ABSTRACTS.

Speed Meter for Aircraft.

The instrument described is based upon the fundamental equation: Velocity—increment = Acceleration × Time. Acceleration is measured by displacement from zero of a heavy spring-controlled iron sphere. The extent to which this is displaced is made to determine the speed of a wheel which is geared to a recording dial indicating velocity directly. It is absolute speed with regard to the earth which is measured.

The speed of a train is proportional to the speed of the driving wheels which may therefore be used as a measure of train speed. The speed of a ship or aircraft is not proportional to the speed of the propeller and moreover is subject to the effect of currents and wind. Though it is moving forward through the air an aeroplane may be moving backwards with regard to the earth. The true speed with regard to the earth may be determined by measuring the acceleration and allowing for the time that the acceleration is operative.

The mechanism suggested has an iron rod or track laid horizontally and in the direction of the aeroplane's length. On this rod is a heavy iron ball, which is normally held at the centre of the track by a spring at each end of the latter. When the aeroplane is accelerated the iron ball moves backwards from the centre of the track; when the machine is retarded, the iron ball moves forward.

The second part of the mechanism is a horizontal disc rotated at constant speed by clockwork. On this disc rests a small wheel, which is mounted on and can slide along a square shaft. By means of a prong or fork the iron ball moves the small wheel to one side or other of the centre of the rotating disc. The direction of rotation of the small wheel (and of its square shaft) and its speed of rotation are thus determined by the direction and extent of displacement of the iron ball—*i.e.*, by the degree of acceleration or retardation of the aeroplane.

The square shaft is geared to a recording dial, which indicates the net total revolution of the small wheel at any time. This is proportional to the speed of the aeroplane with regard to the earth. The recording dial may be calibrated accordingly. If the instrument is working properly the speed dial comes back to zero at the conclusion of each flight. ("Elektrotechnische Rundschau," April 11th, 1917, Supplement.)

AERONAUTICAL ENGINEERING.

Organised Aeroplane Spruce Production.

This article gives an account of the organisation in the States of Oregon and Washington of the Spruce Production Division of the Signal Corps of the U.S.A. Army for the purpose of obtaining straight-grained spruce suitable for aeroplane construction.

Operations were commenced in October, 1917, when the total production of the numerous companies working independently was 2,000,000 ft. of timber per month. Railway trucks and roads were not in existence, but after four months' working and in spite of labour troubles 87 miles of railroad and truck roads were constructed, sufficient, as estimated, to supply the needs for 18 months to come; also the total production was increased by 500 per cent. with a much reduced cost per thousand feet.

Only 4 per cent. of the spruce timber in the district is suitable for the rigid requirements of straight-grain aeroplane spruce, and it was found advisable to select the trees for felling, to cut them into logs, and to split them before transport. The splitting aided the grading of the timber.

At the commencement of operations 2,000 ft. of timber were required to make one aeroplane; it now takes 400 ft. Through the work of the traffic department the time taken to move spruce from Oregon and Washington to the Atlantic coast has been reduced from 50 to 10 days, and through the operation of a central cut-up plant at Vancouver, Washington, a saving of 75 per cent. of the number of freight cars, or a total of 3,000 a year, was effected. A technical department in one month increased the production by 11 per cent. as well as improving the specifications.

Oregon and Washington furnish nearly all the aeroplane spruce of the U.S. and its Allies, a small percentage coming from British Columbia, New England, and the south. Sixty per cent. of the produce is taken by the Allies and 40 per cent. by the United States, the total demand being 11,000,000 ft. per month, representing 15 per cent. of the log.

An inventory of the Silka spruce stumpage indicates 11 billion feet of this timber within the spruce belt of the two States, in Alaska 15 to 18 billion, but in the latter case less than a billion are suitable of aeroplane stock. (" Aviation," April 1st, 1918.)

Impregnation of Wings of Aeroplanes.

Quittner and Co., Berlin, advertise " Cellon-emaillit " for the impregnation of the wings of aeroplanes. (" Motorwagen," Jan. 10th, 1918.)

Models of Aeroplanes.

Von Bader, in the " Zeitschrift für Motorluftschiffahrt " (Sept. 29th, 1917), shows that it is possible to use models for testing the constructional strength and stability of aeroplanes. The article contains information regarding the construction of the models required for both purposes, and describes the measurements necessary. (" Zeitschrift des Vereines Deutscher Ingenieure," Nov. 3rd, 1917.)

