took up any more CO than oxygen, in spite of the great difference between the effective concentrations of the two gases.

Sir William Bayliss also asks for experimental tests of the assumption that oxyhæmoglobin is a stronger acid than hæmoglobin itself. The limitations of the hydrogen electrode make the measurement of the hydrogen-ion concentration of hæmoglobin solutions, in the presence of oxygen, a difficult problem. I have been able to show, however, that if gas is boiled off in a vacuum from dialysed hæmoglobin solution, the electrical conductivity of the solution is considerably increased by shaking with oxygen or CO. (Precautions have, of course, been taken to exclude the possibility of the increased conductivity being due to impurities in the gas used.)

While this is naturally not a proof that combination with oxygen increases the acid dissociation constant of hæmoglobin, it is nevertheless the result to be expected if this be the case, and is a fact to be explained by any theory, chemical or physical.

Prof. Hill and I have pointed out that the divergent results of investigators of the heat of combination of oxygen and hæmoglobin may be due partly to bacterial action, and (in experiments on blood) partly to failure to allow for the heat changes involved when oxyhæmoglobin turns out CO_2 from carbonates. By eliminating these sources of error we have been able to get quite consistent results in experiments on defibrinated blood.

Without making any assumptions other than the recognised laws of chemical combination and chemical equilibria, it is possible to explain the behaviour of hæmoglobin by regarding its reactions with CO and oxygen as purely chemical. Sir William Bayliss has said that he doubts whether it is justifiable to apply these laws to a system in which the number of the phases may be uncertain. Surely the best way to decide this is by results, and, judging by results, the chemical theory has amply justified its position as a fruitful working hypothesis.

Can the adsorption theory explain the phenomena so completely, with so few untested assumptions? Since the paper by Wo. Ostwald in 1908, no attempt has been made, so far as I am aware, to put forward a complete theory of the reactions of hæmoglobin as adsorption phenomena. Much experimental work has been done since then, and until such a theory is put forward it is difficult to weigh up satisfactorily the merits of the two views.

At present the adsorption theory is in danger of going by default.

W. E. L. BROWN.
Physiology Department,
University of Manchester, June 4.

A Puzzle Paper Band.

AN easy solution of the paper-band puzzle described by Prof. C. V. Boys in NATURE of June 9, p. 774, is obtained as follows: Hold the hand with thumb up and palm towards you; place the paper band over the index finger, letting the ends hang down. Observe which way the original four half-twists were applied. Treat the nearest of these to the index finger on the palm side of the hand as if it were that of an ordinary single half-twist band; which complete, by looping up one-half of the band over the finger (the other twists being pushed out of the way into the remaining half). Then apply the surfaces one upon another at the finger; and turn the other half of the band inside out so as to get rid of two of the twists. It will be found to fit exactly upon the first half, as required.

ANNIE D. BETTS.
Hill House, Camberley, Surrey, June 11.

Paradromic Rings.

PROF. C. V. BOYS, in his letter "A Puzzle Paper Band" in NATURE of June 9, p. 774, gives scant credit to the geometers. Forty years ago they described the endless band of paper with a half-turn twist in it, and found that if cut down the middle line it gave a single endless band with four half-twists. But they were so obsessed, he says, with the consequence of cutting down the middle line that they missed the result he now describes. This consists in taking a band with four half-twists and converting it by manipulation into a half-twist band of double thickness.

But the difference between the known result and the proposed novelty seems not more than trivial: for if the medially cut band has its adjacent half-widths simply slid sideways, one over the other, along the entire length of the band, the double-thickness band of half-width is at once produced. Or, reversely, if the pulleys of Prof. Boys are made twice as wide, and the outer band is teased sideways at its entry on to each revolving pulley, the two halves of the band will presently come edge to edge throughout and are then seen to be nothing but the half-twist band medially cut.

As regards this lateral shifting, it is obvious that any endless band, however much twisted and knotted, may, when cut down the middle, be continuously "shuffled," in the way in which a "pack" consisting of only two cards may be shuffled. Each neighbour slides over the other in perpetual oscillatory contact, alternately face to face and edge to edge. Two different superpositions and two different edge-to-edge positions occur alternately and cyclically. In particular, the band with four half-twists may be arranged as a two-ply half-twist not in one way only but in either of two ways. For either of the two different faces of the former may be completely exposed or completely concealed in the latter.

The sheer puzzle of the manipulation Prof. Boys plans to make even harder by varying the sense of the twists, as right-handed or left-handed. I should propose (somewhat on behalf of the geometers) to escape this difficulty by letting the paper discriminate for itself. The instructions would be these. Strip the band along, two-handedly, until the twists are concentrated on a short section. They come to form roughly a circular cylinder, showing two turns of a ribbon screw. Take two adjacent widths, touching helically edge-to-edge at any point, and fold them together as if closing an open book. Then feed the short circuit at the expense of the long loop until they come equal, and fit together by stripping. These operations may quite easily be done blindfold.

Prof. Boys says that the double band shows only two of the half-turns, and that it is amusing to find where the other two have gone. But this is *vieux jeu*: for Tait explained it in his first paper on "Knots" in 1877; and he was only following Listing, who had these things clear in his "Topologie" of 1847. If the paradox is still alive it may be reinforced, for those who do not know that torsion and curvature are convertible; for the double-twist may be hung over one finger as a festoon of three equal loops, with the six pendant planes all (approximately) parallel to the finger, and then not merely half but the whole of the twist appears to have gone.

In a parenthetic confession Prof. Boys admits that he made his discovery while lying awake one night; but this may almost be interpreted as an indirect testimonial to the day labourers.

G. T. BENNETT.
Emmanuel College, Cambridge, June 12.