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Rifle Grenades. (C. Warringer, W.T.M., Vol. 43, No. 8, August, 1939, pp. 342-348.) (71/1 Germany.)

The earliest types of grenades were fitted with a stick which was inserted into the rifle barrel, the grenade projecting beyond the muzzle. As a subsequent development, the grenade was fitted with a central passage and placed in a separate funnel shaped container attached to the muzzle. The normal projectile of the rifle passed through this hole and the grenade was projected by the powder gases following the projectile. (Maximum range about 100 m. for .5 Kg. grenade.) It is obvious that the range could be increased if the leak through the grenade could be stopped. This naturally leads to the closed type of grenade, in which the rifle bullet becomes imbedded (Brandt). Although a range of up to 400 m. now becomes possible, the grenade has to be built to stand the impact shock and this detracts from its primary function as an efficient carrier of explosive. The increased range is almost entirely due to the sealing of the explosive gases and would be reduced by only 10 per cent. if the bullet were allowed to travel through the grenade without shock and means of sealing the passage after transit could be devised. The author described such an arrangement consisting of a spring loading flap valve which closes after the passage of the bullet. Differences in range at constant elevation can be obtained by a variable gas leak or by adjusting the distance of the grenade from the muzzle exit.

High Explosive Bombs. (T. L. Davis, Army Ordnance, Vol. 20, No. 116, September-October, 1939, pp. 91-94.) (71/2 U.S.A.)

Anti-Personnel bombs must explode as soon as they touch the ground. Bombs for the destruction of buildings on the other hand must penetrate before exploding, i.e., the explosive must be insensitive enough to stand the shock of impact and only respond to a separate fire mechanism functioning with a definite delay. Both types of bomb fillings must not explode if accidentally struck by bullets or shell splinters whilst being carried by the aircraft.

Dynamite and other explosives containing nitroglycerine are much too sensitive for bomb filling. The usual explosive for this purpose is T.N.T. (trinitrotoluene). In cases where destruction by " blast " is effective, trinitro benzene is recommended.

A lot has been heard about liquid oxygen as a constituent of bomb fillings. Mixtures of liquid oxygen and cork dust or powdered aluminium form powerful and safe explosives. Unfortunately the liquefied gas evaporates and the explosive

must be used very soon after preparation in order to be effective. As an alternative, liquid NO_2 can be used in closed containers. Mixed with CS_2 or petrol it forms the explosive called anilite. T.N.T. does not contain enough oxygen for complete combustion and thus produces a black smoke. This difficulty is overcome by the addition of ammonium nitrate, the mixed product being known as amatol. The ammonium nitrate is itself explosive and since it contains an excess of oxygen the addition of powdered aluminium is very effective. It is very likely that the German bombs used in Spain and described in the press as containing an explosive made from air, contained ammonium nitrate since the latter is a by-product of the fixation of atmospheric nitrogen.

Bomb Release with Climbing Flight. (C. Rougeron, Nova Air Revue, No. 45, August, 1939, pp. 2-5.) (71/3 France.)

The object of bomb release while climbing is to increase the range (horizontal trajectory) of the bomb. This forces the defending A.A. artillery to be distributed over a much larger area and naturally reduces the fire density. Conditions most favourable to the bomber thus arise if a coast line is attacked.

Large increases in bomb range are only possible if the bomb is launched by means of an aircraft gun or if some method of rocket propulsion is employed. The actual range obtained will depend markedly on the weight and design of the bomb.

The author is of the opinion that ranges of the order of 10-20 Km. should be possible in the near future. If stratosphere bombers are employed, the possible range would be extended to 50 Km. and beyond. Such a high release causes the bomb to travel for a considerable part of its trajectory in air of very low density and the ballistic problem thus resembles that of the long range gun.

Co-operation Between A.A. Artillery and Fighters. (L. Gretschkosy, Luftwehr, Vol. 6, No. 7, July, 1939, pp. 296-7, from the Russian.) (71/4 U.S.S.R.)

Three types of co-operation are possible:—

1. Zone of operation of fighter is limited to certain altitudes (*a*), or he is instructed to keep above certain landmarks (*b*).
2. The artillery and the fighters attack different targets.
3. Artillery and fighters attack same target simultaneously.

1a. The disadvantage of altitude co-operation is the fact that the enemy is likely to pass rapidly from one zone to the other, and if he happens to operate in the intermediate safety zone previously laid down he may escape attack for a period. Moreover by arranging the method of attack according to altitude, the bomber is able to adopt the type of formation most favourable to him, i.e., close formation above the A.A. zone and open formation below it.

1b. Keeping above certain landmarks is extremely difficult for the fighter, unless he is in constant telegraphic touch with the ground batteries. This naturally detracts from his fighting capacity.

2. If fighter and A.A. are to attack different targets, priority is generally given to the artillery, which attempts to break up the enemy formation which is then attacked by the fighters.

3. Simultaneous attack with fighters and artillery can be carried out in two ways.

(*a*) The bomber formation is fired at from the ground and also attacked laterally by means of multiseat fighters whilst single seat fighters attempt to drop bombs on them from above.

(*b*) The artillery fire is in salvos, the fighters attacking between the periods of rest arranged previously. This necessitates frequent change of course for the fighters, and puts the crews of the latter to great physical strain, thus impairing their fighting efficiency.

The most difficult form of co-operation exists if the enemy appears suddenly out of the clouds. If the possibility of such an attack can be foretold from acoustical records, the A.A. artillery must open a barrage fire. The rôle of the fighter will then be to keep in as close contact as possible with the enemy and correct the artillery fire.

It will be noted that all co-operation between fighters and A.A. artillery depends on the efficiency of the means of communication between the two. Wireless and especially optical signals are relied on. The time available is however very short and the signals must therefore be of the simplest type.

Effective co-operation thus entails lengthy practice under simulated war conditions.

Explosives for Aerial Bombs (from the Italian). (Rev. de l'Arm. de l'Air, No. 117, August, 1939, pp. 445-6.) (71/5 Italy.)

In the 1914 war, the principal explosives were picrid acid (melinite) and T.N.T. The latter requires 400 kg. of coal for 1 kg. of explosive and an aerial bomb of 2,000 kg. is thus equivalent to a trainload of coal.

As a result, alternative methods of manufacturing explosives have been considered, which take CO as a starting point. This is hydrogenated, producing in turn methyl alcohol and formaldehyde. The latter acts as basis for four complex explosives,

pentrite (tetranitrate of pentærythrene)
T_4 (trimethylene trinitroamine)
tetranitrate of isobutylglycerine
peroxide of hexamethylene diamine

Only the first two of these are of interest for aerial bombs. Although the cost is over twice that of T.N.T., the expenditure may be justified in view of the fact that these explosives are 50 per cent. more powerful that T.N.T. and the weight of the bomb is thus reduced. Although the finished product is very stable, the filling process is complicated by the fact that fusion and decomposition temperatures are relatively close. For this reason the new explosives are often mixed with other products to reduce the sensitivity. We thus have the pentrinite of Prof. Stettbacher (pentrite + nitroglycerine), the Bonite of Bofors (T_4 + T.N.T.) and finally the product of the Italian chemist Tonegutti (pentrite + Ammonium nitrate + dicyanodiamide).

Present Position Concerning Nature and Consequences of Barrel Wear. (D. Bornemann, Z.G.S.S., Vol. 34, No. 9, September, 1939, pp. 267-269.) (71/6 Belgium.)

Barrel wear is most marked at a distance of a few calibres from the beginning of the rifling and near the muzzle. If cartridge ammunition is used, the unrifled barrel in the neighbourhood of the neck of the casing (i.e., on a level with the base of the projectile) also shows signs of wear.

The wear originates in the friction generated in the rifling and is aggravated by gas leakage. It can be controlled by proper choice of barrel material, type of explosive and type of mounting for guide ring on shell.

The main effect of wear is a large decrease in range arising from oscillations of the projectile in its trajectory (canting of projectile on leaving muzzle).

The muzzle velocity is also diminished. It is, however, interesting to note that maximum muzzle velocity is only reached after a new gun has fired a certain number of rounds. This is attributed to a polishing effect inside the barrel which subsequently is destroyed by wear producing the drop in muzzle speed referred to above.

Speaking generally, cartridge ammunition is the worst offender in this connection.

Effect of Transition in Cross-Sectional Shape on the Development of the Velocity and Pressure Distribution of Turbulent Flow in Pipes. (E. Mayer, Forschungsheft, Vol. 9, No. 389, March-April, 1938. N.A.C.A. Tech. Memo., No. 903, August, 1939.) (71/7 Germany.)

In this paper the results are presented of pressure and velocity distribution measurements in transition pieces in order to investigate the effect of the change in shape of the cross section contour for equal area of cross section. For the two investigated transition pieces (which differed in their transition lengths) a circular cross section is deformed into one of rectangular shape.

The most important factors affecting the velocity and pressure distribution in the transition pieces are enumerated and it is attempted to show their effects at least qualitatively. The greatest effect is that produced by the local retardations and accelerations.

It is concluded from the measurements for the transition rectangle circle that the change in turbulence mechanism due to the cross section deformation does not very greatly affect the velocity distribution in the transition cross sections themselves. The change in the friction perimeter of the cross section due to the deformation is, however, important.

At the conclusion of the paper are given the loss coefficients for the two transition pieces in both flow directions.

Universal Logarithmic Law of Velocity Distribution as Applied to the Investigations of Boundary Layer and Drag of Streamline Bodies at Large Reynolds Number. (G. Gurjienko, Trans. C.A.H.I., No. 257, 1936. Available as Air Ministry Translation T.M. 842.) (71/8 U.S.S.R.)

The Karman expressions for the velocity distribution in a boundary layer and the surface drag both include a so-called " universal " constant. Up to now the value of this constant was deduced from experiments on the flow in pipes (Nikuradse) and it was assumed that the same value of the constant applied both in the velocity distribution and surface friction expressions. Assuming a value of .4 for this constant, the authors have calculated the thickness of the boundary layer in the case of the " Acron " airship hull, with the result that the theoretical values are approximately 50 per cent. greater than those given by experiment.

