T.O. NO. 00-25-35

FIGHTER PILOT GUNNERY

HOW TO MAKE YOUR BULLETS HIT!

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INTRODUCTION

Your job as a fighter pilot is three-fold:

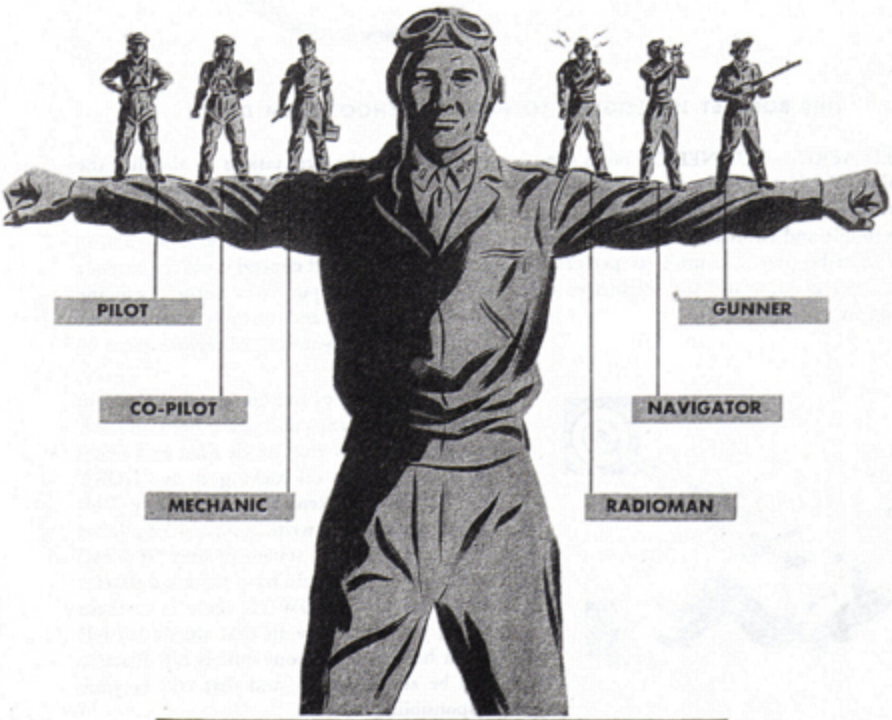
1. Be able to fly your airplane instinctively.

2. Be able to leave your base, find your destination, and return.

3. Be able to accomplish your mission—destruction of the enemy.

You as a fighter pilot have a tremendous concentration of fire power in your plane's fixed guns. The closer you get to the enemy, the more you will want to know how to use these weapons. Here is the opportunity. Learn how it can be done NOW. If you do fly a fighter, this is YOUR BUSINESS.

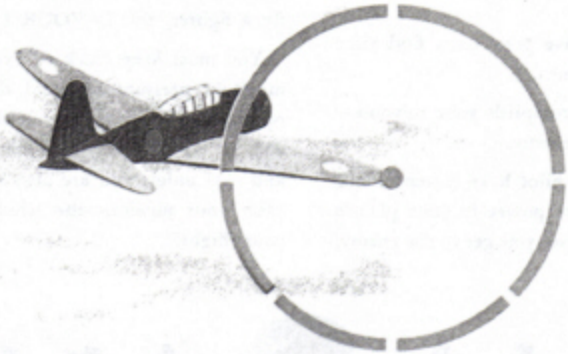
You must keep track of everything from manifold pressure to wind drift, to radio operation. Yet what use is there in being able to do all these with the greatest skill and ease unless you are also able to accomplish your mission—the whole purpose of your flight?



"YOU ARE A ONE-MAN CREW"

You already have had months of training in how to fly your airplane as easily as you walk. You have had hours of plotting courses, winds, headings, and speeds. Now comes the time to add the third factor to the job. If you cannot make your bullets hit, your whole training is wasted.

YOUR MISSION IS THE DESTRUCTION OF ENEMY AIRCRAFT!



THIS BOOKLET IS DESIGNED TO HELP YOU SHOOT THEM DOWN

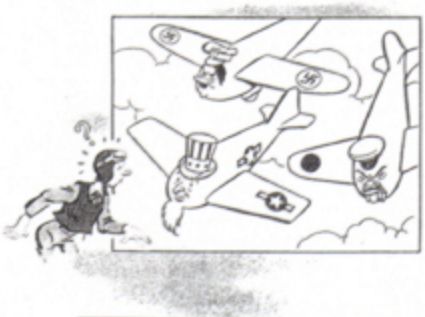
FIXED AERIAL GUNNERY is not a simple subject. Yet if it is to become successfully accomplished in the air, the process must become simple and effortless to you. Then the routine must be practiced until its performance becomes as automatic and instinctive as breathing in your sleep.

Therefore, the first task is to simplify the process in your own mind; later on we'll get around to making it instinctive. First LEARN the principles laid down here. Your ability to execute them will depend upon the amount of practice you put into them. Combine enough learning and enough practice and you can be the best trained fighter pilot in the world.

The simplicity of this booklet doesn't mean that any important points have been omitted. Rather, it means that much time and effort have been spent on making it as SHORT AS POSSIBLE! Remember the canny Voltaire's apology for writing such a long letter to a friend and his statement that "if I had had more time I would have written a shorter letter." If you KNOW all there is in these pages, you will know all that words can tell about how to make your bullets hit. Practice will be all you need—and that will be your responsibility.

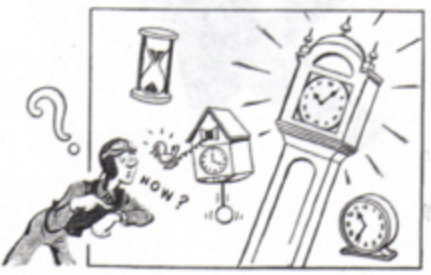
THE WHO, WHERE, AND WHEN SYSTEM

The way to make a job simple is to divide it into separate operations, each distinct from the others and all performed in logical, chronological order. Such a chronology is the WHO—WHERE—WHEN system of Fixed Gunnery. Good proof of this is to consider what happens when you ask yourself these three questions:



WHO—friend or foe?
(and what species of foe).
This is the first thing I must know, since it partly dictates the answers to WHERE and WHEN.

WHERE do I aim?
This depends upon the speed and course of the target. The best way to determine THAT is to recognize the aircraft.



WHEN do I fire?
This depends entirely upon my range from the target, an answer which I must learn to read in the ring of my gunsight.

LET US BRIEFLY CONSIDER THE QUESTIONS A LITTLE FURTHER.

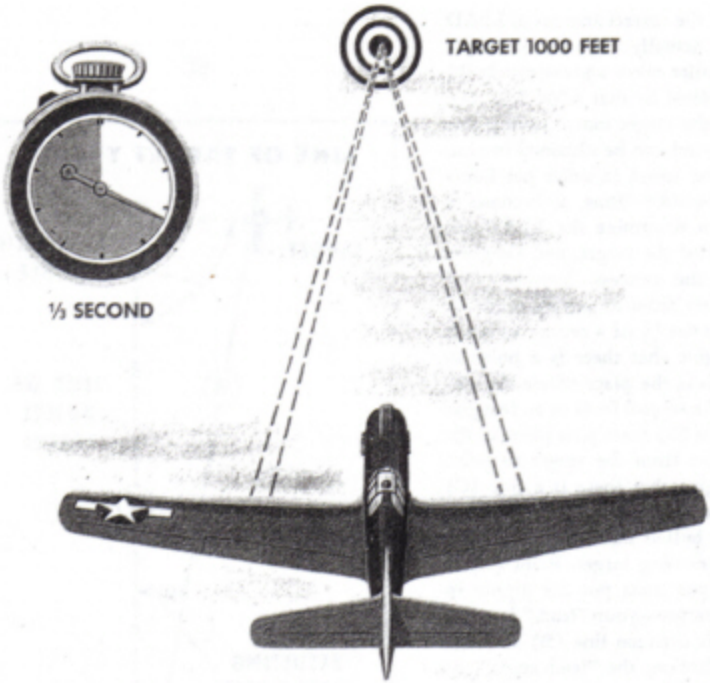
WHO? . . . obviously the first question in any contact. Without the answer to this, there can be no answer to WHERE or WHEN.

