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(Prepared by R.T.P.)

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On the Wave Making Resistance and Lift of Bodies Submerged in the Water. (N. Kotchin, Trans. Conf. on Theory of Wave Resistance, Moscow, May, 1936, pp. 65-134.) (45/1 U.S.S.R.)

General expressions are deduced for the forces acting on a submerged body moving with steady linear motion under a free surface. The resulting surface waves are assumed to be so small that the usual assumptions of the wave theory may be accepted. The method worked out is based on the introduction of a special function in terms of which the wave making resistance and lift of the body can be expressed directly.

In the first place, the problem of lift and wave making resistance is discussed for the case of motion under the surface of a heavy fluid, with special reference to calculation of the changes in circulation due to the effect of the free surface.

The same problem is also discussed for a three-dimensional flow.

Accepting the first approximation, it is possible to obtain results similar to those obtained by Havelock for the motion of a sphere and of an ellipsoid. As a particular case, similar formulæ are deduced for the wave making resistance of a ship moving on the surface of a fluid.

Finally, both the two- and three-dimensional problems are solved by numerical solution of the integral equations.

The Theory of Isotropic Turbulence. (H. L. Dryden, J. Aer. Sci., Vol. 4, No. 7, May, 1937, pp. 273-280.) (45/2 U.S.A.)

The intensity and the scale form two statistical properties of turbulence which can be studied experimentally. The intensity is measured by the root mean square fluctuation of the speed and the scale by $\int_0^\infty Ry\, dy$ where Ry is the correlation between the velocity fluctuation at points a distance y apart on a line perpendicular to the mean flow.

A theory of the behaviour of intensity and scale is developed somewhat similar to that of electro-magnetic radiation. Turbulence may be described in terms of an energy distribution and wave length, and it is assumed that the former tends to a limit determined by the law of dissipation. Alternatively, if the latter is

known, the law of decay of the total energy and the change in turbulence scale can be predicted.

The author shows that satisfactory agreement with experiment can only be obtained if the dissipation is assumed to vary as the square of the velocity.

Theory of Rectangular Wings of Small Aspect Ratio. (W. Bollay, J. Aer. Sci., Vol. 4, No. 7, May, 1937, pp. 294-6.) (45/3 U.S.A.)

The theory presented differs from the conventional treatment of the subject in that the trailing vortices leave at some angle to the wing and thus do not all lie in a horizontal plane passing through the trailing edge. At the same time assumptions were made for the lift distributions which are applicable to small aspect ratios.

The present theory thus supplements the linear Prandtl theory which is more adapted to large aspect ratios.

Both asymtotic values for zero and infinite aspect ratios are correctly given and the theory holds well for aspect ratios of less than unity.

Reaction Jets with Supersonic Speeds of Flow. (J. Chalom, Comp. Rend., Vol. 204, No. 22, 31st May, 1937, pp. 1614-5.) (45/4 France.)

The increase in reaction obtained by the use of convergent-divergent nozzles has been studied. The flow was examined by means of an interferometer and the decrease in reaction at very high (supersonic) speeds was traced to the formation of reflected wave systems in the nozzle which decreased the available discharge section. It has been found that under these circumstances a diverging-converging profile for the nozzle gave better results.

Progress in Aerodynamics. (T. v. Kármán, Les Ailes, No. 836, 24/6/37, pp. 7-8.) (45/5 France.)

The following are the main points considered by v. Kármán in his recent Paris lecture:—

1. N.A.C.A. researches are in progress with the object of controlling boundary flow and maintaining its laminar character over a greater proportion of the body surface. Reference is made to photographs of the airflow over a wing of 1 m. chord, showing the laminar layer persisting for a distance of over 30 cm. from the nose.

2. Lift distribution for wings with small aspect ratio is being studied. There appears some difficulty of accounting for experimental results by an extension of the classical theory.

3. The effect of central flaps and marginal vortices on the lift distribution being investigated. An extension of the flaps over the whole wing is recommended for the landing of large aircraft with heavy wing loading.

4. Above 30,000 feet, air-cooled engines are difficult to cool and this accounts for the renewed interest in liquid-cooled engines with cowled radiators (Allison).

5. Three-wheeled landing carriages with a nose wheel are coming into favour for large machines (Douglas D.C. 4). In this arrangement the tail surfaces are kept away from the ground and this makes the control more efficient.

The Leakage of Gases through Narrow Channels. (A. Egli, J. App. Mech., Vol. 4, No. 2, June, 1937, pp. A63-7.) (45/6 U.S.A.)

By introducing non-dimensional variables, a differential equation is derived for the pressure drop of an ideal gas flowing in a parallel channel. This differential equation is integrated for the case of flow through a channel of length S, starting from rest, this being the most important case in technical applications of narrow space flow. Results are given graphically, showing in non-dimensional form the relationship between mass flow, pressure drop and frictional resistance. In addition to being a function of Reynolds number, the frictional resistance coefficient

λ depends on the aspect ratio (length of channel/clearance) and on the roughness of the channel wall; λ can easily be determined from leakage tests. Results of tests of the leakage of air and steam through the narrow clearance between a valve stem and bushing are given graphically and afford practical evidence of the use of the theory. Formulæ are derived for the calculation of the leakage of gases through reamed bushings on ground stems and expressions obtained for the leakage of liquids (incompressible fluids) as special cases of the gas formulæ.

Fluid Flow Analyser. (H. L. Parr, Engineer, Vol. 164, No. 4251, 2/7/37, pp. 24-25.) (45/7 Great Britain.)

The apparatus described has been developed in the Mechanical Engineering Department of Columbia University. It consists of a shallow glass box 12in. wide, 48in. long and $\frac{1}{4}$in. deep through which air is drawn by means of a small electric fan. The streamlines are marked by means of titanium tetrachloride jets evenly spaced across the inlet section. Models to be examined are cut out of $\frac{1}{4}$in. rubber sheet and clamped between the top and bottom of the observation box. The article is illustrated with sample photographs showing the streamline flow round various obstacles.

On the Resistance Experienced by a Body in Motion Relative to a Viscous Fluid. (V. Valcovici, Z.A.M.M., Vol. 17, No. 3, June, 1937, pp. 177-80.) (45/8 Germany.)