In order to remove this discrepancy, the author suggests a " compromise " law, in which the universal constant has a value .2 to .3 in the velocity distribution formula and a value .4 in the expression for the drag in the laminar sublayer.

The article shows how the integration of the pertinent equations is simplified by the use of functional scales which are given in an appendix. By means of these scales calculations can be readily carried out for any value of the "Universal" constant and in the case where another logarithmic law (e.g., that of Nikuradse-Prandtl) is adopted.

D.2 Aerofoil Series. (E. Solodkin, Trans. C.A.H.I. No. 264, 1936.) (71/9 U.S.S.R.)

The D.2 series varies in thickness ratio σ from $\sigma = .1$ to $\sigma = .22$, the value of the maximum lift coefficient being rather high (.69 referred to ρv^2) and the lift/drag ratio varying from 15 to 21 at $Re \sim 10^6$.

Tests show that a whole span split flap fitted to these aerofoils causes an increase in maximum lift which can be represented by the following empirical equation.

$$C_{L\max} = \cdot 75 - 7 \cdot 43\ (\cdot 29 - \sigma)^{1 \cdot 82}.$$

As a criterion for the effect of the flaps on landing speed, the ratio of the maximum lift coefficient with flap to that without can be used. This ratio varies linearly with thickness ratio and can be expressed by

$$(C_{L\max} \text{ with flap}) / (C_{L\max} \text{ without flap}) = 1.25 + 3.666.$$

It must be remembered that both the above formulæ only apply to aerofoils of the D.2 family, the pertinent parameters of which are given in the report (maximum thickness well forward, slight upward curvature of trailing edge).

Effect of Proximity of the Ground on the Aerodynamical Characteristics of an Aeroplane. (I. Serebrijsky, Trans. C.A.H.I. No. 267, 1936.) (71/10 U.S.S.R.)

The experiments by the author were carried out by the well known " image " method, a special suspension enabling the two models to be displaced simultaneously and symmetrically. Only the case of steady horizontal flight near the ground is investigated and the results obtained are considered to be in sufficiently good agreement with theoretical calculations in which the wing is replaced by a Helmbold Vortex system. Some experimental data on the longitudinal stability of a wing in close proximity to the ground are given and the author concludes with a critical examination of experimental methods for the determination of the ground effect.

Note by Abstractor.—As was pointed out by Grusoon (Comp. Ren. No. 7, 15/2/37), the image method gives misleading results in the case of interference between the vortices shed by the two models. A new vortex street is formed and the ground effect is no longer represented.

The Use of Heavy Gases or Vapours for High Speed Wind Tunnels. (I. A. Rubinsky, J. Aeron. Sci., Vol. 6, No. 11, Sept., 1939, pp. 446-450.) (71/11 U.S.A.)

In order to take into account the effect of compressibility model tests must be carried out at the same Mach number as full scale. This means that the tunnel speed must be practically the same as under actual conditions. By replacing the air in the tunnel with a gas of higher molecular weight, C, the speed of sound is reduced and since Mach number $= V/C$, the tunnel speed V can be lowered without affecting dynamic similarity. This in its turn reduces the power required to operate the tunnel very considerably, but introduces experimental difficulties (sealed tunnel and remote controls).

The author gives a preliminary design for a heavy vapour tunnel utilising carbon tetrachloride. The gas speed is 650 feet/sec., giving a Mach number of 1.3 and the experimental section is 1 sq. ft.

The h.p. required for this installation will be of the order of 250, which is less than 10 per cent. of the power required when operating with air at the same density and the same Mach number.

The Aerodynamic Characteristics of Six Full-Scale Propellers having Different Aerofoil Sections. (D. Biermann and E. P. Hartmann, N.A.C.A. Report No. 650, 1939.) (71/12 U.S.A.)

Wind-tunnel tests are reported of six 3-blade 10 ft. propellers operated in front of a liquid-cooled engine nacelle. The propellers were identical except for blade aerofoil sections, which were: Clark Y, R.A.F. 6, N.A.C.A. 4,400, N.A.C.A. 2,400-34, N.A.C.A. 2R 200, and N.A.C.A. 6,400. The range of blade angles investigated extended from 15° to 40° for all propellers except the Clark Y, for which it extended to 45°.

The results showed that the range in maximum efficiency between the highest and the lowest values was about 3 per cent. The highest efficiencies were for the low-camber sections. An analysis of the results indicated that blade sections for controllable propellers which are not limited in diameter should be selected chiefly on a basis of minimum drag (which affects maximum efficiency) inasmuch as the maximum lift coefficients had only a small effect on the take-off characteristics within the range investigated because stalling, in general, did not occur.

Sections for fixed-pitch propellers should be selected on a basis of both minimum drag and maximum lift, particularly for blade-angle settings of 20° and over, because the take-off thrust power increased with maximum lift for the higher blade angles.

Flight Tests of N.A.C.A. Nose-Slot Cowlings on the BFC-1 Aeroplane. (G. W. Stickle, N.A.C.A. Tech. Note No. 720, August, 1939.) (71/13 U.S.A.)

The results of flight tests of four nose-slot cowling designs with several variations in each design are presented. The tests were made in the process of developing the nose-slot cowling. The results demonstrate that a nose-slot cowling may be successfully applied to an aeroplane and that it utilises the increased slipstream velocity of low-speed operation to produce increased cooling pressure across the engine. A sample design calculation using results from wind-tunnel, flight, and ground tests is given in an appendix to illustrate the design procedure.

Adhesion of Ice in its Relation to the De-Icing of Aeroplanes. (A. M. Rothrock and R. F. Selden, N.A.C.A. Tech. Note No. 723, Aug., 1939.) (71/14 U.S.A.)

The most important conclusions drawn from the present tests are possibly not new, but they seem to be quite definite.

1. Ice will adhere to any solid surface tried thus far with a force greater than the cohesive forces within the ice.

2. Ice will not adhere to a surface provided that there is a liquid interface between the ice and the surface. If such a liquid interface is formed, the force required to remove the ice will be little more than the aerodynamic or aerostatic forces tending to hold the ice to the surface.

3. The outlook for preventing ice formation on the surfaces of an aeroplane wing by means of some liquid surface is not encouraging. The amount of liquid required will probably be large and some mechanical force is necessary to overcome the air forces in order to remove the ice. The use of such liquids for windshield de-icing or for small surfaces may be successful.

4. For propellers, where a centrifugal force is always available, the use of liquids for de-icing will probably continue to be the most efficient method.

5. Although wind-tunnel tests have indicated that heating the wings of an aeroplane as a means of preventing ice formation is feasible, no full-scale tests have been made to determine the practicability of the method. It is believed that such tests should be conducted as soon as possible.

The Effects of Surface Waviness and of Rib Stitching on Wing Drag. (M. J. Hood, N.A.C.A. Tech. Note No. 724, Aug., 1939.) (71/15 U.S.A.)

CONCLUSION.

1. Surface waviness of a magnitude common to aeroplane wings will not seriously increase the drag unless the waviness exists on the forward part of the wing, where it may cause premature transition or premature compressibility effects. Waves 3 inches wide by 0.048 inch high, for example, increased the drag about 1 per cent. when the waves covered the rear 67 per cent. of both surfaces and 10 per cent. when they covered the rear 92 per cent.

2. A single wave 3 inches wide by 0.020 inch high at the 10.5 per cent. chord position on the upper surface was just high enough to cause transition to occur at the wave. The resultant drag increase was 6 per cent.

3. Rib stitching corresponding to a rib spacing of 6 inches increased the drag 7 per cent.; the drag increment was proportional to the number of ribs for larger rib spacings. About one-third of the increase was due to the premature occurrence of transition at the forward ends of the stitching.

In all the above cases the lift coefficient is .15 and the Reynolds Number 10.3×10^6.

Effect of Engine Nacelles and Undercarriage on the Characteristics of a Thick Monoplane Wing. (V. Gorsky, Trans. C.A.H.I. No. 259. Available as Air Ministry Translation No. 529.) (71/16 U.S.S.R.)

The experiments were carried out on a model wing of 1.5 m. span and .2 m. chord, double convex profile, with a maximum thickness ratio of 20 per cent. Nine different types of engine nacelles were used, the number on the wing varying from 6 to 12. Four separate types of undercarriages were tested. The wind speed varied between 10 and 50 m./sec. On account of the relatively small value of the Reynolds number, extrapolation to full scale is uncertain. It is, however, considered that the relative values obtained give some guide to the designer.

The following are some of the principal conclusions.

1. The engine nacelle disturbs the distribution of the circulation on the wing and is equivalent to an induced resistance which may be several times greater than the head resistance of the nacelle tested separately.
2. Maximum induced resistance is caused by engine installations above the wing or by nacelle situated near the leading edge especially if the size of the nacelle is relatively great compared with the thickness of the wing.
3. The best position appears to correspond to the axis of the nacelle being slightly below the wing chord.
4. The detrimental effect generally increases as the distance between the nacelles becomes less.
5. The interference effects of the undercarriage are very small.
6. The experiments show the importance of cowling the radiators.

Wind Tunnel Investigations of Aeroplane Spin, Taking into Account the Radius of the Trajectory. (A. Jouravchenko and E. Verjanskaia, Trans. C.A.H.I. No. 260.) (71/17 U.S.S.R.)

It is very difficult to mount a spinning model on a balance except for the case $r=0$ (radius of trajectory zero). This entails certain corrections which must be applied for the general case $r \neq 0$. The authors determine these corrections theoretically and show that they are only of importance in the case of the centrifugal forces and rolling moments. By arranging so that the ellipsoid of inertia of the model becomes a sphere, the centrifugal moments disappear when $r=0$ and the correction for the general case becomes very simple.

