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AIRCRAFT ENGINES, FUELS AND LUBRICANTS

1 Fuels and Lubricants

Tests of Makhonine Fuel on Civil Aviation Aircraft. (L'Aeronautique, No. 93, Feb., 1927.) (8.51/5962 France.)

This article is a full report of tests on Makhonine fuel carried out by the Air Union and the C.I.D.N.A., using Salmson C.M.9. 260 h.p. engines. Both these companies started with bench tests in order to find out the proper adjustment and to permit of comparisons being established with the performance on petrol. The total duration of flying tests carried out by the Air Union was five to six hours. -The engine was started on petrol to warm up the engine to 75° C. Difficulties were experienced at first; means of heating the fuel had to be devised and a strainer had to be fitted in the tank to eliminate the trouble due to black deposits in the fuel choking up the filters. The tests were carried out with Zenith 55 DC, Zenith 60 DS and Claudel C-7 R carburettors. The total duration of the flight tests carried out by the C.I.D.N.A. was about ten hours. The fuel does not appear to foul the engine; on the contrary it would seem to act as a decarboniser. The tests showed that a special carburettor should be developed for this fuel and the composition of the fuel was neither constant nor stable.

It is concluded that although complete success cannot be claimed for Makhonine, the tests warrant continuation of the work of development.

Safety Spirit for Aero Engines. (A. Grébel, Le Génie Civil, 16/4/27, XC., 16.) (8.51/6112 France.)

In this, the 3rd and last instalment of an article bearing the above title, the writer deals with "white spirit," solvent naphthas and coal tar derivatives. The author quotes reports by MM. Dumanois and Le Grain, of bench and flight tests carried out with white spirit 130°-180° and with a "safety" spirit 140°-205°, a non-backfiring Le Grain carburettor being used in the latter case.

The author concludes that for successful use of fuels of low volatility it is necessary to improve the ignition systems so as to obtain absolutely reliable ignition, and since heating of the carburettor is essential with heavy fuels so that the risk of the fuel becoming ignited by back-firing in the carburettor still exists, to provide the carburettor with safety devices preventing back-firing.

New Cracking Process for the Production of Anti-Detonating Fuel. (W. D. Leamon, Motorwagen, 30/9/27, XXX., p. 595.) (8.512/7544 Germany.)

Reference is made to the Stellarene process of oil cracking where the reaction takes place mainly in the gauger phase. A fuel rich in olefines and naphthenes is obtained, possessing a high detonating point,

Modern Lubrication Theory. (E. Falz, Z.V.D.I., 18/7/27, LXXI., 25, p. 889.) (8.4/7036 Germany.)

This is a review of several articles by Falz on lubrication, the chief one having been published in *Maschinenbau*, 1927, VI., p. 213.

Special attention is paid to the effect of bearing deformation on increased friction. Colloidal graphite for running in is recommended. It is pointed out that minimum wear at the bearings does not necessarily occur under condition of smallest friction and that therefore the tests with machines of the Deely type must be applied with caution.

Carbon Deposits. (C. J. Livingstone, Nat. Petr. News, 6/7/27, p. 78—abstr. in *Autom. Abstr.*, V. 8, p. 253.) (8.44/7513 U.S.A.)

Oil from Gulf Crest Crudes left in the engine only half as much carbon as was deposited by those made from Mid-Continental blends or Pennsylvania distillates or blends.

It is concluded that the carbon found in an internal combustion engine is produced from that part of the oil which does not boil away from the inner surfaces of the cylinder head space at the prevailing temperature. Requisite viscosity has to be combined with ability to volatilise without cracking on the engine hot spots.

2 Thermodynamical Investigations—Dopes and Detonation

Low Temperature Oxidation of Hydrocarbons. (J. Stanley Lewis, J. Chem. Soc., July, 1927.) (8.514/7613 Great Britain.)

In an article on low temperature oxidation of hydrocarbons the author refers to the inhibiting action of tetraethyl lead. He states that the gumming of cracked spirit is attributed chiefly to the formation of peroxides of the "dienes" present. More than a year ago, two samples of cracked spirit were enclosed in glass cylinders; only one of them containing 1 per cent of tetraethyl lead; the author states that this still remains clear and colourless, whilst a thick gum has collected at the bottom of the untreated sample, which is now yellow.

These results seem to support Callender's statement that the action of the tetraethyl lead is to prevent the formation of peroxides. The conditions are, however, entirely different in the two experiments; in the one described above, the temperature is that of the room and the tetraethyl lead therefore remains as such; at high temperature it is decomposed and any negative action must be exerted by the lead itself.

A second experiment was carried out with two equal volumes of a light lubrication oil, contained in four separate flasks. No. 1 flask was heated to 250° with constant stirring and then cooled. It darkened rapidly and became almost opaque. No. 2 flask contained tetraethyl lead and during the same treatment underwent little change except in colour (light yellow to light reddish tint) but was otherwise quite transparent. The oils in Nos. 3 and 4 flasks, of which only the former contained tetraethyl lead, were exposed to sunlight for some weeks. The latter darkened gradually and the final appearances of these samples were identical respectively with those of Nos. 1 and 2, which had been heated. In all cases, a solid was deposited after several months' standing.

Lower Limit of Inflammability of Ethyl Alcohol, Ethyl Ether, Methyl Cyclohexane and their Mixtures. (Yoshio Tanaka, Yuzaburo Nagai and Kinsei Akiyama, Tokyo Imp. Univ. Aeron. Research Inst., Report No. 21, March, 1927.) (8.57/7234 Japan.)

The authors describe the results of their research on the lower limit of

inflammability of ethyl alcohol, ethyl ether, methyl cyclohexane and their mixtures in air. The limits were determined in a glass tube of 5 cm. internal diameter and 65 cm. long, in which inflammable mixtures were ignited from the top by electric spark. The theoretical flame propagation temperatures were also calculated from the lower limits.

The results showed that the lower limit of inflammability of ethyl alcohol, ethyl ether and methyl cyclohexane for open firing are 3.81 per cent., 1.93 per cent. and 1.15 per cent. respectively, and that the theoretical flame propagation temperature of methyl cyclohexane are nearly the same as those of paraffin hydrocarbons, showing that the naphthene ring has no effect on the theoretical flame propagation temperatures of hydrocarbons. It was also shown that in all mixtures examined in this research, Le Chatelier's rule holds well, the deviation being of much the same order as the experimental error.

Influence of Ethyl Bromide on the Limits of Inflammability of Hydrogen-Air Mixtures. (Yoshio Tanaka and Yuzaburo Nagai, Tokyo Imperial University Report No. 22, April, 1927.) (8.57/5963 Japan.)

The flame propagated by the upper limit mixture of hydrogen (the mixture of 71.2 per cent. of hydrogen and 28.8 per cent. of air) is calculated by the authors to have the temperature of 1090°C.

The experimental results are tabulated and fully discussed. It was found that the range of inflammability of hydrogen containing 1.3 per cent. of ethyl bromide is 9—51 per cent., about two-thirds of that of hydrogen, and the density of the mixture is 0.113 (the density of air is taken as unity), which is larger than that of hydrogen ($H=0.069$), but smaller than of helium ($He=0.138$). Thus it seems possible to make hydrogen less dangerous without much increasing the density of the gas.

Influence of Organic Bromine and Iodine Compounds on the Upper Limit of Inflammability of Hydrogen-Air Mixtures. (Yoshio Tanaka and Yuzaburo Nagai, Tokyo Imperial University Report No. 23, April, 1927.) (8.57/5964 Japan.)

The effects of the organic bromine and iodine compounds other than ethyl bromide on the upper limit of inflammability of hydrogen in air have been investigated. It was found that ethyl and methyl iodides had an effect of lowering markedly the upper limit of inflammability of hydrogen by nearly the same degree as ethyl bromide, and so the flame temperature necessary to activate the molecules of methyl and ethyl iodides to burn will be equal to that obtained for ethyl bromide. The effects of ethylene bromide, bromoform and methylene bromide were much less significant. It was therefore suggested that the extinctive effects of the bromine compounds on hydrogen flame do not depend on the number of the bromine atoms in the molecules, but on the chemical nature of the compounds.

Influence of Di-ethyl Selenide on the Limits of Inflammability of Hydrogen-Air Mixtures. (Yoshi Tanaka and Yuzaburo Nagai, Tokyo Imperial University Report No. 24, May, 1927.) (8.57/5973 Japan.)

Di-ethyl selenide acts more effectively than ethyl bromide, ethyl iodide, methyl iodide, etc., on narrowing the range of inflammability of hydrogen. The upper limit of inflammability of hydrogen is lowered markedly by the addition of a small amount of di-ethyl selenide and the lower limit of inflammability of hydrogen is also lowered slightly. The density of hydrogen containing 2.4 per cent. of di-ethyl selenide is 0.18 (density of air=1), little larger than that of helium. But the range of inflammability of this mixture is only 9.41 per cent., about a half of that of hydrogen (range of inflammability of hydrogen=9.71 per cent.),

The theoretical flame temperature necessary to activate the molecules of di-ethyl selenide to burn has been found to be $1,750^{\circ}\text{C}$., which is higher than that given for alkyl bromides or iodides.

The experimental results are fully discussed.

Influence of Hydrogen Selenide on the Limits of Inflammability of Hydrogen-Air Mixtures. (Yoshio Tanaka and Yuzaburo Nagai, Tokyo Imp. Univ. Report No. 25, May, 1927.)

The effect of hydrogen selenide on the upper limit of inflammability of hydrogen is very similar to that of di-ethyl selenide, except that the lowering effect of the former on the upper limit of inflammability of hydrogen is less than that of the latter.

It is noteworthy that, by the addition of 4 per cent. of hydrogen selenide, the lower limit of inflammability of hydrogen has been raised up to 12 per cent. of hydrogen. This is due to small heat of combustion of hydrogen selenide.

The flame temperature necessary for the activation of hydrogen selenide is $1,750^{\circ}\text{C}$., which is equal to that obtained for di-ethyl selenide. But the amounts of these selenides required to raise the theoretical flame propagation temperature of hydrogen from the initial value of $1,090^{\circ}\text{C}$. to $1,750^{\circ}\text{C}$. are not the same, namely, about 1 per cent. in the case of di-ethyl selenide and about 2 per cent. in hydrogen selenide; that is to say, the amount required depends on the nature of the positive atoms or atom groups combining with the selenium atom. This may be ascribed to the difference in the mean cross sectional areas of the molecules of the selenides and so to the difference in the probabilities that the molecules of the selenides will collide with the hydrogen molecules activated or being activated.

As the calculated flame propagation temperature of hydrogen sulphide is $1,040^{\circ}\text{C}$., it may also be concluded that the flame temperature, at which the molecules of a substance begin to be activated, is a function of the nature of the negative atom in the molecules and is independent of the nature of the positive atom or atom groups in the molecules.

Ultra-Violet Spectroscopy of Engine-Fuel Flames. (G. L. Clark and A. L. Henne, J. Soc. Autom. Eng., May, 1927, XX., p. 644.) (8.57/7488 U.S.A.)

Details are given of the method of control of the engine so that quantitative and reproducible measurements of detonation and comparisons with spectra can be made. Typical data are tabulated and photographs are shown of the free-burning flames of hydrogen, carbon monoxide, methane, gasoline in a blow-torch, and the like. The spectra of explosion and of detonation in the engine confirm earlier conclusions. By means of a synchronous shutter, the spectra of radiation during the four quarters of a stroke are obtained for straight-run gasoline under detonating and non-detonating conditions for the same fuel containing tetraethyl lead, aniline and iodine as knock suppressors and for cracked gasoline blends. The outstanding result is that, during detonation, the first quarter spectrum extends far into the ultra-violet; that of the second quarter, a somewhat less distance; the third and fourth quarters are characterised by very little radiation energy. During normal explosion, or when knock suppressors, irrespective of their chemical nature, are used in the engine under detonating conditions, the spectra of all four quarters have the same length and essentially the same intensity. Lead emission lines from tetraethyl lead appear only in the first quarter. These and other facts are considered in the light of theories of the mechanism of knock suppressors and inducers.

In the discussion following the paper the value of spectroscopic investigation of the fluid reactions in an engine is set forth, data to show that the ionisation theory is wrong are referred to, and an illustrated description of a theory of detonation is presented.

The Self-Ignition of Liquid Fuels. (K. Neumann, Z.V.D.I., Pt. 3, 1927.)
(12.81/7497 Germany.)

The author describes experiments using a cylindrical steel bomb into which the fuel was injected. The initial pressure and temperature in the bomb could be raised to 500 lb. per sq. inch and 700°C. respectively. The air could also be circulated at will by means of a fan so as to imitate engine turbulence. The fuel was injected under pressure at a definite instant and indicator records of the resultant combustion taken on a time basis. Experiments were also conducted on three solid injection engines. These were the Deutz 200 h.p. 4-cylinder, 300 r.p.m., the Junkers 2-cylinder, 120 h.p., 375 r.p.m., and the Koerting, two-stage ignition engine, 300 h.p., two cylinders, 160 r.p.m. The ignition was most rapid in the Junkers engine, owing to its high compression ratio and the extra turbulence created by the sloping inlet port. The author points out that a rapid ignition is intimately connected with a high rate of heat transfer between the heat and the air.

Detonation Characteristics of Petroleum Motor Fuels. (S. P. Marley, D. R. Stevens and W. A. Gruse, J. Soc. Autom. Eng., May, 1927, XX., p. 639.) 8.514/7437 U.S.A.)

An examination of the detonating qualities of 18 petrols was made by the authors, the methods used being those of direct engine tests and of chemical analysis. A single-cylinder lighting plant engine, suitably modified, and a direct reading detonation indicator were utilised and are described. The method of Morrell and Egloff was followed in the chemical analysis. This consists in determining the proportions of paraffins, naphthenes, unsaturated and aromatic hydrocarbons and calculating the aromatic equivalence of the hydrocarbons so found by the use of data compiled by Ricardo on the relative knock-reducing tendency of unsaturated hydrocarbons, naphthenes and aromatic hydrocarbons.

Experiments were made in which a constant proportion of one hydrocarbon of each class was added to a fuel, and the detonating tendency of the resulting mixture was determined by engine test. In general, the benzol equivalents calculated from chemical analysis did not agree satisfactorily with those found by engine test. In the absence of published data on the influence of volatility of gasoline fractions on detonating tendency, a straight-run mid-Continent fuel was fractionated into 18°F. fractions, and succeeding fractions were then added to the original fuel in fixed proportions. The distillation data and detonating tendencies of the mixtures are given. The work confirms the general belief that detonating tendency increases with rise in boiling point. The indications of the work are that petroleum gasolines of satisfactory anti-knock value are available, and that the detonating tendency of fuels is best determined by direct engine test.

Important written contributions on the relation of volatility to detonation, on comparison of detonation characteristics and on combustion experiments appear in the discussion.

Vibrational Movements which Occur during the Inflammation of Combustible Gases. (J. D. Morgan, Phil. Mag., 1927, III., pp. 1161-1166—abstr. in Chem. Abstr., XXI., p. 2790.) 8.514/7515 Great Britain.)

