ABSTRACTS FROM THE SCIENTIFIC AND TECHNICAL PRESS.

Issued by the

Directorates of Scientific Research and Technical Development, Air Ministry.

(Prepared by R.T.P.)

No. 52. FEBRUARY, 1938.

On the Stability of Kármán's Vortex Street. (Bl. Dolaptschiew, Z.A.M.M., Vol. 17, No. 6, Dec., 1937, pp. 313-23.) (52/1 Bulgaria.)

The author deals with the behaviour of Kármán's vortex street in the case of disturbances of the second order. Two special kinds of disturbances are introduced: " Uniform " and " alternating." It is shown that in the first approximation both kinds of disturbances lead only to a translation. In the second approximation, an instability seems to appear in the case of alternating disturbances. A closer examination by the author shows, however, that this instability cannot actually arise.

Further Studies of the Ground Effect on the Aerodynamic Characteristics of an Aeroplane, with Special Reference to Tail Moment. (I. Tani, H. Itokawa and M. Taima, Aer. Res. Inst., Tokio, Report No. 158, Nov., 1937, pp. 117-45.) (52/2 Japan.)

The present paper deals with the effect of the ground on the aerodynamic characteristics of an aeroplane, with special reference to the effect on the tail-plane characteristics. Results of wind tunnel tests on a low-wing monoplane model show that the effect is of considerable importance. The changes in the lift and drag characteristics are quite similar to those for a wing alone, which have been fully discussed in Report No. 156. The pitching moment becomes definitely nose-heavy owing to the effect of the ground, so much so that this may in some cases necessitate alterations in the design of the elevator.

Satisfactory estimates of the foregoing effects may be obtained by theoretical calculation, although it seems that theory somewhat underestimates the effect on lift when the trailing edge flaps are working. The correlated error in the pitching moment is negligibly small.

Efflux of Gases through Orifices—Kinetic Theory. (B. V. Korvin-Kroukovsky, J. Frank. Inst., Vol. 225, No. 1, January, 1938, pp. 81-93.) (52/3 U.S.A.)

The efflux of gases through orifices was treated heretofore on a basis of adiabatic expansion, postulating a decrease of temperature, which is not observed in everyday experience. Consideration of molecular motion (kinetic theory) shows the possibility of the expansion of a gas through an orifice without change of temperature, and permits the formation of simple quantitative relations which are in a satisfactory agreement with test data. For small difference in pressure

the new expression for discharge becomes identical with Fliegner's formula. It is explained that reduction of temperature postulated by adiabatic formulæ should be understood to apply to the observer moving with stream, and that no change of temperature is registered by a stationary observer. From a consideration of the reduced number of impacts between molecules with reduction of the pressure ratio, the new " kinetic " formulæ are extended to include critical flow phenomena.

Universal Logarithmic Law of Velocity Distribution as Applied to the Investigation of Boundary Layer and Drag of Streamline Bodies at Large Reynolds Number. (G. Gurjienko, Report No. 257, Central Aero-Hydrodynamic Institute, Moscow, 1936. Available as Translation T.M. 842.) (52/4 U.S.S.R.)

The logarithmic law of velocity distribution of Kármán, applied to a figure of revolution and to a flat plate with the generally accepted value of $K=0.4$, gives too sharp an increase in the boundary layer thickness and too small values for the drag.

This is due to the fact that a much smaller value of the constant K ($K_1=0.2-0.3$) corresponds to that region where the logarithmic velocity distribution law is actually applicable (i.e., where the effect of viscosity is negligible).

If the logarithmic law is applied to the region near the wall where the effect of the viscosity shows up strongly and where the law, strictly speaking, is not applicable, an error in principle is made which it is possible to compensate by taking $K=0.4$.

Since a variable K cannot be introduced, it is proposed that in the formula for the velocity distribution a value $K_1=0.2-0.3$ be taken, and in the formula for the drag, $K=0.4$.

This, of course, only represents a temporary expedient and the search for a more general law covering all states of flow is one of the most urgent problems in hydrodynamics.

The Two-Dimensional Hydrodynamical Theory of Moving Aerofoils—II. (R. M. Morris, Proc. Roy. Soc., Series A, Vol. 164, No. 918, 4/2/38, pp. 346-68.) (52/5 Great Britain.)

The previous solution of the problem of a general cylinder moving in liquids is generalized to include the effect of a vortex-sheet wake extending backwards in the liquid from a trailing edge. Assuming the wake to be of any shape and to have associated with it a total circulation which is equal and opposite to that of the main circulation round the cylinder, general formulæ are derived for the potential function of the fluid motion and the resultant of the fluid pressures on the cylinder boundary.

It is shown that under the usual conditions assumed for the wake, the lift force produced is greater than that produced by the corresponding simple circulation, and that this greater lift is attained without the drag which accompanies it in the simple circulation.

Pressure Distribution Over a Clark Y-H Airfoil Section with a Split Flap. (C. J. Wenzinger, N.A.C.A. Tech. Note No. 627, December, 1937.) (52/6 U.S.A.)

An investigation was made in the N.A.C.A. 7 by 10 foot wind tunnel of the distributions of air pressure over one chord section of a Clark Y-H aerofoil with a split flap. The results obtained are given in the form of diagrams showing the chordwise distribution of pressure on both aerofoil and flap and as plots of calculated aerodynamic coefficients for both aerofoil and flap. (six references.)

Free-Spinning Wind Tunnel Tests of a Low Wing Monoplane with Systematic Changes in Wings and Tails. II—Mass Distributed Along the Fuselage. (O. Seidman and A. I. Neihouse, N.A.C.A. Tech. Note No. 630, December, 1937.) (52/7 U.S.A.)

Eight wings and three tails, covering a wide range of aerodynamic characteristics, were independently ballasted so as to be interchangeable with no change in mass distribution. For each of the 24 resulting wing-tail combinations, observations were made of the steady spin for four control settings and of recoveries for five control manipulations, the results being presented in the form of charts comparing the spin characteristics. The tests are part of a general investigation that is being made in the N.A.C.A. free-spinning tunnel to determine the effects of systematic changes in wing and tail arrangement upon the steady spinning and the recovery characteristics of a conventional low-wing monoplane for various loading conditions.

For the tails having a deepened fuselage and a raised stabiliser, recovery was satisfactory and the results were very similar to those previously reported for the basic loading condition. For the more nearly conventional tail, the effects of wing plan form and tip shape were quite marked and there appeared to be an adverse effect of the present loading, except for the case of N.A.C.A. 6718 section, which gave more rapid recovery than for the basic loading condition.

