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(Prepared by R.T.P.)

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Soviet Air Force—Parachutes. (U.S. Nav. Inst. Proc., Vol. 65, No. 440, Oct., 1939, p. 1513.) (72/1 U.S.S.R.)

The Russian press recently announced that two designers have been rewarded for making a semi-automatic instrument for opening parachutes during a jump. No technical details are given, except that, working on the principle of clock mechanism, it ensures that the parachute will open at a given height set before the jump. It is claimed that the instrument has undergone exhaustive tests, including one in which the parachute opened at a height of some 2,000 ft., having been released with a dummy at 18,000 ft.

Some Experiments on the Penetration of Projectiles. (P. Regnauld, Mem. de l'Art. Française, Vol. 17, 1938, pp. 731-772. Z.G.S.S., Vol. 34, No. 10, Oct., 1939, p. 288.) (72/2 France.)

The projectile used for these experiments was of 13.2 mm. calibre, with brass coating and steel core. Both the velocity and the hardness of the core of the bullet could be varied. The penetration into an unlimited quantity of dry sand is practically constant (25 cm.) for any muzzle velocity beyond 400 m./sec. At 800 m./sec., however, the bullet will pass readily through a wall of sand of double this thickness (50 cm.).

Firing into a lead block yielded similar results. In the case of a lag block the penetration (22 cm.) is again independent of muzzle velocity above 500 m./sec. The perforation depth at 800 m./sec. is now, however, only 25 cm.

Hardness of bullet core governs penetration of steel, the softer bullet spreading on impact and being reflected. In the case of aluminium plates, however, the hardness of the bullet has but little effect on penetration. It is interesting to note that at 800 m./sec. the penetration is of the order of 5 cm. for mild steel (hard core bullet) and a double this for cast aluminium. It appears that each material has a limit of maximum penetration which cannot be exceeded, however great the impact velocity except by increasing the mass of the bullet.

Air War in Poland. (F. Latsch, Flugwehr und-Technik, Vol. 1, No. 9-10, Sept.-Oct., pp. 240-242.) (72/3 Switzerland.)

At the beginning of the war, Poland disposed of approximately 1,000 aircraft, of which three-quarters were fighters and reconnaissance and one-quarter bombers.

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The major part of this force never left the ground since the Germans from the start of hostilities undertook the systematic destruction of all aerodromes within reach of the frontier together with their ammunition and fuel supplies.

Having achieved command of the air (the Polish A.A. fire being ineffective without fighter co-operation) the lines of communication of the Western Polish armies were destroyed systematically and their retreat hampered. In this connection, the heavy fighter No. 110 (20 mm. cannon) was used against locomotive (perforation of boiler), the standing trains being subsequently destroyed by dive bombers.

All these attacks were preceded by a detailed photographic study of the position so that the target of importance could be selected.

Special reference is made to the utilisation of a group of Fieseler-Storch slow speed aircraft for the bombing of a wood held by the Poles and thus opening a way for the German tanks.

Air Operation in the Civil War. (W. M. Graf, Flugwehr und-Technik, Vol. 1, No. 9-10, Sept.-Oct., 1939, pp. 244-246.) (72/4 Switzerland.)

The author served for 2½ years with the Republican A.A. Artillery and some of his conclusions are of interest :—

1. The 20 mm. Oerlikon gun gave trouble with the glycerine recoil brake, due to the large differences in day and night temperatures. This prevented the gun being used at elevation above 70°.

2. The German guns had a higher rate of fire (35 against 22 per minute). The Oerlikon guns were completely worn out after 3,000 rounds.

3. The German gunners concentrated the fire on the leading aircraft and did not generally put up a barrage.

4. Toward the end of the war, bombing attacks were carried out in open formation. German operations were always preceded by most detailed photographic reconnaissance.

5. Junkers 86 K and Fiat C.R. 32, the latter fitted with 11 mm. Breda machine guns, are specially mentioned as being efficient.

6. Speaking generally, the Italian airmen were more aggressive than the Germans, but not so well organised.

General Mathematical Considerations on the Errors Associated with A.A. Fire. (H. Brandli, Flugwehr und-Technik, Vol. 1, No. 9-10, Sept.-Oct., 1939, pp. 247-248.) (72/5 Switzerland.)

If the gun setting remains constant in elevation and azimuth, successive projectiles will follow the same trajectory.

If, however, the gun elevation varies during the firing, the locus of all the projectiles in space at a given instant will be a new curve which intersects the trajectory associated with each elevation. If the rate of fire during the steady motion of the gun is high enough, there will then be an almost continuous string of projectiles travelling outwards from the gun like ripples on a pond. The " age " of these projectiles reckoned from the time they left the gun will vary along this locus, projectiles of the same age lying approximately on the same arc of a circle with the gun as centre. The arc corresponding to the time fuse setting on the projectile will determine the position of successive shell bursts. The projectile position locus clearly terminates at the burst and the string of projectiles spreading outwards from the gun thus gradually shortens, *i.e.*, the angle subtended at the gun finally vanishes. If thus the angle of elevation of the gun is increased during the fire, low flying aircraft at a distance corresponding to the fuse setting will be endangered by the shell burst whilst at the same time aircraft passing over the gun position at a medium altitude are subject to a direct hit. The author hopes to give numerical examples in a subsequent article.

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Acoustical Range Finding (Artillery Spotting). (R. Sanger, Zurich, 1938. Original available in R.T.P. (continued). (72/6 Switzerland.)

The author develops the differential equations of the curved sound rays in the practical case and obtains a solution under the simplifying conditions of constancy with altitude of wind and sound velocity gradients.

A closer approximation to practical conditions may, however, be obtained by assuming a homogenous wind undergoing periodic variations in velocity which are propagated at a definite speed. In this way some allowance is made for atmospheric turbulence. Fluctuation in wind speed cause periodic changes in the recorded time intervals between the reception signals of consecutive muzzle explosions. These changes may amount to 1/100 sec. and the resultant position error varies inversely as the base length. If this error is to be kept within 1 per cent. of the distance, a base length of at least 500 m. must be used.

When the absolute distance of the gun is not known with sufficient accuracy it may be necessary to duplicate the installation and thus obtain two possible asymptotes, the intersection of which fixes the distance to the required degree of accuracy. In this case care must be taken that the base lines of the two stations do not overlap.

When sound ranging for gun positions the time interval of the sound of the muzzle explosion reaching two receivers placed at the ends of a base line is measured.

Assuring that the atmosphere is homogeneous and is entropic (velocity of sound independent of direction and position of source), the locus of the source is a rectangular hyperbola of which the two receivers are the foci. The direction ϕ of the asymptote with the base is given by

$$\cos \phi = \pm C\,(\Delta t/b)$$

where C = velocity of sound.

Δt = observed time interval.

b = length of base.

The direction of the sound source with regard to the base will approximate closely to the direction of the asymptote for large distances and can be obtained with sufficient accuracy by rotating the asymptote through a small angle depending on the distance of the gun. In practice matters are complicated by the fact that the atmosphere is not homogeneous and that a wind is generally present.

Radio Controlled Target Plane. (Sci. Am., Vol. 161, No. 5, Nov., 1939, p. 288.) (72/7 U.S.A.)

The small target monoplane has 12-foot wing span with pronounced dihedral. The estimated ceiling is 5,000 feet. Two propellers are driven in opposite directions by a single air-cooled petrol engine. The plane is launched by means of a catapult and its subsequent flight controlled by radio. A parachute is fitted which is ejected as soon as the engine stops and controls the rate of descent of the plane. This parachute can also be released by wireless from the ground. The advantages claimed for such a target plane are the small cost of construction and ease of repair and maintenance. Since an aerodrome is not required either for landing or take-off, shooting trials can be held in any locality otherwise suitable.

Photographs show the plane in position on the catapult and packed for transport on a motor car.

The device is undergoing test by the Army Air Corps (U.S.A.) at the Wright Field, Dayton.

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Study of Axial Flow—Air Propellers. (M. F. Dowell, Gen. Elect. Review, Vol. 42, May, 1939, pp. 210-7. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 89.) (72/8 Great Britain.)

