Commentary on "The Flying Service from a Medical Point of View"

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Great advances have been made, both in the skill of air pilots and in the actual machines, during the past twelve months. The speed of aeroplanes has greatly increased, chiefly on account of engine power, but partly also due to the design. There is no doubt that the aeroplane of today is a much safer machine than that of twelve months ago. Faulty designs have been more or less eliminated and the aeroplane much strengthened. Formerly a good many of the aeroplane accidents were caused by the collapse of some portion, usually the wings, and chiefly in monoplanes. This seems to be a quite rare occurrence now, the accidents that do occur being, as far as can be gathered from inquiry, due either to air conditions placing the aeroplane out of control or to some error on the part of the pilot.

Both these causes apparently will continue, but the increased speed now available counteracts the loss of control from the former cause. Errors on the part of the pilot will probably be further guarded against to a certain extent by reliable instruments, which will show the flying state of the aeroplane, and so avoid a dangerous condition.

High-velocity Accidents

With an increased speed of aeroplanes, now in many machines up to seventy miles per hour, the crushing effect on striking earth nose first will be very great, and will demolish a great part of the aeroplane even from a very little height. Cases occur where the pilot has not been crushed, but has been seriously injured, by apparently hitting a part of the machine due to the forward velocity of his body when the aeroplane strikes on its nose and suddenly stops. These incidents occur only in aeroplanes that have the engine in front and the pilot well behind (such as all modern tractor biplanes and monoplanes). The engine takes the shock, and the portion of the aeroplane directly behind the engine (where the passenger seat usually is) crumples up, while the pilot's seat, etc., which is behind, may suffer comparatively little damage. It is usually the pilot's head that suffers. His body apparently comes to a sudden stop, owing either to a safety belt or a hand outstretched, while the head bends forcibly forward on the neck. The result is usually that the head strikes some portion of the machine, and is injured, or the neck is forcibly wrenched. The injuries sustained in such accidents seem to be chiefly injuries of the skull due to actually striking; but in one case the only injury found was a fracture or dislocation of the neck.

There seem two ways to avoid this: one is a safety belt having shoulder straps, to keep the body from being propelled upwards and forwards. This would be unpopular with pilots, and would give trouble in releasing before landing. A second and better solution would be to have some giving material in the position in front of the pilot, where the head would strike.

Safety Belts in Aeroplanes

The question of safety belts in aeroplanes, e.g. some means of strapping the pilot in his seat, has been much discussed in the last year. Most pilots are in favour of such, and do wear belts, but a few are averse to them. I have heard several well-known and experienced pilots, in discussing the use of belts, say that they object to them, because if the machine crashes to earth suddenly the pilot may be crushed in his seat when the machine turns over; whereas, if he has no belt, and the aeroplane turns over on the ground, the worst that can happen is that he is thrown out. Also, if strapped in he probably could not clear himself if the aeroplane caught fire after a smash, and quick releasing devices do not always act.

The objection to belts can, I think, be easily overcome by devising a release which can be readily used just before a landing is made. The present type, while the release pin is on the belt and releases the belt from the body, is not reliable or easy to manipulate when the pilot is busy, his attention being taken up with working controls, engine, etc. for landing. A lever on the side of the machine by the pilot's side, which releases the belt from its attachment to the seat, is, I think, a more suitable, more convenient, and quicker *arrangement. A case happened recently when an aeroplane capsized on a forced landing just outside the flying ground: the pilot was found unhurt, but suspended face down, owing to the quick-release device failing, the buckles of which were not able to clear owing to being fitted faultily in the aeroplane.*

Safety Helmets

Whether these should be worn or not is also a matter for discussion amongst aeroplane pilots. The objections put forward against helmets are that they are uncomfortable, and would not save the head from a fall except from the smallest of heights. If one falls on any other part of the helmet but the actual top of the crown, the additional height of the crown would force the head backward or forward, and so break the neck. Also, if wearing one in a tractor machine, the added propeller draught beating on a high-crowned helmet forces the head back in a most uncomfortable manner. In favour of helmets it can be stated that they are quite comfortable if a proper size is used; that in a ground smash they protect the head from a blow of broken spars; that if the pilot is thrown out, and his head hits a wire, they save a scalp wound; and that the earflaps save damage to the ears. Moreover, if be is thrown on to the ground, the helmet would save injury to the scalp, and possibly a fracture of the vertex or the base of the skull. All the above would be, of course, in the case of an aeroplane smashed on actually landing. Everything seems to favour helmets being worn. They are light and can be quite comfortable, and in the modern engine-in-front machine the pilot is protected a good deal from the propeller draught.