Pressure Distribution Over an N.A.C.A. 23,012 Aerofoil with an N.A.C.A. 23,012 External Aerofoil Flap. (C. J. Wenzinger, N.A.C.A. Report No. 614, 1938.) (52/8 U.S.A.)

Pressure distribution tests of an N.A.C.A. 23,012 aerofoil with an N.A.C.A. 23,012 external aerofoil flap were made in the 7 by 10 foot wind tunnel. The pressures were measured on the upper and lower surfaces at one chord section on both the main aerofoil and on the flap for several different flap deflections and at several angles of attack.

The data are presented in the form of pressure-distribution diagrams and as graphs of calculable coefficients for the aerofoil and flap combination and for the flap alone. The pressure distribution tests showed that, as with other types of flap, the greater part of the increment of total maximum lift due to deflecting the external aerofoil flaps downward arises from the increased load carried by the main aerofoil.

When the plain and flapped aerofoils are compared at the same angle of attack, it is apparent that the flap influences the air flow around the main aerofoil so that the aerofoil carries a much greater load without stalling than is possible without the flap.

Investigation of the Effect of the Propeller Slipstream on the Downwash and the Elevator Efficiency. (H. B. Helmbold, L.F.F., Vol. 15, No. 1/2, 20/1/38, pp. 3-8.) (52/9 Germany.)

The propeller slipstream usually reduces the longitudinal stability of an aeroplane to an appreciable extent.

The stability mainly depends on the downwash and on the elevator efficiency, and the author investigates the effect of the propeller slipstream on each of these factors separately.

The results are compared with model experiments, including British tests.

In most cases the agreement is satisfactory and substantiates the modern theory of downwash.

Wind Channel Tests on Aerodynamic Brakes. (D. Fuchs, L.F.F., Vol. 15, No. 1/2, 20/1/38, pp. 19-27.) (52/10 Germany.)

When diving aerodynamically efficient aircraft, the terminal velocity may become unduly high. A simple remedy is here provided by fitting aerodynamic

brakes. Such brakes may, however, alter the longitudinal moment and the zero lift line. In addition the wake behind the brake may reduce the efficiency of control surfaces and induce flutter.

These drawbacks are overcome by a proper choice of position and dimensions of brake. As a result of his model experiments, the author recommends fitting the brake on the lower surface of the wing in close proximity to the front spar. Under these conditions, a tail-heavy additional couple is introduced which reduces the diving moment. The provision of a slot between the brake and the wing reduces the troublesome effects of the wake without affecting the braking action.

The Development of the Catapult by the Heinkel Aircraft Works. (K. Schwarzler, L.F.F., Vol. 15, No. 1/2, 20/1/38, pp. 48/53.) (52/11 Germany.)

The following table gives the principal characteristics of the compressed air catapults developed by Messrs. Heinkel.

Type	K_1	K_2 and K_4	K_8	K_{10}	K_{11}
Launching speed (Km./h.)	105	108	105	150	150
Weight of aircraft (Kg.) ...	2,500	3,500	3,000	18,000	18,000
Weight of carriage (Kg.)	400	406	290	2,100	1,700
Weight of installation (Kg.)	—	23,440	13,220	95,000	—
Air pressure (atm.)	85	80	85	180	140
Launching run (m.) ...	11.85	20.00	13.40	31.60	31.5
Retardation run (m.) ...	2.20	3.00	2.70	5.75	6.68
Acceleration mean (g.) ...	3.65	2.30	3.24	2.80	2.80
Acceleration max. (g.) ...	4.92	3.00	4.00	3.50	3.50
Retardation mean (g.) ...	19.7	15.30	16.10	15.40	13.20
Retardation max. (g.) ...	30.0	25.0	22.0	32.0	21.50
Launching time (sec.) ...	0.81	1.33	0.92	1.52	1.51
Launching work (m.t.) ...	108.5	160	130	1,600	1,600
Average H.P.	1,760	1,600	1,880	14,000	14,100

K_1 was the first type experimented with in 1925. K_2 and K_4 are fitted to the ocean liners " Bremen " and Europa " for catapulting the postal planes. K_8 is a military version of K_4 built for the Dutch navy. K_{10} and K_{11} represent the latest types with a launching work capacity of 10 times that of K_2 or K_4. K_{10} has been used with the seaplane H_a136 in its north Atlantic crossings. The article gives some constructional details of the catapults, the most interesting feature being the air admission valve.

Improvement of Aileron Effectiveness by the Prevention of Air Leakage Through the Hinge Gap as Determined in Flight. (H. A. Soule and W. Gracey, N.A.C.A. Tech. Note No. 632, January, 1938.) (52/12 U.S.A.)

A flight investigation was made of the increase in effectiveness of ailerons that can be obtained by preventing flow of air through the wing at the hinges and of the possibility of reducing the aileron operating force by replacing ailerons having normal open hinge gaps with narrower but equally effective ailerons having sealed hinge gaps. Tests were made with a Fairchild 22 aeroplane with two sizes of plain unbalanced ailerons, one set having a chord equal to 0.18C. and the other a chord equal to 0.09C.

The results of the investigation show that improvement in the lateral-control effectiveness is obtained by completely preventing the flow of air through the wing at the hinge axis of conventional ailerons. The magnitude of the improvement depends on the aileron chord. For the 0.18C. ailerons the gain in aileron effectiveness due to sealing the gap at the hinge axis was of the order of one-fifth and for the 0.09C. ailerons the gain was about one-third. The importance of

sealing the gap was demonstrated by the fact that the 0.09C. ailerons with a slight increase in deflection range were made as effective as the 0.18C. ailerons with an unsealed gap but required only about one-third as large an operating force.

Smoke Wind Indicators on Landing Grounds. (Rev. de l'Arm. de l'Air, No. 101, December, 1937, pp. 1397-1402.) (52/13 France.)

The article describes the smoke wind indicator recently installed at the Bourget aerodrome.

The smoke is produced by an automatic oil burner supplying hot air into which the smoke producing substance is injected. The smoke produced is very white and can be controlled from the control tower of the aerodrome (start, stop, continuous or intermittent emission). In the latter case, the smoke can be used for signalling purposes (Morse code).

The system can be advantageously adapted to the marking out of emergency landing grounds in wartime, since it can be put out of action immediately.

Fixed Wing Gyroplanes. (J. H. Crowe, Airc. Eng., Vol. 10, No. 108, Feb., 1938, pp. 39-46.) (52/14 Great Britain.)