The author has made a comparative study of (1) small-axial-depth, narrow-bladed propellers, and (2) large axial-depth wide-bladed propellers. The air-flow was observed by photographing wisps of smoke entrained in the air-currents. A very large quantity of concentrated light is necessary, because the smoke tends to thin out quickly. An ultra-high-speed motion-picture camera was used. Dull black backgrounds and flat white reflecting surfaces for the parts in motion yield the best results, and speeds ranging from 1,000 to 1,200 pictures per sec. are sufficient. The pressure and velocities of the stream were studied by means of a pitot-tube arrangement. One or more sources of stroboscopic light were used for visual observations of smoke-flow through propellers. A one-segment commutator attached to the shaft of the driving motor flashes the light at predetermined positions of the rotating propeller, thus causing the elements to appear stationary. In order to find the sources of noise, a very small exploring crystal microphone with a low vibration-response was placed directly on the blade and rotated with it, the connections being made by mercury cups. Metallic vibration or blade-resonance must be avoided by covering the blades with rubber and cushioning the spindle. The results indicate that a wide-blade large-axial-depth propeller gives less vortex-formation and less noise than does a narrow blade.

Measurement of Pressure Variations in the Neighbourhood of a Full-Size Air-screw Blade. (J. Obeta, Y. Yosida, U. Yosida, Aero. Res. Inst., Tokio, Report No. 179, July, 1939.) (72/9 Japan.)

Previous experiments by the authors were confined to model propellers ($\frac{1}{3}$ and $\frac{1}{4}$ full scale).

The present measurements were carried out on a full-scale 3 bladed aluminium alloy propeller, 2.9 m. diameter, driven by an electric motor. For most of the experiments, the blade angle at $\frac{3}{4}$ radius was reduced from its normal value of 26° 50′ to 12° in order to obtain supersonic tip speeds at a relatively small power expenditure. The measuring microphone was only 14 mm. in diameter, the pressure variations being explored along straight lines at a distance of 18 cm. and 11 cm. from the front and rear of the longitudinal axis of the propeller blade. Records were also obtained in the plane of rotation and at several points perpendicular to this plane up to a maximum distance of 50 cm.

The oscillograph records show the time variation of the pressure at a fixed point. From this it is possible to reconstruct the pressure distribution relative to the propeller blade. Whilst in the small model experiments maxima of both pressure and suction coincided with blade position, in the case of the full scale propeller travelling at supersonic tip speed, maximum pressure lags considerably behind the blade position on the front side, but agrees on the rear side of the blade. By extrapolating the law of pressure variations with distance, the pressure distribution over the rotating blade can be estimated. The results obtained so far, only give agreement with the measured thrust in certain cases (low speed). It is hoped to investigate this more fully by improvements in the microphone (absolute calibration; slip-stream shield) and repeating the experiments at a much smaller distance from the rotating blade so as to make the extrapolation more certain.

Forces and Moments on a Yawed Aerofoil. (S. Hoerner, L.F.F., Vol. 16, No. 4, 20/4/39, pp. 178-183. N.A.C.A. Tech. Memo. 906, August, 1939.) (72/10 U.S.A.)

The existing experiments with straight wings (zero dihedral), wings with dihedral, and wings with sweepback are evaluated within the range of sound angles of attack, explained by calculations and generally enlarged.

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1. The total forces (c_a and c_w) are practically unaffected by yaw (up to $\tau \approx 25°$). The newly appearing lateral force is derived for wings with and without dihedral.

2. The rolling moments due to yawing which exert a righting effect on straight aerofoils (zero dihedral) in contradiction to the calculations made up to the present, are explained by a corner effect, an edge effect, and by the dissimilar yawed flow of the two wing-halves. The known wind-tunnel experiments are given in diagram form so that the rolling and yawing moments can be read off.

3. Dihedral produces subsidiary rolling and yawing moments due to yaw. The calculation of the rolling moment is confirmed by measurement.

4. The yawing moments due to sweepback were computed. Both yawing and rolling moments are confirmed by measurement.

5. Since the yawing moments due to yaw are often very small, considerably greater instrumental accuracy is required in order to achieve agreement between calculation and measurement.

Laminar Friction Resistance with Pressure Gradient. (E. A. Wright and G. W. Bailey, J. Aeron. Sci., Vol. 6, No. 12, Oct., 1939, pp. 485-488.) (72/11 U.S.A.)

From the Karman Momentum theory it follows that in the case of a pressure gradient $\frac{dP}{dx} = -\rho U \frac{dU}{dx}$ the local coefficient of friction c_f is given by

$$c_f = 2\left(\frac{d\theta}{dx}\right) + 2\theta\left(2 + \frac{\bar{\delta}}{\theta}\right)\left(\frac{1}{U}\right)\left(\frac{dU}{dx}\right)$$

when θ = momentum thickness of laminar boundary layer.
$\bar{\delta}$ = displacement thickness of laminar boundary layer.
U = potential floor velocity outside boundary layer.

The authors carried out experiments in a special boundary layer research tunnel using a flat plate under conditions of positive and negative pressure gradients. The results show that over this range of gradients employed

$$\frac{2\theta}{x} = 1.328/(u_x/v)^{\frac{1}{2}} \quad \bar{\delta}/\theta = 2.59 = \text{constant}.$$

Substituting in the Karman equation above, we obtain

$$c_f = .664/(u_x/v)^{\frac{1}{2}}\left[1 + 8.18\,\frac{x}{U}\frac{dU}{dx}\right]$$

which includes the effect of pressure gradient over the range investigated.

The University of Washington 250 m.p.h. 8 × 12-foot Wind Tunnel. (F. K. Kirsten and F. S. Eastman, J. Aeron. Sci., Vol. 6, No. 12, October, 1939, pp. 494-498.) (72/12 U.S.A.)

The tunnel is of the Venturi closed throat double return type, each duct being provided with a 500 h.p. propeller.

Extra electric motors can be coupled to these propellers, so that a further increase in speed to 320 m.p.h. will be possible in the future.

Chief interest attaches to the six component balance, which has been designed so that readings can be obtained quickly and the model easily changed. A set of 15 readings can be taken in 3 to 5 minutes. Thus 4 or 5 sets of readings at different angles of attack can be obtained in 15 minutes when investigating yawing stability. Electrical recording is used throughout and simultaneous readings of all 6 components, dynamic pressure, angle of attack, angle of yaw, time, air temperature and barometer can be obtained by photographing the instrument panel, or recording milliameters can be used.

The drag of the mounting fork is less than 25 per cent. of the minimum drag of a representative aerofoil. Flexure pivots designed by Eastman (J. Aeron. Sci.,

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Vol. 5, No. 1, Nov. 1937, pp. 16-21) are used in the suspension system and forces ranging from 25 to 2,500 lb. can be measured to the same accuracy of 1 per cent.

A Flight Investigation of the Distribution of Ice-Inhibiting Fluids on a Propeller Blade. (L. A. Rodert, N.A.C.A. Tech. Note No. 727, Sept., 1939.) (72/13 U.S.A.)

The flow of ice-inhibiting fluids over the blade surfaces of a 12.5 foot diameter propeller was investigated in flight by discharging dyed fluids at various stations along the leading edges of the blades. The effects on the distribution of varying the fluid composition, the blade-surface roughness, and the orifice design were also observed.

The flow patterns obtained indicated that, under favourable combinations of type of fluid, surface smoothness, and orifice design, the fluid would flow from an orifice near the propeller hub along the leading edge to about the 40-inch blade station (53 per cent. of the blade radius). The fluid would not flow along the leading edge beyond the 40-inch station regardless of orifice location.

Fluids consisting of 85 per cent. alcohol and 15 per cent. of either glycerine or ethylene glycol flowed farthest along the leading edge. Decreasing the percentage of alcohol decreased the percentage of the blade length covered by the fluid. Discharging the fluid from an orifice that spread the fluid out in a thin film in intimate contact with the blade increased the blade area coverage of a given volume of fluid. Surface roughness of the blade reduced the radial distribution.

Wind Tunnel Investigation of an N.A.C.A. 23021 Aerofoil with Two Arrangements of a 40 per cent. Chord Slotted Flap. (F. Duschik, N.A.C.A. Tech. Note No. 728, September, 1939.) (72/14 U.S.A.)

An investigation was made in the N.A.C.A. 7 by 10 foot wind tunnel of an N.A.C.A. 23021 aerofoil with two arrangements of a 40 per cent. chord slotted flap. The effect of slot shape, flap position, and flap deflection on the section aerodynamic characteristics was determined. The envelope polars and the section aerodynamic characteristics are given and are compared with those of an N.A.C.A. 23021 aerofoil with a 25.66 per cent. chord slotted flap and of an N.A.C.A. 23012 aerofoil with a 40 per cent. chord slotted flap. Plotted contours of flap-nose positions for maximum lift and minimum drag were used for selected optimum conditions.

Both the maximum lift coefficients and the minimum drag coefficients were higher for the N.A.C.A. 23021 aerofoil with the 40 per cent. chord flap than for the N.A.C.A. 23021 aerofoil with the 25.66 per cent. chord flap, but the percentage increase in drag was greater than the percentage increase in lift. A comparison of the aerodynamic characteristics of the N.A.C.A. 23021 aerofoil with a 40 per cent. chord flap and of the N.A.C.A. 23012 aerofoil with a 40 per cent. chord flap showed that the thick section reached approximately the same maximum lift as the thin section but, as anticipated, had a considerably higher drag coefficient.

