ABSTRACTS AND NOTICES

FROM THE

SCIENTIFIC AND TECHNICAL PRESS.

Issued by the

Directorates of Scientific Research and Technical Development, Air Ministry.

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

No. 44. JUNE, 1937.

On the Mapping of the Velocity Potential and Stream Functions of an Ideal Fluid. (A. C. Erickson, Science (N.S.), Vol. 81, No. 2098, 1935, pp. 274-275; Phys. Berichte, Vol. 17, No. 1, 1/1/36, p. 10.) (44/1 2310 U.S.A.)

A new electrical process for determining the stream lines in the case of a two-dimensional potential flow is described. The shape of the body under investigation, round which the flow passes, is either cut out from a sheet of electrically conducting paper (black paper) or is made from good conducting material and laid on this paper. By touching this paper with electrodes, equi-potential lines can be traced, using a galvanometer. The method also permits the velocity field to be determined quantitatively.

The Effect of Pressure upon Natural Convection in Air. (O. A. Saunders, Proc. Roy. Soc., Vol. 157, No. 891, 2/11/36, pp. 278-291.) (44/2 3366 Great Britain.)

Many experimenters have determined the effect of l (representative length) and θ (representative temperature difference) upon the heat loss from surfaces to the surrounding atmosphere, but the effect of pressure has not been investigated systematically except in one particular case. The present paper describes measurements with vertical plane surfaces of four different heights in air at pressures from 0.001 to 65 atm. It is shown that the results can be expressed satisfactorily in terms of a dimensionless number and the values are given over a wide range. Natural convection at higher pressures, up to 1,000 atm., is also discussed and results for a hot wire in N_2 are mentioned.

General Laws of Natural Convection. Conditions for the Appearance of the First Régime. (P. Vernotte, Compt. Rend., Vol. 202, No. 9, 2nd March, 1936, pp. 733-5.) (44/3 5419 France.)

Attention is drawn to the difficulty of deciding when the laws for natural convection cease to hold and should be replaced by those for forced convection. Two cases are examined theoretically—that of a fluid contained in the space between two concentric spheres and that of a horizontal cylinder. For the latter case the transition should occur when Péclets number has a value of about unity and experiments are in agreement with this.

Smoke Method for Rendering Flow Visible Round Obstacles. (J. Valensi, L'Aeron., No. 213, Feb., 1937, pp. 17-26.) (44/4 5558 France.)

The smoke (air charged with NH_4Cl) is emitted either in the form of a continuous jet at the speed of the air stream, or in puffs of regulable frequency, with the aerodynamic field to be studied. The smoke is observed either stroboscopically, by means of light from the " Stroborama " (in the case of intermittent emission of smoke the light is modulated at the same frequency), or continuously by a beam of light. The phenomena can be photographed in both cases and observations have been made without difficulty at air speeds up to 80 m./sec. Illumination by the " Stroborama " has enabled marginal vortices of propellers and wings to be photographed. Continuous illumination is employed for determining the direction of velocities in permanent or semi-permanent flow. The application of the method to various problems is described and the results illustrated.

On the Response of a Vane Anemometer to an Air Stream of Pulsating Speed. (E. Ower, Phil. Mag., Vol. 7, No. 157, May, 1937, pp. 992-1004.) (44/5 6027 Great Britain.)

The behaviour of a vane anemometer in a pulsating air stream is examined theoretically. It is shown that the anemometer over-estimates the average air speed, and an expression is given for the magnitude of the error in an air current whose speed pulsations follow a sine law. In order that the equation of motion may be integrable analytically a small term is neglected, and this step is shown to be justified by comparing the approximate solution with the results of numerical integration of the complete equation of motion. The response of a particular vane anemometer to a pulsating air stream has been observed in the wind tunnel, and the results of the experiments confirm the theoretical conclusions.

On the Influence of the Ground on Lifting Airscrews. (A. Betz, Z.A.M.M., Vol. 17, No. 2, April, 1937, pp. 68-72.) (44/6 6110 Germany.)

On the basis of simple considerations, the effect of the ground on the motive power producing a given thrust is determined for the case of a lifting screw at a small or large distance from the ground and the result is represented graphically. The expression deduced is also used to determine the effect of the ground on the thrust at a given speed of rotation and finally it is shown how the effect of additional propeller losses can be taken into account.

The Second Invariant of the Tensor of Deformation. (M. Lagally, Z.A.M.M., Vol. 17, No. 2, April, 1937, pp. 80-4.) (44/7 6112 Germany.)

In the motion of a viscous fluid, as defined by the fundamental equations of Euler and Stokes, the deformations form a tensor whose well-known invariants are the divergence and the curl. Of equal interest, but more difficult of interpretation, is the " second invariant," which plays an important part in the dissipation function. The " second invariant " occurs among the geometrical invariants of the field of velocities of a compressible fluid and is treated by Hamel.

Conformal Transformation with the Aid of an Electric Tank. (K. N. E. Bradfield, S. G. Hooker, and R. V. Southwell, Proc. Roy. Soc., Series A, No. 898, 1/4/37, pp. 315-346.) (44/8 6155 Great Britain.)

There exists a well known analogy between the stream function of an inviscid fluid and electric potential. Similar harmonic functions appear in many elasticity problems, but usually the boundary conditions are difficult to satisfy in the electrical experiments. The authors, however, point out that the solution obtained with a conducting boundary can be used to give the required information by

conformal transformation. The method is illustrated by applying it to the study of the torsion of an isotropic prism with an equilateral triangular base. The results obtained are in excellent agreement with those obtained by the elastic theory and it appears that the electric tank can be put to a wider use than has hitherto been contemplated.

Study of the Flow of Air in the Immediate Neighbourhood of a Wall. (L. Sackmann, Compt. Rend., Vol. 204, No. 18, 3rd May, 1937, pp. 1313-5.) (44/9 6201 France.)

A stream of chemically active fluid passing in the neighbourhood of a suitably sensitised wall can produce a chemical reaction accompanied by a colour change, thus tracing on the surface the local direction of flow. The following points are to be noted:—(1) The reaction must not alter the roughness of the wall. (2) From the point of view of a rapid reaction it is advisable to use a coloured indicator for sensitising the wall, a gaseous reagent (acidic or basic) being contained in the fluid. (3) The traces obtained must be stable and correspond to the flow phenomena without deformation or diffusion. The method has been applied to the study of flow round a cylinder and over aeroplane wings; in the latter case a model (Göttingen profile 433, Reynolds number 88,000) being used. A figure shows the results obtained with the wing at an incidence corresponding to a stall ($i=15°$). It is known that the sudden decrease in lifting properties of a wing is accompanied by complete change in the condition of flow over the upper surface, and that the line of commencement of turbulence is very far forward towards the leading edge. By this method its location can be determined exactly, and the surprising result is obtained that it remains rectilinear and extremely clearly defined, in spite of the turbulent nature of the flow on the upper side.