These experiments lead to the conclusion that "knocking" is due to the correlation of two factors, namely, the rate of generation of heat in the flame

front and the vibration frequency of the gas in the direction of travel of the flame. It follows that the tendency to "knock" can be reduced by reducing the rate of heat generation and this is apparently the object of those working on the chemical side of the problem. However, since the vibrations set up in the gas depend upon the length and size of the cylinder, a change in cylinder size or design and the igniting position may possibly neutralise the benefit available from the lower rate of heat generation.

Utilisation of Liquid Fuels. (P. Dumanois, *La Rév. Pétr.*, 3/9/27, 233, p. 9.) (8.514/7508 France.)

The author deals with the phenomenon of detonation and its prevention. He accepts the theory of Moureau and Dufraisse as to the action of dopes, but points out that the detonation can be as effectively controlled by suitable design. Even if detonation is no longer the limiting factor, the compression ratio is limited by the phenomenon of auto-ignition. For petrols this corresponds to a compression ratio of the order of 13 to 14. Hot spots in the engine, however, cause auto-ignition at a very much lower compression ratio. The author points out that high speeds of operation as well as high turbulence, by reducing the time of contact between gas and hot spot, reduce the tendency to ignite.

Mechanism of Uniform Movement in the Propagation of Flame. (H. F. Coward and E. G. Meiter, *J. Am. Chem. Soc.*, 1927, XLIX., p. 386—abstr. in *Fuel in Sc. and Prac.*, July, 1927, VI., 7.) (8.57/7072 U.S.A.)

The speed of uniform movement of flame in mixtures of methane with air and with artificial "atmospheres" containing 20.9 per cent. of oxygen, the remainder being argon or helium, was observed in tubes of various diameters for upward, horizontal and downward propagation of flame. The results indicate that, in this instance at least, the important factors which determine flame speeds are: (1) The heat developed in the flame and the heat capacities of the burnt and the unburnt mixture; (2) the rate of chemical reaction. The rate of transmission of energy from the flame, whether it be by conduction of heat or by some force of readily-absorbed radiant energy, is so rapid that little change in the flame speed is observed when helium (of high thermal conductivity and low absorption for radiant energy) is replaced by argon (of low thermal conductivity and with higher absorption for radiant energy than helium) the inert gas being present to the extent of about three-fourths of the whole mixture. Certain observations concerning the composition of the "maximum flame speed mixtures" of methane in various "atmospheres" lead the authors to suggest that the temperature coefficient of the rate of combustion of methane is comparatively small at flame temperatures.

Chemical Action in the Electric Spark Discharge—The Ignition of Methane. (H. F. Coward and E. G. Meiter, *J. Am. Chem. Soc.*, 1927, XLIX., p. 396—abstr. in *Fuel in Sc. and Prac.*, July, 1927, VI., 7.) (8.57/7074 U.S.A.)

The authors observed the amount of reaction which took place when a known number of sparks of strength just insufficient to produce general inflammation were passed through various mixtures of methane with air, and methane with oxygen. It was found that a spark from an induction coil will start the general inflammation of the most readily ignited mixtures of methane with air (8 to 9 per cent. methane) when it is of a strength sufficient to inflame just over 0.5 cu. mm. of the mixture at ordinary temperatures and pressures, and when it is discharged between bluntly pointed electrodes 0.5 mm. apart. Under the same conditions it was found that a condenser spark had to be capable of igniting 0.9 cu. mm. of the same mixture in order to start general inflammation. The

analysis of methane-air and methane-oxygen mixtures, through which a number of weak sparks had been passed, showed the presence of much carbon monoxide and some hydrogen, even in the presence of excess of oxygen. A discussion of the results leads to the conclusion that, in igniting an inflammable gaseous mixture, the electric spark acts principally, if not entirely, as a source of thermal energy.

Ignition of Gases, Pt. VI., Ignition by Flames—Mixtures of the Paraffins with Air. (N. S. Walls and R. V. Wheeler, J. Chem. Soc., Feb. 1927, p. 291—abstr. in Fuel in Sc. and Prac., July, 1927, VI., 7.) (8.514/7071 U.S.A.)

The minimum periods of time necessary for mixtures of methane, ethane, propane and n-pentane with air to ignite, when brought into contact with a small fully-aerated coal gas flame, were determined. The composition of the most readily ignitable mixture with each gas, as determined by the shortest time of contact with the flame for ignition, was found to correspond fairly closely with that in which the initial speed of flame is the most rapid. Ease of ignition, therefore, corresponds with the ability of the flame to travel through the mixture after the source of ignition has been removed. This is the same deduction as that drawn with respect to ignition by the impulsive electrical discharge, and a similar explanation, viz., that a certain minimum volume of an explosive nature must be burnt in order that there shall be a spreading of inflammation through it is advanced.

Velocity of Combustion and Gas Equilibria. (W. Allner, Z.V.D.I., 1927, LXXI., p. 411—abstr. in Fuel in Sc. and Prac., July, 1927, VI., 7.) (8.57/7070 Germany.)

This paper reviews previous researches on gas equilibria and the velocity of reaction in the flames of solid, liquid and gaseous bodies. Even at high combustion temperatures, the time of reaction has a finite value and cannot be neglected without some consideration. The time and the retarding of catalytic accelerating effects of the combustion space determine how far reactions at high temperatures approach equilibrium and how far such equilibrium is displaced on diminution in temperature. The headings of sections are: Gas equilibria in flames, flame temperatures, significance of time of reaction, velocity of reaction in the carbonisation and combustion of solids, and duration of reaction in the flames and explosions of gases.

Flame Propagation in Closed Cylinders. (G. R. McCormick, G. B. Upton, A. C. Davis and H. Diederichs, Cornell Univ. Eng. Exp. Sta. Bull., No. 8, 15/3/27, pp. 1-24—abstr. in Sc. Abstr. B., 25/7/27, XXX., Pt. 7.) (8.57/7213 U.S.A.)

In flame propagation in closed vessels it has been observed that an arrest in the velocity seems to occur when the wave front has travelled about two-thirds of the length of the vessel. Effects on this of variations in mixture strength and bomb dimensions forms the subject of the present investigation. The bomb used was a glass cylinder with C.I. heads provided with necessary valves, sparking plug and pressure recording diaphragm. Various acetylene-air mixtures were exploded at atmospheric pressure and temperature, and the progress of the flame and the rise in pressure recorded photographically. The flame front arrest was verified and found to be most pronounced in the case of non-detonating mixtures. An accompanying pressure arrest was also found to occur. These phenomena could be eliminated by turbulence.

The results of a number of tests are recorded and subjected to detailed analysis, account being taken of the flame front area, mechanical and chemical velocities, and changes in volume of the gas. These represent the phenomena

accompanying normal combustion, and it is intended to extend the investigation with reference to detonation.

3 Heavy Oil Engines

Development of Large Diesel Engines: Comparison between Single and Double Acting, Four-Stroke and Two-Stroke. (M. Gercke, Z.V.D.I., Pt. 3, 1927.) (12.81/7496 Germany.)

The author gives particulars of a series of modern Diesel engines varying in cylinder capacity from 200 to 2,000 b.h.p. Of interest is a table of mean intensity heat flow per square metre of cylinder wall. This ranges from 60,000 to 90,000 kilocalories per hour, depending on type. Two-stroke engines have a heat flow which is only approximately 60 per cent. greater than that of a four-stroke running at the same b.h.p. and m.e.p. The greater simplicity of the two-stroke design makes it possible to cope with this increase. The author favours the double acting two-stroke with the M.A.N. Scavenging system (scavenge and exhaust ports on same side as cylinder wall). This is the only system which can be considered for really large units of the order of 2,000 h.p. per cylinder. The single acting four-stroke still commands the field of simple small units 200-300 h.p. per cylinder. Intermediate powers are catered for by either double acting four-strokes or single acting two-strokes. In a subsequent discussion of this paper it was pointed out by Professor Magg that the author's conclusion would require modification when the question of supercharging was considered.

Relation between the Indicator and Torque Diagrams of Two-Stroke Compression-Ignition Engines and the Rotational Oscillations of their Shafts. (A. Schroder, Z.V.D.I., 12/3/27, LXXI., 11.) (12.81/5968 Germany.)

In this article the writer gives a short report of his paper accepted in 1926 by the Technical College of Berlin, bearing the above title and dealing with a method developed by the author on the basis that since all two-stroke compression ignition engines yield approximately the same indicator diagram (when working under the same load), the harmonic rotational forces of the same order must have the same phase displacement ϕ_n and the same amplitude ρ_n in all two-stroke compression ignition engines. Under these conditions, taking the ordinary indicator diagrams, ρ_n and ϕ_n can be represented as function of ρ_1 , which considerably simplifies the calculation of the influencing forces.

The author investigated the relation between the engine loads, the harmonic rotational forces and that between the crank angles in multi-cylindere engines and the harmonic rotational forces, and obtained nomograms containing all the values of ρ_n and ϕ_n as a function of ρ_1 necessary to determine the harmonic rotational forces. The investigations required the harmonic analysis of the torque diagrams for various degrees of loading for which a new method of analysis, based on the Fischer-Hinnon method, but much less complicated, was used with marked success.

The Design and Calculation of Cams and Valves for the Fuel Injection System in Diesel Engines. (Jatindra Nath Basu (Calcutta), Der Motorwagen, 10/5/27 and 20/5/27, Nos. 13 and 14.) (12.81/7526 India.)

The author seeks to develop a basis for the design of cams for the fuel injection system, suitable alike for large and small engines of the high speed or low speed types.

He takes valves both with spreader plates and spreader sleeves and four cams forms and examines the various factors entering into the efficiency of the cams, showing how they react on the indicator diagram.

Transmission and Removal of Heat by the Cooling System of Diesel Engines.
(Lt. W. Wakefield, U.S. Navy, J. Am. Soc. Nav. Eng., Aug., 1927,
XXXIX., p. 514.) (12.81/7542 U.S.A.)

The opinion is expressed by the author that the heat combustion in a Diesel engine is conveyed to the chamber walls wholly by radiation. The radiant heat being proportional to the volume, the depth of the flame becomes greater and greater per unit area of surface as the volume of cylinder size is increased. Experiments made on gas engines with polished combustion chambers show a perceptible increase in mean effective pressure and this is held to be a proof of the importance of the radiant part of the heat loss. The author goes on to analyse resultant heat flow from the wall to the water jacket and especial attention is given to the stresses set up by variations in skin temperature.

Factors in the Design of Centrifugal Type Injection Valves for Oil Engines.
(W. F. Joachim and E. G. Beardsley, N.A.C.A. Report No. 268.)
(12.81/7528 U.S.A.)

This research was undertaken at the Langley Memorial Aeronautical Laboratory, at Langley Field, Va., in connection with a general study of the application of the fuel injection engine to aircraft. The purpose of the investigation was to determine the effect of four important factors in the design of a centrifugal type automatic injection valve on the penetration, general shape and distribution of oil sprays.

The general method employed was to record the development of single sprays 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. Investigations were made concerning the effects on spray characteristics, of the helix angle of helical grooves, the ratio of the cross-sectional area of the orifice to that of the grooves, the ratio of orifice length to diameter and the position of the seat. The sprays were injected at 6,000, 8,000 and 10,000 pounds per sq. in. pressure into air at atmospheric pressure and into nitrogen at 200, 400 and 600 pounds per square in. pressure. Orifice diameters from 0.012 to 0.040 in. were investigated.

It was found that decreasing the pitch of the helical grooves and thus increasing the centrifugal force applied to the spray increased the spray cone angle considerably, although the percentage increase was much less in dense air than in the atmosphere. On the other hand, the spray penetration decreased with increase in the amount of centrifugal force applied. About twice as much spray volume per unit oil volume was obtained with a high centrifugal spray as with a non-centrifugal spray. The spray cone angle increased, and the spray volume to oil volume ratio and spray penetration decreased with increase in the ratio of orifice area to groove area. Maximum spray penetration was obtained with a ratio of orifice length to diameter of about 1.5. Slightly greater penetration was obtained with the seat directly before the orifice.

The High Speed Oil Engine. (H. F. Shepherd, Mech. Eng., Sept., 1927, XLIX.,
9, p. 991.) (12.81/7522 U.S.A.)

The author examines modern tendencies in oil engine design. The great discrepancy between aero engine and oil engine weights is caused by the following factors:—

1. Low speed range 600-900 r.p.m. against 1,600-2,000.
2. Low brake m.e.p. 75 lb. per sq. in. against 140.
3. Detachable heads and cast iron liners against closed heads and steel liners with valve seat in the forging and passage and guides in the head.

4. Flywheel against no flywheel.
5. Block engine frames for stiffness against sheet metal jacket.
6. Reasonable wear and safety factors and no organised servicing against a life of 40 to 50 hr. before the top overhaul and a major overhaul after four minor overhauls.
7. Salvaging after three to four major overhauls.

The Ignition and Combustion Phenomena of Diesel Engines. (Dr. S. Sass, Z.V.D.I., 10/9/27, LXXI., 37.) (12.81/7506 Germany.)

Early investigators of this phenomena considered that the fuel vapourised prior to ignition. The fuel vapour was also considered to split off hydrogen to which gas, an important role in the subsequent combustion, was attributed. Wollers and Ehmcke were the first to disprove this theory by extensive experiments at Kraus. Further evidence was obtained by the author by measuring the bulb temperatures of a hot bulb engine operating under various conditions. Whilst oil gases caused by the decomposition of fuel oils range in ignition temperature from 450 to 700, the engine could be operated faultlessly with bulb temperatures of the order of 300°C. Hydrogen has an ignition temperature of the order of 600°C. and therefore cannot enter into the ignition problem of the hot bulb engine. It is also considered highly improbable that the injected fuel has adequate time to gasify during the ignition delay period. Modern theory indicates that the liquid fuel ignites directly with the oxygen of the air forming peroxide. Experiments by Tauz and Schulte have shown that the ignition point depends very markedly on the pressure, whilst generally diminishing; in a few instances an increase of the ignition temperature with pressure was noted.

It is now certain that the fuels both during the ignition delay and subsequent combustion go through a large series of intermediate reactions before the final simple products of combustion are reached. In many cases hydrogen peroxide is formed.

The Light Supercharged Diesel Engine for Air Use. (E. A. Sperry, Mech. Eng., July, 1927, XLIX., 7.) (12.81/7480 U.S.A.)

The author discusses the present position of the Diesel engine, reviewing the various suggestions made to reduce its weight, including substitution of two-cycle for four-cycle working. The author examines the advantages obtained by high supercharging; he is of the opinion that there is a great aeronautical future for the compression ignition engine.

M.A.N. Solid Injection Engine. (Autom. Eng., July, 1927, XVIII., 230.) (12.81/7078 Germany.)

