SIGHTING AND SIGHTS

RESTRICTED

Don't shoot from the hip . . .

In the excitement of combat too many gunners spray their bullets at the enemy like a movie cowboy shooting from the hip. **Don't do it.**

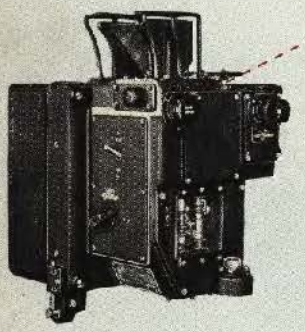
Use your sight—and use it correctly—or you won't stand a chance of hitting. You will only throw away ammunition on which your life may depend.

Firing a gun from a fast moving bomber is far different from shooting on the ground. Except for one very rare case, you can't possibly hit a fighter by pointing your gun straight at him. You must aim a certain distance away, called **deflection.** To apply the right amount of deflection you use your sight.

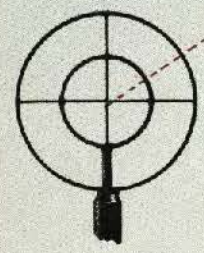
Two main types of sights are used by air gunners. **Computing sights** calculate the deflection automatically. You make certain adjustments. The sight does the rest. How to use computing sights is explained in the last part of this section.

But if your guns have **ring sights,** you must measure off the deflection yourself. You can only do so by using the accurate and combat-tested method of sighting called **Position Firing,** which is explained in these pages.

Ring sights fall into two classes. One kind—the iron sight—is simply an iron ring near the back of the gun which you line up with a bead on a post at the front of the gun. The other kind—the reflector sight—uses a system of lenses to make the ring, the center bead and the enemy fighter all appear on the same glass screen.



Some sights, both iron and reflector, have one ring. Others have two rings, and the newest Army Air Forces sights have three rings. But Position Firing works with all of them, regardless of the number of rings. This section is illustrated with a three ring reflector sight. Once you know the rules of Position Firing, you will have no trouble applying them with any other type of ring sight. The principle remains the same. Always remember that no matter how good a shot you are on the ground, you can never shoot down an enemy fighter who is making a continuous attack on you unless you **use your sights correctly** and follow the rules of Position Firing. There is only one exception—dumb luck—and that isn't good enough. The enemy may be lucky first.



POSITION FIRING

When the fighter attacks . . .

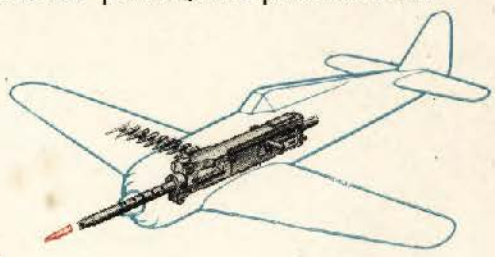
When you see an enemy fighter like this, with his guns blazing, you won't have time to think about the rules of Position Firing. You will have to know them so well that you act as quickly and automatically as your gun.

Fortunately, Position Firing boils down to three simple rules.

They have been proved in combat and scientifically checked. They work—better than any other system of sighting.

You may run into gunners who use other methods or no method at all. However, if there is a ring sight on your gun, this is the way to use it against a fighter making a direct and continuous attack on you.

If you follow the rules of Position Firing, you can get your mission through and get yourself safely home. But you will have to know these rules letter-perfect, and practice them until they become second nature.



. . . he is a flying gun

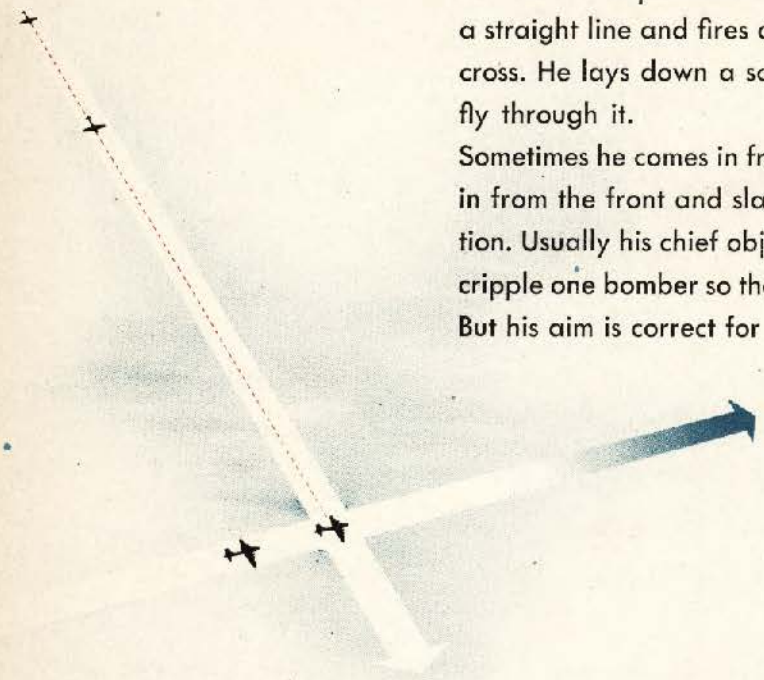
To understand Position Firing, it is necessary to know what the fighter does when he attacks a bomber.

His guns are fixed. They are mounted in his wings and fuselage, pointing straight ahead. To aim them, he must aim his entire plane. He is really nothing but a flying gun.

To hit you, he must point his nose at a spot ahead of the nose of your bomber, so that his bullets will be there by the time you get there.

To do this he can make a **fly-through attack,** or he can fly a **pursuit curve.**

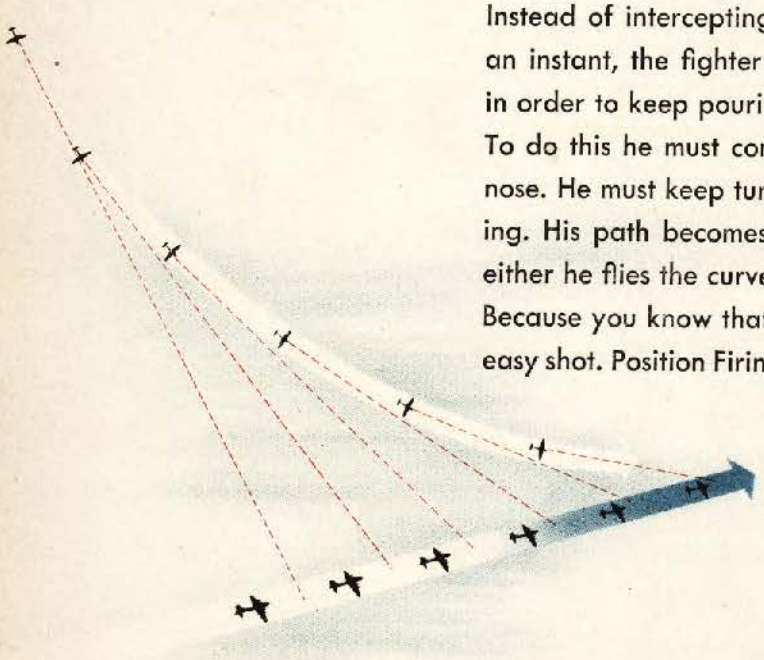
Fly-through attacks . . .



. . . are as simple as this picture indicates. The fighter flies in a straight line and fires at a point he expects your bomber to cross. He lays down a screen of fire and hopes that you will fly through it.

Sometimes he comes in from the side, like this. Often he comes in from the front and slams right through the bomber formation. Usually his chief object is to break up the formation or to cripple one bomber so that he can pick it off when it straggles. But his aim is correct for only an instant.

Pursuit curve attacks . . .

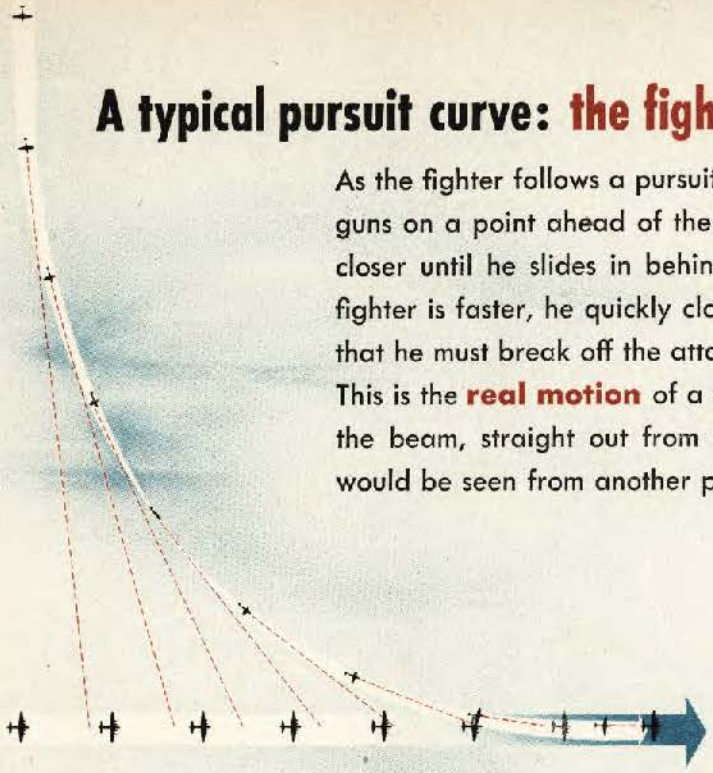


. . . develop like this. They are the standard type of fighter attack, and the most dangerous.

Instead of intercepting your bomber with his bullets for just an instant, the fighter tries to maintain a continuous attack, in order to keep pouring a constant stream of bullets at you. To do this he must continue to point ahead of the bomber's nose. He must keep turning in the direction the bomber is flying. His path becomes a smooth curve. He has no choice—either he flies the curve or his bullets won't keep hitting.

Because you know that he must fly this curve, he becomes an easy shot. Position Firing tells you how to hit him on that curve.

A typical pursuit curve: the fighter does this



As the fighter follows a pursuit curve, continually keeping his guns on a point ahead of the bomber, he moves closer and closer until he slides in behind the bomber's tail. Since the fighter is faster, he quickly closes in. Finally he gets so close that he must break off the attack.

This is the **real motion** of a fighter on a pursuit curve from the beam, straight out from the side of the bomber, as it would be seen from another plane high overhead.

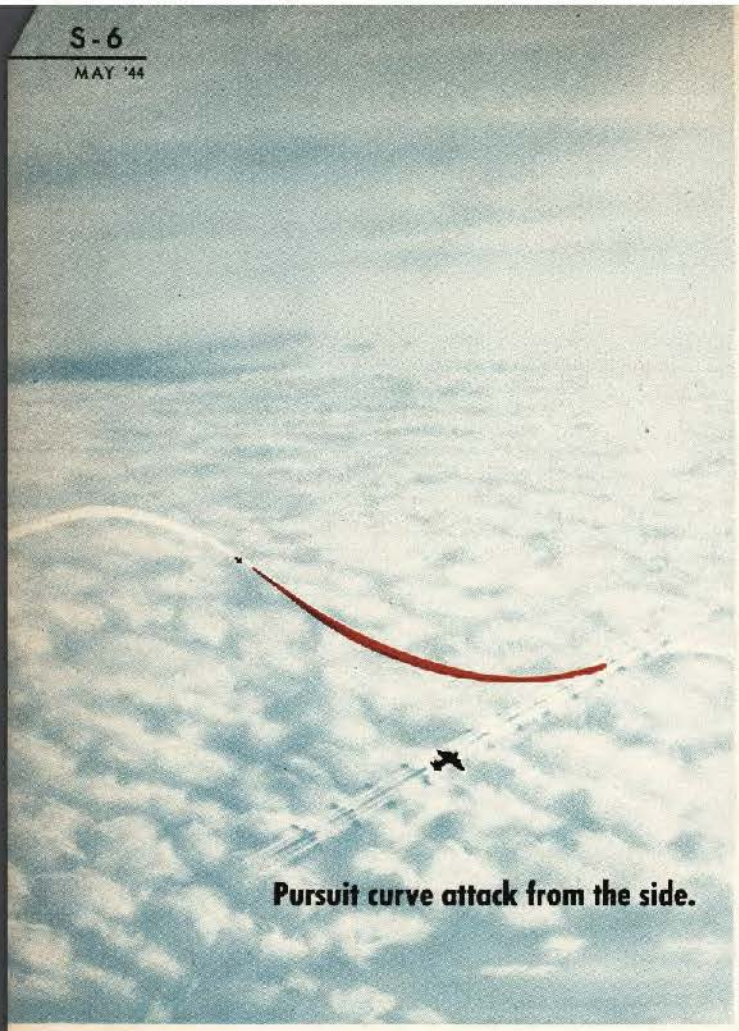
A typical pursuit curve: the gunner sees this

To the gunner, the fighter flying a pursuit curve always appears just about head-on. This is the one sure way to spot an attack.

Although the fighter really flies in a curve, he always looks to you as though **he slides sideways, in a straight line, toward your bomber's tail.** This is the line of the fighter's **apparent motion.**

He also keeps getting bigger, because he is coming closer—fast.

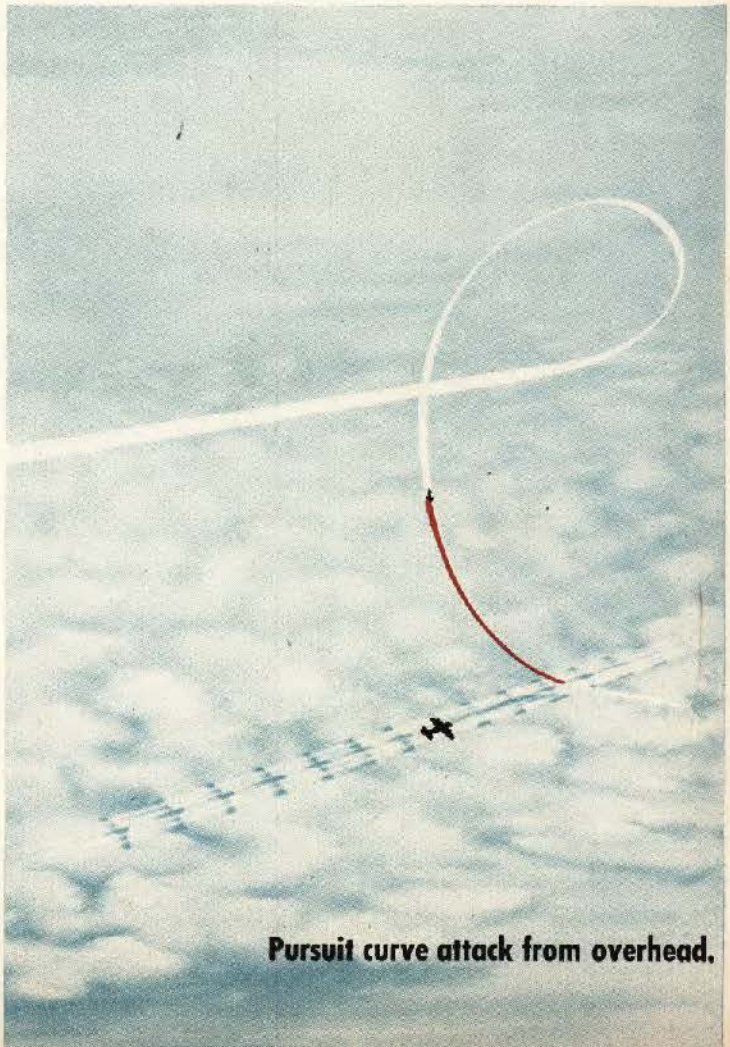
To you in the bomber, the beam attack above looks like this.



Pursuit curve attack from the side.

Pursuit curve attack from the bow.

Pursuit curve attack from the tail.



Pursuit curve attack from overhead.

Fighters will try anything . . .

They may come in from the side, the bow, the tail, or even from overhead. But all these attacks have one thing in common, as shown on the opposite page. No matter from what direction the fighter approaches, he must maneuver into a position where he can get his guns bearing on you.

To keep them bearing he must fly a pursuit curve.

That is the part of the attack where he is really dangerous to you,
and fortunately, that's where Position Firing makes him easiest for you to hit.

Remember, you are moving too . . .

This is not as self-evident as it seems, because when you are flying in a bomber, you're rarely conscious of your own motion.

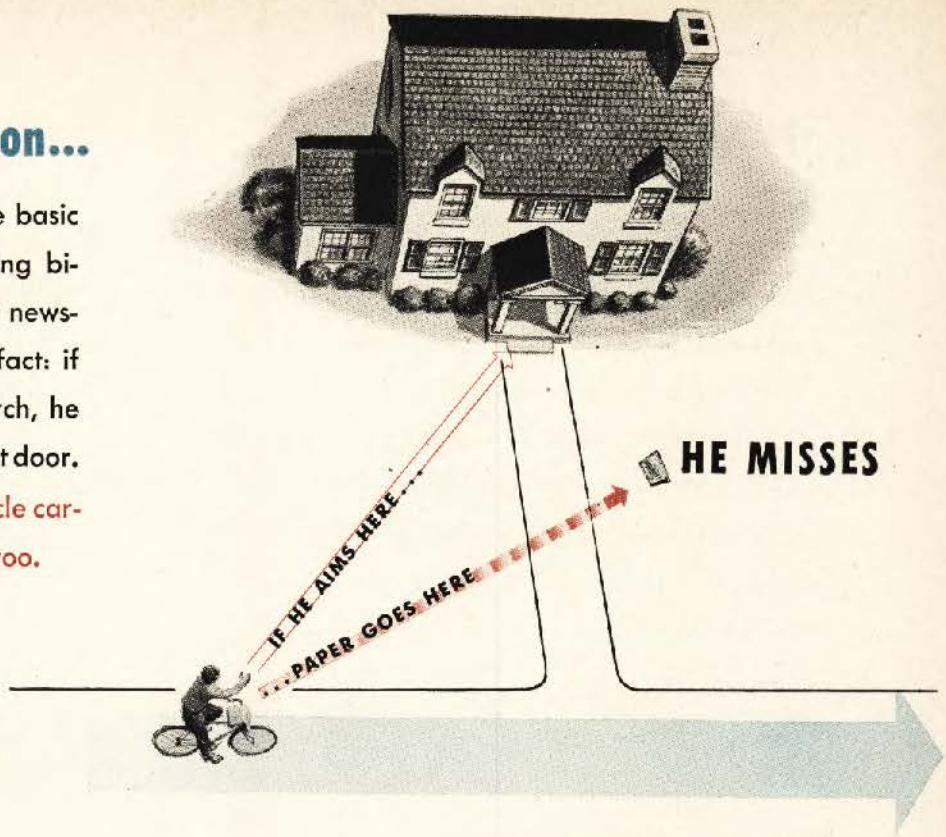
But the simple fact that you are moving at high speed is of the greatest importance in learning where to aim.

Believe it or not—

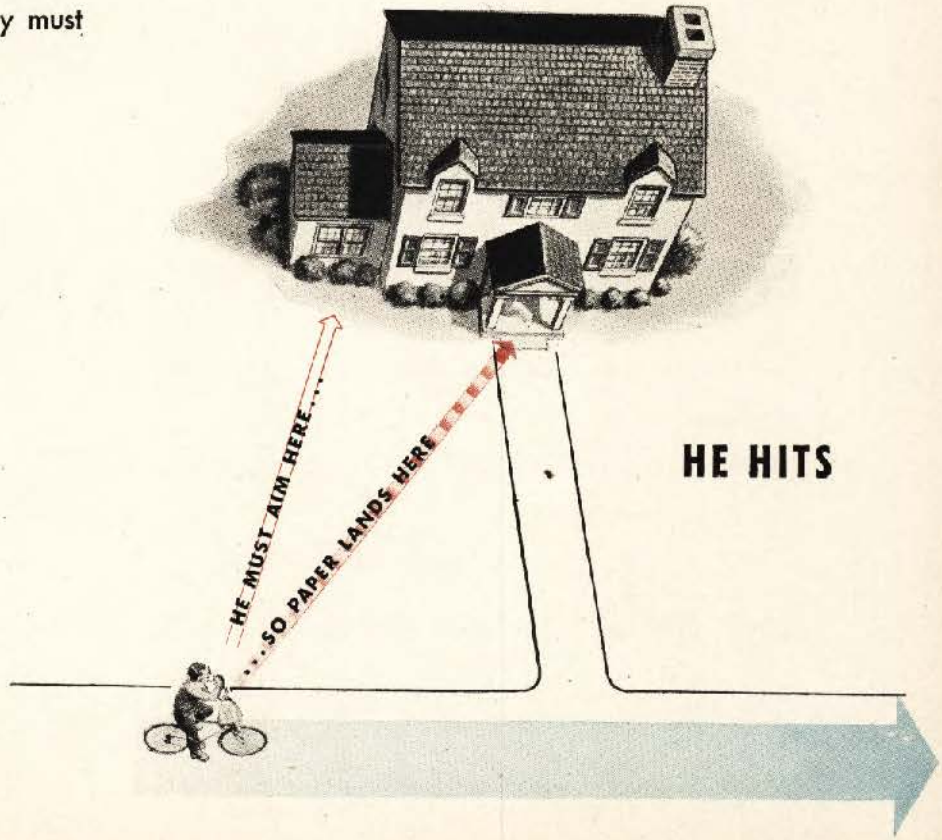
Your bullets do not go where you point your gun.

The newsboy's lesson...

Every newsboy soon learns the basic trick of aiming from his moving bicycle. The first time he tosses a newspaper he discovers a simple fact: if he aims directly at a front porch, he misses, and the paper lands next door. The forward motion of his bicycle carries the newspaper forward, too.



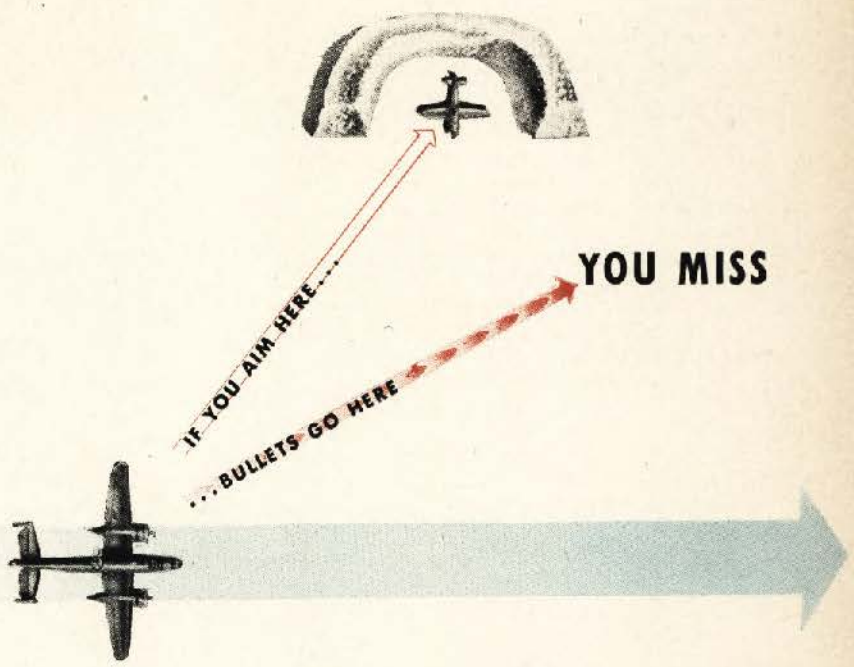
To hit the porch, the newsboy must aim like this



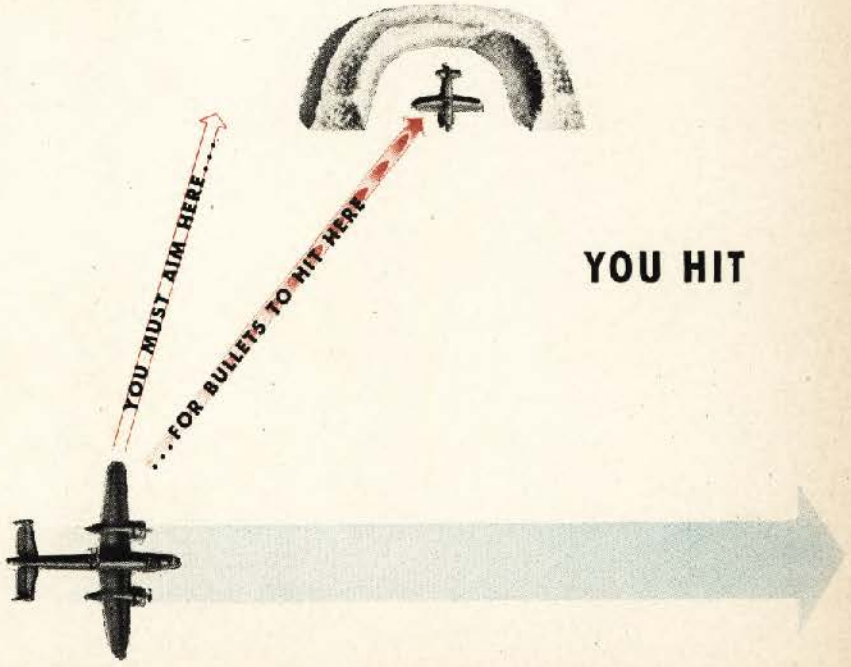
...applies to bombers, too

The same thing happens to a bullet fired from a moving plane. Before the bullet is fired, it is carried forward in the same direction as the bomber. When the gun is fired, the bullet shoots out of the barrel in a different direction. As soon as it leaves the muzzle, the bullet turns and follows a path between those two directions. It keeps the forward motion given it by the moving bomber.

You will miss if you fly over a field and shoot like this at a fighter on the ground.



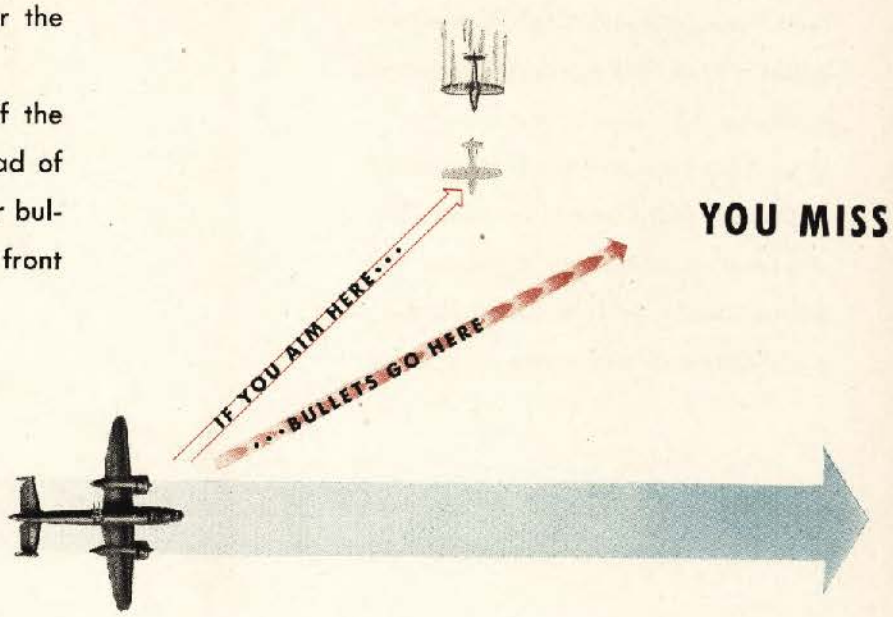
To hit, you must aim like this.