Laminar and Turbulent Boundary Layers as Affecting Practical Aerodynamics. (E. N. Jacobs, Paper to S.A.E. Aeronautical Meeting, 11th March, 1937; J.S.A.E., Vol. 40, No. 5, May, 1937, p. 44.) (44/10 6214 U.S.A.)

The aerodynamics of aerofoil sections are considered with special reference to the determination of where transition from laminar to turbulent flow takes place along the aerofoil surface.

There being no experimental equipment for studying the problem in the higher full-scale range of Reynolds numbers, two theoretical methods have been tried. In the first method the laminar boundary layer is supposed to become unstable. In the second the mechanism of transition is supposed to be something like separation, this comparison having the advantage that the separation phenomenon is comparatively well understood and can be dealt with quantitatively by existing theory. Separation and its relation to the transition phenomena are therefore considered and the actual behaviour of the flow during its change from laminar to turbulent is illustrated. Suitable equipment capable of reaching very large Reynolds numbers will be necessary to ascertain whether the theoretical gains indicated by the theory are possible in practice.

The Dynamics of Large Hailstones. (E. G. Bilham and E. F. Relf, Quarterly Journal of the Royal Met. Society, Vol. 63, No. 269, April, 1937, pp. 149-162.) (44/11 6341 Great Britain.)

The form of the relation between terminal velocity and diameter of the hailstone is deduced from values of the drag coefficient obtained from observation on spheres towed by aeroplanes. Values of the terminal velocity are calculated for various mean densities of the ice and it is concluded that an upper limit of about 1.5lb. is set to the possible mass of a spherical hailstone by aerodynamic considerations. The terminal velocity under these conditions is of the order of 180 feet/sec.

Recent Research in Aircraft Structures. No. II. (D. Williams, Engineer, No. 4231, 5, and 12/2/37, pp. 153-4, 177-180.) (44/12 4712 Great Britain.)

Recent work in aeronautical structure research, of general interest in other branches of structural engineering, is described. Problems dealt with are:—

1. A tube of rectangular cross section under torque loads.
2. Tubes and channels subjected to bending without twisting.
3. The Hardy-Cross method of solving rigid-jointed frame problems:—
   (*a*) The original demonstration by Prof. Hardy-Cross.
   (*b*) The Hardy-Cross method applied to the continuous beam.
   (*c*) The Hardy-Cross principle in relation to the plane braced frame with rigid joints.
4. The design of beams by Wagner's tension field theory.
5. The synthesis and analysis of simply stiff structures.

Thirteen references.

The Fuelling of Land- and Seaplanes. (J. Retel, L'Aeron., No. 212, January, 1937, pp. 9-15.) (44/13 5054 France.)

Stationary refuelling depots usually consist of large underground sheet iron tanks, embedded in concrete, and filled by gravity from tank wagons, etc. Mobile depots consist of tank lorries, etc., equipped with fuel pumps, filters and fuel gauges. For military purposes vehicles must be able to traverse any type of ground and a number of light lorries is preferable to a few large tank wagons owing to the time saved by simultaneous refuelling of a number of planes.

In actual refuelling of a plane speed and safety are the main considerations. At no time must the fuel be in contact with air and at the end of the operation there must be no overflow from the tank. To ensure rapid filling the diameter of pipes must be as large as possible without reducing manœuvrability, and high pressure may be employed. The speed of flow is limited by the necessity for filtering and the danger of formation of charges of electricity. The above requirements are met by the following conditions:—(1) Maximum diameter of the pipe feeding the fuel tank—45 mm. (2) Pressure about 1 kg./cm.^{2} for a difference in level of 3 m. between the level of the aeroplane tank and that of the pump. (3) Speed of flow about 3 m./sec. The main difficulty of tightness of the connections between pipe and tank has now been overcome. The Rellumit rapid connecting system is shown diagrammatically. Flow is stopped automatically when the tank is full.

Wind Tunnel Tests of a Clark Y Wing with "Maxwell" Leading-Edge Slots. (W. E. Gauvain, N.A.C.A. Tech. Note No. 598, April, 1937.) (44/14 6028 U.S.A.)

The Maxwell type of leading-edge slot differs from the Handley Page slot in that the moving parts operate solely by rotation. The Maxwell slot also provides a means for producing an unbroken leading-edge contour when it is in the closed condition. Experiments on a Clark Y wing fitted with the Maxwell slot were carried out in the N.A.C.A. 7 × 10-foot channel on a wing 60 inches span and 10 inches chord at an air speed of approximately 80 m.p.h. The performance of the device depends on the width of slat. With a wide slat (chord 3 inches) and trailing edge flap (60°) C_L max. = 2.53. With a narrow slat (1.75 inches) and no flap, the performance of the wing was approximately the same as when fitted with a Handley Page slot of the same slat size, except that the gliding angle of the Handley Page device is approximately 30 per cent. steeper. A common disadvantage of all slotted type of wings is the high angle of attack at which C_L max. occurs. This means that a combination of flaps and slots will have to be used for landing.

Vibration Phenomena in Ternary Wing Flutter. (K. Sezawa, S. Kubo and H. Miyazaki, Aer. Res. Inst., Tokio, Report No. 147, April, 1937, 40 pp.) (44/15 6187 Japan.)

The present paper is an extension of two preceding papers to a more general case of ternary flutter, including the special cases of binary and unitary flutters. The character of the flutter was ascertained, mathematically and experimentally, through its vibrational frequencies and amplitudes for any wind velocity. The fact that flutter is a condition of unstable vibration, but not a resonance phenomenon due to turbulence of wind, was confirmed by comparing the mathematical solution of the free and forced vibrations. From model experiments it was confirmed that, while in the stage where ternary flutter begins, namely, the stage of lower wind velocity, the vibrations are merely of deflectional type; in the secondary stage, namely, the stage of higher wind velocity, they are almost torsional. The present investigation suggests that by use of a vibration damper consisting of a suitably selected inertia mass and elastic as well as damping resistances, it will be possible to raise the critical speed for wing flutter to any extent, besides minimising the vibration amplitudes even in its flutter state.

