VI. *On a new photometer, with its application to determine the relative intensities of artificial light, &c. By* WILLIAM RITCHIE, *A. M. Rector of the Academy at Tain. Communicated by the President.*

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1. IN a paper which I lately communicated to the Edinburgh Philosophical Journal, I endeavoured to show, that caloric flies off from the surface of a heated body by the repulsive energy existing between its own molecules, and consequently, that their velocity increases with the temperature of the body. This conclusion I deduced from the fact, discovered by DELAROCHE, that invisible caloric freely permeates very thin plates of glass, in the same manner as light, but that it is completely intercepted by thicker plates. If the temperature of the body be raised, the atoms of caloric will be brought nearer each other, their repulsive energy augmented, their velocity increased, and consequently, they will now find their way through a plate of glass which formerly intercepted them. If the temperature of the body be raised still higher, the molecules of caloric will acquire a velocity sufficient to permeate the various humours of the eye, and produce an impression on the retina, or in other words, they will become light. From this view of the subject, I was naturally led to the invention of an instrument which would be affected by visible caloric or light, whilst

it would not be sensibly acted upon by invisible coloric, or heat.

In short, I was led to the invention of a photometer, which appears to be the most accurate and delicate which has yet been described. But though such were the theoretical views which led to the invention of the instrument, its perfection does not depend upon any peculiar theory of light and heat. It is founded on the axiom, that equal volumes of air are equally expanded by equal quantities of light, converted into heat by absorption by black surfaces: and also on the well established principle that the quantity of light diminishes as the square of the distance of the luminous source from the object on which it is received.

2. The instrument consists of two cylinders of planished tin plate from 2 to 10 or 12 inches in diameter, and from a quarter of an inch to an inch deep. One end of each cylinder is inclosed by a circular plate of the same metal soldered completely air tight, the other ends being shut up by circular plates of the finest and thickest plate glass, made perfectly air tight. Half way between the plates of glass and the ends of the cylinders, there is a circular piece of black bibulous paper for the purpose of absorbing the light which permeates the glass, and instantly converting it into heat.

The two cylinders are connected by small pieces of thermometer-tubes which keep them steady with their faces parallel to each other, but turned in opposite directions, and also serve to make the insulation as complete as possible. The chambers are then connected by a small bent tube in

the form of the letter U, having small bulbs near its upper extremities, and containing a little sulphuric acid, tinged with carmine. The instrument is supported upon a pedestal, having a vertical opening through the stem to allow the glass-tube to pass along it, and thus secure it from accidents.

A small scale divided into any number of equal parts, is attached to each branch of the tube. In the annexed figure, Plate XII. ABCD and EFGH are the cylinders, AB and FG the plates of glass. CD, EFG the ends shut up by the circular tin plates, the blackened paper is represented by the lines between AB, CD and EH, FG. The other parts will be obvious from the mere inspection of the figure.

3. The accuracy of the instrument evidently depends upon the perfect equality of its two opposite ends. To ascertain, if it be accurately constructed, place it between two steady flames, and move it nearer the one or the other till the liquid in the tube remains stationary, at the division of the scale at which it formerly stood. Turn it half round without altering its distances from the flames, and if the liquid remains stationary at the same division, the instrument is correct. To show the extreme delicacy of the instrument, place it opposite a single candle, and it will be sensibly affected at the distance of 10, 20, or 30 feet, provided it be of sufficient diameter, whilst it will not be sensibly acted upon at the same distance by a mass of heated iron affording twenty times the quantity of heat. In order to cut off effectually the influence of mere radiant heat, I sometimes use screens composed of two plates of glass, placed parallel to each other, with a quantity of water interposed.

4. Place the instrument between any number of steady lights whose intensities are known, as for example, between four wax candles opposite one end, and one candle opposite the other, and move the photometer till the fluid remain stationary at the division where it formerly stood, and it will be found that the distances are directly as the square roots of the number of candles; or in other words, that the intensities of the lights will be inversely as the squares of the distances. If gas lights be employed, having burners capable of consuming known quantities of gas in equal times, and the photometer be placed between them, so that the effect upon the air in each chamber shall be the same; it will be found that the quantities of gas consumed by each, will be exactly proportional to the squares of the distances of their respective flames from the ends of the photometer.

5. This instrument seems well adapted for determining the relative quantities of light given out by the combustion of coal and oil gas. Place the instrument as before between the two burners, and ascertain the relative intensities of the two lights, by squaring their distances from the adjacent ends of the instrument; ascertain the quantities of gas consumed by each of the burners in the same time; multiply these quantities by the squares of the respective distances, and the product will be the relative quantities of light, afforded by the gases. Let d be the distance of the coal gas light and d' that of the oil gas light; and let q be the quantity of coal gas consumed in a given time, and q' the quantity of oil gas consumed in the same time, then the intensity of the coal gas will be to that of the oil gas $q\ d^2$ to $q'\ d'^2$.

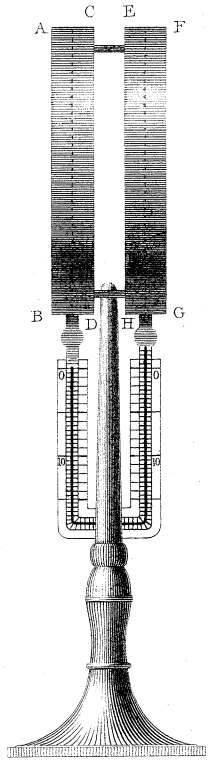
6. To find the ratio between the quantities of light given

out by the sun, and that afforded by a common candle, place one end of the instrument opposite the sun, and bring the candle opposite the other end, till the fluid in the stem remain stationary at the original division, and the light given out by the candle, will evidently be to that given out by the sun, as the square of a few inches to the square of the number of inches contained in 95,000,000 miles, provided none of the sun's light had been absorbed in its passage through the atmosphere. The delicacy of the instrument is such, that if it be placed opposite the sun without a counteracting force, the light absorbed from the body will be so great as to cause the liquid to move through a tube 20 or 30 feet long. By covering one end of the instrument, and directing the other to various quarters of the sky, we can ascertain the relation between the quantities of light reflected from the atmosphere, and clouds floating in those regions.

I am just now constructing a photometer about two feet in diameter, and two or three inches deep, with which I hope to appreciate the effect of heat in the feeble rays of the moon.

7. Though this instrument has some resemblance to Professor LESLIE's photometer, yet it is founded on principles essentially different. The one depending on the *difference* of the temperatures of the two bulbs, whilst the perfection of the other results from the equality of the temperature of the air contained in both chambers. The one has a scale a few inches long attached to one branch of the bent tube, whilst the scale of the other is the distance between the two antagonist flames. The delicacy of the one is, from its very

nature, confined within very narrow limits, whilst that of the other may be increased at pleasure. There are numerous problems which this photometer is capable of solving, and which, if this paper be favourably received, may form the subject of future communication.



Js. Basire, fc.