

THE CONVEXITY OF WATER.

SIR,—I beg leave, as referee appointed by Mr John Hampden, to submit to you my report of the experiments made on March 5, 1870, on the "Old Bedford" canal.

FACTS.

In consequence of a challenge thrown out by Mr John Hampden, of Swindon, Mr Alfred R. Wallace agreed to "prove the convexity or curvature, to and fro, of the surface of a canal, river, or lake." The spot chosen was that portion of the "Old Bedford" canal between Old Bedford Bridge and Welney Bridge—a distance of six miles in a straight line.

An oblong signal 6ft. by 3ft. was placed on Old Bedford Bridge, its centre being 13ft. 4in. above the water. At three miles distance along the canal a staff was erected, having a red disc of wood 1ft. in diameter affixed thereto, the centre of which was also 13ft. 4in. above the water; and on Welney Bridge, three miles further, a third signal was placed, reaching the top of the bridge, 13ft. 4in. likewise above the water.

The observations were made by means of a large telescope (4in. object glass), and also to and fro, according to agreement, by means of a level by Stanley, Holborn, and were carried out from bridge to bridge the full six miles.

NOTE.—On the central signal staff there was a red disc already attached, which was allowed to remain 9ft. 4in. above the water, or 4ft. lower than the other.

OPINIONS.

1. The experiment as a whole is unsatisfactory and inconclusive, except to those who, in consequence of previous investigations, fully understand its real value.

2. A better experiment would be to have a small boat rowed from the place of observation to the end of the six-mile distance, and observe whether, and how soon, it would be lost to the observer's view, the observer being on the water at the height of the boat.

DEFINITIONS.

When the term "straight line" is used in this report it shall be considered to mean a line such as would exist if drawn at right angles to the plumb-line at the point of observation, and therefore a line such as would form a tangent to the sphere, if the earth be one.

When the term "level" is used it shall be considered in its ordinary mechanical sense, and not as understood by astronomers as being a curved line equidistant from the earth's centre.

THE VIEW IN THE LARGE TELESCOPE.

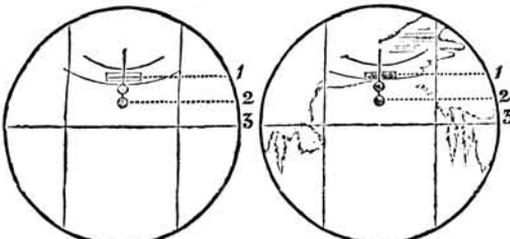
The view sketched by my co-referee, as seen in the large telescope, I signed under protest—my signature being subscribed to the protestation—that it was valueless in connection with the question at issue:—

First. Because it showed but two points when a comparison had to be instituted between three.

Secondly. Because it was not levelled, and therefore could not be said to have been in a straight line with either signal absolutely, though it might be said to have been so with each signal alternately, and for the sake of argument. And therefore, if it be said to have been in a straight line with the first signal, then the other and more distant signal, being apparently lower down, would be contrary to the state of things which Mr Wallace intended to prove, namely, that a central point was five feet higher than a straight line from end to end, as indicated in his diagrams. And if it be said to have been in a straight line with the second or more distant signal, it would tend to show that the central signal was certainly higher than the line of sight from end to end, as Mr Wallace intended; but, at the same time, it would show that that line of sight was not a line at right angles to the plumb line at the point of observation, which it should manifestly have been.

THE VIEWS IN THE LEVEL TELESCOPE.

1, Centre of signal; 2, centre of signal; 3, centre of telescope.



As seen by means of inverting telescope from Welney Bridge, March 5, 1870, 3.10 p.m.

This is correct, (Signed) M. COULCHER, W. CARPENTER.

View through inverting telescope from Old Bedford Bridge, March 5, 1870, 4.30 p.m.

This is correct, (Signed) W. CARPENTER, M. COULCHER.

ARGUMENT.