The procedure adopted by the author is so simple that the mathematical analysis can be carried out simultaneously with the experiment.

Effective Loads on Undercarriage. (S. N. Chichkine, Trans. C.A.H.I. No. 269, 1936.) (71/18 U.S.S.R.)

The loads on various parts of the undercarriages of two aircraft of 2 ton weight were measured by means of extensometers during landing and take off. Records of time/stress showed that the impact (shock) load during a normal landing may exceed the static load of 3.25 times.

The results are utilised for a proposed revision of load factors of landing gears.

Alighting of Flying Boats on a Heavy Sea and in the Dark. (W. Parker, Flugsport, Vol. 26, 1934, pp. 51-54 and 73.) (71/19 Germany.)

The author favours the provision of drag ropes about four times the length of the machine. Warning of the approach of the water surface is thus given to the pilot under conditions of bad visibility and the drag of the rope in the water materially reduces the landing run. It is very important that the rope should be attached near the C.P. of the aircraft so as to introduce no considerable pitching movement. Some rubber damping by means of an elastic attachment must also be provided to reduce the shock of impact of the rope with the waves at the instant of contact. As every seaplane must already carry a sea anchor, the extra weight

due to the drag rope for alighting can be kept small. After discussing various methods of towing seaplanes, the author refers especially to the landing sail of Hein. This consists of a sail towed behind the ship and kept flat by means of transverse laths. Tubular compartments are fitted on the underside through which the water flows as the sail is dragged along and this assists in steadying the sail. Lateral floats produce the necessary buoyancy. The sail is dragged against the wind and the seaplane runs on to the sail at a high speed and after coming to rest can be towed even in a rough sea. Communication between ship and plane is simplified and even small repairs can be carried out. The surface of the sail protects the aircraft from spray and by flooding the sail (i.e., reducing buoyancy of floats or reducing drag speed) the seaplane parts company with the sail if a new take-off is contemplated.

Abstractor's Note.—A landing sail in the rolled up condition is shown in Engineering, Vol. 144 (1937), p. 100, whilst some descriptive matter is contained in an article entitled " The Seaplane Catapult Ship ' Ostmark ' " on pp. 109-110 of the same journal.

Tank Tests to Determine the Effects of the Chine Flare of a Flying Boat Hull. (J. W. Bell and R. E. Olson, N.A.C.A. Technical Notes No. 725, August, 1939.) (71/20 U.S.A.)

Twenty-two models of flying-boat hulls were tested in the N.A.C.A. tank for the purpose of determining the effects on water resistance and spray of 13 variations in the transverse section of the bottom of the forebody and of three variations in the form of the afterbody. The forebodies were of the same overall dimensions and differed in the type and amount of chine flare. The afterbodies included one with a pointed plan form and straight buttocks, one with a second step and straight buttocks, and one with a second step and concave buttocks. The depth of the step at the keel was the same in all models. Conclusions:—

1. The height of the spray originating where the chine of the model was above the water level was reduced by the chine flare.
2. The height of the spray originating at the side of the portion of the chine that was below the water level was not reduced by the chine flare. In some cases, the height of this spray was increased by chine flare.
3. The resistance at best trim at the hump and at high speeds was only slightly affected by chine flare.
4. The resistance at best trim at intermediate planing speeds was reduced by chine flare.
5. In the free-to-trim tests, the trim and the resistance at the hump were increased by chine flare.

Present Position and Future Prospect of Transoceanic Aviation. (F. V. Buddenbrock, W.R.H., Vol. 20, No. 18, 15/9/39, pp. 283-289.) (71/21 Germany.)

Transoceanic aviation has been on trial over three major ocean routes: the South Atlantic, the Pacific and lastly the North Atlantic. Of these the first presents the smallest meteorological difficulties and a regular postal service has been in operation over this route for several years by German and French machines. The latest German seaplanes on this route average 280 Km./$_h$ over the 3,000 Km. Bathurst-Natal, the total time for the post to reach Rio from Frankfurt-Main being generally less than 2½ days. Between February, 1934, and the spring of 1939 there have only been seven cases of delay, amounting to 1-2 days, the majority of the causes being connected with the feeder lines and not the main ocean crossing. A fair amount of experience has also been gained on the Pacific route, which is operated by American Flying Boats. The regularity of this service, however, leaves much to be desired. The North Atlantic route is by far the most difficult and in spite of propaganda is not yet ripe for a regular passenger service through-

out the year. The author considers it a great mistake to operate such a passenger service without previous experience of postal traffic. According to him the North Atlantic service requires flying speeds of the order of 580 $Km/_h$ in order to make it attractive. Such a speed would render a night crossing possible. It is probable that medium-sized flying boats (15-50 passengers) will hold the field for oceanic crossings for some time (mainly because expensive landing grounds are not required). It is unlikely that the huge flying boat projects discussed lately in the press and carrying 100 and more passengers will materialise except in the very distant future.

The Effect of Fixed Wing Slots on the Stall Characteristics of a Modern Bi-Motor Aeroplane. (C. L. Johnson and R. L. Thoren, J. Aeron. Sci., Vol. 6, No. 11, September, 1939, pp. 437-445.) (71/22 U.S.A.)

A major design problem of modern aircraft is to combine high performance with good flying qualities. Blind flying especially calls for low speed manœuvrability and stability together with favourable stall characteristics.

Flight tests on the Lockheed 14 transport aircraft showed that the stall was preceded with insufficient warning for the pilot and was combined with a high rate of roll, particularly in the case of a power stall. This trouble was overcome by incorporating fixed wing slots covering less than 10 per cent. of the wing area over $\frac{1}{4}$ of the wing span near tip. The author describes quantitative measurements of the stall, using special equipment such as left and right hand aileron deflection indicators, as well as elevator and rudder angle indicators (all these operated on the D.C. Selsyn system).

The angle of attack was measured with a special instrument consisting of a small low aspect ratio aerofoil with a pressure orifice near the leading edge. When suitably dimensioned, the pressure recorded by this instrument is a function of the angle of attack only (independent of air speed).

The stalling of the air flow on the wing was recorded on a cine camera (wool tufts).

It is stated that although the drag of the wing section behind the slot is probably doubled, the percentage of this wing area to the total is so small that the net effect of fitting these slots on speed and climb is negligible.

An Analysis of the Problem of Ice on Aircraft. (W. C. Geer, J. Aeron. Sci., Vol. 6, No. 11, Sept., 1939, pp. 451-459.) (71/23 U.S.A.)

After briefly discussing meteorological conditions responsible for ice formation on aircraft, the author describes the principal methods which have been suggested or tried for overcoming this danger, classifying them according to the particular part of the aircraft to be protected, i.e.:—

1. Windshields and windows.
2. Propellers.
3. Wings, struts and other aerodynamically shaped surfaces.
4. Ailerons and control surfaces.
5. Pitot static.
6. Radio parts.
7. Carburettor.
8. Nose, pontoons and fuselage.
9. Air scoops and edges of other open channels.
10. Landing and running lights.
11. Projections on wing surface.

Although none of the schemes (chemical, mechanical or thermal) may claim any finality it is a fact that the ice hazard has been reduced during recent years. The ultimate goal of safety under all ice conditions is however still far off.

A useful bibliography of 71 items concludes this interesting paper.

Boiler and Turbine in One. (Power, September, 1939, p. 65. Metropolitan-Vickers Tech. News Bull., No. 676, 15/9/39, p. 5.) (71/24 Great Britain.)

This article briefly describes the Huettner rotative boiler-turbine, which combines a steam generator air heater and fan, steam turbine and a condenser in one unit. Greatly reduced weight and space requirement is claimed, there being virtually no auxiliary machinery. The steam path and the course of the condensing water and air supply to the burners in the furnace are described and indicated by means of a diagram for a 100 kw. unit. It is estimated that the total weight of a 500 h.p. unit is 2.5 lb./h.p. and for a 2,000 h.p. unit about 1.7 lb./h.p. Space requirements are said to be comparable with those of an electric motor of the same output.

Illustrated with one diagram.

Constant Pressure Blowers. (E. Sorensen, Z.V.D.I., 12/8/39, pp. 925-931. Metropolitan-Vickers Tech. News Bull., No. 673, 25/8/39, p. 9.) (71/25 Germany.)

The author first considers the general and physical bases of axial and radial blowers, and the adoption of the constant pressure principle in the so-called Schicht blower. He then deals with the mathematical bases of the constant pressure blower, the importance of the diffuser of the constant pressure blower, and the design of the latter. In conclusion he gives a number of examples of actual constant pressure blowers, together with the results of tests, and refers to the application of the constant pressure principle to pump design.

Illustrated with fourteen diagrams and two photographs.

Blowers; Their Types and Dimensions. (O. Schmidt, Archiv. fur Warmewirtschaft, August, 1939, pp. 213-7. Metropolitan-Vickers Tech. News Bull., 25/8/39, p. 9.) (71/26 Germany.)

The author first discusses the advantages and disadvantages of axial blowers, following which he considers radial blowers (blading, arrangement, shape of impeller, losses, dimensions and method of suction).

Illustrated with twelve diagrams.

Attributes of the Buchi Exhaust Turbo-Charging System. (Oil Engine, Sept., 1939, pp. 157-8. Metropolitan-Vickers Technical News Bulletin, No. 677, 22/9/39, p. 9.) (71/27 Great Britain.)

In the Buchi system of supercharging for Diesel engines use is made of the exhaust gas energy, in a turbine driver blower to obtain a supply of pre-compressed air; 30 to 40 per cent. of the compressed air is used for scavenging. The air pressure at the end of the exhaust process during scavenging must be low since the flow is dependent on the difference in pressure between the inlet and exhaust manifolds. To achieve this, the method of working, which is described, creates abnormally large and suitably timed exhaust pressure fluctuations before the turbine.

Illustrated with two photographs and one diagram.

