GUN REPORT NOISE[1]—ACTION OF THE MAXIM SILENCER AND THE DIFFERENCE BETWEEN REPORT NOISE AND BULLET-FLIGHT NOISE EXPLAINED.

By Hiram Percy Maxim.

[With 7 plates.]

When a gun is discharged it is the common idea that there is a single noise heard—the report noise. That such is not the case, and that there are two entirely separate and distinct noises has been proved in a very interesting manner by the advent of the Maxim silencer. The history of the research work which led up to this device is very instructive and well worth recording.

When the work was undertaken, at the beginning the object was to annul report noise so that concealment of position, partly attained by smokeless powder, would be completed. When the firing line became invisible there was only left the report noise to indicate its position and also its strength or number of guns.

To attain this object, it was thought only necessary to check the suddenness of the release of the high pressure powder gases into the atmosphere. This pressure, in the caliber 30 United States service Springfield rifle, was approximately 10,000 pounds per square inch, when the base of the bullet emerged from the barrel muzzle. A device must be found which would present an unobstructed path for the bullet, but this path must not be available to the gas, at least easily.

The search for a path which would give a bullet an absolutely unimpaired passage, and yet would check gas at 10,000 pounds pressure per square inch, was a long one. For a year it persisted without results. Its successful ending came in a very interesting though extremely prosaic manner. The essential element was a hole which would be pervious to a rifle bullet but impervious to high-pressure gas. One morning, after taking a bath and pulling the plug in the tub drain hole, the water was given an accidental twist and the

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familiar little whirlpool was created. It attracted the eye and finally the mind, since there was a hole through which water was passing but slowly, notwithstanding the fact that the drain plug was removed. In a flash the analogy was apparent. It was obvious that centrifugal force prevented the water from passing through the hole rapidly. If the powder gases in a gun were given the same vigorous whirling action, they would also acquire centrifugal force, and, if their outlet hole were located at or approximately at the center, they would exit relatively gradually. They simply could not exit until they had slowed down at least a little. The search was ended.

A little gas whirling device was quickly made and adjusted to the barrel of a rifle and the first shot fired was the first quiet rifle shot ever discharged from a high-power rifle.

When shooting was done in several different places, it began to be apparent that the noise depended upon the place, at least when a high-power rifle was used. It seemed to be impossible to eliminate a certain sharp "crack." The character of this crack was similar to a whiplash crack. It was entirely different from the more dull boom of the report. By accident it was found one day that this "crack" noise existed a long way down the range. A listener located at the 500-yard mark on a 1,000-yard range, detected the crack noise apparently overhead. This indicated immediately that it was connected with the bullet flight in some manner and was entirely separate and apart from the report noise.

Tests were made to bring out additional facts, and some of these are instructive. It was suspected that the bullet flight created a bow wave, creating a little zone of compressed air which moved out from the trajectory, and that this wave was heard by reflection. The person shooting the gun always heard a different noise from the person located at a distant point down the range. A terrain was selected on the extensive meadows on the Connecticut River bank below Hartford, where a series of clumps of bushes and small trees existed. There were three separate clumps in front of which the bullet from a Springfield service rifle could be made to pass. When the gun was fired, the listener at the gun heard three separate sharp cracks, and a low rattle of many minor cracks. This pointed fairly conclusively to the fact that the bow wave was reflected back from each of these clumps, and separate noises were heard from each, because they were separated by enough distance to give a distinguishable interval.

It was then thought that firing down a railroad track which ran along the open meadow, and had telegraph poles at regular intervals, would give a good test. This was done, and the result was a rapid succession of cracks, just as had been anticipated.

Then it occurred to the writer that if he could find a place to shoot where there would be no object from which reflection could occur, he ought to secure quiet shooting. It seemed a difficult condition to find until he bethought himself of getting up on a knoll away from trees and other objects and shooting straight up into the air. There would be no objects up in the air to reflect back the bow wave, and, if the theory were correct, such shooting should be almost entirely quiet. It was with much interest that a suitable place was searched out. One was finally found, and the first firings were felt to be of great moment. The first shot told the story, for the only noise was the puff of gas from the silencer, which sounded very soft and low. There was absolutely no bullet flight sound heard. The bow wave went on and on and never returned.