A favourite headgear of pilots just now is a leather skull-cap with ear protection pads, such as is worn by the racing motorist. The ideal helmet, no doubt, would be one that took its support from the shoulders, but it would be rather cumbersome, and would encase the wearer, and so be rather unpopular. The question of what type of helmet is most suitable is now under consideration.

Clothing

As a protection from cold, lined leather jackets are generally worn, with, in cold weather, a "sweater" (woollen) underneath. The Admiralty now issue a leather-lined coat and trousers; these are light and serviceable. The hands are shielded by lined, leather gauntlet gloves. Aeroplaning, even in cold weather, seems to cause very few chills on the abdomen or chest, probably because pilots take the precaution of being adequately clothed. The only cases of chills can usually be traced to inadequate protection. Modern aeroplanes with their protecting screens are more comfortable for the pilot.

Physical Requirements of Candidates for the Flying Service

The candidate must be physically fit, and I would reject the anaemic type. Particular attention must be paid to eyesight. Full normal vision and colour vision is required. Hearing must be good. The teeth ought to be in good condition. Height does not matter.

Age- It is not possible at present to lay down any hard-and-fast rule as to age. My opinion is that the age for selection is between 20 and 30 years. Over the age of 30 is, I think, too old to 'begin to learn flying' with a view to being a Service pilot, e.g. to take up a flying career and fly under all conditions.

Type- This I have studied carefully, but have come to no conclusion. The active type, the man who is keen on such things as motoring, motor bicycling, riding, hunting, the exciting sports with an element of danger, seem to make the best pilots.

Sight- Full normal vision is important for all aeroplane pilots, and all candidates should be carefully examined for vision. Full vision is important for landing an aeroplane, because the machine, diving towards earth at an angle, is then turned up, or what is called "flattened out," at the right moment for landing: this right moment is at a certain distance from earth which the pilot must gauge. If he turns up too soon, the aeroplane drops from a height and probably smashes; if he turns up too late, he dives into the earth and wrecks the machine. The accidents on landing are, in the majority of instances, probably due to error of judgment on the part of the pilot; but that error, I think, in some cases is due to defective vision, although so far there is no proof of this. Good vision is also needed in looking for a suitable field for landing, when a forced landing has to be made due to engine trouble or other defect.

Hearing- This must be good, as any engine defect in the air gives first indication by sound. Failure to instantly detect, by hearing, any engine defect may lead to serious accident while flying.

Effects of Aeroplane Flying on the Pilot

During the previous year an attempt was made to find out if the pulse-rate and blood pressure were affected. This was continued during the early part of 1913, but the results were most unsatisfactory from a research point of view. In some cases the pulse-rate showed an increase after only a short flight in calm weather, while in others the rate remained normal. After a flight in bad weather conditions, the pulse-rate was always increased.

Nearly all the cigarette smokers seem to have an increase of pulse rate, and as a great number of aviators are cigarette smokers, one can expect some increase in pulse-rate after flying. As regards blood-pressure, the only way to get any definite results seems to be to send the subject up in the air with a recording blood-pressure apparatus, *but unfortunately the vibrations of the machine, due to the engine, affect all pressure-recording instruments, and the results are very doubtful. I think as machines improve it may be possible to carry out such experiments, and obtain some definite data.*

Commentary

This is a fascinating article by HV Wells, the first doctor associated with the Royal Navy (RN) to win his wings, a feat he achieved in a Bristol aircraft in the skies over Eastchurch, Kent (1). He was appointed to the Naval arm of the Royal Flying Corps (RFC), which would subsequently become the Royal Naval Air Service (RNAS), and went on to publish in the Journal of the Royal Naval Medical Service on subjects such as the effects of altitude on the body, injury and disease associated with flying (2). Aviation medicine did not start at the time of Wells; John Jeffries, a doctor with British Forces during the American Revolution (1765-1783) became the first doctor to fly and understandably had an interest in the effects of altitude on the body (1). What was new to doctors of Wells' generation were the stresses imposed by powered, fixed-wing flight on the body.

At the time of this article, Naval fixed-wing aviation was in its infancy and the preceding five years had seen the first RN Officers learning to fly (1909), the purchase of two aeroplanes by the Admiralty (1911), and the establishment of the first Naval Flying School at Eastchurch (1911) (3). Expansion of the RNAS was breathtaking, such that by the end of the Great War in 1918, when the RAF was formed from the merger of the RFC and the RNAS, the latter consisted of 55,000 officers and men, 2,900 aircraft (such as that depicted in Figure 1) and 126 air stations (3). Incidentally, it was after an internal RAF reorganisation in the 1920s, that the maritime arm of the RAF became known as the Fleet Air Arm of the Royal Air Force. In 1939, control for Naval aviation was passed back to the Admiralty (3).