Hitting a moving fighter...

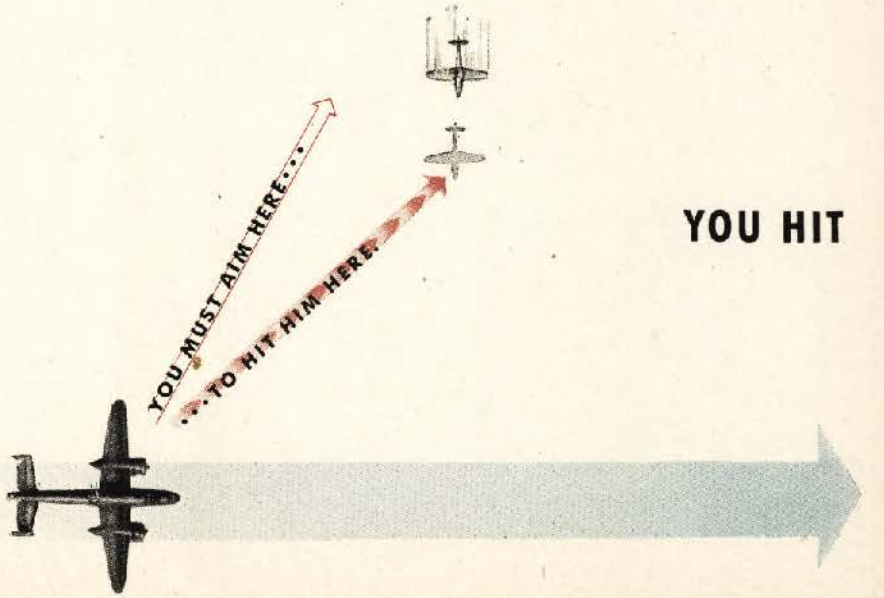
If the fighter is moving toward your bomber, you must still allow for the forward motion of your bullet.

If you aim at a point ahead of the moving fighter, as you aim ahead of a running fox, you will miss. Your bullets, carried forward, will pass in front of the fighter.



YOU MISS

To hit, you must aim like this. Then the fighter and your bullets will arrive at the same place at the same time.

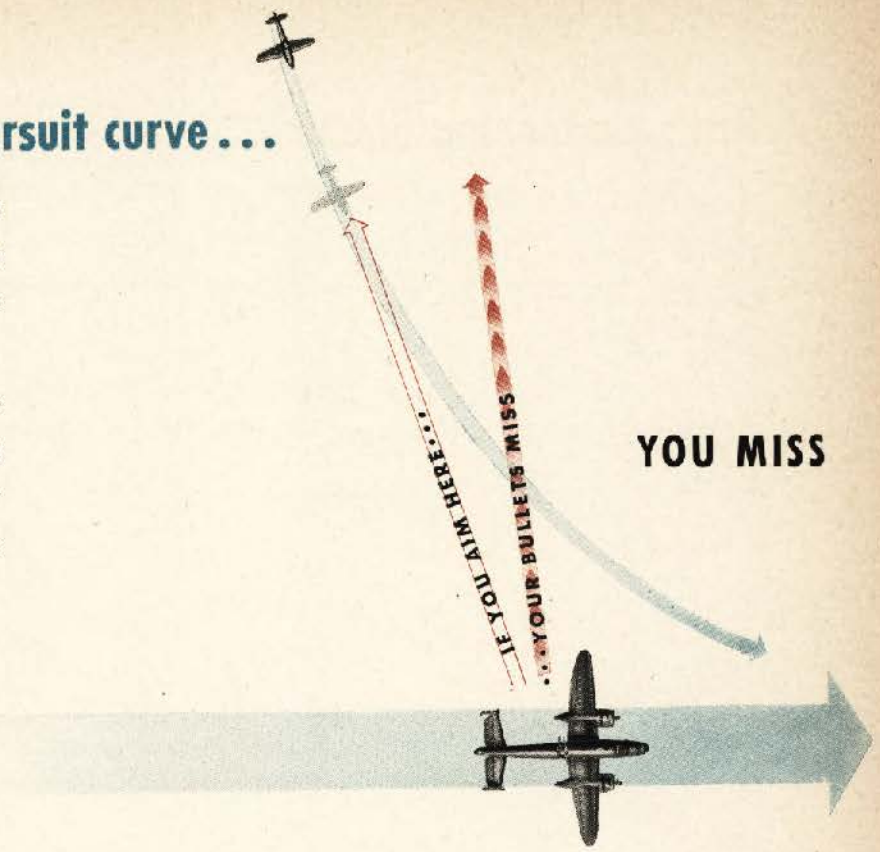


YOU HIT

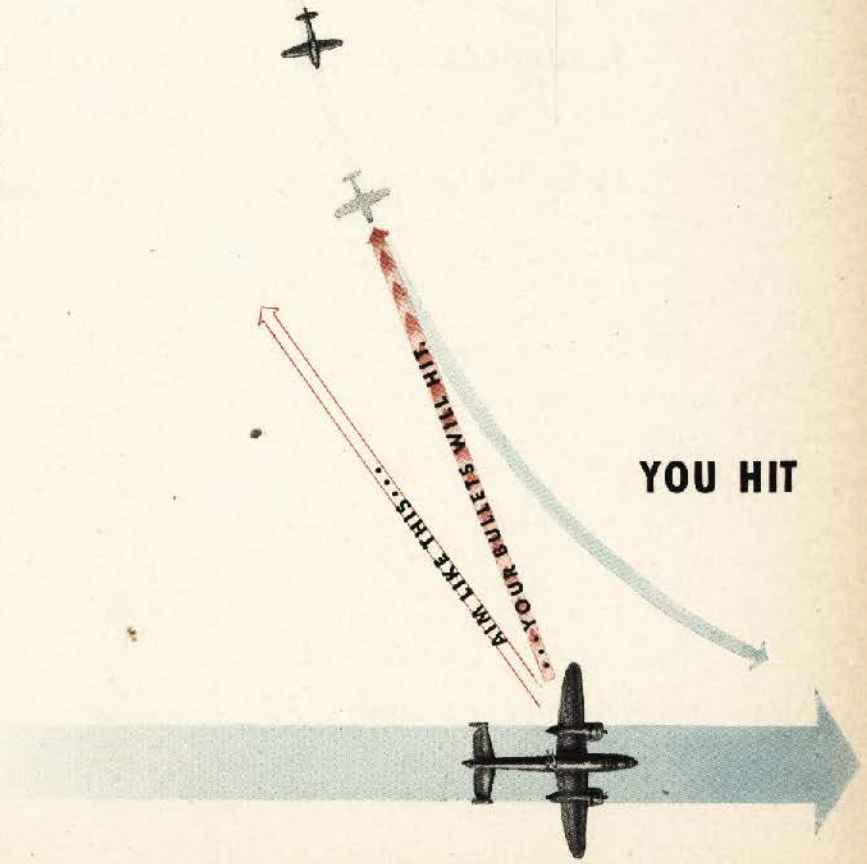
Hitting a fighter on a pursuit curve . . .

If the bomber and fighter are both in the air, and the fighter is making a pursuit curve attack, the same principle holds.

If you try to lead ahead of a fighter, as you ordinarily would aim at a flying duck, you will miss, because your bullet, carried forward by your own speed, goes ahead of him.



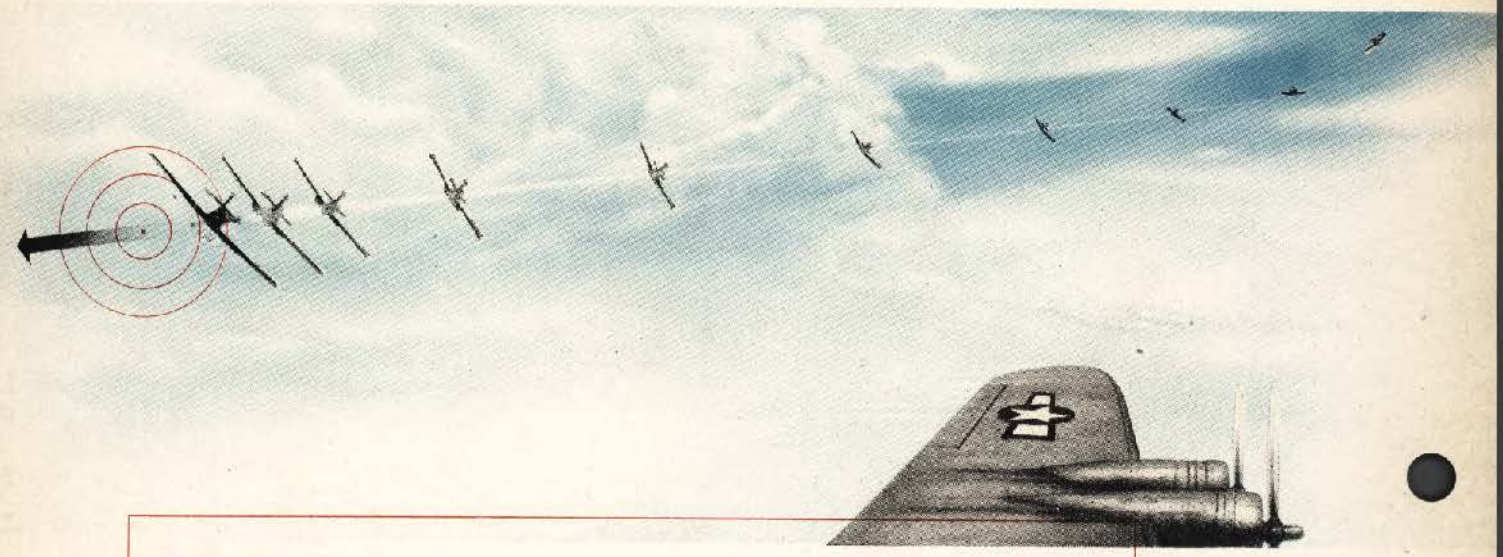
To hit you must aim like this. Position Firing corrects for the distance your bullet is carried forward so that it will meet the fighter instead of passing in front of him.



Where you aim . . .

You have seen in the preceding pages, that if you shoot in any direction other than dead ahead or dead astern, your bullets do **not** go where you aim. The bullets not only move away from your gun, but they are also carried forward—and they are carried forward regardless of whether you fire to the side, above, or below.

Like the boy on the bicycle, you must always allow for this forward motion. Make this allowance by using the **first rule** of Position Firing:

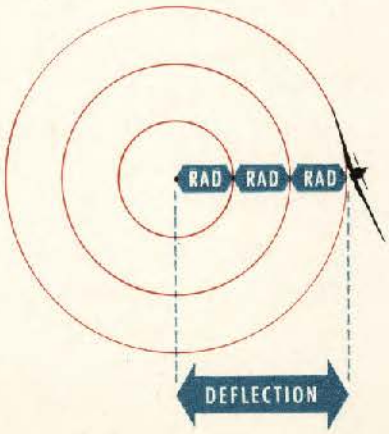


Always aim between the attacking fighter and the tail of your own bomber along the line of the fighter's apparent motion

This line of his apparent motion is always in the direction of that spot on the horizon toward which your bomber's tail points.

Rads . . .

The amount you aim away from the fighter is called **deflection.** It is measured in **Rads**—the distance between the center and the inner ring, or the distance between two rings in your 35-70 mil ring sight.



The right deflection

varies in accordance with your own bomber's speed. When your bomber's normal speed is 200 knots, the right deflection will vary from 3-0 rads, depending on the direction of the fighter's attack.

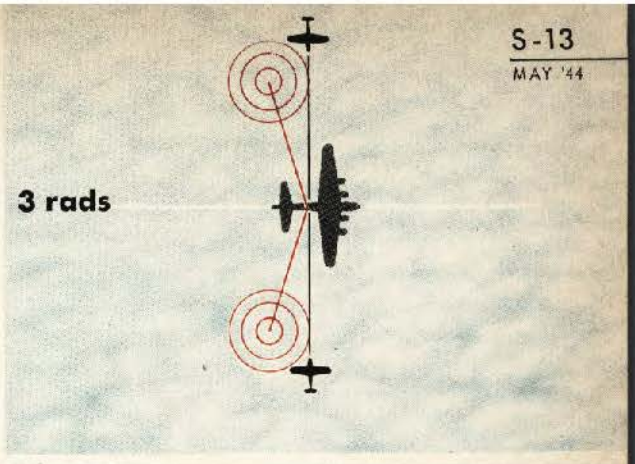
Therefore the Second Rule is:

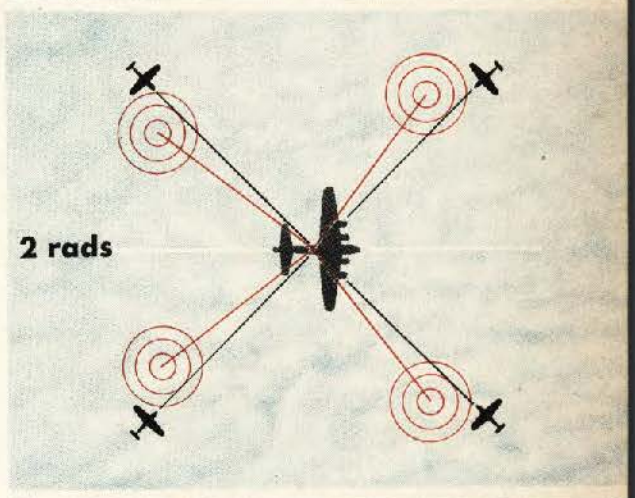
Use the right amount of deflection

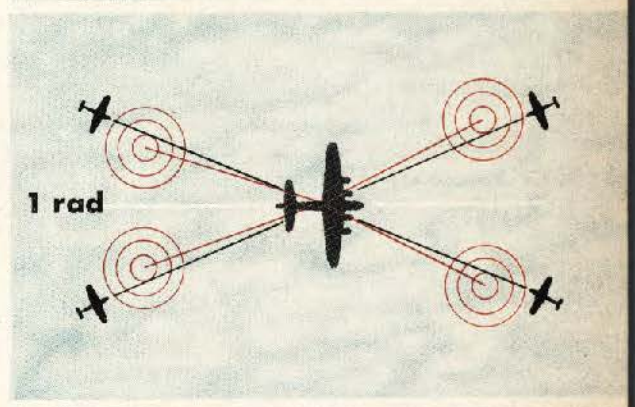
If you are flying in a bomber whose speed is 200 knots and fire at a ninety degree angle—straight out from the beam—you must make the maximum allowance of 3 rads for the amount the bullet is carried forward. When you fire dead ahead or dead astern, the forward motion of your bomber does not change the direction of your bullet; therefore, the direction is 0 or point blank.

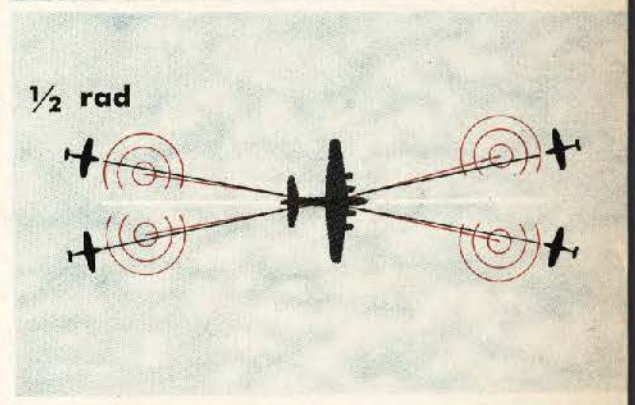
At any other angle in between, the right amount of deflection is somewhere between 3 and 0 rads.

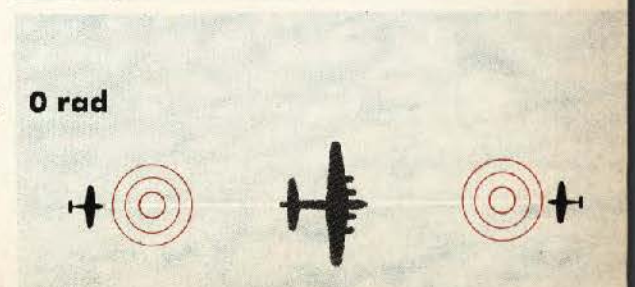
Learn the deflections for the key directions of attack shown alongside. When you are assigned to a squadron you must learn the right deflections in accordance with the normal speed of the bombers in your squadron.

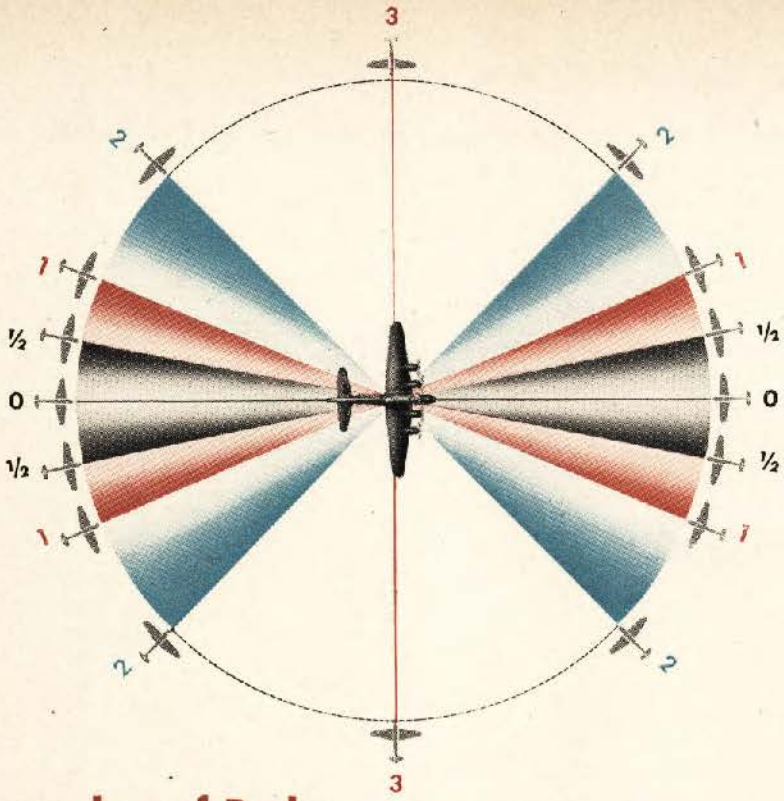








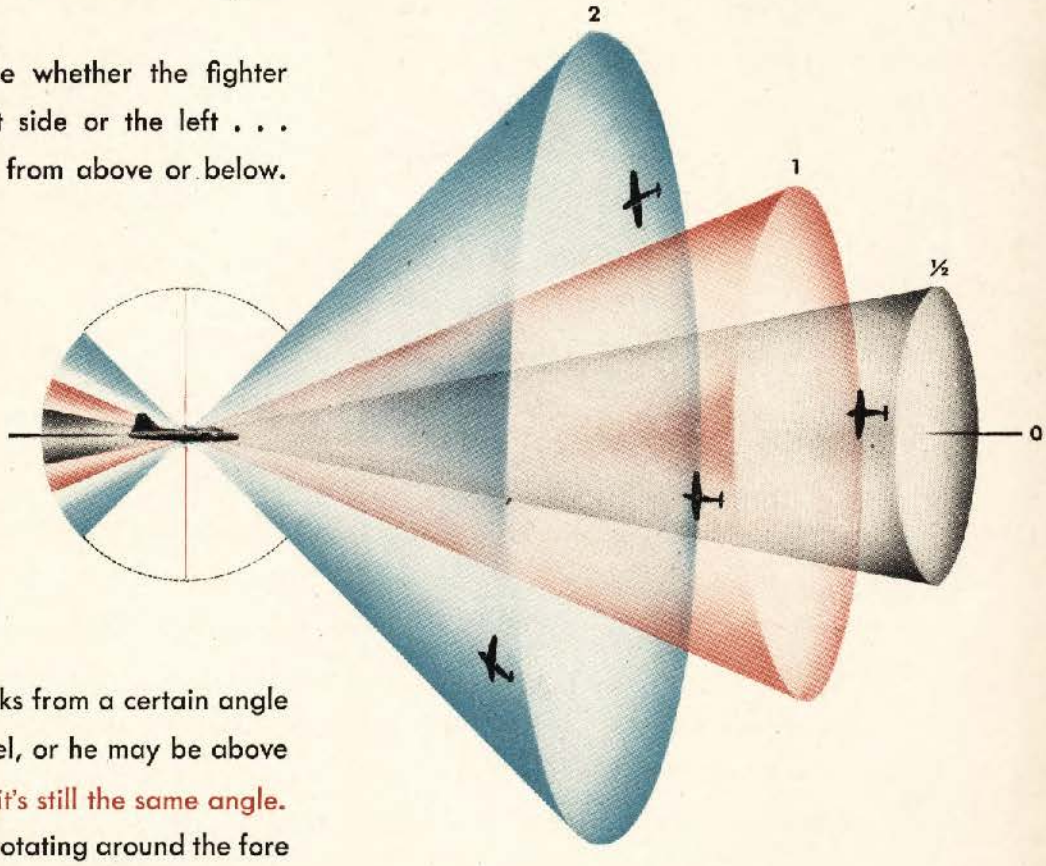




The number of Rads...

always depends on the fighter's angle to your fore and aft axis.

It makes no difference whether the fighter attacks from the right side or the left . . . or whether he attacks from above or below.

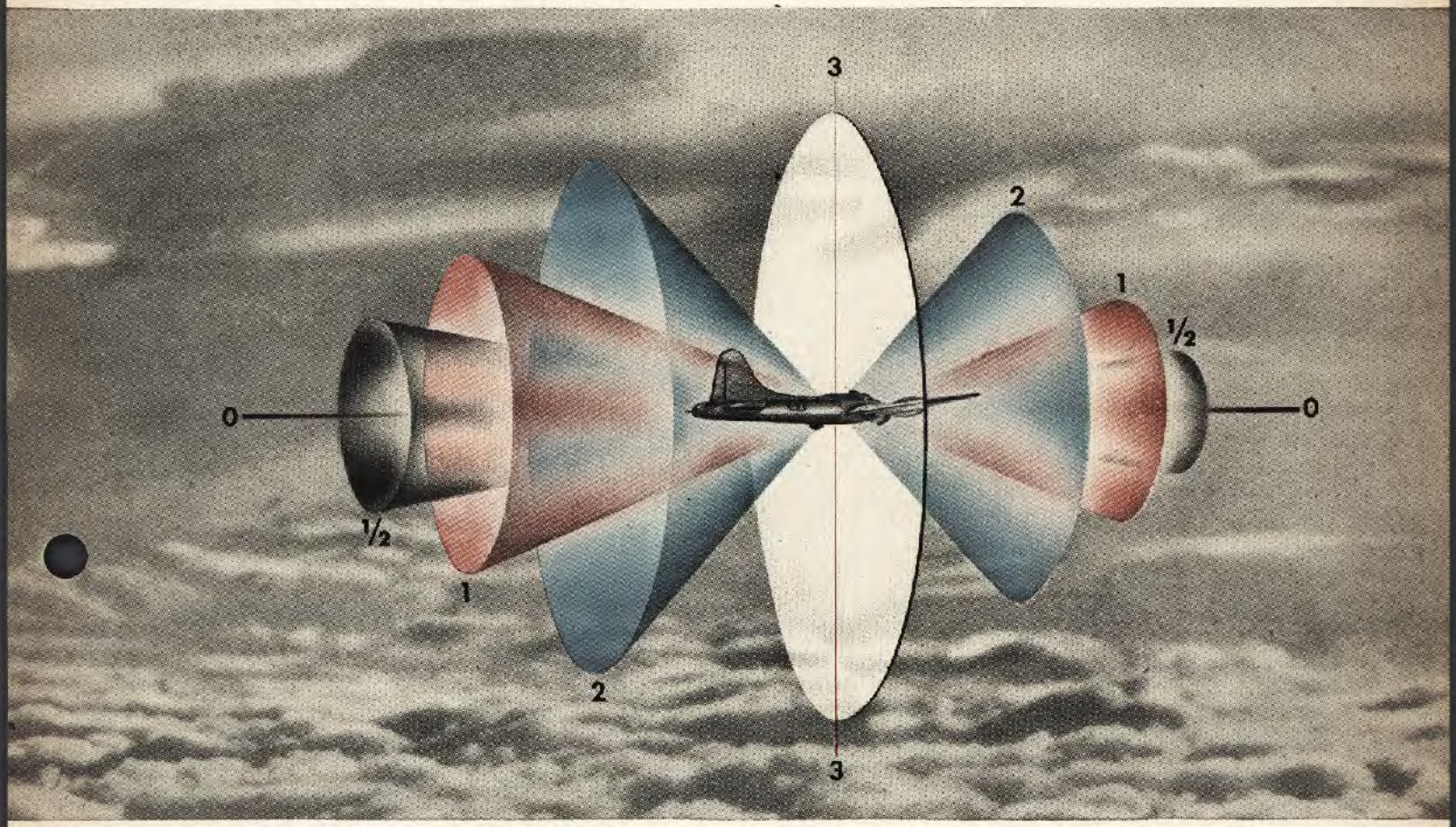


When the fighter attacks from a certain angle he may be at your level, or he may be above you or below you. But it's still the same angle. Think of that angle as rotating around the fore and aft axis of your bomber so that it forms **the surface of a cone.**

The cones tell you the deflection...

Think of the key directions of attack as surfaces of cones which go out into the sky around your bomber, both behind and in front of you.

Remember these imaginary cones by their numbers—½, 1, 2, 3. The number of the cone gives you the deflection in rads for any fighter on the surface of that cone, whether he attacks from the right or the left; high, level, or low, based on your bomber's speed.



Know your true airspeed...

Changes in the speed of the fighter on the pursuit curve do not change your deflection.

BUT CHANGES IN YOUR TRUE AIRSPEED DO CHANGE YOUR DEFLECTION.

The deflections shown above are correct for 200 knots true airspeed of the bomber.

To hit an attacking fighter on cone ½—off your fore-and-aft axis—use ½ rad deflection.

For a fighter on cone 1, use 1 rad, and for a fighter on cone 2, use 2 rads of deflection.

The 3 rad position—at right angles to your line of flight—is a wheel rather than a cone.

But the same rule applies: for a fighter in this position, use 3 rads of deflection.

(A good rule of thumb to remember is:—For each 25 knots increase in bombers speed, increase deflection ⅓ rad. For each 25 knots decrease in bombers speed, decrease deflection ⅓ rad.)