While the teaching of RECOGNITION is no part of this subject, the necessity of knowing types of friendly and enemy planes is the basis of fixed gunnery and cannot be over-emphasized. The reason for this is obvious, when we consider the next two headings. It is not enough to recognize an enemy plane. You have to know what it is—its characteristics that are vital to you—its size and its speed, particularly.

Assume that you have made contact with an enemy aircraft and have decided to attack:

The next question is: WHERE DO I AIM?

You aim at a definite spot in space that will become full of enemy airplane when your bullets reach there. The correct point of aim for any given target will depend upon (1) its speed, (2) its flight path and (3) the velocity at which your bullets travel.



For example: The average velocity of a bullet during its first 1,000 feet of travel is approximately 2,900 feet per second. Thus, it takes slightly over ⅓ of a second to go 1,000 feet. An airplane traveling at 300 miles per hour moves 147 feet in the same ⅓ of a second. So, if you fire straight at the moving target it will be a long distance away by the time the bullet gets to the spot where you aimed. If you were directly behind the target this wouldn't matter, for the bullet would almost instantly overtake it. But, if you were even a little bit to one side or the other, the bullet would miss its mark. You correct this by LEADING—aiming ahead of the target —so that the bullets and the target reach the same place at the same time—just as a duck hunter LEADS the duck.

You must realize that your bullets do not reach the target instantly. It takes a certain definite time depending upon the range and the bullet's velocity. During this "time of flight" of the bullet the target moves a certain distance. You must estimate this distance and lead the target to allow for it.

LEAD OR DEFLECTION

Calculation of the correct amount of LEAD or deflection, is actually a matter of simple arithmetic: A bullet takes approximately 1/3 of a second to travel its first 1,000 feet. The number of feet the target moves during this same 1/3 of a second can be obtained by simply translating its speed in miles per hours into feet per second.* Thus, it becomes a simple matter to determine the LEAD for any given speed of the target, and Diagram (A) illustrates the process. Suppose your plane is 1,000 feet from an enemy plane. It will take your bullet 1/3 of a second to reach the target. Imagine that there is a point in space (A) which is the place where the target will be 1/3 of a second from now. Imagine that there is a line (B) from your plane to the target, and a line from the target to point (A). Then imagine that there is a line (C) from your plane to point (A). This is the path which your bullets must follow in order to intercept the moving target. Point (A) is the spot where you must put the pipper in order to hit the target—your "lead," in other words. The angle between line (B) and line (C) is your deflection, the "lead angle," or simply lead in radii.

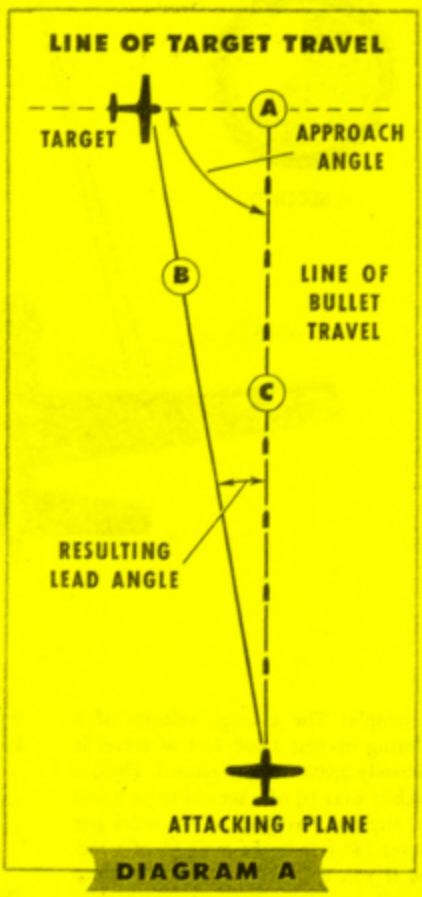


DIAGRAM A

*One mile per hour—1.47 feet per second. Multiply this by the number of miles per hour the target is traveling and you have the number of feet it moves in one second. One-third of that is your answer. (But don't worry. You're not going to have to do higher mathematics in combat!)

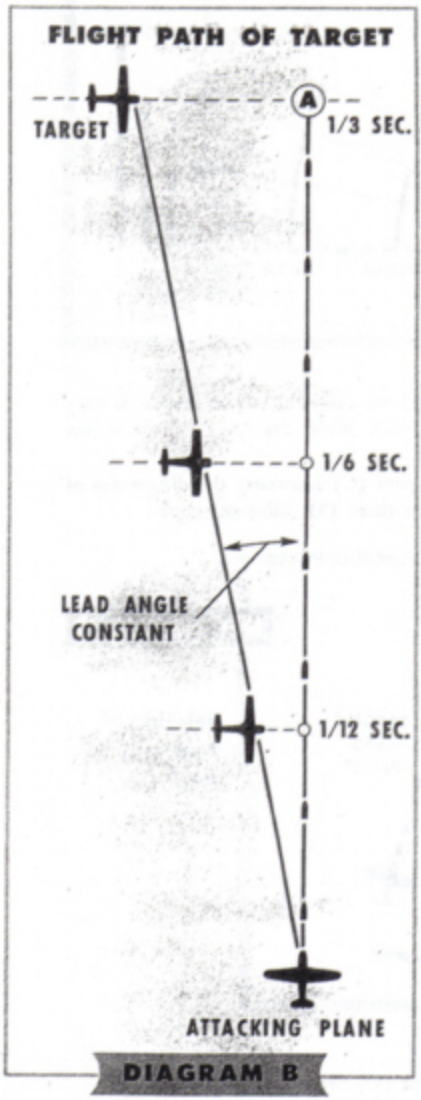


DIAGRAM B

Fortunately the lead angle remains constant at any range for any ONE approach angle (the angle between the path of the bullet and the flight path of the target) and target speed. Note in Diagram (B) that if we proportionately double, halve or otherwise increase or decrease the time of travel of both bullet and target, the lead angle does not change, because the target's travel time is changed in the same proportion as the bullet's travel time.

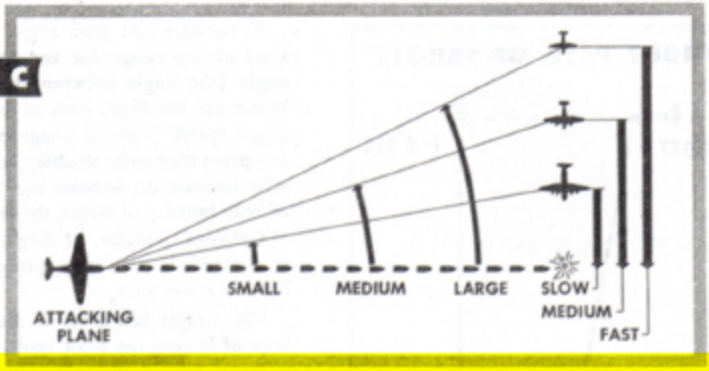
This simple fact gives us the great advantage of having the radii lead which we give a target remain the same regardless of the range. For this reason you will never hear mentioned the length of lead. All leads will be measured in angles and expressed in sight radii.*

THUS (1) THE *SPEED* OF THE TARGET AND (2) THE *ANGLE* OF APPROACH ARE THE ONLY TWO VARIABLES WHICH WE MUST CONSIDER.