The Use of Spruce in Aeroplane Construction.

General information is given relative to red, Sitka, and white spruce grown in the U.S.A., the data being obtained by the Forest Products Laboratory of the Forest Service, in charge of J. A. Newlin. The influence of moisture conditions on aeroplane stock, and the relation of density to moisture content, shrinkage, and strength are also considered.

It is stated that spruce of very rapid growth is usually inferior to that of slower growth. Up to about 15 annual growth rings per inch, the greater the number of rings the greater the strength. Wood with less than 8 to 10 rings per inch is usually weak and light.

Contrary to the usual case of timber, spruce is found to show no difference in quality with height in the tree; but the quality varies according to location in the cross section of the tree. Wood immediately surrounding the pith centre is usually light and weak, increasing in strength and density as the distance from the centre increases. The increase in density is not so marked as increase in strength. In trees above medium size neither density nor strength continue to increase with diameter.

The closeness with which the spruces follow the general law of increasing strength with increasing density is shown by curves giving the variation in modulus of rupture and maximum crushing strength with specific gravity. The following relations are given for red, Sitka and white spruces:—

$$\text{Modulus of rupture, lbs. per sq. inch} = 25{,}000 \sqrt{G^3}$$
$$\text{Maximum crushing strength} \quad ,, \quad = 12{,}000 \sqrt{G^3}$$

where G is the specific gravity based on the green volume. The tests were made on small clear specimens tested in a green condition, pieces falling within 3 inches of the pith centre being omitted.

As an instance of the important effect of drying on strength, it is stated that clear green wood having a modulus of rupture 4,500 lbs./sq. in. and a maximum crushing strength of 2,000 lbs./sq. in. along the grain, would, on drying to the condition of aeroplane stock, increase in these strengths to about 8,000 and 4,000 lbs./sq. in. respectively.

At the present time spruce is used too rapidly to permit of long-time storage and air-seasoning under favourable conditions. After the lumber is cut up it is run into conditioning chambers, in which the seasoning of the lumber is hastened. Under these circumstances there is a wide variation of moisture content of machined specimens, observations made at various aeroplane plants indicating that the variation may be as much as 10 per cent. It is thought safe to assume that the better pieces of machined timber will frequently have at least 5 per cent. more moisture than they will ultimately have. A change in moisture content of such magnitude would cause a reduction in tangential dimensions of nearly 2 per cent. and in radial dimensions of $1\frac{1}{2}$ per cent. Since denser specimens generally shrink more than lighter ones, it follows that the rejection of parts because they are slightly under size—except where dimensions are taken immediately after machining—may result in rejection of the higher quality pieces.

Also, since lighter specimens generally dry more quickly than denser specimens, the random selection of pieces for strength tests without reference to moisture content is greatly to be discouraged; 1 per cent. difference in moisture content causes approximately 5 per cent. difference in the crushing strength parallel to the grain. ("Aerial Age Weekly," April 1st, 1918.)

Application of Die-Castings in Aircraft.

Considerable emphasis is laid in this article by Charles Pack, chief chemist and metallurgist of the Doehler Die-Casting Co., on die-casting being essentially a quantity production process.

From his experience, he finds that few parts could be considered practical die-casting propositions in less that 1,000 lots. Where 10,000 or more castings are required the cost of the die is readily absorbed and fades into insignificance. Also, for suitable castings, the author considers that it is essential for success to use a metallic mould capable of withstanding the action of the molten metal and the rapid changes to which it is subjected, to have an appliance specially suitable for delivering the molten metal into the die under pressure sufficient to ensure a casting of perfect contour, and to cast only alloys suitable for this process.

Continuing, attention is drawn to the fact that the advent of the commercial aluminium die-casting at the beginning of the present war increased considerably the number and quantity of alloys available for aircraft work. Apart from accessories, the use of the so-called "Babbitt" metals is referred to, particularly respecting their extended adoption for aero engine bearings. A soft babbitt, it is pointed out, is more likely to squeeze or pound out under pressure due to its low compressive strength, whereas a hard babbitt is likely to crack and crumble under a pound. To overcome this, the so-called babbitt lined bronze back bearing has been developed and is used almost entirely in aero engine construction.

The following bronze back alloys are referred to:—

	Copper.	Zinc.	Tin.	Lead.	Phosphorus.
1	85	5	5	5	—
2	84	2	5	9	—
3	89	—	10	—	1
4	80	—	10	10	—
5	82	—	3	15	—

Of these, the first is an S.A.E. bronze specification, and the second has been found by the author to be the best as far as the actual efficiency of the bearing is concerned.

