able for examination, it is clear that the Dehra Dun value of g should be strengthened by a new direct determination of the difference Kew—Dehra Dun.

This could be made by sending the Indian pendulums back to Kew for a further set of observations to be made there, or, if the use of Invar pendulums is contemplated, then the new set of pendulums could be employed for this purpose. It is imperative that the value of g at Dehra Dun should be established so thoroughly as to be unimpeachable.

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November 29.

THE remarks by Mr. Oldham in NATURE of November 18, p. 665, relating to a suggested variation in gravity, are of great interest. As a result of measurements of g at Melbourne in 1913, a doubt as to the invariability of g relative to that at Potsdam was forcibly borne to mind. The report (Gravity Observations, British Antarctic Expedition, 1910–1913) which gives the results of the Melbourne measurements, has been delayed in the press, but it is felt that there is some evidence in this case of a lack of constancy in the value of g relative to Potsdam.

The problem is discussed in greater detail from another point of view in the Glaciological Report (Wright and Priestley), which is due to appear shortly.

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November 20.

Action of Cutting Tools.

IN the interesting letters by Mr. Mallock and Prof. Coker which have recently appeared in NATURE, some points of importance to the elucidation of the action of a tool when operating on materials have been raised.

Mr. Mallock appears to adhere to the view expressed in his paper of 1881 that the action is simply a phenomenon of shear. H. Tresca, however, two years after Mr. Mallock's paper showed in his classical and extensive "Mémoire sur le rabotage des métaux" (*Mémoires présentés par divers savants à l'Académie des Sciences de l'Institut de France.* Tome 27, No. 1,

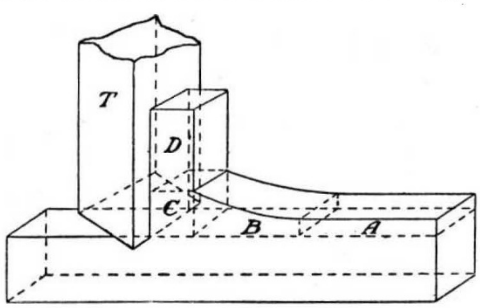

FIG. 1.

1883) that the phenomenon was primarily one of plastic flow. The periodic rupture of the chip which takes place is subsequent to the plastic flow stage and depends upon the nature of the material being operated upon, the angle the tool face presents to the advancing stream of material, and the velocity with which the material moves relative to the tool.

This stage of the action is complex and does not appear to be understood fully. The plastic flow stage, however, is comparatively simple.

In the diagram (Fig. 1) suppose that the tool T presents a plane face square to the advancing material. The portion A, which will ultimately form the chip D, as it approaches the tool begins to flow in region B, which is Tresca's *zone d'activité.* The flow reaches a maximum in the region C from which the chip or jet of metal D emerges, and Tresca in the light of the results of his remarkable and historical investigations on the flow and deformation of solids likens the action to the flow of the metal through a tube of shape ABC with its orifice open horizontally at the top part of C. Since no change in the density takes place the product of the co-ordinates xy (where the origin is at the tool edge) of a point on any surface in B and C continuous with a horizontal plane in A must be constant, so that the traces of these surfaces in the sides and also the free edges of B are hyperbolas.

This zone B can be seen in some of the beautiful photographs of cutting tools published by Mr. J. F. Brooks (Proc. Inst. Mech. Engrs., 1905, p. 365) and more especially in the last photograph of Plate 10. If now vertical lines be scribed upon the sides, the state of affairs during flow of a material which does not rupture for large body-shifts, such as lead, is represented by Tresca in Fig. 2.

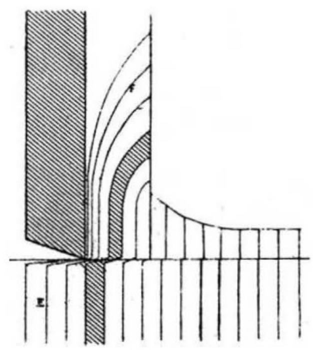

FIG. 2.

Here the maximum slide velocity is at the edge of the tool and in the horizontal plane through the edge. But one of the two important principles enunciated by Tresca is that during flow the maximum shear and maximum slide velocity are co-directional. We should therefore expect the material to rupture along this horizontal plane, and I think this can clearly be seen in Plate 11 of Brooks's photographs of the tool in action on mild steel.

Turning now to Prof. J. T. Nicolson's and Dempster Smith's experiments (*Engineer*, 1905, p. 358) and their diagram of the formation of a chip (Fig. 9), it may be seen that though the diagram is complicated by rupture phenomena and by the fact that the tool is acting on a wedge-shaped part of the forging, Tresca's representation of the plastic phenomena is well substantiated and the maximum shear is clearly seen in the initial stages.

The start of rupture along the horizontal plane is also clearly shown by Frederick Taylor in his presidential address before the American Society of Mechanical Engineers in 1906 (vol. 28), which is a monumental work on "The Art of Cutting Metals."

The same views are expressed by C. Codron in his extensive series of "Expériences sur le travail des machines-outils pour les métaux," published in the "*Bulletin de la Société d'Encouragement pour l'Industrie Nationale,*" 1903–1905.

The second important principle enunciated by Tresca, namely, the maximum shear across any face of a small right six face is a constant = K (Tresca's plastic modulus), together with the one already mentioned, enabled Saint Venant to develop the general equations of plastico-dynamics. If the mathematicians