*One radius of the N-9 sight, or the distance from the center dot to the circle, is the correct lead angle for a target plane traveling 100 mph at full deflection.

DIAGRAM C

Relation of Target Speed to Lead



1. TARGET SPEED

If we change the distance which the target travels in one second, the lead angle must change, because the average speed of the bullet remains constant. Decrease the target's speed and the lead decreases. Increase it and the lead increases. (This, of course, is why you have to know the speed of the enemy plane.)

Diagram (C) illustrates the differences of lead for three (3) different speeds.

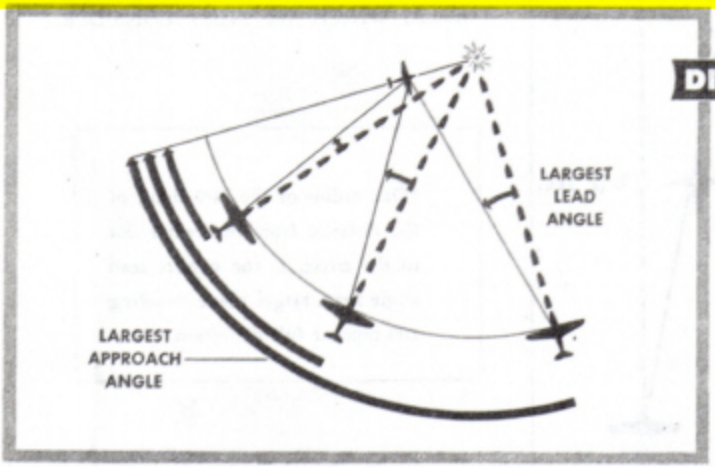


DIAGRAM D

Relation of Approach Angle to Lead

2. APPROACH ANGLE

Likewise if the angle of approach to the target changes, the lead angle will be changed. The greater the approach angle (90° being the maximum), the greater the amount of lead. The closer we come to a tail or head-on approach, the less the amount of lead angle. Diagram (D) serves to illustrate the point.

You have to estimate both of these variables and whether or not you figure the lead correctly depends upon your ability to accurately judge the target's speed and the angle of your approach.

★ TARGET SPEED AND LEAD ★

On sighting a target, your first estimation must be of its speed, because if that is far in error, all your subsequent work is hopeless. If you surprise the enemy, especially if he is a bomber, he is usually flying at his fastest cruising speed. After you attack, however, he will invariably put his nose down and go at maximum speed. The relationship between changes of speed and change in lead is directly proportional.

Therefore, if you know the two basic speeds of your target you have a reliable yardstick to use in judging your correct lead for the attack.

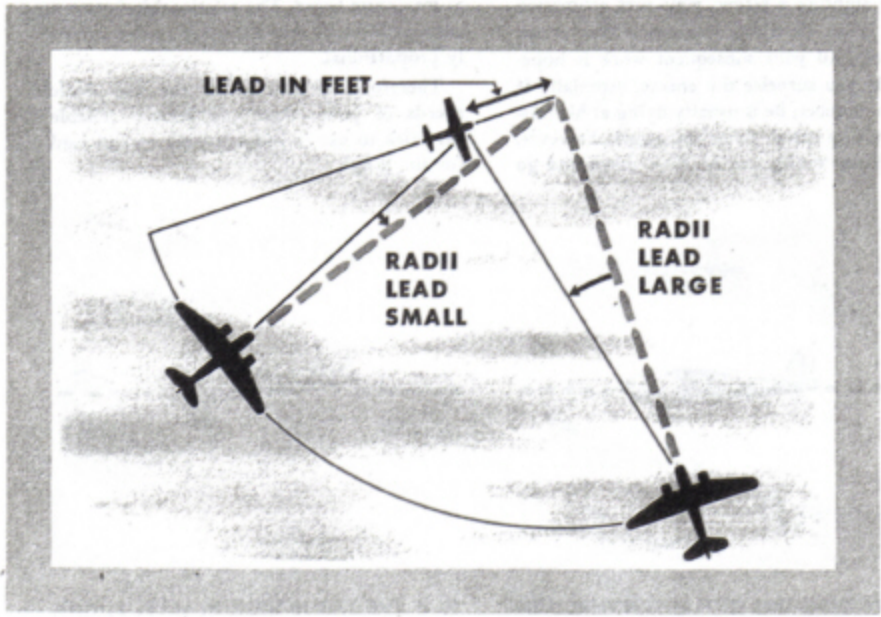
★ WHEN ITS LINE OF FLIGHT IS THROUGH ITS CENTER, IT IS FLYING AT ABOUT CRUISING SPEED.

★ IF THE TAIL IS HIGH IN LEVEL FLIGHT, IT IS FLYING AT MAXIMUM SPEED.

★ A CLIMBING ATTITUDE SHOULD INDICATE ABOUT THREE-QUARTERS OF ITS CRUISING SPEED.

★ IN A DIVE IT MAY BE DOING ANYTHING UP TO TERMINAL VELOCITY.

★ APPROACH ANGLE AND LEAD ★



From any given range the number of feet that you must lead the target remains constant no matter from what angle the bullet comes. This is because it takes the bullet the same length of time to cover the distance to the target, regardless of the approach angle. During that time the target will travel forward the same number of feet, regardless of the direction from which the bullet comes.

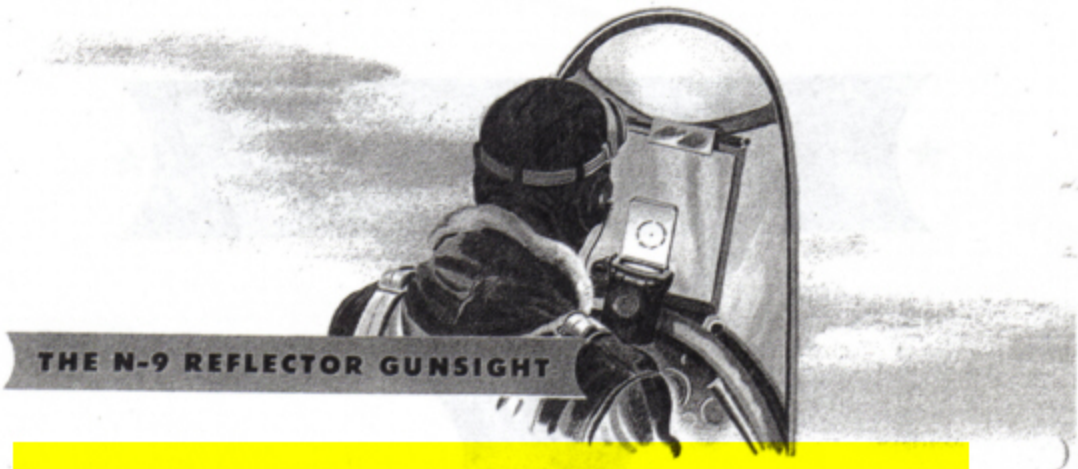
But, even though the lead in feet remains the same, the lead in radii diminishes as the approach angle decreases from broadside to tail.