Measurement of Vibration in Flight. (C. S. Draper, Paper to S.A.E. Aeronautical Meeting, 11th March, 1937; J.S.A.E., Vol. 40, No. 5, May, 1937, p. 44.) (44/16 6212 U.S.A.)

The M.I.T.-Sperry apparatus for measuring vibration in aeroplane structures and power plants during actual flight is described. This has been developed as a result of a co-operative research programme carried out by the Bureau of Aeronautics of the U.S. Navy and the Massachusetts Institute of Technology, with contributions to design by the Sperry Gyroscope Co., Inc., and consists essentially of a number of electrical pick-up units operating a central amplifying and recording unit. The recorder is a double-element photographic oscillograph. Each pick-up is specially adapted to the type of vibration which it is intended to measure and is made so small that it does not appreciably affect the vibration characteristics of the member to which it is rigidly attached. By using a number of systematically placed pick-ups, all necessary information regarding vibration on an aeroplane can be recorded during a few short flights. The following are described in detail:—Flight test installation, sample records and results from flight test, measurement of vibratory strains, pick-up units, strain-gauge, amplifier, oscillograph and calibrator.

The Practical Application of Fowler Flaps. (F. D. Fowler, Paper to S.A.E., Aeronautical Meeting, 11th March, 1937; J.S.A.E., Vol. 40, No. 5, May, 1937, p. 44.) (44/17 6215 U.S.A.)

Practical design procedure for obtaining the most efficient characteristics of the Fowler high-lift wing device is dealt with. Points discussed include:—The importance of location of tail surfaces, the need for greater control power in the case of large aeroplanes using flaps, normal and horizontal forces in Fowlers, their reduction in a new type of aerofoil section and consequent influence on the weight of the complete flap installation. The trend towards high wing loading limits the use of slit flaps, but the limit may be extended by the use of Fowler's of 15 to 40 per cent. chord, the maximum lift increasing with chord size. Advantages of Fowler's in take-off and landing, with reference to the possible use of the nose wheel and the effect of the slipstream on the flap are pointed out. Emphasis is placed on the need for a spare wing (Fowler flap) as an extra safeguard in case of partial engine failure, ice formation or in emergency landings.

Longitudinal and lateral controllability is not necessarily reduced by Fowler's as compared with the requirements for the basic aeroplane.

Three-Wheel Landing Carriage of the Douglas DC.4. (Les Ailes, No. 831, 20/5/37, p. 7.) (44/18 6268 U.S.A.)

This new 40-seater aircraft is to be fitted with three landing wheels, one near the nose of the aircraft and the other two below the wings. The wheels are orientatable in all directions, the design being similar to that developed by the N.A.C.A. for light aircraft. Cross wind landings are thus possible and the tail being always off the ground, the attitude of the machine remains horizontal when coming to rest and the comfort of the passengers is increased. In order to concentrate the propeller slipstream on to the tail surfaces the engine axes are not parallel, but radiate outwards. The wing structure follows that of the Junker G.31, in that it is carried through the floor of the passenger cabin, the hollow wing space being utilised for luggage space.

Giant Flying Boat—Boeing 314. (Inter Avia, No. 428, 1/5/37, pp. 4-5.) (44/19 6331 U.S.A.)

This flying boat, which will be ready by the end of the year, weighs 30-40 tons and will be equipped with sea wings and fitted with four Wright engines of 1,500 b.h.p. each.

The new boat follows the general lines of the Martin Clipper, but will carry 72 passengers and a crew of eight as well as 5,000lb. of cargo. The boat has three decks, a top deck with the flight bridge and accommodation for the crew, a main deck for passengers and a third deck or hold consisting of a series of watertight compartments. This deck also contains the main fuel tanks (14,000lb.) and the freight. Additional fuel tanks (1,000lb.) are placed in the wings and sponsors.

The expected speed is 200 m.p.h. and the range 5,000 miles.

The Future of the Airship. (F. W. Lanchester, Engineering, Vol. 143, No. 3724, 28th May, 1937, pp. 613-4.) (44/20 6353 Great Britain.)

Doubt is expressed as to whether the airship has any prospect of a commercial future. Safety can be ensured only by inflation with helium, and in the case of the Hindenburg, this would have reduced the lift by 14 tons, equivalent to two-thirds of the pay load, and the airship would then have had no commercial value. It is stated that had the R.101 been filled with helium it would have been unable to rise from the ground at all. By comparison, over a flight of 12,000 miles, of the performance of an airship, with that of the probable future type of aeroplane (four Diesel-engined flying boat, of speed 200 m.p.h. and capable of undergoing minor repairs in flight) it is shown that allowing four 8-10-hour stops of the flying boat, it can still cover the distance in 100 hours, as against an estimated non-stop journey of 150 hours by the airship. There is no prospect of increasing the speed of airships beyond 100 m.p.h. unless their size is considerably increased.

Comparison of Combustion and Working Processes of Various Types of Internal Combustion Engines. (E. F. Schmidt, Z.V.D.I., Vol. 80, No. 25, 20/6/36, pp. 769-779.) (44/21 1904 Germany.)

Indicator diagrams have been obtained by means of the D.V.L. glow-lamp indicator, and special interest attaches to the diagrams for pressure differences between the various parts of the sub-divided combustion space of new types of Diesel engines. In particular the relationship between fuel consumption and mean and maximum pressure in the cylinder is explained and the effect of ignition lag on the pressure curve and progress of combustion investigated. The processes in a Diesel engine with sub-divided combustion chamber are more closely investigated, and the effect of differences in wall temperatures are noted.

Piston Ring Friction in High Speed Engines. (L. Illmer, Trans. A.S.M.E., Vol. 59, No. 1, January, 1937, pp. 1-6.) (44/22 4578 U.S.A.)

The recent trends towards higher speeds in internal combustion engines has been accompanied by a sharp rise in frictional losses due primarily to abnormal piston ring drag. The problem is of particular importance in multi-cylinder engines of small bore in which the ratio of the combined contacting surface of the sealing rings to the piston area is unduly large. The increased drag is due to a relatively high pressure which is built up in the annular chamber under the first, or top, ring. Available test data from different sources is collected in this paper and analysed to establish a criteria for normal frictional drag at different speeds and groove pressures. Results are used to predict the piston ring friction of a heavily loaded engine running at maximum speed.

Hydraulic Starter for Aircraft Engine. (Autom. Ind., Vol. 76, No. 17, 24/4/37, p. 622.) (44/23 5969 U.S.A.)

