sole merit to be found in the motion in a flat spin is that the vertical velocity is quite often so small that little more than a crashed under-carriage results from hitting the ground. In this type of spin the wings are acting rather like those of an autogiro, but very inefficiently, of course, since one wing is entering the air by its trailing edge.

Another method of full scale test making use of a kinematograph camera on the ground has been employed in Germany. The size of the image on the film gives a rough measure of the distance away of the airplane, whilst the angular distance and the time are readily noted. Cinema methods are also in use in U.S.A. (A cinema film furnished by the National Advisory Committee for Aeronautics of America, and showing a seaplane performing a flat spin, was shown at the end of the lecture.)

When new types of airplanes are tested at the R.A.F. Station at Martlesham in order to ascertain their performance under all conditions of flight, they need to be spun both to left and right and not merely in one direction only. This is because of the influence of the direction of engine rotation upon the slip stream, and because of the gyroscopic couple due to the rotating engine and airscrew which will try to depress the nose of the craft in one case and raise it in the other. Recovery is required to be simple and sure even when this gyrostatic couple assists the inertia couple in opposing the pilot's actions.

At first it was not realised that an airplane that could easily be brought out of a spin of a few turns would not necessarily be easily brought out if the spin were continued for a large number of turns. The reason for this is not certainly known, but it can scarcely fail to be associated with sheer lapse of time allowing the forces opposing recovery gradually to raise the nose of the machine, and so get it into a condition in which for one reason or another the pilot's controls are less effective. Nor has it long been realised that the effect of small differences in the actual mode of entry into the spin can persist even after many turns, and so sometimes render recovery unexpectedly difficult. This explains the previously puzzling question why pilot A's report on the controllability of a given machine in a spin differs entirely from pilot B's. The explanation no doubt is that the two pilots follow a slightly different technique in putting their airplanes into spins. For research investigations it is feasible always to employ the same technique, but during the performance testing of new aircraft consideration must be given also to what is likely to happen when this definite technique is not followed.

The Woof.

A recent discovery is the 'Woof'. This is a word coined by the Martlesham pilots to describe the unsteady form of spin sometimes met with in which there is an oscillation in pitch combined with an oscillation in spin, so leading to a very uncomfortable motion. This is so little understood at the moment that one of the Air Ministry Scientific Research Staff in a recent report had to admit that "the origin of the air forces necessary to maintain this fluctuation in attitude is at present a mystery, and this obscurity is typical of the present stage of the spinning problem". In one recent test the jerkiness of the motion could be distinctly seen from the ground. The unevenness of rotation was accompanied by an appreciable oscillation in pitch, the rate of rotation decreasing as the nose of the aircraft rose and increasing as it fell. Accelerometer records showed the mean period of the pitch oscillation to be rather more than 5 seconds, whereas the corresponding mean times per turn of these spins was only about $4\frac{1}{2}$ seconds. The complexity of the motion may be inferred from the different periodic times.

It may be of course that, long before these highly complex phenomena are fully understood, some novel constructional device will be produced which will at once render all spins controllable. A device which went so far as to prevent spinning altogether would probably not be desirable since it might also prevent the useful manœuvre of the 'roll'.

It is true, I fear, that in these matters we ask a great deal. We ask that the airplane shall do everything that the pilot wishes, but shall have no will of its own other than a moderate wish to remain the right way up, but even this not to be thrust too prominently before the pilot's notice. We want a docile machine. We want, in fact, an amount of docility which though often sought is but rarely found, even in humanity.

[1] *Z.T.M.*, Nov. 14, 1929.

Obituary.

Mr. W. J. Greenstreet.

BY the death of William John Greenstreet on June 28 the mathematical world loses, not an explorer or a geographer, but, if the metaphor may be pressed, a traveller familiar with a larger variety of landscape than almost any of his contemporaries. Born in 1861 and educated at St. John's College, Cambridge, he was an assistant master from 1882 until 1889, and headmaster of Marling School, Stroud, from 1891 until 1910, when he retired to Burghfield Common, near Reading, with the intention of devoting himself to literary work. For many years he had been a regular contributor to *Notes and Queries* and to the *Westminster Gazette*, and editor of the *Mathematical Gazette*, and he had every reason to anticipate a life congenial to his frugal tastes.

The War, however, put an end to Greenstreet's work for the *Westminster Gazette*, and at the same time raised the cost of living to an unforeseen level. The result was an extension of an activity which he had created, namely, the supervision of the

education of pupil-teachers in village schools; the value of this work, which he had begun voluntarily in the schools nearest to his home, came to be recognised by the county educational authorities, and soon from eighty to ninety students looked to him for guidance, and he was known throughout the countryside, reaping in labours which earned him a livelihood the reward of spontaneous help given to his neighbours in happier years.