The next thing was to locate the limits of this bullet flight noise. It evidently persisted in certain guns while in others it never occurred, while in still others it occasionally occurred. Bullets from various cartridges were fired and it very soon developed that when the bullet velocity reached the velocity of a sound wave, the crack became noticeable. When the bullet velocity fell below the velocity of sound, there was no crack noise. The velocity of sound then appeared to be the critical point above which the ordinary bullet could never be fired quietly. It developed that the .22 caliber smokeless cartridges, except in the case of the long, gave quiet shooting, because their velocity was below 1,085 feet per second. The long cartridge appeared in some cases to be above this velocity though not always. There was evidently un-uniformity. The long rifle cartridge was always beautifully quiet, as was of course also the short cartridge. The .22 W. R. F. cartridge, which is a special high power, seemed to be just on the critical line. For example, in a box of 50 cartridges, about half would shoot without bullet flight noise, whereas the other half would make a loud crack. With all the larger caliber regular cartridges bullet flight noise occurred. By using special loads, they all gave quiet shooting. In some cases very heavy bullets were used, and the striking energy maintained in spite of the lower velocity. The reduced velocity of course reduced the distance at which accurate shooting could be accomplished. Two hundred yards always was possible, however, with bullet velocity of 1,000 feet per second, which is well inside of the critical point.

Before the question was considered settled, it was thought necessary to make various shaped bullets. Some were made of approximately perfect stream line shape. Others were made with a central hole all the way through the bullet. A copper gas check was used over the base when firing, and this fell off as soon as a bullet left the gun barrel. There never was a single piece of evidence upon which to hang a theory that the noise was in the slightest degree altered.

Then came the desire to actually see this peculiar manifestation and, incidentally, to conclusively prove the silencer. It was always a bit difficult to prove to the ordinary mind that the noise heard when shooting a rifle equipped with a silencer was made out in the air beyond the silencer and that the latter should not be held accountable.

The United States Navy, through their Ordnance Department, produced the best photographs which have been taken. These were made by mounting the gun in a dark room and setting up the camera with an open shutter along the line of bullet flight. Two wires leading from an electric condenser were dropped down directly beside the trajectory so that the bullet would short circuit these wires when it passed and create a spark, the duration of which was of radio frequency, possibly something approximately one five hundred thousandths of a second. This almost infinitely short exposure gave a clear photograph of the bullet and the variation in density of the air in the bow wave caused a variation in the refraction of the light, causing less light to fall where the pressure was high and more light where the pressure was low. Beautiful pictures of the noises made when the gun is discharged were obtained. Some of these are shown herewith. A series were taken showing the noises when the service rifle without silencer was fired and another series with the silencer. In the former, the report noise is shown, the birth of the bullet flight noise, and the bullet itself. In the latter the entire absence of report noise is shown and the very high efficiency of the silencer demontrated.

Plate 1 (photo I) represents the condition existing immediately following the emerging of the bullet at the muzzle of the Springfield rifle without silencer. The two vertical wires are shown and the bullet is enveloped in the mass of powder gases and can not be seen. The first wave appears to be made from a rush of air out of the muzzle and the main report noise wave is shown just back of it, being the broad dark line, irregular in places.

Plate 2 (photo J) represents conditions just a bit later. The bullet has emerged from a cloud of powder gases and has just begun the creation of its bow wave. It is shown puncturing the main report noise which shows particularly strong in this picture. By looking carefully the noise waves set up by flying particles of unburned smokeless powder can be seen.

Plate 3 (photo N) represents conditions still later and out beyond the disturbance of the blast of gas from the muzzle. The bullet flight bow wave has developed further and the greater velocity of the bullet over the report noise wave is very well shown. It is not plain at this time why the main report wave should be divided at the rear of the bullet. This completes the series of photographs taken without silencer.

Plate 4 (photo A) represents the first picture with silencer on the rifle. The bullet is shown emerging from the muzzle of the silencer, the bow wave of bullet flight noise is shown and there is absolutely no sign of any report noise. Indeed, there seems to be no disturbance created at all except the bow wave from the bullet.

Plate 5 (photo B) represents the conditions just a bit later. The bow wave and also a stern wave from the bullet is shown, the discharge from the silencer, but absolutely no report wave.

Plate 6 (photo E) represents a still later period, the bow wave being distinctly shown and the wake of the bullet. The stern wave has begun to disappear, for what reason it is not quite plain.

Plate 7 (photo F) represents a still later time and the wake of the bullet is the principle point of interest. This seems to partake of a spiral motion. The bow wave and the remnants of the stern wave are shown, but no report wave.