Aeroplane Demagnetisation and Neutralisation. (J. G. Lee, J. Aeron. Sci., Vol. 6, No. 12, October, 1939, pp. 489-493.) (72/15 U.S.A.)

Sources of magnetic disturbance in aircraft, when located, can be eliminated by demagnetisation (by means of an alternating current) or by neutralisation (reducing magnetic strength by application of a suitable direct current coil).

As a general rule, compact bodies or long slender parts are best demagnetised. Complex structures of large dimensions or small integral parts of a large unit are best dealt with by neutralisation.

Experience gained by the Chance Vought Aircraft Company shows that the neutralisation correction is permanent, provided it is applied after the aircraft has been in operation for at least one hour (material shaken down).

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Much subsequent trouble can be saved by previous demagnetisation of all raw material and a systematic check of finished assemblies and employing as far as possible non-magnetic material in the neighbourhood of the compass. In this connection stainless steel is preferable to chrome-molybdenum.

The Grant Streamline Flap. (W. L. Nye, J. Aeron. Sci., Vol. 6, No. 12, October, 1939, pp. 502-504.) (72/16 U.S.A.)

The Grant Flap consists of two or more slotted parts by means of which the curvature of the rear portion of the wing can be gradually increased, the slots preventing break away of the flow. It is stated that maximum lift coefficients of the order of 3 are obtainable using wing profile N.A.C.A. 23012, the minimum drag coefficient being as low as .012. No details of the flap operating mechanism are given.

Normal flap operation impairs aileron control. In the case of the Grant flap, it is suggested to overcome this difficulty by having outer flaps to act as ailerons, the deflection of which is only $\frac{1}{2}$ that of the main inner flaps. Due to the slotted nature of the flap, good lateral control is maintained in spite of large inner flap deflection.

Design and Shop Problems in High Pressure Hydraulic Systems on Aircraft. (H. W. Adams, J.S.A.E., Vol. 45, No. 5, November, 1939, p. 14 (Digest).) (72/17 U.S.A.)

High pressure systems employ oil pressures in excess of 2,000 lb. per sq. in. and this leads to an important saving in weight of the installation (600 lb. in the case of the D.C.4 aircraft). The reduction is mainly associated with the weight of pipe lines, whilst the pump (which now has to be of the piston type) comes out slightly heavier than the low pressure vane or gear type. High pressure systems present no serious production problems, since the closer tolerances required are made easier to obtain by the greater wall thickness. Installation and servicing is simpler since all the parts are smaller.

Danger in the event of failure is about the same for high and low pressure systems.

Trans-Atlantic Aeroplane Design. (R. J. Nebesar, J.S.A.E., Vol. 45, No. 5, November, 1939, pp. 478-484.) (72/18 U.S.A.)

After reviewing the leading characteristics of large American land and sea planes, including projects such as the Sikorsky S.47, the author presents details of two land plane projects each of app. 50 tons gross weight worked out by the Avia Company of Prague. In these designs the passengers are housed inside a bulge over the central section of the wing, somewhat on the lines of the Burnelli Aircraft. The tail surfaces are carried on two separate booms. It is claimed that this arrangement reduces drag and increases lift. Detailed performance estimations are given and the flying cost for the Paris—New York trip is reckoned as low as 167 dollars per passenger (29 passengers carried).

An Aerodynamic Power Plant. (J. Ackeret and C. Keller, Schw. Bauzeitung, Vol. 113, May, 1939, pp. 229-30. Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, p. 102.) (72/19 Germany.)

The authors discuss a new system of power generation which is undergoing trials. The circuit is a gas circuit in which air is utilized as the gas (other gases can be used) and the circuit, unlike that of the ordinary gas-turbine process, is a closed circuit comprising gas-heater, preheater, regenerator, compressor, and turbine. A formula is given for the heat-efficiency of the ideal cycle, i.e., without taking into account the losses in the turbine compressor, gas-heater, and preheater. With this system the thermal efficiency can be improved without increasing the pressure, as in the case of steam plant, with its consequent complication in design

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and necessity for safety-devices. The exhaust air from the turbine flows through the regenerator and yields up its heat to the air flowing from the compressor to the gas-heater. The regenerator air is further cooled, so that the compressor takes in cold air. The cooling-water process forms only a small item in comparison with a steam plant, and no special attention to the quality of the water is necessary.

Development of High Duty Motors—Especially of Aero Engines. (F. Jaklitsch, Autotech. Z., Vol. 42, 25/5/39, pp. 273-87. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 87.) (72/20 Germany.)

The author considers that a new stage in the development of aero engines is at hand, in which units ranging up to 2,000 h.p. are being considered. The fundamental factors governing design are therefore being explored energetically in many quarters. A comprehensive discussion, based upon statistical data, of the effects of the leading dimensions is presented. The stroke/bore ratio for a number of aero engines and diesel road motors is examined and it appears that in most cases the power per litre falls as the stroke/bore ratio increases: all of the comparisons are made in respect of engines by the same maker. The author suggests as the best relation: H.P. $\propto \sqrt{(\text{Bore} \div \text{Stroke})}$, and emphasizes the need in rating an engine for specification or duration. Denoting by Pt, P_1, and P_{100} the power-output over t minutes, 1 minute, and 100 hr. respectively he derives the relation $t = \{ (N_1 - N_{100})/(N_t - N_{100}) \}^3$. The cost of production is discussed in detail and is plotted in terms of total horsepower and of type; the cost decreases as the number of cylinders increases, and the radial engine appears to be the cheapest form. The author emphasizes the importance of drag resistance, in regard to which the radial engine is not the best type.

Aircraft Engine Research of the National Advisory Committee for Aeronautics. (C. Kemper, J. Aeron. Sci., Vol. 6, No. 12, October, 1939, pp. 479-484.) (72/21 U.S.A.)

The major part of the work has been concerned with fuel injection for spark ignition engines and with improvements in the finning of air-cooled cylinders.

Fuel Injection.—The power output of a standard air-cooled cylinder can be increased 10-15 per cent. at the same specific fuel consumption by replacing the carburettor by an injection pump. The increase in power is almost entirely due to increased volumetric efficiency. A further advantage of fuel injection is the possibility of using " safety " fuels, certain of which, when doped, give the same power and consumption as iso-octane.

Finning.—The N.A.C.A. have increased the finning of a conventional cylinder head six times by using preformed sheet aluminium fins bonded to the cast head. At the same time the finning of the barrel has been increased three times by brazing sheet steel and copper fins to the barrel. By this means it was found possible to increase the indicated power output three times over that of conventional designs for the same cooling pressure drop across the cylinder (3 in. to 10 in. water) and the same mean temperature difference between head and cooling air (300°F.).

Piston Temperatures under running conditions have been measured, using thermocouple embedded in the piston connection with a potentiometer being made for about 10° of crank angle at the bottom of the stroke using pneumatically operated plunger contacts.

The following average temperatures were obtained on a conventional air-cooled cylinder operating under normal conditions.

Head temp. (average of 22 couples) ...	325°F.
Barrel temp. (average of 10 couples) ...	260°F.
Piston skirt (one couple)	275°F.
Piston crown (average of 3 couples) ...	450°F.

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Of interest is the small temperature difference between barrel and skirt. As all the piston temperatures can be lowered by lowering the barrel temperature increased finning on the barrel is logically indicated.

DIESEL RESEARCH.—A single cylinder four-stroke, boosted air-cooled Diesel (5 in. bore, 5½ in. stroke) using the displacer type of combustion chamber has been developed. Minimum specific fuel consumption (.36 lb.) is obtained at b.m.e.p. of 100-120 lb. per sq. in. For take-off, the b.m.e.p. can be increased to 170 lb. per sq. in. (specific consumption .48 lb.). The estimated weight of a 9 cylinder radial would be 10 per cent. more than that of the corresponding spark ignition engine.

It is however thought that the most promising design for aircraft work will be a two stroke fitted with mechanically operated valves (possibly some form of sleeve valve mechanism).

Problems of Submerged Engine Installations. (W. E. Beall and E. G. Emery.) *Propeller Requirements for Submerged Engine Installations.* (G. W. Brady, J.S.A.E., Vol. 45, No. 5, November, 1939, p. 21 (Digest).) (72/22 U.S.A.)

