, pp. 139). (10.31/5883 Germany.)

I. Test methods and appliances for bending, pressure, tension, torsion, impact, hardness. Adhesives and micro-structure.

II. Numerical results for 28 different kinds of timber for selected specimens free from faults are tabulated.

III. Influence of dimensions on results.

IV. Relations between compression, tension, bending and torsional rigidity.

V. Influence of the direction of the grain.

VI. Influence of the condition and treatment of the timber. Difficulties arising from lack of uniformity, variable density. Diseases of timber.

VII. Tests on adhesives.

VIII. Laminated test pieces.

IX. Nomenclature and description.

There are 221 photographs and micro-photographs.

Himalayan Silver Fir and Aeroplane Construction (Nature, Vol. 119, No. 3002, p. 728). (10.31/5823 India.)

The article refers to the Indian Forest Research Institute Bulletin, No. 69, Economic Series No. 26. It is estimated that the existing mixed spruce and silver fir forest could supply a sustained annual yield of more than two million cubic feet; the best localities are enumerated in the bulletin. Investigations were carried out to ascertain the strengths of the two timbers for aeroplane and other construction. Incidentally, it was found that spruce red wood, which is simply the darker, denser material near the central lower portion of the tree trunk, is in no way inferior to spruce white wood, when taken from healthy living trees. Tests have demonstrated that the timber of silver fir is stronger than spruce, and that this is also the case in some parts with the European species of these genera.

Tests have shown that the Himalayan spruce and silver fir are at least as durable as, and stronger than, the corresponding species of Europe and America. Himalayan silver fir has proved to be stronger than Sitka spruce.

37 Rubber

Commercial Possibilities of Rubber Electro-Deposition Process (J. W. Schade, J. Soc. Autom. Eng., Vol. 20, No. 4, April, 1927). (10.52/5837 U.S.A.)

Advantages possessed by anode-deposited rubber are superior ageing properties, reduction in the quantity of material used, applicability to the process of dispersed reclaimed rubber, reduction in size of plant and size and cost of equipment needed, lower labour and power costs, and reduction in waste of material.

The process will be applicable, it is stated, to the various processes of the present rubber factory, such as making continuous rubber sheet, forming continuous tubes in long lengths, impregnating fabric with rubber throughout its structure, part way through, or on one surface only, coating metal with a tightly adhering coat of rubber, forming rubber articles of various shapes with uniform wall thickness or with varied thickness, and making rubber sheets that are thinner than the thinnest that can be calendered.

Electro-Deposition of Rubber (S. F. Sheppard, J. Soc. Autom. Eng., Vol. 20, No. 4, April, 1927). (10.52/5836 U.S.A.)

A brief description is given of the nature of rubber latex together with a review of its physico-chemical properties. The nature of the rubber particles and of rubber after coagulation of the particles is described and the method of rubber plating is explained.

The deposited rubber can be given almost any desired cure by vulcanisation by varying the proportions of sulphur, fillers and accelerators in the mixture. Any stage of softness and elasticity up to that of hard rubber can be secured. Ultra-accelerators may be used which speed up the process at ordinary temperatures to such an extent that they cannot be blended on the rubber rolls.

Any available dyes can be used for colouring the product in the process of deposition, and a grain finish can be given mechanically while the rubber is in a plastic state before it is completely dry, or a natural grain may be left. Ageing properties of the electro-rubber are superior to those of rubber made in the usual way.

ARMAMENT

38 *Guns*

Swedish Aeroplane Machine Gun (Sven. Dag., 23.5.27). (9.14/5859 Sweden.)

Lt. Lars Landin, of the Smaoland Artillery Regiment, and Per Lundgren, Chief of the Jonkoping Fire Brigade, have applied for a patent for a new machine gun which differs from existing types mainly in the mechanical drive which is hydraulic, extremely simple and has a very high degree of precision.

Tests of a model machine gun were recently carried out at Jonkoping and it was found that the precision with which the machine gun fired was the same, whether a single round or a burst of 20 rounds were fired. The machine gun is synchronised for firing through the propeller.

39 *Anti-Aircraft Gunnery*

The Problem of Directing Anti-Aircraft Artillery (Dr. F. Sandkamp, Major a. D., Die Luftwacht, Feb., 1927, pp. 69-79).

The author discusses Oberstleutnant a. D. v. Keller's papers—Artill. Monatsheft, Sept./Oct. and Nov./Dec., 1926, and Luftnachrichtenblatt, No. 10, Oct., 1926. The problem is one of elementary spherical trigonometry when tables of trajectories at all elevations and ranges are available. Von Keller introduces simplifying approximations based on the assumption that the observed angular displacement of the aircraft is less than 10° of the anti-aircraft battery. Three readings must be taken and reduced to gun setting angles, the time being given as 15 secs. down to 10 secs. in favourable cases for loading, sighting and firing. But in 1918 the "Schonian" anti-aircraft director required only $5\frac{1}{2}$ seconds for the cycle. The author admits the value of v. Keller's work, but puts forward the advantages of a sighting circle, replacing the usual bead sight. More accurate methods are to be "mechanised" for rapid reduction to meet the greater heights and higher speeds of aircraft. The probability of a hit is given by v. Keller as proportional to the fifth power of the ratio

operating time ÷ trajectory time/operating time ÷ trajectory time − constant.

Anti-Aircraft Progress in U.S.A. during 1926 (Army Ord., Vol. 7, No. 41). (15.21/5814 U.S.A.)

This article is a review of experiments carried out during 1926 with anti-aircraft guns. An anti-aircraft data computer and a stereoscopic height finder are illustrated in the article. The results of tests are given in graphical form.

40 *Probable Errors in Bombing and Anti-Aircraft Fire*

(H. B. Hedrik, Coast Art. J., Vol. 66, No. 4.) (9.33/5875 U.S.A.)

The author assumes the usual form of the probable law, and proceeds to make a mathematical analysis of probable errors of bombing and anti-aircraft fire. Tables are given for various conditions.

41 *Forms and Deformations of Explosion Waves*

(T. Vautier, Compt. Rend., 183, 1335; abstr. in Eng. Abstr., No. 31, April, 1927). (9.61/5870 France.)

The form of explosion waves from the discharge of a pistol in a cylindrical water conduit was investigated by the author's interference method. The wave was reflected backwards and forwards in such a manner that it passed before the interferometer several times. In general the time-pressure curve is broken or discontinuous, rising very suddenly to a peak, at its first few passages before the interferometer. Afterwards, it gradually becomes a smoother curve, with a lower peak and a greater distance from front to peak; also, the velocity of the wave decreases gradually to a limiting and constant value. This is illustrated by the graphs obtained. The distance from front to summit is also plotted against the distance travelled, *i.e.*, against the number of times the wave has passed the interferometer.

42 *The Resistance of Rapidly Moving Bullets in Water*

(Ann. der Phys., Vol. 82, No. 7, page 1014). (9.16/5857 Germany.)

In Annalen der Physik, Vol. 80, pp. 232-244, reference was made to Bauer's experiments on the resistance of rapidly moving bullets in water, and it was stated that the resistance coefficient in water was substantially that which would be given by exterpolation from Prandtl's experiments on the resistance of bullets in air. The journal referred to above now publishes some remarks by the same author in which it is stated that this comparison is not a sound one, unless the forms of flow are substantially the same in the two cases. Reasons why this cannot be legitimately assumed are given.