ELASTICITY OF WIRES[1]

THE experiments described in this paper form a continuation of experiments undertaken in connection with the work of the Committee of the British Association for commencing secular experiments on the elasticity of wires.

Long-continued application of stretching force increases to a very great extent the tensile strength of soft iron wire. Thus in experiments described to the British Association in 1879 (see Report of the Committee just referred to), a particular very soft iron wire was shown to have a breaking weight 10 p.c. higher if the weight necessary to break it is applied half a pound at a time per day, than it has if the breaking weight is applied half a pound at a time at intervals of say two minutes. It was found also that this wire, quickly broken, extends before breaking by as much as 25 p.c. of its original length; whereas if the application of the stress is very slow, the extension is not more than 5 or 6, or perhaps 8 p.c. Further experiments have been undertaken on this subject, and are still in progress.

Using a continuous arrangement for applying the stretching weight and employing some very soft iron wire which had been specially prepared, and which was used in former experiments, the greatest weight which could be rapidly put on the wire without breaking it was determined. It was found that with a weight of 41 lbs. gradually applied in 6¼ minutes the wire stretched by 24·4 p.c. of its original length, and broke 18 minutes after the weight was put on. With the same weight, 41 lbs., applied in 6¾ minutes, the wire stretched 22·1 p.c. and broke in 24 minutes. With 41 lbs., however, applied in 7⅛ minutes, the wire stretched 18 p.c., and did not break. This weight, therefore, appeared to be just as much as the wire would bear with this method of applying the weight. Accordingly it was applied to a great number of wires for different lengths of time for the purpose of hardening them, and arrangements have been made for keeping a number of wires for very long times with this stretching force applied to them. The amount of extension produced by the application of the hardening stress was observed in each case.

After the hardening stress had been applied for a certain time the additional weight necessary to break the wire was determined, and also the additional elongation before breaking, which was in all cases almost insensible. The wires seemed permanently set in about forty minutes from the time when the hardening stress was applied. They did not alter in length till just before they broke, when they generally stretched 1 or 2 millimetres on a length of about 1,800 mm. The following table shows some of the results out of a great many that have already been obtained.

Length of wire used.	Hardening stress applied in pounds.	Time taken by continuous machine in applying the hardening stress in minutes.	Extension produced by application of hardening stress in p.c. of original length.	Duration of hardening stress in hours.	Total breaking weight after hardening.
150 cm.	41	6¼	24·4	Broke with 41 lbs.	
,,	,,	6¾	22·1		
,,	,,	9½	18·7	24	47·44
,,	,,	7	17·2	27	47·5
,,	,,	8	17·3	117	48·13
,,	,,	7⅛	18·1	790	52·31

Curves have also been obtained and were exhibited to the Section showing the extension with gradually applied weights both of a number of wires and of the different parts of the same wire; also curves showing the extension at different intervals of time from the beginning of an experiment in which the wire is running down under a weight sufficient to break it finally.

The author acknowledged the great assistance that he had received from Mr. A. C. Crawford and other students the in Physical Laboratory of the University of Glasgow.

Similar experiments are in progress on wires of copper and tin, and it is intended to test gold wire very soon, as it will probably give interesting results, and results very different from those given by soft iron wires.

[1] Strength and Elasticity of Soft Iron Wires. Abstract of a Paper read at the British Association, by J. T. Bottomley, M.A., F.R.S.E.

SPECTROSCOPIC NOTES, 1879-80.

DOUBLE Reversal of Lines in Chromosphere Spectrum.—The magnesium lines of the *b* group, and the two D-lines of sodium have been seen several times (first on June 5, 1880) *doubly-reversed* in the spectrum at the base of a prominence.

A bright line first appears in the centre of the widened dark lines; then this bright line grows wider and hazy at the edge, and a thin dark line appears in its centre, as shown in the figure. The phenomenon lasts usually from ten minutes to an hour. It is evidently the exact correlative of the double reversal of the bright sodium lines, observable in the flame of a Bunsen burner or alcohol lamp under certain circumstances when the quantity and temperature of the sodium vapour in the flame are greatly increased.

The H-lines in the Chromosphere and Sun-spot Spectra.—In 1872 I found the H- and K-lines to be reversed in the spectra of prominences and sun-spots, as observed at Sherman, 8000 feet above the sea. Until recently I have not been able to verify the observation, except for a moment during the eclipse of 1878. During the past summer, however, I have succeeded in seeing them again, and with suitable precautions as to shade-glass, adjustment of slit to true focal plane for these special rays, and exclusion of extraneous light, I have no further difficulty with the observation. The spectroscope employed has collimator and view-telescope each of 1¼ inches aperture, and about 13 inches focal length, and a speculum-metal Rutherfurd grating with 17,300 lines to the inch. A shade of cobalt-blue glass greatly aids the observation. The solar image is 1¼ inches in diameter.

In the spectrum of the chromosphere, H and K are both *always* reversed. I have never failed to see them both when circumstances were such that *h*, the nearest of the hydrogen lines, could be seen.

Furthermore, H, in the chromosphere spectrum, is *always double:* that is, a fine bright line always accompanies the principal line, about one division of Ångström's scale below. The principal line seems to be exactly central in the wide dark shade, the other is well within the nebulosity. K on the other hand shows no signs of duplicity.

In the spectrum of a sun-spot H and K are also, both of them, generally, though not always, reversed; and the reversal is not confined to the spot, but covers often an area many times larger in its neighbourhood.

In the spot spectrum, however, H has never yet been seen double. The companion line of H is therefore probably due to some other substance than that which produces H and K; a substance prominent in the chromosphere, but not specially so in the neighbourhood of spots. In view of the recent observations of Vogel, Draper, and Huggins, it is natural to think that hydrogen is probably the element concerned. If so, it may be expected that H will be found doubled in the spectrum of a spot which reverses the hydrogen line *h*. I have not yet been able to test it in this way, as *h* is rarely seen reversed, though C and F occur pretty frequently.

[*Note.*—An observation made since my paper was written leads me to modify this opinion, that the companion of H is due to hydrogen, and satisfies me that in all probability both H and K must themselves be hydrogen-lines. At 11 A. M. on October 7, a bright horn appeared on the S.E. limb of the sun. When first seen it was about 3′ or 4′ in elevation, but it rapidly stretched up, and before noon reached a measured altitude of over 13′ (350,000 miles +) above the sun's limb. It faded away and disappeared about 12.30. It was brightest about 11.30 with an altitude of about 8′ and at this time both H and K were distinctly, and for them, brilliantly reversed in it clear to the summit. H was not double in it to any notable elevation, though the companion of H was visible at the base of the prominence. The H- and K-lines also showed evidence of violent cyclonic action, just as C did. *h* was only faintly visible in the prominence; F and the line near G were of course strong. But no other lines, either of sodium, magnesium, or anything else, could be traced more than a very few seconds of arc above the sun's limb. I am not able to say how long the H-lines continued visible, or to what elevation they extended afterwards, as I returned to the C-line to watch the termination of the eruption. If I remember rightly, this eruption reached a higher elevation than any before observed. There was (and is to-day) nothing on the sun's limb visible with the telescope which would account for it.—Princeton, October 8.]