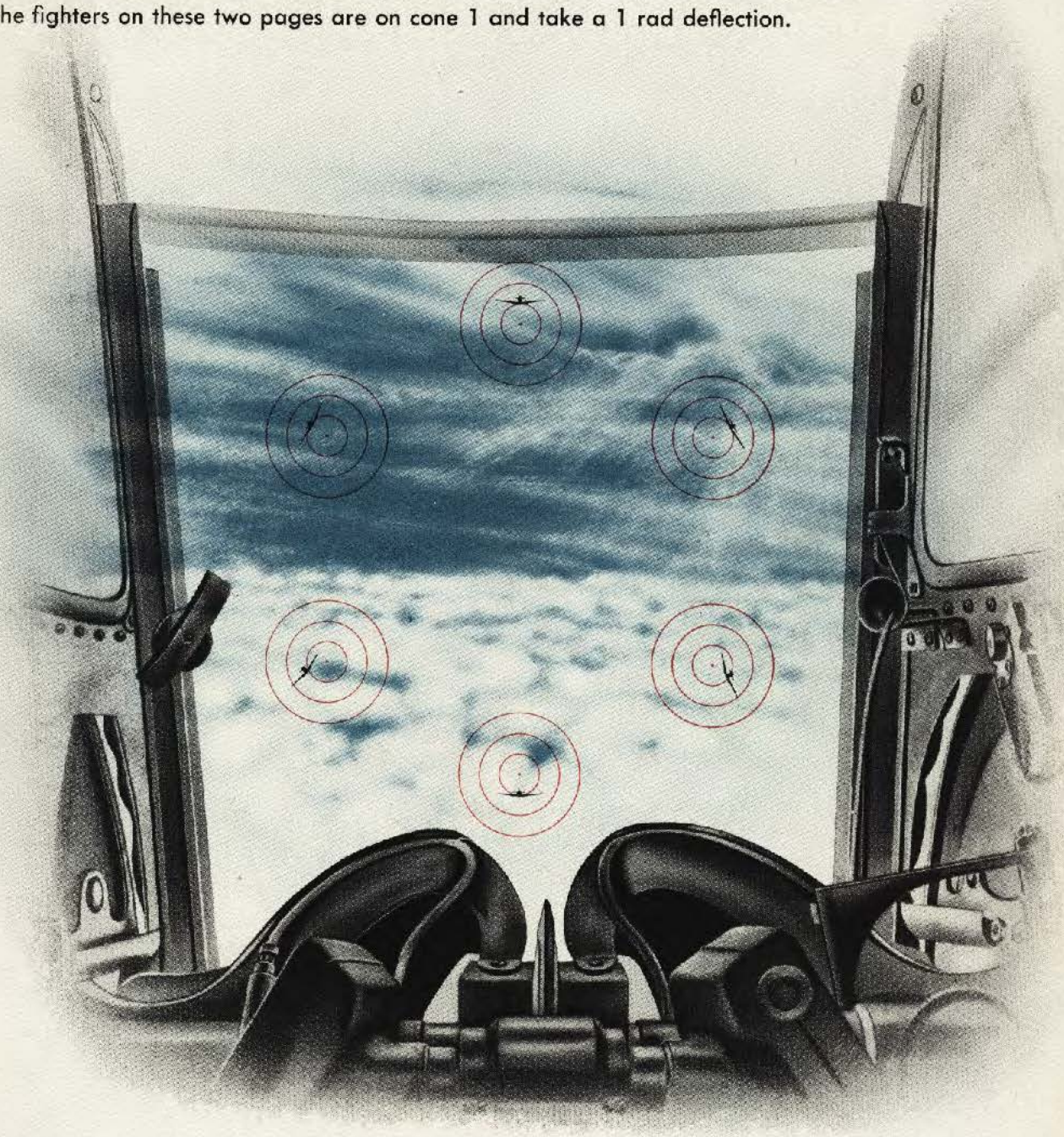
Check your true airspeed with your pilot, navigator or bombardier.

The illustrations on these two pages demonstrate how to apply Rules 1 and 2—using the three-ring optical sight which is shown in all the drawings in this section.

Note, on both pages, how the deflection is laid off in the direction of the tail of your bomber (Rule 1).

Note also how all fighters coming from the same angle are given the same deflection (Rule 2)—regardless of whether they come from above, below, or to one side.

All the fighters on these two pages are on cone 1 and take a 1 rad deflection.



The tail gunner aims like this . . .

On tail attacks you always aim **inside** the fighter. When he dives on you, aim below him. When he climbs on you, aim above him. In these illustrations, of course, the sliding motion of the fighter toward the bomber's tail cannot be seen. But the point of aim has been placed along his line of apparent motion.

In attacks from the front, the fighter's line of apparent motion is still in the direction of your bomber's tail.

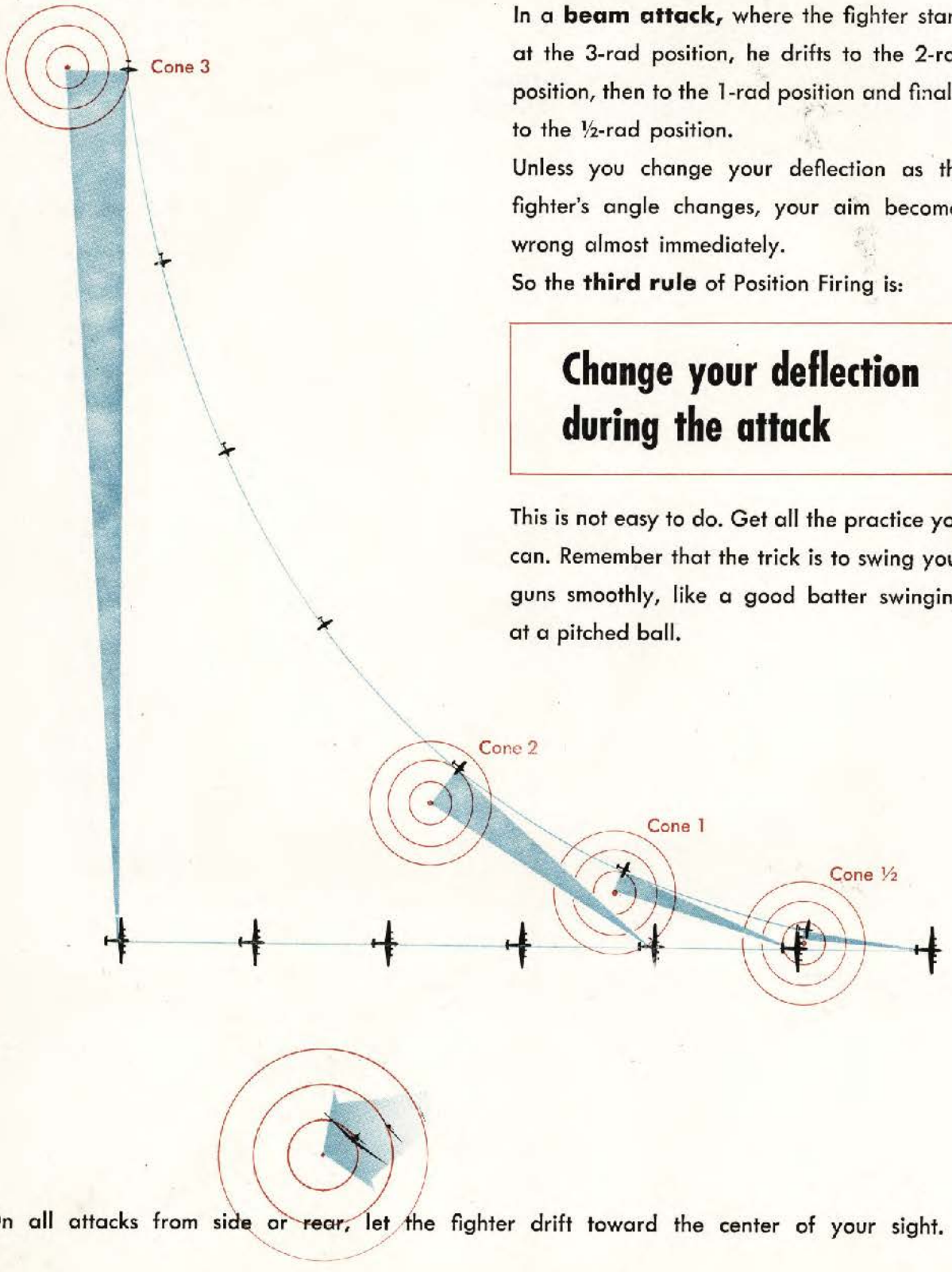
If you have trouble thinking of aiming in the direction of the tail, just remember to aim away from your bomber's nose—which is the same thing.

The bow gunner aims like this . . .

On frontal attacks, you always aim **outside** the fighter. When he dives on you, aim above him. When he climbs on you, aim below him.

Deflection changes during an attack . . .

The fighter is sliding in from . . .



The fighter never stays on one cone. His pursuit curve always forces him closer to the bomber's tail. During the attack, he moves from one cone to another—and he moves fast.

In a **beam attack,** where the fighter starts at the 3-rad position, he drifts to the 2-rad position, then to the 1-rad position and finally to the ½-rad position.

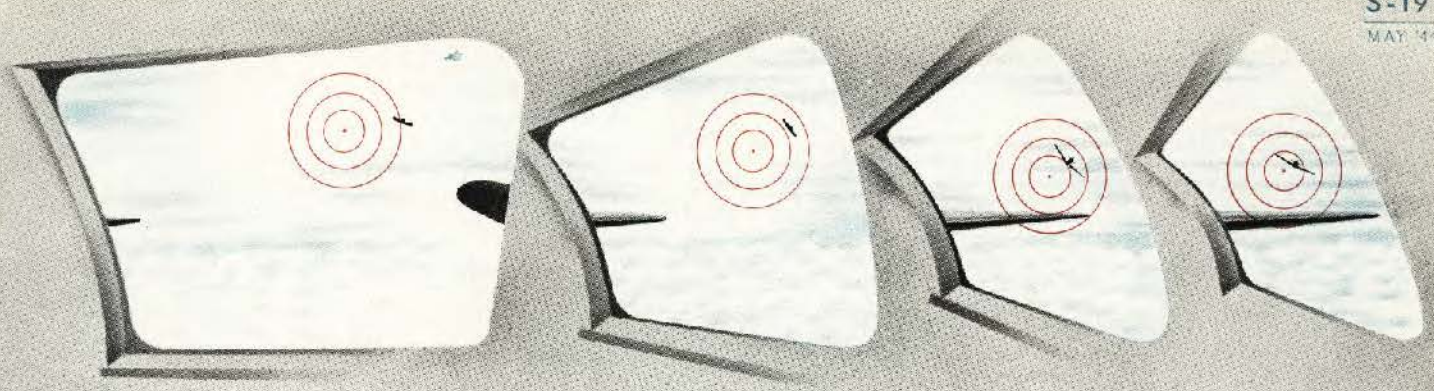
Unless you change your deflection as the fighter's angle changes, your aim becomes wrong almost immediately.

So the **third rule** of Position Firing is:

Change your deflection during the attack

This is not easy to do. Get all the practice you can. Remember that the trick is to swing your guns smoothly, like a good batter swinging at a pitched ball.

On all attacks from side or rear, let the fighter drift toward the center of your sight.



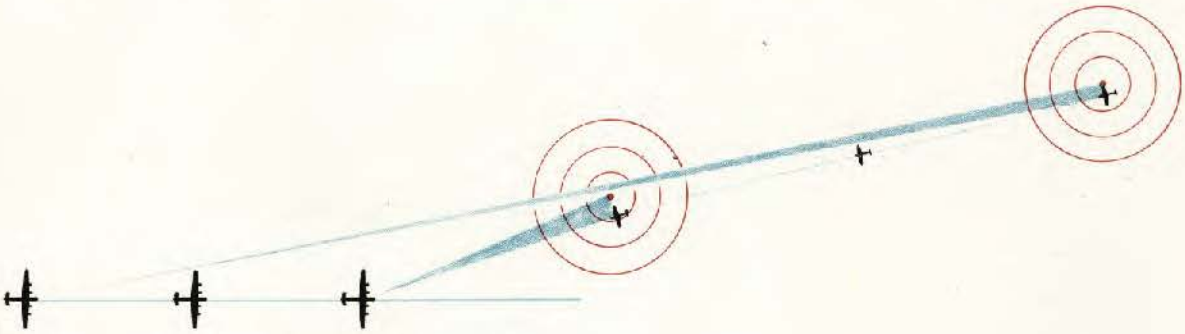
He is on your beam at right angles. Give him 3 rads.

As he slides to Cone 2, reduce your deflection slowly to 2 rads.

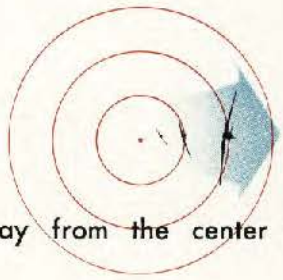
He swings to Cone 1. Follow through smoothly to give him 1 rad.

As he moves to Cone ½, let him slip in to ½ rad.

These pictures show how you change deflection during the beam attack on the opposite page.



If a fighter starts a **bow attack** on Cone ½, he will move very quickly to Cone 1 and even faster toward Cone 2—if he can hold his pursuit curve that long without blacking out.



On attacks from the front, let the fighter drift away from the center of your sight.

When he's on Cone ½, you give him ½ rad.

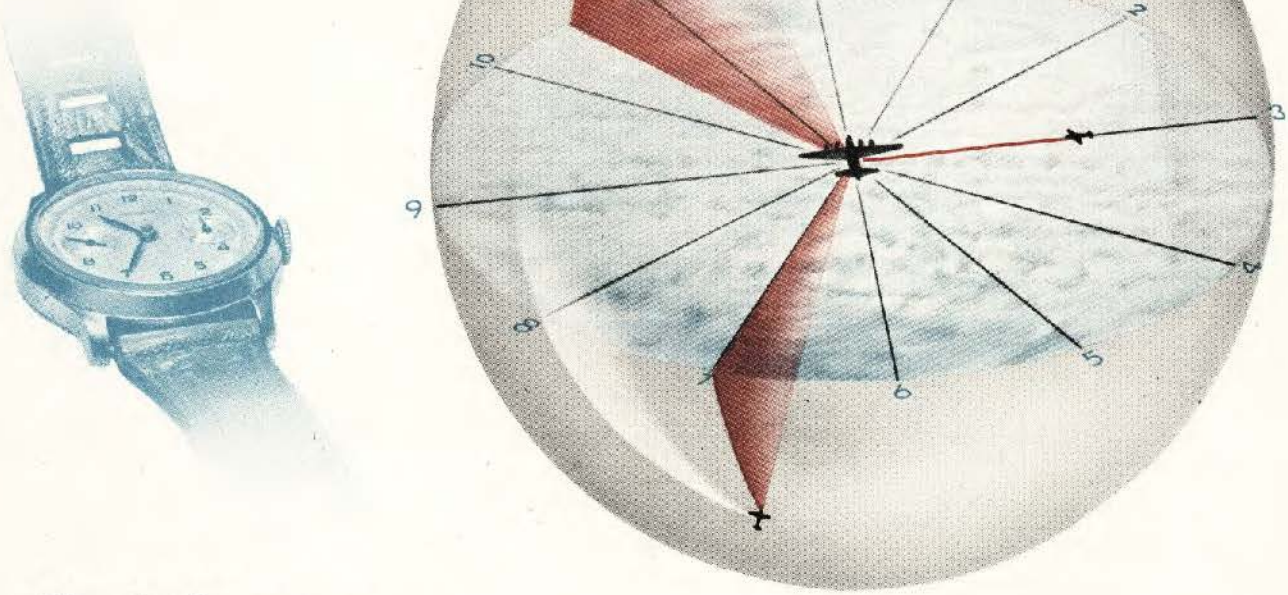
He changes to Cone 1. Let him drift out to the 1 rad ring.

As he whips toward Cone 2, increase deflection to 2 rads.

You've got to be on the ball—or else.

No bomber is safe unless each gunner searches the sky constantly throughout each mission. Search systematically and continuously the portion of sky assigned to you, especially in the sun and in broken clouds, where fighters like to hide. Be ready for any trick from any fighter you see. You are responsible for seeing that your airplane is never surprised.

Bombers and their crews have been needlessly lost because gunners were not watching and let fighters sneak in on them.



The clock system . . .

. . . has nothing to do with the cones. You use it to tell the entire crew when there are enemy fighters in the sky, and exactly where they are.

Simply think of your bomber as flying in the center of a huge clock, the face of which is on a horizontal plane, with the nose pointed toward 12 o'clock and the tail toward 6 o'clock.

If you imagine the hand of this imaginary clock pointing at a fighter you want to locate, the hand will show at what "o'clock" that fighter is.

If you are a tail gunner, don't be confused by the fact that you are riding backward. You are facing 6 o'clock. 3 o'clock is on your **left,** 9 o'clock is on your **right.**

When you spot an enemy, sound off . . .

1. "Bandits"—The word used to call attention.
2. The number of bandits and the type—for example; "two bandit fighters".
3. The approximate range.
4. At what o'clock the bandit is.
5. "High", "level", "low", depending on whether the bandit is above, at the same level, or below your bomber.
6. "Coming in" but only when the bandit really turns into the attack.

For the top fighter in the picture call:

One Bandit - 10:30 o'clock. - High.

For the right hand fighter call:

One Bandit - 3 o'clock. - Level. **Coming in!**

For the bottom fighter call:

One Bandit - 7 o'clock. - Low.

Never fail to sound off when bandits appear, because you may be the only one who sees them. No single crew member can see all the sky around the bomber from his turret or window. Even the pilot can see very little except straight ahead.

Your warning may be the crew's only notice of an attack. It will help other gunners bring their guns to bear and will allow the pilot to take the necessary evasive action.

On the other hand, don't jam the interphone with excited double talk. Be sure to say "coming in", but **only** when the fighter really turns in. Otherwise you may have the whole crew swinging their guns at a plane a mile away, while some smart fighter slips in and picks you off. Some pilots may want you to call "in range" when the fighter is about to get his guns bearing, to guide them in any special evasive action they may wish to take.

WATCH THIS ONE—he's up to no good.

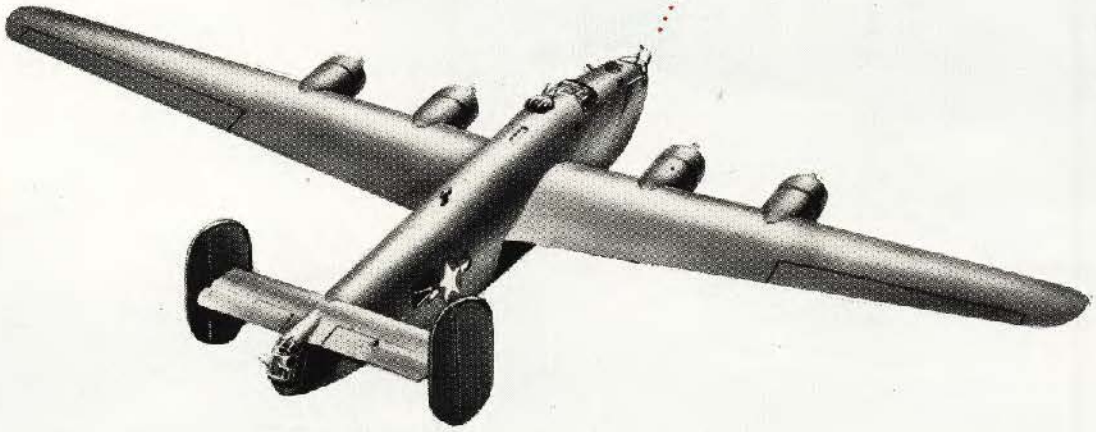
When to fire...

Expert studies show that aerial machine guns are most effective at ranges up to 2000 feet. Very careful calculations prove that further out bullets scatter so widely that they make your chances of a hit almost entirely a matter of luck. You can't hope to break even on the game that way.

Most fighters who are any good won't open up on you outside of 2000 feet. A good fighter pilot may wait until he is much closer. Watch him through your ring sight. Be ready with the right deflection and let him have it at 2000 feet. Nose attacks are so fast that you should begin shooting when he's lined up on you—normally at 3000 feet.

The exact time to start firing and the proper length of burst to fire depend on combat conditions. They are determined, in each theater, by the type of mission usually flown, ammunition loads, and enemy tactics.

.....GIVE HIM THE WORKS.....



Some squadrons, for example, instruct their gunners to start shooting as soon as the fighter appears head on, short bursts at first, longer ones as he gets within 2000 feet. Bursts at a longer range than 2000 feet have been known to scare fighters away. On long missions the length of bursts must be kept short to conserve ammunition. **You can't afford to be left with empty ammunition cans.**

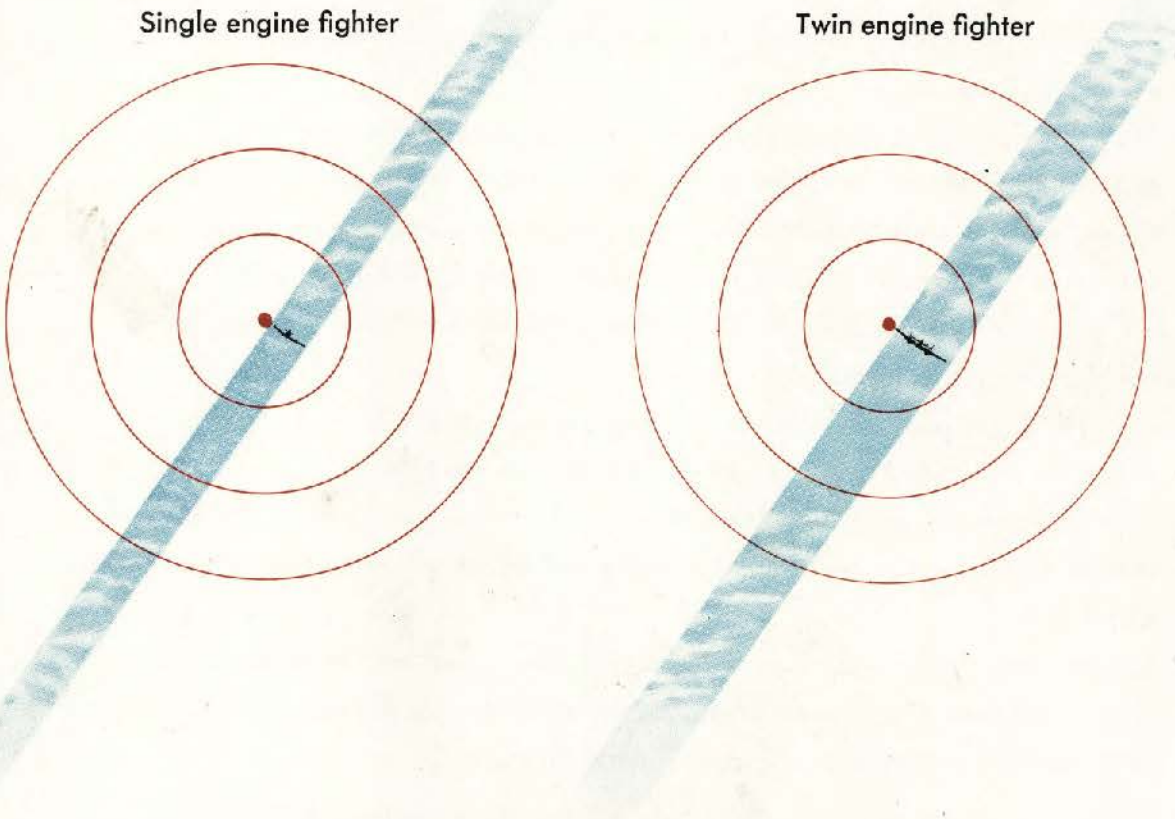
If you do run out of ammunition, or your guns fail, keep swinging them at the enemy anyway. Never let them know you can't hurt them—or they will be all over you.

.....LET HIM GO

You can tell the range...

by the size of the fighter in the 35 mil rad of your sight. At 2000 feet the average single engine fighter fills about ½ rad in your ring sight. Most twin engine fighters fill ¾ of a rad. At 3000 feet they fill less—⅓ of a rad for a single engine fighter and ½ of a rad for a twin engine fighter.

How a fighter looks at 2000 feet



Average single engine fighter	Range	Average twin engine fighter
⅓ rad	3000 feet	½ rad
½ rad	2000 feet	¾ rad

When you spot a fighter — or get the warning over the interphone— be ready for anything.

There's no use kidding yourself. Enemy fighter pilots are good. They know every trick in the book.

The enemy has good planes, and pilots who know how to get everything out of them. Fighter pilots will take advantage of all their strong points—such as armor, speed, maneuverability. They will look for any weak points on your bomber or your formation—such as a gun position which is not firing, or a spot with the fewest guns bearing on them. When a bomber is crippled or straggles out of position, they will attack it viciously.

A smart fighter pilot will also use weather. He will sneak out of a cloud or out of the sun—trying to get in close before you can see him.

Often fighters will gang up. One fighter, or several, will make fake attacks to draw your attention. In the meantime, the real attack will come from somewhere else.

Against these tactics, your best defense is to keep alert—and to keep calm at the same time. Watch every enemy fighter carefully, but don't let him trick you in to firing at him when you don't have a chance.

On pages S-26-31 you will see four fundamental fighter attacks.

To make these attacks, the fighter must go through certain easily recognized maneuvers—illustrated on the opposite page for an attack from the left beam. All these attacks have some or all of these phases, but they all end up with guns bearing in the pursuit curve—sliding toward your tail.

That's when he's your meat.

OVERTAKING

The fighter flies a parallel course with the bomber, usually more than 3000 feet away. He continues this until he reaches the right point for his . . .

TURN-IN

The fighter banks for a turn that will bring his guns to bear slightly ahead of your nose. For a moment he seems to hang motionless in the air—his far wing up, as though hanging from a hook.

ROLL-THROUGH

He has now turned toward you, but must still reverse his turn to get his guns bearing.

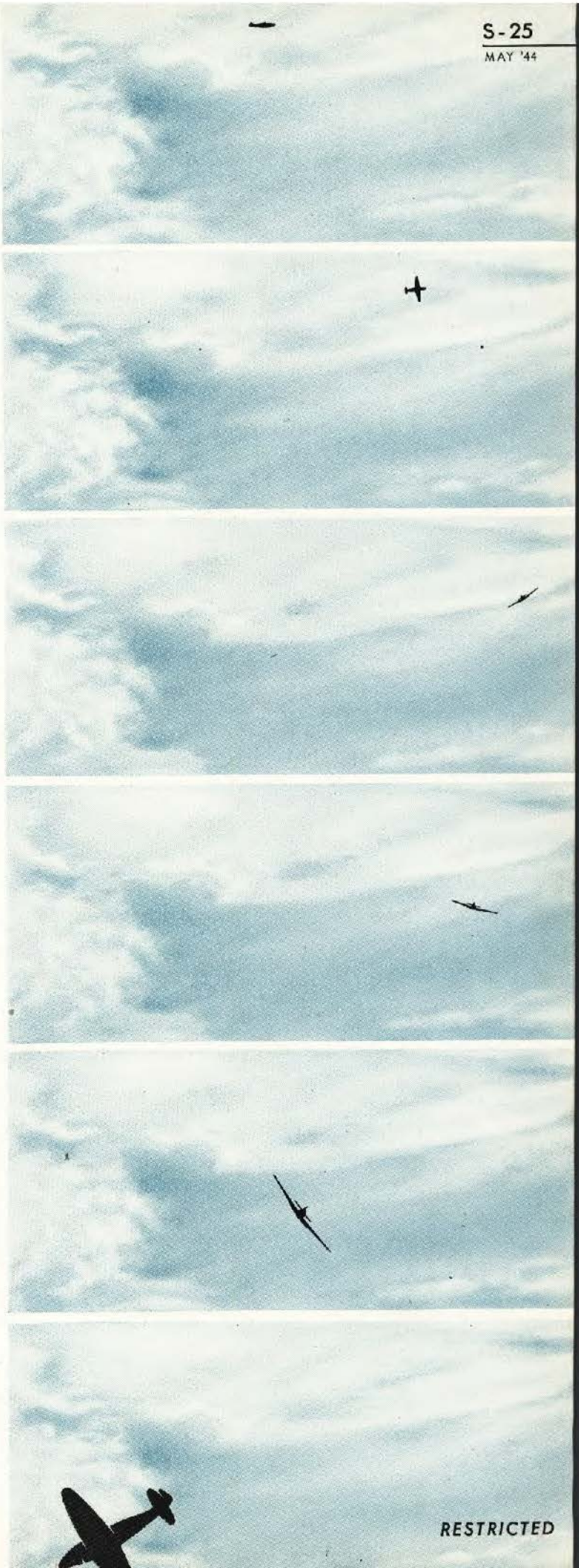
As he does this, he rolls his high wing down, which brings him to the beginning of . . .