Placing the engine inside the wing makes a heavier and more costly installation. Accessibility is reduced and the possibility of endangering the primary structure of the aircraft in case of engine or propeller failure is increased. The only advantage is the possibility of increased aircraft speed, and in the opinion of the author this does not outweigh the disadvantages listed above. In several cases, the expected increase in speed with submerged or partly submerged engines was not realised in practice and it is rather significant that the German Heinkel aircraft holding the world's speed record had a short cylindrical cowl with no propeller shaft extension.

In the submerged installation, special attention must be paid to propeller hub drag. Fairing of the blade shanks will save 90 h.p. at 400 m.p.h. and over 300 h.p. at 500 m.p.h. in the case of a 1,200 h.p. propeller.

Incidentally this fairing is already adopted on standard engine installations and in the case of radial engines will not only reduce the drag but improve the cooling of the engine.

Petrol Injection or Carburettor? (C. Mazzuchelli, Flugwehr und-Technik, Vol. 1, No. 9-10, Sept.-Oct., 1939, pp. 254-6.) (72/23 Switzerland.)

The main disadvantage of the present day aero-engine carburettor is the icing danger. This is best overcome by placing the carburettor behind the blower and utilising special fuel pumps capable of overcoming the increased induction air pressure. This also reduces fire risk, since the high speed air from the blower prevents flame egress due to back-fire.

In most modern carburettors, the float chamber has been replaced by a diaphragm and the attitude of the aircraft is therefore no longer of any consequence.

The problem of petrol injection is entirely one of a suitable pump. Whilst certain specialist firms are capable of turning out satisfactory pumps, there is no doubt that servicing and maintenance of such instruments is more difficult than that of a carburettor.

Apart from distribution, there is no evidence that either power or specific consumption can be improved by adopting petrol injection, provided of course the comparison is with a first-class carburettor installation. Timed injection however renders possible internal cylinder cooling by air scavenging and also brings in the 2 stroke petrol engine as an alternative line of development.

Summing up, the author is of the opinion that a change-over on existing plants employing pressure carburettor is scarcely worth while, but that petrol injection must be seriously considered in any development work or new designs.

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Results of Investigations on Used Lubricating Oil Taken from the Maybach Motors of the Three-Coach Diesel Trains of the Netherlands Railways. (H. L. Matthijsen, De Ing. (Verkeerswezen), Vol. 54, 16/6/39, pp. 31-5. Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, p. 113.) (72/24 Germany.)

The author gives the results of investigations of the quantity of fuel-oil absorbed by the lubricant, the quantity and the character of the sludge formed in the lubricant, and the quantity and origin of the iron found in the sludge. In his conclusions, he states that in the Maybach motors the lubricant absorbed very little fuel-oil. The sludge consists largely of blow-by carbon originating in the fuel. The design of the fuel-sprayers has considerable influence upon the sludge-content, which, for sprayers having five orifices, was four times that with sprayers having four orifices. The average iron-content of the sludge was 3 per cent., consisting principally of very fine particles detached from the roller bearings. Increase in speed caused deterioration in the lubricant, which aged more intensively owing to the higher temperatures in the motors, whereby the viscosity and the sludge-content were increased.

Mixture Distribution and Volatility. (L. A. Peletier, J. L. Tops, W. J. Heeckeren, Airc. Eng., Vol. 11, No. 129, Nov., 1939, pp. 407-10.) (72/25 Great Britain.)

CONCLUSIONS.—1. The relation between mixture distribution in the Wright Cyclone engine and fuel volatility was found to be much more complex than had so far been generally presumed.

2. The experiments have not led to conclusive evidence as to what is the best volatility to be used.

3. There would seem to be two conditions at which an ideal distribution could be obtained:—

(*a*) When complete immediate evaporation takes place in the carburettor and the impeller is being fed with a homogeneous vapour-air mixture.

(*b*) When no evaporation takes place between the carburettor and the impeller the latter serves as distributing agent for the liquid.

4. The deflection of the mixture between carburettor and impeller is the main cause of distribution irregularities when neither of the ideal cases obtain.

5. All the above considerations do not touch upon the subject of the degree of wetness and homogeneity of the charge in the cylinder and the possible effects thereof on engine performance.

Investigations of Vapour Lock in Aircraft Fuel Systems. (O. C. Bridgeman, J.S.A.E., Vol. 45, No. 5, November, 1939, p. 21 (Digest).) (72/26 U.S.A.)

Vapour lock usually occurs at the fuel pump inlet or at the carburettor, these being the points at lowest pressure in the fuel system. The difficulty becomes especially pronounced at altitudes above 20,000 feet. For any given fuel, the following remedies are suggested:—

1. Low pressure drop in fuel system.
2. Elimination of heat in neighbourhood of system.
3. Fuel coolers.
4. Pump design.
5. Short fuel lines, sloping continuously back to the tank.
6. Supercharged system (tank, pump and carburettor under pressure).

Integral fuel tanks in the wing help to keep the fuel cool provided no hot exhaust gases are in the neighbourhood. It must always be remembered, how-

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ever, that the fuel in such tanks will not cool rapidly after leaving the ground, and separate coolers may still be necessary.

No information is available as to whether the cooled fuel precipitates carburettor icing.

Recent Developments in Diesel Lubricating Oils. (G. L. Neely, J.S.A.E., Vol. 45, No. 5, Nov., 1939, pp. 485-500.) (72/27 U.S.A.)

Development and service properties of a new compounded Diesel-engine lubricating oil are described in this paper. Properties of the oil brought out by the author include anti-ring-sticking value; prevention of lacquer formation; reduction of carbonaceous deposits; that it is non-corrosive to all types of bearing metals; and that it reduces piston-ring and cylinder wear at both high and low temperatures. Although recommended specifically for Diesel engines, the oil is also suggested for petrol engines, particularly where engine deposits are troublesome.

A fundamental property of lubricants is described which relates to the highest temperature at which an oil will wet a metal surface with a fluid film of sensible thickness. Data are presented showing that engine scuffing difficulties are prevented by lubricants having good spreading properties at high temperatures, and that the new lubricant possesses superior spreading characteristics to which its breaking-in and surface-conditioning properties are attributed.

The comparative economics of engine operation with this new type of lubricant and straight mineral oils is discussed. Application of the oil for cleansing or purging of both Diesel and petrol engines is explained.

ABSTRACTOR'S NOTE.—From the discussion it appears that the compounded lubricating oils recommended by the Author have not worked satisfactorily in petrol engines. Deposits of Ca Sulphate, which lead to detonation troubles, are likely to form in the combustion chamber.

Is There a True Creep Limit? (U. Dehlinger, Z. fur Metallk, Vol. 31, No. 6, June, 1939, pp. 187-191. In course of translation.) (72/28 Germany.)

The true creep limit is defined as the limiting load below which there occurs no further deformation (plastic or elastic) however long the load is applied. The creep limit at a small but finite rate of deformation is necessarily higher than this.

From thermodynamic considerations the author concludes that in the absence of any chemical change the maximum deformation S corresponding to a given load K must satisfy the condition

$$K = \frac{\partial E}{\partial S},$$

where E is the elastic component of the total energy of deformation. The creep limit is thus given by the maximum value of $\frac{\partial E}{\partial S}$ as a function of S. In the case of a homogeneous single crystal, subjected to shear, tension or compression, $\frac{\partial E}{\partial S} = O$. The crystal thus begins to flow under the smallest load and there is no creep limit.

In the more general case of a multi-crystalline substance, flow is necessarily accompanied by a deformation of the grains, $\frac{\partial E}{\partial S} \pm O$ and a creep limit must exist, provided there is no re-crystallisation.

For amorphous substances such as glass, the flow can produce a rotation of the volume elements and no true creep limit exists.

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From a review of data it appears that the ultimate strength under fatigue approximates to the true creep limit, at any rate in the case of coarse grained substances.

Combined Beam—Column Stresses of Aluminium—Alloy Channel Sections. (R. Gottlieb, T. M. Thompson and E. C. Witt, N.A.C.A. Tech. Note No. 726, September, 1939.) (72/29 U.S.A.)

The test specimens were extruded 24ST aluminium-alloy channel sections 2.1 inches wide and 0.1 inch thick with legs (or flanges) varying from approximately 0.5 inch to 2 inches in depth.

The results of the tests of about 70 specimens were graphed for stresses due to axial load and stresses due to bending load as functions of length to radius of gyration of the specimens. From these graphs a design chart suitable for ready use was derived.

Metal Sprayed Bearings for High Speed Operation. (H. Shaw, Power Transmission Vol. 8, May, 1939, pp. 213-221. Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, pp. 113-4.) (72/30 Great Britain.)