Thus we see that for any given speed and approach angle it is possible to ascertain the correct lead.

But it is also apparent that the business of estimating the correct lead must be made so simple as to be virtually instantaneous.

This has been achieved in two ways:
(1) BY MEANS OF THE GUNSIGHT.
(2) BY MEANS OF CONVENIENT RULES-OF-THUMB.

If you do not fully understand everything you have read so far, go no further. Go back and REREAD. What follows will make sense to you only if you comprehend FULLY the above basic principles. Remember, in this game you can fool no one but yourself, but you CAN cause a lot of other people to get hurt by not knowing your stuff. If you can't honestly face yourself and say you KNOW what it all means . . . Don't read on . . . go back and get it down cold.



THE N-9 REFLECTOR GUNSIGHT

The first shortcut you have been given in determining correct lead is your gunsight, which will calculate the right lead and give you the proper distance at which to begin firing. An understanding of its workings is both interesting and useful. (Incidentally, it's a delicate precision instrument—don't use it as a handhold in getting in and out of the cockpit.)

When you look at an object, your eyes automatically FOCUS for the distance between you and the object. Objects at other distances are "out of focus".

However, your eyes possess a quality known as "depth of focus". The further away an object is from your eyes, the greater the depth of focus. In other words, if your eyes are focused on a point 500 feet away, almost everything beyond is in focus. Only a small adjustment in your vision is necessary to bring into focus an object 1,000 or 5,000 feet beyond.

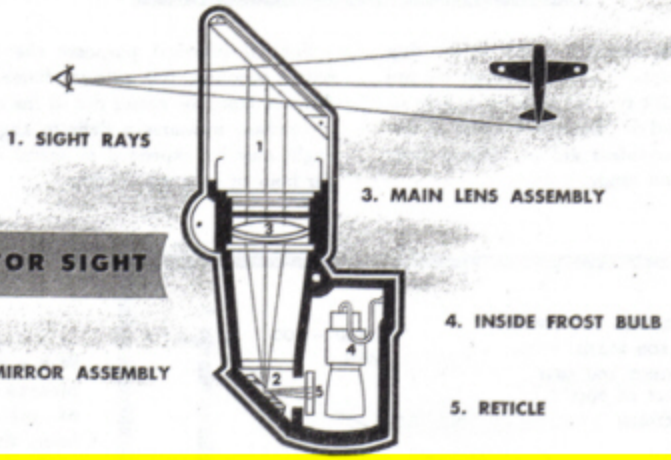
On the other hand, if you focus on an object only six feet away, a major adjustment in your vision is necessary to bring something 500 feet (or even 10 or 12 feet away) into focus.

In the case of previously used gunsights of the open and telescopic types (with a peep and bead which had to be aligned) it was necessary to focus back and forth between target (in the distance) and the sights (in the immediate foreground), to use the sight effectively.

In addition, the sights were usable with one eye only and required the pilot to hold his head rigidly in one position to get alignment of the elements.

The REFLECTOR sight eliminates all these disadvantages. A compact INSTRUMENT, it consists of a piece of transparent glass through which the target is visible just as though the glass were not there. Because of the angle at which the glass is mounted, it catches and reflects to the eye the image of a RETICLE (mask) which is inserted within the sight.

By means of the optical system inside the sight, the image of the reticle, although it is only a matter of inches away from your eye, is made to look as though it were distant in space. This is accomplished in the same manner that a nearby object is made to appear far off when viewed through the wrong end of a pair of binoculars. Thus, there is no need for constant readjustment of focus and the sight may be viewed with both eyes open.

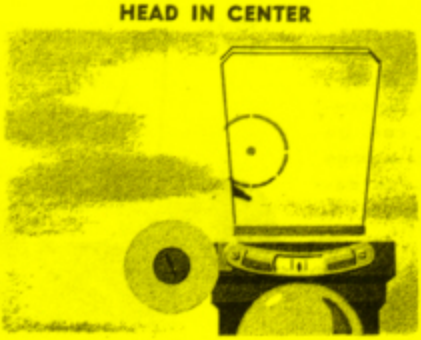


A REFLECTOR SIGHT

The pilot can move his head in relation to this sight without disturbing the alignment of sight and target. Both move together, which gives the pilot considerably more freedom of movement and eliminates the former critical necessity of keeping everything perfectly aligned.

HEAD IN CENTER

HEAD TO THE RIGHT

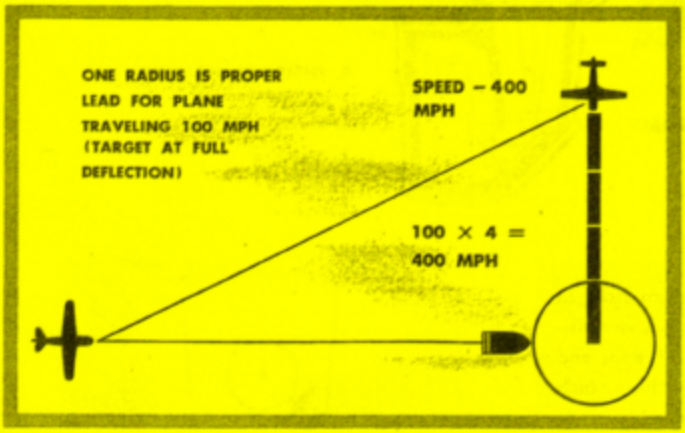


HEAD TO THE LEFT

★ THE 100-MILE RETICLE ★

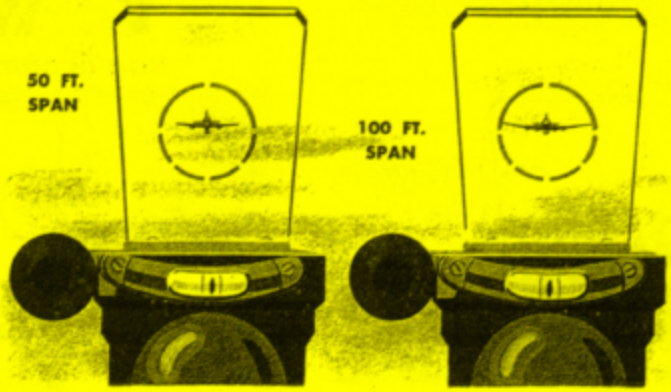
The 100-mile reticle is based on the ring and dot principle. The only reason we use the ring and dot type of sight is to give us an angle instead of distances. Because of this we have a convenient aid in judging both target speed and range.

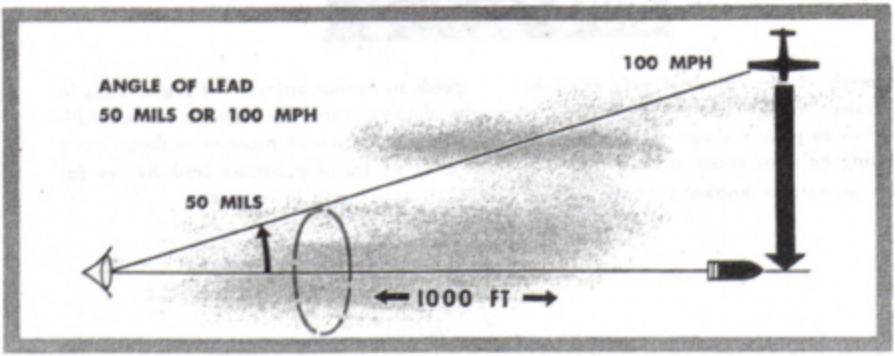
For all practical purposes the 100-mile reticle measures 100 mils in diameter. The distance from the center dot to the circle, or the radius, measures a definite angle. This angle may be expressed in terms of miles per hour or in terms of mils.