Having now shown the conditions existing at the muzzle of a firearm, equipped with a Maxim silencer, and proving as conclusively as seems possible that the noise of the gun is eliminated and that the only noise remaining is the bullet flight, we may ask the practical results. These have been very carefully studied from every imaginable angle. Field tests, accuracy tests, and tests at night have been conducted officially by war departments with bodies of troops equipped with silencers. Briefly summarized, these amount to the following:

1. The most important advantage on a shoulder rifle seems to be the diminution of sound on one's own firing line, which permits officers's commands to be heard during periods of the most rapid and concentrated fire. Without the silencer the human voice can not be heard.

2. The concealment of position of the firing line and the concealment of the number of guns comprising it. This is a natural advantage which might be imagined.

3. Improvement in marksmanship because of reducing the tendency to flinch. The elimination of the concussion entirely and the reduction of the recoil by 50 per cent makes the modern military rifle a much more gentle gun, and the rank and file in innumerable military tests always make higher scores than with the bare rifle.

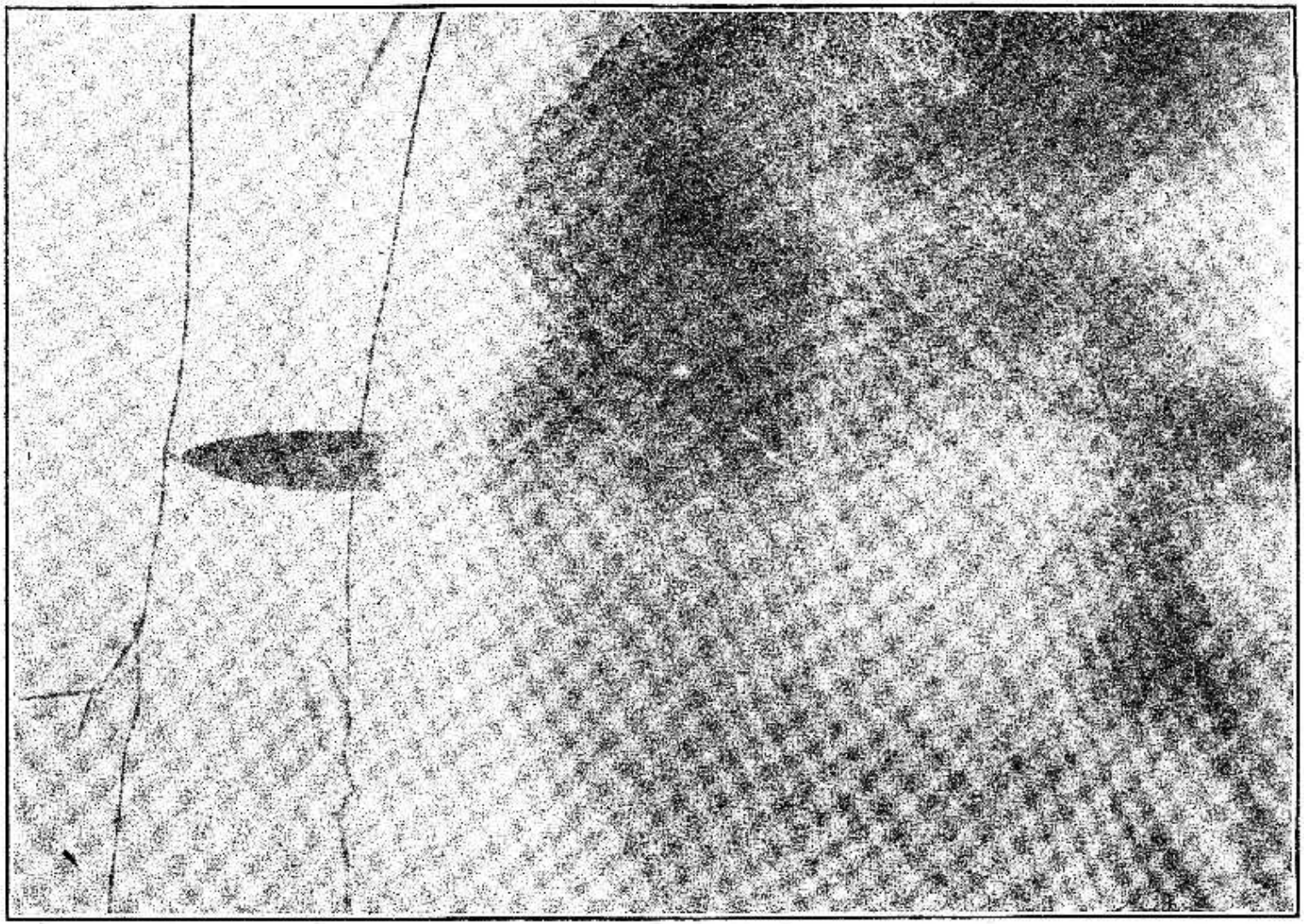
4. Elimination of muzzle flash at night makes location of the shooter invisible. This is supposed to constitute an important military advantage.