The difference between the resistance experienced by a body in the case of accelerated flow of a fluid, the body being at rest, and that experienced for accelerated motion of the body, the fluid being at rest at infinity, is equal to the force of inertia of the fluid displaced by the body. This theorem, originally established by the author, and confirmed by St. Neumark in a special case (Z.A.M.M., Vol. 16, No. 2, April, 1936, pp. 117-20), is proved here for the general case of curvilinear motion of a body in a viscous fluid.

Experimental Study of Transverse Stability in Flight and in a Wind Tunnel. (L. Coroller, Journées Tech. Int. Aéronaut, Paris, 1936, pp. 467-486.) (45/9 France.)

Full-scale and model tests of a Potez twin-engined low wing monoplane, of 3,000 kg. total weight, are described. Flight tests included observation of the position of either the rudder or the aileron control to maintain (1) steady rectilinear flight, (2) and (3) steady turns to the left and to the right of known angular velocity, the other lateral control being held fixed, and the tests being made over a range of speeds and with engines at fixed throttle settings (including fully open). The difference between the control positions for straight and curvilinear flight determines the degree of stability or instability for a given test speed. A wing dihedral angle of about 5° was found to give stability over the flying range of speeds. Rolling and yawing moments of a model were measured in a wind tunnel over a range of angles of yaw and incidence. A stability diagram can be obtained by plotting curves for the ratio of the rates of change of rolling and yawing moment with angle of yaw against wing incidence or aeroplane speed, the constant parameter being wing dihedral. To each dihedral angle there corresponds a speed below which instability sets in.

Trouble with Goodrich De-icers. (Inter Avia, No. 438, 5/6/37, p. 3.) (45/10 U.S.A.)

The Department of Commerce, U.S.A., after finding that parts of the wing leading edge of air liners on which Goodrich rubber de-icers had been applied, had weakened, has suggested to the air lines the removal of these devices and a thorough inspection. Improved methods of attachment are in course of development.

The Argus Wheel Brake at the Brussels Aero Show. (Inter Avia, No. 438, 5/6/37, pp. 4-5.) (45/11 Germany.)

One side of the Argus wheel, which is cast in one piece, forms a brake casing and is provided with a brake casing lid; the brake unit is located in the brake casing between the interior hub tube and the brake flange. The brake unit consists of an elastic braking element between symmetrically arranged sprung torsion discs which carry the brake linings. By forcing oil into the braking element, the brake linings are pressed against steel discs which are fastened to the brake casing. No servo apparatus is required and the braking effect is thus eased off without jamming or slipping; the brake may be used for either direction of the Argus wheel which rests on ball or roller bearings. The connecting units between the brake and the feeder tube are fitted with valves which open automatically when joined together. When the coupling is disconnected the two valves close automatically and the loss of braking oil as well as the penetration of air and dust into the feeder system is made impossible. On changing the wheel, no filling or airing of the braking system is required.

Four-Engined Land Transport Planes. (Inter Avia, No. 439, 8/6/37, pp. 1-2.) (45/12 ——.)

Modern land plane construction tends towards four-engined aircraft which is already the usual arrangement in the case of flying boats.

The following is a table of four-engined land planes now under construction or planned:—

Country.	Type.	B.H.P.	Gross Weight (tons).	Passengers.	Top Speed (as given by firm)	State of development.
Germany ...	Junkers Ju.-90	4 × 800	20	40	220/236	Undergoing trials.
France ...	Bloch 160	4 × 690	—	—	—	,, ,,
,,	Breguet 760	4 × 1100	24·5	56	236	Planned.
,,	Farman F. 223	4 × 690	—	Mail.	225	Ready for flight shortly.
,,	Farman F. 224	4 × 815	18	44	194	In service.
,,	Wibault	4 × 1300	25	73	239	Large model completed
England ...	DH. 91 Albatross	4 × 450/550	11·5	22/30	200	Undergoing trials.
,,	AW.-27 Ensign	4 × 795	20	27/42	200	Ready for flight.
Holland ...	Fokker F. 56	4 × 1100	22·5	56	220	Planned.
U.S.A. ...	Boeing 370	4 × 1205	21·5	32	—	Under construction.
,,	Curtiss	—	—	—	—	,, ,,
,,	Douglas DC.-4	4 × 950/1100	30	40	230	,, ,,
,,	Glenn Martin	—	—	40	—	,, ,,
U.S.S.R. ..	A.N.T. 20	4 × 1200	40	60	171	Ready for flight shortly.

Compressed Air, Hydraulic and Electricity Aboard Aircraft. (Ch. Waseige, Inter Avia, No. 440, 12/6/37, pp. 1-3, and No. 441, 15/6/37, pp. 1-3.) (45/13 France.)

The principal conclusions of the lecturer were as follows:—

1. *Drive.*—For the operation of electric generators, air and liquid pumps, the most fortunate solution is the installation of a separate gearbox which is engine driven through a flexible shaft. Provision is made on the box for driving the various accessories at appropriate speeds.

It has been found that a number of smaller units (such as generator or air pumps) are preferable to single units of equal capacity (increased efficiency and reduced cooling difficulties).

2. *Compressed Air.*—The use of a single air compressor with various stages of pressure reduction has not proved feasible and thus separate high pressure (30 atm.), medium pressure (2.5 atm.), and low pressure (0.5 atm.) blowers have to be provided. (The high pressure is mainly used for engine starting, brakes and shock absorbers, medium pressure for automatic steering apparatus and low pressure for de-icing.)

In addition an exhauster is now usually fitted to operate the gyro.

3. *Hydraulic Gear.*—The great latitude as to gear ratio renders the hydraulic system specially suitable for the operation of controls.

4. *Electric.*—The use of alternating current 110 volt, 150 cycles, is recommended.

Span Load Distribution for Tapered Wings with Partial Span Flaps. (H. A. Pearson, N.A.C.A. Report No. 585, 1937.) (45/14 U.S.A.)