When expressed in terms of miles per hour, the ring-sight can be used to solve the problem of speed

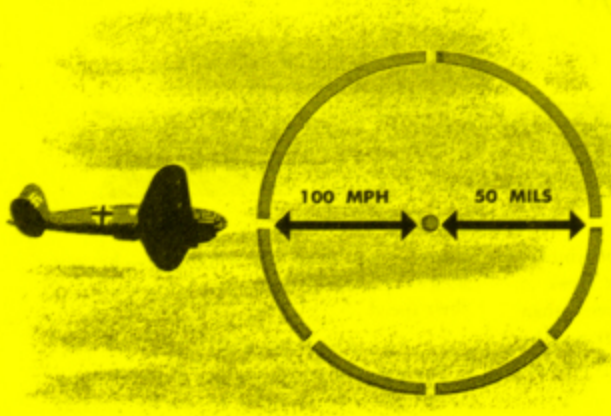
When expressed in terms of mils, the ring-sight can be used as a range estimation device





The 100-mile reticle is speed rated at 100 miles per hour. This means that on full deflection shots you lead the target one radius for every 100 miles an hour it is doing in speed. Based on an average bullet velocity of 2,900 ft. per second over the first 1,000 foot range, the ratio of target speed in miles per hour and size of the reticle in mils is almost exactly 2 to 1.

To determine the speed rating of your sight, jack up the airplane so that the sight points to the ground 1,000 feet ahead. Mark the point where the dot falls. Get someone to walk out at right angles and mark the point where the ring cuts the ground. The distance in feet between the two points will be the mil value of the sight. Since one mil has an approximate speed value of two miles per hour, a sight measuring 50 mils in radius will have a speed rating of 100 miles per hour.



With a full understanding of the elements of our sight we are now ready to start the important business of applying the rules-of-thumb which will translate target speed into radii lead.

RULE FOR SPEED

Inasmuch as one radius of your gunsight is equivalent to 100 miles of target speed it is possible to greatly simplify the matter of converting miles of speed to radii lead.

Each aircraft is known to have specific speeds in various attitudes of flight. Thus in its simplest form the answer to our full-deflection radii-lead becomes nothing but a matter of learning correct lead figures for direct application in combat.

Plane	Radii Lead
Focke-Wolf 190	4
Me 109G	4
Me 110	3½
Type 97 SSF "Nate"	3
Type 96 M/B "Nell"	2½
Type 97 M/B "Sally"	2½
Type 97 M/ "Zeke"	3
	2½

MEMORIZE THE NUMBER OF RADII LEAD REQUIRED ON EACH TARGET PLANE IN A 90° ATTACK

REMEMBER THESE LEAD FIGURES ARE CALCULATED FOR MAXIMUM (LEVEL FLIGHT) SPEED ONLY. ADJUST FOR OTHER ATTITUDES OF FLIGHT.

Fortunately, in most theaters of combat only a limited number of different types of enemy planes appear. As a rule not more than four or five types of enemy aircraft will be operating within an area of several thousand miles.

A pilot going into a new theater of operation can generally know just what type of aircraft will form the opposition—he can memorize their length, their wing-span and their speed.

HE HAD BETTER!

For your convenience a list giving data on lastest operational types of enemy aircraft has been compiled and appears elsewhere in this booklet.

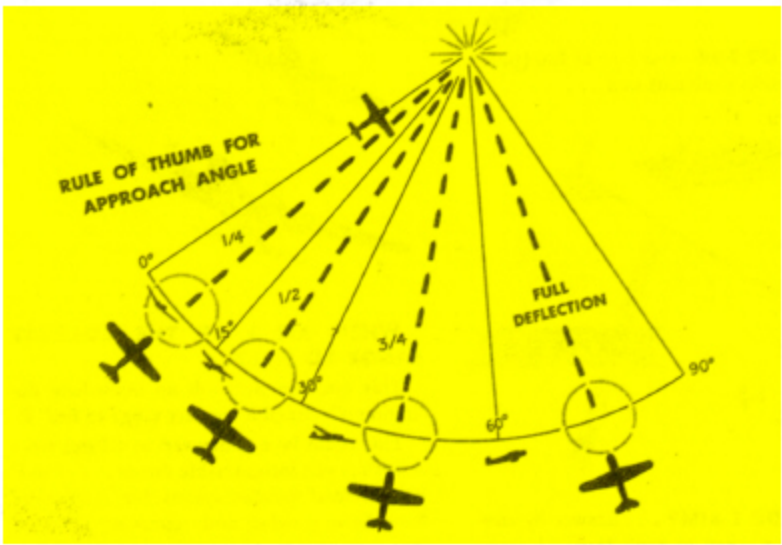
RULE FOR APPROACH ANGLE

We know that as the approach angle changes from broadside to tail there is a corresponding reduction of radii lead. For all practical purposes this change may be grouped in four categories:

90°—60° 60°—30°
30°—15° 15°— 0°

Experience has proven that this is completely satisfactory and that the angles are easy both to judge and to remember. The rule-of-thumb we will adopt then, is this: For a 90° to 60° approach angle allow full deflection; for 60°—30° allow ¾ full deflection; for 30°—15° allow ½ full deflection; and for 15°—0° allow ¼ full deflection.

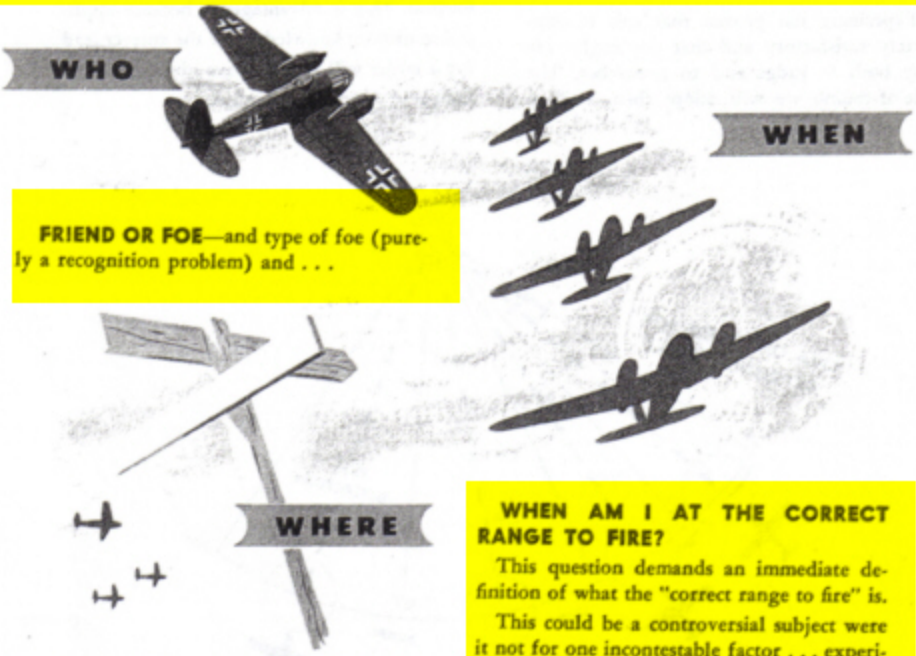
Note that in every case the decrease in radii lead is given as a fraction of full deflection. This is advantageous because application of your knowledge for the correct lead for a target will already have given you your radii-lead for full deflection.



