WEAPON-
AND
SHOOTING TECHNICAL GUIDE

for the Order Police

With over 400 Illustrations
4 Color and 2 black and Folding Tables*

Published and Edited on Behalf of the
Reich Leader SS and the Chief of the German
Police in the Reich Ministry of the Interior
by

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5th Improved and Expanded Edition

1944

Verlag R. Eisenschmidt · Berlin NW 7, Mittelstr. 18

***(Modified here as Single-Page Illustrations)**

English Translation
by
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"Special Equipment".

I. Shooting Instruction.

This shooting lesson is occupied with the movement of the bullet. The **inside** shooting lesson handles the causes of this movement: burning and the production of force of the powder and bullet movement in the barrel, while the **outside** shooting lesson in contrast concerns the movement of the bullet outside of the weapon.

When the powder charge is ignited in a loaded weapon, gases develop suddenly and violently that have the desire to quickly expand toward all sides (expanding force). The pressure cannot escape from the enclosed sides, only the bullet can escape through the barrel. The bullet receives its kinetic energy from the driving force of these powder gases.

Of paramount importance for this is that the combustion process is regulated by the correct advantageous use of the gas energy. Ignition, type and performance of the powder guide the bullet through the barrel. The length of the barrel and twist rate must complement each other.

Shooting processes in the weapon.

By pulling the trigger, the firing pin goes quickly forward, hits the primer and ignites its charge. The fire streams through two flash holes in the base of the shell and ignites the propellant charge (explosion), that is, the powder is transitioned from a solid to a gas. The gas instantly increases its volume and must try to escape somehow, however, since the burning area is enclosed by the air tight shell wall of the cartridge toward the rear and also to the sides, the gas must escape toward the front in the direction of the base of the bullet. The bullet is put in motion and with increasing power development, propelled through the barrel.

Two forces act on the projectile (bullet):

a) the gas pressure in the direction of the muzzle, and
b) the friction resistance on the barrel walls in the opposite direction to the direction of fire.

Considerably stronger than the frictional resistance at the barrel walls, there is a significant excess of force in the direction of the barrel muzzle, which very quickly, increasingly raises the speed of the bullet in the barrel. While the frictional resistance also represents a force-consuming obstacle to movement, which reduces the projectile speed – it should therefore not be too great, as this resistance is absolutely necessary for internal ballistic reasons so that the powder gases can develop the force necessary for the forward movement of the projectile at high speed. If the barrel resistance were too low, the bullet would give way too quickly to the pressure of the powder gases, the combustion area would increase undesirably quickly, and the pressure of the powder gases would not be able to develop high enough for the bullet to reach the desired initial velocity.

At first, the bullet starts its movement with zero speed, and then leaves the muzzle after a short time (after a few thousandth of a second) with a speed of several 100 m per second (with the Carbine 98k, the initial velocity is 755 m/sec.). The pressure of the powder gas acts quickly on the bullet, whereby the resistance in the barrel is overcome by the much stronger pressure the powder gas.

The proper bullet shape plays a decisive role for overcoming the air resistance and thereby also for the flight velocity. Extensive tests have shown, that the Spitzer {*pointed*} shape (German s.S. bullet) with a smooth outer surface is the most favorable.

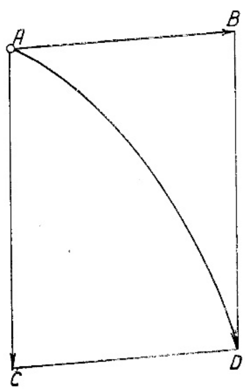
With the forward movement of the bullet in the barrel, the rifling cuts into the guide material of the bullet and is forced, corresponding to the rifling, to have a right spin in the lengthwise direction. This spin, called twist, prevents it from tumbling in the air {*gyroscopic stability*}.

The path that the bullet travels after leaving the barrel muzzle is called the flight path or bullet path.

While in the barrel, only the powder gas acts on the bullet, but now, outside the barrel, inhibiting forces appear that influence the further flight of the bullet and thus the bullet trajectory (see Fig. 1).

The Flight of the Bullet Path.

Under the influence of gravity, a free falling of the body moves with increasing velocity vertically toward the ground. The body is not only affected by the free fall, rather it is also affected by other forces (shock, pressure, yaw, drift, etc.), which give a speed in other (not vertical) directions, therefore its flight path depicts a more or less large curve. Its inherent energy and gravity determine its path. For explaining these actions serve the following examples with the sketch.



Body ***A***, that would fall due to gravity toward ***C***, however has speed, which moves it at the same time toward ***B***. It therefore does not move toward ***B*** or ***C***, but rather toward another point: ***D***. – It moves on the stretch ***A-B*** toward the side, and moreover as a result of gravity falls on the stretch ***A-C***. The new path ***A-D*** is arc-shaped, as the speeds relative to ***AB*** and ***AC*** are uneven.

The **flight path** in the (air filled) area, more precisely referred to as the trajectory of the bullet's center of gravity, is however a variable curve (see Fig. 3). This is broken down into an "ascending" and a "descending" branch, and is marked by the following features:

a) The angle of elevation compared to the muzzle horizontal is normally smaller than the fall angle; b) the bullet velocity is – with the same altitude – less in the descending branch than the initial velocity; c) the apex lies further away from the muzzle horizontal than the fall point; d) the flight time is greater in the descending branch than in the ascending branch, because with increasing distance, the bullet gradually loses speed (energy) by the external effects (gravity, air resistance, etc.); e) compared with a bullet in a vacuum, the bullet range, apex elevation, and flight time is less in the atmosphere.