GUNS BEARING

This is where you get him. Rapidly growing larger as he comes closer, he appears to slide back toward your tail.

BREAKAWAY

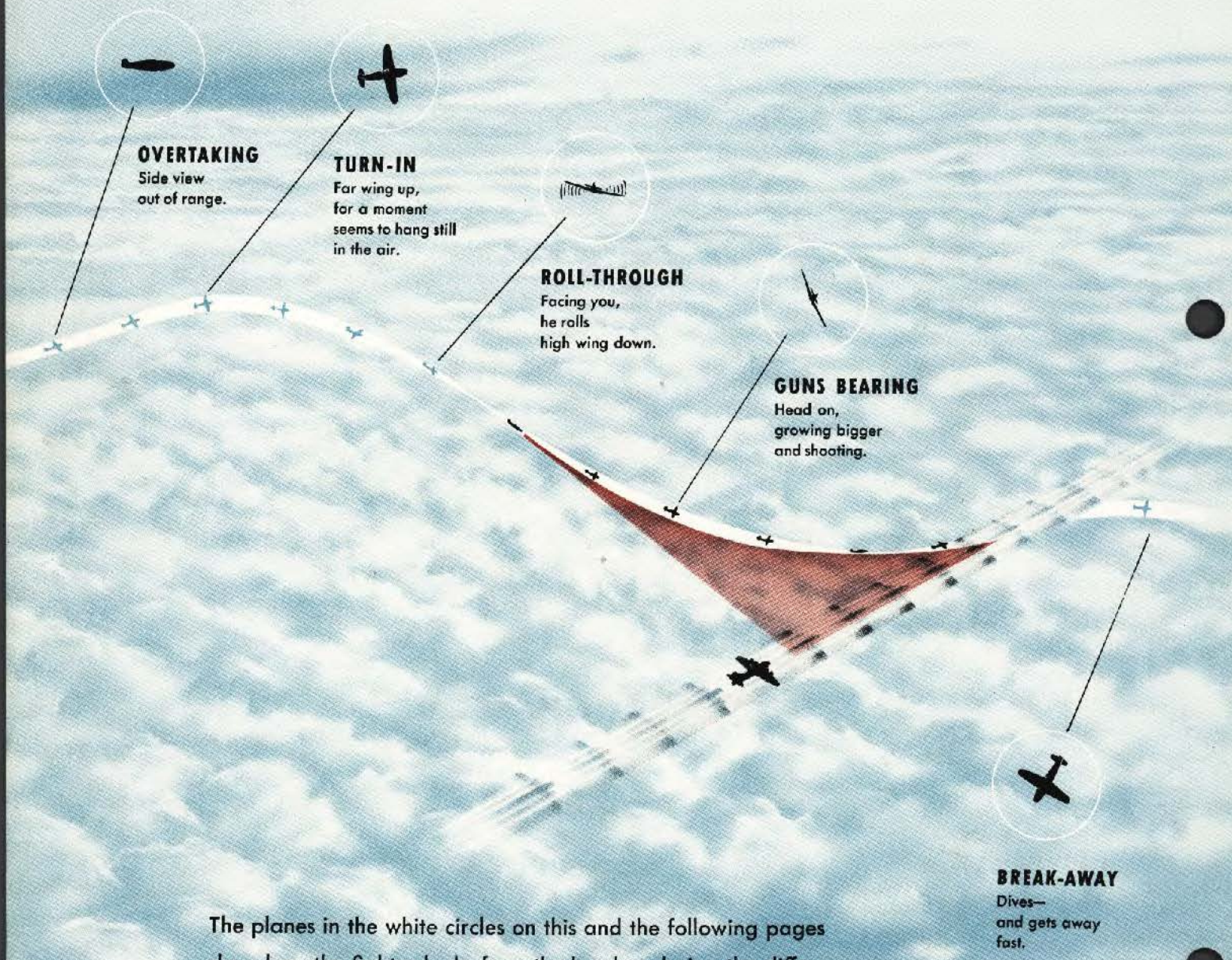
When he decides to break off, the fighter sometimes makes a climbing, but more often a diving turn. He frequently rolls over on his back to expose his seat armor as he tries to get away and into position for a new attack.



SIDE attack . . .

The side attack is usually used against single bombers, rarely against formations. It can be made from above, at, or slightly below your level.

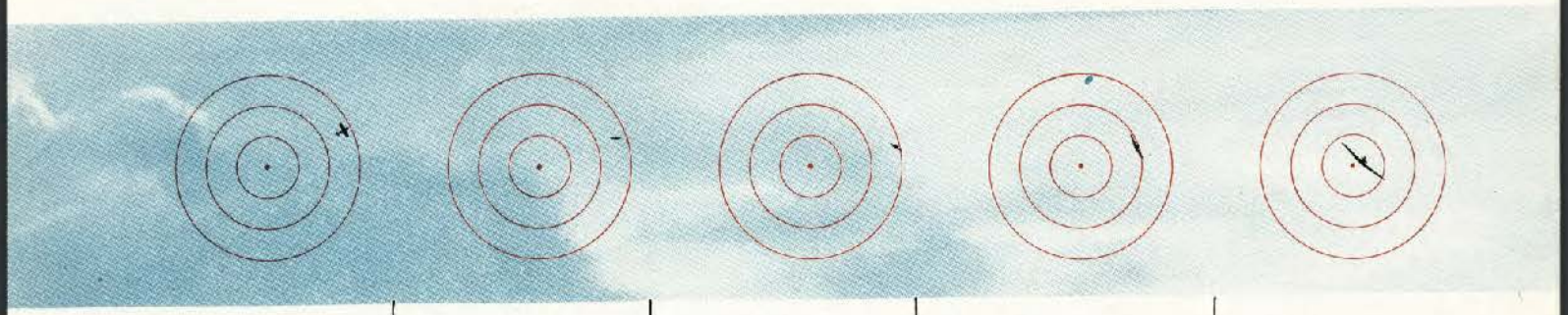
This drawing shows a high side attack from the beam, with the fighter getting his guns bearing about 2000 feet out. To press the attack home to close range, he must drift well into your tail cone where you really have a good crack at him.



The planes in the white circles on this and the following pages show how the fighter looks from the bomber during the different phases of the attacks illustrated.

From a top turret . . .

A high side attack looks like this. Out of range, the fighter pulls ahead of you. His far wing goes up, and for a moment he seems to hang from it as though from a hook. He then quickly swings into a head on position and starts his apparent slide. Rolling his high wing down, he moves in a straight line toward your tail. As he shifts from cone to cone, he gets bigger. He may break away above you. This gives you a momentary no deflection shot only if he appears to hang there. More often he'll roll on his back and dive away under you.



1 He's over 3000 feet. "Give the word" but hold your fire.

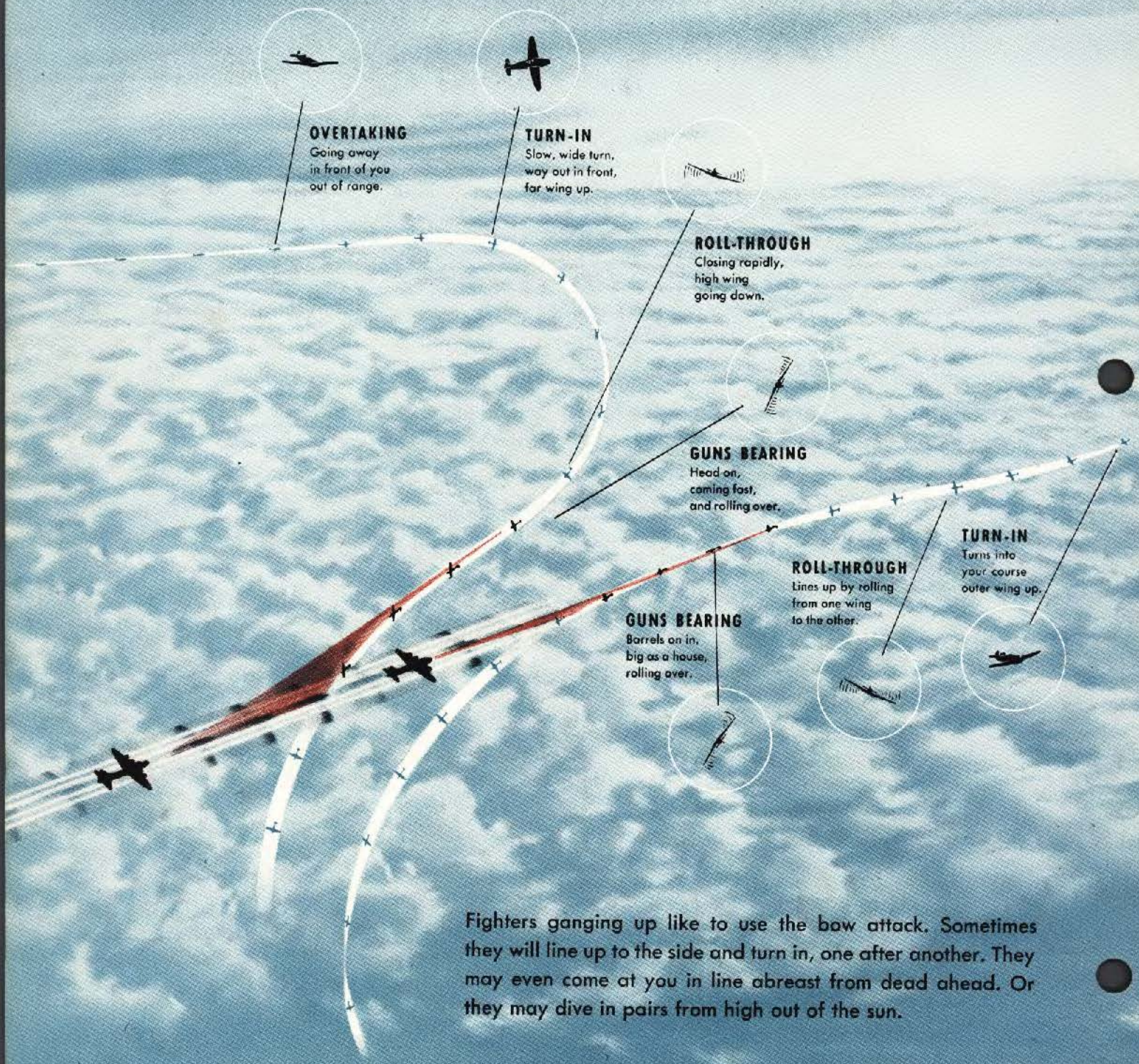
2 Still too far, but start tracking him.

3 2000 feet on Cone 3. Give him 3 rads and start shooting.

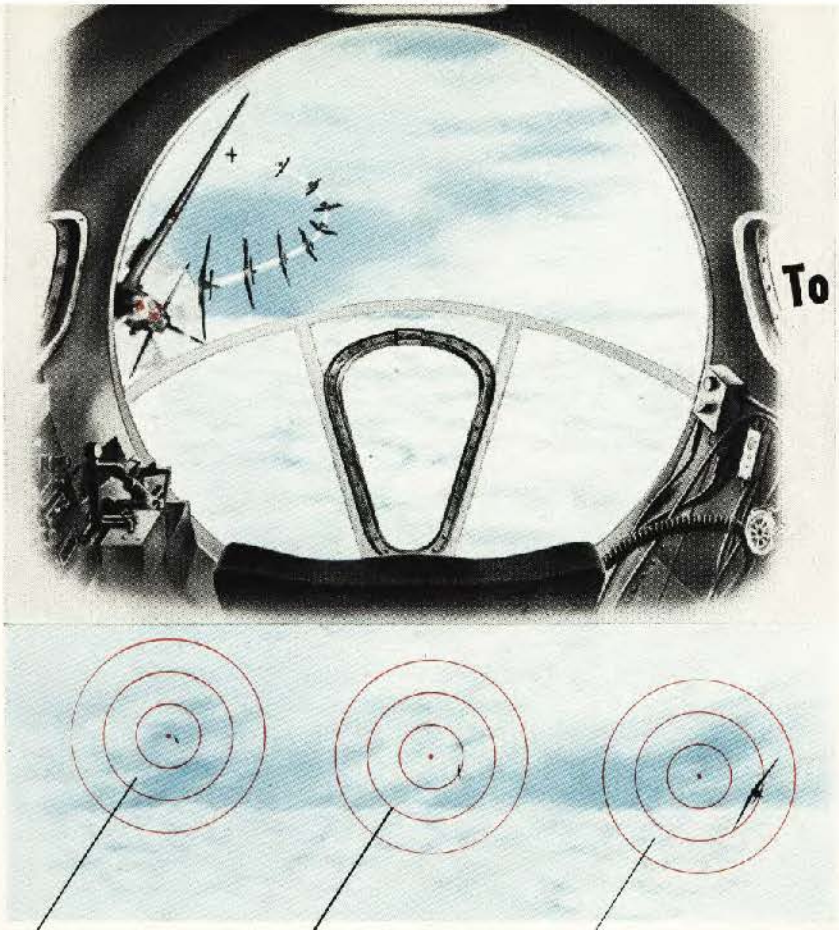
4 1000 feet. By now he's on Cone 2. Let him drift smoothly toward your sight center.

5 500 feet. "He's cooking with gas." Stay with him— ½ rad on Cone ½.

BOW attacks are extremely fast. Closing speeds may be 500 to 700 miles per hour. They may be made by fighters intercepting your formation, or overtaking you while flying in the same direction. The enemy will fly out to the side, well out of range, until he reaches a point far ahead. After turning until he faces you, he rolls through and hurtles toward you. He may try for a few seconds to hold a pursuit curve, a little from the side, and probably high. Or he may come from dead ahead, generally almost level with you, and possibly roll over on his back as he dives under you.



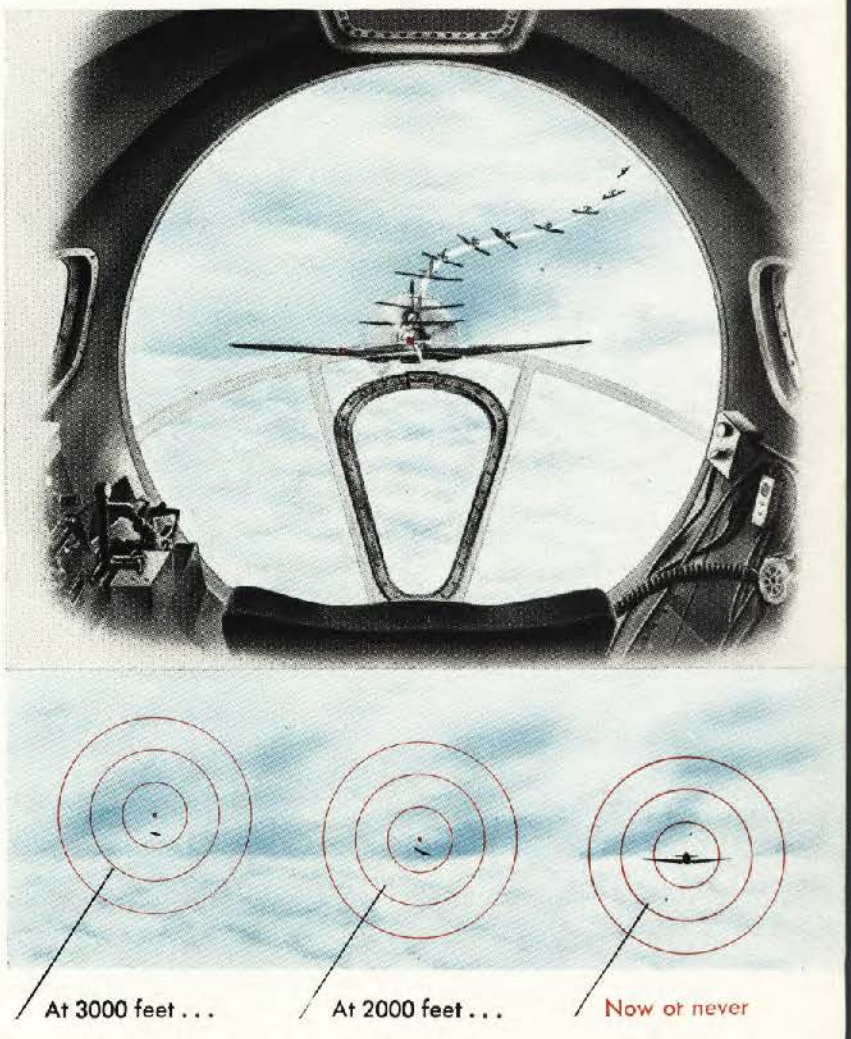
Fighters ganging up like to use the bow attack. Sometimes they will line up to the side and turn in, one after another. They may even come at you in line abreast from dead ahead. Or they may dive in pairs from high out of the sun.



To a bow gunner . . .

. . . a bow attack from the side looks like this. The fighter tries to hold a curve of pursuit for a second or two. As he does it, you must let him drift away from the center of your sight.

This illustration shows how you should follow him in your sight.

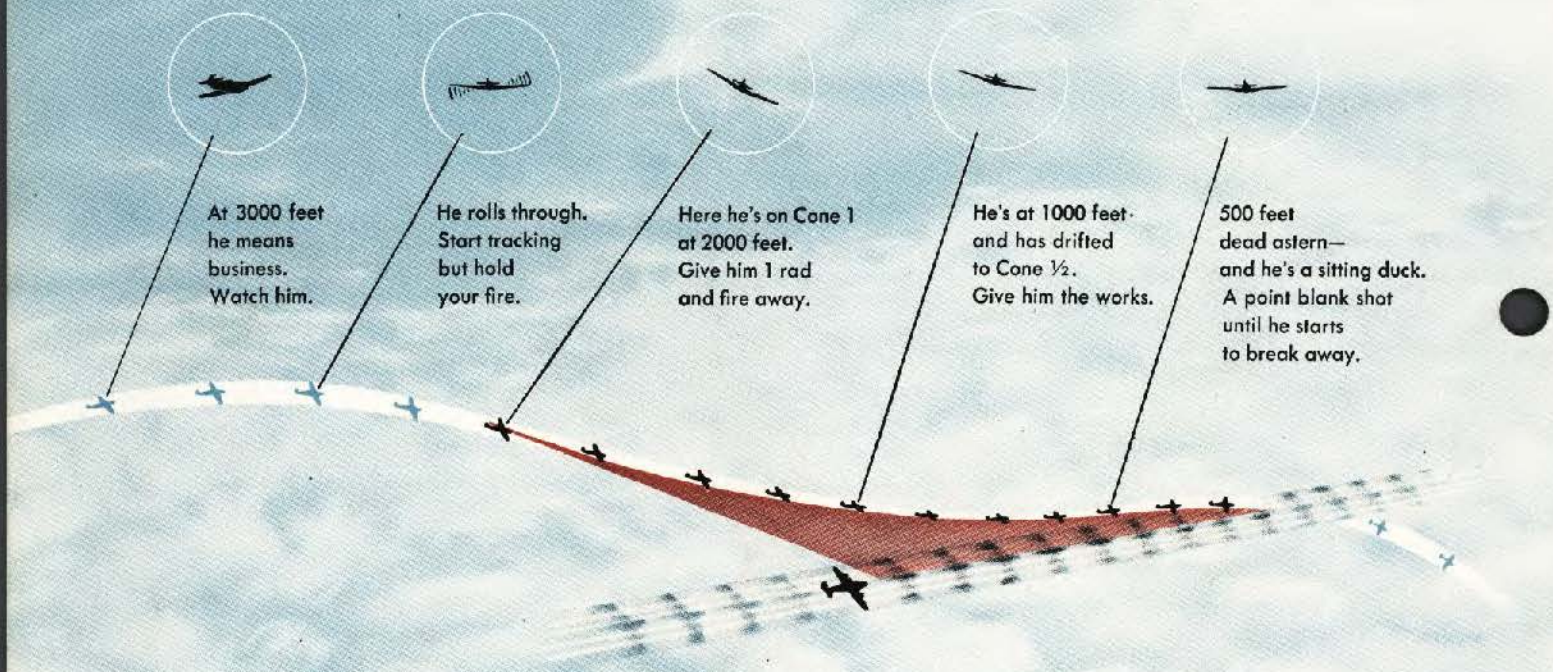


In an attack from dead ahead the fighter lines up with the bomber. He may roll over on his back or come straight on in as shown here. He grows larger at tremendous speed, and whips past almost before you know it. You only have a few seconds, but if you keep cool, he's an easy shot—almost no deflection.

It is a little high, so you aim just above him as he expands in your sight . . . Because of the tremendous closing speed, you should begin firing at all bow attacks when the fighter is about 3000 feet out.

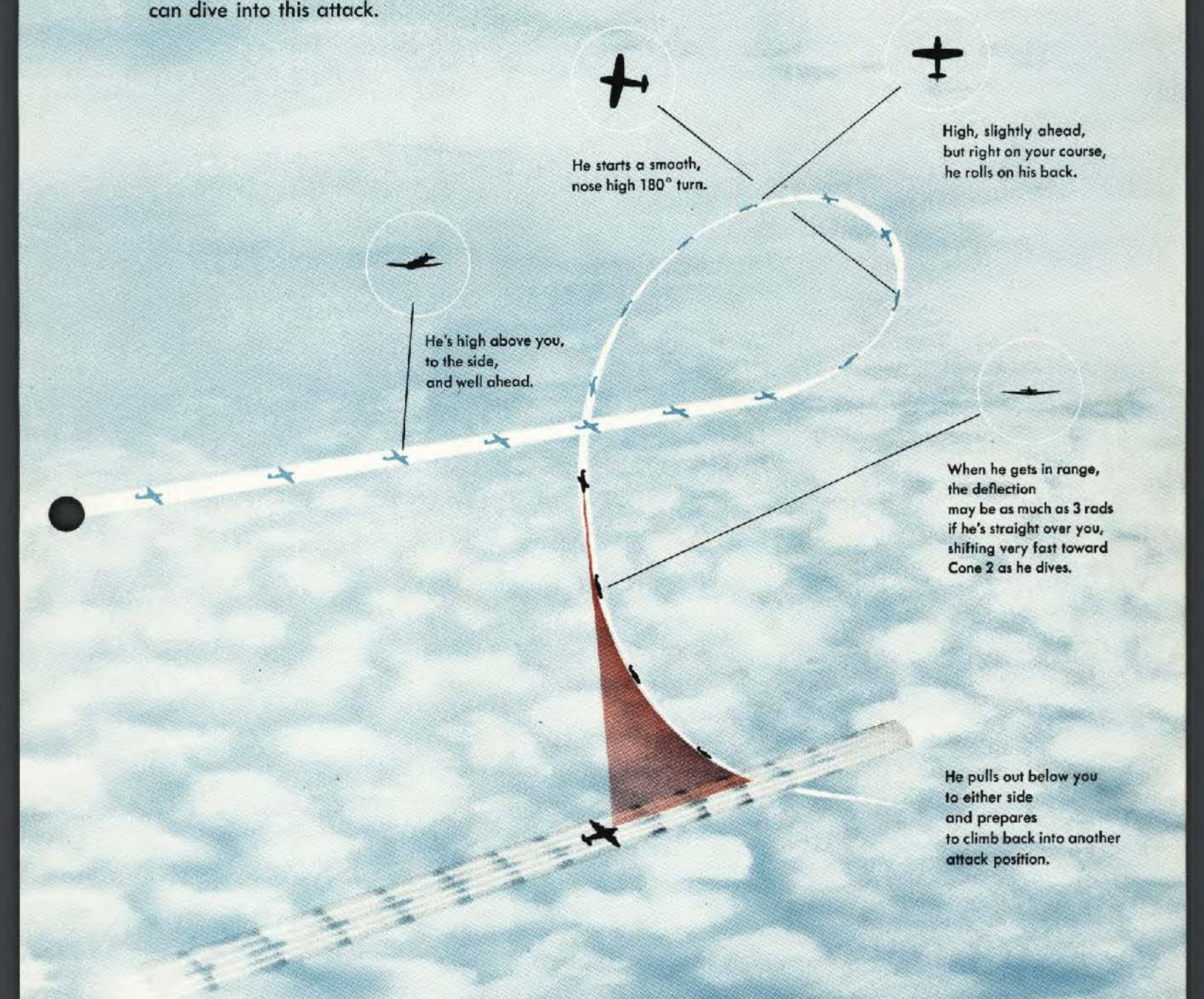
TAIL attack...

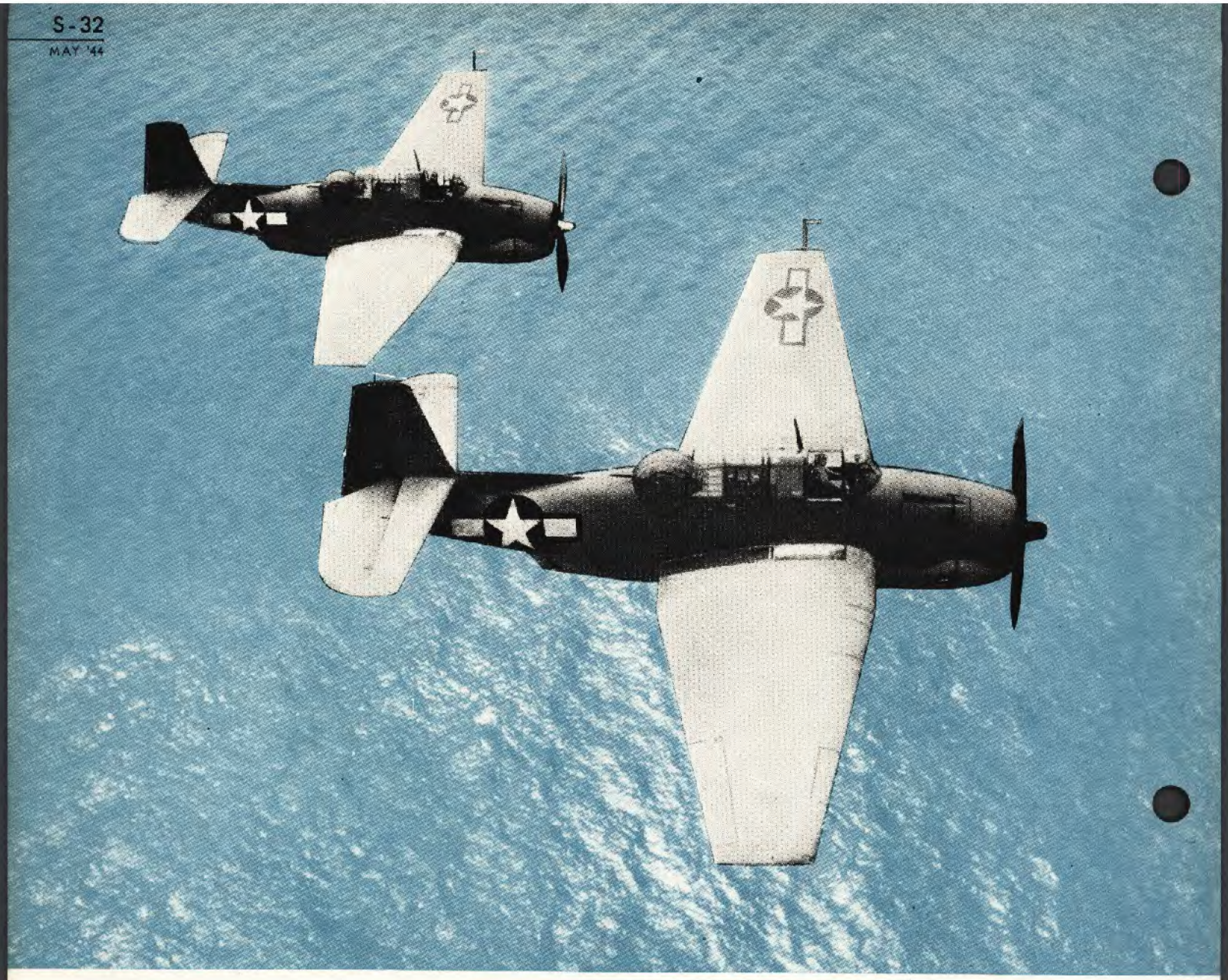
Tail attacks may come from above, below, or at your level. They give the fighter the longest time to fire at you—but that works both ways. You and he both have a small or no deflection shot, but with your turrets the odds are on you if you know your stuff.