Compression-Ignition Engine Performance with Undoped and Doped Fuel Oils and Alcohol Mixtures. (C. S. Moore and H. H. Foster, N.A.C.A. Tech. Note, No. 707, Aug., 1939.) (71/28 U.S.A.)

1. Fuel oils of high cetane number gave no more power than fuel oils of low cetane number but had less ignition lag, lower rates of pressure rise, and smoother engine operation over a complete load range at 2,000 r.p.m.

2. Increased engine speeds and boost pressures resulted in smoother engine operation and permitted the use of fuel oils of low cetane number.

3. Fuel dopes decreased ignition lags and rates of pressure rise and increased smoothness of engine operation. The addition of 4 per cent. tetranitromethane increased engine power by less than 3 per cent.

4. Fuel dopes improved neither the completeness nor the effectiveness of combustion.

5. Alcohol as an auxiliary fuel, in general, decreased power as the proportion of alcohol increased. Any increases in power obtained by double injection did not exceed 4 per cent. and were obtained at the expense of increased fuel consumption. Alcohol increased the ignition lag, the rate of pressure rise, and the roughness of operation.

Design of N.A.C.A. Cowlings for Radial Air-Cooled Engines. (G. W. Shickle, N.A.C.A. Rept. No. 662, 1939.) (71/29 U.S.A.)

The design of a cowling may be divided into two parts: (1) The Nose Section, and (2) the Exit Slot. The functions of these parts are distinct, the function of the nose being to allow the cooling air to enter and provide a smooth separation between the internal and the external flow. The amount of air flowing over the engine is controlled by the Exit Slot. The flow inside the cowling is profoundly affected by baffle plates, which thus form an important feature of good cowling design. The general direction of the air flow at the entrance to the cowling is radial, i.e., it approximates to that round a blunt nosed body. The percentage of air entering is small and the velocity at entry is low. The function of the nose of the cowl is to turn this low velocity air stream through 90°, i.e., to render it parallel to the main air stream, the space available being the distance between the rocker boxes of the engine and the trailing edge of the propeller. It has been found possible to cover normal requirements with only one shape of nose, a second shape being reserved for flying speeds above 350 m.p.h.

The performance of the cowl is much more sensitive to exit slot design than to entry and the author devotes considerable space to the determination of optimum size and position of this slot. The paper concludes with an estimation of the drag associated with the passage of the cowling air and of the drag increase caused by the addition of an N.A.C.A. cowl to the nose of a stream-lined fuselage. In the case of a single engined fighter, with a top speed of 300 m.p.h. and a climbing speed of 150 m.p.h. fitted with an engine of 16.5 sq. ft. frontal area developing 1,000 h.p. at take off, the extra cooling drag due to the passage of the air amounts to only 20 h.p. both for level and climbing flight.

The total increase in drag over a streamlined shape (without internal air flow) corresponds however to over 120 h.p. at 300 m.p.h.

On the Sodium Line Reversal Method of Determining the Temperature in a Gasoline Engine. (U. Yosida, Aer. Res. Inst., Tokio Report, No. 177, June, 1939.) (71/30 Japan.)

The sodium line reversal method of determining the temperature of a flame was applied to engine combustion. A special cylinder, with two quartz windows, was constructed, the light beam passing through combustion space.

A tungsten pointolite, a tungsten lamp, and a carbon arc lamp were used as the light source, a small quantity of sodium ethylate being added to the fuel.

The D-line intensity of the engine flame was measured by a photoelectric cell.

The spectrum in the visible region of the engine flame consisted of C.H. 4,300 A°, C.C. Swan bands, and the continuous bands. The spectra obtained at various crank angle, showed that the temperature in the cylinder is not uniform.

The maximum temperature at various air fuel ratios was measured with the engine running at 800 r.p.m. Although the correct air fuel ratio in the fuel under test was 13.8, the temperature was always maximum at 11.5, which is higher than

that obtained by Hersley and Panton[1] and agrees nearly with the calculated value, taking into account dissociation and heat loss.

Aviation Fuels and Engines. (F. R. Banks, J.S.A.E., Vol. 45, No. 3, September, 1939, pp. 389-406.) (71/31 Great Britain.)

PRINCIPAL CONCLUSIONS.

1. At the moment, the standard fuel for high powered British aero engines contains not more than 4 cc. of T.E.L. per gallon and has a rating of 87 octane by the C.F.R. modified Motor method.

2. Fuel of higher rating is under development. Satisfactory rating of such fuels can only be carried out in full scale cylinders.

3. British engines are considered by the author to be generally in a better position to utilise " temperature sensitive fuels " than American engines. This is attributed by the author to reduced swirl of the 4 valve British design.

4. Direct fuel injection into the cylinder as practised in some German engines is considered a most promising development both for power and economy.

5. Exhaust valves of the standard (poppet) type can now be designed which, together with their seats, stand up satisfactorily to all requirements and the sleeve valve is not considered to possess the outstanding advantage claimed for it. " Stellite " is now being replaced by a new nickel chrome alloy " Brightray " for treating valve heads and seats.

6. The Sinterkorund sparking plug developed by Siemens (sintered A1 oxide insulator) represents marked advantages over other types of plugs in high duty engines using leaded fuels. These plugs are fitted with very thin earth wires which reduces servicing costs.

7. Compression ignition engines have no chance of general adoption until the ratio of take-off to cruising power can be very considerably improved.

Coal Suspension in Light Oils as an Engine Fuel. (F. W. Godwin, Sci. Am., Vol. 161, No. 3, Sept., 1939, p. 159.) (71/32 U.S.A.)

The coal is ground to 300 or 500 mesh, chemically stabilised and suspended in either petrol or light fuel oil. It is stated that the fuel behaves satisfactorily in a standard motor car engine, provided the latter is first warmed up on normal petrol.

The coal suspensions have also been used satisfactorily in many types of commercial or domestic burners for heating.

The new process promises a field of application for the tremendous amounts of " fines " which are a waste product at the mines.

Boundary Friction in Bearings at Low Loads. (L. M. Tichvinsky, E. G. Fischer, J. App. Mech., Vol. 6, No. 3, Sept., 1939, pp. 109-113.) (71/33 U.S.A.)

The paper describes bearing tests performed in the region of semifluid or boundary lubrication. Bearings $2\frac{1}{2}$ in. in diameter mounted in a rigid housing were loaded lightly and their performance studied in an attempt to correlate it with various physical properties of the bearing and journal materials. In this connection special consideration was given to journal surface finish and its measurement.

Within the inherent limits of the experiment it was shown that various journal materials, similarly machined and ground, perform differently in a babbitt shell. A higher value of the coefficient of friction was associated with a relatively rougher journal finish having grinding scratches of the order of 100 micro inches. Such finish in turn was associated with soft journal materials (180 Brinell).

The boundary oil film, formed between several grades of bearing materials and a chromium-plated journal, offered different frictional resistance to motion. In

[1] Hersley and Panton, *Engineering*, Vol. 137 (1935), p. 623.

the combinations of different bearing materials and the same chromium-plated journal, babbitt proved to be superior to bronze or silver.

The Thick-Film Lubrication of Full Journal Bearings of Finite Width. (M. Muskat, F. Morgan, J. App. Mech., Vol. 6, No. 3, September, 1939, pp. 117-121.) (71/34 U.S.A.)

A discussion is given of the results of analytical and experimental studies of the thick-film lubrication of full journal bearings of finite width. The Reynolds differential equation has been solved by a successive approximation method for (*a*) flooded full journal bearings, (*b*) full journal bearings with central circumferential grooves, and (*c*) full journal bearings provided with point sources of lubricant. Calculations were made on the variation of the journal eccentricity, load-carrying capacity, and friction coefficients with the Sommerfield dimensionless variable for the three cases and for different bearing widths. Direct experimental tests are described which confirmed the theoretical predictions for bearings fed with lubricant at point sources.

Ignition Lag in Compression Ignition Engines. (S. G. Bauer, Engineering, Vol. 148, No. 3846, 29/9/39, pp. 368-369.) (71/35 Great Britain.)

The engine experiments of the author are arranged so that firing always starts (i.e., ignition lag terminates) at T.D.C. He then attempts to connect the experimental delay period between beginning of injection and appearance of flame (measured stroboscopically, utilising a window in the cylinder) with the pressure and temperature existing at T.D.C. The function proposed is of the type

$$T \log p = f(t)$$

where T = absolute temperature at T.D.C.
p = absolute pressure at T.D.C.
t = ignition lag in milliseconds.

Whilst there may be some justification for an equation of this type for delay experiments in a vessel in which both p and T remain practically constant during the delay period, in the engine both these factors vary and it is not at all clear why the end or T.D.C. values only should be decisive.

In the author's own words in another part of the paper: "Considering the very involved nature of such measurements, luck must have been favourable to obtain such close agreement."

An Accelerated Oxidation Test for Oils. (W. Francis and K. R. Garrett. J. Inst. Petrol, Vol. 25, No. 190, August, 1939, pp. 501-5.) (71/36 Great Britain.)

The various modifications of the Michie (air bubbling) sludging test that are in use for measuring the oxidizability of an oil are difficult and laborious methods. A new method for determining the oxidizability of oil is described, using a solution of alkaline potassium permanganate under standard conditions as oxidizing agent. The whole determination can be carried out in a few hours with a simple apparatus and the results obtained on a number of different types of oil appear to be capable of correlation with the behaviour of these oils in practice. Not only can the oxidizability of new oils be determined but the state of oxidation of an old oil can readily be ascertained by the new method. The experimental conditions can be modified to increase or decrease the severity of oxidation so as to discriminate more readily between oils of similar oxidizability at either end of the scale.

A New Laboratory Method for Rating Aviation Fuels. (R. Stansfield and H. B. Taylor, J. Inst. Petrol, Vol. 25, No. 190, August, 1939, pp. 566-572.) (71/37 Great Britain.)