Mounted opposite the end of the crankshaft, the Berger starter consists of two opposed cylinders, each containing a piston with a stem having an inclined rack. The central helicoidal pinion engages with the two racks. The oil, maintained under high pressure in a small tank, is admitted into the cylinders by means of a three-way cock operated from the instrument board. By reason of the thrust, the pinion moves forward, engaging with the claw on the end of the crankshaft and turns over the engine by reason of its rotation. At the end of the stroke the pinion disengages and the two racks return to their original position by reason of the coil springs. A spring-loaded ball locks the pinion in the central position. The oil used for the starting motor can also be employed for operating the landing carriage, brakes, or other parts of the plane.

Blower Cooling of Finned Cylinders. (O. W. Schey and H. H. Ellerbrock, N.A.C.A. Report No. 587, 1937.) (44/24 6029 U.S.A.)

Several electrically heated finned steel cylinders enclosed in jackets were cooled by air from a blower. Tests were conducted at air velocities between the fins from 10 to 130 m.p.h. and at specific weights of the air varying from 0.046 to 0.074 pound per cubic foot. The fin dimensions of the cylinders covered a range of fin pitches from 0.057 to 0.25 inch, average fin thicknesses from 0.035 to 0.04 inch, and fin widths from 0.67 to 1.22 inches. The value of a, based on the difference between the cylinder temperature and the inlet air temperature, varied as the 0.667 power of the weight velocity of the cooling air for cylinders having fin spaces from 0.21 to 0.077 inch. The smaller spacings, the exponent increased and the value of a decreased. The power required for cooling varied as the 2.7 power of the weight velocity for a given density and inversely as the air density for a given weight velocity. For a given power, maximum heat transfer was obtained with a 0.045 inch spacing.

Aircraft Engine Reduction Gears. (F. L. Prescott, Paper to S.A.E. Aeronautical Meeting, 11th March, 1937; J.S.A.E., Vol. 40, No. 5, May, 1937, p. 46.) (44/25 6218 U.S.A.)

A brief history of the development of military aircraft engines shows the necessity for the development of reduction gearing. Seven general types of reduction gears which have proved satisfactory for aircraft engines are described with diagrams, and their advantages and disadvantages discussed.

As regards stresses in crank cases and engine mounts, it is shown that crank case torque stresses are greatly reduced if the direction of rotation is the same for the crankshaft and the propeller shaft. Advantages of the use of two propellers rotating in opposite directions on the same engine are discussed, with two suggested methods for gearing the propellers. Mention is made of the advantages of optional propeller rotation on multi-engine installations, methods

of equalising both loads in multiple contact types of gearing, optimum propeller shaft speed, engine speed and reduction gear ratio.

Design Tendencies in French Aeroplane Engines and Propellers. (H. L. Brownback, Paper to S.A.E. Aeronautical Meeting, 11th March, 1937; J.S.A.E., Vol. 40, No. 5, May, 1937, p. 50.) (44/26 6222 U.S.A.)

The French originally built air-cooled engines almost exclusively, but were forced to change to water-cooling (of both V and radial types) during the war. During that period they developed superchargers and the " cannon " engine firing 20 mm. shells through the propeller shaft. Since then development has not been confined to any one type and they now have water-cooled V engines developing 1,200 b.h.p., radial air-cooled engines up to 18 cylinders giving 1,600 b.h.p., and high speed " in-line " and V type engines turning up to 5,200 r.p.m. and developing over 1 b.h.p. per cu. in. displacement. Both water-cooled and air-cooled radial Diesel engines developing 600 b.h.p. have been constructed and flown. Variable pitch propellers are being developed in several models and some interesting types are being worked out. It appears that the propeller and not the engine will soon be the limiting factor in the development of power plant.

The Sklenar Double Rotary Engine. (Les Ailes, No. 832, 27/5/37, p. 7.) (44/27 6346 France.)

This radial engine resembles the differential engine of Siemens (1918), in that the crankshaft and cylinders rotate in opposite direction, the cylinders turning at 1/9 the shaft speed.

The novel feature of the present design consists in making the cylinder heads stationary and in ring form.

The cylinders rotate inside the common circular head, the seal being provided by a conical washer and sealing pads.

The common head is provided with inlet and exhaust ports which are operated by the over-running of the cylinders, the induction and exhaust thus taking place along the cylinder axis.

This arrangement obviates all subsidiary valve gear and it is claimed that the common stationary head can be readily cooled by the slipstream whilst the barrels are cooled independently by the rotation.

The design appears of interest especially for large power units, and it is stated that the French Air Ministry have placed an order for 20 engines.

Colloidal Graphite and Piston Ring Wear. (Autom. Ind., Vol. 76, No. 21, 22/5/37, pp. 766 and 782.) (44/28 6448 U.S.A.)

The engine was run for 15 minutes and then allowed to rest 15 minutes, this cycle being repeated 180 times. During the first five minutes of each period the engine ran light (wall temperature gradually rising to 122°F.). The remaining 10 minutes were run at full load (wall temperature 212°F.). The ring wear was obtained by weighing and in case of a new engine, the wear can be approximately halved by adding colloidal graphite to the oil.

European Trends in Automotive Diesel Design. (Autom. Ind., Vol. 76, No. 21, 22/5/37, pp. 779-781.) (44/29 6457 U.S.A.)

The following are the conclusions:—

(1) Rigidity of structure necessitates cast iron crank cases.
(2) Piston rings of tapering section in the two upper grooves are a cure of ring sticking.
(3) All bearing shells must be set in the housings so as to reduce deformation under load to a minimum and excessive tension of the bearing bolts must be avoided.

(4) Composite bearings combining the load carrying capacity of lead bronze with the dirt accommodating properties of babbit have given good results.

(5) Cylinder head temperatures are best controlled by directed water supply and the water jacket should extend well below the lowest point reached by the rings so as to increase piston cooling.

Supercharger Control (*German Patent No.* 460,703, *Brand Motor Works*). Airc. Eng., Vol. 9, No. 100, June, 1937, p. 174.) (44/30 6474 Germany.)

A multi-stage blower for charging aircraft engines is provided with a rotary valve which may be adjusted from the position in which the inlet of air from the valve to the suction conduit of the fan is cut off and air is supplied through a restricted opening to the conduit leading to the second impeller. The valve is constructed in such a manner that the opening leading to the conduit is increased until it is wide open, after which it begins to reduce again. The inlet to the conduit is then cut off from the interior of the valve, and the conduit is opened fully, in which case all the air supplied passes through both impellers and the full output is obtained.

The Regnier Engine. (Les Ailes, No. 829, 6/5/37, p. 6, and No. 830, 13/5/37, p. 6.) (44/31 6516 France.)