The advantages and disadvantages of the fixed wing for gyroplanes are examined. On the simplest assumptions an expression for the percentage load taken by the fixed wing of a gyroplane is derived. The values so arrived at are compared with those found by experiment and the discrepancy between the two is explained in terms of the increased downwash at the centre of the disc of the gyroplane. It is shown that as much as 50 per cent. of the weight of the aircraft can be taken by the wing at top speed with moderate wing area and the most suitable setting. The advantages of an adjustable wing from the point of view of rotor speed control are pointed out. The lift/drag of the combination is raised by 2 over lift/drag of the rotor alone. The stability of gyroplanes is discussed.

Twenty-Third Annual Report of the National Advisory Committee for Aeronautics, 1937. (52/15 U.S.A.)

Of special interest is the reference to new equipment under construction, which includes:—

(1) 19 × 3 feet atmosphere wind tunnel for air speeds beyond 200 m.p.h. This will enable the carrying out of model experiments at a higher Reynolds number than previously possible.

(2) $7\frac{1}{2} \times 3$ feet refrigerating wind tunnel for studying problems connected with ice formation on aircraft.

(3) Free flight wind tunnel 20 feet in diameter for the study of stability, control and motion of a model undergoing unrestrained flight.

The total amount of money available for general expenditure during the fiscal year 1937 was over $2\frac{1}{3}$ million dollars.

The following are two quotations from the Report.

> "No money estimate can be placed upon the economic value of greater national security through the development of the means of producing superior military aircraft . . . . . .
>
> "The research of this Committee, however, can be measured in dollars and cents . . . . . the annual savings made possible by the Committee's researches exceed the total appropriations for this organisation since its establishment in 1915."

Fire Protection in Harbour Works. (W.R.H., Vol. 18, No. 18, 15/9/37, p. 280.) (52/16 France.)

The principal recommendations are the following:

1. The goods stored must be separated into inflammable and relatively safe varieties which are housed separately.
2. Similar differentiation must be made between goods which are intended for long storage and those which are only in transit.
3. The sheds housing the goods must be provided with subdivisions (fire resisting walls) and safety doors.
4. Automatic sprinkler systems should be installed working in co-operation with foam gear.
5. It is most important that fire fighting squads should be organised amongst the regular employees, so that no time is lost in taking emergency measures (foam gear, shutting fireproof doors, &c.).

It is pointed out that the Port of London, apart from fire floats, relies entirely on the help of the London Fire Brigade in case of emergency. There is no trained personnel on the spot and no fire fighting appliances are available. Moreover only a few of the latest storing sheds (in Victoria Docks) are fitted with sprinklers.

The Most Recent Development in Machine Guns Outside Germany. (H. Nareth, W.T.M., Vol. 41, No. 4, April, 1937, pp. 178/185.) (52/17 Germany.)

The article is mainly concerned with heavy machine guns intended to combat tanks and aircraft. The usual calibre varies between 12 and 14 mm., the Hudson machine gun (U.S.A.) going up to 28 mm. In the latter case the rate of fire is 150 rounds a minute. For the smaller calibres, rates of fire up to 800/minute are possible, the bullet weighing approximately 50 gm.

In most designs the barrel is stationary, the breech mechanism only undergoing oscillations under the combined action of the explosion gas pressure and a control spring. Special reference is made to the Browning gun (U.S.A.), in which the barrel also executes a short recoil against oil pressure. The oil damper is adjustable for altering rate of fire from 600/minute to single (individual) shots.

Aeronautical Consequences of the Berlin-Rome "Axis." (A. Langeron, Les Ailes, No. 864, 6/1/38, p. 10.) (52/18 France.)

The author points out that in the war period 1914-18, Germany was able by itself alone to withstand successfully an Anglo-French industrial coalition.

All the available information seems to indicate that conditions have not appreciably changed and that France would be in a tragical position if opposed alone to Italy and Germany.

The author suggests that efficient aircraft factories be organised in those Central European countries which are friendly to France, and that in addition to British help closer co-operation with Russia should be attempted.

The best solution of all would, however, be a foreign policy directed towards a better international understanding and a curbing of the present armament race.

Smoke Producing Apparatus. (British Patent No. 472,067.) (G.E.C., J. Soc. Chem. Ind. (Abstracts B), Vol. 57, January, 1938, Abstracts p. 25.) (52/19 Great Britain.)

Evaporation of drops of oil without combustion is effected on a surface which is heated by means other than combustion; preferably an electric resistance is used. The surface is roughened, e.g., by using a gauze. The smoke is blown away by a fan producing such a strong current of air that combustion is inhibited.

Army Co-operation—Light Aircraft v. Autogyro. (R. Michel, Rev. de l'Arm. de l'Air, No. 101, Dec., 1937, pp. 1367-9.) (52/20 France.)

High speed aircraft are unsuitable for army co-operation purposes. Not only does the speed render observation difficult, but such machines cannot land in an emergency without the gravest risk. What the army requires is low speed aircraft which can land almost anywhere and for this purpose the Author recommends low powered aircraft (light aeroplanes) constructed out of wood. Such aircraft is cheap to build, the materials are available in France and quantity production could proceed without affecting the output of fighters and bombers which must be built of metal. Modern light aircraft can be built to have practically the same performance as the autogyro aircraft which is considered unsuitable for war purposes on account of its vulnerability and complicated maintenance.

Co-operation Between Tanks and Aircraft (Austrian and German Military Opinions). (Rev. de l'Arm. de l'Air, No. 101, Dec., 1937, pp. 1393-6.) (52/21 ——.)

An interesting discussion on this subject has been going on in the German Military Press for some weeks. According to the Austrian General Eimannsberger, co-operation between tanks and aircraft should make a quick decision on land possible, *i.e.*, a modern mechanised army should be able to overrun the enemy.

In view, however, of developments in modern quick fire artillery, the German authorities taking part in the discussion are of the opinion that a break through even when supported by a specially trained air force will not be possible. Any future war will last for an appreciable time till the morale of the civilian population has been broken. For this reason it will be better to have an independent air force operating against the supply system of the enemy (food depots, munition works etc.).

Targets of this type are more commensurable with the risk run than if low flying aircraft attempt to inflict losses on a ground army.

Anti-Aircraft Shells Detonated by Light Rays. (French Patent No. 803,882.) L. M. Ericsson, Rev. de l'Arm. de l'Air, No. 101, December, 1937, pp. 1417-9.) (52/22 France.)

