

already in 1916 almost every fighter pilot was able to "stunt" his machine. The very nature of air fighting was such that only those pilots were successful who could handle their machines even in abnormal attitudes. Thus, it is said that the well-known French fighter pilot Guynemer during a hard-pressed air fight evaded his German adversary by means of a half-loop upwards, and then shot him down while he himself was in the upside-down position. It is well known that Immelmann frequently attacked by what later became known after him as the "Immelmann turn." I also at that time as a fighter pilot conceived the idea of carrying out new and hitherto unknown evolutions. For instance, I imagined that one would, by a half forward loop followed by a half-roll, be superior, both in attack and defence, to an adversary. The carrying into effect of this idea, however, was precluded by the inferior strength of the machines of that time, which did not enable me to take the risk. The experience of the war years has naturally drawn the attention of all the nations to the military value of "aerobatics," quite apart from the purely sporting interest of "stunting," and to the need for practising and improving on this form of flying. This has been attained with more or less success in the different countries.

Countries with a strong and unrestricted air arm (England, France, Italy) have maintained a relatively great and qualitatively good nucleus of fighter pilots, and have trained new ones. They have, besides, been able, through military subventions, to develop during the post-war years good single-seater fighter machines. So in England, for instance, every fighter pilot is able to do the (inverted) half-loop forward, followed by the half-roll.

From Vol. XXVII, December, 1923, of "The Journal of the Royal Aeronautical Society" I take the following extract:—*

"The first half of an inverted loop can be regarded as yet another method of attaining the inverted position; as, however, it contains special features of interest, I have treated it specially. Although in the second half of an inverted loop, even could it be performed, it is difficult to see any military value, in the first half there are undoubted possibilities. In combination with a half-roll it could be utilised for a rapid change of direction. The pilot would be flying in one direction, perform an inverted half-loop, fly for a moment inverted, and then half-roll out flying in the reverse direction. This manœuvre would actually seem a more rapid way of reversing the direction of flight than that of turning with a vertical bank. In aerial combat the attack is often made in a steep dive. Almost as often it happens that the pilot of the diving aeroplane is compelled to cease firing because his opponent's aeroplane, flying in the opposite direction, passes underneath him. . . . It is certain that a fighting scout, capable of performing any given manœuvre and designed for war, will bring with it the pilot determined to explore its value as a weapon of offence. It is therefore essential that the designer, breaking away from present-day tradition, shall foresee future developments in aerobatics, and as far as possible allow for them in the strength of the design."

From reading this extract one obtains an indication of the importance attached by our military neighbouring states to the carrying out of "stunt" flying. Now, how does our post-war development here in Germany look? According to the Versailles Treaty, the maintenance of a military air fleet is denied us. The inflation period made it financially impossible for pilots of that time to take up flying purely as a sport, and the state was not permitted to make appropriations for such purposes. As a result, the old stock of "stunt" pilots disappeared, and newcomers were not trained. A similar picture is formed by the aircraft industry, which, not until of recent years, has brought out machines in some measure suitable for "aerobatics." The meetings arranged by various clubs and societies at more and more frequent intervals generally offered an opportunity, although for a niggardly compensation, to those few sport and stunt pilots still remaining to do something (the love of flying had to supply the deficit), and thus brought to German sporting flying a certain amount of adherents. How greatly dependent upon public support is the development of flying in general is shown by the development of our commercial aviation during the post-war years. Here we are not subject to the rigorous restrictions, and in this branch of aviation we lead the world.

