XL. The total radiation from a gaseous explosion

Prof. W.M. Thornton D.Sc. D.Eng.

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author has not been so successful with this method—the leaf occasionally adhered to the plate when so coated, and was usually broken in the attempt to remove it. Other coatings were tried and the method finally adopted was this:—a plate of carbon was cut from one of the rods used in arc lamps, and this was filed down until it was about 1.5 mm. thick; its length and breadth were the same as those of the brass plate. It was held firmly against the plate, and the ends were fixed in position by a small quantity of sealing-wax. This carbon surface has never given any trouble, and the electroscope has worked perfectly.

For a description of the special appliances for use with this instrument in order to demonstrate various ionization phenomena, the reader is referred to Prof. Zeleny's paper, where ingenious simple devices for showing the photo-electric effect, ionization by glowing solids, by X-rays, by radioactive substances, &c., are described. As the electroscope requires no attention it is particularly suitable for lecture purposes, but, so far, it does not appear to have come into common use in this country.

Royal Holloway College,
Englefield Green.

XL. The Total Radiation from a Gaseous Explosion. By Prof. W. M. THORNTON, D.Sc., D.Eng., Armstrong College, Newcastle-on-Tyne.*

1. **T**HE argument by which the lost pressure or suppressed heat of a gaseous explosion is made to depend upon the mechanics of two colliding and cohering spheres† may be extended to the case of radiation. Consider two atoms of equal mass m approaching one another with equal velocity v and having equal rotational and translational energies. The total energy of translation before collision is mv^2 , the rotational energy $I\omega^2$. The vibrational energy may be taken as zero at the moment before contact, for radiation is not important until there is chemical combination. The total loss of translational energy in collision, which is equal in the case considered to $\frac{1}{2}mv^2$, is shared between rotation and vibration. If equally shared, the rotational term

* Communicated by the Author.

† "The Lost Pressure in Gaseous Explosions," *Phil. Mag.*, July 1914, p. 20.

gains by $\frac{1}{4}mv^2$, and vibration is established, within or between atoms, having also energy of $\frac{1}{4}mv^2$.

The total radiation under these elementary conditions should therefore be 25 per cent. of the energy of combination, that is of combustion.

2. A complete theory of explosion must account for both the suppressed heat, found experimentally to be half that of combustion, and the energy radiated, which has been observed by Hopkinson and David to be 22 per cent. of the heat of combustion*. In the theoretical case of two equal colliding spheres these are respectively 50 and 25 per cent. of it. This simple conception therefore appears to be capable of explaining these two very important features of gaseous explosion. No reason *à priori* has been given for the radiation to be expected, and it is generally agreed that specific heats do not vary sufficiently to account for the loss of pressure.

3. According to this mechanical view an explosion may be regarded as

- (1) A process such as ionization by collision causing a loosening of the bonds of the molecule of combustible gas and of the oxygen molecule.
- (2) Attraction between ionized oxygen and combustible gas atoms resulting in a violent rush together, the total translational energy of which is the heat of combustion.
- (3) Formation of products of combustion having a mean translational energy one half of that of the combining atoms, mean additional energy $\frac{1}{4}$, and vibrational energy $\frac{1}{4}$ of it.

4. The interchange of energy between, say, rotation and vibration appears to be slower than between translation and rotation, for pressure is instantly checked in rising, whilst radiation up to the time of maximum pressure is only 3 per cent. of the total heat of combustion†. While the pressure remains nearly constant the gas continues to radiate, and is therefore, in the absence of prolonged combustion, receiving energy from the remaining degree of freedom, rotation. Any excess of rotational energy is shared between the other two terms, and in the process suggested there should be both persistence of pressure and of radiation.

* Phil. Trans. Roy. Soc. A. vol. cxxi. p. 375.

† Hopkinson and David, *loc. cit.*