At the Cologne Exhibition of Transport Vehicles two forms of the M.A.N. solid injection engines were on view. Both engines have the same bore and stroke and develop 45 and 68 b.h.p. at 1,000 r.p.m. respectively. An independent fuel pump is provided for each cylinder and the fuel valves are the open nozzle type. The average fuel consumption at full load is .44 lb./b.h.p./hr. From comparative tests between 5-ton petrol and Diesel lorries the respective fuel consumptions were 191 lbs. and 131 lbs. per 100 miles. This is equivalent to a saving in weight of fuel of 27 per cent. and in cost of 73 per cent.

The Diesel Engine applied to Motor Lorries. (Prof. A. Naegel, Z.V.D.I., 26/3/27, LXXI., 13.) (12.81/7077 Germany.)

This article describes the Junkers opposed piston Diesel engine as applied to road traction. The engine consists of two opposed piston units side by side. In this way a short engine possessing a high degree of balance is obtained. The following are the leading dimensions of the engine:—Bore, 80 mm.; stroke

of each piston, 150 mm.; stroke volume, 3l; weight without flywheel, 280 kg.; normal speed, 1,000 r.p.m.; normal output, 45 b.h.p.

The upper piston carries a light alloy extension which acts as scavaging pump. The combined stroke volume of the scavaging pumps is 6.2 litres. The inlet ports are inclined so as to increase the turbulence of the air entering the engine cylinder. The article describes a full set of experiments carried out by Prof. Naegel on this engine. A fuel consumption of .4 lb. of gas oil per b.h.p./hr. could be maintained over a load ranging from 30 to 60 h.p.

Development of High Speed Diesel Engines. (P. M. Heldt, J. Soc. Autom. Eng., July, 1927, XXI., 1.) (12.81/7191 U.S.A.)

The author presents a short history of high-speed Diesel engine development, which includes mention of the main features of the following engines:—Junkers, Attendu, Sperry, Beardmore, Hindlmeier, Lang, Benz, M.A.N., Maybach, Peugeot and others. The engineering problems relating to Diesel engines for automotive use are then discussed, with emphasis on the factors of atomisation and distribution of the fuel in the air-charge, turbulence and airless fuel injection, including types of igniter suitable for engines equipped with an ante-chamber.

A New Form of Atomiser. (Z.V.D.I., LXXI., 40, 1/10/27, p. 1408.) (8.53/7547 Germany.)

Instability in a jet of fluid was produced by causing it to issue through special forms of orifices cut in a thin wall. By combining a rounded entry over part of the surface with square walls over the remainder, instability is reached soon after the jet leaves the surface and fine atomisation results even at low speeds. So far the jet has been applied for irrigation purposes.

4 Carburation and Ignition

Starting Ability of Fuels Compared. (J. Soc. Autom. Eng., July, 1927, XXI., 1.) (8.82/7079 U.S.A.)

Measured amounts of air and liquid fuel were supplied to an evaporating coil maintained at a constant temperature. The discharge tube from the coil was connected to a Pyrex glass bulb. The method of procedure was to vary the air fuel ratio so as to determine the leanest possible mixture which would produce an explosion in the bulb when fired by means of an electric spark lasting $\frac{2}{5}$ second. A large number of fuels were investigated with this apparatus. There appeared to be no difference in the limiting mixture ratio between cracked and straight run petrols.

Spark Plug Insulation. (A. S. Watts, Ind. and Eng. Chem., Oct., 1927, XIX., p. 1123.) (8.92/7541 U.S.A.)

The author describes experiments carried out at the U.S. Bureau of Standards on the Chemistry of Porcelain. These experiments led to the development of an artificial magnesium aluminium silicate containing approximately 10 per cent. magnesium oxide, 27 per cent. alumina and 63 per cent. silica. The author claims that this material is superior to any other spark plug insulator.

Recent Development in Aircraft Ignition Systems. (F. G. Shoemaker, J. Soc. Autom. Eng., July, 1927, XXI., 1.) (8.9/7080 U.S.A.)

The fundamental electrical and mechanical requirements of ignition equipments for aircraft engines are outlined. Various new types of battery and magneto ignition are described. Special consideration is given to high altitude conditions. The principles of shielding the ignition system to prevent inter-

ference with wireless is described. Several types of two-spark magnetos are illustrated and also a pivotless type of high speed breaker mechanism is described. In the author's opinion magneto design has not yet freed itself from the influence of motor car engineering practice.

5 Cooling Systems

Resistance and Cooling Power of Various Radiators. (R. H. Smith, N.A.C.A. Report No. 261.) (8.31/7180 U.S.A.)

Thirteen radiators of various types and capacities were given complete tests for figure of merit. Twelve of these were tested for resistance to water flow and a fourteenth radiator was tested for air resistance alone, its heat-dissipating capacity being known. All the tests were conducted in the 8×8-foot tunnel or in its 4 ft.×8 ft. restriction, the general arrangement and conditions of the apparatus, the observation intervals, the ratio of water flow per unit of cooling surface, the differential temperatures and the air speeds being the same for all tests. Also, for purposes of comparison, the L/D value of 6, which was assumed in the 1921 tests as the L/D of the airplane using the radiator, was also used in the more recent tests.

No attempt is made to enter upon the theory of heat dissipation. Only the actual test results are given and reduced to coefficient form. The precision of the tests as representative of full flights performance and the Navy tunnel performance of this radiator agree within about 3 per cent.

Heat Transfer between Water and Oil. (E. Heinich and R. Stueckle, Research Publication of the V.D.I., Pt. No. 271.) (8.43/7081 Germany.)

The experiments refer to the measurement of the heat transfer between water and oil, the water circulating inside tubes and the oil outside. The following points amongst others were investigated:—

1. Velocity of oil and type of motion.
2. Velocity of water and type of motion.
3. Influence of air contained in water.
4. The influence of temperature and viscosity of the oil.

Very complete experimental details are given and the results are embodied in a series of equations.

New Experiments on the Relation between the Loss of Heat and Surface Friction in a Pipe. (B. Del Nunzio, *Elettro.*, XIV., pp. 234-239—abstr. in *Eng. Abstr.*, No. 32, July, 1927.) (8.35/7483 Italy.)

In a pipe in which water is flowing above the critical velocity the formula of Reynolds, $H = R_0 (T_0 - t)/v$, is deduced. The results of Stanton, Soenneken and Taylor show how this formula must be modified. Although the exact relation between the loss of heat and the surface friction was studied for a long time, it was not determined; differences of 25 per cent. were found between the calculated and experimental results. In 1925 the (British) Aeronautical Research Committee obtained very consistent results with air. The author has devised apparatus for experiments with water. A brass tube about 0.5 cm. dia. and 0.18 mm. thick is carried axially in another brass tube of larger diameter by means of vulcanite discs closing the ends of the larger tube; the water flows through the smaller which is heated by a wire carrying an alternating electric current. In the experiments the length of the inner tube was 100 cm. (3.28 ft.). The temperature was determined by measuring the resistance. The space between the two tubes was exhausted of air and piezometer fittings were arranged in the experimental tube just within the vulcanite discs, and connected by glass tubes passing through the outside tube to a gauge. The heat lost per second by each

sq. cm. of area for 1° difference in temperature was found from the expression $I^2R/SJ(T_s - T_a)$, where I and R denote current and resistance, S the internal surface of the tube, J the mechanical equivalent of heat, and T_s , T_a the temperatures of the inner surface of the tube and of the water respectively. The results obtained verify G. I. Taylor's formula.

The Softening of Radiator Water. (Dr. Schulz, Z.F.M., 14/6/27, XVIII., 117 pp. 256-257.) (8.31/7033 Germany.)

Many radiator faults can be traced to incipient corrosion and overheating set up by the water depositing certain salts on evaporation. By softening the water these deposits can be avoided and increased reliability of the cooling plant results.

The Permutite system of water softening is recommended as being the simplest and cheapest, the cost for one average radiator installation working out at less than $\frac{1}{2}$ d.

6 Torsional Vibrations

On the Detrimental Effect of Fly Wheels in Producing Torsional Vibrations. (Dr. Fred, Vogt, Z.V.D.I., 27/8/27, LXXI., 35, p. 1221.) (8.22/7516 Germany.)

The case of a rotating shaft loaded with n flywheels is examined, one of the flywheels being actuated by means of periodic couple. From the general solution for the resultant amplitude of vibration for any one wheel the special case of a three-flywheel system is deduced, which is of importance when considering the driving of an electric generator by means of a Diesel engine, the engine flywheel being placed between the engine and the generator. Under certain conditions smoother running may be obtained without a flywheel, the torsional oscillations of the system with the flywheel in position being greater than that due to the degree of irregularity of the engine without flywheel.

Torsional Strength of Splined Shafts. (J. Soc. Autom. Eng., Sept., 1927, XXI., 3, p. 222.) (8.22/7523 U.S.A.)

The authors approached the question from a purely theoretical standpoint and showed by hydrodynamic analogy that the low elastic limit of the splined shaft may be readily accounted for by the high localised stress intensity at the sharp corners of the spline when the fillets there are omitted or made of small radius.

7 Mechanical and Heat Losses

Friction of Aviation Engines. (S. W. Sparrow and M. A. Thorne, N.A.C.A. Report No. 262.) (8.64/7215 U.S.A.)

The first portion of this report discusses measurements of friction made in the altitude laboratory of the Bureau of Standards between 1920 and 1926 under research authorisation of the National Advisory Committee for Aeronautics. These are discussed with reference to the influence of speed, barometric pressure, jacket water temperature and throttle opening upon the friction of aviation engines. It is concluded that: (1) Changes in friction due to changes in temperature of the air entering the engine are negligible. (2) Changes in friction which result from changes in atmospheric pressure are due primarily to changes in pumping loss. An approximate figure for the engines mentioned in this report is that the friction mean effective pressure decreases about one-tenth of a pound per square inch for each decrease of one centimetre of mercury in the barometric pressure. (3) The increase of friction resulting from a decrease in throttle

opening is due to the change in pumping loss. For the engines mentioned in this report, the change in friction mean effective pressure which accompanies a change in manifold suction of 1 in. (2.54 cms.) of mercury ranges from 0.20 pound per sq. in. obtained at an engine speed of 1,200 revolutions per minute to 0.39 at 1,800 revs. per minute. (4) For the range of speeds covered in this report, namely, from 1,000 to 2,200 revs. per minute, the friction mean effective pressure increases with speed, but ordinarily the percentage increase is less than the corresponding percentage increase in speed. At low engine speeds the friction mean effective pressure changes much less with change in speed and in some instances remains practically constant. (5) Friction depends upon the viscosity of the oil upon the cylinder walls, which in turn depends upon the temperature of the jacket water. (6) While theoretical considerations would lead one to expect an increase in friction with increase in compression ratio the evidence at hand indicates that this effect is slight.

The second section of the report deals with measurements of the friction of a group of pistons differing from each other in a single respect, such as length, clearance, area of thrust face, location of thrust face, etc. Results obtained with each type of piston are discussed and attention is directed particularly to the fact that the friction chargeable to piston rings depends upon piston design as well as upon ring design. This is attributed to the effect of the rings upon the thickness and distribution of the oil film which in turn affects the friction of the piston to an extent which depends upon its design.

Heat Transmission by Radiation from Non-Luminous Gases. (H. C. Hottel, Ind. and Eng. Chem., XIX., 8, p. 888.) (8.64/7510 U.S.A.)

The amount of heat transmitted from a gas to its boundary surface may be calculated when we know the gas and surface temperature, the gas composition and the shape of the apparatus. Examples are given, illustrating the methods for a series of different shapes of apparatus.

A full bibliography is given.

Experiments with Hydraulic Transmission Gear—System Schwartzkopff-Huuwiler. (W. Paner, Z.V.D.I., 25/6/27, LXXI., 26.) (8.84/7076 Germany.)

The tests were carried out in the Technical High School at Dresden on a 50 h.p. transmission gear. A complete analysis of the losses into friction and slip was undertaken and the effect of speed and oil temperature studied. An over-all efficiency of 80 per cent. could be maintained over wide limits of power.

8 Supercharging

Preliminary Flight Tests of the N.A.C.A. Roots' Type Aircraft Engine Supercharger. (A. W. Gardiner and E. G. Reid, N.A.C.A. Report No. 263.) (8.62/7533 U.S.A.)

An investigation of the suitability of the N.A.C.A. Roots' type aircraft engine supercharger to flight operating conditions, as determined by the effects of the use of the supercharger upon engine operation and airplane performance, is described in this report.

The supercharger has previously been described in N.A.C.A. Technical Report No. 230; the results of laboratory tests are also given there. The compressor has a displacement of 0.51 cubic foot per revolution and weighs 88 lbs.

The selection of a suitable airscrew and the provision of satisfactory intake ducts and adequate engine cooling were preliminary problems. The supercharger was first tested in a modified D.H.4 airplane with a 5.4 compression ratio Liberty 12 engine. Two sets of drive gears which enabled the maintenance of sea-level

pressure at the carburettor intake up to 12,000 and 20,000 feet were provided. The higher gear ratio supercharger was next tested in a DT-2 landplane, which was later converted to a twin-float seaplane; the DT-2 also had a Liberty engine. Loads up to 2,000 pounds were carried in the seaplane with normal and super-charged engines.

Attention was concentrated on the operation of the engine supercharger unit and on the improvement of climbing ability; some information concerning high speeds at altitude was obtained.

The supercharger was found to be satisfactory under flight-operating conditions. Although two failures occurred during the tests, the causes of both were minor and have been eliminated. Careful examination of the engines revealed no detrimental effects which could be attributed to supercharging.

Marked improvements in climbing ability and high speeds at altitude were effected. It was also found that the load which could be carried to a given moderate or high altitude in a fixed time was considerably augmented. A slight sacrifice of low altitude performance was necessitated, however, by the use of a fixed pitch airscrew.

From a consideration of the very satisfactory flight performance of the Roots' supercharger and of its inherent advantages, it is concluded that this type is particularly attractive for use in certain classes of commercial airplanes and in a number of military types.

9 Engine Design

The Effect of Combustion Chamber Design on Performance. (M. de Fleury, *Comp. Rend.*, 22/8/27, CLXXV., p. 446.) (8.514/7521 France.)

Combustion chambers of internal combustion engines can be divided into two extreme classes:—(1) Turbulent heads to speed up combustion; (2) anti-detonating heads which slow down combustion. The latter work either by successive expansion, stratification or internal cooling. Experiments are described by the authors using Alpax heads fitted with deep grooves so as to promote cooling of the charge. Such heads proved to be singularly free from detonating trouble even at high compression ratios.

A New Type of Split Crankshaft. (Motorwagen, 31/8/27, XXX., p. 531.) (8.22/7517 Germany.)

The article describes a crankshaft designed by Mr. Alfred Baer, characterised by the fact that the crank throw can be accurately orientated and then clamped. The clamping is brought about by means of cylindrical discs in which the crank throws are held by friction. For this purpose the discs are partially split and conical adjustment pins are fitted. Various types of crankshafts are shown in the article, the connecting rod in each case being fitted with a new type of roller bearing known as a "needle type." These roller bearings are characterised by their extreme lightness and compactness, the rollers only being a few mm. in diameter.

A Theory of the Torque Converter. (E. K. Sandeman, *Phil. Mag.*, No. 23, Oct., 1927, p. 800.) (5.452/7543 Germany.)