In a paper read before the Association of Metal Sprayers, the author describes tests made at both low and high speeds (1,000—3,000 r.p.m.) and with loads ranging up to 8,000 lb. per sq. in. Results for Babbitt metal, a cadmium-silver-copper alloy, bronze, and lead-bronze are tabulated and plotted in curves. Further tests are in progress with sprayed aluminium bearings.

Fatigue Machines for Testing Structural Units. (R. L. Templin, Amer. Soc. Test. Mater. Preprint No. 41, 11 pp., June, 1939. Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, pp. 114-5.) (72/31 U.S.A.)

The machines described are for the purpose of making fatigue tests upon structural units such as joints, beams, columns, and frames. The largest, which has a maximum capacity of 22.3 tons in tension or compression, consists of a horizontal beam, one end of which is connected through a vertical member to the bed-plate, whilst the other is capable of being oscillated by means of an eccentric crank. The test-specimen is placed in the centre of the beam. A maximum of 312 cycles per minute may be obtained, and the amplitude is variable. The author also describes two other machines for testing riveted joints, which work on similar principles, but at speeds ranging up to 300 or 500 cycles per min. Micro-limit switches are provided so that a change in deflexion of a few thousandths of an inch will shut down the machine when the specimen fails. The calibration of the beams is described. The dial-gauges record deflexions to 0.0002 in. The loads are obtained from the deflexions of the beam. Details of some of the joints tested are given. About 400 specimens which have been tested exhibit a marked consistency. The results obtained have indicated changes that should be made in the design of joints for structures.

An Investigation of the Fretting Corrosion of Closely-Fitting Surfaces. (G. A. Tomlinson, P. L. Thorpe, and H. J. Gough, J. and Proc. Inst. Mech. Eng., Vol. 141, May, 1939, pp. 223-37. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 99-100.) (72/32 Great Britain.)

The authors describe experiments upon the mutual corrosion of metal surfaces in closely-fitting contact when subject to vibration. They demonstrate that the corrosion is mechanical rather than chemical in character. Lubricants modify, but do not prevent corrosion. The mechanism of the phenomenon is discussed, and the authors suggest that it is due to a process of molecular attrition, possibly closely associated with fatigue effect.

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X-Ray Stress—Measurements in Tensile Specimens of Carbon Steel. (F. Bollenrath, V. Hauk, and E. Osswald, Z.V.D.I., Vol. 83, 4/2/39, pp. 129-132. Eng. Absts., Vol. 2, No. 8, Section 1, August, 1939, p. 70.) (72/33 Germany.)

The authors describe experiments made to study the stress-decrease in bending specimens when loaded beyond the yield-point. Tensile specimens of square cross-section were used, and measurements were made, mechanically and by means of X-rays, of the deformations occurring with elongations ranging up to 11 per cent. It was observed that as the yield-point was exceeded the stress-distribution over the cross-section became markedly non-uniform, with internal compression stresses near the boundaries; approximately half the cross-section appeared to be in compression, and the inner half in tension. In order to eliminate dimensional effects, specimens of 17.32 mm., 16.34 mm., and 11.82 mm. square section were used. The central zone for gauging was 140 mm. long, and from the gauge-length, gently tapering lengths of 150 mm. were used to cut out any possible constraint from the grips. Up to the yield-point the stresses deduced by X-ray calculation agreed very precisely with those deduced mechanically from load and cross-section. The authors suggest that the results are of considerable importance in the general study of plasticity, in which stresses actually occurring are very different from nominal stresses. The results indicate also that the crystal frame constant varies with depth from the surface, i.e., from 2.86054 to 2.86136 over a depth of 1 mm.

X-Ray Measurement of Stress in Endurance Testing. (G. Kemmnitz, Z. Tech. Phys., Vol. 20, May, 1939, pp. 129-40. Eng. Absts., Vol. 2, No. 8, Section 1, Aug., 1939, pp 70-1.) (72/34 Germany.)

The author presents the results of an X-ray determination of internal notch stress during testing under alternating stress at 3,000—1,500 r.p.m. of a cross-pierced shaft, and at the fashioned fillet of a test piece. A steel having a nominal yield-point of 25-30 kg. per sq. mm. (16-19 tons per sq. in.) was carefully turned down, the last millimetre being removed by abrasive blocks, annealed *in vacuo* in Jena glass, and investigated with Coradiation, at $\lambda = 1.785$ Å, from a Muller tube operating at 53 kV. and 5 mA. Removal of the outer surface by etching was found to be unnecessary. For this material a Wohler-curve value of 14 kg. per sq. mm. (9 tons per sq. in.) was obtained on the Schenk machine. For loads considerably above the endurance-limit, fracture was normal to the axis, whilst for loads nearer the endurance-limit the more normal type at less than 45 degrees occurred. No special improvement was observed on applying the load in steadily increasing amounts. From experimental results it appears that peak notch stresses are completely elastic until a crack actually sets in, when they sink simultaneously, both statically and dynamically. By separate evaluation of load and internal stress during torsion, it is shown that in the direction of tension flow occurs even below the yield-point; this explains the behaviour of service stresses during dynamical loading and the preponderance of internal pressure stresses following alternating load.

Distortion of a Curved Tube Due to Internal Pressure. (W. R. Dean, Phil. Mag., Vol. 28, No. 189, Oct., 1939, pp. 452-64.) (72/35 Great Britain.)

An approximation to the distribution of stress in a curved tube caused by a uniform internal hydrostatic pressure is already known, but the determination of the displacement presents more difficulty, since the method that gives correctly an approximation to the stress fails to produce a corresponding approximation to the displacement.

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In the present paper some progress is made with the determination of the displacement; a method of successive approximation is used, and the work is carried far enough to find the part of the displacement that is of most interest physically. The stress corresponding to this part of the displacement is compared with the known approximate result, and the two are shown to agree to the correct order of approximation.

Magnitude of the Direct Stress in a Beam of Fixed Span. (R. J. Cornish, Phil. Mag., Vol. 28, No. 189, Oct., 1939, pp. 481-7.) (72/36 Great Britain.)

When a beam, simply supported at two points, is deflected, the points of support must approach one another slightly, since the length of the neutral axis remains constant. If the beam has fixed " pin-jointed " ends or built-in ends, longitudinal movement is prevented, and a direct stress is developed in the beam. The author obtained general expressions for this stress in four representative cases and the probable maximum values of the stress are deduced for steel and reinforced concrete beams. It appears that with beams of steel and reinforced concrete as at present designed the direct stress is small compared with the bending stress.

Notes on Recent Structural Research at Goodyear—Zeppelin Corporation. (K. Arnstein and E. L. Shaw, J. Aeron. Sci., Vol. 6, No. 12, October, 1939, pp. 499-501.) (72/37 U.S.A.)

A practical type of model girder has been developed which permits the axial, bending and torsional elastic constants to be varied independently. Means for the convenient and accurate measurement of corresponding strains and stresses have also been devised. Using this type of girder, a complete model airship was constructed and subjected to various forms of loading, both local and general. Special attention was given to stability and to the effect of initial tension in the shear wires. The results obtained were used to check existing methods of stress calculation.

In the case of models of those structures for which exact theories exist, the test values agree with calculation to within 3 per cent. of the ultimate strength of the prototype member.

In connection with this research, a stress change recorder has been devised, which records both maximum stresses and the total number of stress changes of different magnitude experienced by an aircraft member during flight. The instrument consists of a number of ratchet wheels requiring a definite amount of motion (stress change) for operation. Suitable counting devices give the number of stress changes for each range. The weight of the recorder is stated to be a few ounces.

Empirical Formulæ for Allowable Compression Loads in Stiffened Sheet Panels. (E. R. Reff, J. Aeron. Sci., Vol. 6, No. 12 (Section 1), Oct., 1939, pp. 505-510.) (72/38 U.S.A.)

The author presents a general formula for the strength of any flat sheet-stiffener combination, the necessary empirical constants being given for a limited range of extruded stiffener shapes. It is suggested that this formula may be utilized in laying out test schedules for other stiffener shapes for which such constants are not now available. Existing test results, if sufficiently broad in scope, may be used to determine the empirical constants for stiffener shapes other than those considered. The number of tests necessary to obtain design data for a given range of stiffener shapes and sizes may be greatly reduced by use of the formula, and determining the necessary empirical constants, rather than running a complete schedule of exhaustive tests, will expedite stress analysis procedure. It is recommended that further tests be run to correlate the effects of rivet spacing.

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Increase of the Specific Load Under Tension, Compression and Buckling of Welded Steel Tubes in Aeroplane Construction by Suitable Treatment of Structural Steel and by Proper Design. (J. Muller, L.F.F., Vol. 16, No. 1, 10/1/39, pp. 14-17. Available as Translation No. TM. 912.) (72/39 Germany.)