Meanwhile his editorship of the *Mathematical Gazette* continued, and it was this which made Greenstreet's name familiar to every mathematician in England. While the *Gazette*, as befits the organ of the Mathematical Association, has been concerned primarily with problems of school teaching, from elementary arithmetic to scholarship analysis, the characteristic features of the journal have revealed the editor. Greenstreet always desired to attain, and believed that all teachers benefit if they can attain, to such appreciation of current advances in mathematics as is possible without intensive study of special branches; he therefore encouraged ample notices of treatises, Continental and American as well as English, far beyond the range of school mathematics, until the review pages of his *Gazette* were admitted to be among the best in the world. Also, he had an immense knowledge of the personalities of literary, scientific, and social history, the product of omnivorous and rapid reading and a retentive memory; one result was that his own reviews of historical works, now tracing cross-currents of influence, now bringing a dead name to life by an anecdote or an epigram, enriched alike the books with which they dealt and the journal in which they appeared; another result was that every spare corner of the *Gazette* was filled by a 'gleaning', some quaint incidental reference to mathematics or to a mathematician found perhaps in classical literature, perhaps in a daily newspaper. In short, Greenstreet gave a character and a standing to a periodical which might have become nothing but a pedagogical mouthpiece; and this was the achievement that was acknowledged when the completion, in 1929, of thirty years of his editorship was the occasion of a testimonial to which some two hundred mathematicians subscribed.

Of Greenstreet's literary and musical interests it is impossible to speak here, but mention must be made of his enthusiasm for De Morgan. Once he was addressed as the De Morgan of his time, and this compliment pleased him as no other ever did. In wealth of biographical and bibliographical knowledge each was indeed unrivalled in his day, and this was perhaps all that the comparison was intended to convey, but one may recognise also in the two men the same sense of honour and the same sense of humour. Of the multitude of correspondents and contributors who were grateful for Greenstreet's help and counsel, few could claim to know him personally. His friends hold the memory of a man who never spoke a wounding or complaining word, of one who was prodigal of his knowledge, forbearing in his judgments, and ready with his laughter. E. H. N.

MR. G. H. CURTISS.

IT is with great regret that we record the death at Buffalo, U.S.A., on July 23, after an operation for appendicitis, of Mr. Glenn Hammond Curtiss, whose name, as a pioneer of flight, will always be associated with those of his countrymen, Langley and the Wright brothers. Curtiss, who was born at Hammondsport, New York, was only fifty-two years of age and was therefore somewhat younger than either of the Wrights. Like them, he began life as a bicycle repairer and then turned his attention to motor cycles, motor racing, and engine making.

It was the chance order of an engine for an airship which stimulated Curtiss's interest in aviation. The Wrights had first flown in 1903, Santos Dumont in 1906, and experiments were being made by many other inventors. It was, however, the performances of Orville Wright at Fort Myer, U.S.A., and of Wilbur Wright at Le Mans, France, in 1908 which definitely established the aeroplane as a practical means of transport. That same year, flights were made by other pioneers, among whom was Curtiss. In the summer of 1908 he flew his machine, *June Bug*, a distance of a mile, and this success he followed up by competing with distinction at the famous Rheims meeting of 1909, while in 1910 he won a prize of 10,000 dollars for a flight from Albany to New York, two places associated with the historic voyage of Fulton's steamboat *Clermont* a hundred and three years before.

Continuing his work, Curtiss in 1911 produced the first hydroplane, and by 1914 he had taken up the serious construction of aircraft and had built a multi-engined flying boat. The vast extension of flying during 1914–18 led to the execution of many orders for Great Britain, Russia, and the United States, and to-day the firm Curtiss founded is one of the largest organisations of its kind in the United States.

Curtiss also came into prominence through the Hammondsport trials of the Langley flying machine, which had been tried, but without success, in 1903. Langley died in 1906 but his machine was preserved at the Smithsonian Institution, of which he had been the secretary. Placed in the hands of Curtiss in the spring of 1914, the machine was modified to a certain extent, and on May 28, 1914, Curtiss flew it a short distance. Other trials followed with a Curtiss engine fitted to the machine. These events, together with the wording of the label of the machine as it stood in the museum, unfortunately led to a bitter controversy. Curtiss himself at the time was defendant in a lawsuit concerning the Wright patents, and it is generally agreed that the machine should never have left the museum. The action of the authorities of the Smithsonian Institution has often been criticised, but a short time ago the present secretary, Dr. C. G. Abbot, published a pamphlet in which an effort was made to do justice to all concerned.