A single enemy may dive in at an angle for a quick burst and twist away. Or several fighters may weave in and out, dead astern. Or one of a pair may try to distract you from a real attack by the other. Keep your fire on the one who keeps coming in. As soon as a fighter breaks away, forget him.

OVERHEAD attacks are rarely seen, because few fighter pilots are expert enough to try them. But if they are pulled on you by a good pilot, watch out. Don't be caught flat-footed. The fighter will count on surprising you. His dive is very fast, and you have a tough overhead shot. Any fighter high above you flying in the same direction you are, or on an opposite course, can dive into this attack.





When you finally take off—

- Remember that Position Firing is used only with 35 mil rad ring sights—not with computing sights—and only against fighters attacking you on a pursuit curve—or fly through.
- Position Firing is no cure all but it does take care of the enemy when he is most dangerous to you.
- Never let anybody sneak up on you.
- Spot his cone—pick the right deflection—stay with him.
- Don't waste your ammunition.
- Use your sight and—*never be caught with your guns down.*

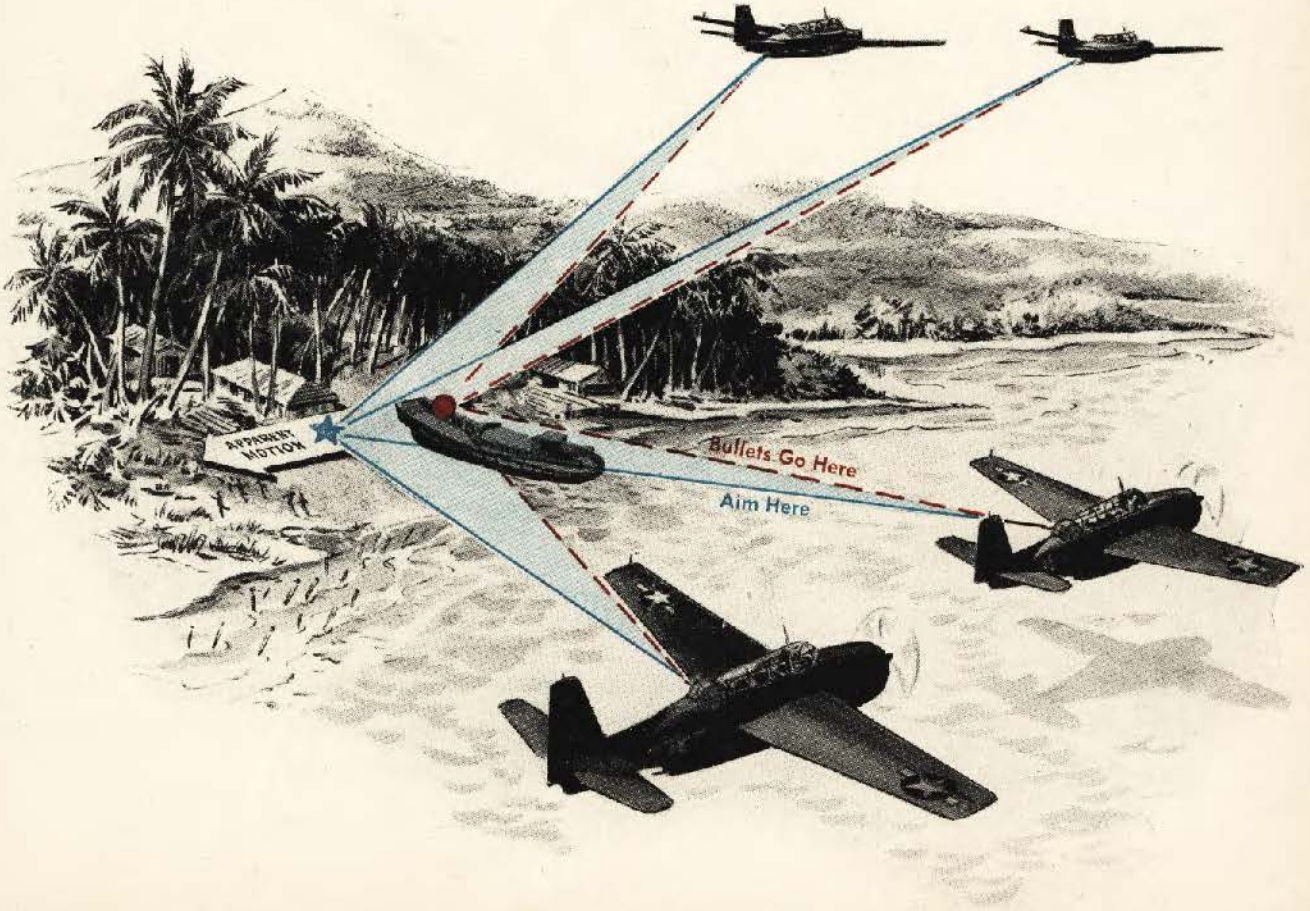
STRAFING

You will probably go often on missions where you will have the opportunity to strafe grounded planes, troops, ships or enemy installations. Your training in Position Firing will help you get the proper deflection. **The principles for strafing are the same fundamental ones that you use in firing at a fighter in a pursuit curve attack.** That point was brought out at the start of the section on Position Firing.

LOOK AT YOUR THREE RULES FOR POSITION FIRING.

1 **Always aim between the attacking fighter and the tail of your own bomber along the line of apparent motion.**

In strafing you also aim behind the target to allow for the effect of the motion of your own plane on your bullet. The picture of the newsboy in the Position Firing section illustrated this point. Just remember that in strafing, as well as in firing at an enemy plane in a pursuit curve attack, the deflection is still always applied **toward your tail.**

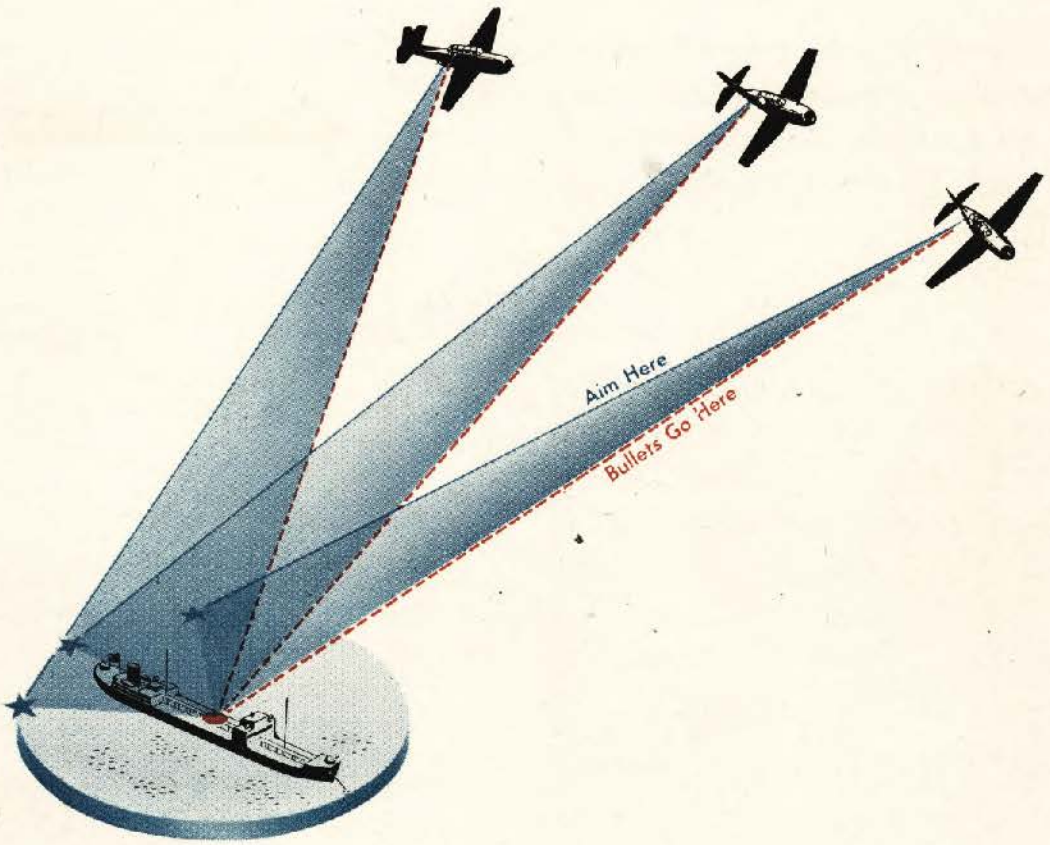


2 Use the right amount of deflection.

Your study of Position Firing will drill into you the correct Position Firing deflections for your own bomber's speed. When strafing, always allow a little bit **more,** usually not more than an additional ½ a rad at 90° and less than that for the smaller angles off, than you use in a pursuit curve attack. That is because of the slight difference between firing at a fighter in a pursuit curve attack and firing at a stationary target.

3 Change the deflection during the attack.

In strafing you also change your deflection according to the angle-off of the target. When strafing, it sometimes will be possible to see where your bullets are hitting. This will aid you in correcting and changing your deflection, but use the basic rules of Position Firing as the primary method of determining deflection.

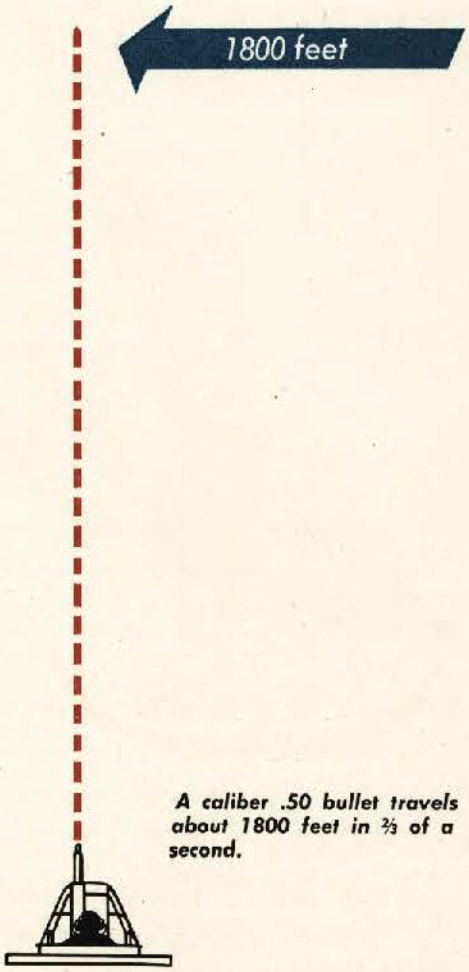


The fact that Position Firing principles apply whether your plane flies a curved course or not is a great help in strafing. Even if your pilot flies a curved course around your target, your correct deflection is based on your own speed and the target's angle-off.

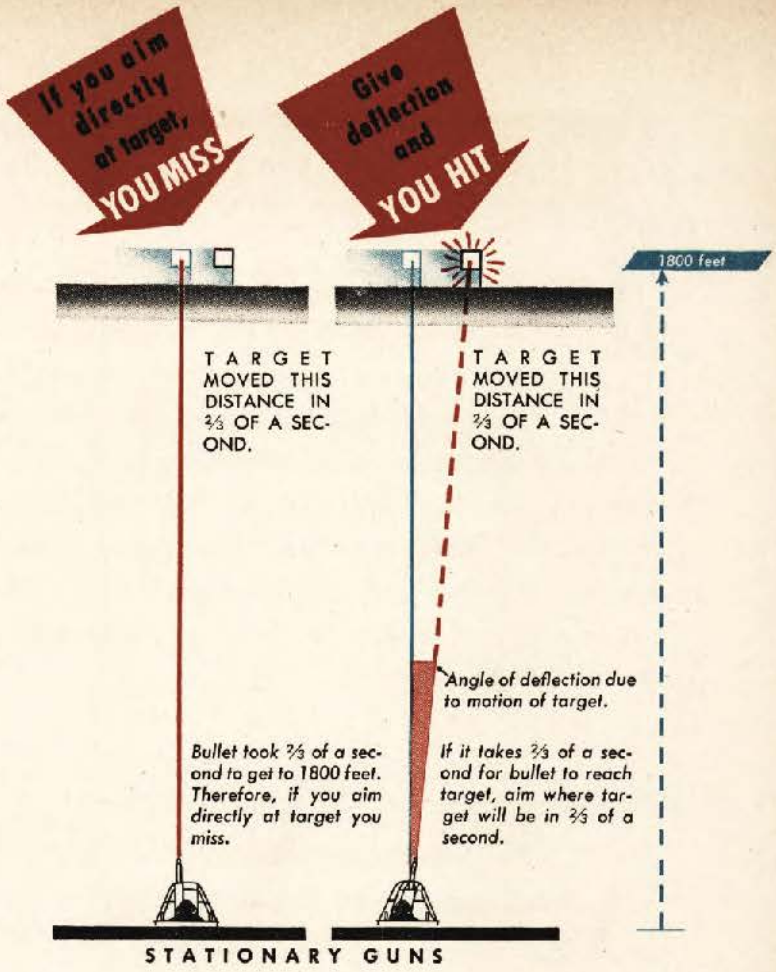
2/3 OF A SECOND METHOD OF SIGHTING

Position Firing has been emphasized in this manual because it is considered the best sighting method for the most dangerous firing situation you will face; namely, the pursuit curve attack. It "works" whether your pilot flies a straight or curved course when under attack. Furthermore, as has been said, the principles of Position Firing can be used in strafing. Important practice in Position Firing will be gained on the **3A-2 Trainer,** which is the best ground device so far developed for aerial free gunnery sighting training. Gunners returning from combat say their work on the 3A-2 trainer was a great help in preparation for combat gunnery. **Make the best use of your time in the 3A-2 rooms.**

Sighting practice, however, is not limited to the 3A-2. It can also be gained on your gunnery school machine gun ranges. It is difficult to simulate a pursuit curve attack on the railroad and towed sleeve ranges. These ranges do, however, give you practice in applying deflection on a moving target. On these ranges you should use another sighting method that is also a part of your free gunnery knowledge—namely, the ⅔ **OF A SECOND METHOD.** This is a **LINE OF APPARENT MOTION** method of sighting. You have already learned about the "line of apparent motion" in Position Firing. If you use the ⅔ of a Second Method on your gunnery school ranges you will be better able to handle firing situations in the air that cannot be handled by Position Firing—situations, for example, where a predetermined deflection will not apply.



A caliber .50 bullet travels about 1800 feet in ⅔ of a second.



The main principle of the ⅔ of a Second Method is that it takes a bullet about ⅔ of a second to get out to 1800 feet, a good average in-range firing distance, and a good range for your railroad targets. If you can estimate the distance that the moving target will move in ⅔ of a second, you can give the target the proper amount of deflection and get hits. A way to get the right amount of deflection on a target moving parallel to you at a range of 1800 feet is given in the three steps below:

1 Center the target in your ring sight at 1800 feet.

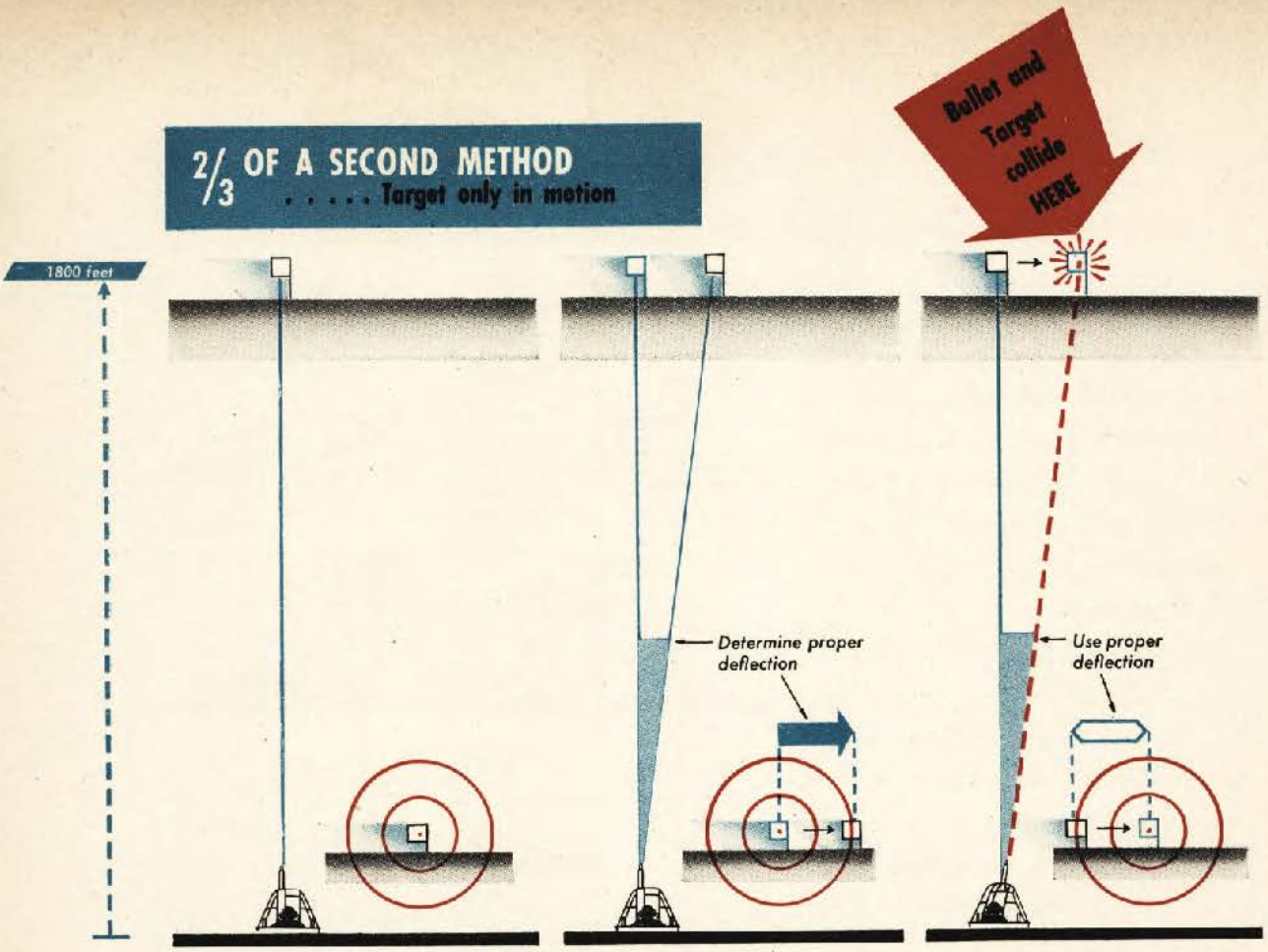
2 "Freeze" your gun and say out loud a word such as "elephant." (It has been found that saying a three syllable word takes about ⅔ of a second.) Note the target's line of apparent motion and how far it moves across your ring sight in ⅔ of a second while saying "elephant."

3 Place the target in the same corresponding position on the opposite side of your ring sight and open fire. You are now applying the proper deflection along the target's line of apparent motion.

If your target range is 1200 feet you should say a two syllable word such as "Japan" rather than "elephant." If the range is 600 feet you should say "Jap."

After enough practice with these steps you should be able to estimate the deflection for your moving target ranges without having to follow the full routine. But use the method at the start. Find out your own deflections on your railroad ranges by this method. With sufficient practice you will learn to determine the correct point of aim without stopping to think about it.

2/3 OF A SECOND METHOD . . . . . Target only in motion



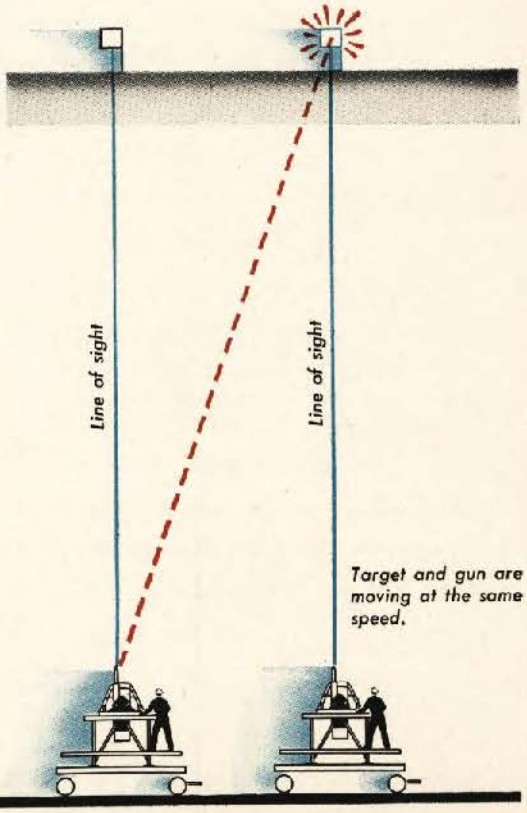
1 *Place target in center of sight.*

2 *"Freeze" gun and note direction and distance target moves in ⅔ of a second.*

3 *Then place the target the same distance on the opposite side of ring sight and fire.*

2/3 OF A SECOND METHOD . . . . . Target and Gun in motion

So far, discussion has been directed toward the use of the ⅔ of a Second Method on the moving target-fixed base machine gun range (the target is moving, you're standing still). When it is used on a moving target-moving base machine gun range (the target moves and so do you), the situation is closer to what it will be in the air. By giving motion to your own shooting base, the real importance of the target's **LINE OF APPARENT MOTION** becomes evident.

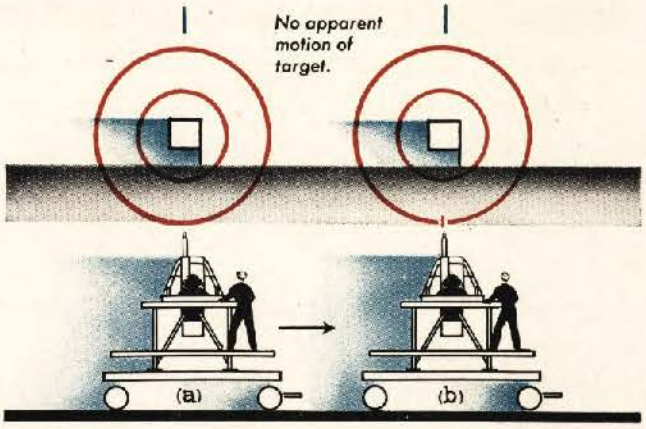


In the following cases, deflection is determined by the target's apparent motion.

1 WHEN TARGET IS MOVING AT SAME SPEED AND IN SAME DIRECTION AS YOU ARE . . .

(a) Freeze gun on target and note that there is no apparent motion in ⅔ of a second.

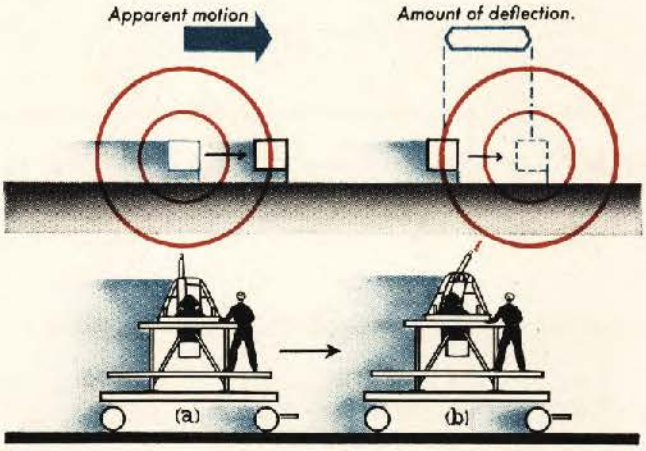
(b) Center sight on target (for all intents and purposes a no deflection shot) . . . . . and fire.



2 WHEN TARGET IS MOVING FASTER THAN YOU ARE . . .

(a) Determine line of apparent motion by freezing gun and note distance target moves on line in ⅔ of a second.

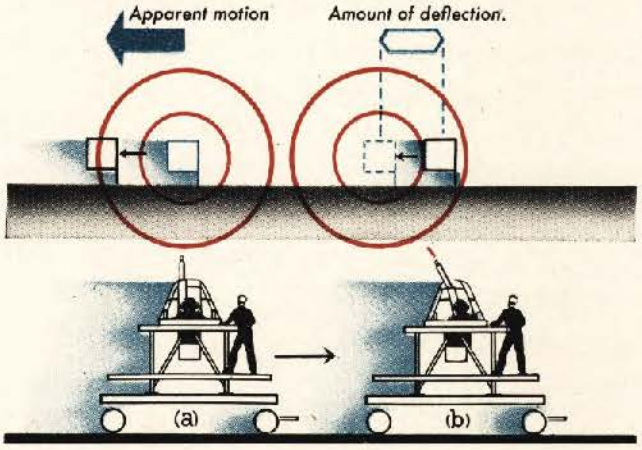
(b) Place target on opposite side of center of sight an equal distance on line of apparent motion and . . . fire.



