

place is rendered by a dark shadow, an optically thin one by a light shadow. From the behavior of the shadowing, the behavior of the density variation can in turn be deduced. If the term "Shadow method", which is established in the literature, is perhaps not quite correct, then the pictures taken must be optically similar with high approximation to the actual ones. But since contrary views have been expressed whether Dvorak's method is really valid, we have made a large number of photographs by the Toepler schlieren method under the same experimental conditions, but we have not been able to establish any significant differences. To be sure, the Toepler schlieren method is considerably more sensitive than Dvorak's, although this was found to be a disadvantage in the present case, since the many irregularities only make precise measurements more difficult. The photographs by Toepler's method are, however, more beautiful to the eye. Figs. 1 and 2 (see Plates XI and XII), which were taken under the same conditions, illustrate this better than longer explanations. Finally, the electrical apparatus of the experiment, Fig. 3, and the method used by us to trigger the illuminating spark, maybe given in a few words.  $F_1$  is the illuminating spark gap, G the gun, and P the photographic plate.  $F_1$  is connected in series to one of two terminals  $F_2$  at the end of a battery of four Leyden jars, which are charged by an influence machine. The terminals  $F_2$  can be placed at any distance from the gun, and can be short circuited by the bullet. For larger distances from the muzzle, more than 200 cm., two wooden frames spanned with tinfoil are used, which were somewhat smaller than the bullet. For the smaller distances, at which the frame would be thrown about by the powder gas emerging from the muzzle in front of the bullet, that is to say, the tinfoil pieces would be torn, we used E. Mach's technique of crossed copper wire, on the ends of which were pushed small glass tubes, which were shattered by the bullet.<sup>1)</sup> The condenser C was charged up by the influence machine to such a

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1) The method used perhaps first by E. and L. Mach, shooting between two parallel bare copper wires (Bericht der Wiener Akademie, Abt. 2a, vol. 98, p. 1310, 1889), was prohibited in our case, since the hot powder gases could easily cause the discharge between the bare wires too early. With respect to closer details con-