By means of electrical analogies the entire field of application of the torque converter has been surveyed to form a basis of future design.

Back Lash Eliminator. (Chem. and Met. Eng., XXXIV., 8, Aug., 1927, p. 509.) (8.64/7545 U.S.A.)

This interesting apparatus has been developed by the Bethlehem Steel Co. of America and has been applied to a range of machinery, varying from large

mechanisms involving great forces to small and delicate instruments. It operates to eliminate back lash in gear wheels, feed screws, bearings, etc., in short, wherever play occurs between moving members. It compensates for wear or for expansion due to heat and is perfectly automatic. The article describes the application of this back lash eliminator to a variety of purposes. In its simplest form the lock consists of a wedge shape member controlled by a spring and operating between two rollers.

Improvements in Aero Engines. (M. Martinet-Lagarde, *Revue de L'Aeronautique Militaire*, No. 39, May-June, 1927, pp. 59-68.) (8.0/7512 France.)

The author is of the opinion that a small bore cylinder operating at high speed is the line of future development. For civil aviation the fitting of two or more 12-cylinder engines of about 300 h.p. each, operating at approximately 2,000 r.p.m. offers the best solution. For higher horse-powers (500-600 h.p.) he suggests 18 cylinders operating at 2,000-3,000 r.p.m. and fitted with reduction gear.

The main cause of breakdown in existing power plant lies in the fuel system and carburettor. About 25 per cent. of all involuntary stoppages of military aircraft in France during 1926 were attributed to this source.

10 Cam Type Engines

Fairchild Caminez Engine. (Aviation, 4/7/27, XXIII., 1.) (8.12/7183 U.S.A.)

It is stated that this cam type aircraft engine, particulars of which have already been published in this country, is now being placed in production by its manufacturers. The first of the production type engine was recently subjected to a 50-hour test with satisfactory results.

AERODYNAMICS AND HYDRODYNAMICS

11 Fluid Motion

Study of Open Jet Wind Tunnel Cones. (F. E. Weick, N.A.C.A., Tech. Note 260.) (5.32/7539 U.S.A.)

Tests have been made by the National Advisory Committee for Aeronautics on the air flow in an open jet wind tunnel with various sizes, shapes and spacings of cones, and the flow studied by means of velocity and direction surveys in conjunction with flow pictures. It was found that for all combinations of cones tested the flow is essentially the same, consisting of an inner core of decreasing diameter having uniform velocity and direction, and a boundary layer of more or less turbulent air increasing in thickness with length of jet. The energy ratio of the tunnel was obtained for the different combinations of cones, and the spilling around the exit cone causing undesirable air currents in the experiment chamber was noted. An empirical formula is given for the design of cones having no appreciable spilling.

Flow of Air Behind a Plate. (A. Fage and F. C. Johnson, *Procs. Roy. Soc., CXVI., A.773*, pp. 170-197.) (5.32/7552 Great Britain.)

The authors explore the periodic detachment of vortices behind a flat plate in a wind channel with hot wire instruments. Extensive experimental work was carried out with the full resources of the N.P.L. The lengthy reductions for comparison with v. Karman's mathematical theory are not very satisfactory. From an added note the paper appears to have been presented some three months before attention was drawn by H. Glauert to the influence of vortex images in the channel walls which had previously escaped notice. With this reduction fair agreement with v. Karman was obtained.

The Similitude of Viscous Fluids. (L. Escande and M. Ricaud, *Comp. Rend.*, 1925, CLXXX., 18, pp. 1326-1328.) (5.32/7331 France.)

Sets of experiments were carried out to test the principles of dynamical similarity.

I.—At small velocities the configuration of flow satisfied Reynolds' criterion for a variation of the coefficient of viscosity in the ratio 300:1. This suggests a method of determining the undetermined viscosity of a fluid by comparison with the flow of another fluid of determined viscosity.

II.—If the two-third power of the ratio of viscosities is equal to the scale ratio λ then volumes in the ratio λ^3 flow out of a reservoir in times proportional to $\lambda^{\frac{1}{2}}$.

III.—The author states that the configuration of flow is unaffected by viscosity if the flow is irrotational everywhere. (Stokes gave a correct general statement (*Papers* Vol. III., p. 73, 1850), showing that if certain boundary conditions are impressed, the work done on the boundary makes good the dissipation and maintains an initially irrotational configuration of flow unaltered. Excepting in the case of the flow of fluid between coaxial circular cylinders, these boundary conditions are impracticable. Note by translator.)

Motion of (Viscous) Fluid in a Sinuous Channel. (W. R. Dean, *Phil. Mag.*, *Apl.*, 1927, III., 7, pp. 912-924.) (5.32/7209 Great Britain.)

The problem is treated as two-dimensional throughout.

The sinuosity is arbitrarily defined by the assumption that the curvature of the centre line is a simple sine function of axial length, the radius of curvature being everywhere large.

The equations of viscous fluid motion are written down for the case of constant curvatures and by means of simplifying approximations are adapted to the case under consideration. Numerical solutions of the simplified equation are found by expansion in series with complex coefficients. In two examples it is necessary to proceed to the twelfth and twenty-fourth terms respectively. For "slow" motion a streamline through a node in the centre line is found to be a sine curve with the same nodes but decreased curvature. When inertia terms are introduced the alternate nodes only coincide and the curvature is greater or less in alternate half waves. Instability is discussed in a general manner with reference to the work of Rayleigh and Orr. The writer does not take into account the possibility of a type of instability in three dimensions to which the flow is actually more sensitive.

The paper shows that extensive analysis is required even for the simplest case.

Motion of Fluid in a Curved Pipe. (W. R. Dean, *Phil. Mag.*, July, 1927, IV., 20, pp. 208-223.) (5.32/7196 Great Britain.)

The equations of viscous fluid motion are transferred to ring co-ordinates, and after the introduction of various approximations, are solved for first order inertia terms.

The results are in remarkable agreement with the experimental results of J. Eustice (*Proc. Roy. Soc. A.*, LXXXV., pp. 119-131, 1911). The only serious discrepancy is attributed to variation in the cross section of the colour filaments injected.

New Suction Wing. (*Illustrierte Flugwoche*, 18/5/27, No. 8/9.) (5.32/5960 Austria.)

J. Mickl, an Austrian engineer, has designed a wing which contains ducts opening on the upper surface of the wing through which gas or compressed air is

expelled. The circulation about the wing is thus increased and the breaking away of the boundary layer is reduced (as in Lachmann's slotted wing). In this way it is possible even with very big angles of incidence to attain lift coefficients unattainable with normal wings owing to the breaking away of the flow. The special advantage of the Mickl type of wing is that it produces increased lift without any great increase of drag.

The Increase of Lift by Blowing Air along the Suction Side of a Wing. (Seewald F., 76th Report of the German Aerodynamical Institute, Berlin—Adlershof—Z.F.M., 16/8/27, XVIII., pp. 350-353.) (5.32/7330 Germany.)

A metal plate fixed near and parallel to the upper surface of the wing forms a flat nozzle with walls tangential to the wing surface. A sheet of air is blown out under pressures of 2, 3 and 4 atmospheres. At atmospheric pressure there is no blast, and the wing lift is very nearly that of the Göttingen 422 profile. The maximum lift coefficient and stalling angle increase systematically from 1.55 and 20° at atmospheric pressure to 3.35 and 28° at 4 atmospheres. This is held to prove "in a purely qualitative manner" that the circulation and lift are increased (in accordance with Prandtl's explanations), by the blowing away of the boundary layer. The hope is entertained that practical applications may be possible.

The Influence of Vortices upon the Pressure of a Fluid Flowing against a Cylinder. (W. Muller, Z. Tech. Phys., VIII., pp. 62-68—abstr. in Eng. Abstr., New Series, No. 32, July, 1927.) (5.32/7481 Germany.)

When an infinitely long circular cylinder is placed in a fluid moving with a uniform velocity, two vortices are produced behind the cylinder, symmetrically situated with respect to the direction of motion. These increase in strength and retreat from the cylinder until they finally cease to be symmetrical and are cast off from the cylinder and replaced by a new pair. The cast-off vortices arrange themselves in a quasi-stationary arrangement, described by von Karman as a "street of vortices." Using a formula derived by Lagally, the author calculates the effect of the vortex production upon the pressure on the cylinder. If the cylinder rotates, the conditions are unsymmetrical and only one vortex is produced, the conjugate one being imaginary, situated inside the cylinder. As a result of the unsymmetrical flow, the cylinder experiences a side pressure which, on an aerodynamical analogy, may be called the lift. The calculations show a parabolic relation between lift and pressure, which agrees with the results of experiments on a rotating cylinder at Göttingen. The treatment is extended to the case of a cylinder of finite length and the results are compared with experiments. The experimental cylinders were fitted with enlarged end plates and it appears that the agreement between the calculated and the observed values was improved by increase in the size of the end plates.

The Theory of the Joukowsky Profile. (O. Schrenk, Z.F.M., 28/6/27, XVIII., 12, pp. 276-284.) (5.32/7473 Germany.)

A clear exposition of the elementary theory of conformal transformation as applied to the circle and the Joukowsky profiles. A convenient table is given of the formulæ established.

12 Wing Design

Air Force Tests of Sperry Messenger Model with Six Sets of Wings. (J. M. Shoemaker, N.A.C.A. Report No. 269.) (5.31/7530 U.S.A.)

The purpose of this test was to compare six well-known airfoils, the R.A.F. 15, U.S.A. 5, U.S.A. 27, U.S.A. 35-B, Clark Y, and Göttingen 387, fitted to the Sperry Messenger model, at full-scale Reynolds' number as obtained in the

variable density wind tunnel of the National Advisory Committee of Aeronautics; and to determine the scale effect on the model equipped with all the details of the actual airplane. The results show a large decrease in minimum drag coefficient upon increasing the Reynolds' number from about one-twentieth scale to full scale. Maximum lift coefficient was increased with increasing scale for all the airfoils except the Göttingen 387, for which it was slightly decreased. A comparison is made between the results of these tests and those obtained from tests made in this tunnel on airfoils alone.

Drag of Wings with End Plates. (P. E. Hemke, N.A.C.A. Report No. 267.) (5.31/7529 U.S.A.)

In this report a formula for calculating the induced drag of multiplanes with end plates is derived. The frictional drag of the end plates is also calculated approximately. It is shown that the reduction of the induced drag, when end plates are used, is sufficiently large to increase the efficiency of the wing.

Curves showing the reduction of drag for monoplanes and biplanes are constructed; the influence of gap-chord ratio, aspect ratio, and height of end plate are determined for typical cases. The method of obtaining the reduction of drag for a multiplane is described.

Comparisons are made of calculated and experimental results obtained in wind tunnel tests with airfoils of various aspect ratios and end plates of various sizes. The agreement between calculated and experimental results is good.

Analysis of the experimental results shows that the shape and sections of the end plates are important.

The Effect of a Flap and Ailerons on the N.A.C.A. M6 Airfoil Section. (G. J. Higgins and Eastman N. Jacobs, N.A.C.A. Report No. 260.) (5.31/5972 U.S.A.)

This report contains the results obtained at the Langley Memorial Aeronautical Laboratory on an N.A.C.A. M6 airfoil, fitted with a flap and ailerons, and tested in the variable density wind tunnel at a density of 20 atmospheres. Airfoil characteristics are given for the model up to 48° angle of attack with the flap set at various angles, and also with the ailerons set at similar angles. The approximate lift distribution and the centre of pressure variation along the span are determined with the model at 18° angle of attack and with the ailerons displaced 20° . Approximate rolling moment and yawing moment coefficients are determined for the various aileron settings.

A comparison of the calculated angles of zero lift and the calculated lift and moment coefficients with those observed is given in the appendix.

Experiments with a New Type of Slotted Wing. (K. Willand, Z.F.M., 16/8/27, XVIII., 15, pp. 346-350.) (5.313/7329 Germany.)

The paper is a report on preliminary measurements made in the Physics Department of the University of Bale (1925), the work being still in progress.

In a model wing 90 mm. chord, 120 mm. span, and 15 mm. max. thickness, five equi-distant 1.8 mm. bores are drilled parallel to the slot under-surface and to the plane of symmetry, all meeting a transverse bore about $1/5$ chord from the leading edge and piercing the upper surface about $1/6$ chord from the trailing edge. Under suction air is drawn in from the boundary layer, while under pressure jets of air are blown out, more or less parallel to the flat under-surface. The velocity of the five jets is calculated from the ideal relation between pressure head and velocity, as 72 m/s. compared with a maximum stream velocity of $7\frac{1}{2}$ m/s. The experimental results show that suction increases both lift and drag sensibly, while the jets produced by pressure increase the lift markedly and

transform drag into thrust by a jet propulsion effect. The physical phenomena must be complicated, and the loose descriptive explanation (based on Prandtl's recent work) does not carry the solution very far. The use of Bernoulli's equation and other ideal relations gives a misleading appearance of simplicity.

The results are expressed inconveniently in gram weight instead of in non-dimensional coefficients.

Air Force and Moment for N-20 Wing with Certain Cut-Outs. (R. H. Smith, N.A.C.A. Report No. 266.) (5.31/7249 U.S.A.)

The airplane designer often finds it necessary, in meeting the requirements of visibility, to remove area or to otherwise locally distort the plan or section of an airplane wing. This report contains the experimental results of tests on six 5 × 30-inch N-20 wing models, cut out or distorted in different ways, which were conducted in the 8 × 8-foot wind tunnel of the Navy Aerodynamic Laboratory in Washington in 1924.

The measured and derived results are given without correction of Vl/v , or for wall effect and for standard air density, $p=0.00237$ slugs per cubic foot.

Systematic Investigation of Joukowsky Profiles. (O. Schrenk, Z.F.M., 28/5/27, XVIII., 10, pp. 226-232.) (5.31/7040 Germany.)

Five variations in thickness and nine variations in camber give 45 types, of which 30 are discussed.

The effects on profile resistance, maximum lift, lift in comparison with theoretical lift, etc., are given in 12 graphical representations, and a number of known relations between camber maximum lift and moment are illustrated.

Airfoil Lift with Changing Angle of Attack. (E. G. Reid, N.A.C.A. Techn. Note No. 266.) (7.3/7532 U.S.A.)

Tests have been made in the atmospheric wind tunnel of the National Advisory Committee for Aeronautics to determine the effects of pitching oscillations upon the lift of an airfoil.

It has been found that the lift of an airfoil, while pitching, is usually less than that which would exist at the same angle of attack in the stationary condition, although exceptions may occur when the lift is small or if the angle of attack is being rapidly reduced.

It is also shown that the behaviour of a pitching airfoil may be qualitatively explained on the basis of accepted aerodynamic theory.

Huguenard and Magnan Accelerograph. (Les Ailes, 2/6/27, No. 311.) (6.47/7039 France.)

M. Huguenard and Magnan have brought out an accelerograph for measuring the effects of the wing beats of birds. This accelerograph weighs 55 gr.

13 Spinning

Tail Spins and Flat Spins. (B. V. Korvin-Kroukovsky, Aviation, 18/7/27, XXIII., 3.) (7.14/7204 U.S.A.)