The aspects of a quiet shooting firearm in the case of assassins is of interest. We have seen that we can not secure quiet shooting unless we have bullet velocity below 1,085 feet per second. Except in 22-caliber this requires specially loaded cartridges for all calibers.

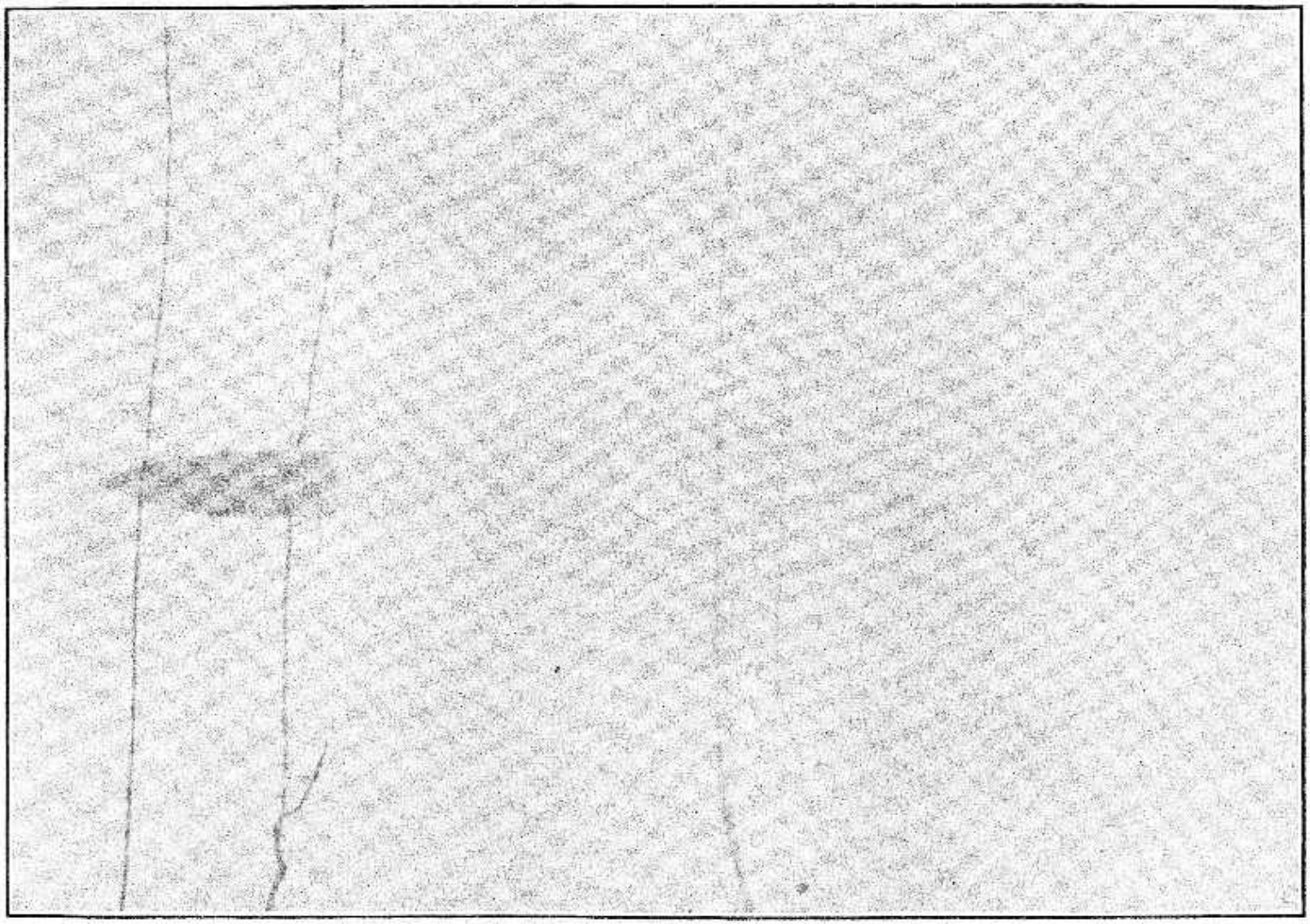
Furthermore, the silencer, being a gas check device purely and simply and applicable only to the muzzle, the ordinary revolver can not be silenced because of the joint between the cylinder and the barrel allowing the gas to escape if it is checked at the muzzle by the silencer. Thus the assassin's favorite arm is unsilenceable, to coin a word.