The stations appeared, to all intents and purposes, equidistant in the field of view, and also in a regular series: first, the distant bridge; secondly, the central signal; and, thirdly, the horizontal cross-hair marking the point of observation; showing that the central disc 13ft. 4in. high does not depart from a straight line taken from end to end of the six miles in any way whatever, either laterally or vertically. For, if so, and (as in the case of the disc 9ft. 4in. high) if it were lower or nearer the water, it would appear, as that disc does, nearer to the distant bridge. If it were higher, it would appear in the opposite direction nearer the horizontal cross-hair which marks the point of observation. As the disc 4ft. lower appears near to the distant bridge, so a disc to be really 5ft. higher would have to appear still nearer to the horizontal cross-hair of the telescope.

And therefore it is shown that a straight line from one point to the other passes through the central point in its course, and that a curved surface of water has not been demonstrated.

OBJECTIONS.

1. If it be decided that the curvature is proved in consequence of experiments that will not stand strict investigation or repetition, it would be unwise.

2. If it be decided that the curvature is proved because at first sight it would appear to be so, it would be jumping to a conclusion.

3. If it be decided that the curvature is proved because the objects at three and at six miles were not coincident with the cross-hair, since surveyors know that, with one of their ordinary levelling instruments, they could not be expected to be so, it would be unfair.

4. If it be decided that both objects seen were in fact lower down than the point of observation marked by the cross-hair, because by reverting the picture they would appear to be so, then, in the opposite view, the objects seen should, in like manner, have appeared higher up instead of lower down as in the first case, which is a dilemma.

5. If it be decided that the central disc was higher than either end point, then a series of signals placed at the same height—one at each mile—should not appear at regular distances (as they certainly would appear, in fact, if the experiment were tried), which would be a mistake.

6. If it be decided that the surface of water is a curved surface, then the terms "level" and "curved" would be synonymous, which is a fallacy.

7. If it be decided that the surface of standing water is convex, then standing water does not find its level, which is a novelty.

8. If it be decided that there is a rise from whatever part of the surface is made the point of observation, it would prove that, instead of us all being on the summit of the globe as we are said to be, the observer, at all events, is always just below it, which would be a contradiction.

canal, river, or lake, by actual demonstration and measurement, or in any other way whatsoever.—I am, &c.,

WILLIAM CARPENTER (Referee for Mr J. Hampden).
7, Carlton-terrace, Lewisham Park, S.E., March 14.

EXPLANATORY DIAGRAMS, by Mr COULCHER.

Showing the mode employed to demonstrate the convexity of the surface of water, as shown at the Bedford river, on March 5, 1870, by Mr A. R. Wallace.

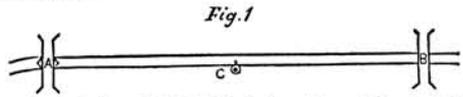


Fig. 1. Ground plan of Old Bedford river, from bridge to bridge.—A, Old Bedford Bridge, and B, Welney Bridge, six miles apart; C, the middle distance post.

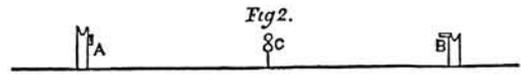


Fig. 2. Longitudinal section of the above.—A, position of signal on Old Bedford Bridge; B, position of telescope and signal on Welney Bridge; C, middle signal post.

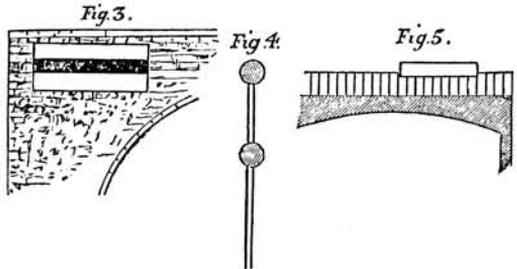


Fig. 3. Enlarged view of signal on Old Bedford Bridge.—The signal 6ft. wide by 3ft. deep, and the centre of the black line 13ft. 4in. above the water.

Fig. 4. Enlarged view of middle signal.—The discs 12in. in diameter, the centres 4ft. apart, and the centre of the upper disc 13ft. 4in. above the water-line.

Fig. 5. Enlarged view of Welney Bridge signal, 3in. above the top rail of the bridge, and 13ft. 4in. above the water-line.

The above sketches show the place and manner in which the experiments were made; and it was previously agreed between all parties concerned that the question at issue should be decided by means of the three signals here shown, and by observations taken at the two bridges.