As is well known, the bouncing pin on the C.F.R. engine will not record true knock if the rate of pressure rise of the preliminary (normal) combustion is greater

than that of the subsequent knock. The author proposes as a true measure of the knock the amplitude of the first detonation wave on the dp/dt record as obtained with a cathode ray oscillograph.

Experience has shown that the absolute magnitude of this first detonation wave is very sensitive to engine conditions and varies even if such major factors as compression ratio, mixture strength and temperature and r.p.m. are kept constant. For this reason the pressure amplitude is compared with that obtained with a standard reference fuel under identical running conditions, the term " Knock Ratio " being introduced by the author for the value $\frac{\text{amplitude with test fuel.}}{\text{amplitude with ref. fuel.}}$

The octane number corresponding to this knock ratio can be obtained subsequently by matching. The comparison is carried out first for mixture strength giving maximum knock (as measured by height of detonator wave) and then for richer mixtures. The results show that whilst most fuels appreciate in terms of the reference fuels (C. and F. mixture) some depreciate, and difference between various fuels tend to become more pronounced. For this reason the authors recommend that the specification for knock testing of an aviation fuel should cover two ratings corresponding to weak and strong mixtures respectively. Satisfactory agreement with full scale rating is claimed for the new method.

Experimental Study of Deformation and of Effective Width in Axially Loaded Sheet-Stringer Panels. (W. Ramberg, A. E. McPherson and S. Levy, N.A.C.A. Tech. Note No. 684, Feb., 1939.) (71/38 U.S.A.)

The deformation of two sheet-stringer panels subjected to end compression under carefully controlled end conditions was measured at a number of points and at a number of loads, most of which were above the load at which the sheet had begun to buckle. A technique was developed for attaching Tuckerman optical strain gauges to the sheet without disturbing the strain distribution in the sheet by the method of attachment. The twisting and the bending of the stringers were measured by means of pointers attached to the stringers.

A detailed comparison was made between the measured deformation of the buckled sheet and the deformation calculated from approximate theories for the deformation in a rectangular sheet with freely supported edges buckling under end compression advanced by Timoshenko, Frankland, and Marguerre.

It appears that the various theories advanced so far do not fit the observations consistently. Thus Marguerre predicts both sheet load and effective width very accurately, but is hopelessly out in his estimate of transverse strain distribution.

The analysis of measured stringer deformation was carried out by Southwell's method (deformation plotted against deformation overload). It was concluded that the stringer failure in the tests was due to instability under continued twisting and bending.

Effect of Service Stresses on Impact Resistance, X-Ray Diffraction Patterns, and Microstructure of 25 S Aluminium Alloy. (J. A. Kies and G. W. Quick, N.A.C.A. Report No. 659, 1939.) (71/39 U.S.A.)

A great number of tests were made to determine the effect of service stresses on the impact resistance, the X-ray diffraction patterns, and the microstructure of 25 S aluminium alloy. Many of the specimens were taken from actual propeller blades and others were cut from $\frac{13}{16}$ inch rod furnished by the Aluminium Company of America.

The average impact resistances were found to be unchanged even after 288,000 cycles in a o— to 33,400-pound-per-square-inch range that exceeded the fatigue limit and the original proof stress of the material. The X-ray diffraction patterns were unchanged as regards any indication of structural change resulting from the fatigue stressing of the alloy. Two structural conditions known as slip-plane

precipitation and veining were observed. The service stresses were not responsible for the slip-plane precipitation and the endurance limit was reduced by it. Veining could be made to disappear and reappear by alternate solution heat treatment and age hardening.

Stability of Rectangular Plates with Longitudinal or Transverse Stiffeners Under Uniform Compression. (R. Barbre, Ing. Archiv., Vol. 8, No. 2, 1937. N.A.C.A. Tech. Memo., No. 904, Aug., 1939.) (71/40 Germany.)

The proper application of stiffeners, i.e., stiffening ribs fixed to a plate, leads to an increase of the buckling strength of rectangular plates. In calculating stiffened plates, we have to distinguish between:—

1. Plates with large spacing of the stiffeners in which the bending stiffness of the plate and ribs appear separately in the calculation, and
2. Plates with small stiffener spacings for which the bending stiffness of plate and stiffeners in the direction of the stiffeners can be combined to a new bending stiffness, provided the stiffeners all have the same cross section. In general, we are allowed to treat such plates as orthotropic plates.

In the present paper, the complete buckling conditions of stiffened plates are developed for uniform compression plates with one or two longitudinal or transverse stiffeners at any point being considered. (Stiffeners in the direction of normal loading are called longitudinal, transverse stiffeners being perpendicular to the loading.)

For the special case with any number of longitudinal stiffeners with equal dimensions and with equal spacings, Lokshin has calculated the buckling conditions. As shown by the author of the present paper, these conditions are not complete.

Metallic Coatings and Their Corrosion Resistance (Part I). (S. G. Clarke, Metal Industry, 28/7/39, pp. 87-90. Metropolitan-Vickers Technical News Bulletin, No. 672, 18/8/39, p. 5.) (71/41 Great Britain.)

The author deals with the resistance of nickel and chromium coatings to outdoor exposure. Since the value of a coating depends primarily on its remaining intact, the author made investigations into the length of time required for a certain amount of corrosion to occur. He deals with nickel which is widely used as an undercoat to chromium but rarely by itself as a protective coating for steel for outdoor purposes due to its porosity and high rate of corrosion. Chromium, probably the most resistant of the non-precious metals to atmospheric corrosion, is also discussed.

Illustrated with four tables.

Kenametal. (Iron Age, 7/9/39, p. 45. Metropolitan-Vickers Tech. News Bull., No. 677, 22/9/39, p. 7.) (71/42 Great Britain.)

The article describes a new carbide tool metal which, it is claimed, is capable of machining steels of all hardnesses with practical economy. The material is known as Kenametal and is produced with the metallic compound $W.Ti.C_2$ as the essential ingredient. Tool tips of this new material have been used for cutting steels of 200 to 500 Brinell. A description of the grinding technique required for these new tool tips is explained. Illustrated with two photographs.

The Anodic Oxidation of Aluminium. (J. W. Cuthbertson, J. Inst. Met., July, 1939, pp. 303-325. Met.-Vickers Tech. News Bull., No. 675, 8/9/39, p. 7.) (71/43 Great Britain.)

The anodic oxidation of aluminium in a number of different electrolytes, using a.c. electrolysis has been investigated with the aid of the cathode-ray oscillograph. The effect of the oxide barrier on the form of the current-time and current-voltage

curves has been studied and is shown to depend on the construction of the electrolyte and operating conditions. Owing to a capacity effect, the current and voltage are always out of phase during the whole or a part of each half-cycle. The current-voltage curve consequently is a closed loop, the area of which is proportional to the dielectric loss in the film. The results obtained suggest that, while the mechanism of anodic oxidation in chromic, sulphuric, and oxalic baths is similar, chromic acid solutions should produce the more satisfactory films.

Illustrated with two diagrams, eight graphs and two tables.

The Creep Properties of Soft Solders and Soft Soldered Joints. (W. A. Baker, J. Inst. Met., July, 1939, pp. 327-347. Met.-Vickers Tech. News Bull., No. 675, 8/9/39, p. 7.) (71/44 Great Britain.)

Chill-cast soft solders were subjected to long-time creep tests at room temperature and at 80°C. In the range of tin-lead-alloys tested, the eutectic was most resistant to creep. The alloys of lower tin content, tinman's and plumber's solders had much lower resistance to creep at both temperatures. Antimonial solders with antimony contents equal to 6 per cent. of their tin contents were 2 to 4 times as resistant to creep as the corresponding non-antimonial alloys. Single-lap soft-soldered joints on mild steel, copper, and brass were subjected to prolonged shear stress at room temperature and at 80°C. The creep strength of the joint was determined by the creep properties of the solder film, the latter being dependent on the solder used, and on the alloying, if any, with the material joined.

Illustrated with one photograph, two diagrams, five graphs and five tables.

Some Corrosion Problems Relating to Modern Aircraft. (A. J. Sidery and W. W. Willstrop, J. Roy. Aeron. Soc., August, 1939, pp. 606-628.) (71/45 Great Britain.)

The authors deal with a number of isolated problems arising during the operation of modern aircraft without discussing general principles or the theoretical aspect of the subject.

Considerable space is given to the effect of heat treatment on the corrosion resistance of Aluminium Alloys and the temporary protection afforded by pigmented wax-hardened lanolin preparation is discussed.

Although not intended to take the place of paint, the lanolin preparation has the advantage of ease of application and low surface weight (.6 oz. per sq. yard against 2 oz. for enamel coating).

Radiator corrosion due to glycol can be considerably reduced by an inhibitor (triethanolamine plus phosphoric acid).

The authors conclude that complete prevention of corrosion in all metals and alloys is something which is extremely unlikely ever to be achieved.

In nature, the metals are combined with other elements and subsequent purification does not alter the natural affinity for returning to the combined state.

Metallic Coatings and Their Corrosion Resistance (Part II). (S. G. Clarke, Met. Ind., 25/8/39, pp. 181-184. Met.-Vickers Tech. News Bull., No. 674, 1/9/39 (p. 8). (71/46 Great Britain.)

The tests carried out in connection with the corrosion-resisting properties of certain metallic coatings are described. All the tests were carried out indoors, and the results of these tests after one year are given. In conclusion, the author discusses the results of his experiments, both indoor and outdoor, and suggests various reasons for the corrosion of metallic coatings, and ways of preventing it.

Illustrated with two tables and one graph.

Compressive Tests of a Monocoque Box. (W. Ramberg, A. E. McPherson and S. Levy, N.A.C.A. Tech. Note, No. 721, August, 1939.) (71/47 U.S.A.)

The following conclusions were drawn from the compressive tests of the monocoque box specimen of aluminium alloy for this investigation.

1. The loading fixtures were adequate in producing uniform compressive strain over the section of the specimen.

2. The special equipment for measuring stringer strains on a specimen of this type gave consistent and reproducible results.