Two rings of lateral orifices are provided on the shell, one ring being situated near the nose, whilst the second is close to the base of the shell.

Light is emitted through one set of orifices by the combustion of a special powder. If the shell passes near the target, the light reflected from the target enters the other set of orifices and operates a photoelectric relay which initiates the detonation of the shell.

Compensating devices to rule out the effect of stray illumination are described.

Improvements in the Design of Aircraft Bombs. (French Patent No. 809,077.) (M. Sabathe, Rev. de l'Arm. de l'Air, No. 101, December, 1937, p. 1420.) (52/23 France.)

The principal objects of the invention are the following:—

1. The explosive charge and the fuse are introduced into the bomb through separate orifices.
2. Charge and fuse are separated by a bulkhead so that no mixing can take place during the handling of the bomb.
3. The bomb will only explode if it strikes the ground with a considerable force and is thus safe if accidentally dropped near the ground and will even withstand a forced landing of the aircraft carrying the bomb.

In the design illustrated, the explosive is housed in a porcelain container inserted in the bomb body and provided with a filling orifice at the tail. The fuse can only operate if the casing at the nose is torn off by a drop from a great height.

Friction in Aircraft Supercharger Impellers. (V. Varley, Aeron. Eng., U.S.S.R., No. 6, June, 1937, pp. 61-75. Original in Russian.) (52/24 U.S.S.R.)

1. The coefficient of friction for an open-type impeller does not depend
   (*a*) On the circumferential speed of the rotating impeller; this has been confirmed by experiments in which the velocity was varied from 60-160 m./sec.
   (*b*) On the quantity of air passing through the impeller.
   (*c*) On the clearance between the fixed casing and the rotating impeller; in the experiments quoted this was varied between 0.5 and 1.9 mm.

2. The coefficient of friction depends only on the construction of the impeller (*i.e.* the shape and number of its blades and the diameter.) The coefficient of friction may be calculated from the following empirical formula, deduced from experimental results

$$\beta = C + (2.33/100)\ (300 - D)$$

where D is the diameter of the impeller, and
C is a number depending on the type and number of the blades.

A table of numerical values for C is given.

3. In the case of all open impellers, the friction varies according to a parabolic law. The speed exponent for all impellers tested varied around 2.9, *i.e.*

$$N_r = An^{2.9}$$

where the constant A depends on the number of blades and the diameter of the impeller.

The Cooling of the Turbine Blades of Exhaust Driven Superchargers. (J. Oderfeld and J. Sachs, Les Ailes, No. 864, 6/1/38, p. 7.) (52/25 ——.)

The following schemes for cooling the turbine blades are already in use or have been proposed.

1. Rotor cooled by slipstream, the turbine (open delivery) being placed outside the fuselage. This method is extensively used in the U.S.A. (G.E.C. construction).

2. Alternate air and exhaust discharge nozzles are used. Disadvantages are high shock losses and wear.

3. Lorenzen proposes hollow turbine blades, the cooling air being compressed in the rotor and utilised for supercharging. In a more recent design, the combination of turbine and compressor in one unit is given up, the cooling air being discharged to atmosphere.

4. Messrs. Brown Boveri attempt to cool the blade (hollow) by discharging the air through a number of holes placed near the nose of the blade. It is claimed that a heat insulating boundary layer is formed which prevents direct contact with the exhaust.

After pointing out the disadvantages of the above methods, the authors describe their own solution (Polish Patent No. 23,525) which consists in placing a circular hoop round the blade tips and providing this hoop with a number of circumferential fins which run in a chamber in communication with the slipstream.

Piston Rings—The Theory Underlying the High Point Design. (N. Stern, Autom. Eng., Vol. 28, No. 367, January, 1938, pp. 27/28.) (52/26 January.)

The author is of the opinion that ring vibration (flutter) in the groove plays an important part in the subsequent wear both of the ring and cylinder. This vibration is set up by the action of the gases during the combustion stroke. As a remedy for damping out the ring " flutter " the author suggests a deliberate increase of the radial pressure (mainly over the gap portion) of the ring when fitted. An increase in static ring pressure over that usually employed is not

considered objectionable, since the effective radial pressure during the combustion stroke leads in any case to a large increase.

Wind Tunnel Tests of Carburettor Intake Rams. (F. H. Highley, N.A.C.A. Tech. Note No. 631, January, 1938.) (52/27 U.S.A.)

An investigation was conducted in the N.A.C.A. 20 foot wind tunnel of the ramming effect of three general types of carburettor-intake rams for radial engines, namely, the internal constant-area type, the external constant-area type, and the external expanding type. The rams were installed on a radial air-cooled engine nacelle and tests were made with and without the propeller operating.

The internal constant-area type secures air for the carburettor from within the engine cowling and forward of the engine cylinders. The external constant-area type secures air for the carburettor from the air stream outside the engine cowling. The external expanding type secures air at high velocity from the air stream outside the engine cowling and reduces its velocity and increases its pressure by an expanding tube before it reaches the carburettor.

The results indicated that: The external types having entrances near the front of the engine cowling gave the greatest ramming effect and these results are still further increased by the effect of the propeller.

Spark Plug Endurance Tests with Special Reference to the New Scintilla Aircraft Plugs. (Autom. Ind., Vol. 78, No. 3, 15/1/38, pp. 87-8.) (52/28 U.S.A.)

The plug (designated as Bendix 5AFL) has a central one piece electrode surrounded by a copper tube, which rests on the inner surface of the electrode nose and is intended to assist in the heat dissipation. The electrode is mica insulated and the external plug body is provided with 15 deep cooling fins.

The ground electrode is of the adjustable 4 prong baffle type, the nose of the central electrode being spherical and of considerable area. By the choice of suitable material, erosion is limited to the baffle which can be easily replaced. It is claimed that the baffle action prevents the accumulation of lead and other foreign matter and that the plug has operated satisfactorily for 500 hours on a high duty engine without requiring any adjustment.

Supercharging Effect on Diesel Engines. (Autom. Ind., Vol. 78, No. 3, 15/1/38, pp. 88-9.) (52/29 U.S.A.)

To obtain full advantage from supercharging, the combustion chamber must be fully scavenged by providing sufficient blower pressure and valve overlap. Engines using a precombustion chamber may require an auxiliary valve to ensure this.

A piston or roots blower is preferable to a centrifugal supercharger as the characteristics of the former are less affected by engine speed.