The shape of the trajectory is determined by the following forces: 1. the initial velocity of the bullet, 2. the direction at which the bullet leaves the barrel, 3. gravity, 4. air resistance, 5. the spin rate of the bullet on its lengthwise axis, 6. the weather influences.

1. Velocity.

With velocity (flight velocity), one understands it is the distance, measured in meters, that a bullet (moving body) would travel in one second with consistent movement; the starting velocity is therefore the distance that the bullet would travel if it maintained the speed as when it left weapon.

Under the influence of the muzzle velocity alone, the bullet would fly in a straight line in the exiting direction. With just gravity, which causes an added falling during the flight, a curved line arises as the flight path, whose highest point in the middle and whose shape on both sides of the highest point are the same.

However, due to the wind resistance which continuously decreases the forward velocity of the bullet, the shape of the flight path changes, so that the curvature of the flight path is steeper with increasing distance. The highest point (apex) lies closer to the end than the start. Therefore the bullet range is shorter and the fall angle is greater than the starting angle, and the final velocity is slower than the initial velocity (see Fig. 3).

The muzzle velocity V_0 is usually measured 25 m (or 12.50 m or 50 m) in front of the muzzle (V_{25} etc.) with the help of a special apparatus. With s.S. {*schwere **S**pitzer = heavy-pointed*} bullets, the shooting table-like initial velocity with use of the Carbines 98a and k is 755 m/sec., and with the Pistol 08 is 320 m/sec.

The initial velocity is subject to fluctuations caused by the different influences in the barrel (differences in the diameter, wear), influences of the temperature and the humidity content of the powder, and by weight and caliber variations of the bullet.

2. The Direction.

The direction in which the bullet varies after leaving the weapon is determined by the angle that the extended axis of the bore makes with the tangent of the flight path; this angle, the initial angle, consists of both the sight angle and the departure error angle. The latter can be positive or negative. Therefore: The departure angle is + or – the departure error angle. The sight angle is made by the elevation differences of the rear and front sights and gives the barrel the position that is necessary for attaining a designated range. It is also the fall height, that the bullet would sink with falling back a certain path distance, taken into account from the outset by the sighting angle. The higher the sight is set, the more the barrel is elevated (the sight angle is increased) and the further the shot will fly.

If the rifle, during the bullet movement in the barrel, remains unchanged from the direction given by the sight angle, the sight and departure angles remain equal to each other. However, since the barrel material with firing the shot is set in vibration (twisting of the barrel material, stress on the parts of the weapon), the direction of the bore axis before the shot is usually not perfectly in line with the departure angle of the bullet (after it leaves the barrel). The departure fault is slight, it can however, depending on vibrations of the barrel, change and influence bullet dispersion.

The direction of the bullet is also changed by external influences. Stronger wind to the side, storms, and rain cause a more or less strong deflection toward the side and change the direction of the shot.

3. Gravity.

Gravity, the constant which always acts with the same strength on an unsupported body, produces an evenly accelerating movement in the vertical direction toward the midpoint of the Earth. The constantly increasing acceleration from second to second is 9.81 m, or about 10 m. A free falling body starts its movement with the speed of 0, after 1 second reaches a speed of about 10 m, after 2 seconds about 20 m, after 3 seconds about 30 m, etc. The **path** (the actual falling) is in the first second about 5 m (exactly 4.90 m) and with each passing second, is about 10 m more. From that, the **fall height**, that is, the fall length, can be determined after the course of several seconds (e.g. 5) by calculating the fall distance.

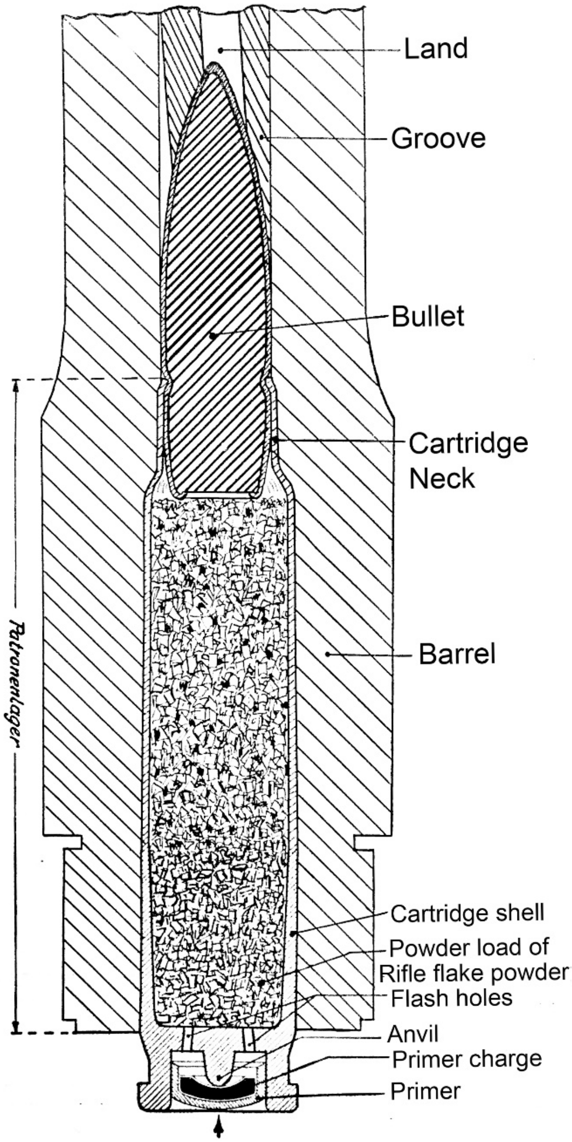


Fig. 1
Barrel and bullet
cutaway

Example: The path and fall distance for the first 5 seconds is:

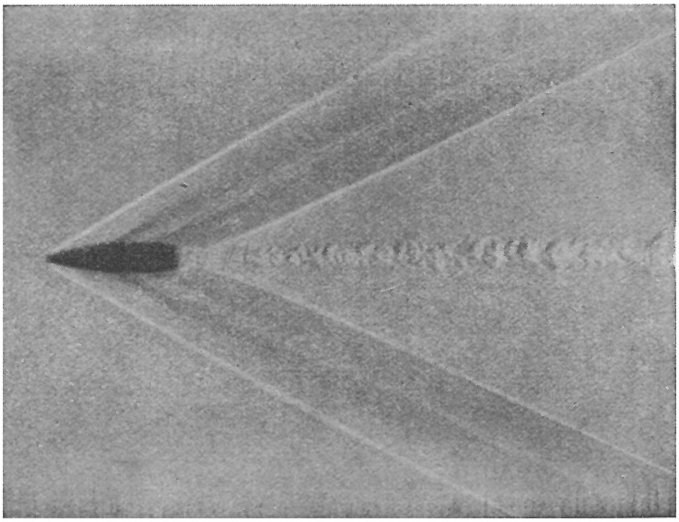
Path in the	1st	second	5 m,	fall height after the	1st	second	5 m.
“ “ “	2nd	“	15 m,	“ “ ” “	2nd	“	20 m.
“ “ “	3rd	“	25 m,	“ “ ” “	3rd	“	45 m.
“ “ “	4th	“	35 m,	“ “ ” “	4th	“	80 m.
“ “ “	5th	“	45 m,	“ “ ” “	5th	“	125 m.

After 2, 3, or 4 times the time, however 4, 9, 16 times the fall height will be attained {$time^2$ = *fall height*}. For the calculation, the formula: $h = \frac{g}{2} \times t^2$, where **h** is the fall height, **g** is gravity (9.81 or 110 m) – the fall acceleration in one second, and **t** represents the falling time in seconds.

4. Air Resistance.

The air, a gas mixture, resists the flying projectile. The projectile must shove aside the air particles during its movement. These accumulate in front of the projectile, so that in front of it, an air compression arises. The compressed air flies off toward the rear and increases the friction on the projectile walls. Behind the fast flying projectile arises an air-depleted space (suction) {*drag*}, that is on the base of the projectile and

Fig. 2



is longer, the faster the projectile flies. The suction generates a vacuum effect and impedes the flight of the projectile. Thereby, energy is constantly consumed, which is lost for use of the movement of the projectile. The flight speed of the projectile is always decreasing. Behind the vacuum is the so-called vortex trail, that is clearly visible in Fig. 2.

To reduce drag, the base surface of the projectile (e.g. with s.S. projectiles) is tapered toward the rear, whereby in particular, the oscillation and the center of gravity are taken into account. The conical bullet shape is mainly used for cartridges that are intended to achieve high speeds.

The amount of air resistance therefore depends on the speed and shape of the projectile, as well as the nature of the air.

The greater the speed of the bullet, the greater the air resistance. The latter increases approximately with the square of the speed, that is, with 2, 3, or 4 times the speed, the air resistance is 4, 9, or 16 times greater.

The nature of the air (air density) also influences the projectile movement. The more dense (thicker) the air, the greater the resistance, which causes shorter shots. Less dense air causes longer shots.

The air density decreases at higher altitudes, so that the air resistance is also reduced. Conversely, at low altitudes the air resistance is greater – because of the higher air density.

Stronger wind from the front lessens the shot range; wind from the rear increases it. Wind blowing from the side pushes the projectile toward the side. The longer the shot range, the farther the wind pushes it.

Wind direction and speed affect the shot direction, and more so with longer flight times and lighter projectiles.

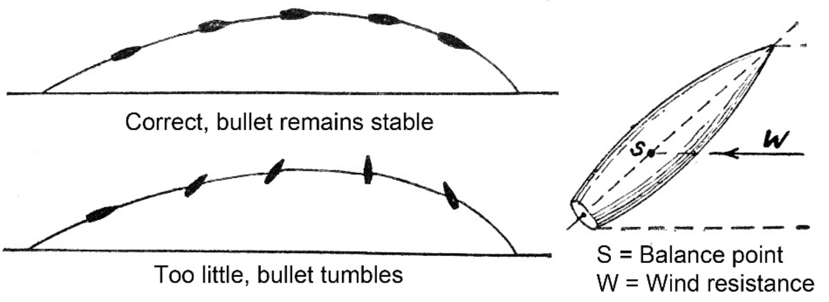
With a favorable projectile shape, as for example with the s.S. projectiles (pointed shape, tapered rear, see Fig. 2), the air resistance is kept to a minimum.

5. Projectile Spin.

By the action of the air resistance, a long projectile, shot from a smooth-bore barrel, tumbles across the course of the shot. The flight is irregular, the range is shortened, and the accuracy is poor. These disadvantages are avoided by the use of rifled barrels. In them, the projectile spins on its lengthwise axis due to the lands being impressed onto the projectile. Thereby is attained, that the projectile remains with the point toward the front and it strikes on the target with it.