3. The 0.026 inch sheet between stringers buckled at a stress of about 2,500 pounds per square inch and the 0.075 inch shear web buckled at a stress of about 8,800 pounds per square inch. These values were in agreement with the theoretical buckling stresses for rigid clamping of the sheet at the edges parallel to the load. Permanent set became noticeable at a load of 115,200 pounds; this value corresponded to an average stress in the stringers of about 16,000 pounds per square inch.

4. The measured strain at the stringer centroids near the midsection of the box are within 10 per cent. of the measured average strains up to the maximum load of 115,200 pounds. The measured average strain at the midsection was within 2 per cent. of calculated strain at all loads up to the maximum load of 115,200 pounds. The calculated strain was obtained by dividing the load by the product of Young's modulus and effective cross-sectional area, the effective area of the sheet being obtained from Marguerre's formula for a sheet with simply supported edges and from Cox's formula for a sheet with known buckling strain. These formulas had given effective widths in agreement with measured values for the panels described in Technical Note No. 684. (See Abst. No. 71/38.)

Local Instability of Centrally Loaded Columns of Channel Section or Z-Section. (E. E. Lundquist, N.A.C.A. Tech. Note, No. 722, Aug., 1939.) (71/48 U.S.A.)

CONCLUSIONS.

1. The critical compressive stress at which cross-sectional distortion occurs in a thin-wall column of channel section or Z-section is given by either of the following equations:—

$$f_{cr}=\frac{\{n\,k_F\,\pi^2\,E\,t_F^2\}}{\{12\,(1-\mu^2)\,b_F^2\}} \qquad f_{cr}=\frac{\{n\,k_W\,\pi^2\,E\,t_W^2\}}{\{12\,(1-\mu^2)\,b_W^2\}}$$

where

E and μ are Young's modulus and Poisson's ratio for the material, respectively.
b_F and b_W, the width of the flange and the web, respectively.
t_F and t_W, the thickness of the flange and the web, respectively.
k_F and k_W, non-dimensional coefficients.
n, a factor taken so that nE gives the effective modulus of the flange and web at stresses beyond the elastic range.

2. At stresses beyond the elastic range, the value of the effective modulus nE, for local buckling of thin-wall columns of channel-section and Z-section will depend upon tests. In the absence of such tests, however, it is reasonable to assume that n is a function of τ, where τE is the effective modulus of an ordinary column at stresses beyond the elastic range. A careful study of the theory and such experimental data as are available indicates that it is conservative to assume

$$n=\frac{(\tau+3\sqrt{\tau})}{4}$$

provided that τ is evaluated by use of the accepted column curve for the material.

The Fundamentals of Stress Optical Investigations. (N. G. Tchentzow and G. A. Ozerow, Trans. C.A.H.I., No. 270, 1936.) (71/49 U.S.S.R.)

The present paper contains the theoretical basis and some practical recommendations concerning the photoelasticity method.

Chapter I deals with elastic theory. The equations show the relationship between the stresses in models made from different materials but subjected to the same conditions of loading.

Chapter II discusses the electromagnetic theory of light and the relations between the parameters of the Fresnel ellipsoid and the strain parameters.

Chapter III deals with interference phenomena.

Chapter IV describes methods of plotting isoclinic and isostatic lines and discusses their properties with special reference to the neighbourhood of singular points.

Chapter V discusses several methods for measuring differences in principal stress and the graphical method for eliminating initial stress is described.

Chapter VI deals with different methods of separating principal stress.

Appendix I gives a detailed comparison between the experimental investigation of the case of a disc compressed along a diameter and the theoretical solution.

Appendix II gives an extended bibliography.

(The Soviet Government attach special importance to this report and have arranged for a larger edition than is normally the case for the transactions of the C.A.H.I.)

Analysis of Spherical Shells of Variable Wall Thickness. (M. F. Spotts, J. App. Mech., Vol. 6, No. 3, Sept., 1939, pp. 97-102.) (71/50 U.S.A.)

This article presents a solution to the problem of finding the forces and moments which occur in a spherical shell which is axisymmetrically loaded, when the variation in wall thickness is taken as a quadratic function of the co-ordinate of latitude.

The so-called Love-Meissner differential equations for the case of non-uniform wall thickness are derived. By appropriate substitutions these are reduced to one linear equation of the fourth order having constant coefficients. The solution to this equation when taken in the homogeneous form is first given. This homogeneous solution will be the general solution for all problems where the shell surface is free from external force, and the only loads on the shell consist of forces and moments applied at the boundaries.

When, however, the shell surface itself is loaded, a particular integral (which will depend upon the type of loading) must also be obtained for the non-homogeneous equations.

The method of solution contained herein is illustrated by a numerical example for a shell of one boundary when acted upon by dead-load forces, and the results are plotted.

A Theory of Flexure for Beams with Non-Parallel Extreme Fibres. (W. R. Osgood, J. App. Mech., Vol. 6, No. 3, September, 1939, pp. 122-6.) (71/52 U.S.A.)

A theory of flexure for beams with non-parallel extreme fibres is presented. The theory is shown to reduce to the ordinary theory of flexure as the angle between the extreme fibres approaches zero. Maximum fibre stresses computed by the theory and by the ordinary theory for a plate girder with non-parallel flanges show that for angles between the flanges up to twenty degrees the ordinary theory can never be in error more than about five per cent., but for larger angles the error in general increases rapidly with the angle. Finally an example is given of the application of the theory as an approximation to a beam with curved extreme fibres. In this case the theory was confirmed by the results of tests.

Clamped Rectangular Plates with Centre Concentrated Load. (D. Young, J. App. Mech., Vol. 6, No. 3, September, 1939, pp. 114-116.) (71/51 U.S.A.)

A general method of solution for rectangular plates with clamped edges and any kind of loading has been developed by Professor S. P. Timoshenko (1). The present paper gives the results of calculations using this method for the maximum deflection, moment, and edge shears for rectangular plates of various proportions with all four edges clamped and loaded by a single concentrated load at the centre. Similar data for a clamped rectangular plate with a uniformly distributed load have been given by I. A. Wojtaszak and also T. H. Evans (2). A report of an experimental investigation of this problem with some analytical results has been given by R. G. Sturm and R. L. Moore (3).

Static and Dynamic Model Similarity. (F. Nagel, J. Aeron. Sci., Vol. 6, No. 11, Sept., 1939, pp. 468-469.) (71/53 U.S.A.)

In many cases applied air loads cause deflections in the structure of an aeroplane which in turn change these loads to a very large extent, especially if an unstable equilibrium condition is approached. In actual aeroplane design, this is primarily known as wing divergence and flutter. The analytical treatment of these cases is in general very involved and can often be carried out only with simplifying assumptions. An entirely different method of approach is to build an elastically similar model and test it in the wind tunnel. A brief summary of the similarity laws which govern these conditions is given by the author.

Analysis of Circular Rings for Monocoque Fuselages. Additional Help in Beam-Leg Identification. (J. A. Wise, J. Aeron. Sci., Vol. 6, No. 11, Sept., 1939, pp. 460-463.) (71/54 U.S.A.)

The distribution of reactions to loads transmitted by rings to skin in a monocoque fuselage is discussed. Formulas are derived for the moment, shear, and axial stress at all points in circular rings which are subjected to a moment, a radial force, or a tangential force applied at one point on the circumference. Curves are given for each case and their use in obtaining the stresses in the ring under any loading by superposition of separate effects is illustrated by an example.

Strip Welding. (D. A. McArthur, Steel, 28/8/39, pp. 42-64. Metropolitan-Vickers Tech. News Bull., No. 676, 15/9/39, p. 3.) (71/55 Great Britain.)

The highest possible efficiency of handling operations is an essential requirement of modern strip welding lines. The author gives in his article a description of modern procedure equipment and methods. Comparisons are made between the relative times required for joining the ends of successive coils by stitching the ends, and by flash welding, and some figures relating to these two methods are given. Problems with regard to alignment and location of the strips through the shears and welding machine are discussed and the best feed speed is considered.

Illustrated with one photograph.

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(1) "Bending of Rectangular Plates With Clamped Edges," by S. P. Timoshenko, Proceedings of the Fifth International Congress for Applied Mechanics, Cambridge, Mass., September, 1938. For abstract see *Journal of Applied Mechanics*, Trans. A.S.M.E., Vol. 60, September, 1938, p. A-132.

(2) "The Calculation of Maximum Deflection, Moment, and Shear for Uniformly Loaded Rectangular Plate With Clamped Edges," by I. A. Wojtaszak, *Journal of Applied Mechanics*, Trans. A.S.M.E., Vol. 59, December, 1937, p. A-173. Also "Tables of Moments and Deflections for a Rectangular Plate Fixed on All Edges and Carrying a Uniformly Distributed Load," by T. H. Evans, *Journal of Applied Mechanics*, Trans. A.S.M.E., Vol. 61, March, 1939, p. A-7.

(3) "The Behaviour of Rectangular Plates Under Concentrated Load," by R. G. Sturm and R. L. Moore, *Journal of Applied Mechanics*, Trans. A.S.M.E., Vol. 59, June, 1937, p. A-75.

X-Ray as a Production Tool. (O. T. Barnett, Steel, 28/8/39, pp. 38-41. Metropolitan-Vickers Tech. News Bull., No. 676, 15/9/39, p. 3.) (71/56 Great Britain.)

The article gives a description of a portable 400,000 volt X-ray machine and describes the use of penetrameters. A set of examples of exographs show a typical bad weld, and a description of the technique used to obtain them is given. The use of fluorescent screens intensifies the exograph negative and result in considerable saving in exposure time. The author considers that as knowledge of radiography is gained by those concerned so will X-ray apparatus become more generally used as a production tool.

Illustrated with ten photographs and one diagram.

New Types of Heat-Treating and Process Control Apparatus. (F. J. Oliver, Iron Age, 3/8/39, pp. 50-3. Metropolitan-Vickers Tech. News Bull., No. 673, 25/8/39, p. 1.) (71/57 Great Britain.)