The location of the blower drive is extremely important (torsional vibrations) and satisfactory results can only be obtained if the engine is designed for supercharging from the outset. Tests show that for a 50 per cent. increase in power, both piston temperature and specific fuel consumption are not affected to an appreciable extent. For rail cars, switching locomotive and heavy motor trucks, the author considers the supercharged Diesel engine as definitely superior (from the point of view of cost and weight) to a normal design of equivalent power.

More About Supercharging Diesel Engines. (Autom. Ind., Vol. 78, No. 3, 15/1/38, pp. 89-90.) (52/30 U.S.A.)

Supercharging a Diesel engine has a beneficial effect on the engine, since the ignition lag is reduced and the exhaust valve cooled by the scavenge. The reduction in ignition lag stops high gas pressures associated with late combustion and this in its turn reduces bearing loads and torsional vibrations.

In the past, supercharging has not been extensively applied, partly on account of prejudice and partly on account of cost. It is thought however that this will change as the inherent advantages of supercharging, especially when applied to the Diesel engine, are more generally realised and an increased experience renders higher degrees of supercharge possible.

In the present state of development, it is not yet possible to say which of the various types of superchargers (piston, roots, centrifugal or turbo blower) will ultimately hold the field.

Experiments with a Two-Stroke Diesel Engine. (H. List and E. Niedermayer, Forschung, Vol. 8, No. 6, November/December, 1937, pp. 265-78.) (52/31 Germany.)

The experiments were carried out on a 2-stroke engine of 120 mm. bore and 180 mm. stroke operating at 700 r.p.m. and the research is a continuation of previous work (both theoretical and practical) carried out by the authors on larger engines.

The scavenging efficiency of a 2-stroke is defined as:—

$$\eta_s = 1 - v'/v$$

where $v' = CO_2$ content of compressed charge before ignition, and
$v = CO_2$ content of exhaust.

Instead of measuring the CO_2 content of the charge by means of a sampling valve, the whole of the charge is transferred to the sampling capacity by means of a subsidiary delivery valve, working in conjunction with the engine piston. For this purpose the piston is split, the upper portion (crown) remaining in T.D.C. position as soon as the gas pressure is relieved. Experiments were also carried out with various degrees of supercharge, for which purpose a rotary valve was incorporated in the exhaust pipe. Scavenging efficiencies of the order of 95 per cent. were obtained with an excess air coefficient of 1.50. Of special interest is the calculation of the heat transfer coefficient during the scavenging process.

The Ignition and Combustion Process of Diesel Engines Working on the Vortex Chamber and Air Capacity Principle. (H. Petersen, Forschung, Vol. 8, No. 6, Nov./Dec., 1937, pp. 279-84.) (52/32 Germany.)

The experiments were carried out in a special bomb placed on the cylinder head of an air compressor, communication being by means of an automatic valve. The air intake to the compressor is heated electrically, whilst the delivery from the bomb is throttled and passed again to the compressor intake. When the requisite temperature is reached in the bomb the delivery is closed, fuel is injected and the resultant combustion photographed. Depending on the crank angle of the compressor at which injection takes place, the pressure in the bomb will vary, since delivery from the compressor takes place through the automatic valve at the base.

Since the weight of air handled by the compressor is known, the air speed in the bomb corresponding to the charge transfer can be calculated. Various inserts to represent vortex combustion chambers (Ricardo-Comet) or air capacities (Henschel-Lanova) were inserted in the bomb and the flame photographs studied as a function of the air velocity. The results obtained are in general agreement with engine experiments but have the great advantage that the effect of small alterations in the design of the combustion chambers can be quickly ascertained.

The Effect of Gas Inertia on Volumetric Efficiency. (J. Aschenbrenner, Forschung, Vol. 8, No. 6, November/December, 1937, pp. 285-94.) (52/33 Germany.)

The volumetric efficiency of high speed piston engine is markedly affected by inertia phenomena in the inlet pipe.

The author investigates analytically the flow of air in a pipe subjected to a small pressure difference and starting from rest. The paper thus presents a simplified version of previous investigations by the author which covered the more general case of large pressure differences.

The results are directly applicable to engine practice and a worked example shows the application of the formulæ to the case of a high speed motor car engine. The predicted timing of the inlet valve for maximum volumetric efficiency is in good agreement with test results.

An Efficient Silencer for Pipe Lines. (M. Bentele, Forschung, Vol. 8, No. 6, November/December, 1937, pp. 305-11.) (52/34 Germany.)

The silencer described works on the principle of resonance and has the great advantage that it can be tuned to give optimum results after installation.

The theory underlying the design of such silencers is given and verified by experiment. If the resonator chamber is lined with sound absorbing material, the damping curve becomes flatter and the tuning less pronounced.

An example of such a type of silencer as applied to a large roots blower is described and illustrated.

The Effect of Detonation on Engine Stresses. (J. Geiger, Autom. Tech. Zeit., Vol. 40, No. 24, 25/12/37, pp. 614-9.) (52/35 Germany.)

The author investigates the differential equation of motion of a piston/connecting rod system undergoing elastic deformation under the influence of a periodic gas force. He points out that in the case of resonance, the maximum force in the connecting rod will exceed the maximum gas pressure very considerably. In the case of detonation, gas pressure vibrations occur which in the opinion of the author, are of the same order of frequency as those of the piston connecting-rod system. Under these conditions, therefore, bearing pressures much in excess of those usually assumed occur which may explain design troubles associated with " harsh running " Diesel engines.

In conclusion the author refers to experiments by G. Le Mesurier and Stansfield on the vibration of engine structures (North East Coast. Inst. of Eng. & Shipbuilders). These authors measured the actual stresses in the cylinder of an engine under various conditions of operation and found that even a relatively small increase in the rate of application of the gas pressure produced a considerable increase in the peak stress values.

Stresses in Crank Webs—The Disadvantages of Circular Webs. (E. A. Wedemeyer, Autom. Tech. Zeit., Vol. 40, No. 24, 25/12/37, p. 620.) (52/36 Germany.)

By means of model experiments, the author demonstrates that circular webs subjected to bending deformation give rise to unfavourable stress concentrations at the crankpin and journal. This probably accounts for the large number of fractures of shafts with webs of this type.

Square or oval webs on the other hand allow the bending stresses to be equalised, especially if a shallow groove is cut into the web in the neighbourhood of the pin.

Carbon Deposits as Affected by Fuel and Oil. (H. N. Bassett, Autom. Eng., Vol. 28, No. 367, January, 1938, pp. 31-32.) (52/37 Great Britain.)

