far to seek. We would submit that many easy ways suggest themselves of avakinng a sluggard without need of molesting the sleep of his just, and presumably virtous, neighbour. There be, in manifold variety, clock-alarums, clepsydras, sand-glasses, and galvanic appliances, which are fully competent to privately admonish a slumberer, without any public scandal; not to speak of the old English method, by which an active lad gained a weekly wage by ringing the house-bells of his heavier-sleeping comrades. In one word, there is a right and a wrong in this matter of the bell-ringing, as science has made plain. It is not in the least a question to be determined to-day or to-morrow by the votes of interested parties; for the correct and the final solution of it was written long ago, in the name of eternal justice and the immutable fitness of things.

ON AN ALLEGED EXCEPTION TO THE SECOND LAW OF THERMODYNAMICS.

According to the received doctrine of radiation, heat is transmitted with the same intensity in all directions and at all points within any space which is void of ponderable matter and entirely surrounded by stationary bodies of the same temperature. We may apply this principle to the arrangement recently proposed by Prof. H. T. Eddy[1] for transferring heat from a colder body A to a warmer B without expenditure of work.

In its simplest form the arrangement consists of parallel screens, which are placed between the bodies A and B, and have the form of very thin disks with certain apertures, and the property of totally reflecting heat. These disks, or screens, are supposed to be fixed on a common axis, and to revolve with a constant velocity. For the purposes of theoretical discussion, we may allow this velocity to be kept up without expenditure of work, since we may suppose the experiment to be made *in vacuo*. If the dimensions and velocity of the apparatus are such that the screens receive a considerable change of position during the time in which radiant heat traverses the distances between them, the apertures in the screens may be so placed that radiations can pass from A to B, but not from B to A. It is inferred that it is possible, by such means, to make heat pass from a colder to a warmer body without compensation.

In order to judge of the validity of this inference, let us suppose thermal equilibrium to subsist initially in the system, and inquire whether the motion of the screens will have any tendency to disturb that equilibrium. We suppose, then, that the screens, the bodies A and B, and the walls enclosing the space in which the experiment is made, have all the same temperature, and that the spaces between and around the screens and the bodies A and B are filled with the radiations which belong to that temperature, according to the principle cited above. Under such circumstances, it is evident that the presence of the screens, whether at rest or in motion, will not have any influence upon the intensity of the radiations passing through the spaces between and around them; since the heat reflected by a screen in any direction is the exact equivalent of that which would proceed in the same direction (without reflection) if the screen were not there. So, also, the heat passing through any aperture in a screen is the exact equivalent of that which would be reflected in the same direction if there were no aperture. The quantities of radiant heat which fall upon the bodies A and B are therefore entirely unchanged by the presence and the motion of the screens, and their temperature cannot be affected.

We may conclude *a fortiori* that B will not grow warmer if A is colder than B, and none of the other bodies present are warmer than B.

Since the body A, for example, when the screens are in motion, does not receive radiations from every body to which it sends them, it is not without interest to inquire from what bodies it will receive its share of heat. This problem may be solved most readily by supposing the screens to move in the opposite direction, with the same velocity as before. One may easily convince himself that every body which receives radiant heat from A when the apparatus moves backward, will impart heat to A when the apparatus moves forward, and to exactly the same amount, if its temperature is the same as that of A. J. W. Gibbs.

[1] Journ. Frankl. inst., March, 1883.

PHOTOGRAPHIC FOCUSING.

Considerable discussion has arisen of late as to the propriety of focusing with a large stop, and then using a much smaller one with which to make the exposure. Most of those who have written upon the subject have assumed that it was merely a question of spherical aberration. It seems to the writer, however, that spherical aberration has little, if anything, to do with it, as, in lenses constructed on the modern curves, this defect has been practically reduced to zero. If now we take a perfectly corrected, wide-angled lens, and focus it on the centre of the plate, we shall find that the objects near the edges are somewhat indistinct, and by no possible combination of curves can this difficulty be wholly remedied; it is, however, reduced proportionally to the size of the stop employed. It has been shown, by Prof. E. C. Pickering and Dr. C. H. Williams (*Proc. Amer. acad.* 1875, 300), that, with a single lens, a series of concentric circles would be focused on a spherical plate whose radius of curvature was 0.7 the focus of the lens. On the other hand, the diameters of these circles could only be accurately focused on a spherical plate whose radius of curvature was 0.3 of this focus. As far as the writer is aware, no name has ever been given to this optical defect; but for convenience' sake it might be called the *field aberration*.

If the central object on the plate is of the most interest, we shall focus on it, and then push in the plate as far as possible without injuring the central definition, to obtain the best possible result at the edges. Supposing now we insert a smaller stop, the definition over the whole plate will be improved certainly; but, that at the centre having been sufficiently sharp before, we can now afford to push in the plate a little farther still, and obtain better definition at the edges, without perceptibly injuring that at the centre. Therefore, on theoretical considerations merely, we should always focus with the stop we are going to use. But, on the other hand, for lenses of less than 45° angle, or when the illumination is very faint, the practical advantage of a bright image for focusing would more than compensate for the advantages of using the other stop. In practice, for accurate work, the best way would be to determine once for all the difference of focus required by each stop, and then focus with the largest, and apply the proper correction, depending on the stop used.

W. H. PICKERING.

HISTORY OF THE APPLICATION OF THE ELECTRIC LIGHT TO LIGHTING THE COASTS OF FRANCE.[1]

II.

THE Serrin regulator, arranged for alternating currents, has been adopted as the standard lamp. No other apparatus has given better results. Especially with alternating currents, its working is excellent, because the armature of the electro-magnet detaches itself very easily; and besides, as the consumption of both carbons is uniform, the arc remains absolutely fixed.

The machines for generating the current have been of late years the subject of attentive study, which has been unfortunately confined to three types, — the Alliance, Gramme, and de Meritens. The luminous intensities of each of these machines have been measured under carefully arranged conditions. Photometric measurements in such cases are rather delicate. To make them, since the intensity varies in the vertical direction with different heights, a movable mirror is used, which is placed at different heights in the same vertical plane, and which, in each position, throws the rays on the photometer; and thus the average intensities could be obtained. But, as the intensity of the electric light constantly varies, it was necessary to make the observations at one-minute intervals for each position of the mirror. It is not necessary here to go into the details of construction of the different machines; the table below gives the results obtained.

MACHINES.	Number of revolutions per minute.	Horse-power.		Luminous intensity.	
		Total.	Less power used in transmission.	Total.	Per horse-power.
				Carcels.	
Alliance	450	5.18	4.62	275	59.5
Gramme, No. 1 .	550	12.04	11.48	1,010	88.5
" No. 2 .	600	6.01	5.45	493	90.0
" No. 3 .	680	7.06	4.20	342	81.4
De Meritens . .	790	8.06	7.50	536	84.8

It will be seen, that the Alliance machine gives a far less intensity per horse-power than the two others, which are approximately equal. The de Meritens has certain characteristics of stability and solidity which the Gramme machine does not possess; it was, besides, preferred to use alternating currents. For these reasons it has been adopted, and will be installed in all the new lighthouses.

The figures giving the intensity in the preceding table refer to the naked light. When this is placed in a fixed-light apparatus, these intensities become, in round numbers, 12,000 carcels with the Alliance, and 20,000 carcels with the Gramme No. 2. The flashes increase

[1] Continued from No. 5.