In the case of the automatic pistol it is almost an impossibility to attach the silencer and moreover the almost instantaneous opening of the breech permits a back blow and usually upsets the ejection of the empty shell enough to cause a jam. So we can not expect to see the automatic pistol silenced as things stand to-day. The assassin will have to design a small arm with a breech mechanism constructed on the lines of a rifle if he is to take advantage of any silencing device. Such a weapon does not exist at the present time.

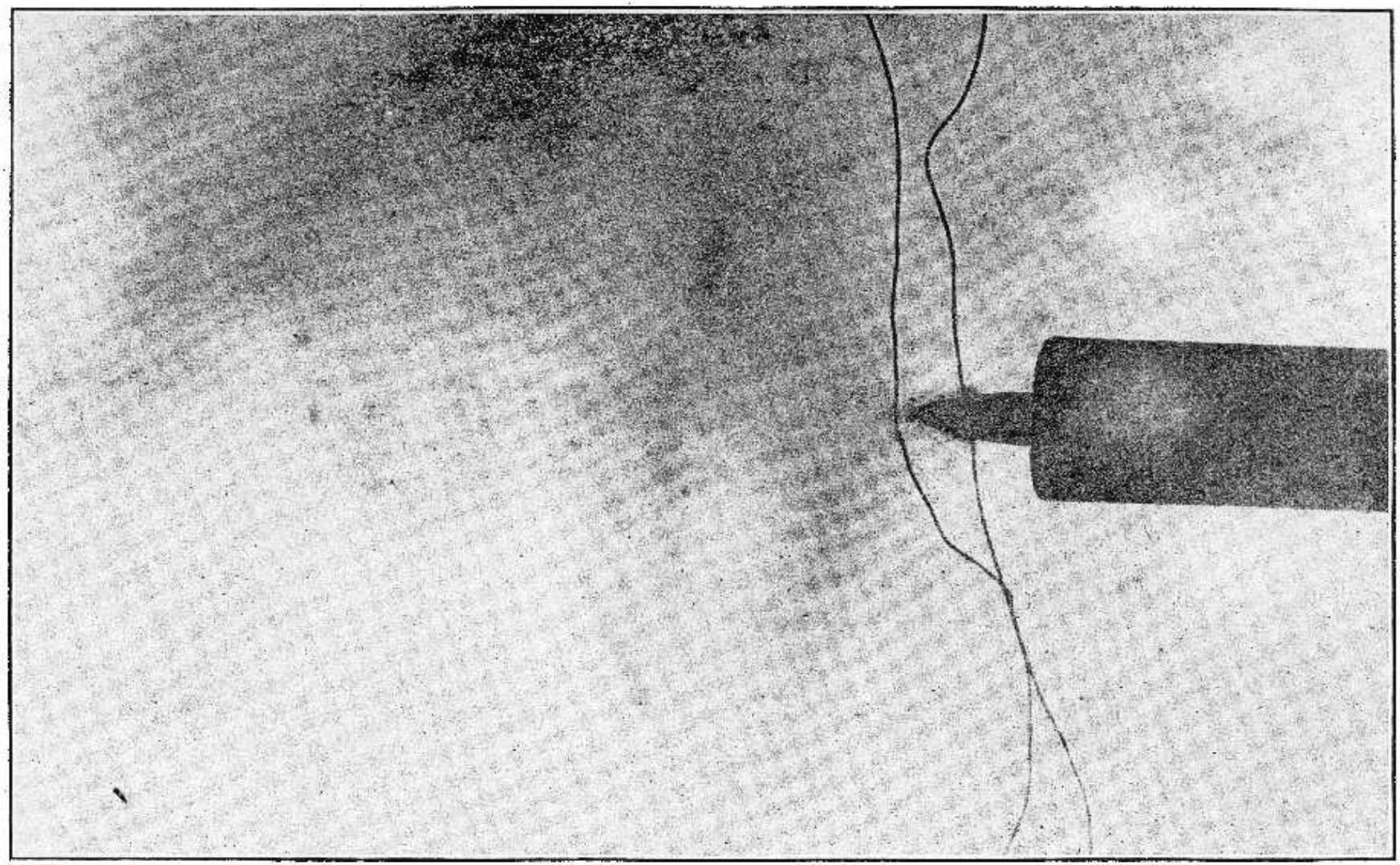
PHOTOGRAPH TAKEN DIRECTLY AT MUZZLE OF RIFLE WITHOUT SILENCER.