If the rate of spin is properly chosen, and the rotation speed (number of revolutions) of the projectile is not too fast or too slow, then the projectile follows the flight path with its lengthwise axis tangent to the path, that is, the projectile remains "stable". If the rotation speed {*spin*} is too slow, then the air resistance grabs the balance point of the projectile and causes it to rise and roll over gradually (result: poor accuracy). Finally, if the rotation speed is too fast, the axis of rotation strives to maintain its position in space. The projectile no longer flies with the point forward on the flight path, but remains positioned somewhat forward. The air resistance is hereby increased and reduces the effect of the impact. See the following sketch.

Spin of the bullet



By the rotation, the projectile point is pushed toward the side toward the rotation, by the pressure of the air resistance. With our firearms with right twist, this is toward the right, however on small arms it is so small, that it is not generally considered.

During projectile flight, the rate of rotation gradually decreases due to the effects of air resistance.

The rotation speed is measured as the initial velocity (V_0) divided by the twist length. With the Carbine 98k, the V_0 is 755 m/sec., the twist length is 0.24 m; this results in a spin of 3145 rotations per second: or about 630 m.

6. Weather Influences.

Weather influence is understood to be the effect of air density, wind, and the fall of the flight path.

Air density. The sight angle (sight elevation) is calculated for an average air density of 1.22 kg/m^3 (corresponds to an equivalent elevation of about 150 m above mean sea level, a barometric pressure of 745 m, an air temperature of + 10° C, 70% humidity), calm wind and a medium initial velocity. Therefore, a sight range can be given only under these circumstances. The air density is dependent on air pressure, temperature, and humidity of the air. The influence of humidity is so small that it can be ignored. Less dense air increases the shot range, higher air density decreases it.

Air temperature can significantly change the shot range. In general with warmer weather, one has far shots, with colder weather, shorter shots can be expected. A change of the air temperature of 10° shifts the mean point of impact in elevation by about 1 meter, and about 30 m in range.

The influence that air pressure makes is only noticeable with great variations in elevation.

Air pressure is read either on an elevation meter (barometer), or is calculated according to the elevation of the firing position above sea level (using a map). An 11 m elevation difference corresponds to about 1 mm of air pressure change.

With the calculation of air pressure from the elevation of the firing position above sea level, the daily fluctuations of air pressure are insignificant. These are so small, that they can be ignored for their effect on the dispersion of the M.G. cone of fire.

Wind. Wind from the front shortens the shot range, wind from the rear increases it. Medium wind (4 m/sec) in the shooting direction displaces the cone of fire at 100 m by about 10 m in range. Wind from the side (4 m/sec) causes a displacement to the side of 2 to 3 m at 1000 m. Stronger wind (8 m/sec.) displaces the fire at double this rate.

When air density and wind act in the same sense, at medium distances (up to 800 m), a sight adjustment can be necessary of up to 100 m, and at far distances (over 800 m), up to 150 m.

Eliminating the influence of wind on the M.G. cone of fire is difficult. We usually use the estimation of the ground wind. Wind direction and strength decrease however from the ground speed at greater elevations. The consideration of the ground wind speed alone however does not lead to accurate shooting. This influence must be overcome by fire of sufficient depth and width. The calculation of wind influence for s.S. ammunition is determined in the shooting table. However hereby is to observe, that the values in the shooting table refer to the ballistic effect of the wind, that is, the effect on the bullet that results on average from the wind in the air layer.

For the strength of the ground wind, the following observations offer a hint:

Wind effect	Wind speed in m/sec
Smoke rises almost vertically, leaves are motionless	0-1
The exact wind direction can only be determined by smoke. Leaves of the trees are moved at times	2
A pennant is moved slightly. Wind can be felt on the face. Leaves rustle softly	3
Leaves are constantly moving	4

A pennant is moving vigorously. Dust and paper swirl up, thin twigs are constantly moving. The surface of standing water ripples more strongly	5
A pennant is stretched	6
Standing water has small ripples, leafless, weak branches are moving.	7
Wind feels very unpleasant, stretches out large flags, moves larger, leafless branches	9
Wind can be heard on solid objects, moves weak trees, throws up waves on standing water, which occasionally show foam heads.	11
Wind acts on standing water waves with imprinted foam heads, moves leafless trees of medium strength, walking against the wind is uncomfortable.	13-15
Roofs are damaged, leafless larger branches break off.	19-21
Trees are blown over. Wind causes greater destruction.	Over 22

The wind direction can be determined from a smoking chimney, thrown up dirt or sand, with cigarette smoke or by a moist finger.

Precipitation. Rain, snow, and hail shorten the shot range. For the measure of this shortening, one is reliant on observation or estimation.

Effect on the target. The projectile that shall hit on the target with its point with the correct stabilization of its boat tail, is still able to do a certain amount of work due to its inherent energy (kinetic force, mass). The latter depends on its speed and weight, and is referred to as impact energy.

The calculation of the power can occur according to the following formula:

Energy (E) = p (projectile speed)

^{2} (speed) ÷ 2g (fall speed = 9.81 m)

Flight Path Arc with Shooting Technique Explanation.

See Figs. 3 and 3a.

Muzzle horizontal is the thought-of horizontal level, in which the middle of the muzzle lies at the moment at which the shot leaves the barrel. The information of the shooting table (H.Dv. 240) relates to the muzzle horizontal.

Target horizontal is the thought-of horizontal level, at which the target lies. Muzzle and target horizontal fall together {*are the same spot*}, when the target is at the same elevation as the muzzle.