The first article gives constructional details of a light aeroplane engine rated at 60 b.h.p. (four-cylinder in-line, air-cooled, inverted, 2.8 litres swept volume, dry weight 72 kg.).

The good performance of this model has led to the design of a 12-cylinder V engine destined for lightweight fighters and described in the second article.

The following novel features are incorporated:—(1) Crankshaft bearings are held in place by steel tie rods which go through the crank case. By adjusting the tension of these rods, the free period of the crank case can be adjusted and resonance avoided. (2) Two Roots' superchargers are employed. It is claimed that their installation reduces the induction temperature. (3) Two concentric propellers driven in opposite direction by a synchronised differential gear are fitted. It is claimed that this increases manœuvrability (no reaction torque), smaller propellers can be used, and the resistance due to the slipstream is reduced since it is no longer helicoidal. The propulsion efficiency is thus increased by 5-10 per cent.

Neither the stroke volume nor r.p.m. of this new design are given, but it appears that relatively high speeds of rotation are contemplated. The design is thus an attempt to utilise in a production engine the experience gained with the high speed racing engines in the Coupe Deutsch.

High Speed Motion Pictures of Engine Flames. (G. M. Rassweiler and L. Withrow, Ind. Eng. Chem (Ind. Ed.), Vol. 28, No. 6, June, 1936, pp. 672-7.) (44/32 1688 U.S.A.)

A high speed motion picture camera has been designed for studying the ignition and combustion phenomena in a running engine. The engine is a single cylinder ell-head engine ($2\frac{7}{8}$in. bore, $4\frac{3}{4}$in. stroke, compression ratio 4.6 to 1), provided with a fused quartz plate in the cylinder head allowing an unobstructed view of the whole combustion chamber. The window is capable of withstanding the gas pressures accompanying moderate knock. The camera photographs about 30 pictures of a single explosion at rates up to 5,000 pictures per second. Film and image motion are synchronised by means of thirty lenses carried in a disc mounted on the engine crankshaft. Use of a focal plane shutter enables the time of exposure to be adjusted without decreasing the effective speed of the optical system, and enables the moving lenses to work at full aperture during most of the explosion. Pressure time curves of the explosions are recorded

simultaneously. A set of thirty photographs of a single explosion is reproduced. This shows the ignition spark, the spread of the flame through the combustion chamber, gas movements behind the flame front and an increase in luminosity of the burned gases near the sparking plug as the explosion proceeds and the pressure rises. When flame pictures photographed with this camera at a rate of 3,000/sec. are projected as ordinary moving pictures, the flame motions are slowed down over 200 times and changes can be followed easily.

The Viscosimetrical Inspection of Lubricating Oil in Service. (L. Steiner, Engineering, Vol. 141, No. 3675, 19/6/36, pp. 659-660.) (44/33 1742 Great Britain.)

Plotting of viscosity temperature curves forms the most reliable laboratory method for routine testing of different batches of lubricants or for following the changes in their properties during use. By means of the Steiner viscometer it is possible to plot a temperature viscosity curve of 25 points in about 40 minutes and only 6 ccs. of oil are required. This instrument is based on measurement of the time of rise of an air bubble through a graduated tube containing the oil. The bubble is of piston form and its length has no effect on its rate of movement. The tube is surrounded by a glycerine bath provided with a thermometer. The instrument is placed in a horizontal position to be heated by a hot plate, spirit lamp, etc., and after each measurement is inverted to allow the bubble to travel back to the bottom of the tube. Tables are provided for converting readings into Redwood, Saybold, or other units. Reasons for alteration in the properties of oils used for various purposes are briefly discussed and typical temperature viscosity curves before and after use, obtained with the Steiner viscometer, are given.

A Visual Study in a Displacement Piston Compression Engine. (A. M. Rothrock, J.S.A.E., Vol. 40, No. 1, January, 1937, pp. 22-27.) (44/34 4419 U.S.A.)

High speed cinema photography has been applied in investigating the effects of a displacer piston on air flow, and the effect of the latter on the fuel spray and flame formation in a compression ignition engine, 2,200 exposures per sec. being taken of the phenomena in the combustion chamber of the N.A.C.A. apparatus. This consists of a single cylinder test engine which is operated under its own power for a single cycle. A vertical disc combustion chamber, the sides of which were formed by two 2½in. glass windows and a single 0.020in. fuel injection nozzle were used. By using " Schlieren " photography the air flow, fuel injection and flame formation were recorded simultaneously.

By projecting the motion pictures, the phenomena can be observed at 1/150th of their actual speed. The results showed that, although the core of the fuel spray was not destroyed by air velocities as high as 300 ft./sec., the direction of the spray was changed and the spray envelope carried away by the moving air. The volume of the chamber reached by the combustion was considerably increased by use of the displacer piston. The air movement set up during the induction of air into the engine cylinder could be controlled so as to considerably assist the air flow set up during the last of the compression stroke.

Anti-Knocks and Pro-Knocks in the Combustion of Fuels. (A. V. Belov and M. B. Neumann, Nature, No. 3523, 8/5/37, pp. 798-9.) (44/35 6093 Great Britain.)

It is now generally recognised that detonation in an engine is due to an intense oxidation reaction in the unburnt charge prior to its ignition by the flame. From experiments carried out with pentane in a small bomb, the authors conclude that the unburnt charge may give rise to a so-called " cold " flame after a short induction period. This cold flame is accompanied by unstable products which

act as accelerators and may produce the familiar knock. The induction period of this flame can be increased or decreased by the addition of certain dopes (tetraethyl lead or amyl nitrite) and the chemical theory of detonation is thus confirmed.

Engines Using Hydrogen as Fuel. (B.P. 462,605.) (R. A. Erren, Engineer, Vol. 163, No. 4244, 14/5/37, p. 583.) (44/36 6138 Great Britain.)

Experiments have shown that inefficient working is due to insufficient mixing of the hydrogen and the air. Under certain conditions a cushion of unmixed hydrogen may form immediately above the piston and escape past the piston ring into the crankcase, and where there is considerable danger of it being ignited. In other cases back-firing in the air intake pipe is caused by unmixed hydrogen escaping past the valve seating and being ignited in a similar manner. To overcome these difficulties the hydrogen is injected in a tangential direction so as to assist in mixing the gases. The injection of hydrogen begins preferably immediately the inlet valve has closed—that is, at latest at 220 deg. of the cycle from inner deal centre—and ends at latest at 280 deg. of the cycle.