Tables are given for determining the load distribution of tapered wings with partial span flaps placed either at the centre or at the wing tips. Seventy-two wing flap combinations, including two aspect ratios, four taper ratios, and nine flap lengths are included. Comparison between theory and experiment shows that the predictions of this report as to load distribution are sufficiently accurate for structural purposes. The data are also of interest in relation to the stalling of tapered wings with flaps. Only qualitative agreement is however to be expected, especially in the case of partial span flaps, since theory neglects the relatively large transverse flow caused by abrupt changes in lift distribution produced by the flap. This flow delays the stall of sections immediately adjacent to the flap and causes the initial stalling point to move outward away from the flap ends.

The "Pouit" Wing Flaps. (Les Ailes, No. 837, 1/7/37, p. 6.) (45/15 France.)

Immediately prior to landing, the Pouit flap acts as an ordinary high lift device, the flap being at approximately 20° to the wing chord. As soon as the aeroplane has touched the ground, the incidence of the flap is reversed so that it now makes an angle of 20° in the opposite direction. This causes the aircraft to be pressed down on to the ground by aerodynamic forces as well as gravity. The braking system is rendered more effective and the landing run is reduced considerably.

Aerodynamic Brake on Polar Aircraft. (Les Ailes, No. 837, 1/7/37, p. 6.) (45/16 U.S.S.R.)

The Russian plane A.N.T.6 which was the first to land at the pole was provided with a tail parachute, which was released as soon as the skis touched the ice. The pull of the parachute was transmitted to the central wing section and caused a considerable reduction in the landing run.

Some of Germany's New War Weapons. (U.S. Naval Institute Proceedings, Vol. 63, No. 412, June, 1937, p. 892.) (45/17 U.S.A.)

Germany is the only country which has built up an anti-aircraft organisation as an integral part of its flying force. The air force is divided into three branches:—

(1) The air force proper.
(2) Anti-aircraft defence.
(3) Signal corps, which is charged with communication duties and observation and detection of raiding planes.

The Germans use 20 mm. and 37 mm. guns as well as machine guns on double mounts for low flying planes and 88 mm. for heights of 4,000 m. and above. Co-operation between searchlight and gun is electrical, the searchlight crew controlling the gunfire. It is stated that experiments are in progress to make the sound detectors control both searchlights and guns automatically.

A new kind of bomb has been evolved with an electrostatic fuse instead of the more normal chemical percussion fuse. Until an electric condenser inside the bomb is charged, the bomb is perfectly harmless. The release mechanism renders the bomb " live " by charging the condenser and it is stated that the sensitivity to impact is much greater than that of the normal type.

Flying Searchlights (*Views of Air Defence*). (The Royal Air Force Quarterly, Vol. 8, No. 2, April, 1937, pp. 112-117.) (45/18 Great Britain.)

The proposed searchlight carriers resemble multi-seater fighters, the searchlight (high pressure mercury vapour) being carried in the nose (pusher airscrews). A crew of two is carried and the speed of the aircraft is the same as that of the accompanying fighters. The object is to show up the enemy aircraft and facilitate the attack of the fighters. It is stated that a searchlight 25 to 30 inches in diameter will have a range up to 1,500 yards. No details as to the electrical installation are given.

Ramming Attack against Bombers. (The Royal Air Force Quarterly, Vol. 8, No. 2, April, 1937, pp. 141-146.) (45/19 Great Britain.)

The suggestion is put forward to design special interceptor fighters to ram bombing aircraft with the object of carrying away the tail unit. The cockpit is placed well aft so as to enable the pilot to escape by parachute. No armament is carried, the weight saved being utilised by having an armoured bulkhead so as to deflect the bullets of the bomber. It is thought that present-day bombers will be practically defenceless against this form of attack. If carried out at high altitude, the ramming pilot has a reasonable chance to escape by parachute. In the case of low altitude bombing attack, however, the parachute is probably of little use.

Experience with Heavy Bombers in Spain. (Les Ailes, Vol. 17, No. 836, 24/6/37, p. 12.) (45/20 Spain.)

The French B.C.R. (twin-engined bombers, crew of four) of which a large number have been put into service, has failed under practical war conditions in Spain for the following reasons:—

(1) Defective armament.
(2) Lack of speed and manœuvrability.

(1) The bomber suffers from a complete lack of fire co-ordination for its three machine guns. Attempts are now being made to fit an electrical signalling system. But even if this difficulty could be overcome and the gunners kept informed of the position of the attacking fighters, the turrets as supplied are very unsatisfactory. They appear to be makeshift contrivances on which, in contradistinction say with the engine installation, very little thought and care has been expended. The motion of the turret, instead of being smooth and progressive is harsh and jerky. The transparent portions deform to such an extent that serious errors are introduced in the sighting of the gun. Theoretically, the field of fire of the bomber should possess no blind spots. In practice it was very different and the fighter soon took advantage of this.

(2) As regards the inferiority of speed mentioned above, it appears that this can be overcome by special designs such as the Potez 63. But what is the use of speed without fire accuracy Only by combining both will it be possible to hold the mastery of the sky.

Observations on Cylinder-Bore Wear. (M. M. Roensch, J.S.A.E., Vol. 40, No. 3, March, 1937, pp. 89-98.) (45/21 U.S.A.)

The main causes of cylinder-bore wear in approximate order of their importance are:—(1) *Abrasion* (wear due to foreign particles in the oil film); (2) *erosion* (wear due to metal contact between the pistons or rings and the cylinder bore);

(3) *corrosion* (oxidation or chemical attack of the cylinder wall by the products of combustion). In certain cases the relative importance of these effects may be completely changed by the conditions of operation, engine design, air cleaner design, piston and ring equipment and the lubricating oil. (1) The main cause of *abrasion* is road dust entering the crankcase or the intake system. The only real solution is to keep the dirt out by means of air cleaners; cylinder wear in presence of dust may be reduced by hard cylinder block metal and wider piston rings of suitable design and material. (2) In preventing *erosion*, design of the cylinder block and piston ring are of outstanding importance. The heavy erosion which occurs during starting up from cold, due to the fact that the piston heats and expands more quickly than the cylinder, can be improved by anodising or tin plating of the piston. (3) The worst *corrosion* occurs when an engine is cold, due to condensation on the cylinder walls. Solutions under consideration include the use of light oils which get into circulation rapidly, high jacket temperatures and adequate supply of oil.