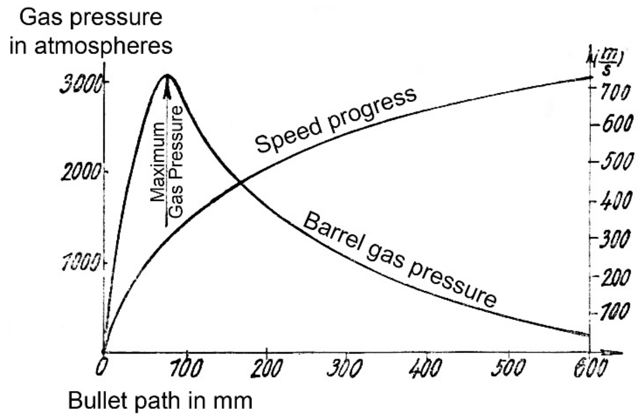


Fig. 3a Schematic representation of the velocity and gas pressure data on a bullet in the barrel.

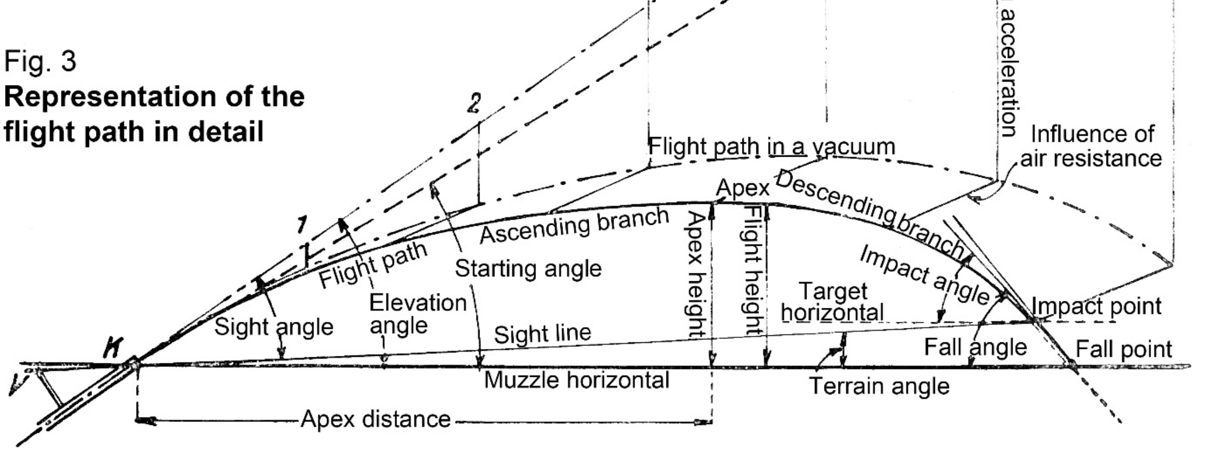
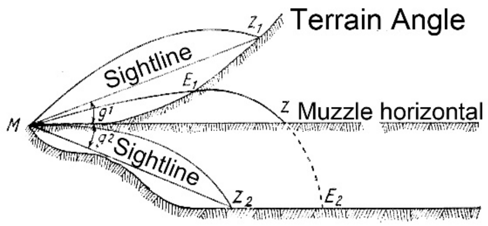


Fig. 3
Representation of the flight path in detail

Sight line is the imaginary straight line created by the middle of the rear notch and front bead sights.

Sight angle is the angle which the sight line makes with the axis of the bore.

Terrain angle is the angle which the sight line makes with the muzzle horizontal. It is positive when the target is above the muzzle horizontal direction, and negative when the target lies below it.



Elevation angle is the angle which the axis of the bore of the aimed weapon before firing the shot makes with the horizontal.

Departure angle is the angle that the axis of the bore makes with the muzzle horizontal at the moment the shot leaves the barrel. Elevation angle and departure angle are usually slightly different than the departure error angle. This is caused by the vibration of the barrel when shooting, which varies with each weapon type and ammunition, and even with the same weapon.

The departure error angle is dependent on the location of the support of the weapon. For the rifle (or carbine) with prone attack position it therefore requires to be laid on a support under the handguard. The departure error angle can be positive or negative. Departure angle – Elevation ± the departure error angle.

With carbines, the departure error with use of s.S. ammunition is + 3 minutes 40 seconds {*of angle*}.

In the following explanation of the flight path, it is assumed that the target and muzzle are not in the same horizontal.

The **apex point** is the highest point of the flight path. The plumb {*vertical*} distance of the apex point from the muzzle horizontal is the apex height.

Apex distance is the space measured on the muzzle horizontal of the apex height from the muzzle.

The **ascending branch** is the part of the flight path from the muzzle to the apex point. The **descending branch** is the part from the apex point to the end of the flight path.

Flight height is the plumb space of any point of the flight path from the muzzle horizontal.

Fall angle is the angle which includes the tangent of the flight path on the fall point with the muzzle horizontal.

Fall point is the second intersection of the flight path with the muzzle horizontal.

Impact angle is the smaller of the two angles, which the tangent of the flight path makes with the impact point of the target surface.

Impact speed is the speed at which the bullet impacts the target.

Impact point is the point in which the bullet in its flight path impacts the target or target terrain.

End speed is the speed of the bullet in m/sec. at the fall point.

Flight time is the duration in seconds of the projectile movement from the muzzle to the impact point. The shooting table in H. Dv. 240 contains the flight times from the muzzle to the fall point (shooting table flight times).

Force (of the projectile) is the kinetic force, expresses in mkg (meter kilograms) {*mkg* ✕ *7.236 = ft.lbs.*}.

Impact force is the force of the projectile at impact.

Muzzle and Projectile Crack.