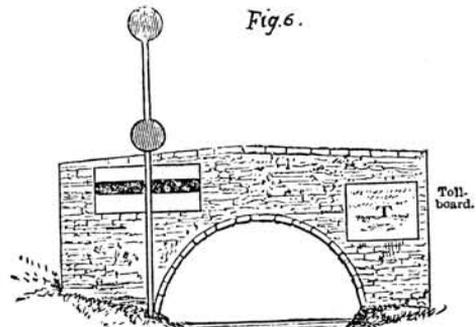


Fig. 6. Diagram, showing what was seen in an achromatic telescope of 4 1/2 in. object glass (power about 50), placed on Welney Bridge at 13ft. 4in. above water line, and directed towards the signal on Old Bedford Bridge. Drawn from rough sketch made on the spot by Mr Coulcher, and signed by Mr Carpenter.

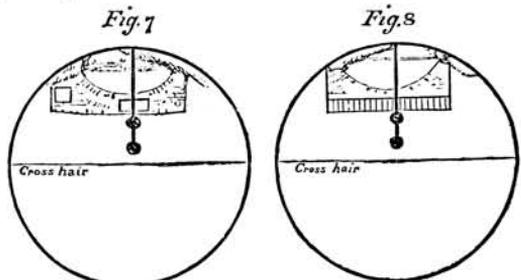


Fig. 7. Diagram, showing what was seen in the telescope of a sixteen-inch Troughton-level, accurately adjusted, and placed in the same position and height above the water as the large achromatic. The same objects are seen as in Fig. 6, but with a lower power and an inverting eye-piece. The sketch was taken on the spot by Mr Coulcher, one of the referees.

Fig. 8. Diagram, showing what was seen in the telescope of a sixteen-inch Troughton-level, accurately adjusted, placed at the side of Old Bedford Bridge, on the level of the signal, 13ft. 4in. above water-line, and directed towards the middle signal and Welney Bridge. Drawn from rough sketch taken on the spot by Mr Coulcher, one of the referees. The sketch, signed by both referees, is here annexed.

I hereby certify that Mr Alfred Wallace has demonstrated entirely to my satisfaction the convexity of the surface of water, by experiments shown on the Old Bedford river on the 5th day of March, 1870.

March 7. M. W. B. COULCHER, Referee,
A copy of this I gave to Mr Carpenter, referee for Mr Hampden.

DECISION IN HAMPDEN v. WALLACE.

THE undersigned having been appointed in writing by the principals concerned in the above bet (in default of the umpires, who could not agree) as referee, and having received the several reports of the umpires, Messrs Carpenter and Coulcher, and conferred on them with Mr Solomon, optician, of Albemarle-street, at the request of Mr Hampden, decides as follows:

Mr A. R. Wallace, by means of the experiment agreed on as satisfactory to Mr Hampden and his umpire by both of these gentlemen, has proved to my satisfaction "the curvature to and fro" of the Bedford Level Canal between Welney Bridge and Welch's Dam (six miles) to the extent of five feet, more or less. I therefore propose to pay Mr A. R. Wallace the sum of £1000, now standing in my name at Coutts's Bank to abide the result of the above bet, next Thursday, unless I have notice to the contrary from Mr Hampden. J. H. WALSH.
346, Strand, March 18.

9. If it be decided that there is a rise of five feet in three miles, a similar rise would have to be admitted on turning the telescope half round, and looking in the opposite direction, which would make the surface of the earth or water a series of arcs of a small circle, and which would be an absurdity.

10. If it be decided that there is a rise of five feet in three miles, a similar rise would have to be admitted in all directions from the point of observation, thus proving the said point to be the lowest point in a circular concavity, which would be a curiosity.

11. If it be decided that there is a curvature of five feet in six miles, then the accredited curvature—as put down by the highest authorities—being 24 feet in six miles, would require to be altered which would be a correction.

12. If it be decided that there is a curvature of but five feet in six miles, then it must follow that the earth is a much larger globe than it is believed to be, and this would be remarkable.

13. If it be decided that there is a curvature of only five feet in six miles, it is less than the amount intended to be shown, namely, five feet in three miles, which would be a failure.

CONCLUSION.

I therefore beg leave respectfully to submit that Mr Wallace has *not* proved “the convexity or curvature, to and fro, of the surface of any