★ WHEN DO I FIRE? ★

Having beaten your brains out over this matter of deflection, you are probably convinced by now that there are few ways of making the subject more complicated. Remember, however, that we have given you the WHOLE picture, with all its apparent arithmetical confusion. This was necessary to a full comprehension of the subject. But remember also that we have boiled the whole thing down to the simplest of rules-of-thumb.

SO FAR, ALL YOU HAVE TO DO IS ANSWER THE QUESTIONS:



FRIEND OR FOE—and type of foe (purely a recognition problem) and . . .

WHERE DO I AIM? . . . answer by converting target speed to radii lead. (A completely instantaneous affair with an equally instantaneous correction for approach angle.)

It should be emphasized that the answers to both WHO and WHERE can almost invariably be had when the target is still far away. This leaves ample time for cool and deliberate decision and for answering that final important question . . .

WHEN AM I AT THE CORRECT RANGE TO FIRE?

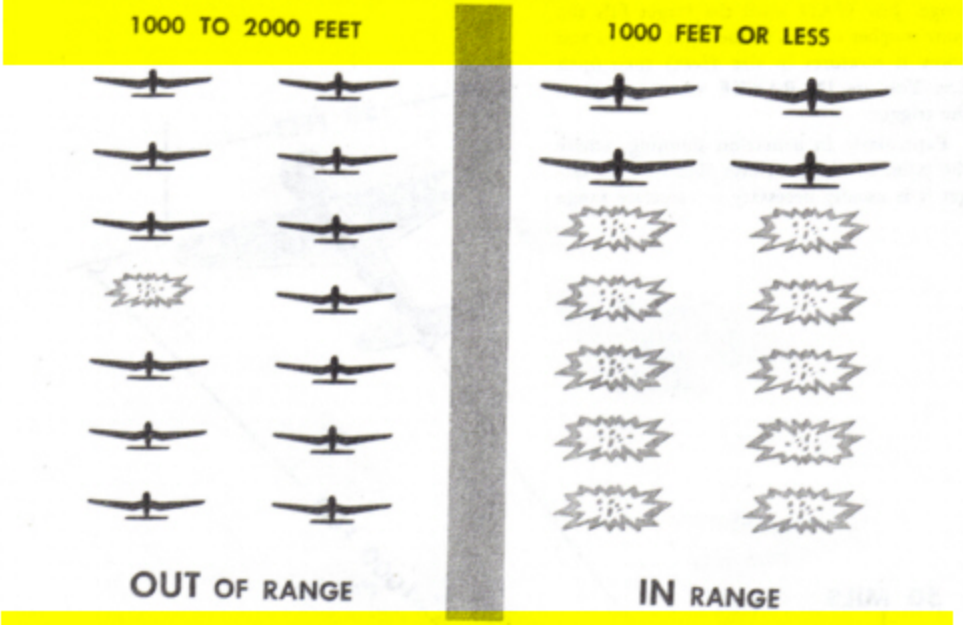
This question demands an immediate definition of what the "correct range to fire" is.

This could be a controversial subject were it not for one incontestable factor . . . experience. Actual combat results for some time have been proving and reproving that the best "get your man" range for opening fire is 1,000 feet.

As you close on your target from 1,000 down to 200 feet, the lethal area of your guns is most effective, for at any given instant you have the greatest number of bullets concentrated within the most efficient area and consequently stand the best chance of hitting effectively.

An analysis of 3,600 actual combat films shows that only one out of 14 enemy planes attacked was shot down at ranges between 1,000 and 2,000 feet, while 10 victories out of every 14 attacks were obtained at 1,000 foot range or less.

The big point about range is: Are you IN RANGE or OUT OF RANGE? You may well say this over and over again. If out of range hold your fire. If in range, give 'em hell!



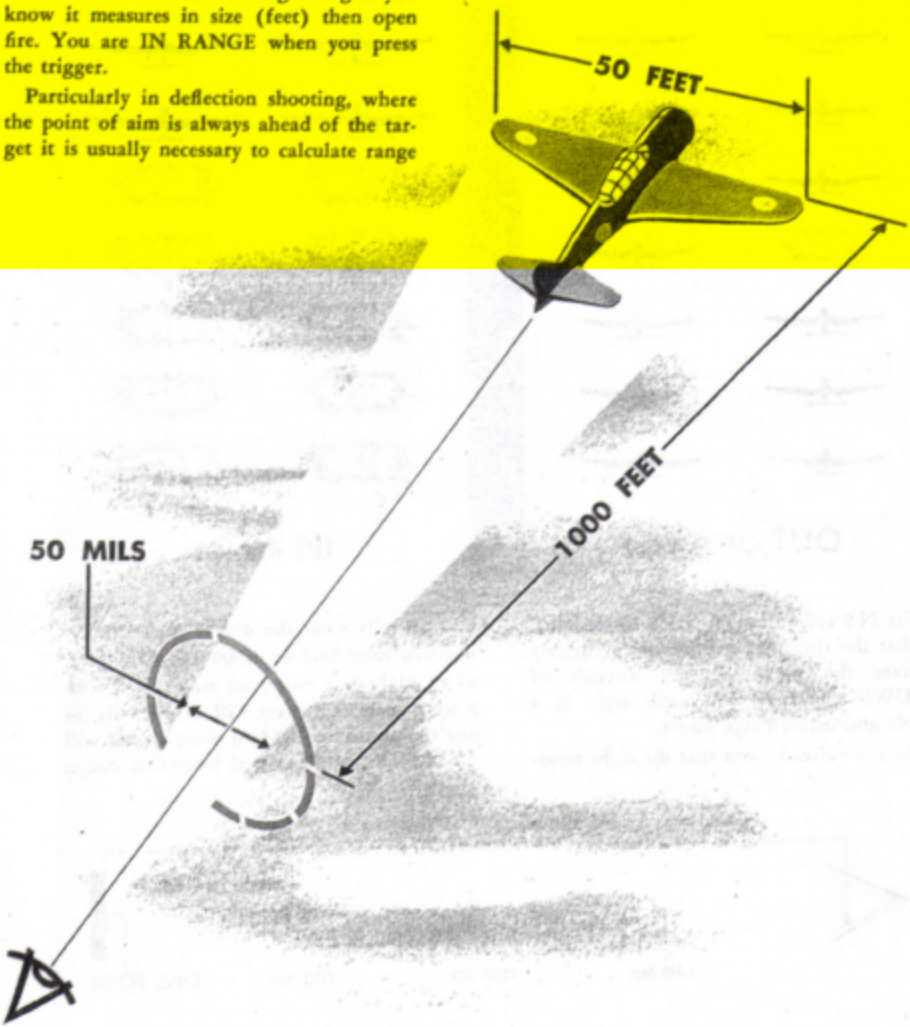
The N-9 reflector sight has been designed so that the ring will quickly and accurately indicate the range of any aircraft of KNOWN SIZE. In effect the sight is a simple and useful range finder.

We have already seen that the sight measures 50 mils from the dot to the circle. A one-foot ruler held up 1,000 feet away gives us an angle of 1 mil. Thus an airplane with a wing span of 50 feet will fill 50 mils, or one radius; and a 100-foot wing spread will fill 100 mils, at the critical 1,000-foot range.