Pateras Pescara Free Piston Compressor. (Les Ailes, No. 834, 10/6/37, p. 7.) (45/22 France.)

Although no reference is made to the fact, this compressor shown at the Paris Exhibition, works on the same principle as the Junkers free piston compressor, described in the technical Press in 1935 (Abstract No. 30,582—A. and N., No. 35, p. 21).

As already suggested by Junkers, the scheme lends itself to aircraft propulsion, the compressed air, after heating by the exhaust, being led to a number of subsidiary turbines which drive the propellers. It is stated that M. Pateras is designing a 1,200 b.h.p. unit on these lines, the overall weight being of the order of 800 gm. per b.h.p. As in the case of Abstract 30,582, no details of the coupling system are given (this is probably of the ratchet type).

Reduced Maintenance of Aircraft Engine Power Plants. (A. V. Willgoos, J. Aer. Sci., Vol. 4, No. 7, May, 1937, pp. 286-287.) (45/23 U.S.A.)

The expense of engine upkeep depends on two factors—reliability and durability. These factors in their turn depend on design, operating technique, power output, fuel and oil and overhaul technique. The outstanding improvement in design over the last ten years has been the assurance of adequate lubrication to all parts and especially to the valve gear. With the new lubrication system now available, it is possible to run engines 600 hours between overhauls without any inspection of any parts other than spark plugs (60 hours) and renewal of oil (120 hours). Attention to the last two items is likely to reduce maintenance costs considerably (better plugs and oil cleaners). At the moment operating technique still differs appreciably with different flying personnel and this reflects adversely on maintenance. With the provision of automatic carburettors this will be avoided in the future.

Low Pressure Fuel Injection System. (Aero Digest, Vol. 30, No. 6, June, 1937, pp. 46 and 48.) (45/24 U.S.A.)

The petrol injection system developed by Messrs. Marvel-Schebler Carburettors has been approved as standard equipment for the Continental W-670 engines. The article describes the system in detail with the help of a cross-sectional diagram and photographs. A single metering orifice controlled by the air throttle supplies as many pump plungers as there are cylinders. An over-riding adjustment allows for altitude control. The plungers are reciprocated by means of a swash plate, the connection being such that a simultaneous partial rotation of the plungers is produced. The spray nozzles are placed close up to the engine inlet valves and it is stated that the pick up and acceleration are both remarkably good. Three

hundred and fifty hours of winter flying without external heat and in all sorts of weather demonstrated complete freedom from icing troubles.

High Output in Aircraft Engines. (R. N. du Bois and V. Cronstedt, J.S.A.E., Vol. 40, No. 6, June, 1937, pp. 225-231.) (45/25 U.S.A.)

With the advent of high octane rated fuels, the power output of an engine can be considerably increased by a simultaneous rise in boost and compression ratio. The same high power output can be obtained either at a low boost and high compression ratio or at a higher boost and a correspondingly lower compression ratio. The low boost job will have a higher thermal efficiency, but a considerably higher explosion pressure. Although experimental single cylinder units have gone up to 1,700 lb./sq. in. (I.M.E.P. 420 lb./sq. in.) no general data as to maximum permissible pressure are available on this subject. The author calls attention to the fact that high explosion pressures are generally subject to considerable variation from cycle to cycle (probably due to changes in ionisation at the spark gap leading to variable ignition timing)* and this may affect the smooth operation of multi-cylinder units. The possibility of using pressure inhibitors (as distinct from detonation inhibitors) is envisaged. The effect of increased speed on engine output is also briefly considered. It is concluded that a cylinder which will stand the thermal and mechanical stresses due to high boost and compression ratio at normal speeds is not seriously affected by a further increase in r.p.m.

Aircraft Engine Installation Vibration Problem. (J. M. Tyler, J.S.A.E., Vol. 40, No. 6, June, 1937, pp. 252-262.) (45/26 U.S.A.)

When studying vibration problems, two types of instruments have given useful service. In the one, the structure is subjected to known impulses by means of an exciter which is attached to it. From the nature of the response, an idea of the natural frequence of the system can be formed. The second type of instrument records the actual vibrations of the structural elements as they occur in practice. Such recording is usually carried out photographically by means of electro-magnetic pick ups. A recent improvement consists in embodying an harmonic analyser in the electric amplifying circuit. This enables the amplitude to be read separately for each frequency present in the system, the operator simply copying down a meter reading. The advantage of this method over photographic or mechanical vibration recording is very great since the results are immediately available and do not depend on records being measured up or films developed. Having determined the vibration spectrum of the installation, it will be possible to predict vibration characteristics if the excitation and operating conditions are known. Until recently, discomfort in aircraft has been attributed almost entirely to propeller disturbances. With the appearance of better sound insulation, the effect of engine roughness on passenger comfort becomes more marked. The study of vibration is thus receiving an additional impetus quite apart from mechanical safety.

Compression Ignition Engine Performance at Altitude. (C. S. Moore and J. H. Collins, J.S.A.E., Vol. 40, No. 6, June, 1937, pp. 263-272.) (45/27 U.S.A.)

The tests were carried out on a single cylinder 5in. by 7in. four-cycle compression ignition engine, using a displacer piston combustion chamber. Intake and exhaust pressures were regulated by means of blowers and the temperature of the intake air (at the inlet valve) could be lowered to $-3°F.$ by passing the air over two radiators charged with solid CO_2 mixed with prestone and paraffin oil respectively. In this way atmospheric conditions both as regards pressure and temperature could be reproduced up to standard altitudes of the order of 14,000

* See also Tranlation No. 470 (Abstractor's Note).

feet. In addition tests were carried out in which the inlet air temperature and pressure and the exhaust back pressure were controlled as single variables. From the altitude tests it appears that the compression ignition engine has a slight power advantage over the carburettor engine for the same inlet temperature. This advantage is considerably increased if the carburettor engine intake has to be heated to prevent icing. It was found that the maximum performance of this particular C.I. engine followed neither a density nor an air consumption law accurately.

New Type of Engine Sleeve Valve. (Inter Avia, No. 441, 15/6/37, p. 5.) (45/28 Great Britain.)

