Boltzmann law of total radiation already mentioned.

Planck's "action constant" has turned out a most useful quantity in all sorts of investigations, and although its actual nature is somewhat doubtful,[3] it may yet turn out to be, like the velocity of light, one of the fundamental constants of nature.

But before any quantum theory of radiant energy can be accepted, it must make its peace with those phenomena (chiefly diffraction and interference) which overthrew Newton's emission theory, and established the wave theory of light. That has not yet been done, or even attempted, so there is but little prospect as yet of a decisive battle. E. E. FOURNIER D'ALBE.

TRANSPARENCE OR TRANSLUCENCE OF THE SURFACE FILM PRODUCED IN POLISHING METALS.[1]

IN a communication to the British Association (B.A. Report, 1901, p. 604) it was suggested that all smooth metal surfaces are covered with an enamel-like transparent layer. In a subsequent communication to the Royal Society (vol. lxxii A, p. 218) the actual formation of a surface layer or skin by polishing was demonstrated. Two of the photo-micrographs in the latter paper, Figs. 5 and 6, plate 9, showed that minute pits on a polished surface of antimony had been covered over by a film of this description. It was suggested that the diminished reflecting power of the film covering the pits probably indicated that it had become translucent, but no direct evidence of this translucence was afforded by these particular observations. It was also suggested that the film might have been carried across the pits on a support provided by small granules or flakes which had filled up the pit to the level of the general surface. The purpose of the present communication is to record and illustrate certain recent observations which show:—

(1) That the film which covers the pits is transparent, or at any rate highly translucent, and

(2) That in the case of the smaller pits the mobile film has been carried across the empty pit without any support from below.

In the casting and working of copper, unless certain precautions are taken, the metal is always more or less spongy owing to the presence of gas bubbles. When the surface of this metal is ground and polished some of the gas bubbles are laid open and appear on the surface as tiny pits. If the cast metal has been subjected to cold working, by rolling or otherwise, the larger bubbles are distorted and take elongated and other varied forms.

By any method of polishing which will give a fair surface the pits are flowed over and obliterated, but by lightly etching the surface with a solvent the surface skin can be removed, and the pits are again disclosed. By careful regulation of the action of the solvent it is possible to remove the surface layer step by step, and the film covering the pits can be reduced to extreme thinness. Through this thin film one seems to be looking right into the pit. In polishing metal surfaces the amount of the metal which is removed by the polishing agent can be varied through wide limits under conditions which need not be specified here. It is sufficient for the present purpose to state that by suitable methods the skin developed on the surface may be raised to a maximum thickness or reduced to a minimum. For the present inquiry it was desirable that the film produced should be as thin as possible. The copper used in these experiments received its final polishing on fine linen stretched over a hard, flat surface, and moistened with one of the ordinary commercial brass polishing liquids. On the copper surface prepared in this way the pits, as seen under high magnification, appear as blue spots on the pale rose-coloured ground of the solid metal. While some of the film-covered pits appear uniformly blue, others show patches of red at various parts of their surface. When these red patches were first noticed it was supposed that they indicated a thickening of the film at these points to the extent necessary for normal reflection. More careful study has shown that the red patches are due to reflections from the inner concave surface of the pit. The beam of light from the vertical illuminator behind the back lens of the object glass of the microscope passes through the film covering the pit, strikes the concave metallic surface, and is reflected back through the film to the object glass and thence to the eyepiece. The reflecting surface of the pits is evidently far from optical perfection, and the reflected beam is therefore more or less broken up by irregularities of the reflecting surface.

By the use of autochrome plates it has been possible to obtain high power photo-micrographs in natural colours of pits on a copper surface. Four of these transparencies have been reproduced by the three colour process, and are shown on the plate issued as a supplement to this week's NATURE. Figs. 1 and 2 are at a magnification of 800 diameters, and 3 and 4 at 1800 diameters. In Figs. 1 and 3, the pits are covered by a blue film, but show patches of red on the blue. Figs. 2 and 4 show the same pits after the film has been dissolved and removed by a 10 per cent. solution of ammonium persulphate acting for 20 to 30 seconds. On comparing the members of each pair, 1 with 2, and 3 with 4, it is seen that the red patches in 1 and 3 correspond with the spots of light reflected from the concave surfaces of the uncovered pits as shown in 2 and 4.

It is clear that the pits which show these reflections from the under surface must have been practically empty when they were covered by the film, so that the film during its flow was quite unsupported from below.

The thickness of the films covering the pits is probably of the order of 10 to 20 micro-millimetres.

[3] It is an energy divided by a frequency, but has also been regarded as an angular momentum.

[1] Paper read before the Royal Society on February 12 by Dr G. T. Beilby, F.R.S.