The author is of the opinion that the presence of anti-oxidants in an engine oil may be expected to reduce the quantity of deposits formed. In confirmation of this view, the results of certain experiments on small air cooled cylinders are quoted which apparently showed beneficial effect of doping the lubricating oil with 1 per cent. of tetraethyl lead. (It should however be pointed out that on account of the relatively large oil consumption of such small units, the beneficial

effects, if any, could be accounted for equally well by the dope affecting the combustion characteristics of the fuel.)

Synthetic Motor Spirits. (J. Hiles, Fuel, Vol. 17, No. 1, January, 1938, pp. 1-2.) (52/38 Great Britain.)

The article refers mainly to the Fischer-Tropsch process, in which a mixture of CO and H_2 is passed over a catalyst. By varying the composition of the mixture, its temperature and pressure as well as the type of catalyst, the nature of the product varies from alcoholic to paraffinic. The yield of paraffin products reaches a maximum at atmospheric pressure, the temperature of the catalyst being of the order of 200° C. This temperature varies with the nature of the catalyst and must be very carefully controlled.

The main disadvantage of the process appears to be the low octane value of the motor spirit obtained which necessitates either doping or blending with benzol. The Diesel oil fraction however has a cetene number of 100 and can be blended with inferior fuel (tar oil). A further objection to the process is the very large space required for the reaction chambers, since the work is carried out at atmospheric pressure. The capital outlay for plant and catalyst is thus heavy.

Pylonol Oil Dope. (Aero Digest, Vol. 32, No. 2, Feb., 1938, p. 83.) (52/39 U.S.A.)

Pylonol is an oil concentrate mixed with a gas oil carrier which evaporates. The remaining 75 per cent. of the solution does not evaporate and will stand a considerably higher temperature than conventional lubricating oils before breaking down. The addition of the concentrate Pylonol does not affect the viscosity characteristics of the parent oil, but on account of its penetrating properties it reduces ring sticking.

It may also be injected into the inlet manifold to loosen valve pistons.

It is claimed that the new dope does not increase engine wear.

A Sound Pressure Level Meter without Amplification. (E. Z. Stowell, N.A.C.A. Tech. Note No. 629, December, 1937.) (52/40 U.S.A.)

The N.A.C.A. has developed a simple pressure-level meter for the measurement of sound-pressure levels above 70 db. The instrument employs a carbon microphone but has no amplification. The source of power is five flashlight batteries. Measurements may be made up to the threshold of feeling with an accuracy of ± 2 db.; band analysis of complex spectra may be made if desired.

Effect of Yaw on Vane Anemometers (R. H. Heald and P. S. Ballif, Bur. Stan. J. Res., Vol. 19, No. 6, Dec., 1937, pp. 685-90.) (52/41 U.S.A.)

The effect of yaw on the performance of three vane-type anemometers was determined in the wind tunnel. Observations were made for angles of yaw within a range of 35 degrees on either side of the zero position. Maximum positive errors of 1, 4 and 5.5 per cent. were found for the three instruments when the angle of yaw was approximately 15 degrees. The magnitude of the error depends on the design.

Plastics as Structural Materials for Aircraft. (G. M. Kline, N.A.C.A. Tech. Note No. 628, December, 1937.) (52/42 U.S.A.)

It is the purpose of this report to consider the mechanical characteristics of reinforced phenol-formaldehyde resin related to the use of such a product as a structural material for aircraft. The data and graphs which have appeared in the literature on this subject are reproduced in this survey as needed to illustrate the comparative behaviour of plastics and materials commonly employed in aircraft construction. (45 references.)

Torsional Stability of Cylindrical Shells. (A. Zahorski, J. Aer. Sci., Vol. 5, No. 2, Dec., 1937, pp. 62-7.) (52/43 U.S.A.)

The design of thin-walled cylindrical shells carrying compressive loads can be greatly simplified by means of diagrams giving the so-called " ellipse of critical stress." For a given form of cross-section and material, only one diagram is necessary. The average critical stress has an elliptical relation to certain dimensionless parameters of the geometry of the shell. Economical shells should have high torsional rigidity examples of the design of equal-legged angles and circular arc sections are given, together with some of the experimental results.

Hydrodynamic Corrosion of Cylinder Liners. (W. Mangold, Z. Metallk., Vol. 29, No. 12, Dec., 1937, pp. 420-2.) (52/44 Germany.)

The contact P.D. between an electrolyte and a metal will depend on the state of motion of the electrolyte and will be markedly different for streamline and for turbulent flow.

The author is of the opinion that examples of cylinder liner corrosion examined by him are due to difference in the state of motion of the cooling water (turbulent at entry and streamline at exit). By suitable guide vanes (especially at entry) these large differences can be smoothed out and the author shows examples of such modified cooling water passages which were free from corrosion troubles.

Relation of Wahl Correction Factor to Fatigue Tests on Helical Springs. (F. P. Zimmerli, Trans. A.S.M.E., Vol. 60, No. 1, January, 1938, pp. 43-4.) (52/45 U.S.A.)

This paper presents the results obtained in an effort to test Wahl's correction factor for spring stresses. Fatigue tests were run on springs of various indexes which were coiled from the same bundle of wire and blued at the same time to ensure uniform treatment. As the results were not uniform, four series of tests were made, with additional tests to demonstrate the inertia effect of the beam of the testing machine and the influence of speed and stroke. With high spring loads the inertia effects of the beam during the down stroke were neutralised by the spring pressure. Stress ranges for the various indexes as obtained in the tests were corrected for (*a*) spring rate, (*b*) stroke, and (*c*) motor speed and the corrected values plotted. From this chart, the conclusion is drawn that the Wahl factor over corrects the stress values for low indexes.

Hot-Pressing Technique for Plywood. (T. D. Perry and M. F. Bretl, Trans. A.S.M.E., Vol. 60, No. 1, January, 1938, pp. 59-68.) (52/46 U.S.A.)

The authors review briefly the history of the cold pressing of plywood with various adhesives, and discuss the development and adoption of hot pressing with thermo-setting synthetic resin adhesives which are more water resistant than the adhesives developed for cold pressing. The various types of domestic and foreign hot presses and their characteristic features are described. It is shown that several factors in the behaviour of wood under heat are common to all known types of resin adhesives; these are the speed of heat penetration through various thicknesses of veneer and the heat losses encountered in practicable bonding periods of time, both differentiated as to core thicknesses, moisture content, and temperature. Specific pressure and wood species are found to have little if any influence on these factors. Another factor is the effect of heat on the tensile strength of wood, which is shown to be relatively unchanged in practicable bonding periods. These phenomena are shown by tables and graphs and are fully described. Other factors individual to the adhesive used, and the characteristics of a resin film, are outlined in tables and are described. The authors predict that the rapidly growing adoption of hot pressing and resin adhesives is widening the plywood market.