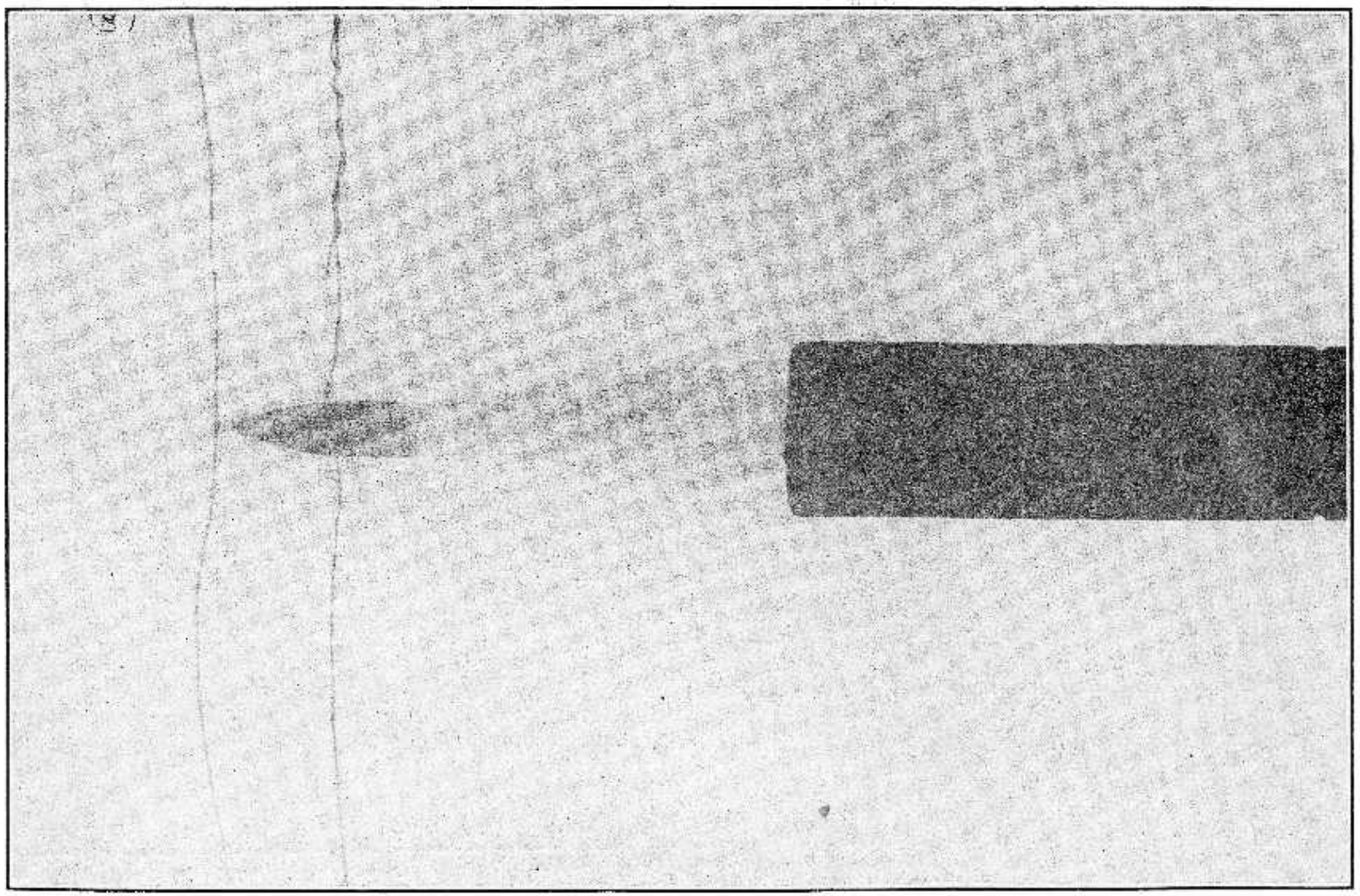
PHOTOGRAPH TAKEN ABOUT 4 INCHES FROM MUZZLE OF RIFLE WITHOUT SILENCER.