Direct Injection of Petrol into an Internal Combustion Engine. (A. Labarthe and A. Ponomareff, Compt. Rend., Vol. 204, No. 18, 3rd May, 1937, pp. 1316-8.) (44/37 6202 France.)

Tests have been carried out with a high speed variable compression petrol engine (having a special cylinder provided with a fuel injection device and a sparking plug) to determine the effect of direct injection of fuel into the cylinder at different stages of the induction and compression strokes. Results show that the maximum mean effective pressure was obtained when the commencement of injection was in the middle of the induction stroke and optimum fuel consumption was obtained by injection during the first part of the induction stroke. Knocking was reduced by injecting during the compression stroke. At the optimum conditions of injection as shown by the tests, a further series of tests was carried out to determine the variation in power and fuel consumption as a function of the speed of rotation, the richness of the mixture being constant. Similar tests were carried out with an engine having a normal carburettor. Comparison shows that injection of the fuel gives an increase in power, and of 12-17 per cent., and it is considered that this improvement could be further increased by better design. The decrease in specific fuel consumption is about 7 per cent.

The Value of Octane Numbers in Flight. (D. P. Barnard, Paper to S.A.E. Aeronautical Meeting, 11th March, 1937; J.S.A.E., Vol. 40, No. 5, May, 1937, p. 42.) (44/38 6210 U.S.A.)

Improvements in octane number of aviation petrols are estimated in terms of the increased earning power of current type transport aeroplanes, by computing the change in earning power of a gallon of petrol as reflected in altered fuel consumptions or take-off load capacities. In general it can be said that:—

1. The revenue earning power of one gallon of petrol may be increased from 2 to 8 cents per octane number improvement, depending upon engine design and operating conditions.

2. If the improvement in octane number involves a decrease in energy content, the apparent improvement must be discounted by about two octane numbers for each one per cent. reduction in heat content below that of petrol.

3. The economic necessity for high octane number fuels is particularly apparent when long range operations are involved.

4. The increased earning power due to improvements in octane number is so great that cost cannot influence the trend towards higher octane numbers to any considerable extent.

Engine and Laboratory Tests of the Stability of Aviation Oils. (O. C. Bridgeman, Paper to S.A.E. Aeronautical Meeting, 11th March, 1937; J.S.A.E., Vol. 40, No. 5, May, 1937, p. 42.) (44/39 6211 U.S.A.)

Three types of laboratory method for testing the stability of aircraft engine oils were selected and data obtained for two of them using 22 oils. The methods were:—(1) Heating the oil with the surface exposed to the air, but without aeration, and (2) heating the oils under aerating conditions. Results were compared with engine data obtained with the same oils covering 30 hours' operation at cruising power in each case in a Pratt and Whitney Hornet engine. It was concluded:—

1. That laboratory methods can be developed which will rate the stability of oils in almost any order, depending upon test conditions.

2. Methods involving aeration of oils are much too severe and do not correlate with engine data.

3. Optimum test conditions appear to be heating without aeration at a temperature of approximately 175°C. Data obtained under these conditions correlate satisfactorily with the service performance of the oils in aero engines of moderate output.

Sunbury Knock Indicator. Cylinder Vibration Pick-up. (Autom. Ind., Vol. 76, No. 19, 8/5/37, pp. 693-4.) (44/40 6237 Great Britain.)

Tests on the C.F.R. engine have shown that during detonation, the cylinder is subjected to longitudinal strains, the mean velocity of vibration being a measure of the effect on the ear. In the Sunbury knock indicator this mean velocity is determined by securing an iron rod to the upper part of the cylinder and bringing its lower ends within a few thousandths of an inch of the pole of a magnetic pick-up. The induced current is rectified, amplified and measured in the usual effect by a thermal galvanometer. The advantages claimed for this instrument are that it is not subjected to the heat of combustion and the adjustments are not critical. Moreover, only one setting is required for the entire range of octane numbers.

Oiliness, what it is and what it means. (Aut. Ind.,Vol. 76, No. 19, May, 1937, pp. 697-698.) (44/41 6239 U.S.A.)

According to experiments carried out in the Pennsylvania State college, the absolute viscosity of lubricating oils increases with pressure, the rate of change being characteristic of the nature of the oil (*i.e.*, origin of crude).

The effect of pressure is most marked at relatively low temperature (high viscosity).

Thus with a load of 20,000lb. sq. in. the following results were obtained with two typical oils of different origin but similar viscosity characteristics (at atmospheric pressure):—

	Atmospheric Pressure.		20,000lb. sq. in.	
Origin of Oil.	Viscosity at 55 °C.	Do. at 90 °C.	55 °C.	90 °C.
Western ...	50 c.p.	20 c.p.	1800	300 c.p.
Eastern ...	50	20	550	170

When the oil lubricates a bearing, it thus undergoes change in viscosity due to pressure quite apart from those due to temperature and the so-called "oiliness" is an expression for the pressure sensitivity of the oil.

Relative Knocking Characteristics of Motor Fuel in Service. (J. M. Campbell, W. G. Lovell and T. A. Boyd, J.S.A.E., Vol. 40, No. 4, April, 1937, pp. 144-150.) (44/42 6325 U.S.A.)

In this investigation some of the underlying principles affecting the knocking characteristics of motor fuels in service have been studied. Briefly, the experiments indicate that the relative knocking characteristics of certain cracked petrols

with respect to straight-run petrols may be affected by the relationship of spark timing, engine speed and mixture ratio. From the standpoint of engine design the most advantageous of these variables in a given engine varies according to the nature of the fuel used. It is suggested that some of the anomalous characteristics of benzol blends are the result of vapourisation phenomena in the induction system, as also are certain " depreciation " effects which occasionally have been observed among straight-run petrols containing tetraethyl lead.

Engine Temperature as Affecting Lubrication and Ring Sticking. (C. G. A. Rosen, S.A.E. Journal, Vol. 40, No. 4, April, 1937, pp. 165-172.) (44/43 6328 U.S.A.)

The experiments were carried out in a small single cylinder Diesel engine arranged in such a way as to permit rapid inspection of piston and rings. The blow by on this unit was measured and the experiment stopped when the leakage from the crank case reached the arbitrary value of 85 cubic feet per hour. (Normal operation is characterised on this engine by a leakage of 12 to 20 cu. feet per hour.) The running time under these conditions varied between 100 and several thousand hours depending on the lubricant and the temperature conditions of the engine. It is claimed that the results are in agreement with practical experience and demonstrate the superiority of compounded oils. In the case of paraffin base oils, a high piston temperature is an advantage in certain cases, since the hotter ring groove loosens the deposits and frees the rings which have become stuck at the lower (normal) operating temperature. The question of ring sticking thus depends intimately on the piston design as well as on the type of oil used.