In the well-known Euler Formula for the buckling strength of a strut, the limiting load at a given slenderness ratio $L/_k$ (where $K^2 \times$ area = Moment of Inertia of Section) depends only on Young's Modulus of the material, and is thus practically independent of the heat treatment of the steel. Failure is assumed to take place under bending only and compression forces are neglected. This is legitimate for very long struts. Shorter struts however may fail under compression and the limiting load is thus very much lower than that given by Euler. By using heat treated Cr. Mb. steels, the Euler curve will be approached at smaller value of the slenderness ratio, and the buckling load for short struts raised appreciably above that obtainable with ordinary steels, provided failure at the weld is avoided, i.e., weld made as strong as the rest of the tubes. The simplest manner of achieving this is to thicken the tube ends and a method of construction embodying this feature has been patented by the Focke-Wulf Aircraft Company (Germany). The undercarriage of the F.W.200 (Condor) aircraft incorporates this feature.

If the component is under tension, the saving in weight for long struts can be made to approach the ratio of annealed to heat treated strength of the material, i.e., approximately 50 per cent.

The following table gives test results on a series of steel tubes tested for buckling with no end fixity.

Material.	Ultimate Strength kg./mm.²	Buckling Strength kg./mm.² at Slenderness Ratio. 20	40	60	80	100
Carbon Steel	60	40	35	30	25	20*
Cr. Mb. Steel (no heat treatment) ...	70	60	50	40	30*	20*
Cr. Mb. Steel (heat treated)	115	—	70	55*	30*	20*
Cr. Mb. Steel, with ends reinforced and welded as per F.W. Patent ...	115	95	90	55*	30*	20*

* This indicates that the Euler value is reached at this slenderness ratio. All the other values are below the Euler limit.

Bearings. (C. F. Smart, Metal Progress, Vol. 36, No. 4, October, 1939, pp. 349-50.) (72/40 U.S.A.)

Recent progress in bearings has been more along structural lines than through the development of new or improved alloys. Silver, and silver-lead, and aluminium have been given some attention, but these are apparently still much in the experimental stage. In general, four types of materials are in extended use for bearing metals—lead base babbitts, tin base babbitts, cadmium alloys, and copper-lead alloys. Each of these appears to have a field of usefulness determined by working conditions and design requirements.

Powder metallurgy is proving useful in some phases of bearing manufacture; one bearing soon to be available will be a new type copper-lead bearing, made by powder metallurgy processes, from chemically pure constituents, and uniformly distributed throughout the alloy. In another type of bearing a powder metallurgy composition is sintered on a steel back to serve as a mechanical reinforcement to a relatively thin layer of babbitt metal. Babbitt layers 0.003 in. thick applied over steel backs with an intermediate layer of bronze (the so-called tri-metal bearings) have recently been introduced and some tests indicate that these have appreciably higher fatigue life than bearings with greater babbitt thickness.

Electro-deposition of thin bearing metal layers as a method of producing bearings is in an experimental stage of development.

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Glass Fibre Electrical Insulation. (R. Quarendon, Electrical Engineer, 27/10/39, p. 1020. Met. Vickers Tech. News Bull., No. 682, 27/10/39, p. 4.) (72/41 Great Britain.)

Fine glass fibres are produced in two forms. One is a short staple glass "wool" which is gathered into a sliver and spun into a yarn like wool or cotton. The other is a glass silk which is produced as very fine filaments. These two forms are suitable for electrical insulation. Several advantages are claimed for such insulation, such as mechanical strength at elevated temperatures and resistance to cutting under pressure; insulation resistance and dielectric breakdown strength are also claimed to be superior to those of ordinary insulating materials. Fields of application include traction motors, road and rail, where weight is an important factor, and in chemical process work, where corrosive liquids and vapours are encountered.

Illustrated with one photograph.

Creep of Metals. (H. W. Gillett, Metal Treatment, Autumn, 1939, pp. 115-121. Met.-Vickers Tech. News Bull. No. 683, 3/11/39, p. 1.) (72/42 Great Britain.)

The author directs special attention to the scarcity of creep experimental data and critically considers various attempts that have been made to obtain information about creep behaviour by means of tests of relatively short duration. He also deals with the theories that have been devised to explain the differences in low and high temperature behaviour of metals and gives a review of what is at present known as regards grain size and composition of structure.

Illustrated with one graph.

Rubber Suspension. (A. S. Krotz, J.S.A.E., Vol. 45, No. 5, Nov., 1939, pp. 471-477, Transactions.) (72/43 U.S.A.)

The rubber torsion spring consists of an inner shaft surrounded by an annular layer of rubber bonded to the inner shaft and also to an outer metal shell. The outer shell is split into two segments. The spring is stressed in torsion by anchoring either the shaft or outside shell to the chassis and rotating the other member.

Engineering data and diagrams are presented to assist in the design and application of the rubber torsion springs in various ways to various types of automobile chassis as well as to railroad and streetcar suspensions. Included are methods of calculating angular deformation and considerable data on creep, hysteresis, durometer hardness and stress-strain relationships.

Mechanical and Electrical Methods for the Measurement of Rapidly Changing Phenomena. (J. Geiger, Glasers Ann., Vol. 63, 1/5/39, pp. 107-115. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 97.) (72/44 Germany.)

The author considers critically methods of measuring frequency, especially between 1 and 200 cycles, of importance in present-day development of the high-speed internal-combustion engine. An electrical method has the advantages of indication at a distance, simultaneous registration of a number of associated magnitudes on the same scale, and ability to magnify a selected portion; but scale relations are frequently non-linear, whilst the oscillograph conductor may pick up induced currents unless shielded, and optical errors may occur.

In addition, even a high-speed oscillograph has inertia.

Electrical methods include the resistance/pressure relation (subject to parasites); the piezo-electric effect in quartz (requiring good insulation and short conductors and difficult in matching); the photo-electric cell (requiring high amplification but insensitive to external effects); alteration of air-condenser capacity; armature generating a varying induced current; and the magneto-electric effect (giving

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linear relations and insensitive to moisture and temperature). The last two methods are not suitable for high-frequency variations.

In the case of mechanical devices, the natural frequency of the system (either as a whole or of some parts such as the scriber) sets a limit to the accuracy of the reproduction. In mechanical linkages play is of great importance and the author describes how play can be ascertained by means of a neon light circuit. A small amount of play can usually be eliminated by means of a sufficiently powerful control spring. Curves are given showing the effect of various degrees of damping.

Fine Measuring Appliances. (K. Burger, Maschinenbau, Vol. 18, May, 1939, pp. 227-30. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 98.) (72/45 Germany.)

The author describes advances revealed at the Leipzig Fair of 1939 in fine-gauging appliances. These include automatic sorting-machines for bearing rollers, in which 3,000 rollers per hour are sorted in seven groups varying by 2μ in diameter. He states that electrical methods of measurement were increasingly in evidence, not only in the automatic-sorting types but also in high-precision devices wherein electromagnetic effects are used to avoid mechanical contact and to magnify variations. Dial gauges of new form and minute proportions represent examples of the tendency to extend inspection methods towards visible and away from tactile forms. Similarly a gear-tooth form tester is illustrated, in which errors are recorded on a paper strip; 1mm. deviation of the pen denotes 20 sec. of error, or 5μ at the pitch-circle of a 4 in. wheel. This machine is driven by a small electric motor, the speed of which can be regulated, so that the human element and the touch cultivated in the use of some gear-testers are eliminated. Other innovations indicate a similar drive towards visibility and record; a machine with a capacity of variation of $\pm 35\mu$ records on a strip with a scale of 1 mm. per 1μ variation. Some of the new instruments include pneumatic cushioning to soften the impact of parts under examination, and thus to reduce the wear and tear of the instrument.

Friction Wheels for Instrument Work. (A. Kuhlenkamp, Z.V.D.I., Vol. 83, 3/6/39, pp. 677-83. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 98.) (72/46 Germany.)

The author discusses the foundations of the theory of predictors for anti-aircraft gunnery and demonstrates the suitability of friction gearing for transmitting, multiplying, and correcting various motions connected with aircraft as targets. He observes that many difficulties were encountered at first owing to slip and creep at the contact-surface and that when high-friction materials were used to prevent this, serious wear and attrition occurred. The best materials for accurate friction gearing proved to be steel on steel; and in order to utilise their rather low friction coefficients, high normal pressures are adopted with high-geared reduction of the motion. By using high-speed friction-wheels the forces and slips can be kept low, whilst sufficient accuracy of measurement is attained. The author describes typical trains of gearing coupled by friction-wheels, in which velocity products are derived as required by the ballistic problems, including the usual flat disk on which a small roller is moved radially across the face, and also a more recent arrangement in which the flat disk is replaced by a spherical surface which can be rocked about its centre. He discusses the possibility of using such mechanisms in the computation of accelerations and of higher derivatives of velocity; but he admits that the accuracy of workmanship required becomes prohibitive.