Synthetic Resins in Aircraft Construction (Composition Properties, Present State of Development and Application to Light Structures). (K. Riechers, Luftwissen, Vol. 4, No. 8, August, 1937, pp. 235-242. Available at translation T.M. No. 841.) (52/47 Germany.)

The article deals briefly with the manufacture of synthetic resins of various types and the fillers employed.

Synthetic resin glues are receiving extensive application in the manufacture of high quality plywood for aircraft (including propellers).

Aircraft instrument casings made of synthetic resin are also now coming into general use, especially for electrical instruments.

It cannot as yet be predicted whether it will be possible to improve the strength characteristics of these plastics to such an extent that they can be used for aircraft construction. The problem appears to be mainly concerned with obtaining a suitable filler. A propeller made entirely of plastic material (Micarta) has already had a certain measure of success and the obvious advantages of the material from the point of view of mass production have led to intensive research. (Thirteen references.)

The Use of Aircraft for the Dispersion of Hailstorms. (Les Ailes, No. 864, 6/1/38, p. 7.) (52/48 France.)

Various possible means for the dispersion of hailstorms by the use of artillery are discussed. Lately the bombing of hail clouds by means of aircraft has proved successful. Both percussion and smoke bombs have been tried. In the latter a radio active filling is heated by the combustion of the explosive, leaving a highly ionised trail of smoke as the container descends. As the clouds containing the hail are usually highly electrified, this conducting path facilitates discharge and consequent precipitation of the hail. The aircraft dropping these charges would operate at an altitude of the order of 1,000 m. above the hail cloud.

Ice Formation in Clouds in Great Britain. (W. H. Bigg, M.O. Professional Note No. 81, 1937.) (52/49 Great Britain.)

Ice formation constitutes one of the greatest dangers to the regular operation of air routes in certain parts of the world, such as North America and North and North-West Europe. The object of this note is to co-ordinate the information contained in foreign scientific literature on the meteorological condition favourable to ice formation and to give the results of similar investigations carried out in this country.

It appears that the problem of ice formation is very complicated and that considerable meteorological experience will be required if the pilot has to rely on navigation alone in order to avoid disaster.

For this reason various devices (thermal, mechanical, chemical) have been developed to prevent a dangerous accumulation of ice on the aircraft. More experience will be required to decide which of these means is likely to prove the best practical solution.

Geometrical Considerations on Picard's Method of Iteration. (Th. Zech, Z.A.M.M., Vol. 17, No. 6, Dec., 1937, pp. 341-2.) (52/50 Germany.)

First, the solution by iteration of the equation $x = \phi(x)$ is first considered and a geometrical formulation of the condition for its convergence is given, the usefulness of which is shown by applications, *e.g.*, to Newton's method of approximation. Picard's method of solving differential equations by successive approximations is next illustrated geometrically. In order to ensure a quick convergence of the process we are led quite naturally to Lipschitz's condition.

Mechanical Solutions of Algebraic Equations. (H. C. Hart and I. Travis, J. Frank. Inst., Vol. 225, No. 1, January, 1938, pp. 63-72.) (52/51 U.S.A.)

The paper describes a machine for determining the real and complex roots of higher degree algebraic equations. The principle of operation is found in the correspondence between sine wave quantities and complex numbers. The particular machine is designed for equations of the eighth degree, and finds all the roots with engineering accuracy in the space of a few minutes.

Though primarily designed for facilitating electric network calculations, the machine should find utility in other fields of applied mathematics as well.

Flight Speed of Birds. (M. T. Cooke, United States Department of Agriculture, May, 1937, Circular No. 428, pp. 1-13. Article available in R.T.P. (Abstracts).) (52/52 U.S.A.)

This most interesting pamphlet gives the flight speed of about 100 birds, mostly North American species. A bibliography of 86 items completes the work and gives the authorities for the figures quoted. In the majority of cases, the observer travelled in a motor car and the bird's speed is estimated from the speedometer. In about a dozen cases the bird is timed from an aeroplane and several good observations are recorded from trains. Only very few theodolite measurements are included.

From the author's remarks and the table of speeds, the following general conclusions may be drawn :—

1. A speed of 60 m.p.h. is exceptional and only reached by a few species (plover, pheasant).
2. For most of the birds listed, the speed is of the order of 30 m.p.h.
3. A falcon striking its prey appears to dive at well over 100 m.p.h. Such cases are, however, very difficult to measure.
4. Few birds fly at altitudes above 3,000 feet and none above 5,000 feet.
5. Birds do not like a tail wind and appear to give the best performance with a side wind.
6. The stability in turbulent air differs enormously in different species. In one case crows were unable to return to their nest whilst a flock of geese were apparently unaffected.

A New Method of Infra-Red Photography. (M. Czerny and P. Mollet, Phys. Zeit., Vol. 38, No. 23, 1/12/37, pp. 1008/1010.) (52/53 Germany.)

The process depends on the evaporation of extremely thin layers of paraffin oil deposited on a celluloid film (0.1 μ thick), backed with a thin layer of aluminium.

The thermal effects of the infra-red radiation are thus converted into interference colour changes of the film which can be photographed on a normal plate.

The new process can be used for much longer wave lengths than is possible with red sensitised plates, which generally cannot be used beyond 1.3 μ.

For the shorter wave length of the infra-red spectrum (neighbourhood of 1.05 μ), the direct photographic method is however to be preferred since it requires much shorter exposure times (ratio of 25 to 1).

Dimensional Changes in Aerial Photographic Film and Paper. (R. Davis and E. J. Stovall, Bur. Stan. J. Res., Vol. 19, No. 6, Dec., 1937, pp. 613-37.) (52/54 U.S.A.)

Results of a study of dimensional changes in aeromapping photographic film and papers under controlled conditions are presented. Both films and papers are subject to a shrinkage from processing. These materials are hygroscopic, con-

sequently their dimensions change with the varying moisture content of the air. Dimensional changes from both processing and moisture content are least in the machine direction, that is, along the roll. Films continue to shrink with time, because of a loss of solvents and plasticizer. This shrinkage is illustrated by accelerated ageing tests at 120°F. covering a period of 32 days. Two new instruments developed for measuring film shrinkage are described. A reduction of differential shrinkage in the final print or duplicate negative can be obtained by crossing the machine directions of the negative and printing material during exposure.