The new valve is a short sleeve cut into four segments which reciprocate individually over the ports in the cylinder head guided by slots in the latter. The operation can be by overhead camshaft or push rod. The movement of the segments can take place before valve opening, thus allowing very rapid operation with a gentle cam profile and quite slow acceleration. Both in weight and cost the segments are an improvement on ordinary poppet or sleeve valves and cooling is claimed to be better. The guillotine valve, as it is called, would be most suitable for large bore engines in which poppet valves almost reach their limitation.

Connection between Cylinder Wear and Lubricating Oils of Different Viscosity Index; Effect of Addition of Colloidal Graphite. (E. Norlin, Tekn. Tidskr., Vol. 66, 20th March, 1937, pp. 9-16; Automobil-och Motorteknik No. 2.) (45/29 Sweden.)

A solvent-treated paraffin base oil (V.I. = 100) was compared with a mixed base oil (V.I. = 55) by tests in a Citroen type 7, 1935 model. The two oils had nearly the same viscosity at 50°C., viz., 78 and 76 centistokes respectively, and the maximum crankcase temperature was maintained throughout the tests at 40-65°C. Oil samples were withdrawn at regular intervals and inspected. At the end of the tests, measurements were made of loss in weight of the piston rings, loss in height of the piston rings and increase in diameter of the cylinder bore. The general conclusion was that the mixed base oil caused considerably more wear and produced a dirtier engine than the solvent treated product.

Comparative test runs of 200 metric miles of two Chevrolets using a highly refined paraffin base lubricating oil, alone and with addition of 4 per cent. of colloidal graphite, showed that wear was considerably greater in presence of colloidal graphite.

Cetane Numbers. (R. F. Good, J.S.A.E., Vol. 40, No. 6, June, 1937, pp. 232-242 and 251.) (45/30 U.S.A.)

The author has carried out comparative rating tests on a number of Diesel engine fuels, using both the C.F.R. engine and a full-scale single cylinder submarine Diesel engine (75 b.h.p. at 750 r.p.m.). The C.F.R. rating was carried out either by the knock meter delay method or by the critical compression ratio method. In the full-scale engine the rating was done by the ignition lag and the "computed combustion knock," both of which were obtained from indicator diagrams (special electro-magnetic indicator).

Speaking generally, correlation between the various methods was satisfactory for normal (undoped) fuels, especially in the range of low cetane numbers. In the case of doped (ethylnitrate and lead) fuels, however, the full-scale rating in cetane numbers is considerably higher than that obtained by the C.F.R. critical compression method.

The Influence of Humidity on Knock Ratings. (J. R. Macgregor, J.S.A.E., Vol. 40, No. 6, June, 1937, pp. 243-251.) (45/31 U.S.A.)

It has long been known that the amount of detonation in a spark ignition engine with any fuel decreases markedly with increase in humidity. It was, however, assumed that with the system of fuel rating normally adopted (*i.e.*, bracketing unknown fuel between two blends of reference fuel differing but slightly in knocking tendency) variation in atmospheric condition would have no effect on the result. The present experiments show, however, that the influence of humidity is not primarily the result of change in oxygen concentration, but is a specific effect depending on the nature of the fuel. Differences in knock rating of over three octane numbers were found in certain combinations of test and reference fuels when the humidity was varied over the range normally experienced in knock rating. The exact humidity to be used as standard has not yet been determined, but a water content of 0.0135lb. of water per lb. of dry air appears reasonable. The humidity in the carburettor intake is measured with a wet- and dry-bulb hygrometer and adjusted to the required value either by drying the intake air or adding steam.

The Lubrication of Journal Bearings in Oxidising Conditions. (C. Jakeman and A. Fogg, J. Inst. Petrol. Tech., Vol. 23, No. 163, May, 1937, pp. 350-366.) (45/32 Great Britain.)

It has been claimed that when lubricating oil is used under oxidising conditions in a bearing, a reduction in friction results due to so-called " activation " of the oil. The present experiments were carried out at the N.P.L. to check these claims, with the result that reduction in friction previously observed is now found to be due to mechanical improvement of the running surface with time and has nothing to do with the so-called " oxidation activity " of the oil.

Once a bush has reached the run-in condition, the " orthodox " fluid film lubrication is maintained almost up to seizure.

Substitute Fuels for I.C. Engines in Germany. (Abstracted from the German Press.) (45/33 Germany.)

The term " substitute fuel " is applied in Germany to certain gaseous fuels, such as generator gas (manufactured on the vehicle), compressed coal gas, or liquefied gas such as propane and butane carried in steel bottles. Extensive experiments have been carried out with these fuels side by side with a huge expansion in the manufacture of synthetic liquid fuels (coal hydrogenation and Fischer-Tropsch synthesis). Whilst the use of gas fuels in certain special cases may be justifiable (especially if producer gas is made from wood) the organisation required for the provision of filling stations, etc., together with the relative short radius of action of the vehicle so equipped will always severely limit the general use of " substitute fuels." Thus in 1936 only 1 per cent. of the newly registered vehicles were driven by gas. At the present moment the use of gaseous fuels is considered in Germany as a passing phase, it being hoped that the country will soon be in a position to meet all its requirements from synthetic liquid fuels.

Influence of Motor Fuel on Lubricating Oil. (A. Capetti and M. Segre, Ric. Scient., Vol. 2, 1936, pp. 403-9.) (45/34 Italy.)

By distilling various mixtures of lubricating oils and petrol or ethyl alcohol under temperature conditions similar to those obtaining in an internal combustion engine, information was obtained on the reduction in viscosity of lubricating oils as a result of crankcase dilution.

Motor Fuels. (I.G. Farbenindustrie A.G., B.P. 463, 218, 4th March, 1936.) (45/35 Great Britain.)

Fuels containing monohydric alcohols are rendered harmless to magnesium and its alloys by saturating such fuels with complex alkali fluorides soluble in them. Fluorides of the alkali metals or ammonia are claimed.

Fuel Pumps for Aeroplanes. (W. C. Clothier, J. Inst. Autom. Eng., Vol. 5, May, 1937, pp. 12-46.) (45/36 Great Britain.)