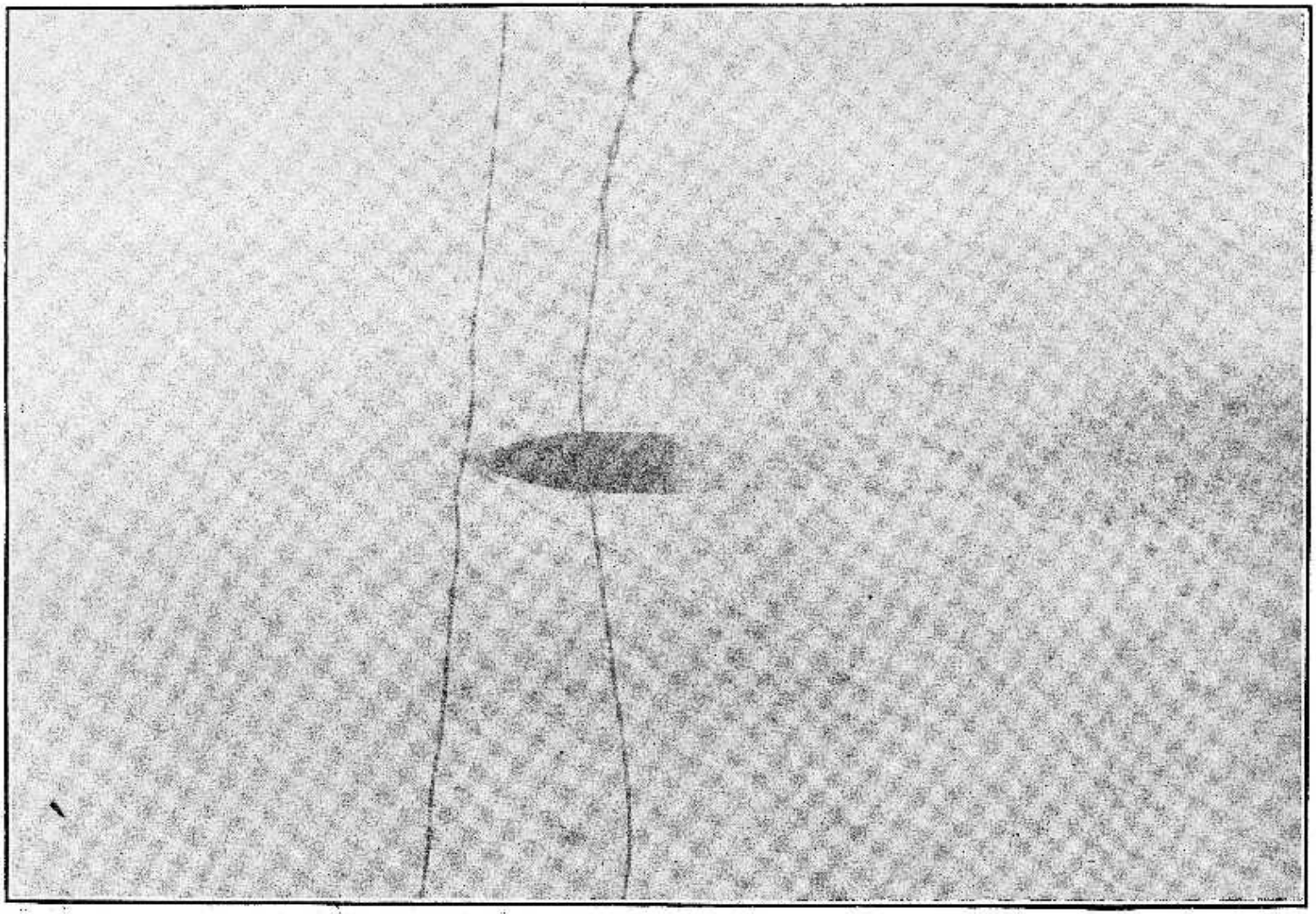
PHOTOGRAPH TAKEN ABOUT 8 INCHES FROM MUZZLE OF RIFLE WITHOUT SILENCER.