Librascope Power Computor. (Aero Digest, Vol. 35, No. 4, Oct., 1939, p. 149.) (72/47 U.S.A.)

The computor consists of a small case on which are mounted 5 dials, calibrated respectively to read r.p.m., manifold pressure, fuel air ratio, altitude and intake

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temperature. On setting the requisite values on these dials, 3 additional pointers give automatically the b.h.p., fuel consumption (gallons/h.) and b.m.e.p.

One setting of the instrument thus gives results which normally could only be obtained by three or more steps when using the engine performance chart. The instrument is specially useful for obtaining quickly the optimum operating conditions either for maximum power or best economy with change in altitude or intake temperature. It appears that the fuel consumption for constant h.p. can be reduced by decreasing the r.p.m. and increasing the boost. The ultimate limit to this adjustment is set by detonation in the engine and a maximum m.e.p. must therefore not be exceeded.

In cases where the engine is provided with an automatic mixture control, it is possible to dispense with one of the control dials, the calculation being carried out on the basis of r.p.m., boost, altitude and intake temperature only.

New Developments in the Riveting and Welding of Light Metals. (E. von Rajakovics, Z. Metallk., Vol. 31, May, 1939, pp. 137-40. Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, p. 112.) (72/48 Germany.)

The author observes that the ordinary aluminium-copper-magnesium alloy (duralumin type) cannot be used for riveting in the hard state, and that, owing to age-hardening, heat-treatment is complicated. He describes a new alloy of this type—duralumin 681 H—which can be used in the hard state, and has the further advantage that the shear strength of the rivets is increased by striking, whilst it is especially suitable for split rivets. Owing to corrosion, rivets of the aluminium-magnesium type cannot be used for joining duralumin or duroplat. In a new method of joining aluminium, introduced by A. and H. Weibel, the edges of the sheets to be welded are turned back through about 100 deg., and these flanges are welded with two carbon electrodes, bevelled at their inner faces and at an angle of about 20 deg. to each other. The flanges are heated to redness by the short-circuiting of a low-tension alternating current, the weld heat being thus virtually independent of the resistance of the welded material. Not only is less flux required for this method than for autogenous or resistance welding, but also a less sensitive flux may be used. The method is suitable for welding all light-metal sheets of 0.2-1.5 mm. (0.008-0.06 in.) thickness.

New Processes for Welding and Soldering Zinc, Aluminium and Magnesium. (K. Heinemann, Z. Metallk., Vol. 31, May, 1939, pp. 141-53. Eng. Absts., Vol. 2, No. 8, Section 2, August, 1939, p. 112.) (72/49 Germany.)

In order to avoid the use of lead-tin alloy ordinarily required for soldering pure zinc, a welding process has been developed. For galvanized sheet a zinc flux and zinc wire are used, the temperature of about 420°C. (790°F.) being obtained with a flame. Most zinc alloys cannot be satisfactorily welded, especially if they contain aluminium. For these alloys a kind of puddling weld can be made by using a templet, melting wire over the joint, and puddling the oxide out of the weld. Aluminium and its alloys can be welded, using covered electrodes, with a current of 140-280 amp. at 25-30 volts. This method is especially suitable for 5-10 mm. (0.2-0.4 in.) sheet; for thinner sheets, the Weibel method (Abstract 72/48) is recommended. In joining aluminium cables, the ends are passed into a graphited steel mould and a stearin flux is added; the whole is heated to 850°-900°C. (1,560°-1,650°F.) and aluminium is poured in, the insulation being protected by screening and cooling. Another method involves the reaction of heavy-metal chlorides with a soft aluminium solder, but there is a danger that the oxide skin may not be completely dissolved. Commercial magnesium alloys are, in general, easily weldable; those containing aluminium can have only short welds, owing to their liability to weld cracks. Magnesium is also now used in conductors of interior switches; for welding these, the ordinary flux and pure magnesium wire are used

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with a supporting templet. In repairing welding of magnesium castings, the weld requires protection owing to the impossibility of removing the last traces of flux, which may lead to corrosion at the weld-seam.

Rationalisation by Production Control and Inspection. (W. Knichahn, Maschinenbau, Vol. 18, May, 1939, pp. 219-223. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, pp. 93-4.) (72/50 Germany.)

The author emphasizes the importance of system and measurement in the maintenance of general industrial efficiency. Citing as an example a commercial adding-machine, in which more than 70,000 manufacturing operations are required, he describes typical methods of improving or eliminating inspection. He illustrates a very accurate trigger, in which originally thirty-nine tolerances required inspection, which was redesigned so that only seventeen tolerances are needed. The relative cost of manufacture and inspection is illustrated by the gear-box-casing of a milling-machine and by a side-frame of the adding machine. In the former, making requires 335 minutes, and inspection 25 minutes, whilst in the latter, making needs 5 sec. and inspection 20 sec. The percentages are therefore 7.5 and 400 respectively. In order to render inspection cheaper and more reliable, limit gauges are replaced by indicator methods; and when the numbers are sufficient the parts are automatically inspected and sorted for selective assembly. The author advocates the use of methods for quickly revealing faulty work; e.g., when a bush is pressed into a lever the assembly-pressure is used as a check on the fit of bush and hole. He demonstrates, by data from practice, the possibilities in instrument work of new ideas. The typical adding-machine labour is distributed as to one-quarter in making the parts and three-quarters in assembly, so that the savings realizable in assembly by making details perfect are more than sufficient to cover the extra manufacturing cost of those details. The author demonstrates how by proper planning and control the cost of such work decreases progressively from year to year.

Tightening of Bolts. (H. Dentler, Maschinenbau, Vol. 18, April, 1939, pp. 185-7. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, pp. 94-5.) (72/51 Germany.)

The author describes an investigation into the security and uniformity of assembly of airscrews on aero-engine flanges. Five fitters with varied training and experience were selected, three types of nut and bolt were provided, and a number of spanners fitted with a lengthening-piece to afford extra leverage were rendered freely available. The men were instructed to pull up the nuts by their sense of feel and touch; the threads and nut-faces were oiled and greased. By a simple arrangement of a dial-gauge on the bolt-end, the extension and pull in the bolt were measured. The results are tabulated. The variation from the mean tension in the bolts attained 45 per cent. in one bolt. The author concludes that bolts and nuts involving risk to life cannot be safely left to the touch of the erector, and he recommends control by measurement of bolt-length.

ABSTRACTOR'S NOTE.—In an addendum Schönung describes three forms of safety spanners. These measure or indicate the torque exerted by the erector, whilst in one, operated hydraulically, the spanner slips as soon as a prearranged torque has been exerted.

Interchangeability in Modern Aircraft Production. (C. Heriel, J.S.A.E., Vol. 45, No. 5, Nov., 1939, p. 15 (Digest).) (72/52 U.S.A.)

With respect to aircraft mechanisms produced by conventional machine production methods, interchangeability is assured by tooling methods common to all

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industries. The author deals with the more complex parts of the structure, such as wing and fuselage, and the development of faired surfaces involving double curvatures. Such curves and outlines are laid out full scale in a lofting department but it is not practical for shop men to scale dimensions direct from such lofted outlines, as no two men would scale to the same identical dimension. Therefore tables of offsets and bevels are prepared by the lofting department to convert significant points on the moulded surface into numerical values useful to engineering and tooling personnel. With a structure as large as the wing, a system of applied analytical geometry is used to calculate any point on the wing structure, which is treated as a geometric solid.

The Final Assembly of Aircraft. (H. F. Schwedes, J.S.A.E., Vol. 45, No. 5, November, 1939, pp. 15-16 (Digest).) (72/53 U.S.A.)

An efficient line assembly calls for design on production lines. The various component assemblies are manufactured complete in jigs in various departments, and are brought in to final assembly completely finished and painted, no fitting or other hand work being required.

It is essential, of course, that the sub-assemblies manufactured under this system are all ready for final assembly at the required time, and this necessitates efficient production control. Experience for this is gained by starting with a preliminary lot of say 5 planes to complete tooling and checking of jigs. The final assembly is accompanied by moving the plane progressively through a set of stations (usually 8) with a special crew at each station trained for the particular work required.

It is claimed that by adopting these methods, the North American Aviation Co. have established a peacetime production record over the first six months of 1939 by turning out 103 aircraft in one month of 23 working days.