Conditions of working of aeroplane fuel pumps are discussed and examples given of typical pumps developed specially for the purpose. The effective head comprises the sum of heads due to gravity, acceleration, pipe friction and the pressure required by the carburettor. The gravity head will depend on the relative position of the engine and reservoirs. The height will commonly be 6 to 8ft. from reservoir to engine, but in large flying boats may be 16ft. The largest accelerations occur when pulling out of a dive, up to a value of 3 g., *i.e.*, a 3ft. vertical lift becomes equivalent to 9ft. while the acceleration lasts. Frictional head is due to the pipes and filters in the system and may equal several feet. Delivery pressure to the carburettor may range between 0.3 to 4lbs./in.^{2}. Other considerations are the most suitable position for the pump and the power to drive it, pump capacity, pressure control and reliability in operation. All present-day pumps are of the displacement type either (1) diaphragm, (2) piston, (3) vane, or (4) gear. (Examples of each kind are described.)

Molecular Structure and Oiliness of Lubricants. (J. J. Trillat, Rev. Gén. Sci., Vol. 48, 1937, pp. 95-107.) (45/37 France.)

Oiliness is a property specific of the interface formed between an oil and a metal rather than of the oil itself. Molecules on which the positive and negative charges are not distributed symmetrically have a permanent electrical moment and such oil molecules orient themselves on a metallic surface. This property may be given temporarily to even a paraffin hydrocarbon by placing it in an electrical field. An oily oil, *i.e.*, one whose molecules contain an active group, adheres firmly without spreading and is useful for low speed with heavy load. A paraffinic oil wets the surface and spreads, affords hydrodynamic lubrication, separates the surfaces and absorbs the heat. X-ray studies have demonstrated orientation and the gliding of one molecular layer on another. Diffraction of electrons is a more sensitive means of studying the same phenomena. When a paraffin oil containing a small addition of oleic acid was filtered through paper or glass wool, almost all the oleic acid was removed. In lubricating by wick the oil lost a good part of its active molecules by absorption on the fibres. A similar loss took place when the oil was passed over a number of steel balls; this is exactly what happens when the same oil is used to lubricate bearings or any metal surfaces.

German Fuel Regulations Revised. (Autom. Ind., Vol. 76, No. 26, 26/6/37, p. 941.) (45/38 Germany.)

A number of changes have been made recently in the regulations requiring German manufacturers of motor spirit to mix it with alcohol. By law, each manufacturer of such fuel is compelled to take from the Reich Alcohol Monopoly 10 per cent. of his sales of motor fuel in alcohol. The alcohol supplied for this purpose by the monopoly will hereafter contain one part in three (instead of one part in six) of methanol (wood alcohol).

The percentage of this mixture in motor fuel has been increased from 11 to 13-16, the rest consisting of petrol. The petrol may also be mixed with up to 10 per cent. of benzol. Mixtures of gasoline containing more than 10 and less than 30 per cent. of benzol can be sold only when a special permit has been obtained. Petrol without an alcohol addition can be sold only for aviation pur-

poses and then only if a certificate has been issued by the Minister for Air attesting the need for such fuel.

The M.T.T. Sperry Apparatus for Measuring Vibration. (G. S. Draper and others, J. Aer. Sci., Vol. 4, No. 7, May, 1937, pp. 281-285.) (45/39 U.S.A.)

The equipment records linear and torsional vibration of aeroplane structures and power plants in flight. Electro-magnetic pick-ups of small size are used and the records are photographed by means of an oscillograph. By taking simultaneous records, phase and amplitude relations can be studied.

(For the D.V.L. mechanical recorder utilising the scratch method, see translation No. 469.)

The West Telemagnetic Remote Reading Compass. (Aviation, Vol. 36, No. 5, May, 1937, p. 48.) (45/40 U.S.A.)

The compass operates a suitable indicator on the instrument board by means of electrical capacity changes. A small condenser plate is attached to the needle of the compass and two other plates to the bowl. Immediately below is placed a miniature vacuum oscillator which responds to the capacity changes and transmits the deflection to the steering indicator. Sensitivity control is provided and the indicator is unaffected by dip up to 10° to the horizontal.

The Lateral Instability of Deep Rectangular Beams. (C. Dumont and H. N. Hill, N.A.C.A. Tech. Note No. 601, May, 1937.) (45/41 U.S.A.)

Experimental and analytical studies were made of solid and hollow deep rectangular beams to study their lateral instability under various conditions of loading and restraint. The tests were made on bars and tubes of 17 S.T. aluminium alloy. Failure by lateral buckling occurred only in tests on the solid beams. It was found that, within the elastic range, the test results were in agreement with the classical theory for the lateral buckling of deep beams as given by Prandtl, Michell and Timoshenko. The tests were extended to the inelastic range where it was found that the substitution of Young's modulus by an average modulus of elasticity derived from the stress-strain curve made it possible to predict instability at high stresses.

Combined Stress Calculations. (F. R. Shanley and E. I. Ryder, Aviation, Vol. 36, No. 6, June, 1937, pp. 28, 29, 43, and 66.) (45/42 U.S.A.)

The system of determining the allowable loads under combined loading conditions put forward by the authors is called by them the " stress-ratio " method. It is non-dimensional, since it only deals with ratios and is also homologous, since the ratio must be between stresses of the same kind. The method has been applied to cases involving elastic stability, plastic stability and stress or material failure. Although the evidence is not conclusive, it appears that in many cases a single interaction curve or surface will apply to all these types of failure for a given combination of loading or stress conditions. It also seems that in certain specified cases the nature of the interaction is independent of geometrical proportions and fixity conditions. The generality of these conclusions must, however, be determined by further experiments. (Eight references.)

Rotary Fatigue—Bending Test Machine with Spring Control. (W. Spath, Z.V.D.I., Vol. 81, No. 25, 19th June, 1937, pp. 710-12.) (45/43 Germany.)

Theoretical considerations show that the results of a load test depend not only on the test bar, but also on the elastic properties of the test apparatus. For example, experiments with the Schenk fatigue bending test machine have proved that the load diagram is considerably affected by the manner in which the load is applied. Whilst most present-day machines using weight loading give very smooth diagrams and show the commencement of plastic deformation only by a

gradual change in direction of the curve, the modified apparatus, in which the load is applied by a strong spring, shows small plastic deformations with a clearly visible fall in stress. With apparatus of this kind it is therefore possible to obtain much more detailed knowledge of the processes occurring in loaded materials. Aluminium in the state of yield showed a much indented deformation load diagram, even from very low loads. The question as to whether the observed decreases in stress are directly connected with the fatigue strength cannot be decided at the present stage. In any case it is certain that a short time test carried out on a material does not necessarily give an idea of the state of the material under continuous loading.

