

the process concerned, and frequently to give up these questions to numerical approximations.

Experimental Apparatus

A gun of 8 mm. caliber and its ammunition with smokeless powder was used. In general it was discharged with normal loading. Experiments with weaker loading and correspondingly lower pressures gave no significant difference in the behavior of the phenomena. Since this process took place in very short time intervals, it could be photographically recorded only by the use of spark photography. Furthermore, since the flow phenomena become evident principally through density changes, spark photography must be combined with schlieren methods, as had already become apparent in several of the above-mentioned earlier works. Two methods were available for this method, the Toepler schlieren method and so-called shadow procedure of Dvorak and Bodys. The latter method is one which, without any kind of an intermediate lens system, traces out a silhouette of the process on a screen brought quite close behind the orifice. Hence it is advantageous to use the smallest possible point source of light at a large distance. There is a most favorable distance for the photographic plate which is best found by trial.¹⁾ The air strata that are produced act like lenses, which briefly refract the light, so that behind an optically thick spot the air produces a dark shadow, while the surroundings are more or less bright. Therefore, in the photographs an optically thick

1) In general we had 90 cm. for the distance of the plate from the light source, and 10 cm. from the orifice. As a light source, we used a spark between magnesium electrodes, and, of course, the spark gap was so placed that the path of the spark was in the direction of a plumb-line from the spark gap to the plate, in order to attain a point-like action. If spark gaps are used in which the path of the spark is vertical to the line joining the spark gap and plate, then it is of great importance to see that the light glow, which always forms at the electrodes and is relatively slow, be covered up by suitable diaphragms. If this is not done, then it is easy to obtain somewhat indistinct pictures. In the case of the first-mentioned apparatus used by us, this error did not enter seriously in the phenomenon.