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he turned for a second run over the test-course, knew that too tight a turn would lose him consciousness and almost certainly life itself.

Blackouts during turns were reported by Schneider Trophy pilots as long ago as 1922 when the world's best land and sea planes tortoisised round the course at about 200 m.p.h., but little attention was paid to the phenomenon at the time and it was not until many years later that detailed information was either sought or obtained.

Remember Spain?

About 1935, however, Germany and Italy had awakened to the value of the dive-bomber as a means of hurrying in the New Order in backward areas like Abyssinia and Spain, and at the Tempelhof laboratories of the Reich Air Ministry a gigantic centrifuge was built to find out just how hard a dive-bomber could dive and at the same time confine the damage to the target area.

In this Wellian contraption large animals and human subjects were rotated (in something more than the vernacular sense of the word) and simultaneously X-rayed by means of an automatic plant installed in the frame with the subject.

In this manner was gathered an imposing amount of data on the effects of centrifugal force on the body.

Vision Suffers First

Vision suffers first, for example, when centrifugal force drains blood from the head. This, medical men explain, is because, even under normal conditions,

blood is supplied to the eyes against the resistance of muscular pressure within the eyes themselves. When banking at speed, therefore, the airman is conscious first of spots or a veil, before his eyes, followed by visual blackout. If the turn is violent enough, mental blackout supervenes rapidly, but for this to occur the Germans discovered that the centrifugal acceleration (as it is called) must be more than five times the pull of gravity, or 5G, and must last for more than four seconds.

Along with the reduction of blood pressure in the head and upper body a corresponding build-up of pressure occurs in the lower limbs. Fighter pilots have told of the intense pain in the legs caused by engorged veins and arteries and some have returned from combat bearing the stigmata of high-speed turning in the form of ugly blood-blistered formed by the rupture of vein walls.

Nor is blood alone affected by these stresses. All the internal organs tend to be displaced when strains are prolonged and the Tempelhof investigators, gravely spinning a group of anaesthetised monkeys, found that the apex of the heart dropped as much as three inches if the pull reached a strength of 8G.

Blood and Iron

Yet perhaps stranger than these discoveries was the degree of recuperative power shown in the flesh and blood of the subjects. A number of rabbits, for example, were subjected twice daily for a fortnight to 90-second spells at an acceleration of 15G. In spite of this tremendous strain none of the animals suffered injury and one even gave birth, 14 days later, to a healthy litter. Just one vicious circle after another.

And as evidence of what the human body can stand, one German investigator, a Dr. von Diringshofen, detailed an experiment with a Henschel dive-bomber in which a pilot underwent a stress of 8.2G over a period of six-and-a-half seconds. One can only appreciate the strain endured by that airman when it is understood that for the seeming eternity of those seconds his blood had the weight of iron. No doubt Bismarck would have approved the test.

Accelerations beyond 10G, however, are now known to cause concussion, and though reliable scientific data on even greater pressures were gathered by both sides during the War, in most cases neither the planes nor the men who piloted them survived.

How "Cobber" Kain Died

Blackout occurs, as has been pointed out, when centrifugal force draws blood from the upper part of the body, and since in normal aerobatics and combat flying the pilot's head is towards the centre of the circle round which the plane is flying the blackout is the normal physiological reaction to a fast turn. In the normal loop, for example, if it happens at all blackout will occur when the pilot is climbing up and over after the initial dive to gain speed. But should the loop be made forward, with the pilot on the outside of the curve, or should a pilot bank steeply in the same outer position, then what he suffers is not a blackout, but a "red-out" caused by the building up of blood-pressure in the chest and head.

It was this type of attack which, in the opinion of one medical authority, Captain Ernst Jokl*, killed "Cobber"

*A South African, author of *Medical Aspects of Aviation*, from which most of the scientific detail of the above article was derived.



"COBBER" KAIN
Red should have been a warning

Kain, the Wellington airman who was the first British ace of World War II.

Here is his reconstruction of what happened on that tragic afternoon in June, 1940, when Kain, already posted to instructional duties in England, stunted for the last time over Blois airfield.

"... at 350 m.p.h. Kain dived upside-down towards the aerodrome. Although at this phase the main acceleration impact did not affect his body in the dangerous longitudinal axis, the fact that he flew in an inverted position already implied a considerable strain upon his blood circulation. Missing the ground by a few feet, 'Cobber' performed a sharp vertical turn, shooting up to 1,500ft. in less than a minute. The writer has calculated that during this manoeuvre powerful centrifugal forces about four times the gravity of the earth were produced, affecting him now in the longitudinal body axis... under such circumstances, Kain must at this moment already have experienced visual disturbance of the 'reddening-out' type. Since he was an unusually tough and daring fellow, we may assume that he disregarded this first warning symptom, especially since (unfortunately) its significance had never been explained to him. A few seconds later, when he reached 1,500ft. he turned his right wing up and started rolling. This was a risky and extremely dangerous manoeuvre since it brought into operation additional centrifugal impulses shifting more blood from the legs and pelvis towards chest and head. The resisting power of his vascular system became definitely overstrained at this point.

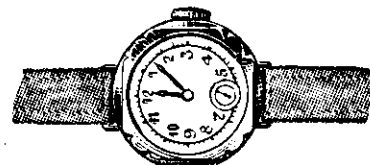
"It is more than doubtful if 'Cobber' ever intended to carry out two consecutive rolls from a height of only 1,500ft. We are told that he didn't straighten out after the first but completed a second and even started a third roll. The writer has no doubt that his conscious control became impaired as early as during his first roll. Before crashing he was handling his controls in an automatic manner, in the same way in which a groggy boxer continues fighting without really knowing what he is doing."

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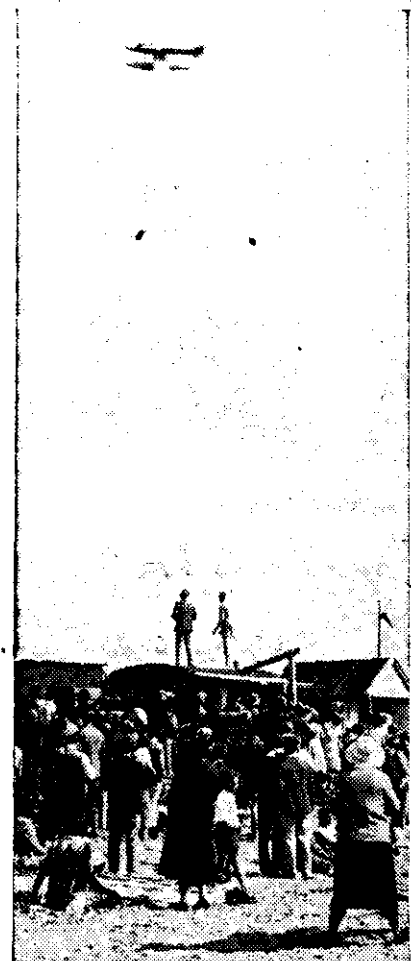
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BANKING STEEPLY at over 300 m.p.h., Flight-Lieutenant Boothman roars over the watching crowd at the Solent in 1931, when he won the Schneider Trophy outright for Great Britain. Blackouts were first reported as a result of turns like these.