Spring Support of the Engine Unit in Motor Vehicles and Aeroplanes. (B. Riediger, Z.V.D.I., Vol. 81, No. 25, 19th June, 1937, pp. 713-20.) (45/44 Germany.)

Vibrations caused by the unbalanced mass forces in engine units with a small number of cylinders (such as those used in road vehicles and light aeroplanes) can be counteracted by spring support of the engine. In the present paper equations are deduced for the forced vibrations, and the requisite stops are calculated. The results are not limited in any way by the size of the engine and are therefore of importance for engines of much greater power such as those in ships.

Influence of Mean Stress of Cycle Corrosion—Fatigue. (H. J. Gough and D. G. Sopwith, Iron and Steel Inst., Advance Paper, 21/5/37, 21 pp.) (45/45 Great Britain.)

Whilst much attention has been devoted to the resistance of materials to corrosion fatigue under cycles of reversed stress, no work has hitherto been carried out on the equally important practical cases of repeated or fluctuating stresses. This paper describes the results of tests under these conditions made on six aircraft materials, the behaviour of which under reversed stresses has previously been reported. These comprised a cold-drawn 0.5 per cent. C steel, three stainless steels, duralumin and a Mg. alloy containing $2\frac{1}{2}$ per cent. of Al. These were tested in air, also in a spray of 3 per cent. salt solution, under cycles of repeated and of fluctuating stresses. The results show that, as in air, the fatigue resistance of a material in a corrosive environment is considerably influenced by the mean stress of the applied cycle. As in the case of reversed stresses, no corrosion fatigue limit was indicated for any of the materials. If the range for any given endurance is plotted against the mean stress, the form of the curve obtained is in general similar to that obtained in air, using the fatigue limit in place of the endurance range.

Lux Engine Compartment Fire Extinguisher (CO_2). (Aviation, Vol. 36, No. 5, May, 1937, p. 48.) (45/46 U.S.A.)

The Lux automatic extinguisher weighs 18lb. for single, 27lb. for twin and 29lb. for a tri-motor installation. The liquid CO_2 is stored in a special light weight container and is discharged through a perforated duralumin ring surrounding the engine. A manual control is placed on the instrument board.

Globular Lightning Strikes Aircraft. (Les Ailes, No. 837, 1/7/37, p. 10.) (45/47 Australia.)

A Junkers Ju. 86 (fitted with Jumo 205 engines) was struck by globular lightning whilst flying in dense clouds at an altitude of 1,200 m. (Australia). The discharge was in the form of a sphere of light (reddish-yellow), 60 cm. diameter which formed on the nose of the aircraft. During the very short time it lasted, the cockpit was illuminated " as with magnesium flashlight."

No mechanical effect on the aeroplane was noticed in the air, but subsequent examination on the ground revealed that a small portion (approximately ½in. diameter) of the metal skin of the rudder had fused.

Medical Aspect of High Altitude Flying. (Les Ailes, No. 837, 1/7/37, p. 11.) (45/48 France.)

As military operation at altitudes between 6,000 and 10,000 m. offer important tactical advantages, it is of the utmost importance to be able to operate under these conditions. The main difficulties are physiological, and the author describes the French Medical Aviation Centre at Bourget where tests are carried out in high altitude chambers. High altitude flying requires frequent medical inspection of the pilot and a manœuvre involving rapid changes in altitudes (such as dive bombing) should not be carried out more frequently than once every five days.

It appears that 6,000 m. represents the average altitude without special oxygen. The provision of simple and efficient breathing apparatus together with training in its proper use forms one of the most important military requirements. Above 10,000 m., oxygen breathing alone is not sufficient and heights of this order and above will require either a pressure tight cabin or a special suit for the pilot.

The record stunts of to-day lead the way to practical application in future combats.

The Origin of the Noise of Air Propellers. (W. Erusthansen, L.F.F., Vol. 13, No. 12, 20/12/36, pp. 433-440.) (45/49 Germany.)

The experiments were carried out on a model propeller of symmetrical profile and zero incidence, 40 cm. diameter, which could be rotated up to 17,000 r.p.m.

The following principal conclusions were arrived at:—

(1) The pressure field near the airscrew is in satisfactory agreement with theory.

(2) The sound field can be considered as due to a series of fixed sources in the plane of rotation, the amplitude of the sources or radiators being determined only by the variation in field intensity at the point considered.

(3) Two propellers have equal sound intensity, if they are of the same diameter, same frequency, and are characterised by the same radial change in the pressure field at the same distance on both sides of the plane of rotation.

(4) Obstacles in the neighbourhood of the propeller blade increase the noise and change the directional characteristics.

(5) The note due to rotation is radiated mainly in the plane of rotation whilst the noise associated with the propeller is concentrated in the direction of the propeller axis. Change in propeller profile affects both the spectrum and the directional characteristics.

(6) If the resulting top speed is kept below 250 m./sec. the propeller makes relatively little noise.

(7) The acoustical output of the experimental propeller amounts to approximately 1 per cent. of the total propeller losses. This percentage is reduced as the top speed goes down. (Five references.)

New Aircraft Spotting Device. (Inter Avia, No. 433-4, 22/5/37, p. 13.) (45/50 U.S.A.)

Experiments have recently taken place from Fort Monmouth, New Jersey, by the military authorities with a new aircraft spotting device. The instrument is a very delicate heat detector which, through the use of infra-red rays, can trace the fastest fighting plane flying without lights and engines shut down. The machines were immediately spotted and illuminated by the ray which only shows

as a faint pencil of light along its course, but brilliantly lights up the object on which it is trained. By automatic triangulation the exact location of the object to be detected is determined within a period of 2 sec. mechanically within a range believed to be at least 20 miles. Particulars of the instrument, which is said to be of revolutionary importance, are being kept secret.