With shooting with carbines and the M.G., two different sonic phenomena arise:

a) the muzzle crack, caused by the exploding powder gas behind the bullet;
b) the projectile crack, caused by air compression (the so-called head shock wave), that is created in front of projectile flying faster than the speed of sound (see Fig. 2).

With enemy fire, one first hears the mostly bright projectile crack, and afterward the dull muzzle crack. Behind the weapon or sideways to the rear, only one crack is heard, as the muzzle crack and projectile crack arrive together. Also, the gunners lying behind the weapon hear only one crack.

Aiming.

As the projectile falls under the extended axis of the bore after leaving the muzzle by the action of gravity, the barrel, to hit a target at a designated distance, must be aimed as much above the target as the projectile falls before its impact.

When with a horizontal position of the barrel, the projectile falls the distance of A-Z at a target distance of M-A (Fig. 4), one must elevate the axis of the bore above the target that same distance Z_1 (Fig. 5), in order to hit the target.

Fig. 4

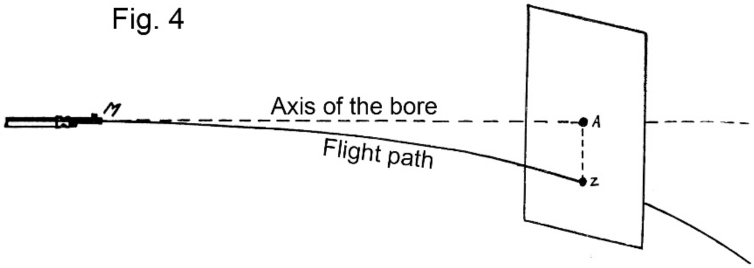
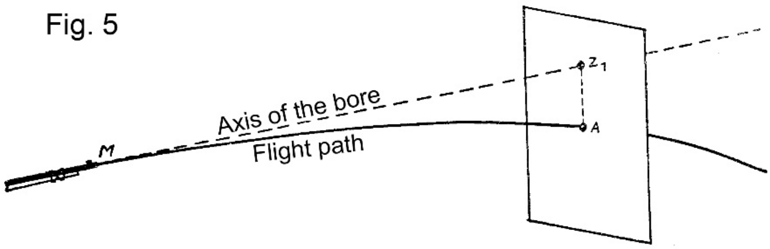


Fig. 5



With aiming however, the hold point must lie on or close under the target. Therefore, the weapon is provided with a sight assembly (front and rear sights). When one sets up the sight line on a designated point with the eye, it is called aiming.

With the aiming manner "level front sight", the shot hits in the middle of the target (in the black). The upper edge of the front sight must lie in the middle at the same height as the upper edge of the rear sight.

This means:

Hold point: The point on which the sight line shall be aligned.

Deviation: The point on which the sight line is actually aligned with firing the shot.

The further away the target, the greater the sight angle must be, that is, the shot must be aimed with a higher sight setting.

As the rear sight lies higher than the point of the front sight above the axis of the bore, the flight path intersects the sight line shortly in front of the muzzle. The distance to the second intersection of the flight path with the sight line, where also the hold point and impact point fall together, is called the sight shot range and the corresponding shot sight setting.

If the distance to the target is shorter than the relevant sight shot range, one must hold on that measure of the flight height under the desired impact point.

Depending on the choice of the hold point on the target, on its lower or upper edge, one says:

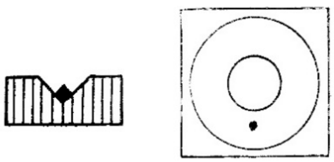
In the target,
Target sits on, or
Let the target disappear.

With small elevation differences between the target and the firing position, the terrain angle with direct aiming (aiming across the front and rear sights) is accurate enough by aiming exactly at the target.

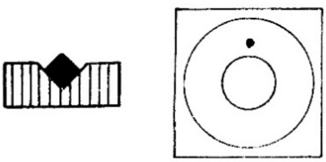
Large terrain angles (e.g. shooting in mountainous terrain), usually requires a sight that is set shorter than the actual distance. The consideration of the terrain angle with the sight setting comes into question for the shooting carbine and light M.G. shooting ranges only with terrain angles over 30°.

Aiming Faults.

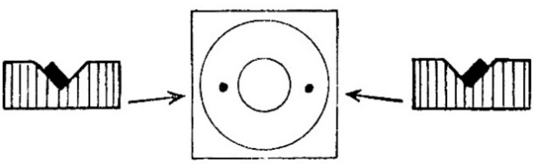
Aiming faults influence the impact point position and can only be avoided by taking a good attack position and conscientious aiming.



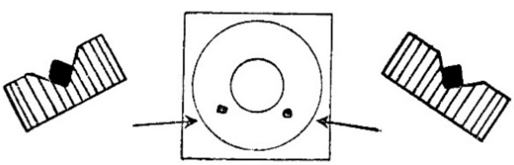
Fine front sight
The shot hits low.



Full front sight
The shot hits high.



Left jammed sight
The shot hits left.
Right jammed sight
The shot hits right.



Left tilted carbine
The shot hits low left
Right tilted carbine
The shot hits low right.

A front sight brightly lighted from above makes it appear larger than normal. Then you tend to shoot with a “fine front sight” and shoot too low.

If the right side of the front sight is brightly lighted, the actual sight is not in the middle of the rear sight, rather only the shiny front sight point. Result: A left shot. The reverse, a left lighted sight, produces a left shot.

Shooting Performance (In General).

The shooting performance of a weapon and its ammunition is recognized by:

the shape of the flight path (speed),

the dispersion, and the shot effect.