Properties of Synthetic Lubricating Oils from Kogasin. (H. Koch, Brennst. Chem., Vol. 18, 1937, pp. 121-7; Brit. Chem. Absts. B., Vol. 56, May, 1937, p. 408.) (44/44 6378 Germany.)

Lubricating oils prepared from the olefines in kogasin by the action of anhydrous Al Cl_3 have flat viscosity temperature curves; and for the same viscosity index they have a higher mean molecular weight than paraffin base mineral lubricating oils. Olefinic linkings in the oils are readily hydrogenated and the viscosity index of the product is thereby increased. The oils are as stable towards air and light at room temperature as are mineral lubricating oils, and their stability is increased by hydrogenation. Subjected to the British Air Ministry oxidation test the oils show a greater increase in viscosity index but a smaller increase in Conradson carbon than do mineral lubricating oils; no asphalt separation occurs with the kogasin oils. Hydrogenation of an oxidised oil restores its original properties to a considerable extent. The kogasin oil behaved satisfactorily in a road test. The less viscous synthetic oils have a high dielectric strength and are suitable as insulating oils.

Mechanical French Diggers and their Influence in Aerial Warfare. (Revue de l'Armee de l'Air, No. 93, April, 1937, pp. 383-389.) (44/45 6348 France.)

The mechanical diggers described will construct and subsequently fill in a trench 80 cm. deep and 15 to 30 cm. wide at the rate of approximately ½ km./hour. At the moment such devices are principally employed for laying electric power cables, but the author points out possible applications of special aeronautical interest:—

(1) Drainage of aerodromes.
(2) Burying telephone cables.
(3) Protecting combustible material or ammunition against aircraft attack.
(4) Protecting troops on the march or in camp by providing shelter when attacked by aircraft.

Problems of Anti-Aircraft Fire Control. (P.E., Revue de l'Armee de l'Air, No. 93, April, 1937, pp. 461-471.) (44/46 6349 France.)

The author gives a summary of published information from Swedish, German and American sources. During the great war, it took between 600 and 6,000 AA shells to bring down one enemy aeroplane. According to some tests carried out in 1931 with 75 mm. Vickers' gun on a towed target moving at an altitude of 6,000 feet, at 175 m.p.h. and a distance of three miles, 40 per cent. hits were recorded (target 10 x 2 m.).

As most of the bombing raids will be carried out at night, effective co-operation with searchlights forms the major problem of AA fire control and reference is made to a paper by Col. Grove-White (Royal United Service Institution, February, 1936) as giving representative British opinion.

The article concludes with solutions of certain tactical problems published in the German Militar-Wochenblatt (No. 2, 3 and 17, 1936).

It appears that the main difficulty in AA defence is its comparative lack of mobility.

Radio Typewriter for Aircraft. (Inter. Avia., Nos. 426-427, 27/4/37, p. 4.) (44/47 5962 U.S.A.)

Tests are being carried out aboard aeroplanes by American airlines with the " Facsimile " reception machines. Similar experiments were made by T.W.A. approximately a year ago. The " Facsimile " apparatus was developed by the Radio Corporation of America. In the case of aeroplanes, only the reception apparatus is installed so that the crew will be able to receive written instructions from the ground. The transmitting apparatus consists of a high speed typewriter, a photocell and a standard radio transmitter.

R.C.A. Direction Finding for American Air Lines. (Aero Digest, Vol. 30, No. 5, May, 1937, p. 64.) (44/48 6050 U.S.A.)

Eight R.C.A. aircraft radio direction finders have been installed by American Airlines, Inc., on their flagship sleepers. This increases the total of radio receivers carried by each sleeper to four:—Long wave beacon, short wave airline, battery operated emergency, and the radio compass. The electro-statically shielded loop of the R.C.A. compass is housed in a small streamlined bakelite nacelle, 24in. long by 9in. diameter, mounted underneath the fuselage. The apparatus is remotely controlled from a control head on the instrument board, and directional reading is given by a left-right visual indicator mounted in a standard round instrument case. For several months past American Airlines have been conducting performance tests on various types of aircraft D.Fs., with a view to selecting the final type for their entire fleet of 54 aeroplanes (and 12 more flagships now on order). In addition to the R.C.A. D.Fs. on the sleepers, the airline also has two Bendix visual D.Fs. on DC-3 Douglas aeroplanes, as well as one radio guide and one aural type D.F. on DC-2s. Tests indicate that the final instruments to be adopted will be of the visual type, and the company intends to make the final decision and outfit the balance of the fleet with aircraft D.Fs. before 1st October, 1937.

Proposed Blind Landing Device (Sorensen). (Aero Digest, Vol. 30, No. 5, May, 1937, p. 64.) (44/49 6051 U.S.A.)

The proposed equipment consists of a number of ultra high frequency receivers (300,000 kc.) which are equally spaced over the landing field, each receiver serving a plot of 1,200ft. square. Each plot is furnished with a relay controlled audio oscillator which radiates its identifying note non-directionally. The oscillator only functions when excited by the landing beam transmitted by the aircraft and which is adjusted to coincide with the normal gliding path. Identifying notes received aboard the aeroplane cause appropriate lights to flash on

an indicating dial. For longitudinal indication, marker beacons are placed on each side of the field and respond to a second beam transmitted vertically downwards by the aircraft. The resulting identifying notes operate the corresponding green and red lights on an indicating dial in the aircraft. Original orientation of the aircraft with respect to the landing area is relegated to the conventional direction finder and the proposed system is intended for the landing only.

Automatic Radio Navigation—French Patent 786,890 *by Radio Navigational Instrument Corporation, U.S.A.* (Revue de l'Armee de l'Air, No. 93, April, 1937, pp. 473-480.) (44/50 6350 U.S.A.)

The object of the invention is to provide an automatic device which—

(1) Gives continuous indication of the direction of an emitting station.
(2) Gives the distance of such a station.
(3) Marks the course of the aircraft or ship on a chart.

The author of the article criticises the apparatus adversely and refers the reader to a better solution, *i.e.*, the Busignies Radio Compass, described in Revue de l'Armee de l'Air, No. 84, July, 1936.

The Hydrocal. A Hydrodynamic Calculating Machine for Solving Unsteady State Problems in Heat Transfer and Other Types of Diffusion. (A. D. Moore, Ind. and Eng. Chem. (Industrial Edn.), Vol. 28, No. 6, June, 1936, pp. 704-708.) (44/51 1691 U.S.A.)