3 WHEN TARGET IS MOVING SLOWER THAN YOU ARE . . .

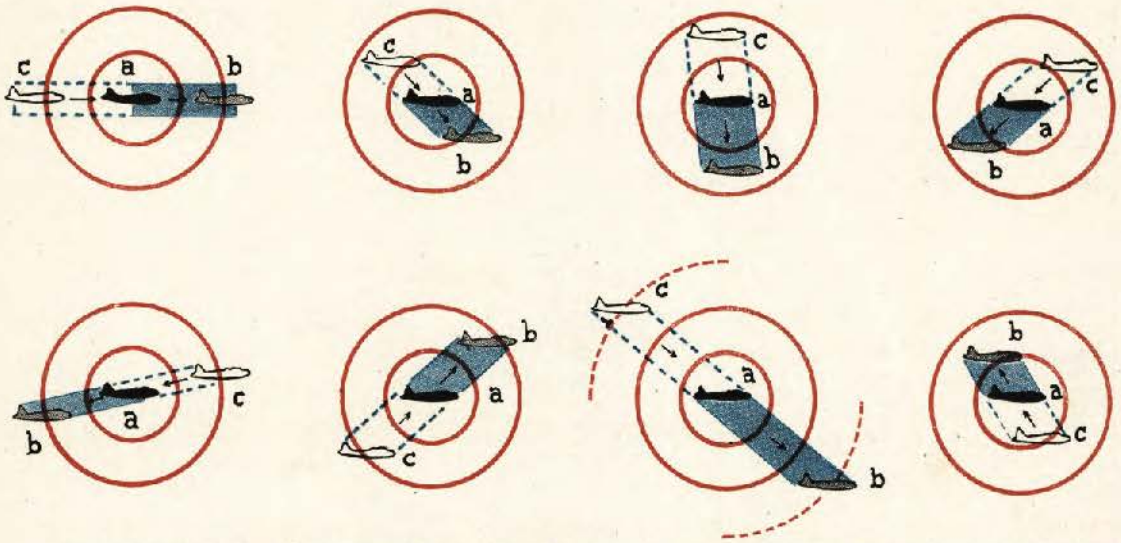
(a) Determine line of apparent motion by freezing gun and note distance target moves on line in ⅔ of a second.

(b) Place target on opposite side of center of sight an equal distance on line of apparent motion and . . . fire.



The same picture is present in the air. Assume that you are flying parallel to an enemy bomber. If the enemy is moving faster than you are, he will move forward in your ring sight. If he is moving slower than you are, he will move backward in your ring sight. In the air, the line of apparent motion may be in any direction—forward, back, up or down. As on the ground, you will find that when you fly a straight course, the deflection will always be applied along the target's line of apparent motion !n air firing, at any but close ranges, a slight allowance for bullet slow-down will have to be made.

WHEN AN ENEMY BOMBER IS FLYING IN THE SAME GENERAL DIRECTION OR ON A PARALLEL COURSE AND IS WITHIN RANGE.



APPARENT MOTION FROM **a** TO **b**. PLACE ENEMY PLANE AT **c** AND FIRE.

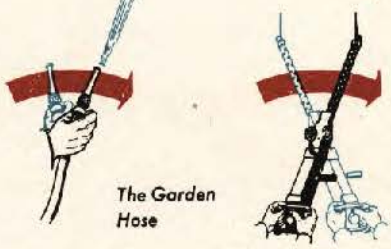
As illustrated in the examples above, the apparent motion may be in any direction. Through your training in the ⅔ of a second method, you can determine the line of apparent motion and the amount of deflection.

In Position Firing, deflections can be figured out ahead of time, based on the speed of your own plane. This is possible because a fighter plane trying to hit you usually flies a set track known as a Pursuit Curve. The fighter is limited by his fixed guns. However, oftentimes while on patrol you may come in contact with enemy bombers. On some occasions you may attack those planes; on other occasions, they may attack you. When they attack, the course they can fly is not limited by fixed guns. They will also have free guns and possibly turrets. The rules of Position Firing cannot ordinarily be used against this type of attack, but the principles of the **"LINE OF APPARENT MOTION" METHOD OF SIGHTING** learned on your gunnery school ranges through the use of the ⅔ of a Second Method **can.** Whenever you have a duel with an enemy bomber, while flying a **STRAIGHT** course, you can use the fundamentals of the ⅔ of a Second Method, learned on your gunnery school machine gun ranges.

TRACER

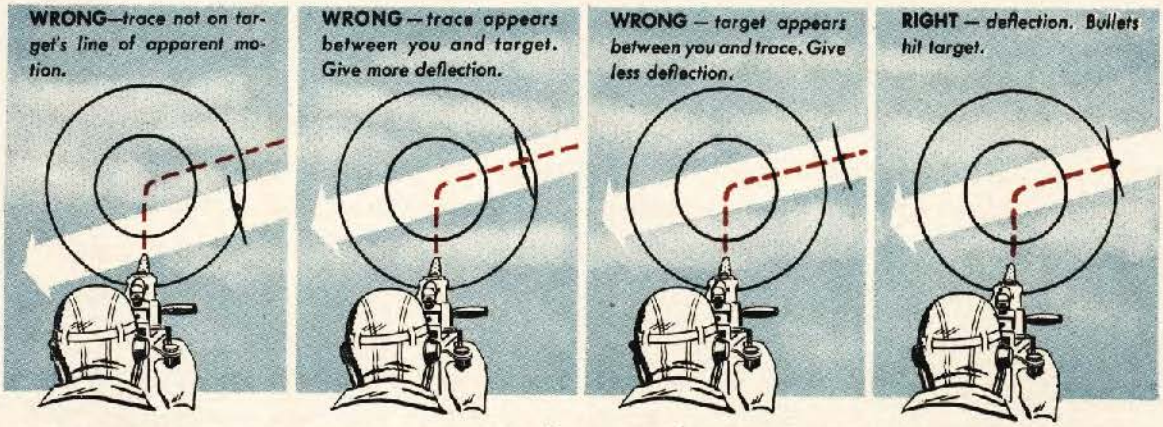
Tracer can be of help to you in sighting, but it also can play many false tricks unless you understand its behaviour. The main point to remember about tracer is—**never use it as the sole means of sighting.** When you use it, it should be used in connection with your ring sight and your regular sighting method.

Tracer bullets actually do not curve any more than any other kind of bullet, but when fired from a moving gun they appear to have what is called "CUT BACK." "Cut back" is what a stream of water appears to do when you swing a garden hose. When you swing your guns, the trace also appears to "cut back." The faster you swing your guns, the greater the "cut back." This effect will often make you think you are hitting the target when actually you are not. This is particularly true if you watch the whole tracer path, but if you watch the trace through your ring sight **at the target,** tracer can help. It can help you keep on the target's line of apparent motion. It can help you correct your deflection, if you watch the trace at the target. If the trace appears between you and the target, you are not giving enough deflection. On the other hand, if the target appears between you and the trace, you are giving too much deflection.



The Garden Hose

Cut back occurs in the opposite direction to the swing of your gun.



Again—to use tracer properly, use your regular sighting method to determine deflection; then watch the trace at the target through your ring sight.

Squadron doctrine will determine whether you have tracer belted in your ammunition and how it will be belted. When you have it, remember that tracer alone is not to be used as a sighting method. However, tracer can be a supplement to your regular sighting method, if properly used.

YOUR SIGHTS

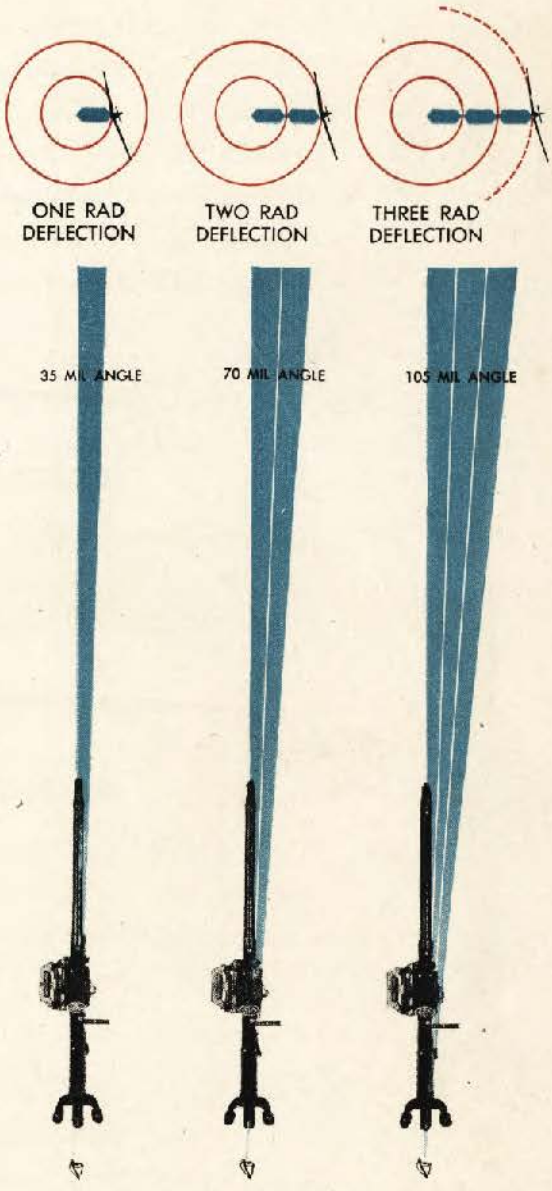
Every gun you will use in combat, regardless of its construction, is equipped with some type of gun sight. The sight in **your** gun is a ring sight. It is designed to do two jobs. It can tell you, in the first place, when a fighter is in range, and in the second place, where to aim your gun to knock down that fighter.

THE **35 MIL RAD** IS THE BASIC MEASURE OF ALL REFLECTOR AND IRON RING SIGHTS IN CURRENT USE IN NAVAL AVIATION FREE GUNNERY

To help you estimate range and apply the deflections required for Position Firing, your ring sights should have rads that are of a convenient size for range estimation, as well as of a standard size for Position Firing deflections.

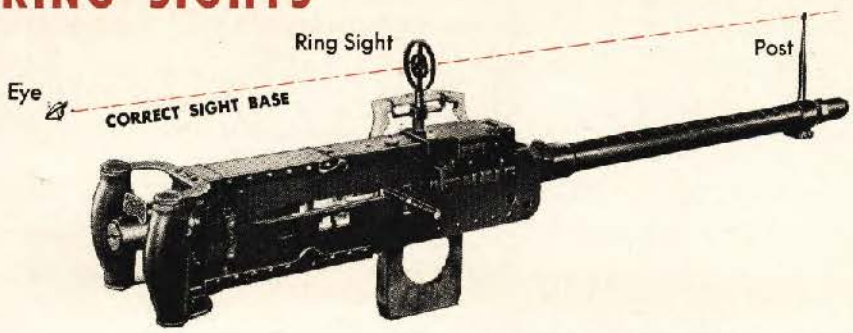
Rads are based on mils. A mil is a unit of measurement for very small angles. One gunnery mil is the angle formed at the eye when viewing a one foot object at 1000 feet.

A 35 mil angle measures off 35 feet at 1000 feet. One rad of your sight is 35 mils. Therefore, a 1 rad deflection must offset the gun barrel at an angle of 35 mils. A 2 rad deflection must offset the gun at an angle of 70 mils, and a 3 rad deflection must offset it at an angle of 105 mils. The standard rads deflections given in the section on Position Firing apply only when 1 rad of a sight is equal to 35 mils. Thus, the inner ring of all ring sights must have a radius which will give a 35 mil angle.



Although the caliber .50 BAM gun is the gun that the great majority of you will use, the illustrations for iron sights are made with the caliber .30 gun because iron sights are more frequently used with this gun.

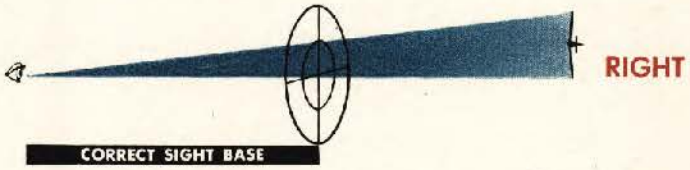
IRON RING SIGHTS



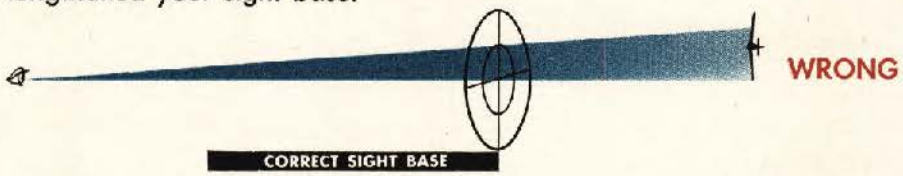
a Mk 13 ringsight and a Mk 7 post mounted on a cal. 30 B.A.M. gun.

The simplest of all aerial gun sights is the iron sight—a metal ring or set of rings at the rear of the gun and a metal post topped by a bead or small ring at the front. By lining up the center of the rear ring sight and the center of the bead or ring on the front post, your guns will fire in the direction you want them to fire. If your sights are not lined up, you will not get hits. Another important rule that you must remember when using iron sights is to keep your eye the proper distance behind the rear ring at all times. The distance between your eye and the ring is called your **sight base.**

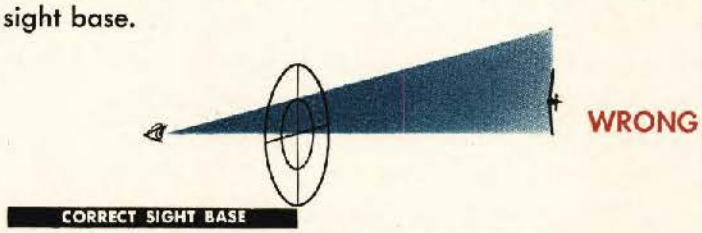
Look through a 35 mil iron ring sight using the proper sight base. A 35 foot plane at 1000 feet fills exactly one rad of your iron ring sight.



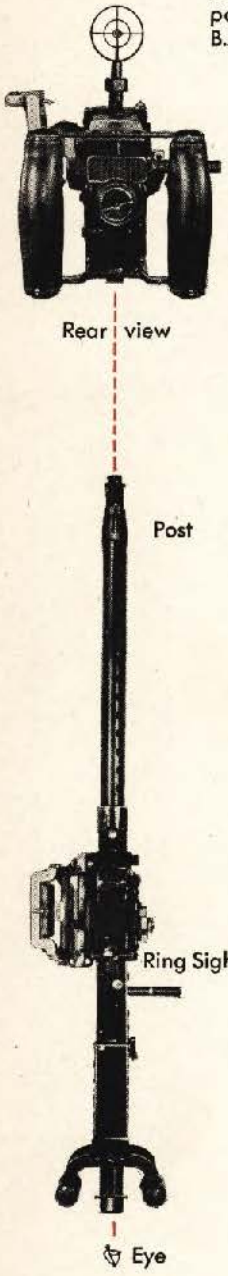
Now move your eye back from the correct sight base and the plane fills more than one rad. The sight has become less than a 35 mil sight because you have lengthened your sight base.



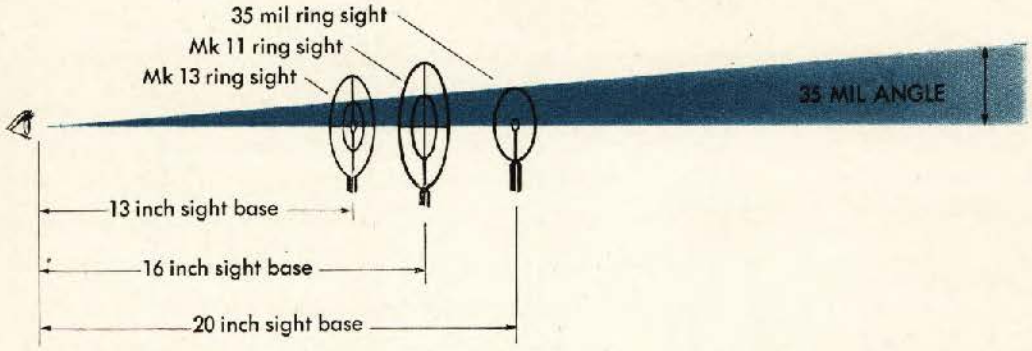
Next move your eye closer than the correct sight base and the plane fills less than one rad. The sight is now more than a 35 mil sight because you have shortened your sight base.



A correct sight base is therefore **essential** to keeping your iron sight a 35 mil sight.

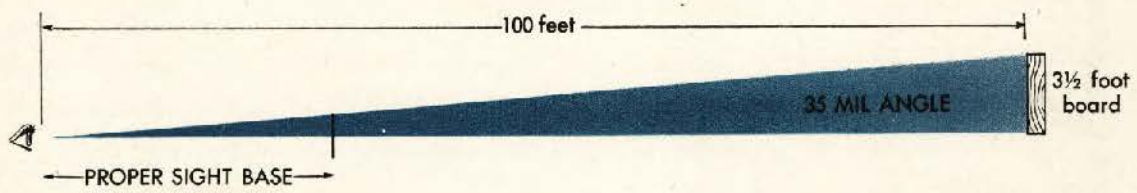


The correct sight base varies with the actual size of the ring sight itself. Below are shown a number of correct sight bases for 35 mil sights of various sizes.



While all of these ring sights are of different sizes, their sight bases have been so adjusted that they are all 35 mil sights. Proper sight bases are given for each 35 mil iron sight in the Aviation Ordnance Equipment Catalogue.

However, if you are ever in doubt as to whether you have a 35 mil sight or not, place a board 3½ feet long at a right angle to the eye and 100 feet away. Line up your ring sight on the board, and if the board fills 1 rad of your sight you know that you have a 35 mil sight.



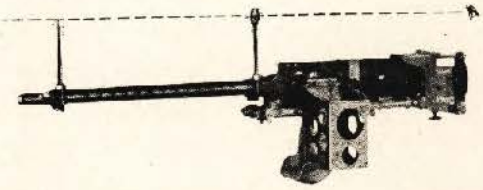
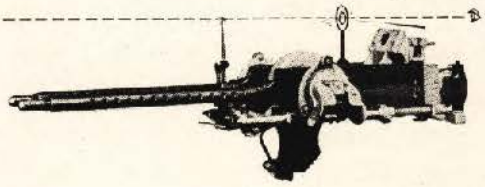
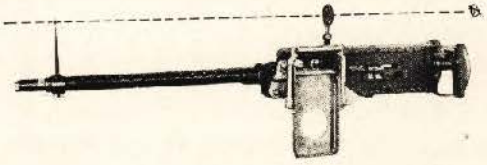
To sum up, maintaining the correct sight base with a 35 mil iron sight is essential for:

1 **Proper range estimation.** Remember the single engine fighter fills ⅓ of a rad of your 35 mil sight at 3000 feet, the in-range firing distance for bow attacks, and ½ of a rad at 2000 feet, the in-range firing distance for other attacks. The twin engine fighter fills ½ rad at 3000 feet and ¾ rad at 2000 feet.

2 **Proper use of Position Firing Deflections.** Your deflections are given in terms of rads of 35 mils. When applying the deflection with an iron sight, keep the proper sight base and apply the proper number of rads deflection toward your own bomber's tail.

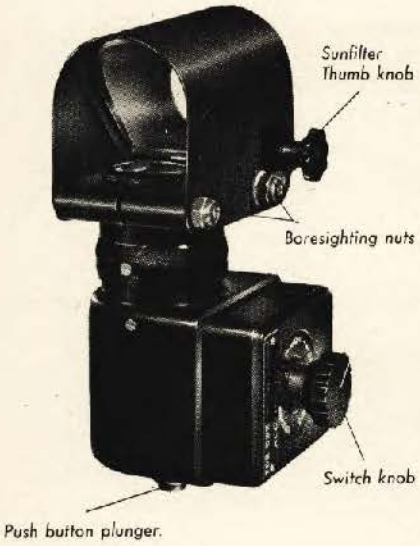
The 35 mil iron sights that you may use are shown below.

IRON RING SIGHTS AND CORRECT SIGHT BASE

Name and description	Post Ring	Mounted on gun
35 MIL TRAINING SIGHT **MK 1 FORE POST** Radius of 35 mil ring sight ..... .7" Sight base ..... 20"		20" sight base 
MK 11 RING SIGHT **MK 1 MOD 1 FORE POST** Radius of 35 mil inner ring ..... .6" Sight base ..... 16"		16" sight base 
MK 13 RING SIGHT **MK 7 FORE POST** Radius of 35 mil inner ring ..... .48" Sight base ..... 13"		13" sight base 

One great advantage of iron sights is that they seldom get out of order unless the metal is bent, broken, or rusted through. They need only be checked for these defects which can be seen at a glance. The only care they require is occasional oiling to prevent rust and to make the mounting adjustments operate easily.

REFLECTOR RING SIGHTS



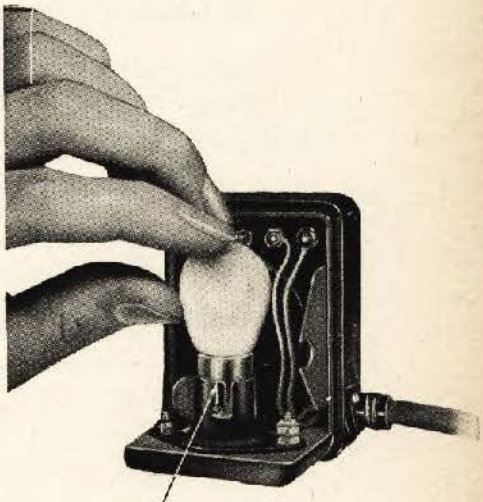
THE MARK 9 or two-ring reflector sight, is a simple arrangement of a single electric light bulb inside a small housing, a reticle, lens and reflector plate. You use the sight by looking at your target through a glass plate on which the light bulb projects the dot called a "pipper," and two rings which show you where to aim.

The pipper shows exactly where your guns are pointed; in applying Rule 1 of Position Firing, you **place the pipper between the attacking fighter and the tail of your bomber, along the fighter's line of apparent motion.** To apply any deflection up to two rads, simply place the fighter on the appropriate place as shown in the diagrams in the section on Position Firing. To apply deflections greater than two rads, simply imagine additional rings outside of the two rings and the same distance apart as the 35 mil ring and the 70 mil ring. Then place the fighter with reference to the appropriate imaginary ring as shown in the diagrams in the section on Position Firing.

With reflector sights there is no problem of lining up the bead and peep and the **optical system makes it unnecessary to keep a set sight base.** Each rad is always equal to a 35 mil angle, even if you move your head as you look into the sight.

Use and care of the Mark 9 sight are extremely simple. Your chief job is to make sure that the sight is in working condition before each mission.

Using the Mark 9 Sights On the side of the case is a knurled thumb screw switch which can be turned to "off," "Night," or "Day" to allow varying degrees of light. A 21-6 candle power double filament, double contact, type S8, **24-28 volt** inside frosted lamp bulb is used in the sight. The lamp bulb has a line on one side of its base. The lamp socket in the sight has a white line on one side of it. **The lamp bulb must be placed in the lamp socket so that the mark on the base of the lamp bulb lines up with the white line on the lamp socket in the sight.**

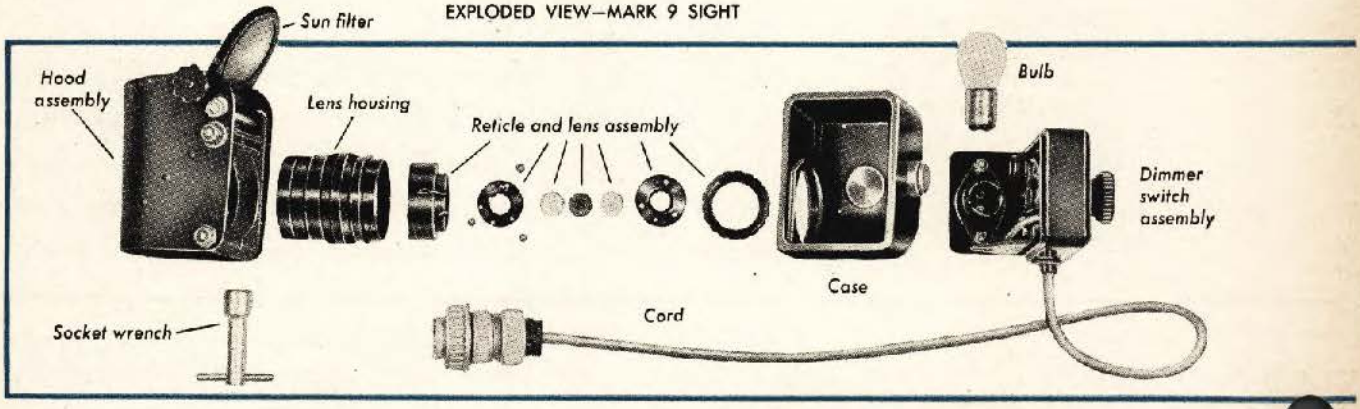


If the lamp is installed so that these two lines do not "line up" a coil in the sight will burn out and the lamp will not light. To change lamp bulbs, pull off the side of the lamp housing by pressing **up** on the button on the bottom of the sight. Replace the bulb as soon as possible after one filament burns out—or in any case after every third mission. **Always carry a spare bulb.**

In front of the hooded section is a sun filter which may be positioned in or out of the line of sight by a scalloped thumb wheel. Always use the filter when firing into the sun.

Keep fingerprints, grease, oil and dirt off the exposed glass parts. If the exposed glass parts get dirty, clean with liquid lens cleaner and a clean chamois or piece of soft tissue paper.

EXPLODED VIEW—MARK 9 SIGHT



Pre-Flight Check.

1. Make sure that the reflector plate is clean.

2. Test the knurled thumb screw switch to make sure that both filaments work and that the dimmer works properly.

3. Make sure that the rings and pipper look sharp and clear.

4. Center the sight on some distant object and then move your head from side to side. The rings and pipper should stay right on the object. If they move away or if they appear fuzzy, the sight needs adjustment.