For shooting visible targets, the speed of the flight path is of more crucial importance. The greater the speed, i.e. the flatter the trajectory, the more the consequences of the unavoidable estimation errors and weather influences are reduced.

Dispersion.

If a large number of shots are fired in succession from a weapon under conditions that remain as constant as possible, the projectiles do not hit the same point, but are distributed over a more or less large area. This is called dispersion (dispersion of the individual weapon).

The causes of dispersion are: vibrations in the barrel of the weapon, fluctuations of the weather influences, small unavoidable differences in the ammunition and in the burning manner of the powder. Dispersion increases by the faults of the individual gunners with aiming and firing (shooter dispersion). The dispersion picture caught on a vertical surface is usually higher than it is wide (height dispersion is greater than width dispersion) (Fig. 6.).

If vertical and horizontal lines are drawn on the impact picture in such a way that the same number of impacts lie to the right and left as above and below these lines, their intersection shows the mean point of impact. The gunner shall know the impact point situation of his weapon, to be able to choose the corresponding hold point.

The mean point of impact with sighted shots should actually fall together with the hold point, however that is never the case. Deviations are always made: up, down, right or left. On this basis, the gunner must choose the hold point toward the impact point position of his weapon. With those that have an unusually high or low impact point, without that a fault of the weapon is able to be determined, it is recommended to set a lower or higher sight than corresponds to the distance. The less that the main point of impact of the individual weapon varies from the hold point, the better is its point of impact location.

The point of impact location provides a measure for the judgement of the performance of a weapon or a gunner.

At first, the individual shots of a dispersion picture will appear to be completely evenly distributed. Only with numerous shots can a certain regularity in the dispersion picture be recognized.

The hits are thickest around the mean point of impact, their distribution is always thinner toward the outside. This corresponds to the laws of probability.

If you draw two parallel lines at the same distance from the horizontal center line of the hit pattern (mean point of the impact axis), so that the corresponding sections include half of the shots fired, that's what the height of this horizontal line is called: the middle or 50% elevation dispersion. The width of a corresponding vertical strip is the average, or 50% width dispersion (Fig. 6).

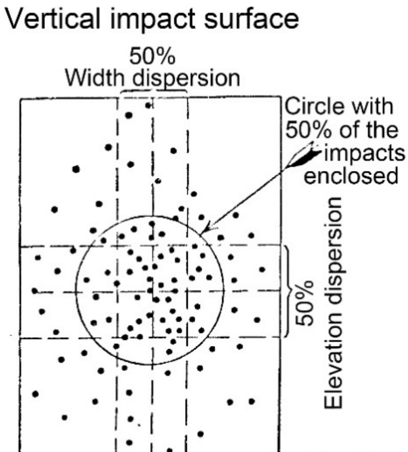


Fig. 6

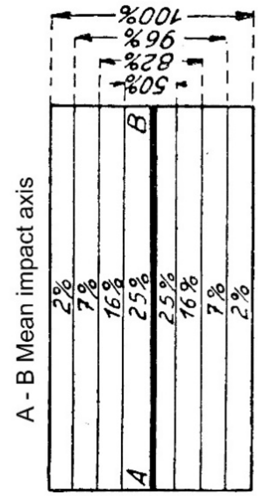
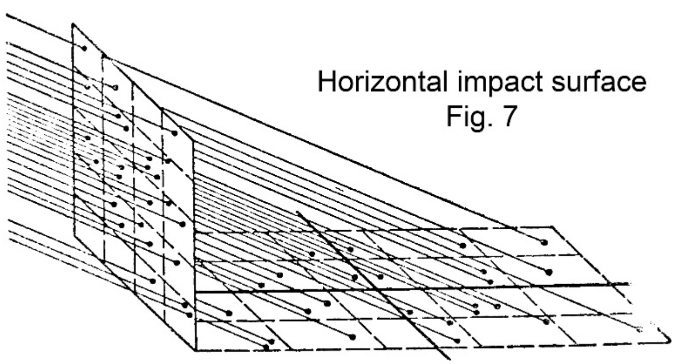


Fig. 8


Horizontal impact surface
Fig. 7

The average or 50% dispersion offers a further measure for the assessment of the performance of a weapon or a gunner.

On the ground, the shots are distributed in a surface, the horizontal impact surface (Fig. 7), whose width increases with the distance and whose length depends on the size of the height dispersion and the fall angle (length dispersion).

For short distances, whose height and width dispersions are not very different, the radius of the circle which includes 50% of the impacts (Fig. 6) provides a suitable measure for assessing the accuracy.

A circle with this radius drawn on the mean point of impact includes the inner half of the strikes; a circle with double the radius covers about 94% of the impacts (average values). Dispersion data can only give a probability, not a certainty. It may therefore never be viewed as fixed comparison figures.

Dispersion increases with an increasing shot count, and attains a certain high limit only with a high shot count. With a smaller shot count, as mostly expected, the deviations fluctuate between the highest and lowest shots, and between the farthest right and farthest left shots very significantly. Therefore, the measure of the largest deviations is not suitable for experimental purposes. With small shot counts, it is not permissible to speak of 100% or complete dispersion; one therefore uses the term "greatest dispersion in height or width". For this, one uses the 50% height or width dispersion, that itself with a smaller shot count delivers consistent values.

The Cone of Fire.

With the delivery of fire bursts by a light M.G. or with shooting with several carbines, the impacts are distributed over a larger surface than with single fire of the light M.G., or with shooting with one carbine. The flight paths of the bullets from one fire burst from a light M.G. or from several carbines make a cone of fire. Its density decreases gradually from the middle of the impact surface toward the edges. The more shots that are aimed at a target, the more regularly the hits are distributed in such a way that about half (50%) are in the middle quarter, and about four fifths (82%) are in the middle half of the entire impact area (Fig. 8).