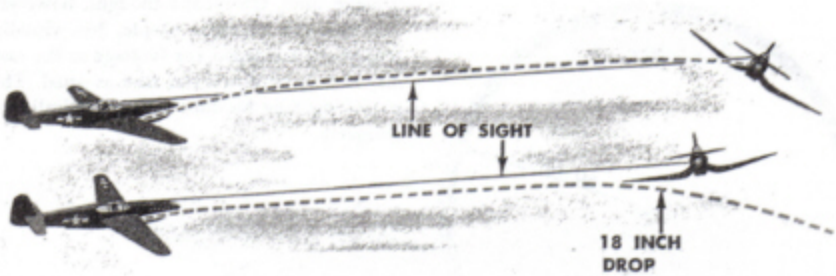
★ RULE FOR RANGE ★

Consequently, if we know the wing span and fuselage length of any given target, it is an easy matter to tell when it is at 1,000-foot range. Just WAIT until the target fills the same number of mils in the sight-ring as you know it measures in size (feet) then open fire. You are IN RANGE when you press the trigger.

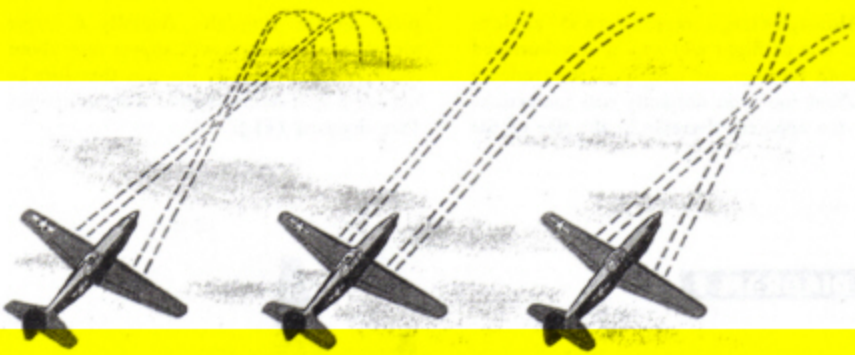
Particularly in deflection shooting, where the point of aim is always ahead of the target it is usually necessary to calculate range by measuring the target's size, not in the middle of the sight but with the target well to one side and usually below the horizontal line.



★ WHEN DO I FIRE? ★



The deadly range of your bullets is quite limited. Gravity will cause them to drop about 18 inches after traveling about 1,000 feet. In fixed gunnery, compensation is made by elevating the guns when bore sighting so that the average rise and fall of the bullets is not more than about 4 inches off the line of sight. At distances above 1,000 feet, gravity will have a damaging effect upon your aim.



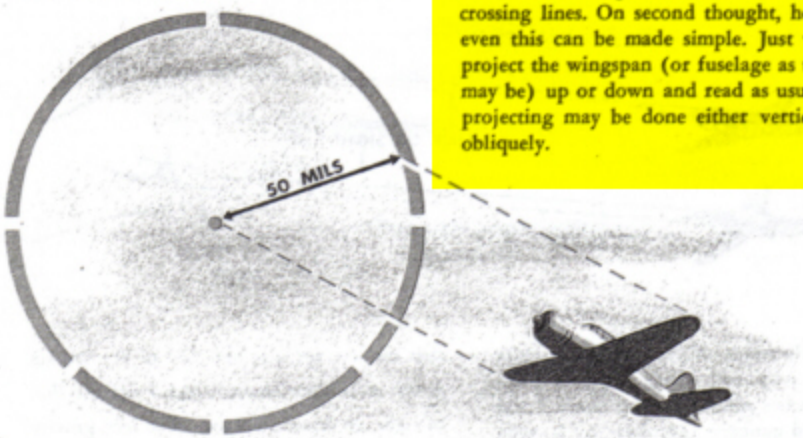
If your guns were set parallel to each other, the dispersion of your bullets would be too great, and to counteract this natural dispersion, each of your guns is set at a different angle so that the bullets converge and you have a lethal pattern from 1,000 feet on in to close range.

(Don't get the wrong idea that this concentration of fire power is any substitute for good marksmanship. If you miss with one gun, it is likely that you will miss with all.)

Because of the speed of planes versus bullets, and the rapid deceleration of the bullets, it is futile to fire at long ranges. Add to this the dispersion of the bullets and the limits of accuracy of the gunner, and you can readily understand why 1,000 feet is established as the present maximum effective range. The best range, however, is even closer to the target—the point nearest the target where smooth, easy flight can be maintained.

Diagram (E) illustrates such a condition. Under these circumstances it first appears difficult to read range between the circles and crossing lines. On second thought, however, even this can be made simple. Just visually project the wingspan (or fuselage as the case may be) up or down and read as usual. The projecting may be done either vertically or obliquely.

★ DIAGRAM E ★



Although a target traveling at a 45° angle to your line of flight will appear foreshortened in both fuselage and wingspan, the tendency to shoot too soon normally will compensate for the apparent decrease in the size of the plane in the ringsight. Actually a target viewed at a 45° angle will appear only about ¾ of its actual size and fire may therefore be opened a split-second sooner than otherwise. (See diagram (F)).

★ DIAGRAM F ★

★ THE RANGE FINDER ★

REMEMBER THAT EITHER WINGSPAN OR FUSELAGE LENGTH CAN BE USED TO ESTIMATE RANGE. JUST USE WHICHEVER ONE IS THE MOST NEARLY FULL-VIEW TO YOU.

When you first learned to drive a car, you probably found it difficult to estimate whether or not it would pass between two obstacles on the road. Similarly, in flying one of the most difficult tasks for you is going to be to wait until you are at 1,000-foot range before opening fire. Firing while still out of range is usually the student fighter-pilot's first mistake and the one he hangs onto most tenaciously. Make it a practice to estimate distances every chance you get, whether you are in a plane, in a car, or on foot.

One of the principal reasons for calibrating the sight in convenient mils is to give yourself a precise way of knowing WHEN you are in range. Take advantage of it. Learn to use it. LEARN TO WAIT.

Thus you can see that once you have RECOGNIZED your target and pigeon-holed it as to characteristics you are able to apply the rules of speed and approach angle correction to get the fight lead and use the gunsight to get RANGE. That's all there is to it — in theory.

The WHO — WHERE — WHEN system now becomes simply a constant challenge that requires nothing but PRACTICE, PRACTICE, and some *more* PRACTICE.

Use your ingenuity to make up all the ways you can of estimating the size of objects and their distances. When you are flying try it on other planes in the air. Practice sighting on other aircraft.

GET ALL YOU CAN OUT OF YOUR WORK WITH CAMERA GUNS. ASK YOUR INSTRUCTOR TO ANALYZE YOUR FILMS WITH YOU. FILMS TELL YOU PLENTY:

(1) THE RANGE at which you opened fire and ceased firing.

(2) THE ANGLE at which you fired.

(3) Whether you had enough lead.

(4) Whether your aim was correct.

WHO—WHERE—WHEN . . . WHO—WHERE—WHEN . . . Think of them every time you see a plane in the air, a model on the ceiling, a picture in a magazine, a movie in a classroom. THINK further OF THE ANSWERS TOO. Learn to recognize every plane. Know its speed, its size, its lead.

FRIEND OR FOE, SIZE AND SPEED.

★

WHERE DO I AIM TO HIT (LEAD AND FIRING ANGLE).