5. Make sure that you have at least one new spare bulb.

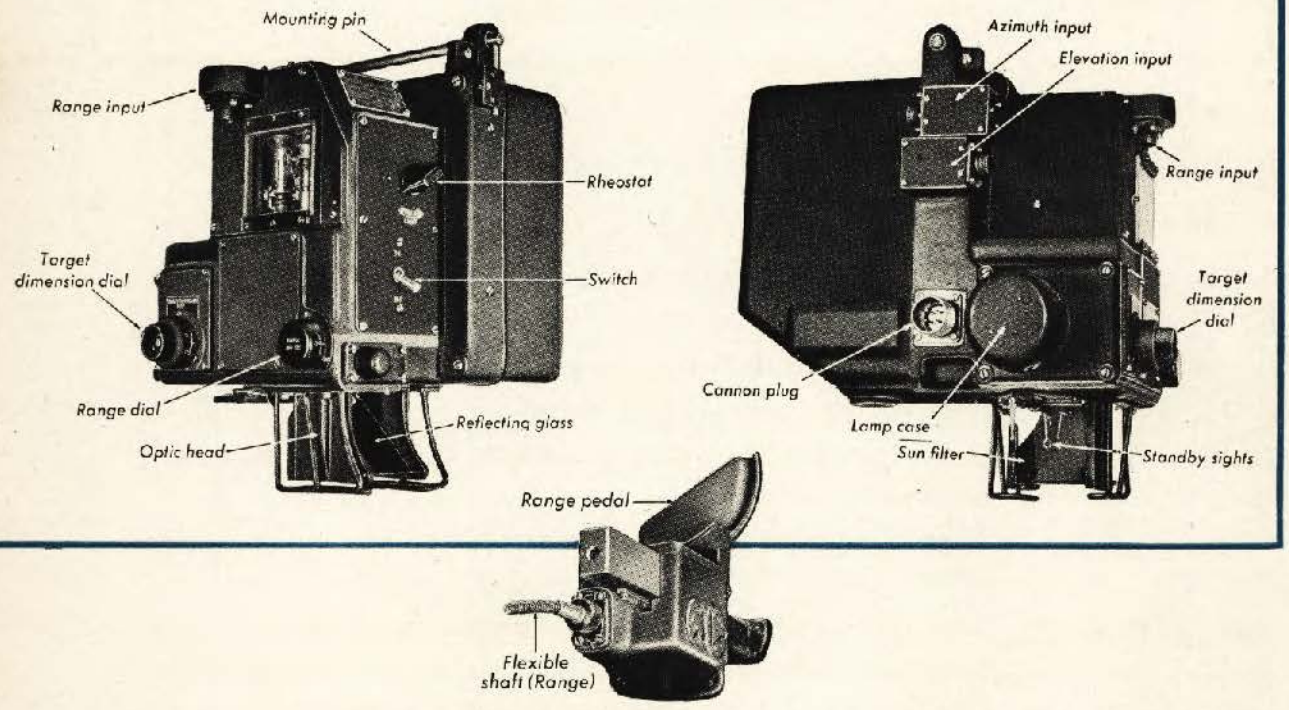
THE MARK 9 Mod 1 SIGHT The Mark 9 Mod 1 sight is identical with the Mark 9 except that it operates on 12 volts. The Mark 9 operates on 24 to 28 volts. If the electrical system of your airplane has an output of 24 to 28 volts you will use the Mk 9 sight. If the electrical system of your airplane has an output of 12 volts you will use the Mk 9 Mod 1 sight. The Mk 9 Mod 1 uses a 21-6 candle power, double filament, double contact, type S8, 12 volt inside frosted lamp. The line of the base of the lamp base must be lined up with the white line on the lamp socket the same as in the Mk 9. Everything stated above with reference to the Mk 9 applies equally to the Mk 9 Mod 1 except as to the voltage.

COMPUTING SIGHTS

Automatic computing sights are one of the new developments of air warfare. These sights serve as mechanical brains in helping the gunner shoot down enemy planes. They do this by calculating the needed deflections and making it simple for the gunner to apply them. They are completely different—in construction, operation, and use—from ring sights. With a computing sight you do not need to apply the rules of Position Firing and range estimation. Instead you must learn a new mechanical technique of aiming. And you will need plenty of practice—for unless you use a computing sight properly, the sight will not calculate deflections accurately.

The descriptions of automatic sights in the following pages are confined to operational information which you need to knock down planes. You will not be concerned with how the mechanisms work, for only trained technicians should make adjustments or repairs.

THE SPERRY K-4



The Sperry K-4, mounted in the Sperry Lower Ball turret, is used by sighting through a glass screen mounted in an optic head—just as you look into a reflector sight. Visible in the K-4's glass screen are three lines called reticles—one horizontal and two vertical. These reticles are used, instead of a ring, to line up the target. Connected with the optic head is a computing

unit which contains all the mechanism for calculating deflections and offsetting the guns to the proper angle.

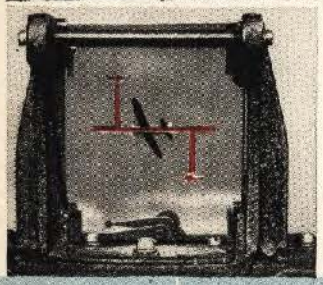
To make its computations, the sight requires three specific items of information about the enemy fighter:

1. The target dimension, which you supply by setting a target dimension dial on the sight housing to the wingspan of the target plane.
2. The range of the fighter, which you supply by adjusting the range control—a pedal which you operate with your left foot—to keep the vertical reticles framing the target.
3. The apparent motion of the target, which you supply by tracking the enemy plane so that the horizontal reticle is always across the center of the target.

Given this information, the K-4 makes computations which increase the effective range of your guns to 3,000 feet.

To use the K-4:

1. Turn on the sight switch, which is on the front panel of the sight housing. This will light the reticles and turn on the computing unit. Use the rheostat on the sight housing to adjust the reticles to the proper brightness. Adjust the filter for proper contrast.
2. As soon as you see an enemy fighter, determine what type of plane it is, recall the wingspan for that type, and set the target dimension dial.
3. Track the enemy fighter by moving your guns to keep the horizontal reticle right across the center of the fighter.

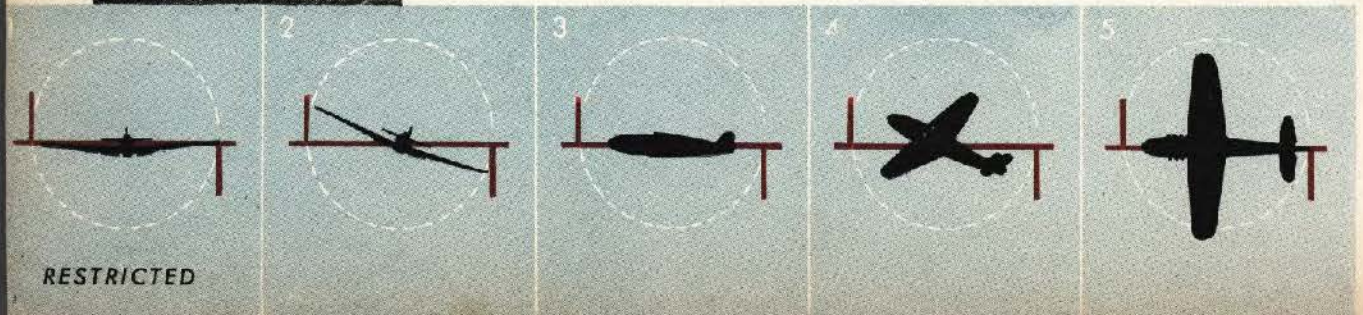


4. Keep moving the range control to make the vertical reticles frame the width of the fighter's wingtips.

By turning the range control, you can move the reticles closer together or farther apart. By keeping the reticles right on the width of the fighter's wingtips, you enable the sight to make a sufficiently accurate estimation of his range.

If the fighter is banked, an imaginary circle through his wingtips should be framed by the vertical reticles.

If you see the top or bottom of the fighter instead of the nose, an imaginary circle through the wingtips should be framed by the reticles. Targets seen from the side present a special problem. On most planes, wingspan and length are nearly the same; ranging will



be sufficiently accurate if you frame the fuselage or an imaginary circle drawn through the ends of the fuselage. But if you know that the wingspan is considerably longer than the fuselage, keep the reticles a corresponding distance from the ends of the fuselage. The target dimension dial registers only up to 60 feet. For the very few enemy planes which have a wingspan over 60 feet, set the dial at half the wingspan and frame the center half of the plane only.

5 Fire at the enemy—using bursts of the length found most effective in your combat theater—as long as he is within range.
When you have set the target dimension dial for the wingspan of the enemy plane he will be in range when he just fills the smallest possible reticle opening.

6 Track the target as smoothly as possible
The sight can work effectively only if you give it a clear, smooth picture of the fighter's apparent motion. Its computations require a little time; your aim will not be correct if you fire without tracking smoothly. This is not too easy and takes a lot of practice.

Care of the K-4

Avoid bumping or jarring the delicate optic head. Don't touch it except to clean the reflection glass, dust shield, and sun filter. Never try to oil or adjust the sight yourself.
Never operate the turret unless the sight switch is on—or you will ruin the computing mechanism.
Never turn on the sight switch before the turret's main power switch has been turned on.

Pre-flight Check

1 Before starting on a mission, turn on the sight switch and make sure that the reticles light, and that the rheostat works properly.

2 Move the guns and track to the left, right, up, and down. The reticles should lag a little, moving across the optic head in the opposite direction.

3 Make sure the vertical reticles move closer together and farther apart as you turn the range control.

THE SPERRY K-3

The Sperry K-3 is the original computing sight developed and was designed for the Sperry Upper Turret. The K-4 is actually an upside down version of the K-3. The range control for the K-3 is a thumb knob or motorcycle type handgrip on the turret control handle.
In all other respects, the K-3 and K-4 are exactly alike.

BORESIGHTING

No sight can do its job accurately unless it is properly lined up with the bore of the gun. The sight and gun must work together; the technique of making them work together is called boresighting.

Boresighting does one thing. It lines up the sight and gun so that you can look through the sight and know where your gun is pointing.

Before you fire a gun you have never used before, be sure it is correctly boresighted. All guns should be checked constantly for boresighting—before each mission in combat zones. All guns, whether hand-held or mounted in turrets, and all sights, whether iron, reflector, or computing are boresighted in the same basic way. In the pages that follow, boresighting of iron sights and hand-held guns will be discussed. In the turret section, a more detailed discussion of boresighting turret guns will be given. With turrets you will usually be dealing with more than one gun. Boresighting of multiple gun installations is called **harmonization.**

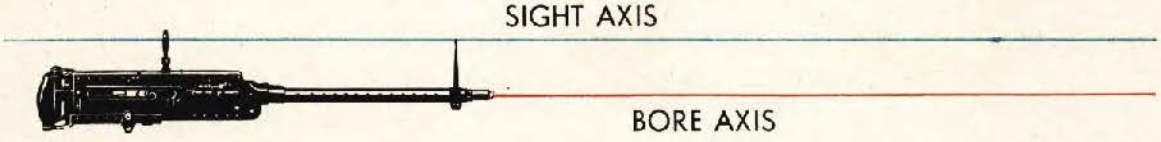
To understand boresighting you must understand two definitions: sight axis and bore axis.

The sight axis is the straight line drawn from your eye through the bead and peep and on out into space. With the reflector sight, this line is drawn from your eye through the pipper out into space.

The bore axis is the straight line drawn through the center of the barrel of the gun and on out into space.

Boresighting establishes a relationship between these lines, so that you can aim your gun accurately.

Squadron doctrine will decide how those two lines are to be set. They may be made to run



parallel; they may be made to **converge;** they may or may not be adjusted so as to allow for the pull of gravity on your bullets. The relationship of those two lines should be set, however, to give the densest pattern to your bullets at a given range.

The simplest boresighting will be on your primary machine gun range in gunnery school. There the target will be about 100 feet from you. You don't need to worry about the effect of gravity drop. Your only problem will be to line up the sight axis and bore axis on the same mark on the target. In other words, you want those two lines to converge or come together on the target.

To do that, take the following steps:

1. Place the gun in a mount which will permit you to lock it in position.

2. Loosen the front post sight locking nuts. (If the Mark 9 Reflector sight is used, loosen the sight adjusting nuts on the hood of the sight.)

3. Remove the back plate, bolt, and driving spring assembly.

4. Trip the accelerator forward.

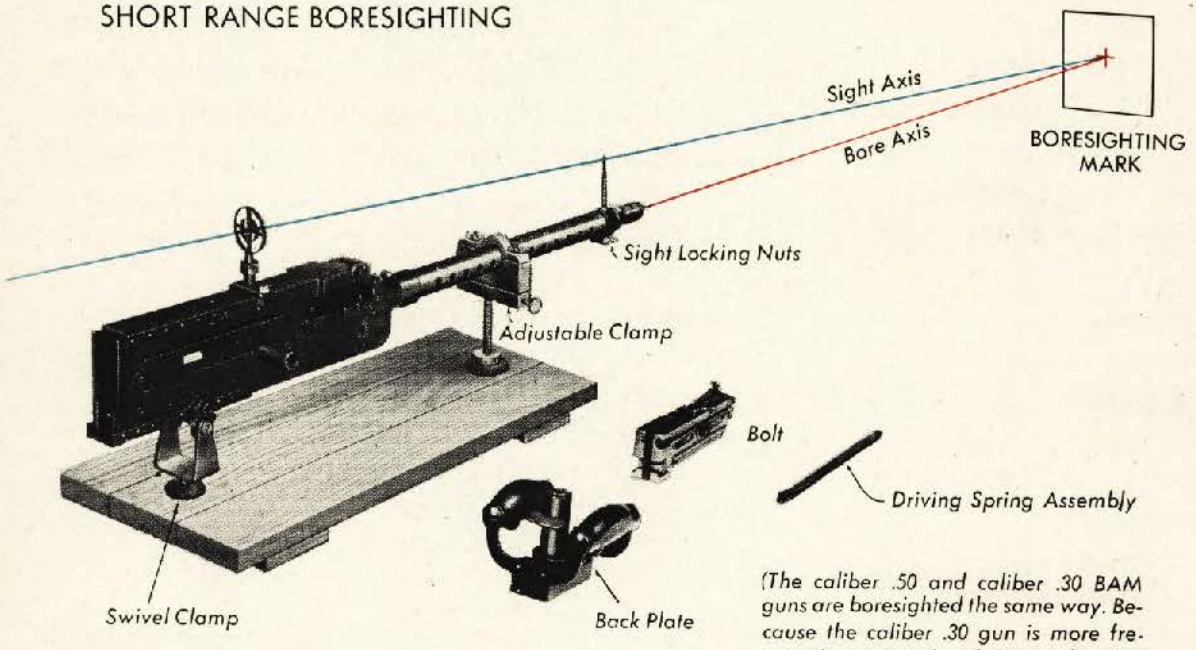
5. Line up the bore axis dead center on the reference mark.

6. Line up the sight axis dead center on the same refernce mark.

7. Tighten the front sight locking nuts. (If the Mark 9 sight is used, tighten the sight adjusting nuts on the hood of the sight.)

8. Reassemble the gun.

SHORT RANGE BORESIGHTING



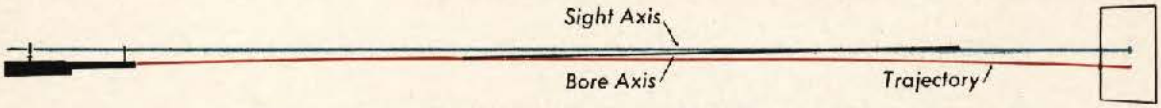
(The caliber .50 and caliber .30 BAM guns are boresighted the same way. Because the caliber .30 gun is more frequently equipped with iron sights, it is used in these illustrations.)

Your gun is now boresighted for firing at a range of 100 feet.

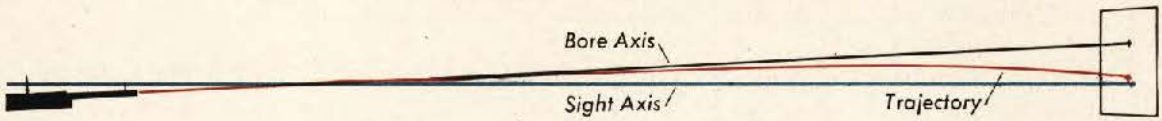
(If a Mark 1 boresighting kit is used, steps 3, 4, and 8 can be omitted, because the kit contains muzzle and breach adapters which are used with a periscope-like attachment, and which make it unnecessary to sight through the rear of the barrel in order to line up the bore axis.)

For longer ranges, the problem is a little different. The bullet will gradually drop off due to gravity, and the further it goes the more it drops.

If you lined up the sight axis and bore axis on the same mark at 1200 feet, for example—the range at which your guns are boresighted for advanced firing in gunnery schools—your bullets would hit about four feet low at that range. To allow for this, two marks should be on your target—the one for the bore axis to be above the one for the sight axis. If you

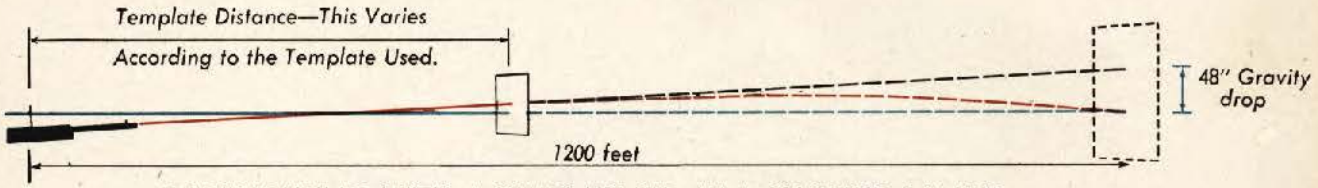


BORESIGHTING WITHOUT ALLOWING FOR GRAVITY



BORESIGHTING ALLOWING FOR GRAVITY

are boresighting your guns at 1200 feet, the marks should be 40″ apart for the caliber .50 gun and 48″ apart for the caliber .30 gun. Boresighting would then be simple if you had a full 1200 foot range. However, this range is not always available. In that case, you use **templates,** which are usually figured out by your gunnery officer. A template is a boresighting card showing the proper marks on which to line up your bore axis and sight axis, and can be used successfully at short distances. The proper position for the marks are figured out mathematically. However, since any error on your template will be magnified at the full range, be certain the templates are official and correct.



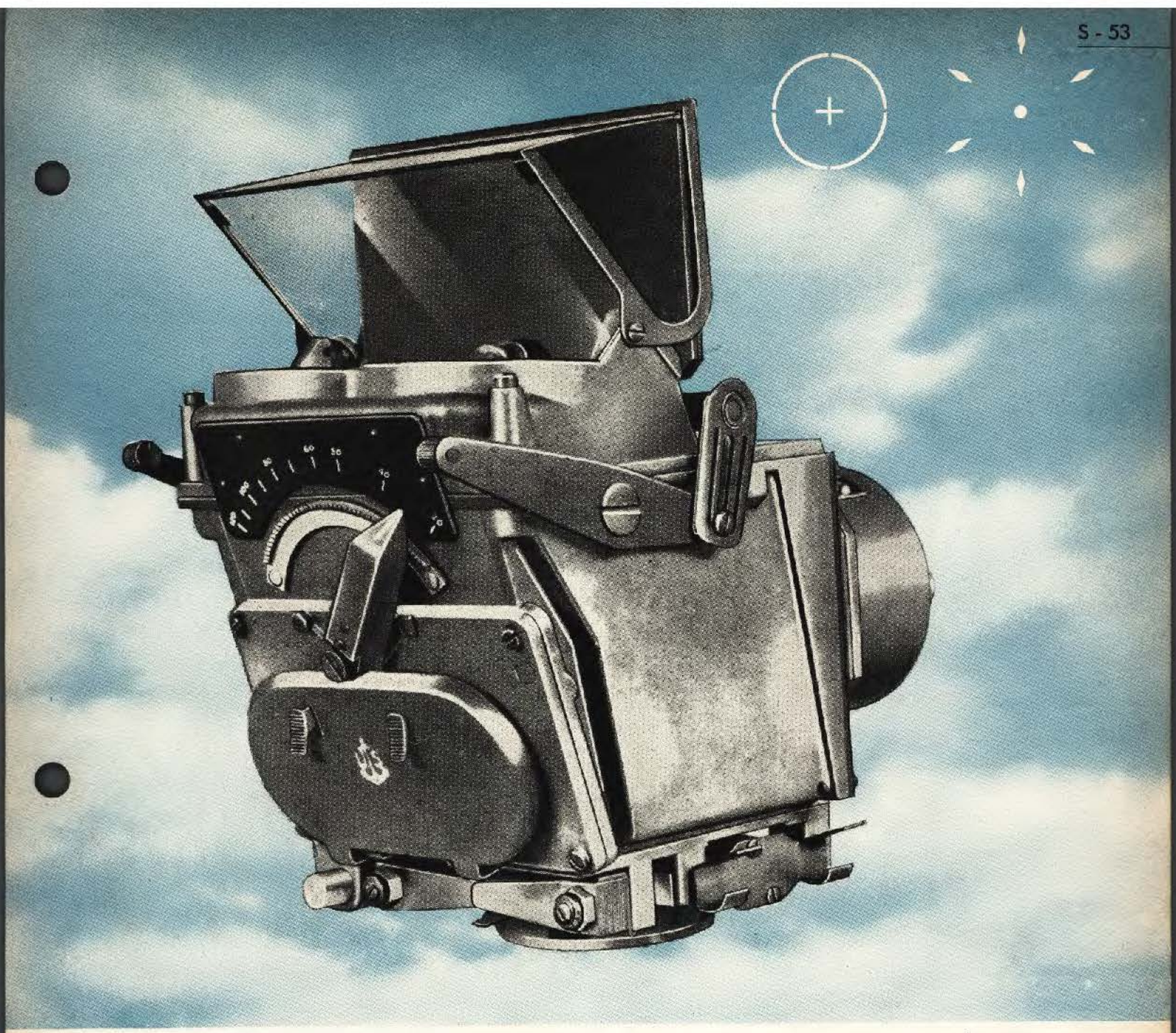
BORESIGHTING WITH A TEMPLATE SET AT A SHORTER RANGE.

THE TEMPLATE
Calculated For A Specific Distance.

Bore Axis Mark
Sight Axis Mark

At gunnery schools a full allowance for gravity drop will be made, because there you are firing on the horizontal. In combat you will not always be firing on the horizontal, which means that there will be a varying effect of gravity drop. In the Fleet, therefore, gravity allowance will be determined by squadron doctrine. You may boresight your guns on a template, or you may merely boresight them on some distant object. The latter method is called infinity boresighting. Boresighting on templates is the general practice on carriers. You will also use templates in gunnery schools. However, for convenience, infinity boresighting is often used in land based squadrons. Regardless of what prescribed marks you use, you follow the same procedure as previously outlined and in the exact sequence.

The point to remember is to be certain that your guns are boresighted properly according to the method prescribed in your squadron.

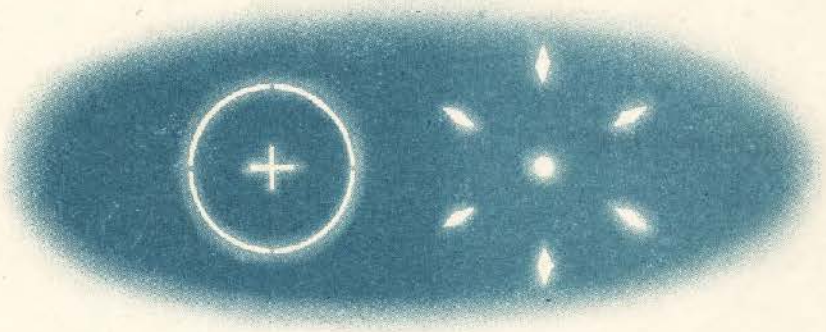


GUN SIGHT MARK 18

The Gun Sight Mark 18 is an electrically operated, computing, reflector-type sight designed for use in power turrets. The gunner makes the proper settings on the control units, after which it is only necessary for him to "range and track" the enemy plane, for the sight automatically figures the proper point of aim. It makes no difference whether or not the enemy plane is in a pursuit curve, or whether the gunner is strafing a stationary target. This sight handles all situations equally well.

It is not necessary for a gunner to be familiar with the internal construction of the Mark 18

Gun Sight or the theory of how it computes deflections. Gunners should never dismantle or open up the sighting head or any of the other units. Only experienced maintenance men are allowed to replace units, alter adjustments or check for malfunctions, except as specified in "Boresighting" and "Gunner's Check."



GENERAL DESCRIPTION

The Gun Sight Mark 18 is really two sights in one. It has two optical systems and two reticles. When you look at these reticles through the reflector plate they appear to be projected out into space. The reticle on the left which you view with your left eye resembles the inner ring of the Mk 9 reflector sight. This is the **fixed reticle.** The reticle on the right side of the reflector plate which you see with your right eye consists of a center "pipper" which is surrounded by six diamond-shaped pips arranged in the form of a circle. This is the **gyro reticle** or **movable reticle.**

GYRO OR MOVABLE RETICLE

The circle formed by the six diamond-shaped pips of the gyro or movable reticle can be made to spread out and close in. When you operate your turret the gyro reticle (the center pipper and six diamonds) moves around on the reflector plate. If you use the Mk 18 sight properly the gyro reticle automatically computes the correct deflection and gets hits for you. All you have to do is keep the enemy framed or "spanned" in an imaginary circle drawn so that it cuts the inside points of the six diamond pips of the gyro reticle. The center pipper of the gyro reticle, also forms the center of the imaginary circle.

THE FIXED RETICLE

The fixed reticle is essentially the same as the inner ring of the Mk 9 reflector sight. The only difference is that the center of the fixed reticle is a cross instead of a round pipper as in the Mk 9. The fixed cross indicates the direction that your guns are pointing.

The fixed reticle is used for aligning the two reticle systems, for boresighting, for maintenance checks (also gunner's checks) and as a standby sight in case of malfunction or failure of the gyro reticle. Sighting with the fixed reticle is the same as with the Mk 9 sight, except it has only a one-rad ring whereas the Mk 9 has a one-rad and a two-rad ring.

THE CONTROL UNITS

The complete Mk 18 sight installation consists of a number of units. Only those units that are of concern to you as a gunner are discussed.

SIGHTING HEAD

The sighting head is in reality the **sight.** It contains the reflector plate through which you view the fixed and gyro reticles.

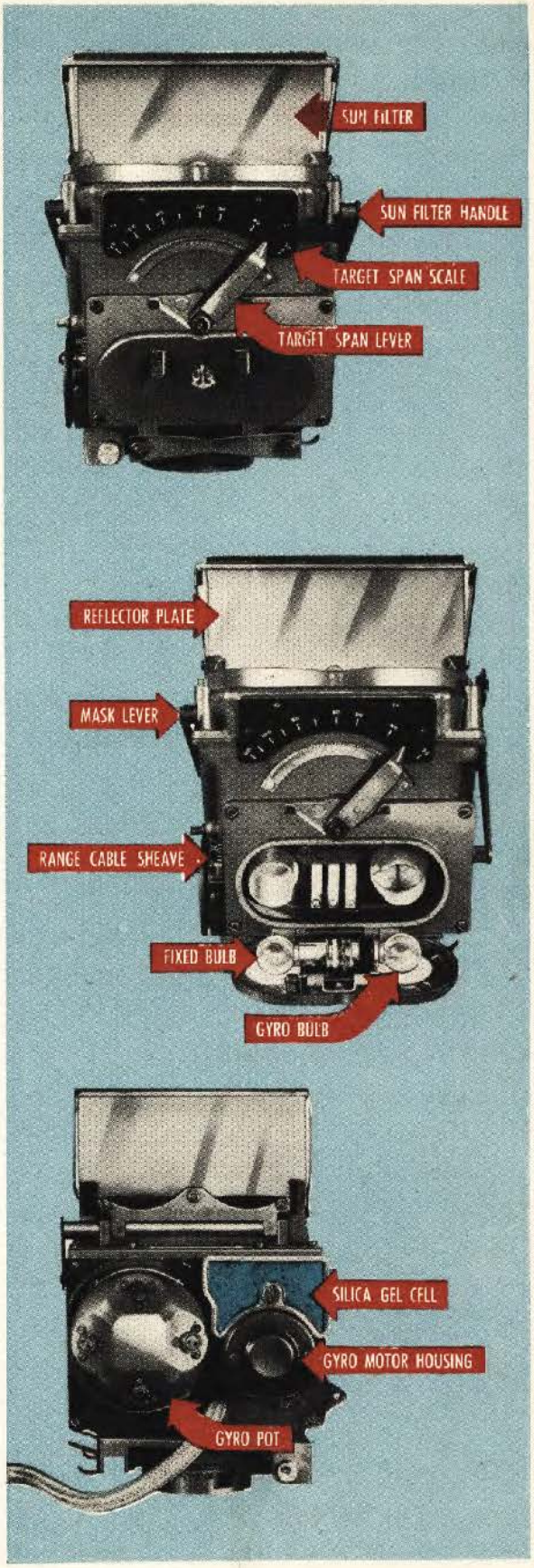
The lever on the right side of the sighting head is the **sun filter control handle.** Depressing this handle lowers the sun filter. On bright days the sun filter may be raised by lifting up the control handle.