New Test for Dimensional Changes in Offset Papers. (C. G. Weber, M. N. V. Geib, Bur. Stan. J. Res., Vol. 19, No. 6, Dec., 1937, pp. 665-73.) (52/55 U.S.A.)

Change of dimension of paper is a serious factor in many of its uses, particularly in multi-colour offset printing where changes of dimensions cause the greatest difficulty—misregister of prints. The changes are caused by variations in the relative humidity of the surrounding air. To predict the relative constancy of dimensions of papers in use, a method was devised for determining the expansivity of paper with variations in relative humidity. Specimens of paper approximately 24 inches in length are mounted under constant tension in a cabinet in which humidity is controlled by salt solutions. Changes of length of the paper are measured by means of an optical lever, with a sensitivity of 0.00025 inch and the humidity and temperature inside the cabinet are determined with a wet- and dry-bulb hygrometer. The data thus obtained checked closely with those obtained by measuring specimens on a flat surface with a micrometer rule and were much more conveniently obtained and more reproducible.

Decibels and Phons. (Nature, Vol. 141, No. 3562, 5/2/38, p. 237.) (52/56 Great Britain.)

The decibel is a unit for specifying changes in intensity, power or energy and not a direct measure of the absolute value of these quantities. Decibels are not additive, since they measure the ratio on a logarithmic scale. Two similar sounds of intensities, I and I^2 are said to differ in intensity by n decibel, if $N = 10 \log_{10} I/I_0$. Therefore a tenfold increase in the intensity corresponds to a change of 10 decibels, a hundredfold to 20 decibels, and so on. One decibel corresponds to an increase of intensity or energy in the ratio of approximately 5/4, and three decibels to a ratio $(5/4)^3$. Hence, doubling the intensity corresponds to a change of 3 decibels. When a sound is said to have an intensity of n decibels, it is implied that it is compared with some standard intensity which has been selected as zero level. The international standard adopted is an acoustical pressure of 0.0002 dyne/cm.^{2}, this being near the threshold of hearing for frequencies of the order of 1,000/sec. The decibel scale is purely physical and does not depend on the characteristics of the ear, which assesses "loudness." For measuring loudness, a pure reference tone of constant frequency (1,000/sec.), but variable intensity has been adopted. The intensity of this is varied till it produces the same sensation of loudness as the noise under investigation. If the intensity of the reference tone above the zero level is n decibels, the noise is said to have a loudness of n phons. For sounds of medium frequency and moderate intensity a phon happens to correspond roughly to the smallest difference detectable by alternate listening under ordinary conditions.

Measurement of the Total Radiation of Steam and CO_2 in Mixtures with Non-Radiating Gases at Temperatures up to 1,300°C. (E. Eckert, Forschungsheft, No. 387, November/December, 1937.) (52/57 Germany.)

The total radiation of H_2O and CO_2 mixed with N_2 was measured at temperatures up to 1,300°C., the layer of gas varying from 10 cm. to 3 m. In the case

of CO_2 the radiation only depended on the product of the partial pressure of the radiating gas and thickness of layer (Beer Law). This law, however, does not hold in the case of H_2O.

The results of the experiments are applied to the calculation of the radiation heat transfer coefficients in boilers and engine cylinders. In the case of a normal water tube boiler, the heat transfer by radiation is of the order 15 K. cal./$m_2$hoC. and reaches about ten times this value at the beginning of the expansion stroke of an Otto engine. From this it would appear that the heat loss due to radiation amounts to 15-25 per cent. of the total heat loss (radiation and conduction) at this part of the stroke. This value is very much higher than is normally assumed.

Heat Transfer by Radiation and the Calculation of Grid Temperatures in Wireless Valves. (S. Wagner, Forschung, Vol. 8, No. 6, November/December, 1937, pp. 314-5.) (52/58 Germany.)

The general problem of determining the individual temperature of n bodies in thermal equilibrium under the influence of radiation only can only be solved under certain simplifying conditions.

The author sub-divides the total radiation received by any one body into two parts, one of which being the radiation received directly, *i.e.*, without previous reflection, whilst the second is the remainder. In order to render the resultant equations tractable, the author further assumes that for each body of the system:

(*a*) The surface temperature is practically constant.

(*b*) The normal component of the temperature gradient along the surface is practically constant.

The resulting solutions are verified experimentally for the case of four plates, one of which can be heated electrically.

In the case of grid temperature in valves, matters are complicated since condition (*b*) above is not fulfilled. The author shows how the practical grid can be replaced by an " idealised " version amenable to mathematical treatment. The final calculated values differ by less than 4 per cent. from measured values.

A Thermionic Trigger. (O. H. Schmitt, J. Sci. Inst., Vol. 15, No. 1, January, 1938, pp. 24-6.) (52/59 Great Britain.)

A simple hard valve circuit is described which provides positive off-on control with any desired differential from 0.1 V. to 20 V. Less than 10^{-6} amp. is required at the input, but up to 20 m.a. at 200 V. is available in the output. Either positive or negative control is possible. The operation cycle occupies about 10 μ sec. Applications to cathode ray oscillography, to " thermostating " and to lighting control are illustrated.

The Ultra Short Wave Guide Ray Beacon and its Application. (E. Kramar and W. Hahnemann, Proc. Inst. Rad. Eng., Vol. 26, No. 1, January, 1938, pp. 17-44.) (52/60 U.S.A.)

PART I.—Proceeding from the present state of the art of air navigation in the U.S.A., and in Germany, the ultra short wave instrument landing system in Europe is described. Mention is made of the experience gained in the operation of the beacon. In the operation of neighbouring beacons, disturbed zones will occur which, by choosing the proper frequency spacing and the proper selectivity of the receivers, may be restricted to such an extent that they will not impair the use of radio beacons in any way. These problems are discussed more in detail.

PART II.—The propagation of ultra short waves is treated on the basis of the theory of combining reflection and diffraction on the earth with respect to their

application to long-range navigation. It results that for a fixed distance and flying height an optimum wave length exists allowing the aeroplane to cover ranges of 250 km. and more.

Examples are given for producing four beams in any desired direction and for introducing the landing beacon in the long range navigation system.

Finally the properties and advantages of an ultra short wave system of navigation are considered in comparison with the use of long wave beacons.