The hydrocal is a hydrodynamic calculating machine for solving unsteady state problems in heat transfer and other diffusion processes. The medium in which the heat flow is to be studied is divided into a number of sections and each is dealt with separately. Water is supplied from a tank to a number of tubes, each one of which represents a sectional element. Small bore flow tubes are arranged to have a resistance to the flow proportional to the known thermal resistance. The volume of water represents the quantity of heat and the height it rises in a standpipe, the rise in temperature. Two models are described, one solving for five sections and the other for 18, and examples of their application are given.

The Contributions of the U.S. Bureau of Mines to Helium Production. (C. W. Seibel, Trans. A.S.M.E., Vol. 59, No. 1, January, 1937, pp. 55-59.) (44/52 4582 U.S.A.)

Investigations into the possibilities of producing helium in commercial quantities were commenced by the U.S. Bureau of Mines in 1917. The source chosen was natural gas from the Petrolia Field of Texas, containing 1 per cent. helium, and the method consisted in liquefaction of all other constituents in the gas by low temperature and pressure. Various air liquefaction processes were tried out, and by November, 1918, the Linde process had produced 200,000 cu. ft. of 93 per cent. helium at a cost of 44 cents per cu. ft. In January, 1929, activities were shut down in the Petrolia Field, owing to anticipated failure of the supply, and the plant moved to Amarillo, Texas. The natural gas here is under a pressure of 700lb. sq. in. and contains $1\frac{3}{4}$ per cent. helium. The plant produces helium of 98.2 per cent. purity and to date has produced 70,000,000 cu. ft. at a net cost of approximately $9 per 1,000 cu. ft. A two-stage process is employed and the final product is obtained at high pressure suitable for direct discharge into tank cars, etc., thus avoiding cost of compression.

Stationary and mobile plants for repurification of helium, which becomes gradually diluted in an airship, have been designed.

Singing Propellers. (H. Hunter, Engineer, 26/2/37 and 5/3/37, pp. 258-260, 285-8.) (44/53 4864 Great Britain.)

Detailed examination of seven bad cases of " noisy " propellers on ships appears to show that whether a propeller is noisy or not is extremely critical. Three factors have to be considered from the point of view of noise production :— (1) The " clapper " or inciting force; (2) the location at which this force acts; (3) the properties of the responding member, in the case of ships, the bronze propeller.

As regards (1) the force is probably due to eddies set up by parts of the hull ahead of the propeller, and can best be reduced by disposing and shaping the hull members so as to avoid eddy formation. A proper shaping of the blades, particularly at the tips, so that they pass through the wake with as little eddy-formation as possible assists in this. As regards (2), it is likely that the inciting forces strike the blade towards the tip, and efforts to reduce eddy-formation should therefore be greatest in this locality. As regards (3) it is possible that the geometrical accuracy of the finished propeller may have to be closer than the usual commercial limits.

Certain physical properties, *e.g.*, modulus of elasticity and elastic hysteresis may have some effect on the responsiveness of the propeller.

The Flow of Metals. (E. N. da C. Andrade, Nature, No. 3,523, 8/5/37, p. 793.) (44/54 6092 Great Britain.)

Prof. Andrade has put forward a theory of liquid viscosity on the basis that the momentum is transmitted, not by the passage of molecules (as in a gas), but by the association of molecules when they touch. On this theory, a formula can be derived for the temperature change of viscosity and for the viscosity at the melting point of a liquid. Molten metals are particularly suited for experiments of this type since they consist of one kind of atom only and are not, in general, associated. The flow of solids is much more troublesome theoretically, but a beginning has been made by the study of single crystals.

Note on the Search for Aeroplanes Lost at Sea. (G. Claude, Compt. Rend., Vol. 204, No. 18, 3rd May, 1937, pp. 1291-4.) (44/55 6199 France.)

The idea of using organic compounds to stain the sea in the region of aeroplane wreckage was tested in January, 1937, by a submarine, by throwing overboard 1 kg. of fluorescin mixed with cork powder in order to spread it over the surface of the water. Solution was so slow that only about one-fifth of the substance, added in the form of the soluble sodium salt, was able to be utilised. An irregular stain, about 200 m. in diameter, was formed, visible to aeroplanes at a distance of 4 km. and lasting for 3½ hours, but most of the colour diffused downwards. Since solutions of fluorescin are rapidly decolourised by the sun it was considered essential that the coloured solution should be formed continuously on the surface. The following process was suggested :—Use of small bamboo cylinders, 10-12 mm. in diameter and 20 mm. in length, each bored with a central hole into which 0.2 gr. of soluble fluorescin is forced between two cotton plugs. A test of this method by a submarine in April, 1937, is described. The stains produced by 10,000 bamboo cylinders (2 kg. of fluorescin) persisted for six hours, and were visible for 1.5-2 km. by a submarine and for 12-15 km. by an aeroplane.

The Italian Height Record. (Les Ailes, No. 831, 20/5/37, p. 7.) (44/56 6267 Italy.)

The French author is of the opinion that the successful record was mainly due to the preliminary engine adjustments carried out in the high altitude chamber and the new type of pressure suit worn by the pilot. This suit was specially designed at Guidonia and consists of a number of garments reinforced both

internally and externally. The helmet is of ample capacity and electrically heated, and it is claimed that the suit is much more comfortable to wear than previous designs. It appears that the engine was practically the standard Piaggio PXI RC 72 (14-cylinder radial, 146 mm. bore and 165 mm. stroke, estimated weight 600 kg., estimated power 1,800 b.h.p.). A specially light fixed pitch four-bladed propeller made of pine wood was fitted.

Aerial Night Camera. (Inter. Avia., No. 428, 1/5/37, p. 5.) (44/57 6332 U.S.A.)

The Fairchild Aerial Camera Corporation has published details of a special aerial night photographic apparatus which for many years has been in use of the U.S. Army Air Corps and which was recently released by the U.S. Army for sale to other governments. The fully automatic camera can be fitted to any aeroplane and will take " snapshots." By pressing a button about 500ft. short of the object to be photographed the pilot releases the flashlight bomb. The greater resistance offered by the parachute to the bomb, than the bomb itself, pulls the ignition tape. The burning fuse causes the bomb to explode in the desired position; the light from the bomb penetrates a light sensitive cell which operates the camera shutter. The camera's present high state of development is the result of experiments over 12 years which hitherto had to be kept secret.