Accelerated Aircraft Production for National Defence. (P. N. Jansen, J.S.A.E., Vol. 45, No. 5, November, 1939, p. 16 (Digest).) (72/54 U.S.A.)

Prototypes must be turned out very much faster than in the past, and this means that many details of the structure will be more expensive, and fittings which eventually will be forgings have now to be hogged out of solid stock. This, however, does not mean that liaison between shop and design departments may be relaxed. In addition to being mainly " performance minded," the latter department must be " production minded " as well. As regards tooling, it is interesting to note that the author considers that any reduction in production costs is small once quantities in excess of 100 are handled. The major part of the costs is connected with installation of parts, accessories and sub-assemblies.

Extreme simplification of the major structural components (such as by the adoption of plastics) does not necessarily produce a reduction in production costs since the installation of accessories and sub-assemblies is bound to become more difficult.

New Method of Developing Prototype Aeroplanes as Applied to Consolidated Model 31. (B. W. Sheahan, J.S.A.E., Vol. 45, No. 5, November, 1939, p. 16 (Digest).) (72/55 U.S.A.)

Outside interference and too close co-operation with the customer is the main reason for time lost in the developing of experimental aircraft. Another source of delay is the time taken up with accessories and installations which are not part of the aircraft proper, but which will ultimately be required if the aircraft is to fulfil specialised duties. It is much better to concentrate on the construction of the aircraft, a study of a mock-up insuring at an early stage that these accessories can be eventually incorporated. By concentrating on essentials, the large con-

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solidated Flying Boat Model 31 was turned out in under ten months, approximately 1,000 drawings being required in all.

Design Problems in the Quantity Production of Engines. (H. C. Hill, J.S.A.E., Vol. 45, No. 5, November, 1939, pp. 16 and 21 (Digest).) (72/56 U.S.A.)

The major difficulty in the quantity production of engines is the relatively large number of changes required (averaging in some case 10 changes per 18 engines built).

Such changes range from finning to connecting-rod design and are not excessive, considering the extreme complexity of the modern power plant, such as a two bank radial. Accumulated service experience calls for design changes and it is the duty of the production department to see that such changes, whilst improving the article, do not detract from the ease of manufacture. A case in point is the forged steel crankcase, machined all over, which now forms a characteristic feature of large power American engines. Such crankcases are as light as the previous alloy cases, but much more reliable. At the same time their cost is the same. A frequent source of hold-up in production is the multiplicity of inspections insisted on by customers. Careful specifications of requirements as to desired finishes and tolerances together with the application of such instruments as the profilometer will avoid much of inspection controversy.

Engine units must become more compact and more accessible. Provision must be made for an increasing number of accessories, each of which should be readily accessible and removable.

Drying with Near Infra-Red Radiation. (L. S. Ickis, Jnr., and H. H. Haynes, Gen. Elect. Rev., Vol. 42, April, 1939, pp. 145-9. Eng. Absts., Vol. 2, No. 7, Section 2, July, 1939, p. 95.) (72/57 Great Britain.)

Heating elements such as the steam radiator, which does not glow, emit infra-red energy of long wave-lengths (far infra-red). The filament lamp, like the sun, is a source of near infra-red energy. This is the portion of the spectrum which lies chiefly in the wave-lengths slightly longer than the red visible radiation. The 250-watt drying-lamp is designed to be most effective for vapourizing the most common solvents and washes. Typical lacquers have their greatest absorption in the visible and near-visible region of the spectrum. The drying-lamps, which are fitted with reflectors, operate at a colour temperature of 2,500 K., in comparison with the 3,000 K. of filament lamps for illumination. Tunnels lined with lamps and reflectors are in use in a motor-car factory. The authors state that the prime coat on a car can be dried in 7 min. and the finishing coats in 14 min.

The Periodic Flow of Heat in a Hollow Cylinder. (J. H. Awberry, Phil. Mag., Vol. 28, No. 189, Oct., 1939, pp. 447-54.) (72/58 Great Britain.)

The problem of the flow of heat in a hollow cylinder, when the temperature of the inner wall is constrained to vary periodically, and the heat loss from the outer surface is proportional to its temperature excess over the surroundings, is investigated mathematically. The theory has applications to the heat phenomena in the cylinder of an engine, and would also be needed in determining the thermal diffusivity of a metal experimentally by measurements of temperature waves in a hollow rod.

The various Bessel functions occurring in the solution are complex numbers, though the expressions for such physical quantities as the amplitude and phase lag are real. The formulæ are written (in terms of the real and imaginary parts of the Bessel functions) so as to exhibit these quantities in a purely real form. The functions themselves are given in the tables of Jahnke and Emde in a form suitable for computation.

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A New Apparatus for Direct Reading of Pitch and Intensity of Sound and its Application. (J. Obata, R. Kobayashi, Electrotechnical Journal, July, 1939, pp. 152-6. Metropolitan-Vickers Tech. News Bull., No. 681, 20/10/39, p. 8.) (72/59 Great Britain.)

In acoustical investigations, it frequently happens that a graphical representation of the pitch of the sound, regardless of its wave form, is required. The authors describe the principle underlying an apparatus designed for this purpose. This apparatus is claimed to be an improvement upon previous arrangements and an additional device for recording variations in intensity has been incorporated. Examples of its application are given.

Illustrated with two photographs, one diagram, five oscillograms and two graphs.

A Sound Pitch Indicator, Incorporating the Thyratron. (T. A. Sterne and H. J. Zimmerman, J. Sci. I., Oct., 1939, pp. 334-6. Met.-Vickers Tech. News Bull., No. 682, 27/10/39, p. 7.) (72/60 Great Britain.)

In an instrument designed for making pitch variations visible, sound impulses are fed to an electronic frequency meter, the output of which is directly proportional to the fundamental frequency. The amplified voltage is applied to the grids of seven thyratrons, which are biased by successively greater amounts. The number of thyratrons which fire at a given signal therefore depends on the frequency of the signal. The firing of each thyratron lights a neon lamp in its plate circuit, and since these lamps are arranged in a vertical column, the effect obtained is a column of light which rises and falls with rising and falling pitch.

Illustrated with one diagram.

The Degenerative Sound Analyser. (H. H. Scott, J.A.S.A., Oct., 1939, pp. 225-232. Met.-Vickers Tech. News Bull., No. 683, 3/11/39, p. 3.) (72/61 Great Britain.)

Noises generated by machinery may be divided roughly into two classes, viz., sounds at the fundamental frequency at which the machine is operating, or harmonics of this frequency, and secondly components which are not definitely related in frequency to the fundamental speed of the machine. Various types of analysers are discussed and the disadvantages of the heterodyne analyser considered. The degenerative sound analyser is then shown to possess qualities which, it is claimed, make it suitable for industrial noise analysis. It consists essentially of a high gain amplifier and a feed-back network which is so designed that all frequencies, except that to which the analyser is tuned, are fed back to the input of the amplifier, with such a phase relationship as to produce degeneration and consequently cancellation of the gain. The maximum gain of the amplifier is obtained, therefore at the frequency to which the device is tuned and drops off rapidly on either side of this frequency. The use of the analyser is described in some detail, with examples.

Illustrated with one photograph, one diagram and four graphs.

Communication With and on Railway Trains. (A. G. Shaver, J. Western Soc. Engrs., Vol. 44, April, 1939, pp. 58-69. Eng. Absts., Vol. 2, No. 7, Section 2, pp. 91-2.) (72/62 Great Britain.)

The author describes the results of experiments made during the past ten years to develop a system of wireless communication for use on trains, between the driver and the guard, between parts of trains that have been separated, or between trains and wayside controlling-points, such as dispatchers' offices and signal-boxes. On the long freight trains run in America such communication is desirable, since whistle and hand signals have only a limited field of usefulness. The track-rails are used to convey the speech effect, reinforced in some localities by a line wire run alongside and connected in parallel, the power for transmitting being obtained

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from the headlight generator or from batteries, whilst the frequency-bands used preclude interference from or with outside sources. The author describes the equipment, and reviews its possible applications.

A General Radiation Formula. (S. A. Schelkunoff, Proc. Inst. Rad. Eng., Vol. 27, No. 10, Oct., 1939, pp. 660-666.) (72/63 U.S.A.)

In this paper a general formula is derived for the power radiated in non-dissipative media by a given distribution of electric and magnetic currents. Magnetic currents are included not only for the sake of greater generality but also because in problems involving diffraction through apertures and radiation from electric horns, the radiation intensity can be made to depend upon fictitious electric—and magnetic—current sheets covering the apertures or horn openings.

Part I consists of an introductory discussion, summary of the formulæ, and examples illustrating the convenience of the general formulæ, Part II contains a mathematical derivation of the radiation formulæ.

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