A photograph that shows the compression lines as well as the flow lines, with the latter again made visible by unburned powder flakes, in the same way as before without shooting a bullet, is reproduced in Fig. 15. Furthermore, the elasticity of the surrounding air appreciably influences the position of the compression lines, as is shown by an experiment in which a wooden wall is placed below the bore-axis and quite near to the place where the compression CPC_1 exists. The resistance that this wall produces, gives the result that the part of the compression line CPC_1 lying in front of it toward the muzzle is bent there, as is shown in Fig. 16.

The formation of the flow pattern described above can also be obtained similarly to that of the Mach waves by means of a reversal of the experimental conditions. In the case of the previous apparatus, the gases flow out from the stationary gun muzzle. If the muzzle is now moved very rapidly against the stationary air, then the same flow pattern must be obtained. In fact, this is also the case if a hollow bullet[1] is used, and this photographed in free flight[2]. Fig. 17 shows that one of the earlier, similar compression patterns is formed behind the bullet.

Besides the previously-illustrated processes outside of the muzzle there occur peculiar contraction and broadening phenomena of the discharge itself, which will be briefly considered, although they were, in fact, in Fig. 13, which represents the form of the flow process at different times. While the shadow image of the discharge is sharply limited in the case of a photograph without a bullet, picture 1 of Fig. 13 shows a strong bulging-out which is brought about by the out-flowing gases. the density of these gases is so great that their shadow on the photographs cannot be distinguished from that of the surrounding air. This bulging, which is indicated only very faintly in the beginning, increases to a maximum. There is gradually formed in the center a contraction, (beginning in picture 2), which in turn increases for a time and attains its maximum value about in picture 3. Later, a dark point is formed in the middle of this contraction (pictures 5 and 6), until finally, at

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1) After preparation of this paper, we learned of a similar photograph that Hyde in North America had taken (Ordnance Pamphlet, Navy Dept., 1913).

2) A method for the triggering of the spark was used here which has been published by one of us in "Schuss und Waffe", vol. 6, p. 400, 1913.