The depth (lengthwise dispersion) of the cone of fire depends on the size of the elevation dispersion and the fall angle. Each influence acts opposite to the other. Increasing the angle of fall decreases the depth of the pattern. The fall angle in the ratio increases quicker than the elevation dispersion, so that gradually, the lengthwise dispersion of the cone of fire decreases. The depth of the cone will expand from the weather influences and faults of the gunner. With multiple influences, the degree of training, visibility of the targets, rate of fire, etc. and especially the physical and mental state of the gunner, fixed numbers for the various distances are unable to be given. For the action on the target, only the inner part of the cone which contains about 75% of the impacts, (the core sheaf) comes under consideration. The effect of strays on the sheaf, which are made up of about 13% of the impacts, are of little importance.

The Sight Area.

M.G. and carbines have a designated distance of sight shots with each sight setting, that is, the shot hits the target on the hold point. If the distance to the target is shorter or farther, it can hit the target with the same hold point, so long as the flight path is not raised above the sight line, more than the height of the target above the hold point, or drops no lower than the sight line, than the part of the target below the hold point. This area in which a target can be hit without adjusting the sights is called the sight area. In Fig. 9, a target ***A*** moves toward the gunner ***S***. At ***A***, where the flight path hits the feet of the target, he steps into the sight range and remains in it until ***B***, where the flight path still hits the

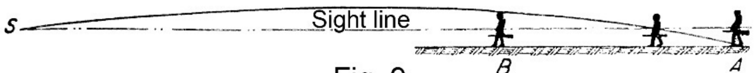


Fig. 9

head of the target. The sight area is dependent on the straightness of the flight path and the size of the target. It is further dependent on the character of the terrain (Fig. 10). For the carbine and light M.G., ammunition with a very straight flight path (greater speed) is especially important.

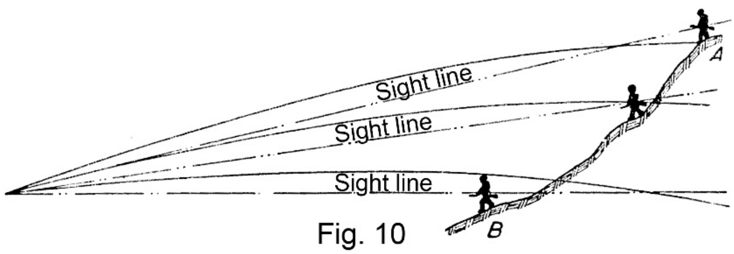


Fig. 10

With delivery of fire bursts by a light M.G. or by the combined fire of several carbines, the sight area increases due to the lengthwise dispersion (***A***-***C*** in Fig. 11).

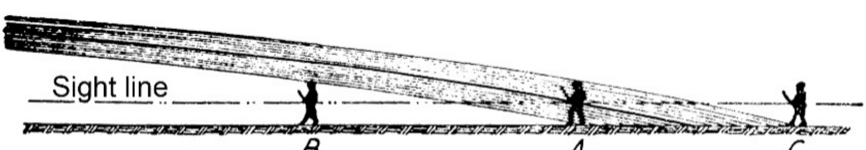
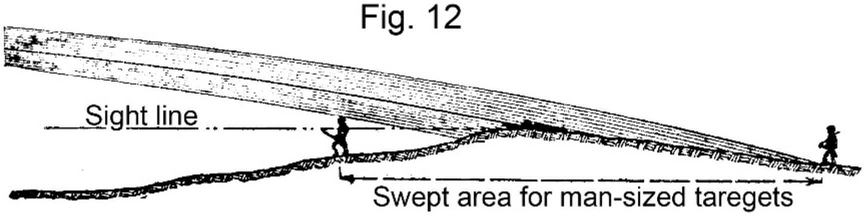


Fig. 11

The Swept Area.

When a target is shot at, a designated area in front of and behind the target is endangered. This endangered part is called the swept area (Fig. 12). In the shooting direction, rising terrain behind the target reduces the swept area, decreasing elevation terrain increases it. The elevation difference between your firing position and the target is also of great influence. When shooting from a higher position, the swept enemy area usually decreases. Large swept areas make the advance of support and the bringing forward of ammunition more difficult.

Fig. 12



The Covered Area.

Unseen areas – covered from view. The area behind a cover that cannot be reached by a bullet in its flight path is called the "covered area" (Fig. 13). It depends on the height of the cover, the size of the impact angle, the depth of the flight path, and the height of the target.

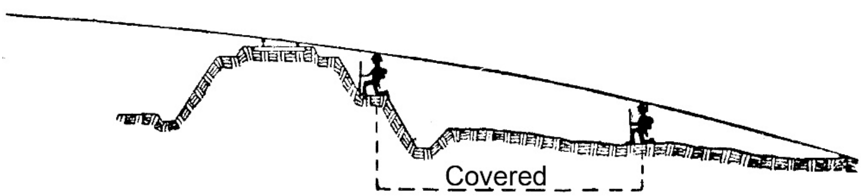


Fig. 13

Ricochets.

Bullets that ricochet upon impact usually continue to fly further as ricochets. Ricochets from short shots can increase the effect on the target and in swept areas. Ricochets particularly appear when the bullet strikes with a low impact angle on hard rocky or with hard grassy overgrown ground or on water. With steeper impact angles the projectiles seldom bounce off. The bullets can also bounce off with impacts on grassy undergrowth, etc.