Figure 1: A Sopwith Pup armed with Vickers 0.303 machine gun. The Pup was the aircraft flown by Sqn Cdr Edwin Dunning RN on 2nd August 1917, thereby paving the way for an era of carrier operations. Reprinted with permission from the National Museum of the Royal Navy.

The principles of crashworthiness discussed by Wells in his article are still taught today, distilled into the acronym CREEP (4): Container; Restraint; Environment; Energy absorption; Post impact.

Container

The idea that the space around the occupant (the container) should be maintained if injury is to be avoided is still a principle of aircraft design and pilot protection.

Restraint

Modern thinking is that, on impact, a restraint system holds the occupant in the container and restricts their movement such that they do not strike surrounding equipment. Thus the requirement for a harness is no longer considered controversial, as the author describes it being in his day. Wells concludes that a seat belt is a "very necessary thing".

Environment

Wells writes that to avoid head injuries on impact, one could have "some giving material [covering cockpit equipment] in the position in front of the pilot, where the head would strike". This remains a valid principle, with surfaces and projections within the 'flail envelope' of modern aircraft made from deformable material where possible. However, as Figure 2 shows, the amount of 'giving material' was extremely limited in Wells' day.

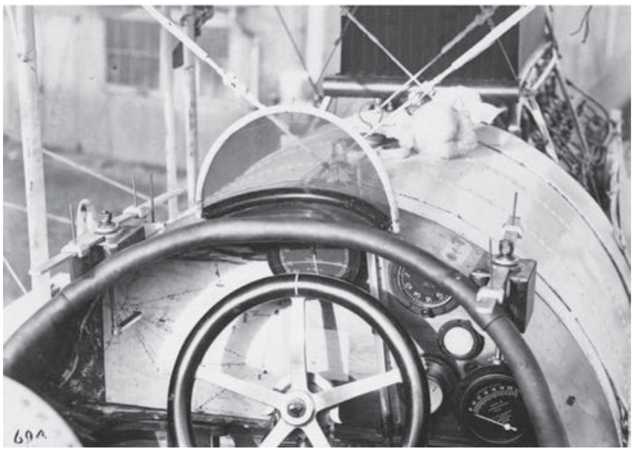

Figure 2. Control panel of a 1916 Short Seaplane showing instruments and sights for torpedo dropping gear. Note the lack of padding in evidence, making the cockpit especially hazardous in the event of a heavy landing or crash. Reprinted with permission from the Imperial War Museum.

Energy absorption

The energy absorbing qualities of headgear have developed since 1915. Back then the leather skullcap was popular, whereas today a helmet may consist of a fibreglass shell over a suspension harness or a foam inner layer. The rigid shell absorbs energy of impact by fracturing, while the suspension harness distributes the force of impact around the head (5).

Post–impact
Wells makes no mention of the management of post-impact hazards, such as fire or landing on water.

Flying clothing
Wells describes cold weather flying clothing at the start of the war as illustrated in Figure 3. Nowadays clothing is also designed to protect against the effects of G-force, fire, cold-water immersion and, when required, hot cabin conditions.

Figure 3. Pilot and observer being recovered after a crash. Note the pilot only wears the soft leather-helmet, but both are wearing fur-lined one-piece leather flying suits. Reprinted with permission from the Imperial War Museum.

Medical standards
The requirement to meet or exceed set medical standards in order to train to fly with the RNAS remains to this day. Although standards of age, hearing and visual acuity are similar to those employed today, his criteria for the psychological grading seem quite dated: "The active type….keen on such things as motoring, motor bicycling, riding, hunting, the exciting sports with an element of danger."

In an echo of the historical reorganisations described in this article, the British military's next fast jet aircraft, the F35 Lightning II Joint Strike Fighter (JSF), will be formed into both RN and RAF squadrons. The performance of the JSF, and its effect on the physiology of the aircrew who fly her, would probably have been unimaginable to Wells; a 5th generation fast jet capable of speeds of Mach 1.6 (over 1km every 2 seconds) and a combat radius of 450 nautical miles (6). Nevertheless, the principles of crash-worthiness that he described can be seen in the F35 design, testimony to the vision of this pioneer of aviation medicine in the Royal Navy.

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