The article describes the ordinary tail spin and examines the influence of shape and arrangement of the wings on the speed and range of auto-rotation, and the effect of auto-rotation on the balance and controllability of an aircraft.

The following conclusions are given:—(1) The velocity of auto-rotation increases as the gap is decreased. (2) Positive stagger of sufficient magnitude prevents the auto-rotation, while negative stagger increases its violence. (3) Decalage was also found to have great effect on auto-rotation, particularly in

the case of positive stagger. As a rule the range and velocity of auto-rotation increase with the angle of incidence of the lower wing. (4) Washing out at the wing tips has a great effect on auto-rotation and can be used for prevention of the tail spin. (5) A tail spin occurs more easily and becomes more dangerous the farther aft the centre of gravity is located. (6) In all cases of a flat spin the machine went into a spin slowly and gradually over a period of several turns and settled down to a fast spin at a very large angle of incidence. (7) The flat spin appears to be the result of backward location of the centre of gravity (beyond 30 per cent. of the chord) combined with wing arrangement capable of very high speed and wide range of auto-rotation.

Accidents in "Figure Flying" and in Spinning with Suggestions for their Avoidance. (Joachim Von Koppen, Z.F.M., 14/7/27, XVIII., 13, pp. 297-299.) (7.14/7527 Germany.)

The author analyses the motion in a spin and the action of the various forces acting on the aeroplane, and shows how the forces tending to keep a machine's nose up in a spin should be overcome by prolonged steady action on the elevator, which should not be manoeuvred in a series of jerks. In a flat spin the power of the elevator is much reduced so that it must be kept fully raised for longer than in a steep spin. In the latter case it is recommended to accelerate the engine in order to obtain the advantage as regards elevator action of the accelerated slipstream, but in a flat spin this only increases the danger for some cause which is as yet unknown, but which may be that owing to the high angular velocity and small radius of turn, the elevator does not get the full benefit of the slipstream, or that with the low speed in a flat spin, the moment tending to depress the tail, which necessarily follows on every acceleration of the engine, predominates over the increase of speed.

AIRCRAFT DESIGN AND EQUIPMENT

14 General Design

Strength Requirements for Gliding and Sailing Aircraft. (A. Lippisch, Report of the Research Institute of the Rhon-Rossitten Society.) (5.26/7035 Germany.)

Rules and formulæ are given for ensuring the airworthiness of these types of aircraft. An interesting rule forbids natural periods of oscillation less than 100-120 per second.

Modern Fuselage Construction. (Civil Eng. Fischer. Flugwoche, 30/6/27, IX., 12.) (5.53/7086 Germany.)

An illustrated article showing details of the Junkers, Rohrbach and Dornier type of metal construction.

As a line of development for the smaller sizes of aircraft, a light alloy cast fuselage (without separate ribs) is foreshadowed.

Wear of Aeroplane Control Cables. (M. Abraham, 77th Report of the Deutsche Versuchsanstalt für Luftfahrt, Berlin-Adlershoff.) (10.14/7327 Germany.)

Cables and pulleys of various sizes in use are rigged on a testing machine so that any number of to and fro movements may be applied and counted under varying loads and conditions (inaccurate centring, etc.). Particulars of 21 pulleys in aluminium, steel and duralumin are given in tables and photographs. Tables and curves of test results are given showing the influence of the material of the roller, the accuracy of alignment, etc., on the number of reversals before

fracture. Photographs of fractured strands enlarged thirty times are reproduced. Rules are deduced for alignment, shape of groove, diameter, material and treatment.

Approximate Method of Determining the Statical Stability of a Monoplane. (A. Lippisch, Z.F.M., 14/6/27, XVIII., 11, pp. 251-256.) (7.21/7034 Germany.)

The wing profile is Göttingen 398, but the coefficient of moment of the wings as a function of the lift coefficient is taken as for Göttingen profile No. 389, and expressed by a linear algebraic relation approximately. The moment of the tail about the C.G. is also expressed as a function of incidence and induced velocity for rectangular and elliptic distribution of lift.

The two moments are added and simple formulæ obtained to the same approximation. These are applied to determine the area and distance of the tail surfaces, and the consequent range of stability is exhibited graphically and analytically.

Photogrammetric Process for Measuring Take-off and Landing Courses. (Paper read before XVth Meeting of the W.G.L., 16-20/7/26—published in *Berichte u. Abhandlungen of the W.G.L., Dec., 1926, No. 14.*) (5.341/5955 Germany.)

This paper describes a method of measuring the take-off of an aeroplane up to the instant when an altitude of 20 metres is reached by taking photographs with an ordinary plate camera or, in the improved method, a cinematographic camera, from a position directly behind the aeroplane. Taking a known dimension of the aeroplane in the direction of the lateral axis (span, wheel track, etc.), the dimension of the image on the plate and the focal length of the camera, it is possible to calculate the distance between the aeroplane and the camera's station at the instant of exposure and by measuring on the photograph the distance between the aeroplane and the horizon the height of the aeroplane above the ground is known. The dial of a stop watch and a horizon datum line are also photographed on the film. The error in the calculation of the distance is of the order of only 0.2 per cent. This process is indicated as especially suitable for seaplanes.

The results of a number of measurements are given in tables and also by means of graphs.

A Full-Scale Investigation of Ground Effect. (Elliott G. Reid, N.A.C.A. Report No. 265.) (4.2/5927 U.S.A.)

This report describes flight tests which were made with a Vought VE-7 airplane to determine the effects of flying close to the ground.

It is found that the drag of an airplane is materially reduced upon approaching the ground and that the reduction may be satisfactorily calculated according to theoretical formulas.

Several aspects of ground effect which have had much discussion are explained.

A Warning Concerning the Take-off with Heavy Load. (E. G. Reid and T. Carroll, N.A.C.A. Techl. Note No. 258.) (7.17/7247 U.S.A.)

A successful take-off can be made with an airplane so heavily loaded that it cannot climb to a height greater than the span of its wings.

The explanation is that the power required to maintain level flight at an altitude of the order of the wing span may be as much as 50 per cent. greater than that necessary when the airplane is just clear of the ground.

The failure of heavily loaded airplanes to continue climbing at the rate attained immediately after the actual take-off is a grave hazard and has resulted in great risk of catastrophe in three notable cases which are cited.

Tail Flutter and Means for its Prevention. (F. N. Scheubel, Paper read before XVth Meeting of the Wissenschaftliche Ges. für Luftfahrt 16-20, July, 1926—published in "Berichte und Abhandlungen" of the W.G.L., No. 14, Dec., 1926.) (5.231/5965 Germany.)

The author deals exclusively with tail plane and elevator flutter. He analyses the negative damping arising in this case and gives a qualitative explanation for its occurrence followed by an example illustrating a method of finding the critical velocity range and the factors on which it depends. He concludes that, for a given velocity, the amplitude of the oscillations depends on the frequency of the disturbing forces. These may be periodic vortices flowing off the wings, but the chief causes are no doubt to be found in the engine airscrew unit and may be due to small differences in the mass of the pistons, unsteady working in one of the cylinders, etc., and disturbances leading to flutter have been known to arise in curvilinear flight with two-bladed airscrews. As regards remedies, the following are suggested:—High rigidity of the fuselage such as is obtained with round fuselages with the tail unit not mounted at the extreme tip (e.g., Curtiss 1922 single-seater racer and Short machine), tail plane stayed by means of V strut, unbalanced surfaces or when balancing is necessary as a last resort, the balance portions should be mounted as far away from the fuselage as possible so that they may be kept light.

When tail flutter occurs in flight, pilots are advised to cut off the engine and to pull back the control column gently so as to make a slow descent. Any manoeuvre tending to accelerate descent is wrong.

The Rieseler Autogyro. (Aero-Revue Suisse, Jan., 1927.) (17.3/7066 Germany.)

A German aircraft constructor, Herr W. Rieseler, has just completed a model of an auto-gyro on which he has been engaged since 1923. The invention is stated to have been developed without any reference to Senor de la Cierva's system, from which it differs essentially by the principles adopted for mounting the wings and for overcoming the upsetting moment. The construction of the full-size aircraft has commenced and it is hoped to have it ready for flight testing early next year.

The Work of the Permanent Commission for Aeronautical Studies in connection with Tests on Seaplane Hulls. (E. Barillon, La Tech. Aeron., No. 64, 15/2/27.) (5.34/7069 France.)

Before the creation of the Permanent Commission for Aeronautical Research (Commission Permanente d'Etudes Aéronautiques), isolated tests of seaplane hulls were occasionally carried out, but led to no definite conclusions because the forms of hull studied bore no relation one to another and because it is not certain that model tests at constant speed are sufficient for estimating the qualities of a hull.

When the Commission recognised the desirability for carrying out systematic tank tests on hulls, various modifications to existing apparatus were made and the scope of the research extended. The necessity for tests on full-scale models and for the establishment of a standard of comparison between full-scale and reduced-scale model tests was recognised and tests on full-scale models were begun with a series of Romano seaplanes.

Such tests are not yet completed, but neither time nor money will be spared to obtain good results.

Model tests are also in course of execution and the reason for the delay in obtaining results in connection with the problems of take-off and alighting will disappear when the new S.T. Aé. Laboratory at Marignane is completed.

The Production of Tubular Wood Members for Aircraft Construction. (O. Steinitz, Motorwagen, 31/3/27, XXX., 9.) (5.21/7042 Germany.)

This article describes the methods adopted by the firm of C. Lorenzen, of Berlin, to make hollow wooden members of various types. The principle of the process is the building up about a solid former having the shape of the member, of plywood walls, the laminations being glued together and pressed on to the former by means of an outer shell made up of two hinged halves. The strength obtained is almost equal to that of a steel tube, whilst the weight is considerably less. The members can be bound spirally with strips of linen and doped with emallite or they may be treated with wood-filler and varnish in the usual way.

15 Airscrews

Characteristics of Propeller Sections Tested in the Variable Density Wind Tunnel. (Eastman N. Jacobs, N.A.C.A. Report No. 259.) (5.42/5961 U.S.A.)

Tests were carried out in the variable density wind tunnel of the National Advisory Committee for Aeronautics on six airfoil sections used by the Bureau of Aeronautics as propeller sections. The sections were tested at pressures of 1 and 20 atmospheres, corresponding to Reynolds' numbers of about 170,000 and 3,500,000. The results obtained, besides providing data for the design of propellers, should be of special interest because of the opportunity afforded for the study of scale effect on a family of airfoil sections having different thickness ratios.

Rupp Airscrew Hub. (Nach. f. Luft., 5/8/26, VII., 31.) (5.462/7550 France.)

In this hub, which is suitable for wood as well as for metal airscrews, the usual bolts, which considerably weaken the cross-section of the hub, are replaced by tapering gudgeons fixed on the rear flange of the hub.

To remove the airscrew it is only necessary to remove the forward flange. The hub is connected to the airscrew shaft by means of a nut which is made with an extension on which a second nut is screwed. This second nut secured an aluminium spinner which fits over the forward flange, so that both this flange and the airscrew are maintained in position.

(The above is a full translation of the paragraph in the N.F.L. compiled from information supplied by the firm.)

16 Fire Prevention

The Prevention of Fire Risks in Aircraft. (M. P. Clerget, La Tech. Aeron., 15/5/27, pp. 145-151.) (16.12/7236 France.)

The author quotes statistics to prove that the chief causes of fire in aircraft are leakages and troubles in the petrol delivery, both of which nearly always lead to backfiring. After an explanation of this phenomenon he deals with the best method of its prevention, namely, the improvement of petrol piping and joints.

The author refers to a number of special joints for petrol piping (illustrated by diagrams), including the Tampier joint, A.M. flexible joint, Bechard fireproof joint and Presto joint, to three joints designed by M. Didillion, an S.T. Aé. engineer, and finally to the A. M. Bozec and R.F.P. cocks for petrol piping.

INSTRUMENTS

17 Photography and Air Survey

Photographic Spectrophotometry in the Red and Infra-Red. (A. L. Schoen, Eastman Kodak Co. Research Lab. Com. No. 293; J. Opt. Soc. Am. and Rev. Sc. Inst., Feb., 1927, XIV., pp. 179-186—abstr. in Sc. Abstr. A., Pt. 7, XXX.) (14.241/7478 U.S.A.)

Plates sensitised with neocyanine are sensitive to 9,000 Å., and when hypersensitised to 10,000 Å. they also keep well. The method outlined employs these plates, and a Sperry 12 in. submarine type "D" high-intensity arc (110 volt, 35 amps.) to give sufficient illumination for the high dispersion necessary. The polarisation spectrophotometer is used in the usual way. Examples are given.

The Optical Transformation of Projections and its Application to Mapping from Air Photographs. (Trans. Roy. Soc. S. Africa, XIV., pp. 51-78—abstr. in Eng. Abstr., No. 32, July, 1927.) (14.31/7479 S. Africa.)

This paper is a brief exposition of the present state of the subject so far as is necessary for the comprehension of other portions which are published by the author for the first time. Those include the different manners in which the equations of optical transformation are established; the extension of the relations connecting conjugate focal surfaces; the generalised graphical solution of the problem of resection in space made applicable to three points at different heights; the arithmetical solution of the same problem; the elimination of the effects of curvature and refraction; the various mechanical constraints which will give conjugate focal planes; and the interference method of mapping. The author discusses the optical transformation of projections and gives a design for a projection camera. Graphical constructions for the determination of the relative positions of two figures in perspective are followed by computations with reference to the work of other writers. He also discusses instrumental methods. He found originally that the projection camera method was laborious and difficult, but he states that recent work by Scheimpflug and Roussilhe has rendered the method simple and expeditious. He discusses mapping from air photographs and gives brief descriptions of various stereoscopic methods.

Air Survey Photography. (F. Tymms, J. Inst. Aero. Eng., July, 1927, I., 7.) (14.1/7185 Great Britain.)

The article consists of a general review of the requirements of photographic air survey. The navigational problems involved, the problem of determining the orientation of the photographic plate at the instant of exposure, and the problems connected with the correction of tilt, are discussed.

18 Navigation

Theory of the Sextant. (V. Theimer, Z. Instrum., Apl., 1927, XLVII., pp. 165-186—abstr. in Sc. Abstr. A., XXX., Pt. 8, 25/8/27.) (6.362/7536 Germany.)

The author deals first with the essential parts of this instrument and the principle underlying the measurement of angles with it, whether with natural or artificial horizons. He next deals with the conditions required to obtain accuracy of setting, and examines errors due (1) to collimation; (2) to inclination of the fixed mirror; (3) to inclination of the movable mirror, constant and variable; (4) to eccentricity of the movable mirror; (5) to scale graduations; and (6) to the coloured diaphragms not being plane parallel. Methods of determining the errors are explained.

Paints for Compass Bowls and Discs. (H. L. Smith, J. Sc. Inst., July, 1927, IV., 10.) (6.34/7214 Great Britain.)

The note deals with a number of paints tested, with a view to overcoming the discoloration of the bowl or liquid used in compasses. Various paints made with an oil medium, an aqueous medium and with solutions of nitro-cellulose, are discussed.