The importance of a good method of joining the babbitt liner to the bronze shell is referred to and a mechanical bond is not considered to be satisfactory, especially in connection with the use in actual practice of bronze back bearings in a certain type of 210 h.p. aero engines. Careful soldering is considered to be necessary, and it is pointed out in this connection that "ringing," as a practical test of good workmanship, is not sufficient. For babbitt liners in aeroplane bearings, the following formulæ for alloys are given in the order of the writer's preference:—

	Tin.	Copper.	Antimony.	Nickel.
1	90	4.5	5.5	—
2	89	3.5	7.5	—
3	89	3.0	7.0	1.0
4	84	7.0	9.0	—
5	90	10.0	—	—

The article contains two illustrations, one of a large number of different types of aluminium die-castings and the other of babbitt lined bronze bearings. (" Aviation," April 1st, 1918.)

Properties of Woods Used in Aeroplane Construction.

This article describes the plant and system used at Vancouver Barracks, Portland, Oregon, where the output capacity is 400,000 to 600,000 ft. of aeroplane stock every 24 hours. Great care is taken in the method of cutting to ensure straight grain stock. The following useful table of the properties of various woods is appended, compiled by the Forests Products Laboratory, Madison, Wisconsin:—

	Spruce, Red, White, Sitka, (*Picea Rubens, Canadenis, Sitchenis*).	Pine Western Yellow or Calif. White Pine. (*Pinus Ponderosa*).	Pine Sugar (*Pinus Lambertiana*).	Fir Douglas.
Specific gravity based on volume and weight when oven-dry:				
Average	41	42	39	52
Minimum	36	38	36	47
Weight at 15 per cent. moisture:				
Lbs. per cu. ft.	27	28	27	34
Shrinkage from green to oven-dry condition:				
Radial	3.9	3.9	2.9	5.0
Tangential	7.5	6.4	5.6	7.9
Static bending:				
Fibre stress of elastic limit:				
Lbs. per sq. inch	5,100	6,800	5,300	6,800
Modulus of rupture:				
Lbs. per sq. inch	7,900	8,700	7,400	9,700
Modulus of elasticity:				
1,000 lbs. per sq. inch... ...	1,300	1,300	1,100	1,780
Work to maximum load:				
Inch-lbs. per cubic inch ...	7.4	6.7	5.0	7.2
Compression parallel to grain:				
Max. crushing strength:				
Lbs. per sq. inch	4,300	5,000	4,300	6,000
Compression perpendicular to grain:				
Fibre stress at elastic limit:				
Lbs. per sq. inch	500	640	540	750
Shearing strength parallel to grain:				
Lbs. per sq. inch	920	1,040	950	1,020
Hardness side:				
Load required to imbed 0.444in. ball one half its diameter:				
Lbs.	430	430	410	580

(J. F. Thornel, " Aviation," April, 1918.)

Aeroplane Propellers of Steel and with Variable Pitch.

[Attention should be drawn to the following note on steel and variable pitch propellers, published in some of the American journals.]

"The National Advisory Committee for Aeronautics desires to invite the attention of all designing engineers, and particularly those interested in propeller design, to two very important problems now confronting the air services of the nation, namely, a steel air propeller and a variable pitch air propeller."

The special sub-committee on engineering problems, consisting of Messrs. Durand (chairman), Stratton, Zahm, Dickinson, Chase and Loening, has reported that these problems have been under consideration for some time, but so far without attaining satisfactory results. These problems require careful mathematical study by technicians fully equipped with a sound understanding of the fundamental principle of aeronautical and structural engineering. The ideal variable pitch propeller should embody means for changing simultaneously the diameter, area, and pitch for changes in air density. It is not necessary that the design of a steel propeller should follow the present practice in wooden air propellers, but after careful consideration has been given to the aerodynamical principles involved, design and experimental work should follow fundamental structural engineering practice. The development of such a propeller should be coincident with the development of the variable pitch propeller.

Aeronautical engineers and other technicians are invited to give thought to this problem and submit brief descriptions of their ideas, with such drawings, data, and photographs as are necessary, to the National Advisory Committee for Aeronautics, Munsey Buildings, Washington. ("Society of Automotive Engineers Journal," April, 1918.)