★

WHEN IS IT IN RANGE? *TIME TO FIRE!*

★ TARGET LEAD AND RANGE TABLE ★

GERMAN AIRCRAFT

WHO — WHERE — WHEN

CLASS	MANUFACTURER	NUMBER	SPEED CRUIS. M.P.H.	SPEED MAX. M.P.H.	RADII LEAD CRUIS.	RADII LEAD MAX.	LENGTH	WING SPAN
FIGHTERS	FOCKE-WULF	FW 190	210	390	2.	4.	29′	40′
	MESSERSCHMITT	ME-109F	210	390	2.	4.	30′	33′
	MESSERSCHMITT	ME-109G	220	400	2.	4.	30′	33′
	MESSERSCHMITT	ME-110	200	350	2.	3.5	40′	53′
	MESSERSCHMITT	ME-210	210	360	2.	3.5	40′	53′
	JUNKERS	JU 88C5	205	350	2.	3.5	47′	66′
BOMBERS	DORNIER	DO-217E	210	320	2.	3.	57′	63′
	FOCKE-WULF	FW 200K	170	250	1.5	2.5	78′	108′
	HEINKEL	HE-111-HAE	200	250	2.	2.5	54′	74′
	HEINKEL	HE 177	220	300	2.	3.	64′	103′
	JUNKERS	JU-88A6	210	290	2.	3.	47′	66′
RECON. & TRANSP.	FOCKE-WULF	FW 189	170	210	1.5	2.	39′	60′
	JUNKERS	JU 52	130	160	1.5	1.5	62′	96′
	JUNKERS	JU 90	150	210	1.5	2.	86′	115′
NAVAL	ARADO	AR-196	120	190	1.	2.	36′	41′
	BLOHM & VOSS	BV-138	120	170	1.	1.5	65′	89′
	DORNIER	DO-26	140	210	1.5	2.	81′	99′
	HEINKEL	HE 115	110	210	1.	2.	57′	76′
GLIDERS	DFS	230	80	170	1.	1.5	37′	72′
	GOTHA	GO-242	80	150	1.	1.5	53′	79′

★ TARGET LEAD AND RANGE TABLE ★

JAPANESE AIRCRAFT

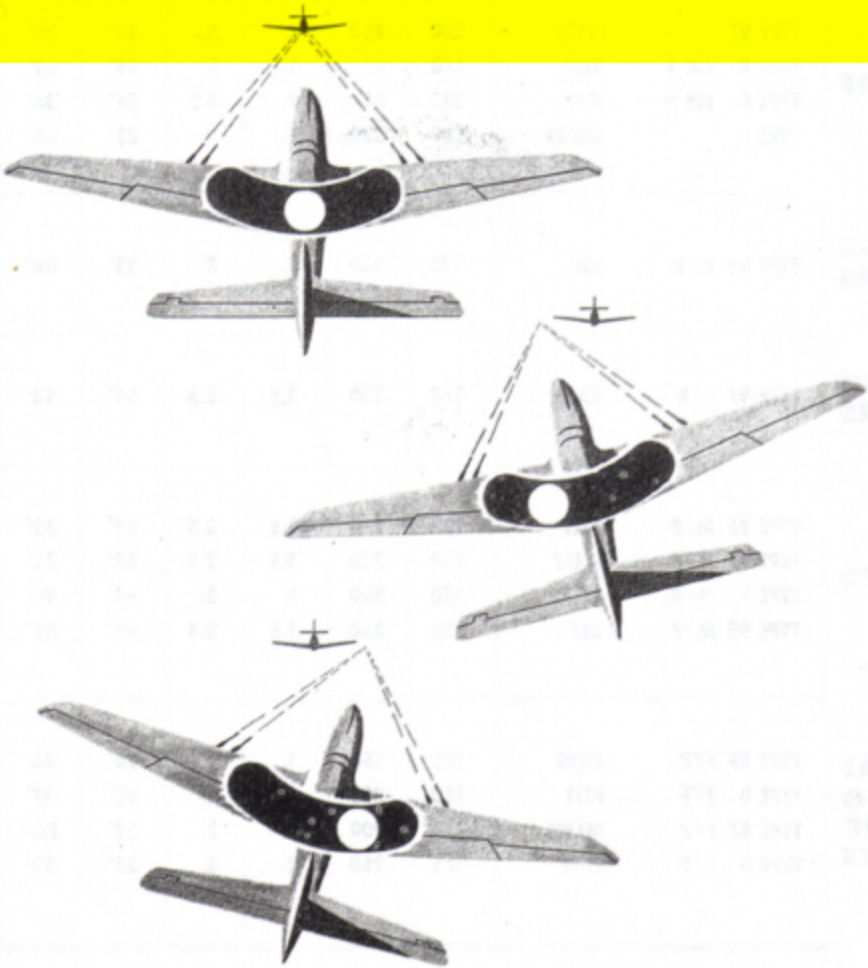
WHO			WHERE				WHEN	
			SPEED		RADII LEAD			
CLASS	TYPE, NUMBER	— ALIAS	CRUIS. M.P.H.	MAX. M.P.H.	CRUIS.	MAX.	LENGTH	WING SPAN
FIGHTERS	TYPE 97	NATE	200	280	2.	3.	24′	36′
	TYPE 0 MK 1	ZEKE	170	325	1.5	3.	29′	39′
	TYPE 0 MK 2	HAP	210	340	2.	3.5	28′	36′
	TYPE 1	OSCAR	180	320	2.	3.	28′	36′
DIVE BOMBERS	TYPE 99 D/B	VAL	190	240	2.	2.5	33′	48′
TORPEDO BOMBERS	TYPE 97 T/B	KATE	150	230	1.5	2.5	34′	52′
BOMBERS	TYPE 96 M/B	NELL	160	230	1.5	2.5	54′	82′
	TYPE 97 M/B	SALLY	150	240	1.5	2.5	52′	72′
	TYPE 1 M/B	BETTY	210	300	2.	3.	64′	80′
	TYPE 99 M/B	LILY	150	240	1.5	2.5	41′	57′
FLOAT PLANES & FLYING BOATS	TYPE 95 F/P	DAVE	125	150	1.	1.5	28′	36′
	TYPE 0 F/P	PETE	150	200	1.5	2.	31′	37′
	TYPE 97 F/P	MAVIS	110	200	1.	2.	82′	131′
	TYPE 0 F/P	RUFE	175	280	2.	3.	35′	39′

★ SLIP AND SKID ★

You have to keep the turn and bank indicator ball in the middle if you are to make your bullets hit. As long as the ball is in the middle your bullets go where you aim.

If the ball is not in the center even though you think you are flying a straight and level course your bullets go to one side.

Until you can fly naturally, with the ball in the middle, you will never hit the enemy, no matter how good your gunnery is. There is but one rule to follow: If the ball is in the middle, fire; if it is not, put it there before you squeeze the trigger.



★ LINE OF FLIGHT ★

Airplanes don't always fly in the direction in which they are pointing. You have to put your dot ahead of where the target will be when your bullets get there and not ahead of where he is pointing. A smart enemy will slip and skid all over the place to put you off your aim. Every time he kicks hard rudder to purposely turn from the direction he is going you will be tempted to lead along the line of apparent flight. As an actual fact he will still make good his original course and no change in deflection is required.

One way of getting the direct line of flight is to watch the streaks made by the sky or landscape in the background. There will be streaks or lines behind the enemy plane, especially when he is in a turn. It will take practice but by watching the lines of streaks and by getting your dot ahead of those lines rather than ahead of where the enemy is pointing your bullets will hit steel instead of sky.