19 Measurement of Air Speed

Measurement of Static Pressure. (Carl L. Fechheimer, Mech. Eng., Aug., 1927, XLIX., 8, p. 871.) (6.38/7489 U.S.A.)

The paper describes a new instrument for measuring static pressure in airflow determinations. Made in the form of concentric brass tubes, the outer of which is $\frac{1}{4}$ in. diameter, the instrument is easily introduced into air ducts through small openings, such as a bolt hole. Pressure is communicated to manometers through two holes, one to the inner tube and the other to the concentric space between the tubes, about 78.5 degrees apart. The instrument is held perpendicular to the flow in such a manner that the direction of flow bisects the angle between the axes of the holes. In this position, which can be determined by balancing the pressure on one manometer, the reading on the second manometer gives the static pressure. The instrument has less error in turbulent flow than other types.

Differential Pressures on a Pitot-Venturi and a Pitot-Static Nozzle over 360° Pitch and Yaw. (R. M. Bear, N.A.C.A. Report No. 264.) (6.381/7211 U.S.A.)

Measurements of the differential pressures on two Navy airspeed nozzles, consisting of a Zahm type pitot-venturi tube and a SQ-16 two-pronged pitot-static tube, in a tunnel air stream of fixed speed at various angles of pitch and yaw between 0° and $\pm 180^\circ$ show for a range over -20° to $+20^\circ$ pitch and yaw indicated air speeds varying very slightly over two per cent. for the Zahm type and a maximum of about five per cent. for the SQ-16 type from the calibrated speed at 0°.

For both types of air-speed nozzle the indicated air speed increases slightly as the tubes are pitched or yawed several degrees from their normal 0° attitude, attains a maximum around $\pm 15^\circ$ to 25° , declines rapidly therefrom as $\pm 40^\circ$ is passed, to zero in the vicinity of $\pm 70^\circ$ to 100° , and thence fluctuates irregularly from thereabouts to $\pm 180^\circ$. The complete variation in indicated air speed for the two tubes over 360° pitch and yaw is graphically portrayed in Figs. 9 and 10.

For the same air speed and 0° pitch and yaw the differential pressure of the Zahm type pitot-venturi nozzle is about seven times that of the SQ-16 type two-pronged pitot-static nozzle.

20 Wireless

Propagation of Short Waves. (E. Quack, Z.f. Hochfrequenz Technik, Dec., 1926.) (13.7/5975 Germany.)

In the automatic records of the signals received from the American short wave station 2XT (16.175 metres) there were often signs of interference from a duplicate signal which, owing to its lag, was inferred to be produced by waves having travelled the other way round the earth. These duplicate signals were recorded by means of an oscillograph.

Successful attempts at sending signals right round the earth and receiving them were made with the 8 kw. short wave station A G A (Nauen) on 15 metres wave. It was found that, on an average, the signals took 0.138 sec., which corresponds to a distance travelled of 41,200 km., assuming the velocity to be

the normal velocity of light. This distance would correspond to a great circle about the earth at an altitude of 182 km. from the earth.

Tests of Short Wave Sets in Aircraft. (Les Ailes, 21/7/27.) (13.7/7534 France.)

In the course of manœuvres carried out at Mailly in September, 1926, by the 1st Cavalry Division, M. Descaissin, an engineer of the Etablissement Central de la Radiotelegraphique Militaire, tested bilateral communication on short waves between a machine gun lorry and a Breguet 14. The aircraft flew from La Perthe to Le Bourget maintaining constant communication with the Mailly aerodrome even after landing at Le Bourget.

The set was then presented to the S.T.I.Ae. for homologation and mounted on a Jabiru aircraft, but never properly tested.

The military wireless department continued unofficial tests with the 34th Aviation Regiment which led to the equipment with a short wave set of the aircraft used by Lt. Gerardot and Capt. Cornillon for their flight to Colomb Bechar. These airmen remained in constant communication with the Eiffel Tower and with Tunis, and were heard clearly over 2,000 kilometres away. During flight tests at Le Bourget the aircraft was heard in America and communicated with Bizerta when on the ground.

Good results were also obtained by the Campardon Squadron during its flight from Agadir to Dakar.

21 Aerodrome Lighting

Illuminating Engineering. (J. W. T. Walsh, J. Inst. Elec. Eng., Aug., 1927, LXV., 368, pp. 733-751.) (20.5/7493 Great Britain.)

The wide range of subjects, physics and engineering, physiology and psychology, coming within the purview of the illuminating engineer is pointed out. A brief résumé of the recent rapid progress in illumination is followed by a description of fundamental principles; in particular the use of the modern conception of luminous flux in illumination calculations is described.

The chief requirements of a lighting system are that the lighting should be both adequate and suitable. It is pointed out that, in the past, adequacy has generally been emphasised to the neglect of suitability. It is, however, difficult to over-estimate the importance of the latter factor in good lighting and it is dealt with in some detail under the following headings:—

- (a) Freedom from glare and excessive contrast in the field of view.
- (b) Adequate but not excessive diffusion.
- (c) Correct colour.
- (d) Correct proportion of local and general lighting.

As an example of the application of the results of a psychological investigation to a practical lighting problem, description is given of a method of so designing a street-lighting system that the glare may not exceed a certain specified limit.

In conclusion the opinion is expressed that the present lighting load could be at least quadrupled, with immense benefit to the community.

22 Engine Indicators

Indicator for High Speed Internal Combustion Engines. (A. Magnan and A. Planiol, Comp. Rend., 14/3/27, CLXXXIV., pp. 667-669—abstr. in Sc. Abstr. B, XXX., Pt. 6.) (6.55/7043 France.)

The indicator consists of a Bowden tube fixed at its centre, the two ends actuating a mirror through flexible strips. The period of the instrument is of the order of 3000 p.s. A liquid column is used for the transmission of pressure.

The arrangement is robust and includes a pump to maintain the quantity of liquid in the column, replacing that lost by evaporation due to the heat at the cylinder head.

23 Diaphragms

Tension Experiments on Diaphragm Metals. (H. B. Henrickson, N.A.C.A. Techn. Note No. 261.) (6.73/7538 U.S.A.)

Strips of German silver, steel, copper, duralumin, nickel and brass were tested in tension in an apparatus in which the change in deflection with time was measured by means of an interferometer. This change in deflection with time caused by the application and removal of a load is defined as "drift" and "recovery" respectively. It was measured in the time interval from approximately five seconds to five hours after loading.

The data are given in a series of graphs in which the drift and recovery are plotted against time. The proportional drift and recovery in five hours are given for a number of the tests, and in addition are shown graphically for nickel and steel.

24 Television

Recent Progress in Telephotography and Television. (C. W. Kollatz, Z.V.D.I., 12/2/27, LXXI., 7.) (13.8/5966 Germany.)

Details of the following systems are given:—

1. Dieckmann's system used at Munich for the transmission of weather maps. The transmission takes about five minutes. The system can be used only for the transmission of black and white pictures.

2. Thorne Baker's system (from the "Wireless World and Radio Review," Vol. 18, 1926, p. 437).

3. Korn's new system for long-distance transmission in which a receiver working on the photographic principle and including an Einthoven galvanometer is used.

4. The American Telephone and Telegraph Co.'s system, based on Korn's principle (from the "Wireless World and Radio Review," Vol. 17, 1925, p. 203).

5. Ranger's system (Radio Corporation of America) used by the Marconi Co. (from the "Wireless World and Radio Review," Vol. 17, 1925, p. 161, and Vol. 18, 1926, p. 686).

6. Jenkins' system especially suitable for the transmission of moving pictures.

7. Television systems. Short references are made to the systems evolved by Prof. Dieckmann (Munich), Dionys von Mihaly (Hungary), Walton (New York), J. L. Baird (London), Campbell Swinton, C. Francis Jenkins & Telefunken Co. (Karolus system).

MATERIALS

25 Hardness and Tensile Strength of Metals

Relation between Hardness and Tensile Strength. (R. Baumann, Z.f. Metallk., Feb., 1927, XIX., 2.) (10.21/5954 Germany.)

In order to establish a relation for calculating the tensile strength from the hardness in the case of non-ferrous metals it was found necessary first of all to obtain a reliable criterion for the hardness. To this end, tests (the results of which are given in a graph) were carried out to determine the hardness values by means of the scleroscope test, Brinell test (pressure) and a dynamic ball imprint test (impact value), the latter being found to give the most constant values (work

of impact over volume of indentation). The great variation of the values obtained shows that the conversion of the different hardness values is only possible when very definite values are obtained. With this restriction the following rough relation may be considered to hold good:—

Brinell hardness = constant \times impact value = 6 \times scleroscopic hardness.

The report then gives shortly the results of tests carried out to establish the relation in the case of aluminium, duralumin, brass and the non-ferrous metals between the hardness and tensile strength.

The Busch Schumann "Projection" for Measuring Imprints in Brinell Hardness Tests. (Z. Metallk., Apl., 1927, XIX., 4—abstr. in Nach. f. Luft., 14/7/27, VIII., 28.) (11.24/7143 Germany.)

This instrument, invented by Dipl. Ing. R. Schumann and constructed by the Emil Busch A.G. of Rathenow, was designed to permit of imprints being read off with great accuracy, this being achieved by the fact that the imprint is illuminated in the direction of the line of sight so that no shadow is thrown by the burr round the edge of the depression. The light from a bulb is thrown in the form of a point of light on to the point to be measured through a condenser and two prisms each deflecting the light at right angles so that it finally falls vertically on to the imprint, total reflection being thus obtained at the undistorted area, whilst the inclined surfaces, such as the depression made by the ball and the burr round the rim of the same, appear darker. Since the latter is lighter than the former owing to the lesser inclination, the edge of the imprint can be clearly seen and the diameter can be measured accurately. This is done by looking down an eye-piece held vertically over the imprint, the eye-piece being provided at the bottom with a Busch anastigmat lens which throws an image of the imprint magnified ten times on to a graduated ground glass disc mounted at the top end of the tube.

On the Connection between Brinell Hardness and Tensile Strength of Pure Aluminium and Heat Treated Aluminium Alloys. (Dr. H. Bohner, Z. Metallkunde, Vol. 19, No. 5, May, 1927.) (11.24/7083 Germany.)

As the result of experiments simple equations were obtained connecting the Brinell hardness and tensile strength for pure aluminium and heat-treated alloys. Precautions had to be taken that the samples conformed to certain dimensions.

26 Light Alloys—Physical Characteristics

Aluminium Alloys Susceptible to Heat Treatment—Substitution of Germanium for Silicon. (W. Kroll, Metall. u. Erz, 1926, 23, p. 685—abstr. in Motorwagen, 30/1/27, XXX., 2.) (10.21/5956 Germany.)

As a continuation of earlier experiments with a view to replacing silicon in aluminium alloys by other elements, Dr. Kroll (after establishing the phase diagram of germanium—aluminium) tried the substitution of germanium for silicon. Germanium is very similar to silicon. Important ageing effects were noticed with the substitution of Ge for Si in an Mg₂ Si Al alloy. An improvement of about 154 per cent. occurs with this alloy, practically devoid of Si, on ageing. With both Si and Ge the strength values are very high. Even a small addition of Ge has a notable influence. If germanium is added to a duralumin with small magnesium content the ageing temperature is higher than room temperature, but in the case of a duralumin with higher magnesium content the ageing phenomena are manifested at ordinary room temperature. A small addition of germanium also improves the malleability of duralumin considerably. Dr. Kroll believes that the industrial use of germanium is not impossible. The results of his tests are given in two tables.

Tension Tests of Spot-Welded Duralumin. (T. W. Downes, Chem. and Metall. Eng., June, 1927, XXXIV., 6.) (10.22/5970 U.S.A.)

The article deals with the tension and corrosion tests of electric spot-welded specimens of sheet duralumin, conducted at the U.S. Naval Aircraft Factory. The article deals with the character of the welds, heat treatment of specimens, corrosion tests and tension tests.

It is considered that, from the standpoint of corrosion, the spot-weld is inferior to the rivet. It is thought that spot-welding of duralumin may have possibilities in place of riveting on cowling and other parts not subjected to severe stresses. A table is given showing the breaking loads of spot-welded duralumin, as welded, after heat treatment, and after heat treatment followed by corrosion tests.

Heat Treatment of Various Aluminium Alloys. (Physikalische Berichte, 1927, Pt. 10—abstr. in A.f. Metallk., 1927, XIX., Pt. 1, pp. 9-21.) (10.22/7031 Germany.)

Nearly all castings can be improved by suitable heat treatment. Special reference is made to the newer alloys, Scleron, Aeron, Lantal and Constructal.

Of these, Scleron contains Lithium, Aeron copper, Lantal copper and silicon, Constructal zinc.

These alloys have tensile strength up to 60 kg/mm². Mention is also made of the special anti-corrosion alloy K.S.

Aluminium Alloys. (K. L. Meissner, Z.F.M., 14/6/27, XVIII., 11, pp. 257-268.) (10.21/7032 Germany.)

After a review of the various alloys developed in other countries, special reference is made to the alloy K.S. made by the firm Karl Schmidt, Neckarsulm i.W., Germany. This alloy is characterised by great anti-corrosion properties. It contains 3 per cent. Mg, 3 per cent. Mn and 0.5 to 1 per cent. Sb. The latter constituent forms an oxychloride in sea water, this chloride acting as a protective film and preventing further corrosion. The Mn which is present in the form Mn Al₃ also exhibits a very small contact P.D. with reference to the Al/Mg mixed crystals and this would further reduce the tendency to corrosion.

Light Alloys. (L'Aeronautique, May, 1927, p. 145—abstr. in Autom. Abstr., 20/7/27, V., 7.) (10.21/7192 Russia.)

K.A. (Koltchug-Aluminium), a high-strength light-weight alloy, is being manufactured in Russia. The composition is as follows:—Copper 4.5 per cent., manganese 0.6 per cent., nickel 0.3 per cent., magnesium 0.5 per cent., aluminium 93.5 per cent. Silicon and iron are contained in small quantities as impurities. The metal is used in the annealed or drawn-back state for pressed work, normally quenched for sheared work and riveting; cold worked (hard) for shearing, riveting and high strength purposes. The highest and best temperature from which to quench is 520°C. At 550°C. K.A. loses all its favourable properties. The draw-back temperature should not exceed 400°C. It varies between 350 and 400°C. and is best at 370°C.

If one is to work the K.A. immediately after quenching, the quenching should take place in cold water. If one must prepare the K.A. in a limited time it should be quenched in boiling water, and stay there for three hours. After this treatment the properties of the material remain constant for a long time. The final mechanical properties of K.A. do not depend on the temperature of the quenching bath. The normal properties of K.A. are developed by seven days of storing. After this they remain constant for at least two years. (This was the age of the specimen tested.)

Inclusions in Light Alloys and their Effect on Mechanical Properties. (H. Stendel, *Z. Metallk., Apl.*, 1927, XIX., 4.) (10.21/7144 Germany.)

1. The object of this paper is to show the effect of various spurious inclusions on the quality of light metals, particularly aluminium alloys.