This article gives a description of the various new types of instruments used for measuring temperatures, pressures, and other factors governing heat-treating and process work. Amongst the apparatus described is a gas calorimeter and a pocket CO_2 indicator. Longer life is claimed in a new type of heat-treating box, and also a longer electrode life is claimed for a new type of electric pot furnace.

Illustrated with ten photographs and one diagram.

Machines for Surface Hardening by the Shorter Process. (Industrial Gases, June, 1939, pp. 61-70. Metropolitan-Vickers Tech. News Bull., No. 673, 25/8/39, p. 8.) (71/58 Great Britain.)

The success of the Shorter process depends upon strict control of the extent and duration of heating and quenching, by means of suitable mechanical devices. These are classified, according to the relative movement between burner, quench and job, into four classes. The article describes a typical machine in each class, showing how the fundamentals of each process have been carried out in respect of different classes of work. The machines described include the Shorter water-cooled blowpipe, the heavy-duty blowpipe, the ring burner blowpipe, the Shorter gear hardening machine, the Shorter-Griesogen automatic gear hardening machine and the Gleason gear hardening machine.

Illustrated with nineteen photographs.

Metal Spraying. (C. Cleveland, Metal Industry, August, 1939, pp. 361-4. Metropolitan-Vickers Tech. News Bull., No. 673, 25/8/39, p. 8.) (71/59 U.S.A.)

The author first traces developments which have taken place in metal spraying during the last forty years, and describes some of the methods adopted. The modern method of metal spraying, introduced shortly after the use of oxygen and acetelyne for welding, is then described, and the construction of recent metal spraying machines is discussed in detail. Finally, the advantages and disadvantages of the process are enumerated, together with the uses to which it can be put, and the various kinds of metals that can be used. The article also describes precautions which must be taken before a surface can be sprayed.

Illustrated with seven photographs and two diagrams.

Metal Spraying with Chromium Steel (P. Leder, Steel, 31/7/39, pp. 38-9. Metropolitan-Vickers Technical News Bulletin, No. 672, 18/8/39, p. 5.) (71/60 Great Britain.)

Results obtained in the spraying of worn machine parts with chromium steels seem to indicate that high carbon, plain chromium rustless steel is superior in its

wear resistance to simple carbon steel of the same sprayed hardness. Examples of such spraying and the savings effected thereby are cited.

Illustrated with two photographs.

Modern Metal Cleaning (Part I). (Mechanical World, 4/8/39, pp. 99-102. Metropolitan-Vickers Technical News Bulletin, No. 672, 18/8/39, p. 6.) (71/61 Great Britain.)

The fundamentals of solvent cleaning of metals and recent industrial applications of plant for this purpose are reviewed. Special reference is made to degreasing and cleaning by means of trichlorethylene plant. The principles on which the plant is designed, and the various precautions which must be observed in its installation so as to avoid undue risk to the operator, are discussed. The capacity, adaptability, operation, means of heating and cooling are also dealt with in some detail.

Illustrated with two photographs and one table.

Superfinish. (A. M. Swigert, Machinist, 5/8/39, pp. 364E-367E. Metropolitan-Vickers Technical News Bulletin, No. 672, 18/8/39, p. 6.) (71/62 Great Britain.)

The author describes the various methods of finishing metal surfaces, such as honing, grinding, etc., and the quality of surface so produced. He then describes apparatus, such as the profilometer, for measuring the quality of surface smoothness, loading properties and general characteristics of surfaces finished by the above methods. The most up-to-date method of finishing, i.e., superfinishing, is briefly described and the results obtained are compared with the results obtained by other methods.

Illustrated with eighteen diagrams.

Automatic Arc Welding. (E. Rosenberg, Welder, Aug., 1939, pp. 239-243. Met.-Vickers Tech. News Bull., No. 675, 8-9-39, p. 8.) (71/63 Great Britain.)

After discussing methods of applying flux to the parts to be welded the author describes methods of automatic feed for the electrode such as by means of a small feeding motor, the armature of which is connected to the armature of a small d.c. control generator with differentially wound field coils. One coil is connected across the arc and the other is excited permanently from a constant voltage exciter. By suitably winding these coils, a change of arc voltage due to a change in length of arc causes the fields of these coils to become unbalanced, hence feeding the electrode as required. The author finally describes large tube welding machine and gives examples of methods used for various work.

Illustrated with four photographs and one diagram.

Automatic Arc Welding Without the Aid of Machines. (G. Hafergut, Z.V.D.I., 19/8/39, pp. 951-2. Met.-Vickers Tech. News Bull., No. 674, 1/9/39, p. 2.) (71/64 Great Britain.)

The author gives details of a simplified method of automatic welding called the " Elin-Hafergut " process for the welding of long straight seams without the aid of machines. All that is required is an auxiliary device in the form of bar made of copper, aluminium or magnesium containing a groove on the underside in which the electrode is held fast without possibility of displacement. Up to now welds have been made in one operation with electrodes $1\frac{1}{2}$ metres long which is not regarded as the limit.

Illustrated with two diagrams and one photograph.

Examination by X-Rays. (R. Mondon, Airc. Prod., Sept., 1939, pp. 386-392. Met.-Vickers Tech. News Bull., No. 674, 1/9/39, p. 8.) (71/65 Great Britain.)

Due to the very high standard of inspection demanded by the A.I.D. for certain components, X-ray examination of metal parts, particularly castings, is now finding an important place in aero-engine and air-frame production. This article gives a description of the application of X-rays to aero-engine production in the works of the Hispano-Suiza Company in France. The author first gives a short account of the theory underlying X-ray principles and then follows a description of the equipment used in these works. The illustrations are actual radiographs from the Hispano-Suiza laboratory. He ends the article by a description of the methods used for X-ray examination of parts such as bearings, valves, castings, and pistons.

Illustrated with seven photographs, seven radiographs, five diagrams, two graphs and one table.

Aircraft Fire Fighting Equipment. (Engineer, Volume 168, No. 4363, 25/8/39, pp. 217-219.) (71/66 Great Britain.)

The article describes the " Graviner " automatic equipment which utilises methyl bromide gassed with nitrogen to a pressure of 60 lb. per sq. in. Six pounds of this chemical is contained in a copper bottle weighing 3 lb. and released by an electrically operated fuse which fires an explosive charge and blows out the stopper, leaving an unrestricted passage for the flow. The chemical is distributed to various danger points, such as engine intake, exhaust stubs, blower system, etc.

The main fuse on the pressure bottle can be operated either by hand (electric switch) or automatically.

The automatic switches are of two kinds:—

1. Inertia and gravity switches which close the circuit either under conditions of sudden impact (deceleration greater than 6 g.) or if the aircraft inadvertently turns on its back during landing.
2. Flame and temperature operated switches which come into action if the temperature at their locality exceeds a critical value (e.g., 150°C).

Twelve diagrams show details of the various components and illustrate the electric wiring.

Aircraft Rate-of-Climb Indicators. (D. P. Johnson, N.A.C.A. Tech. Report, No. 666, 1939.) (71/67 U.S.A.)

The theory of the rate-of-climb indicator is developed in a form adapted for application to the instrument in its present-day form. Compensations for altitude, temperature, and rate of change of temperature are discussed from the designer's standpoint on the basis of this theory. Certain dynamic effects including instrument lag, and the use of the rate-of-climb indicator as a statoscope are also considered. Modern instruments are described. A laboratory test procedure is outlined and test results are given.

The " Riken " Explosive Gas Indicator. (J. S. Jackson, J. Inst. Petroleum Technologists, July, 1939, pp. 456-8. Metropolitan-Vickers Tech. News Bull., No. 673, 25/8/39, p. 2.) (71/68 Great Britain.)

The " Riken " explosive gas indicator, designed by Dr. Z. Tuzi, is based on a principle described in a bulletin of the U.S. Bureau of Mines as long ago as 1913. The indicator relies on the fact that the refractive index of methane is considerably higher than that of air, and incorporates the Doi refractometer, which is similar in principle to the Jamin interferometer. The author describes the indicator in detail and enumerates its advantages. It has great sensitivity, and can be used

to detect extremely small quantities of gasolene in the air. To conclude, an account of the method of carrying out a test, and a set of typical results are given.

Illustrated with one photograph and one diagram.

Notes on the Dynamics of Electrical Measuring Instruments. (T. A. Rich, G.E. Review, July, 1939, pp. 311-6. Metropolitan-Vickers Tech. News Bull., No. 673, 25/8/39, p. 3.) (71/69 Great Britain.)

This article attempts to interpret the fundamental equations in order to facilitate the use of instruments in practical applications to unusual conditions. The equations used cover a wide range of instruments, amongst them being:—d'Arsonval type instruments used either below or above their natural frequency and alternating current instruments. Solutions to these equations are also given as well as the most convenient way of solving them. The article concludes with a discussion on the evaluation of the dynamic characteristics of instruments.

Illustrated with one photograph and six graphs.

Development in the Measurement of Air Flow in Mines. (R. Poole, A. W. Leadbeater, Engineering, 11/8/39, pp. 182-5. Metropolitan-Vickers Tech. News Bull., No. 673, 25/8/39, p. 5.) (71/70 Great Britain.)

The design and application in mines of a spring-controlled vane-type air flow meter known as the Velometer and developed by Dr. Boyle in the United States is described. Certain improvements have been made by the Metropolitan-Vickers Electrical Co. (reduction in damping and pivot friction).

By paying special attention to the pivots and using more sensitive springs it has been found possible to measure velocities as low as 1/10 ft. per second. This represents a velocity pressure of only $2\frac{1}{4}$ millionths of an inch of water.

Illustrated with four photographs, two tables, six diagrams.

Instantaneous Fluid Pressure Recording Equipment. (S. E. Goodall and R. B. Smith, Engineering, 4/8/39, pp. 127-9. Metropolitan-Vickers Technical News Bulletin, No. 672, 18/8/39, p. 1.) (71/71 Great Britain.)