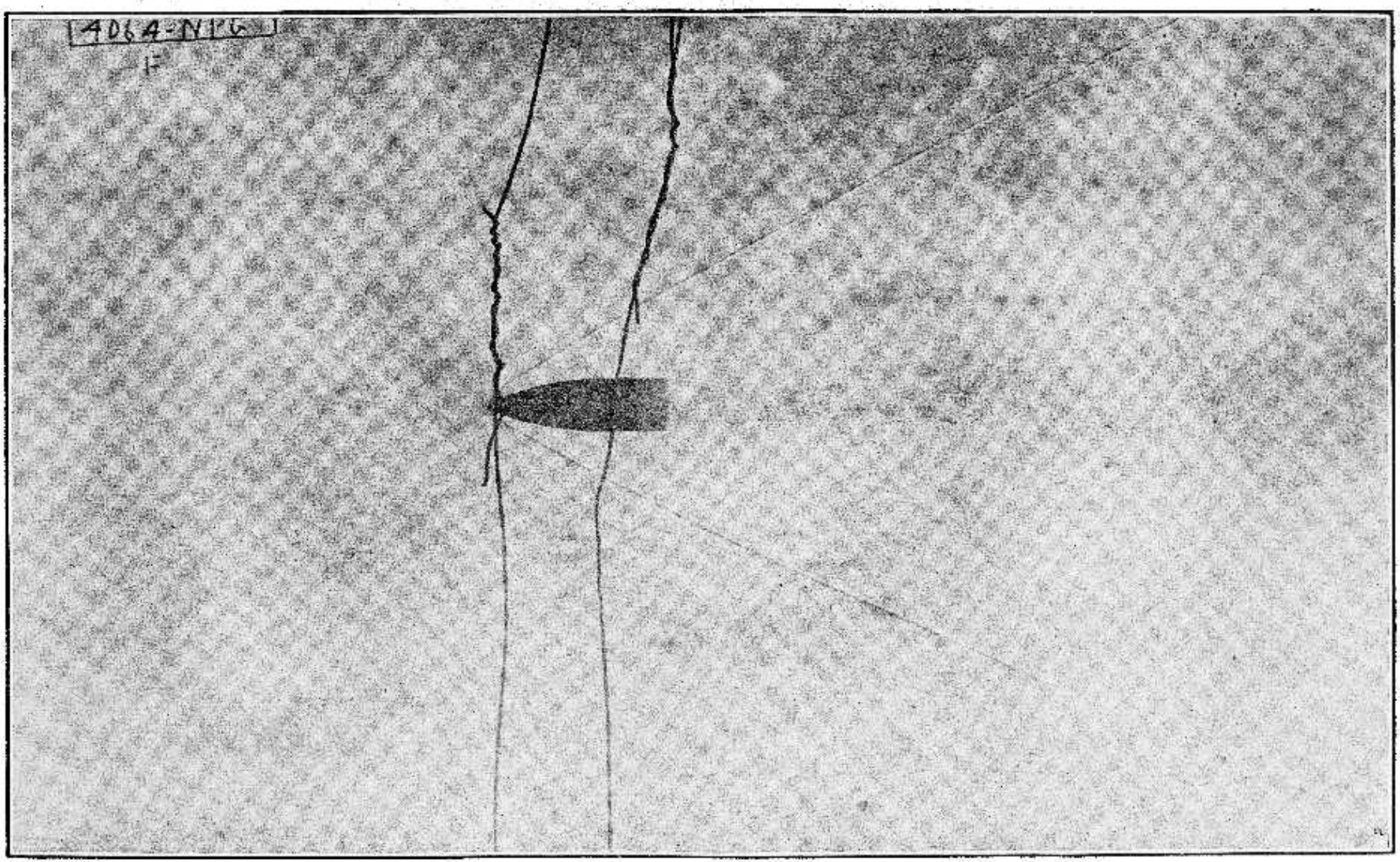
PHOTOGRAPH TAKEN DIRECTLY AT MUZZLE OF RIFLE WITH SILENCER.



PHOTOGRAPH TAKEN ABOUT 2 INCHES FROM MUZZLE OF RIFLE WITH SILENCER.



PHOTOGRAPH TAKEN ABOUT 6 INCHES FROM MUZZLE OF RIFLE WITH SILENCER.



PHOTOGRAPH TAKEN ABOUT 8 INCHES FROM MUZZLE OF RIFLE WITH SILENCER.