2. Iron is the component with the most general detrimental effect. Hence every care should be exercised by the founders to eliminate every trace of iron from pure aluminium, and in the working up of the various alloys suitable precautions must be taken to prevent iron from being taken up again.

3. Components added according to formula to produce given alloys may also have the same effect as spurious inclusions, reducing malleability and uniformity in strength of the worked material.

4. All alloys, and particularly rolling alloys, should be prepared in such a way that all the constituents can be brought into solid solution. Where this is not yet possible, heat treatments capable of producing a more favourable distribution of the insoluble types of crystals should be developed.

5. In the usual shaping processes under press or hammer or by rolling, the metal is worked in one direction so that a line structure is produced. In order to remove the drawbacks inherent in this condition, processes should be evolved in which the material is kneaded in every direction.

6. Various suggestions, based on the practice of steel-making, are made for the improvement of the quality of light alloys.

"Almelec"—a New Aluminium Alloy for Electric Wires and Cables. (E. Dusauguey, *Rev. Gen. de l'Elec.*, 19/2/27, XXI., 8.) (10.58/6205 France.)

Almelec, which is an alloy (98.5 per cent. Al, 1.2 per cent. Mg and Si by analysis) produced by the Compagnie de Produits chimiques et electromagnetiques d'Alais, Froges et Carmargue, is characterised by a high hardness value, obtained by cold drawing followed by heat treatment, equal to that of cold-worked copper. Almelec wire of 3 mm. diameter has the following principal properties:—

Specific gravity — 2.7.

Ultimate strength (mean of 500 tests) — 35 kg./sq. mm.

Elongation (at fracture) 6 to 8 per cent.

Modulus of elasticity 6450 kg./sq. mm.

Coefficient of expansion 23×10^{-6} .

Specific resistance (in microhms per cm.) 3.1.

Conductivity (wire 1 m. in length and 1 sq. mm. in section) in mho, 32.2.

Comparing copper, aluminium and almelec cables of the same conductivity, the mechanical strength of the almelec cable is 50 per cent. higher than the copper cable and 100 per cent. higher than the aluminium cable, whilst its weight is 46 per cent. lower than the copper cable and 8 per cent. higher than the aluminium cable.

It is stated that almelec can be used with steel with far better results than aluminium.

Mechanical Properties of Binary Aluminium—Beryllium Alloys. (W. Kroll, *Metall. u. Erz*, 1926, pp. 616-618; *Chem. Zentr.*, 1927, I., p. 516—abstr. in *Br. Chem. Abstr. B*, 8/7/27, XLVI., 27.) (10.21/7476 Germany.)

Addition of beryllium to aluminium increases the tensile strength, the alloy with 6 per cent. Be having a strength of 13.5 kg./mm.². With up to 6 per cent. Be the elongation decreases slightly, but with further addition of beryllium decreases rapidly without any appreciable increase taking place in the tensile strength. The general effect of beryllium on the mechanical properties of

aluminium is similar to that of silicon, but 30 per cent. more beryllium is required to produce identical results.

Magnesium and its Alloys. (J. A. Gann and A. W. Winston, Ind. and Eng. Chem., Oct., 1927, XIX., p. 1193.) (10.21/7540 U.S.A.)

The relationship between composition, micro-structure and physical properties of magnesium based alloys are discussed. The foundry practice described is based on the use of a flux which protects the molten metal from deterioration. Certain of the alloys can be forged, rolled and extruded, whereby the structure and the mechanical properties are greatly improved, thus in the cast alloy the tensile strength varies between 14,000 and 26,000 lbs. per sq. in., while the elastic limit lies between 4,000 and 14,000 lbs. per sq. in. For the forged material the ultimate tensile is of the order of 30,000-40,000 lbs., while the elastic limit lies between 20,000 and 25,000 lbs. Considerable attention has been paid to the problem of corrosion. The most recent development is to immerse the article in a hot acid phosphate solution which yields a very adherent covering of insoluble magnesium phosphate.

In the cast state the material is suitable for engine crankcases, whilst forgings have been employed for pistons, connecting rods, propellers and aeroplane tail skids. Owing to the absence of distortion, or warping, or ageing, magnesium alloys are used for jigs. An interesting use is the press forge resonator disc for motor car horn, the material in this stage producing exceptionally clear and resonant tone.

27 Engine Parts Made of Light Alloys

Magnesium Pistons. (U.S. Army and Navy Register, 6/8/27.) (10.23/7491 U.S.A.)

An experimental set of magnesium pistons has completed a second 50-hour test in the Wright T-3 engine. The laboratory reports that these pistons are in perfect condition, with scarcely a sign of their having been used. Magnesium pistons for "J" engines, which had not been satisfactory, have now been re-designed to correct the defects and new pistons will be procured for tests in the near future.

Subsequent to the J-5 engine tests, previous accounts of which have been published in the *Army and Navy Register*, one engine has been operated to secure additional data regarding carburation, lubricating oil consumption, etc. This engine has completed a total of 280 hours operation in the laboratory and is still in excellent condition after one major overhaul, necessitated by a piston failure in the course of full throttle endurance testing.

28 Corrosion

The Barff Method of Protecting Aluminium. (Aluminium, 31/1/27, No. 2.) (10.27/5967 Germany.)

This article gives the following details of the Barff process which is an adaptation of the well-known process of the same name used on iron.

All greasy deposits having been carefully removed, the aluminium part is immersed as anode in a solution containing 3 per cent. chromic acid, the cathode being carbon plates. The flow of current deposits a layer of oxide over the aluminium surface. Since this layer becomes thicker as the process is continued, an increase in resistance occurs which must be met by increasing the voltage to about 40v. The duration of the treatment is about 1 hour, and shortly before the end the voltage is raised to 50v. The protective coating deposited in this way is absolutely unbroken. It penetrates into all small holes, scratches and other indentations such as hitherto escaped treatment. The thin aluminium oxide layer is then

rubbed off with lanoline, grease being thus allowed to penetrate into the pores of the oxide deposit, this considerably increasing the resistance to corrosion of the aluminium. This protective coating is white when applied to pure aluminium and grey in other cases. The layer may be coloured since it consists in part of aluminium salts containing hydrogen. This process has recently been patented.

Causes of Corrosion in Aluminium and its Dependence on the Physical and Chemical Properties of the Metal. (Aluminium, 15/2/27, 3.) (10.27/5959 Germany.)

This article is a short review of Prof. Dr. E. Maas, paper read at the annual meeting of the "Reichsausschusses für Metallschutz" (State Commission for the Protection of Metals).

After dealing with the more well-known causes of corrosion, (nature of surface, connection with a metal forming an electric couple, presence of silicon, unsuitable heat treatment, etc.), the writer referring to the solubility of more or less pure aluminium mentioned Koster's research which proved that the silicon in aluminium was only slightly soluble from 0° to 300° maximum solubility being reached from 300° to 500° with 0.5 per cent. silicon content, and from 500° to 580° with 1.5 per cent. silicon content. Centnerzwer had carried out investigations of the induction period in the dissolution of aluminium. It was generally held that the passivity of the surface was due to the oxidation layer and this view was borne out by the experiments carried out by Liebreich and Wiederhold of the Chemisch-Technisch Reichsanstalt. The physical and chemical properties had a direct influence on the dissolution processes (in the case of aluminium) and the speed of the reaction. Tests had shown that the solubility of aluminium in the different acids did not depend on the acid content of the solution or on the concentration of the free hydrogen ions, but that the governing factor was the chemical affinity of the aluminium to the anion of the acid.

Corrosion of Metal Hulls. (U.S. Army and Navy Register, 6/8/27.) (10.54/7490 U.S.A.)

An interesting experiment on PN10 No. 7028 was recently carried out by VS Squadron 28, of the aircraft squadrons of the battle fleet. The hull was finished with one coat of plain bitumastic, followed by a second coat of pigmented bitumastic, and one pontoon finished with two coats of aluminium enamel, while the other was finished with one coat of plain varnish followed by a coat of aluminium enamel. After one week of operation, rivets on both pontoons showed corrosion, while the bottom, coated with the bitumastic, appeared in very good condition.

Problems of Corrosion and Protection of Metals. (J. Hanson, Z.F.M., 14/5/27, XVIII., pp. 2201-2203.) (10.27/7200 Germany.)

Summaries of two of the numerous papers presented at the yearly meeting of the committee, November, 1926. Charlottenburg. i. Dr. Duffek. Tendency to Rust and Rate of Rusting of Special Steels. A rapid method was devised, using the specimen as one electrode, mercury as the other electrode excluding air and introducing oxygen in the neighbourhood of the test piece. Corrosion obtained in 24 hours in this way was equivalent to corrosion under normal conditions in 4 months. The initial electrical potential of solution is taken as a measure of the tendency to rust. The presence of impurities, inclusion of slag, oxygen, etc., are brought out by the electric potential measurement, even when tensile tests do not show falling off in strength.

ii. Dr. Blem (Zurich). Theory of protective coating of oil paint.

The coating consists of surface skin, intermediate layer and adhering layer. The external skin must be tough, elastic and resistant to chemical influences.

The theory of cell building, as developed for aqueous suspensions, is applied to the drying of the oil, on the assumption that thinly spread oil has the faculty of forming cellular divisions.

Complicated physical and chemical reactions take place producing finally a cellular structure throughout the protective film, which is stronger when the structure is not uniform.

Pigments are to be distinguished by their morphological condition, and progress in the preparations and application of protective paints depends on the systematic study of their structure.

Corrosion of Metals at Joints and Crevices. (U. R. Evans, J. Roy. Soc. Arts, LXXV., pp. 544-562—abstr. in Sc. Abstr. A., XXX., Pt. 8, 25/8/27.) (10.27/7535 Great Britain.)

Apart from the influence exerted by the contact of two dissimilar metals, a frequent cause of corrosion is due to differences in the degree of aeration of different parts of a solution surrounding a metal. Differential aeration cells are in this way formed in crevices or pores of a metal or under parts screened locally by some foreign matter from contact with air. In these cells the "un-aerated" electrode forms the anode or corroded pole, and in a cavity corrosion will burrow down, enlarging and deepening the hollow. In selecting materials which are to come into contact at a joint, it is in some cases advisable to make the metal presenting the smaller area weakly cathodic to the other. The most dangerous condition is a capillary crevice existing between two dissimilar metals.

Non-Rusting Steel for Aircraft. (T. W. Downes, Iron Age, 1926, 118, pp. 1265-1268—abstr. in Chem. Abstr. B., 8/7/27, XLVI., 27.) (8.545/7475 U.S.A.)

For the manufacture of tanks for aeroplanes, etc., a steel of the following composition has proved satisfactory:—12.03 per cent. Cr., 0.45 per cent. Mn., 0.10 per cent. C., 0.26 per cent. P., 0.03 per cent. S., and 0.02 per cent. Si., and the remainder iron.

29 Crystal Structure

The Technological Properties of Aluminium Crystals. (G. Sachs, Z.V.D.I., 23/4/27, LXXI., 17, pp. 577-584.) (10.64/7208 Germany.)

The paper is a summarised review of the principal results with regard to Al. crystals reached in a number of publications under the following heads:—(1) Analysis of plastic deformations in crystals, (2) Elastic limit and strain hardening (with load-extension graphs of aluminium crystals with different orientation), (3) Strength and elongation, (4) Planes of fracture and resistance to fracture, (5) Differences between theoretical processes of slip and slip at room temperatures and high temperatures, (6) Hardening phenomena and recrystallisation. The article includes a large number of graphs, also X-ray and other photographs.

Structure of Matter in the Light of Röntgen Rays. (M. Polanyi, Z.V.D.I., 23/4/27, LXXI., 17, pp. 565-570.) (10.63/7245 Germany.)

After dealing with the nature of Röntgen rays, the theory of crystal structure and the relation between the shapes of crystals and lattice structure, the author explains how the latter can now be determined by Röntgen rays from the refraction phenomena, using the method of Max von Laue. The author refers to the method developed by himself and K. Weissenberg based on the refraction of X-rays by the rotating crystals, further to the applications of Bragg's reflection law which include the Debye-Scherrer powder diagrams and the texture diagrams.

30 *Welding*

The Use of X-Rays for the Inspection of Welds. (C. Kantner and A. Herr, Z.V.D.I., 23/4/27, LXXI., 17.) (11.26/7244 Germany.)

This article, which contains a large number of X-ray photographs, is chiefly a report of series of X-ray investigations of welds carried out by different processes on various metals. The tests of the welds were preceded by X-ray inspection of the various metals used for the welds so as to permit of comparison between the metal before and after welding. The plant used is described.

31 *Glass*

Cel-o-Glass—Ultraviolet Transmission. (W. C. Russell and O. N. Massengale, Science, 1925, LXV., p. 619—abstr. by B.C.I.R.A.) (14.241/7477 Great Britain.)

Using the acetone-methylene blue reagent which is decolorised by radiations shorter than 3,200 Å., the ultra-violet transmitting properties of Cel-o-Glass, a glass substitute, are being made. It has been found that 47 per cent. of the light from a quartz mercury lamp, of wave length less than 3,200 Å., is transmitted when the reagent is at a distance of 3 ft. from the lamp. Daily readings by the colorimetric method of the total ultra-violet portion of sunlight, less than 3,200 Å., made over a period of five months, show that 50 per cent. of this radiation passed through the material. Preliminary results in physiological experiments on bone formation in chickens indicate that the percentage of the effective rays which pass through Cel-o-Glass is between 33 and 40 per cent.

32 *Fabrics and Dyes*

Fabrics: Thermal Properties. (I. D. Foos, Text. World, 1926, LXX., p. 3151—abstr. in J. Text. Inst., May, 1927, XVIII., 5.) (10.41/7360 U.S.A.)

The author discusses the properties of a fabric upon which its heat insulation depends, and outlines a test for the thermal transmission of fabrics. The test is in three independent parts:—(1) The rate of escape of heat through the specimen under definite temperature conditions into still air having a prescribed humidity; (2) the rate of flow of conditioned air through the specimen under definite pressure difference and at a definite temperature; and (3) the rate of escape of saturated water vapour through the specimen from water maintained at 100°F. (blood heat) to conditioned still air outside. Detailed descriptions of the apparatus are obtainable from U.S. Bureau of Standards.

Yarn Testing Machine—Tensile Strength and Elongation: Stress/Strain Graph. (H. L. Scott Co., Textile World, 1927, LXXI., 1213—abstr. in J. Text. Inst., May, 1927, XVIII., 5.) (11.24/7358 U.S.A.)

The machine incorporates many new ideas in conjunction with other features of design which have for many years been a success in the standard machines for these purposes. The new tester has a double capacity head with two sets of dial graduations, one reading from 0 to 25 lb. in $\frac{1}{8}$ lb. and the other from 0 to 50 lb. in $\frac{1}{4}$ lb. Description is given of the construction of the machine. The recording device is designed to draw a line on a ruled card of standard letter size, which line is graphically descriptive of both stretch and strength of the material. As a machine for research or practical investigation of material it has much to recommend it.