Heat Transfer During the Induction Stroke of an Internal Combustion Engine. (A. S. Stambuleanu, Z.V.D.I., Vol. 81, No. 23, 5/6/37, pp. 670-671.) (45/51 Germany.)

The experiments were carried out on a cylinder without piston, the air being admitted under pressure through the inlet valve and blown out at the open end of the cylinder. The cylinder walls were heated by an oil bath and the mean air temperature inside the cylinder was measured by a series of thermocouples. The experiment was repeated for series of valve lifts and cylinder lengths and the results show that the heat transfer coefficient α could be represented by the equation

$$\alpha = AC_p\eta_w^{\frac{1}{4}}(T/T_w)^m(w)^n$$

where C_p = specific heat of air at constant pressure.
η_w = viscosity of air at cylinder well temperature.
T = mean air temperature in cylinder.
T_w = mean well temperature.
w = weight of air passing per sec.

A, m and n are functions of the valve lift, valve area, diameter of cylinder and cylinder length. Average values are :—

$$\left.\begin{array}{l} A = 2 \\ m = 1.5 \\ n = 1.0 \end{array}\right\} \text{for valves in the cylinder head.}$$

It is stated that the heat transfer calculated with the above coefficient is in agreement with estimates by Neumann and Ricardo.

Heat Transfer from Cylinders having Closely Spaced Fins. (A. E. Bierman, N.A.C.A. Tech. Note No. 602, May, 1937.) (45/52 U.S.A.)

The heat transfer coefficients have been determined for five steel cylinders having fins 1.22 inches wide and the spacing between the fins ranging from 0.022 to 0.131 inch. The cylinders were tested with and without baffles in a wind tunnel; they were also tested enclosed in jackets with the cooling air supplied by a blower. A maximum heat transfer was reached at a fin space of about 0.045 inch for the cylinders tested with each of the three methods of cooling investigated. The rise in temperature of the air passing between the fins and the change in flow pattern were found to be important factors limiting the heat transfer that may be obtained by decreasing the fin space. The use of baffles for directing the air around the cylinders with closely spaced fins proved very effective in increasing the overall heat transfer coefficient provided that the spacing was not appreciably less than that for maximum heat transfer.

High Speed Camera for Propeller Research. (E. L. Gayhart, Engineer, Vol. 164, No. 4251, 2/7/37, pp. 23-4.) (45/53 Great Britain.)

The author describes the experimental camera used at the U.S. naval model basin. The model propeller operates in a glass tank and is illuminated by a photo flash lamp. Single exposures are taken through a rotating shutter (the speed of which is checked by a stroboscope) on a moving film. The exposure rate corresponds to 960 frames a second, the useful duration of the flash generally sufficing for 16 to 17 frames, of which about half are correctly exposed. The model propeller is 8in. diameter and runs at 1,400 r.p.m. (This corresponds to a full-scale destroyer propeller operating at 350 r.p.m.) Examples of photographic records show the formation of tip vortices and the beginning of cavitation.

The Lorenz Blind Landing System Tested in U.S.A. (Inter Avia, No. 433/4, 22/5/37, p. 9; and Les Ailes, No. 838, 8/7/37, p. 9.) (45/54 U.S.A.)

In the course of an examination of the series of accidents by which the American air traffic was characterised at the end of 1936 and the beginning of the current year, the conclusion was arrived at that the U.S.A. might avail themselves of the progressive development of European ground organisation. The Department of Commerce has meanwhile granted large sums for improving the flying safety in the U.S. New evidence of such reforms is furnished by the fact that American air lines are at present carrying out an exhaustive series of tests at Indianapolis with the German Lorenz ultra-short wave blind landing system; Eastern Air Lines and T.W.A. will participate in the experiments. According to a later notice in "Les Ailes," these experiments are now concluded and have demonstrated the superiority of the German system over that put forward by the Air Corps and the Department of Air Commerce. It is the opinion of the French reviewer that the use of the Lorenz system will soon become universal.

Some Problems of Aviation Radio. (F. X. Rettenmeyer, J. Aer. Sci., Vol. 4, No. 7, May, 1937, pp. 297-299.) (45/55 U.S.A.)

The problems discussed include:—

1. Electrostatically shielded loop antenna, to overcome failure of radio communication under certain meteorological conditions (so-called "rain," "snow," or "sand" static).
2. Cone of silence equipment for airport approach (so-called Z marker).
3. Simultaneous reception of weather broadcasts and radio beacon signals.
4. Increase in transmitter output combined with 110-volt supply.
5. Utilisation of short waves so that a multiple purpose receiver can be used for Z markers, radio traffic control and instrument landing.

(Thirty-four references.)

Control of Wireless Signal Variations. (A. L. Green and G. Builder, J. Inst. Elec. Eng., Vol. 80, No. 486, June, 1937, pp. 610-622.) (45/56 Great Britain.)

The paper describes an experimental investigation, for simple conditions of short distance propagation, of fading control of radio signals by methods which rely on transmission being made on adjacent frequencies. It has been found that the frequency separation of the signals required for optimum fading control is determined by the path difference between the ground and sky rays and is independent of the mean frequency of the wave. In general it is necessary to read messages on such circuits by observing the change in direct current in the detector at the receiver, since the audio-frequency components are uncontrolled. Applications of the system of fading control are suggested in connection with ionospheric research, direction finding, and broadcast telegraphy and telephony.

Aerial Navigation by the Valoris Radio Beacon. (Les Ailes, No. 837, 1/7/37, p. 8.) (45/57 France.)

The beacons are arranged in groups of three and transmit of the same wave length, but modulated to three different audio frequencies. Each beacon transmits in turn for $\frac{1}{3}$ sec., the electrical circuit being such as to ensure this accurately, as well as maintaining constant frequency.

The receiving antenna on the aircraft is non-directional, the messages being filtered out and amplified in three circuits tuned to the respective modulations of the three beacons. In this way the field intensity due to each can be measured and thus the distance from each beacon estimated. The field intensity is recorded optically, the locality of the aircraft with respect to the beacons being determined as the centre of a triangular area on a recording dial.

The advantage claimed for this system of navigation is the fact that the aircraft is not tied to a special course as is the case with the usual "homing" devices.