As the military aspect of "aerobatics" does not come into consideration in Germany, what value has, for us, sporting and "stunt" flying? In the main, there are three reasons for us to present to the general public "aerobatics" at flying

meetings. Firstly, the fact that a well-executed evolution in the air presents an aesthetically beautiful spectacle. Secondly, "stunt" flying has a great value as a sport. It requires the closest co-operation of man and machine found anywhere: the legs operate the rudder; the right hand the elevator and ailerons; the left hand the throttle and ignition controls; the eyes observe approximately eight different instruments; and the ears are constantly listening to the sound of the engine. But the alpha and omega of flying is a certain "feel," consisting in a ceaseless concentration of all faculties, and which cannot be described. Flying is "feel." And now for the third reason. "Aerobatics," or "stunt" flying, with its heavy stressing of the machine, obvious even to the lay mind, brings to the general public a sense of the unquestionable safety of our commercial machines which are flown in a straightforward manner only, and are not, therefore, stressed by far as greatly as is a "stunt" machine.

In what follows I shall deal with the technique and development of the evolutions which I carry out. Before doing so, however, I must point out that I returned to flying in May of 1926, after an absence from flying of nearly seven years. Thus I was no beginner, although I had to spend several weeks in regaining the old sureness, and in order to be able again to carry out neatly and precisely the evolutions which I had been in the habit of making during the war. I saw and felt that in the meantime machines had been produced with considerably higher load factors. For example, the Raab-Katzenstein "Schwalbe," which I use for my "aerobatics" demonstrations, has a safety factor of 14, and now I at last concluded that I should be able to realise my ambition to do some really new "stunts."

As far as I was concerned, seven new "figures," or evolutions, came into consideration. These were:—(1) Rolls, keeping the fuselage in a horizontal position. (2) Half-loop forward (inverted). (3) Downward loop from the upside-down position. (4) Closed inverted loop forward. (If I should succeed in 4, which when I started was a very great question, then I intended to try the following):—(5) Upward loop from upside-down position. (6) Vertical figure-of-eight. And finally (7) Vertical figure-of-eight in upside-down position.

I was quite clear in my own mind that the solution of the task I had set myself would only be possible if I set to work slowly, gradually, and with the greatest possible caution. The roll (1) with the fuselage horizontal, as I had visualised it, caused me considerable difficulties because elevator and rudder controls had to be reversed twice during a roll, and that at a certain definite moment. There are various kinds of roll, but as these are similar, and well known in principle, I do not propose to refer to them here. In my opinion, one can tell the "feel" of a pilot by the way in which he does a roll.

In all my experiments, some of which stressed the machine heavily, I have depended not upon measurements of stresses but upon my own "feel" of the machine. Day in and day out I flew my machine until I felt thoroughly at one with it. Not until then did I attempt to become intimately familiar with the feat of upside-down flying. Before attempting to carry out an evolution with which I was unfamiliar, I would think it out thoroughly in my own mind. In doing this I soon discovered that a new movement, a new evolution, succeeded the better and quicker the longer and the more thoroughly I had thought it out. On account of the often complicated control movements, for instance, in a curve while upside down, I had to resort to the use of a small aeroplane model, on which I studied the different control movements. Then, when going up to make the actual evolution, I found that I did not have to think what control movements were necessary for a certain manœuvre, but could rely entirely on my "feel" of the machine, and I surprised myself by the way in which the desired evolution was carried out without any reflection at all on my part. Thereby I had the feeling that my limbs handled the controls by themselves, or as if my sub-conscious mind directed the manœuvre. After a new experiment of this sort I was not even quite clear how I really had controlled the machine. Only after I had carried out the manœuvre several times could I observe the control movements, and then correct minor faults. A new "stunt" learnt in this way, I would next try to carry it out in the opposite direction. But that would not do. Somehow or other the machine flopped out of it, and I had to start all over again as described above. Especially flying upside down, and all evolutions carried out in the upside-down position, I have had to learn in this fashion. I should further point out that at the beginning of my upside-down experiments I had no feeling of speed at all. This was dangerous on account of the risk of falling into an upside-down spin. At first I

* This reference is to the paper entitled "The Manœuvres of Inverted Flight," read by Squadron Leader R. M. Hill, before the Royal Aeronautical Society, on October 18, 1923.—Ed.