Dyes: Fastness. (H. Pomeranz, Melliand Textilber., 1927, VIII., 162-4—abstr. in J. Text. Inst., May, 1927, XVIII., 5.) (10.42/7359 Germany.)

The author explains the fastness of applied dyes to washing, soap and rubbing, by the formation of labile compounds between the fibre and one component of the dye employed. For example, in dyeing cotton with lead chromate, the dye does not adhere to the fibre if the cotton is first treated with bichromate and then with the lead salt, but a fast dye is obtained if the processes are reversed, due to the formation of a labile compound between the cotton fibre and the lead salt which becomes a fast dye when the bichromate is applied. Other examples are discussed, among them the fastness of indigo to washing and rubbing.

33 *Dopes*

Viscose Films: Tenacity and Elongation. (G. Kita, R. Tomihisa and K. Sakurada, Cellulose Ind., Tokyo, 1926, II., 40-46—abstr. in J. Text. Inst., June, 1927, XVIII., 6.) (10.42/7495 Japan.)

The influence of the conditions of preparation of the viscose on the tenacity and elongation of the films has been studied. The ageing of the alkali-cellulose (up to ten days) has no appreciable influence on the tenacity of the films even though the viscosity is thereby greatly reduced. Longer ageing of the alkali-cellulose, however, retards the rate of coagulation of the film. Under ripe viscose gives rough opaque films on coagulation which subsequently become clear; fully ripe viscose gives clear films immediately. Viscose prepared from well-aged alkali-cellulose or dissolved in more concentrated alkali does not undergo such marked changes in viscosity during ripening as viscose prepared under opposite conditions. The tenacity of the films, however, is unaffected in either case, and with few exceptions the tenacity tends to increase with duration of ripening in an asymptotic manner until it arrives at a constant value; the elongation coefficient of the films passes through a maximum point with duration of ripening. The concentration of alkali in the viscose has no very definite influence on the tenacity, but the elongation is very notably increased when the xanthate is dissolved in 0.12 per cent. sodium hydroxide solution. Dilution of the viscose has no effect on the tenacity of the film.

Cellulose: X-Ray Structure. (J. Duclaux, Chem. Abstr., 1926, XX., pp. 3606-3607—abstr. in J. Text. Inst., June, 1927, XVIII., 6.) (10.42/7494 France.)

The author gives the results of some of his yet unpublished experiments which show that both nitro-cellulose and cellulose films have the properties of an uniaxial crystal cut perpendicular to its axis and that whatever be the conditions under which the film is formed (nature of solvent, thickness of film within limits 0.04-0.4 mm., time of drying, etc.), the bi-refringence remains constant within the experimental error. The paper reviews critically recent work on the bi-refringence and X-ray investigation of cellulose and is followed by an 11-page report of the discussion.

Nitrocellulose: Viscosity. (N. Yamaga, Cellulose Ind., Tokyo, 1926, II., pp. 357-362—abstr. in J. Text. Inst., June, 1927, XVIII., 6.) (10.42/7486 Japan.)

Decrease in viscosity of cellulose nitrate is brought about by the action of heat; light also has a similar action. Change of viscosity does not depend on the decomposition of the cellulose nitrate, but accompanies decrease of molecular complexity.

Cellulose Acetate and Cellulose Nitrate: Solubility. (W. von Neuenstein, *Kolloid-Z.*, 1927, XLI., pp. 183-185—abstr. in *J. Text. Inst.*, June, 1927, XVIII., 6.) (10.42/7485 Germany.)

It is shown that Ostwald's rule, that the quantity of substance going into colloidal solution depends on the quantity of solid present, holds also for the solution of cellulose acetate and cellulose nitrate in organic solvents. The quantity going into solution increases with increasing quantities of solid remaining out of solution. An exception occurred where a constant solubility was obtained at higher and increasing quantities of solid.

Nitrocellulose Lacquer Films: Testing. (G. W. Rundle and W. C. Norris, *Proc. Amer. Soc. Testing Materials*, 1926, XXVI., Pt. 2, pp. 546-555—abstr. in *J. Text. Inst.*, June, 1927, XVIII., 6.) (10.42/7484 U.S.A.)

Films of stress-strain measurements are easily prepared—by flowing them on amalgamated tinned sheet-iron panels, setting them up at an angle of 15° to the vertical and allowing the excess material to flow off. The influence of the thickness of film, humidity, temperature and variations in lacquer composition on the results of stress-strain measurements is discussed.

Cellulose: X-Ray Structure. (R. O. Herzog, *Cellulose Symposium Report, Dominion Convention of Chemists, Montreal, 1926*, 26-31—abstr. in *J. Text. Inst.*, May, 1927, XVIII., 5.) (10.42/7357 Canada.)

In a review of his recent work on the X-ray structure of cellulose and related materials the author gives certain experimental data and shows to what extent experiment and theory agree. A full discussion is reported.

34 Rubber

Mechanical Properties of Rubber Cord. (I. F. Morrison, *Trans. Roy. Soc. Can.*, 1926, XX., 2, pp. 385-394—abstr. in *Sc. Abstr. A.*, 25/5/27, XXX., Pt. 5.) (10.52/7003 Canada.)

The present paper deals with some preliminary aspects of the problem of developing a satisfactory method of determining the loss of energy of impact, due to absorption by a rubber shock absorber cord. Mathematical considerations of the problem are included, together with a note on the manufacture of the cord and of the apparatus and technique employed for the experiments. The results of the experiments on the variation of hysteresis loss due to different rates of loading are shown graphically, and the hysteresis loss is seen to decrease as the rate of loading increases. When a load is applied to the cord there is a sudden stretch followed by a slow additional stretch with time. It is the latter, equivalent to a sort of plastic deformation, which recovers with time when the load is released and causes the hysteresis loop. As the rate of loading is further increased the hysteresis losses again increase. The causes of energy loss are discussed.

Ageing of Soft Rubber Goods. (R. F. Tener, W. H. Smith and W. L. Holt, *Bur. Stan. Tech. Paper No. 342.*) (10.52/7210 U.S.A.)

In this investigation typical rubber compounds were prepared and subjected to different conditions of exposure, etc., in order to determine the influence of various factors, such as light, heat, oxygen, moisture, and the degree of vulcanisation on the deterioration of rubber goods. The rate of deterioration was measured by tensile tests which were made at varying intervals of time. It was found that although all these factors contribute to deterioration, not all rubber compounds are affected the same. For instance, certain compounds were found to be resistant

to heat but not to light, while in other compounds the reverse was true. Comparisons have been made between the results of accelerated ageing tests and natural ageing.

35 *Papèr*

Paper as a Material for Construction. (G. Oehler, Z.V.D.I., 23/4/27, LXXI., 17.) (10.59/7212 Germany.)

This article deals mainly with the various kinds of materials made up of layers of paper, glued together and compressed. The mechanical properties are investigated, it being stated in particular that with certain materials Brinell hardness values (with 10mm. ball and 500 kg. load) of 45 are reached so that these materials are suitable for gears. Stress strain diagrams for panels of different thickness are given and means to avoid the occurrence of defects in production and storage are suggested. The various processes that can be applied in the manufacture of articles from paper materials and the manner in which such processes should be carried out (speed of machines, etc.) are dealt with at length in the second section of the paper, the processes involving tension being given a special place since they require determinations of elongation. This section is followed by a review of the possible applications, the most important being in machine construction (gears) the electrical industry (insulation) and the building trade (coverings for floors, walls, etc.). The paper closes with a reference to "cast" paper.

ARMAMENT

36 *Bombs*

Bombs and Bomb Fuzes. (W. F. Becker, Ar. Ord., May-June, 1927, VII., 42.) (9.31/7186 U.S.A.)

This article reviews the bomb design in the United States, and is well illustrated. The article refers to the relation between the weight of explosive and the weight of case to give the most effective fragmentation, and the proper shape of case to give the best distribution of fragments.

37 *Torpedo Attack*

Notes on Attack by Torpedo Seaplanes. (G. Viansino, Riv. Aeron. No. II., Feb., 1927.) (9.21/7068 Italy.)

After expressing his faith in the efficacy of air torpedoes, the author enumerates the principal desiderata of a satisfactory air torpedo as follows:—

- (1) sufficient strength to act properly even if dropped from 25 to 30 metres altitude, owing to bad weather, etc.
- (2) travel not exceeding 3,000 metres.
- (3) high speed of travel of at least 35 m.p.h. obtained by air heating.
- (4) special position of the holes for regulating.

The author then deals with two methods of torpedo attack, viz., (1) the seaplane launches the torpedo straight ahead whilst approaching the ship on the beam; this facilitates sighting and offers an easy target to the ship's A.A. guns, and (2) the seaplane flies parallel to the ship and launches the torpedo to the side. In connection with the latter method, which is the better, he gives a formula and tables for calculating the angle of sight for varying distances between the parallel courses of ship and seaplane, and introducing the estimated speed of the ship and that of the torpedo.

He concludes with a table of the permissible errors in sighting and estimation of the range.

MISCELLANEOUS

38 *Airships*

Heat Transfer System for Airships. (U.S. Patent Office, Re. 16644, H. F. Parker.) (12.83/7088 U.S.A.)

This invention applies to Airships and refers to water recovery from the engine exhaust as well as buoyancy control by heating the air surrounding the gas containers. The water recovery plant is built into the outer envelope of the ship and projects partly into the space surrounding the gas containers. It is a simple condensing plant and delivers the condensed water to the ballast tanks direct. By means of louvres in the outer envelope, the quantity of air passing over that portion of the condensing plant which projects inside the ship can be varied, and in this way the temperature of the air inside the ship's envelope controlled.

Helium. (Nat. Petr. News, 22/6/27, p. 72—abstr. in Autom. Abstr., July, 1927, V., 7.) (12.62/7188 U.S.A.)

At present there is no commercial production of helium but there is a prospect that there will be some during the present year. A contract has been made by the U.S. Navy with the Kentucky Oxygen-Hydrogen Company for the purchase of 1,260,000 cu. ft. of helium at 62 dollars per 1000 cu. ft.

The Petrolia plant, so far as known, is now delivering enough helium, but in the event of war it could not supply even a small percentage of the gas needed.

39 *Meteorology*

Cup Anemometers. (T. W. Vernon-Jones, Met. Mag., Aug., 1927, LXII., No. 735.) (6.382/7525 Great Britain.)

The article reviews the information available on the relation between speed of rotation of the cups and the wind speed. Curves showing the variation on static torque of a 4-cup anemometer for rotation of the head through 90° are given. It is shown by a large number of measurements that a somewhat more constant torque and factor were obtained by using a 3-cup anemometer system than by using 4 cups, and the experiments have led to the adoption of a 3-cup anemometer as a standard instrument in the Canadian Meteorological Service.

Preliminary Note on the Effect of Dust, Smoke and Relative Humidity upon the Potential Gradient and the Positive and Negative Conductivities of the Atmosphere. (G. R. Wait, Terres. Mag. and Atmos. Elec., March, 1927, XXXII., 1.) (6.23/7193 U.S.A.)

Curves are given showing the relation between the number of nuclei and the atmospheric-electric elements. It can be seen that the number of nuclei is a big factor in determining the values of both the potential gradients and the conductivities. Curves are also given connecting the relative humidity of the atmospheric-electric elements.

The graphs show that the atmospheric-electric elements are not affected to the same extent by a change of humidity as by a change in the number of nuclei.

The Overshooting of the Equilibrium Height of a Free Balloon. (Possner, Lothar (dissertation), Z.F.M., 16/8/27, XVIII., 15, pp. 353-357.) (6.27328 Germany.)

As equation of motion the author obtains a linear differential equation with variable coefficients in accordance with a number of assumptions as to variation of pressure and temperate with height, rate of ballast discharge, etc.

A large variety of cases is worked out and the results are given in tables and graphically.

The excess height is of the order of twice the diameter.

40 Acoustics

Transmission of Sound through Building Materials. (By V. L. Chrisler, Bur. Stan. Sc. Paper No. 552, 16/6/27.) (6.76/7537 U.S.A.)

This paper contains a report of the work on sound transmission through (1) various stud partition walls covered with different wall boards, (2) a few masonry walls, and (3) a few compound walls. Attention is called to the fact that an equal degree of sound insulation can be obtained with lighter walls when they are made double or made with alternate layers of different material fastened together. The results are given for four frequency bands covering a range from 250 to 3,365 cycles per second. Specifications for the construction of the various panels used in transmission tests are appended.

A Study of the Regular Combination of Acoustic Elements, with Applications to Recurrent Acoustic Filters, Tapered Acoustic Filters and Horns. (W. P. Mason, Bell System Technical Journal, April, 1927, VI., pp. 258-294.) (6.76/7251 U.S.A.)

The use of combinations of tubes to produce interference between sound waves and a suppression of certain frequencies originated with Herschel (1833), and was applied by Quincke to stop tones of definite pitch from reaching the ear. Following the development of electrical filters, G. W. Stewart showed that combinations of tubes and resonators could be devised which would give transmission characteristics at low frequencies similar to electrical filters. The assumptions made by Stewart in the development of his theory are that no wave motion need be considered in the elements, and that the lengths of the elements employed are small compared to the wavelength of sound.

The present paper considers primarily regular combinations of acoustic elements, such as straight tubes, and shows that the equations for recurrent filters, tapered filters and horns can be obtained in this manner. The assumption of no wave motion in the elements, made by Stewart, is removed and also account is taken of the viscosity and heat conduction dissipation. The principal difference between acoustic and electric filters is that the former have an infinite number of bands. The effect of using filters between varying terminal impedances is also determined.

Studying next the combination of filters having the same propagation characteristics but in which the conducting tube areas increase in some regular manner, it is shown that a tapered filter results which has a transforming action in addition to its filtering properties. It is shown that if straight tubes are employed and the distance between successive changes in areas is made small, we obtain the horn equations first developed by Webster. The general combination of acoustic elements is then considered, and a proof of several theorems has been given.

41 Heat Insulation by Means of Aluminium Foil

(V.D.I., Vol. 71, No. 40, Oct. 1st, 1927, p. 1395.) (8.36/7546 Germany.)

The Alfol process of heat insulation consists in surrounding the hot body with several layers of aluminium foil containing air pockets. Measurements are given which show a great efficiency of this new method. A further advantage is the small thermal capacity of the new insulating material as well as its light weight.

42 *Windmills*

Wind Power in Russia. (M. W. Grassowsky and G. H. Szabinin, Report of Central Hydrodynamical Inst., Moscow, Report No. 222, 1926.) (5.38/7551 Russia.)

The importance of wind power in Russia arises from the absence of coal and water power. Statistics give distribution of wind power from the years 1917-1921. 170,000 windmills of various kinds were in operation, mostly for grinding grain. Price of wind power in pence per hour is approximately :—

				3 h.p.	10 h.p.
Steam	...	...	...	2.5	1.6
Petrol	...	...	...	2.2	1.6
Electric	...	...	...	1.9	1.5
Windmill	...	...	...	1.1	0.8

Formulae are given for comparison of performance. The general tendency towards many vaned windmills is in accordance with the aerodynamic theory.