Now there are one or two fundamental considerations that seem to be forgotten, and one is that whoever covers the distance in the shortest time will win, though they may finish at a pace slower than any other horse running. Surely, therefore, a horse, like anything else having a limited amount of energy to expend, should go fast downhill and ease himself uphill. This apparently simple expedient is taboo I notice, anyhow at Ascot, where horses are pulled violently to prevent undue speed on the downhill, but must go fast uphill towards the finish.

I acknowledge the advantage of being paced from an aeronautical point of view, but provided you are not first, not much advantage accrues from being last as compared with second. There is also the fact that on any form of circuit, whatever its size, if you run parallel to another horse and can at no time get on the rails, you will have to go (allowing 4-ft. separation) 26 ft. farther. To be on the rails, therefore, is a definite advantage.

A race between a great French horse and a great English horse which I witnessed at Ascot will illustrate my point. The distance was two and a half miles. The French horse was instantly put among the leaders, using the downhill to get there easily, and lay third for most of the race. The English horse was pulled back at the beginning so as to be last, and for most of the race was at least 100 yards behind the Frenchman. Not until about seven furlongs from home, when the going was uphill, was he asked to close the gap. Nobly he did it, but when abreast of the Frenchman, the Frenchman was able easily to shoot ahead and win.

These tactics struck me as scientifically unsound. Were the tactics reversed a different result might have occurred, for I contend, and here I want corroboration or rebuttal, that the English horse was asked to exert more energy in that race than the Frenchman.

Dynamically and physiologically there is mechanical error here, that shows itself in tactics, that has crept into racing and wants exposing, and I should indeed like the views thereon of readers of *Nature*.

Tod Sloane with his forward seat revolutionized riding by jockeys, and he was scientifically right. It would indeed be very enjoyable if *Nature* could expose other fallacies in at present accepted turf procedure.

BRABAZON OF TARA

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I KNOW nothing about the technique of horse-racing, and there may be subtle reasons, or prosaic ones such as not desiring to break the horses' legs, why jockeys should not let their horses go too fast downhill. If, however, they were human and not equine runners, I should certainly say go faster downhill and slower uphill; at a guess, but I have not tried to work it out, I should say let them exert total energy at the same rate throughout the race. They would require less energy to run at the same rate downhill and more energy to run at the same rate uphill; so at a constant rate of energy expenditure they should go faster downhill and slower up.

For running on the flat the results of all physiological experiments allowed one to predict (and I did so predict a good many years ago) that the best times would be done by running at a uniform speed throughout a race. The energy spent in running a given distance increases as some power of the speed, so that you gain less during the time you go slow than you lose during the time you go fast. Running downhill is exactly like running with a following wind: the hill provides some of the energy to overcome air-resistance, the following wind reduces the air resistance. If I were advising human runners on a circular track on a windy day I should say run fast when the wind is behind and slow when the wind is ahead.

I wrote a paper on "The Air Resistance to a Runner"[1]; Best and Partridge wrote one on "The Equation of Motion of a Runner Exerting a Maximum Effort"[2]. Both these papers have a bearing on the same problem. Another paper on the same topic is that by Sargent on "The Relation between Oxygen Requirement and Speed in Running"[3].

Winning races is not always the same thing as doing the best time: there is tactics as well as strategy about it. Certainly, however, for doing the best time and getting the utmost out of oneself over a given distance, these rules apply. I see no reason why they should not apply to horses as well as men. Perhaps Lord Brabazon would like to repeat on horses (if the R.S.P.C.A. would let him) the experiments which Best, Partridge, Sargent and I made on men!

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[1] *Proc. Roy. Soc.*, B, **102**, 380 (1928).
[2] *Proc. Roy. Soc.*, B, **103**, 218 (1928).
[3] *Proc. Roy. Soc.*, B, **100**, 10 (1926).

Soil Perfusion Apparatus

IN view of Audus's communication[1], which describes a modification of my original design of perfusion pump, it is perhaps relevant to note that I simplified the apparatus myself more than two years ago. The simplified apparatus was, as Audus's, actuated by unidirectional air flow and was used for months in experiments that demanded a control of composition of the inflowing gas. It also incorporated the idea of using air-flow through a capillary to regulate an air-pressure difference. This modified design is described in an addendum to some forthcoming papers by Dr. Quastel and myself[2].

Those who contemplate using the perfusion technique may, however, be interested to learn that an entirely new design, far simpler than either Audus's modification or my own, has now been reached. It has been in constant use in this laboratory for eight months; it is completely self-regulating, is worked by unidirectional air (or gas) flow and represents what I believe to be the limit of simplicity in apparatus of this sort. The apparatus[3] was demonstrated at a meeting in Manchester of the Society of Public Analysts on October 19. The design has much to recommend it to bacteriologists, in that a small-scale version of it can be sterilized complete in an autoclave.

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[1] *Nature*, **158**, 419 (1946).
[2] *Biochem. J.*, in the press.
[3] *J. Agric. Sci.*, in the press.