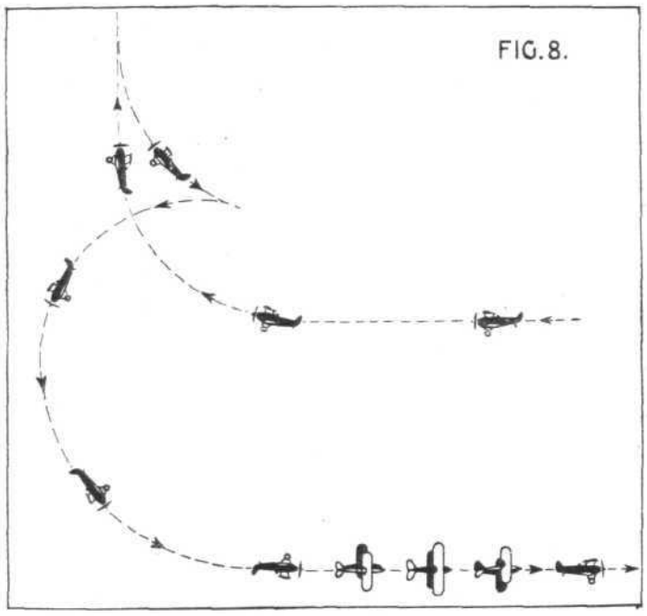
had to depend upon the load on the controls for my speed indication. As is well known, the pressure on the controls increases with speed, as in flying the right way up. I also had to take into consideration the possibility that at some time or other I might get into an upside-down spin, and I had beforehand studied the problems of what I should have to do to get out of such a situation. In the English flying schools a number of pilots have crashed from this cause, among them several experienced pilots. The danger of the upside-down spin is that the control movements necessary to bring the machine out are the reverse of those required in getting out of a spin the right way up.

It was not until after continued training, and by proceeding step by step, in the handling of the three separate conrols, that I developed the " feel " for speed. One very important matter in getting the correct " feel " in upside-down flying is the method of being strapped in. Too slack a harness made me feel unsafe, and once a sudden lurch of the machine caused me to slide off my seat and temporarily to lose control. After that I adjusted the shoulder straps so tightly that they caused a pressure in normal flight. I also had an extra strap made which holds me firmly down on the seat. With this there is no difficulty about control in the upside-down attitude. Nor do I fail to secure my feet to the rudder bar, and for long upside-



" AEROBATICS " : Fig. 8 shows a " stunt " which Herr Fieseler has carried out while carrying a passenger. The " stunt " is started with a " zoom," followed by a tail-slide, from which the machine recovers by diving. It is then flown on to its back, and righted by a roll.

down flights I have my feet strapped to the bar, since otherwise the legs would sink down.

The control movements during upside-down flying can easily be imagined by any pilot, but they are less easy to describe, and the difference in viewpoint between a pilot upside down and an observer on the ground would make an explanation complicated. At any rate, elevator and aileron controls are reversed. The rudder control is not reversed, as seen from the pilot's seat, but only the direction of the curve. All three controls work effectively when flying on one's back, provided sufficient speed is maintained. Above all else, the inexperienced upside-down pilot must take note that the control movement which in normal flight gives an increase in speed, results in a loss of speed when upside down, and *vice versa*.

At the beginning of my experiments the duration of my upside-down flights was quite short. Gradually I made longer flights, and once even as long as three minutes. On these occasions the engine merely idled, so that the flights were only glides. During these I ascertained that when on its back the machine loses height very rapidly, nearly twice as fast as in normal gliding flight. This is, of couse due to the low lift coefficient of the wings in the inverted position. In order to be able to carry out long flights upside down I devised and had made a scheme whereby the engine was kept supplied with petrol and oil even in the inverted position. As, however, there were no data available on this subject, it took several weeks to get this arrangement to work satisfactorily.

Although to-day I can make upside-down flights of 4 to 6 minutes without feeling any special bodily ill-effects, after prolonged flights of this nature a certain fatigue sets in. Thus after landing from my upside-down flight from Cologne to Bonn, I felt as if I had been marching without interruption for 10 hours, or as if I had been doing hard manual work for a whole day. As I jumped from the machine I should have fallen but for the assistance given me by those on the aerodrome.

It is often assumed that after a long inverted flight the blood pressure in the head must become very considerable. Although obviously the blood does run to the head, and I have the feeling that the head becomes big, the pressure seems to reach a certain amount after a time, and to be comparatively slight, without undue ill-being. Only coming into a normal attitude after a long inverted flight does one experience a temporary attack of giddiness.

The Inverted Loop

As is well known, until I demonstrated it the experts had considered the inverted loop impossible. It is true that through an acquaintance I heard in June of last year that after many experiments the well-known American pilot Doolittle had succeeded in making an inverted loop, but he had bloodshot eyes after landing, and was so exhausted that he had to be taken to hospital. He is said later to have expressed the intention never to attempt this evolution again. After my experiences I can understand that this happened. This is probably first and foremost due to the unsuitability of his 450 h.p. machine for this particular manœuvre. Perhaps, also, he maintained the position of the body usual in normal flight and did not follow the necessary precautions which my experiments led me to adopt. The reader will not, I am sure, take it amiss if I do not go into details concerning these precautions, which I have only discovered after comparatively lengthy experiments and at a certain amount of risk.

At first I practised many times the first half of the inverted loop. First with the engine off, then with half throttle, and finally with full throttle. Full throttle I only used in coming out of a stall, since otherwise the engine would have raced, and there would also have been some risk of the propeller bursting. This was a possibility with which I had to reckon, as an unexpected propeller breakage might have led to a catastrophe, and this I realised, like other possible mishaps, before undertaking a new experiment. I thought out clearly and thoroughly beforehand what to do in case of any difficulty that might arise, and in the course of my experiments I ascertained this slow and deliberate procedure to be the correct one. After I knew quite definitely how my machine behaved at various speeds, how the control loads were, and last, but, not least how I myself felt, I proceeded to attempt the second half of the inverted loop, independent of the first half.

At first my machine used to fall out of the inverted loop either sideways or backwards when it had reached the vertical position, or slightly past it. The cause for this unintentional and often very unpleasant manœuvre was that either I had not sufficient speed at the commencement of the second half, or that I used the elevator incorrectly. The correct amount of elevator in the second half of the inverted loop caused me a great deal of speculation, because the control load fell away very quickly after beginning to point the machine upwards (the German word used in the original text is " Hochnehmen," for which we have no equivalent unless one were to use the expression " inverted hoicking "—Ed.), although the speed in a normal loop had proved sufficient to produce a control load. I trace this peculiarity to the aerodynamic characteristics of the machine in this particular evolution. Not until after many attempts did I discover the correct amount of elevator to give. When I added the first half of the inverted loop to the second half at last perfected, at first with a short inverted flight between the two, the new " stunt " was ready, and I could at last begin to think of the " stunts," vertical figures-of-eight. While up till now most of my troubles had to do with the machine and its handling, I now had to fight chiefly against bodily physical difficulties. The precautions which I had discovered to be necessary for the closed inverted loop were now insufficient. This is explained by the fact that during a vertical figure-of-eight there is a reversal of blood pressure in the head. In a normal loop, as is well known, the pilot is pressed into his seat, and there is a draining of the blood from the head. In an inverted loop,