The authors describe equipment developed for instantaneous fluid-pressure recording with special reference to the measurement of pressure rise within switchgear tanks. The principle employed is that the pressure measured produces small capacity changes in a pressure unit which are translated into large current changes in an oscillograph element. Diagrams of the circuit employed are given and details of results obtained and other applications of the equipment are outlined.

Illustrated with nine diagrams.

Liquid Level Control and Distant Indicators. (F. R. Smedley, El. Engineer, 25/8/39, pp. 658-662. Metropolitan-Vickers Technical News Bulletin, No. 674, p. 7.) (71/72 Great Britain.)

The author shows the construction and operation of the "Noflote" control system developed by Evershed and Vignoles, Ltd., the Bore-Hole Depth Indicator, the Plumb-Bob Depth Indicator, the Plumb-Bob Tide level Indicator and Recorder, the Midworth Water level transmitter, and the C. and S. No-contact system. He also describes the "Tangent" audible water level indicator, the "Borough" electric float operated transmitter, made by Gent and Co., Ltd., and the Automatic Water system pumping outfit made by H. J. Godwin, Ltd.

Illustrated with eight photographs and eight diagrams.

"Autosyn" Application for Remote Indication of Aircraft Instruments. (W. A. Reichel and R. C. Sylvander, J. Aeron. Sci., Vol. 6, No. 11, Sept., 1939, pp. 464-467.) (71/73 U.S.A.)

The "Autosyn" system has been developed by the Pioneer Instrument Co.,

U.S.A., to provide a reliable and accurate method of remote indication of such functions as fuel pressure, engine speed, fuel flow and wheel and control surface position. For large machines, the usual method, such as pipe lines or flexible shafts, becomes unsafe and impracticable due to the increased distance between engine or control surface from the cockpit. The Autosyn system is entirely electrical and consists of a transmitter and receiver, each having 3 phase 2 pole stators and single phase 2 pole rotors. Alternating current is supplied to the rotors of transmitter and receiver and the stator leads of one Autosyn are connected to the corresponding stator leads on the other. The rotor currents induce a definite set of voltages across the stator leads, any one position of the rotor corresponding to 3 voltages. If both rotors happen to be in the same relative position, the induced voltages are equal and opposite and non-current flows through the stator, i.e., no torque is produced. If the rotors are initially in different positions, a current will flow causing them to get into step. The system thus operates as a flexible coupling, and the error can be kept easily within 1°. More than one indicator can be run off the same " master " with a slight drop in resultant accuracy. The latest type of Autosyn for aircraft weighs less than 4 oz. per instrument.

The Calibration of Four-Aerial Adcock Direction Finders. (W. Ross, J. Inst. Elec. Eng., Vol. 85, No. 512, Aug., 1939, pp. 192-202.) (71/74 Great Britain.)

The paper describes how it is possible to determine the minimum radius at which a four-aerial Adcock direction-finder may be calibrated for instrumental error without introducing spurious effects due to the proximity of the calibrating transmitter to the direction-finder. It is shown that this minimum radius depends upon the spacing of the aerials, the wavelength, and the inherent accuracy of the direction-finder to be calibrated. In most cases of practical interest the minimum radius is found to be between 0.6λ and 3.5λ. Such distances, while usually easily attainable on the short wave band, may not be possible in the case of medium or long wavelengths.

Radio in Aviation—General Survey with Special Reference to the R.A.F. (with Discussion.) (J. Inst. Elec. Eng., Vol. 85, No. 512, Aug., 1939, pp. 215-241.) (71/75 Great Britain.)

The paper discusses the conditions peculiar to aircraft operation in respect of radio-telegraphy and radio-telephony. Particular stress is given to those conditions not usually met with in other applications of radio-communication and especially to the sources of interference to reception and of danger to the aircraft and its occupants.

It concludes with a brief reference to a few special applications of radio in aviation, and while no attempt is made to describe the equipment itself the fundamental principles on which its construction is based are briefly given.

Measurement of Potential by Means of the Electrolytic Tank. (G. Hepp, Philips' Technical Review, Aug., 1939, pp. 223-230. Met.-Vickers Tech. News Bull., No. 675, 8/9/39, p. 3.) (71/76 Great Britain.)

If an electrode system with fixed electrode potentials is immersed in a conducting liquid the variation of potential between the electrodes will remain practically unchanged. The variation of potential in the liquid can now be measured by means of a probe electrode. An apparatus is described whereby potential fields can be measured and recorded on this principle with the help of models. Several applications are discussed and it is explained in particular how it is possible to reconstruct the paths of the electrons in vacuum tubes by using this apparatus.

Illustrated with four photographs and five diagrams.

The Image Iconoscope. (H. Iams, G. A. Morton and V. K. Zworykin, Proc. Inst. Rad. Eng., Vol. 27, No. 9, Sept., 1939, pp. 541-547.) (71/77 U.S.A.)

An iconoscope having increased sensitivity is to be desired for purposes of improving studio conditions, making possible more universal outdoor work, and permitting greater depths of focus. The new tube described obtains its high sensitivity by making use of an electron instead of an optical image of the scene to be transmitted, projected onto a scanned mosaic. The method permits more efficient and better photo-cathodes, and also secondary-emission image intensification at the mosaic, resulting in a sensitivity 6 to 10 times greater than that of the standard iconoscope operated under the same conditions. The translucent photo-cathode is made by evaporating silver on a transparent surface, oxidising, treating with caesium, and evaporating more silver. The electron image may be focused by either electrostatic or magnetic fields. Several types of mosaics are suitable for receiving and storing the electron picture.

Approximation to a Function of One Variable from a Set of its Mean Value. (M. Greenspan, Nat. Bur. of Stand., Journal of Research, Vol. 23, No. 2, August, 1939, pp. 309-317.) (71/78 U.S.A.)

Measurements involving the variation of a function with its argument generally only cover mean values over an interval. Thus a strain gauge measure total extension over a certain length and the mean strain thus obtained may differ considerably from the actual strains at the centre of the gauge length. The author describes two types of formulæ known respectively as the " central difference " and " descending difference " formula which enable absolute value as distinct from mean values to be computed and which are strictly accurate provided the function under investigation is a polynomial or finite degree n. Although this strict accuracy is not always possible, the use of the formulæ is still justified on the ground that distribution encountered in practice are frequently of a type approximating to a polynomial of low degree. The highest order of difference which can be given advantageously used is determined by the accuracy of the experimental data. Successive differences are increasingly affected by errors of measurement and may ultimately consist almost entirely of accumulated error. For this reason it may be desirable to graduate the function before the difference formulæ are applied.

The author concludes with two worked out examples of the method.

The Spring Clutch. (C. F. Wiebusch, J. App. Mech., Vol. 6, No. 3, Sept., 1939, pp. 103-8.) (71/79 U.S.A.)

A mathematical theory is developed for the spring clutch which consists of two coaxial cylinders placed end to end and coupled torsionally by a coil spring fitted over them. Relations are derived whereby it is possible to design spring clutches in terms of the requirements and the constants of the spring material. Experimental verification of the relations is given. The theory of residual and active stresses as applied to the springs is discussed.

The relations developed are sufficient to determine uniquely the correct spring dimensions for a spring clutch of specified free and gripping torque provided the material constants and the cross-sectional shape (round or rectangular) of the wire as well as the length and diameter of the clutch arbour, are specified. Choice of values for the last two factors is based largely on permissible heating resulting from the slipping in the free direction. If only maximum values of the free torque and minimum values of the gripping torque are given, a number of solutions can be obtained from which to choose the most convenient. By combining the relations derived, in a manner to permit step-by-step calculation, the design of spring clutches is reduced to a simple routine.

World Oil Production, with Special Reference to the U.S.S.R. (Inter. Avia., No. 675, 27/9/39, pp. 1-3.) (71/80 Switzerland.)

The following table shows the 1938 output of the principal oil producing countries:—

U.S.A.	170	million	tons
U.S.S.R.	30	,,	,,
Venezuela	28	,,	,,
Iran	10	,,	,,
Dutch East Indies ...	7·5	,,	,,
Rumania	6.5	,,	,,
Mexico	4.8	,,	,,

Poland comes eighteenth on the list with an annual total of 500,000 tons.

All geologists agree that the Soviet deposits are the mightiest in the world and may account for about a half of the world's entire deposits. Although the U.S.S.R. is thus an important oil power, it does not rank very high as regards oil exports (1.1 million tons in 1938). In the same period Germany consumed 7.3 million tons of which 2.7 million tons were covered by domestic production. The German war-time consumption may be as high as 12 and 15 million tons a year (French estimates). It is clear that Russian and Rumanian imports will have to play an important part in meeting this demand. (Baltic and Danubian waterways as well as rail traffic across new Polish border will be available.)

Measurement and Analysis of Noise and Vibration. (D. Silverman, Instruments, Aug., 1939, pp. 205-236. Met.-Vickers Tech. News Bull., No. 675, 8/9/39, p. 3.) (71/81 Great Britain.)

The author deals with recent developments in acoustical design and describes the two general types of instruments for the study of noise and enumerates the factors influencing the readings. Total sound meters (subjective and objective types) are also considered. The principle of general sound wave analysis is explained and the resonating and heterodyne types of analysing instruments are described, followed by a discussion of special types of analysing instruments.

Illustrated with twelve diagrams, eight graphs and fourteen photographs.

On the Simple Chromatic Photographic. (D. Nukiyama, Aer. Res. Inst., Tokio Report, No. 178, July, 1939.) (71/82 Japan.)

A special photographic camera which gives a simple-chromatic photograph is discussed. With this instrument the problems of contrast, specially the contrast of the image of an object in a foggy atmosphere, are studied. It is proved that with this instrument, the distance of vision can be increased about 10 per cent. to 20 per cent. compared with that of normal vision in a foggy atmosphere.