CORRESPONDENCE

To the Editor of the ROYAL AERONAUTICAL JOURNAL.

Dear Sir,—Respecting the paper on physiological limits of altitude or height in the current issue of the Journal, I do not know whether the following remarks would be of sufficient interest to publish in your next issue.

So far as I could gather from reading the paper and discussion there was no mention of the *ultimate altitude limit* at which the blood of the pilot would boil. This is in the region of approximately 50 millimetres mercury gauge pressure, and I believe I am right in saying this corresponds over a height approximately 60,000ft., that is to say, in a machine with an open cockpit.

On the question of oxygen supplied, I do not think enough attention has been given to the possibilities of subcutaneous injections of oxygen. I believe it is the practice of veterinary surgeons in cases of valuable dogs and other animals affected with pneumonia to inject oxygen under the skin and so supply oxygen to the blood independently of the lungs. This sounds somewhat drastic, but I believe that if practised in the case of high altitude mountain climbing, such as the ascent of the last stages of Everest, it might make all the difference. Calculation shows that a very small quantity of oxygen absorbed in this way would compensate for the last two or three thousand feet and last long enough to see the climber through, likewise it might be of use in extreme cases of high altitude flying, but the altitude limit in an open (no pressure) cockpit would still be 60,000ft. when even if the oxygen supply were maintained the pilot's blood would boil and he would burst. Moreover, at these high altitudes a subcutaneous oxygen supplied would have to be administered with great caution because the volume would be greatly augmented by water vapour.

On the question of caisson sickness, as this is due to nitrogen bubbles being disengaged in the nervous system ("Caisson Sickness," by Leonard Hill, F.R.S., chaps. V and VI), there is very little to fear on this account when pure oxygen is being breathed; but otherwise it would be rash to say that caisson sickness might not arise from rapid decompression, because it is not entirely a matter of absolute decompression in lbs. per sq. inch, but to some extent it is due to *relative* decompression.

Yours faithfully,
F. W. LANCHESTER.

May 10th, 1933.

To the Editor of the ROYAL AERONAUTICAL JOURNAL.

Sir,—In reply to Dr. Lanchester, it is perfectly true that since the vapour-pressure of pure water at body temperature is just under 47 millimetres of mercury, any water in the body, containing no salts in solution, would boil at a height of about 62,000 feet (I.C.A.N. height-pressure law). I did not mention this in my paper (though I made passing reference to it when speaking before your Society) because I had already postulated a lower physiological limit of height, of the order of 45,000 feet, from the factors governing the assimilation of oxygen by the blood, so that a pilot who was carried to a height of about 62,000 feet would have succumbed long before.

With regard to the subcutaneous injection of oxygen there are three things to be taken into account. The skin of dogs is much more loosely attached to the underlying tissues than that of man and can be gathered together by the handful without injury, so that relatively large quantities of gas could be injected under it; while the amount of oxygen that would be necessary to supplement the breathing of pure oxygen at atmospheric pressure at any attainable height largely in excess of 45,000 feet would, if given subcutaneously, produce a painful and extremely incommoding condition of ballooning of the skin, which would make the necessary movements of piloting almost impracticable. Even if these objections could be overcome, the risk of septic infection through the numerous punctures, and the difficulty and discomfort involved make this too much of a surgical operation to be contemplated in connection with a pilot actively engaged in manipulating controls while swathed in several thicknesses of clothing. These objections acquire added force if one compares the extreme physical exercise involved in climbing Everest with the almost complete placidity, and therefore minimal oxygen requirement, of a sick dog.

Turning to Dr. Lanchester's reference to caisson disease, in view of the facts mentioned in my paper that the total range of decompression that it is possible to encounter in aviation can never reach one atmosphere, and that no practicable rate of ascent is even comparable with the rate of ten thousand feet *per second* that has been attained experimentally without apparent detriment, I am still of the opinion, in which Sir Leonard Hill concurs (*vide* p. 402 of your Journal), that there is no danger of caisson disease in flying.

I am, Sir, your obedient servant,

G. S. MARSHALL, *Wing Commander.*

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24th May, 1933.