On the left side of the sighting head is the **fixed reticle mask lever,** which when depressed will blank out the ring of the fixed reticle and leave only the center cross showing. Below the fixed reticle mask lever is the **range cable sheave,** which is mechanically connected to the movable reticle and controls the movement of the six diamond-shaped pips. It is numbered in feet from 600 to 2400.

Directly in front of you on the sighting head is the **target span scale** numbered from 30 to 120. These numbers represent the size of the target in feet. The **target span lever** can be moved from side to side to correspond with the known target dimension.

Just under the target span scale and lever is a double-latched door which opens downward. Depress both latches to open the door, and mounted inside are two lamp bulbs which provide light for the two reticles.

On the front of the sighting head (side farthest from you) is a small plastic container filled with blue material. This is the **silica gel cell** which



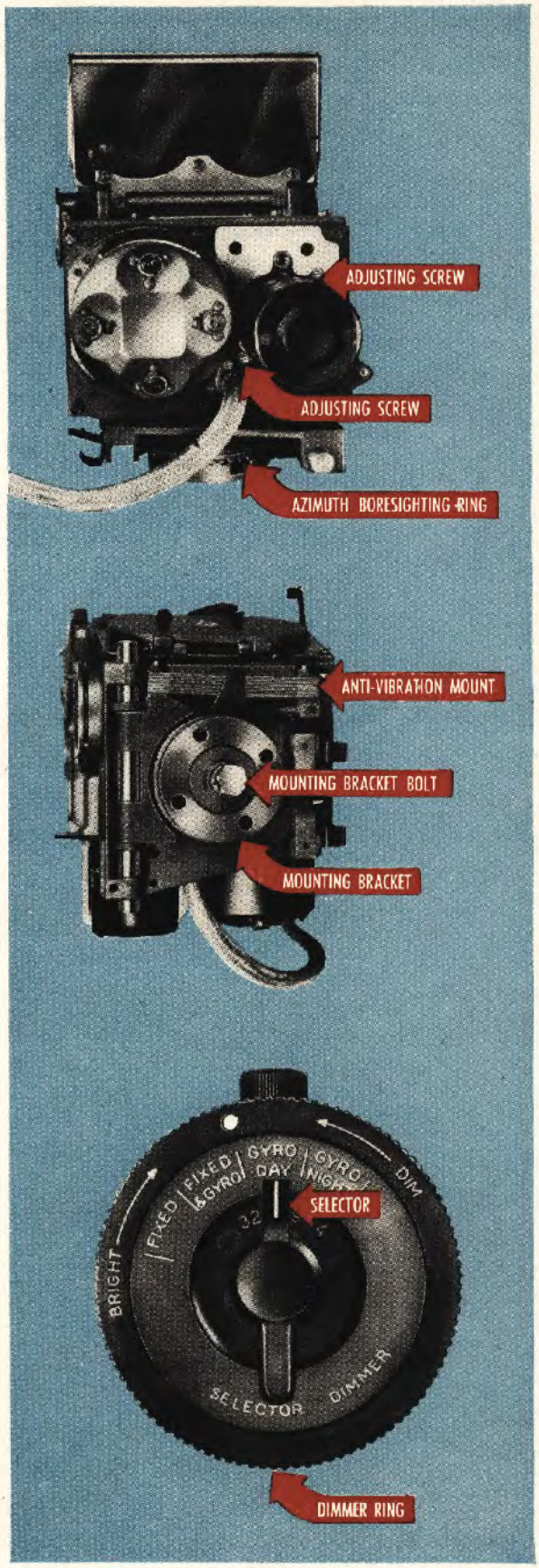
dries out the air entering the sighting head and prevents the sight from fogging up.

The large cup or gyro pot to the side of the silica gel cell houses the gyro and electromagnets of the computing mechanism.

The small cup beneath the silica gel cell is the gyro motor housing. It houses the electric motor which turns the gyro.

On the sighting head next to the gyro motor housing are two small screws. One screw cannot be turned unless the silica gel cell is removed. These two screws adjust the fixed mirror within the sighting head so that the fixed reticle can be aligned with the gyro reticle. The adjusting screw underneath the silica gel cell gives horizontal adjustment while the other gives vertical adjustment.

An azimuth boresighting ring on the bottom of the sighting head is equipped with notches to permit movement of the sighting head. To move the sighting head right or left the number of notches necessary to harmonize the sight to the guns, loosen the mounting bracket bolt projecting from the bottom of the sighting head. To absorb shock, an "anti-vibration mount" is provided on the underside of the sighting head near the mounting bracket.



SELECTOR-DIMMER

This unit consists of a four-point switching device and a rheostat. It is usually mounted near your left hand or on some other place you can reach easily. The "selector-dimmer unit" enables you to turn on either the fixed reticle or the gyro reticle, or both at the same time.

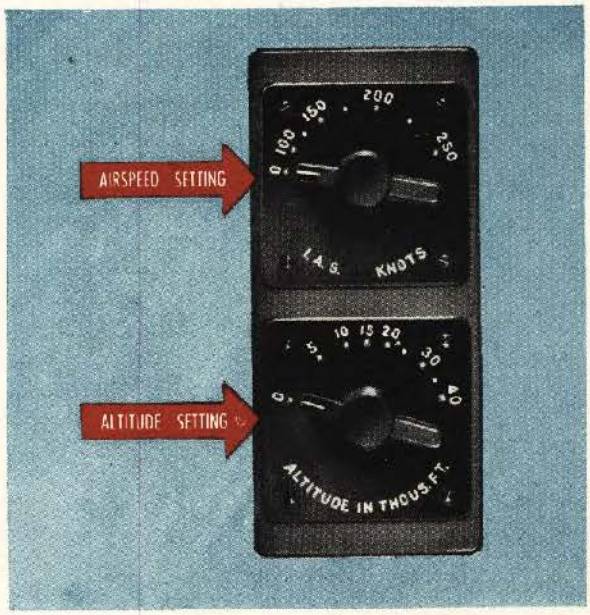
On the face of the unit a pointer can be turned to any one of the following four positions:

FIXED—only fixed reticle visible in reflector plate. This switch position is used for boresighting, maintenance checks, gunner's checks and

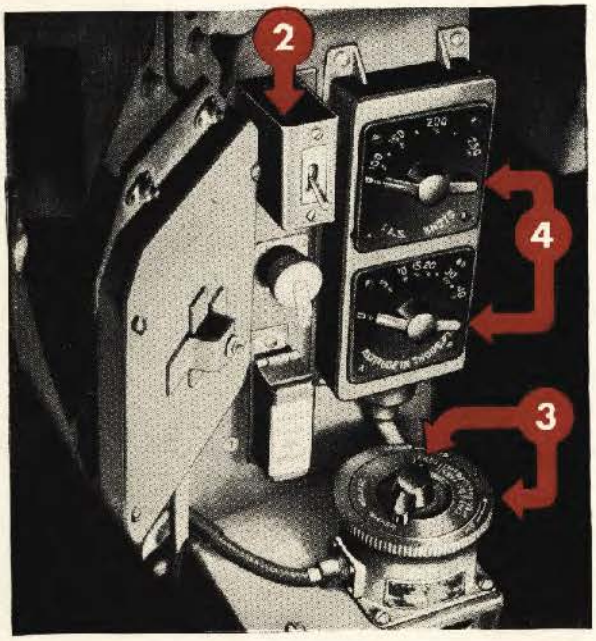
when the fixed reticle is used as a standby sight.
FIXED & GYRO—fixed and gyro reticles visible in reflector plate. This switch position is used for day firing, for alignment of the two reticle systems and for gunner's checks.
GYRO DAY—only gyro reticle visible. This switch position is optional for daytime firing.
GYRO NIGHT—only gyro reticle visible. This switch position is used for night firing because the combat ranges are necessarily short.
On the outer circumference of the selector-dimmer unit is a knurled ring (dimmer) which operates the rheostat controlling the brightness of the reticles. Turn the dimmer clockwise for greater brightness or counterclockwise for dimming the reticles.

ALTITUDE AND AIRSPEED UNIT

This unit is mounted so that its numbers are visible and control pointers easily reached.
The upper half of this unit is the airspeed section and is numbered in knots from 0 to 250. The indicated airspeed (IAS) of your plane is "set in" by moving the pointer to the correct figure.
The lower half of the unit is the altitude section and is numbered in thousands of feet from 0 to 40. The altitude of your plane is "set in" by moving the pointer to the correct figure.



OPERATING THE MARK 18 SIGHT



For Day Firing

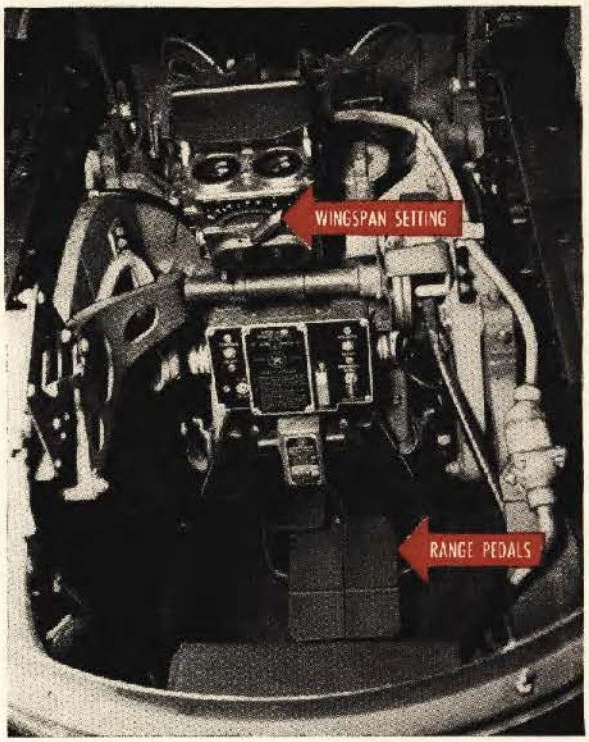
BEFORE YOU SEE THE ENEMY

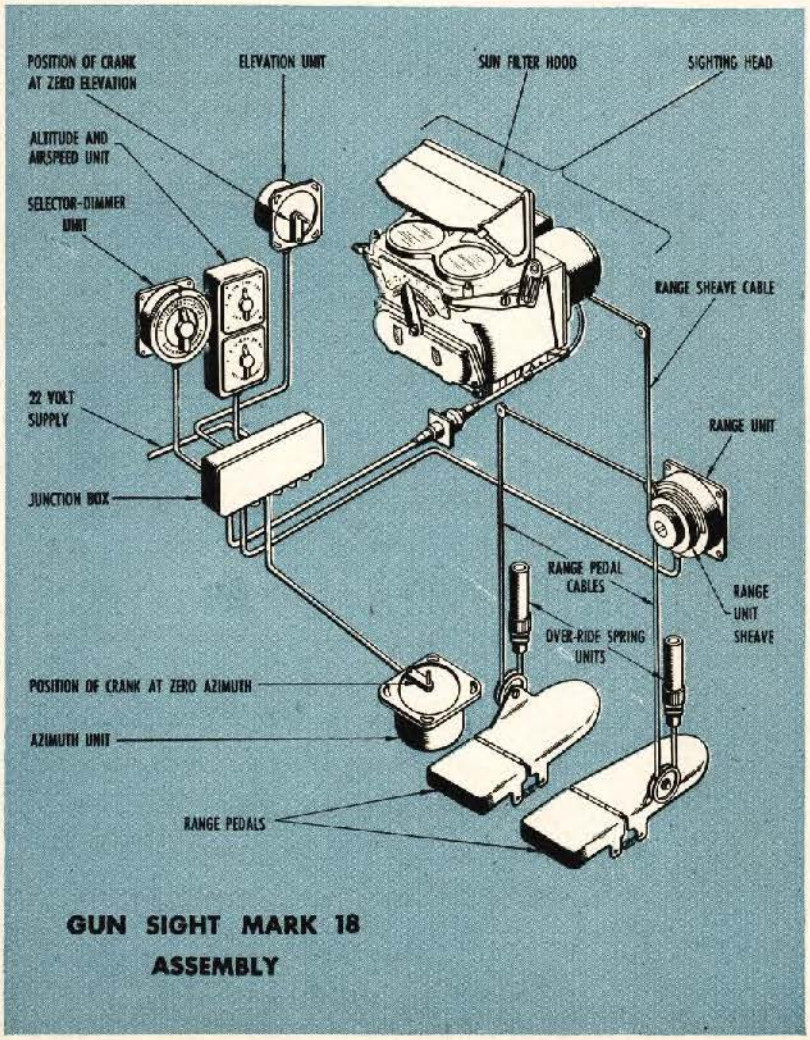
1. Turn on turret Main Power Switch (see Turret Section for location).
2. Turn on Sight Power Switch.
3. Turn Selector-Dimmer to "FIXED & GYRO" position; then turn knurled ring (dimmer) of this unit until the reticles have the desired amount of brightness.
4. Adjust the altitude and airspeed settings of your plane on Altitude and Airspeed Unit. During an attack, however, if your pilot is taking evasive action, do not use precious time re-setting the altitude and airspeed.
5. Raise the sun filter if it is needed.

WHEN YOU SEE THE ENEMY

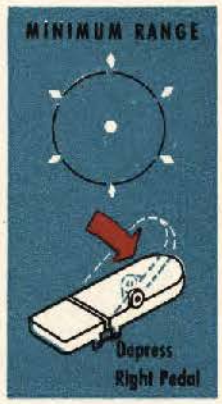
1 Wingspan Setting

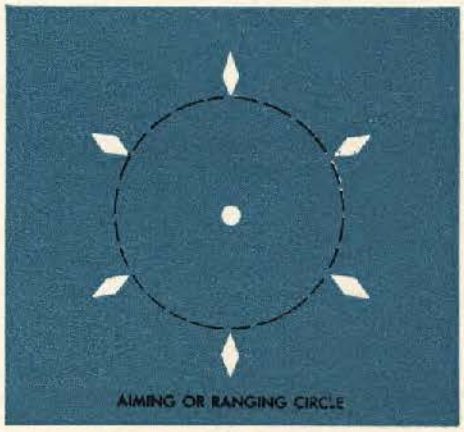
As soon as you recognize the enemy plane, "set in" his wingspan on the target span scale. For example, if you recognize the enemy plane to be the Jap fighter "Hamp" you should know that his wingspan is 36 feet. Move the target span lever to the proper position on the target span scale. If you were attacking or being attacked by a Jap "Betty," set the target span scale at 70 feet. If you were being attacked by both, you must change the wingspan setting when you shift from one to the other. It is very important that you know enemy planes and their wingspans. Keep your knowledge of recognition up to date.

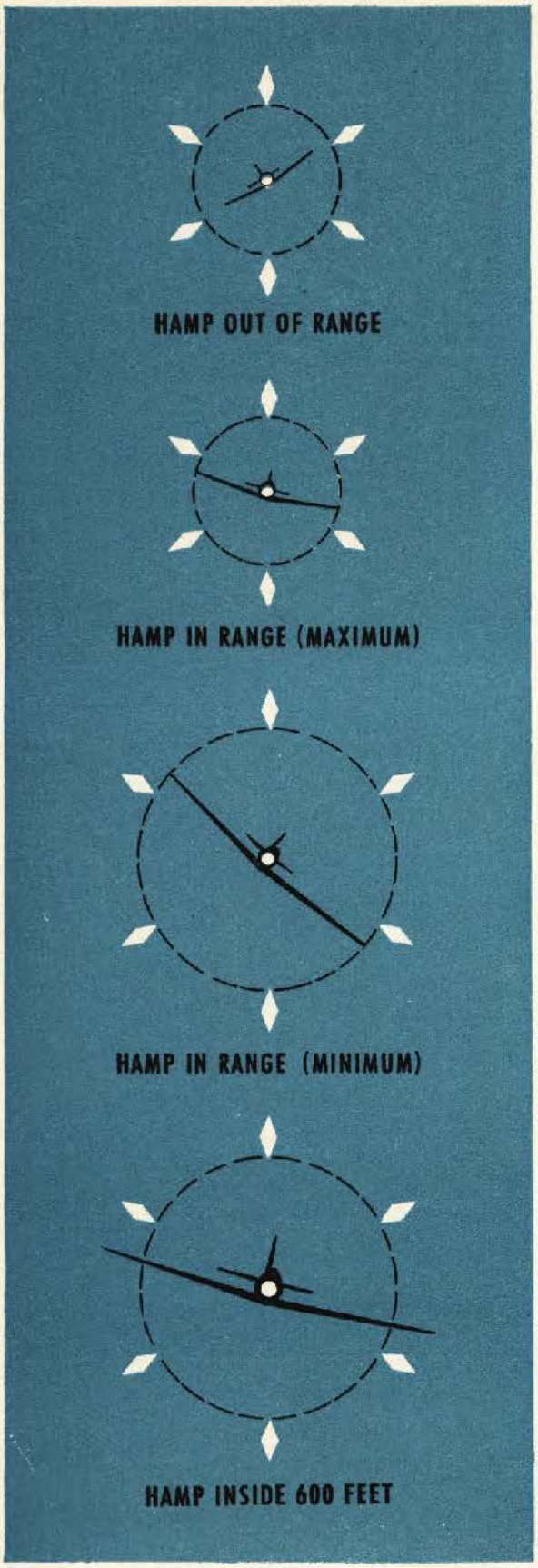




GUN SIGHT MARK 18 ASSEMBLY







2 Ranging

After you have "set in" the correct wingspan of the enemy plane you must "range and track" him properly if the sight is to compute the deflections. You "range" the enemy by the use of the two foot pedals attached to cables in the turret. If you push down on the right pedal the "aiming" or "ranging" circle (an imaginary circle drawn through the inside points of the six diamond pips of the gyro reticle) gets larger. In other words, the six diamonds move farther away from the center pipper, thus making the aiming circle larger. This is minimum range. If you push all the way down on the left pedal the diamonds move closer toward the center pipper and the aiming circle is smaller. This is maximum range. It is very important that you always keep the enemy "spanned" or framed within the aiming circle if you want to get hits.

NOTE: Be sure you frame the enemy plane within a **circle,** not within a six-sided figure formed by joining the pips with straight lines.

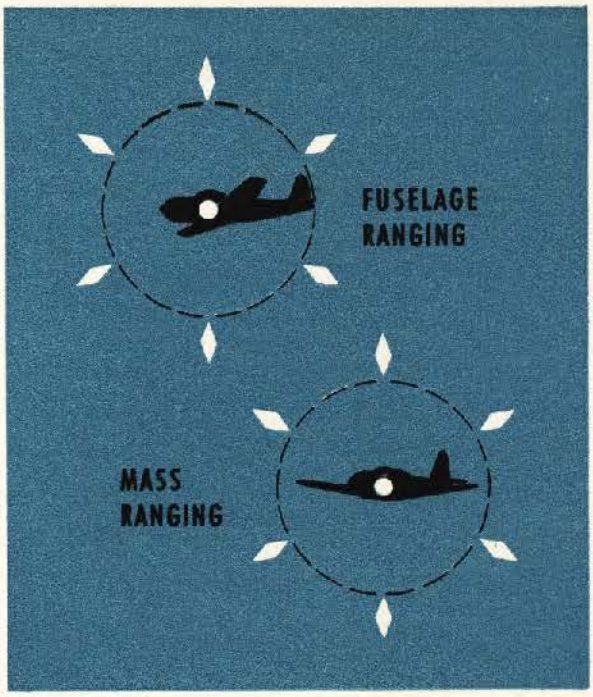
Let's assume that you are in a bomber making 200 knots at an altitude of 20,000 feet. You have already "set in" the airspeed and altitude of your plane. As you are cruising along you see a Jap "Hamp" heading toward you at an approximate range of 4000 feet. You immediately adjust the target span scale to 36. Then place the center pipper of the gyro reticle right on his nose and press the left pedal all the way down to make the ranging circle smallest. At first, Hamp's wingtips may not extend all the way across the ranging circle, as he may not yet be within range. As he gets closer he will appear to get larger, and soon his wingtips

will touch each side of the ranging circle. He is now "spanned" and in range. Open fire. He appears to get larger as he gets closer. It will be necessary for you to make the aiming circle get larger and larger in order to keep it just touching his wingtips. You do this by pressing down on the right pedal gradually and smoothly. **You must track him carefully and keep him accurately spanned or you will not get hits.** Then just keep the center pipper right on the spot you want to hit and watch Hamp fall to pieces.

If an enemy gets within 600 feet of you the ranging circle will not get any larger. This does not mean that the sight is not accurate within 600 feet. It is very accurate. All you have to do now is hold the right pedal all the way down and keep the pipper where you want to hit.

Sometimes it may not be possible for you to span on a full-square view of the enemy's wingspan. If you have a full-square view of the enemy plane's fuselage instead of the wings, you still set the wingspan of the enemy on the target span scale. However, keep the pipper on the cockpit and one edge of the aiming circle on his tail and you will have him "spanned" properly. This is because enemy fighters are approximately one-half as long from cockpit to tail as from wingtip to wingtip.

When the position of the enemy does not present a full-square view of either its wings or fuselage, set in his wingspan as usual; then do your spanning on whatever target dimension appears longest to you. In some cases he may appear wider than long or longer than wide, and in others the enemy plane may simply appear as more or less a



mass in the sky. When spanning such a target keep the ranging circle a little larger than necessary to touch the longest dimension of the target that is apparent to you—about 1/10 the diameter of the ranging circle on each side of him. As soon as the angle of the enemy changes so that you can see his full wingspan or full fuselage, use the procedure for wingspan and fuselage ranging.

The ranging mechanism may not always be controlled by foot pedals. Other types may be developed and used. However, the principles will be the same regardless of the type of control used.

3 Tracking

As the attacking enemy moves in, you must operate your turret to keep him framed within the ranging circle. This is referred to as "tracking." Frequently it will be necessary for you to move your turret rapidly at first to pick up your target. This is called

"slewing." Always keep the right pedal fully depressed while slewing the turret, regardless of the range of the enemy. Otherwise the gyro reticle will "tumble" (drift entirely off the reflector plate) and the sight will be out of commission momentarily. Therefore, when slewing pick up the target with the fixed reticle and swing ahead of it along its line of apparent motion. The fixed reticle shows where your guns are pointing. To help the gyro reticle to "catch up," reverse the direction of slewing along the target path; then depress the left pedal to frame the target with the gyro reticle. Track smoothly for a moment and then open fire. When you are on the target your tracking must be smooth and deliberate. The sight will not compute properly if your tracking is jerky. After you have spanned the target always track a short distance before opening fire to enable the sight computing mechanism to figure deflection.

For Night Firing

1 Turn on turret Main Power Switch.
2 Turn on Sight Power Switch.
3 Turn Selector-Dimmer to "GYRO NIGHT" position; then turn knurled ring (dimmer) of this unit until the gyro reticle has the desired brightness. It should not be very bright.
4 As soon as you see the enemy, put the center pipper on him and keep firing as long as you can see him.

NOTE: There is no need for the sun filter. No setting is required on altitude and airspeed unit; pointer may be in any position. No setting is required on target span scale; target span lever may be in any position. Ranging is not necessary and it makes no difference what you do with the foot pedals. The sight is set for a fixed range of 450 feet, as the range during night firing will rarely be greater than that.

Firing with Fixed Reticle

If for any reason the gyro reticle system does not function properly or fails to function, use the "fixed reticle" as a standby sight. To use the fixed reticle turn selector-dimmer to the "Fixed" position; turn the dimmer to adjust the brightness of the reticle; and then use the fixed reticle the same way you would a Mk 9 sight. The fixed reticle has a 35 mil radius—one rad.

BORESIGHTING

Boresighting the Gun Sight Mark 18 establishes a parallel relationship between the center of the fixed cross of the fixed reticle and the bore axes of the guns. Before boresighting this sight, **the fixed and gyro reticles *must* be aligned.** They are aligned when the center pipper of the gyro reticle and the center of the fixed cross of the fixed reticle are superimposed at an infinite distance with no windage, gravity or relative speed allowances in the system.

ALIGNMENT CHECK

1 Turn the selector-dimmer unit to the "FIXED" position.
2 Turn the turret so that the fixed cross of the fixed reticle bears on some distant object

(at least 1000 feet away). Make sure that the fixed cross is accurately centered on the object.

3 Turn the selector-dimmer to "GYRO NIGHT." The center pipper of the gyro reticle should bear within one mil upon the object on which the fixed cross was sighted. (The diameter of the pipper is approximately two mils.) If the sight fails the above test, the fixed mirror is out of adjustment.

ALIGNMENT ADJUSTMENT

1 Secure the optical gage in position on the sighting head. The gage brings the patterns of both reticles into one line of vision when, without the aid of a distant reference point, both reticle patterns are observed at the same time.

2 Turn selector-dimmer to "FIXED & GYRO."

3 Remove the silica gel cell.

4 Manipulate the range pedals until the range unit sheave is at the 1250 mark. Secure the sheave in this position. The range unit sheave is connected to the range pedals by the range pedal cables. The range unit sheave is numbered from 600 to 2400 feet to correspond with the graduations on the range sheave of the sighting head. The reading of 1250 should be the same on both sheaves. If they are not the same, make adjustments to synchronize them.

5 Disconnect the GREEN wire in the range section of the junction box.

6 Settings of altitude and airspeed are immaterial, and the turret may be turned to any convenient position in azimuth and elevation.

7 Look through the optical gage. Bring the center of the fixed cross to bear upon the center pipper of the gyro reticle by adjustment of the two screws located near the gyro motor housing.

NOTE: The fixed cross is made to move horizontally by adjusting the topside screw and is moved vertically with the lower screw. If no optical gage is available, pick out some distant point (at least 1000 ft. away) and bring the center pipper to bear on this point. Adjust the screws until the center of the fixed cross bears on the same point.

8 When the two reticles are aligned, release the range unit sheave and slowly manipulate the range pedals to move from maximum to minimum range. Observe the pipper and cross; the pipper must not move more than two mils. If the pipper moves more than two mils, replace the sighting head and return to an overhaul shop. The diameter of the pipper is approximately two mils.

9 Remove the optical gage. Replace the GREEN wire in range section of junction box. Replace the silica gel cell.

BORESIGHTING PROCEDURE

1 Level the airplane athwartships and longitudinally.

2 Turn the turret so that the guns are at a right angle to the center line of your plane.

3 Using a spirit level, adjust the nuts on the rear mounting post so that the guns are level. Make sure the level is aligned with the center line of the gun barrel. Secure the nuts on the rear mounting post.

4 Swing the turret to any convenient position, and adjust the guns so that both bore axes bear upon a distant object (at least 1000 ft. away). Do not disturb the elevation setting; the guns need only be adjusted horizontally.

5 Adjust the sighting head so that the center of the fixed cross bears upon the same distant object.

NOTE: It is not necessary to allow for gravity drop of the projectile. The sight automatically compensates for this.

To adjust the fixed sight axis in azimuth, loosen the center bolt in the bottom of the mounting bracket and rotate the sighting head to the desired position. The mounting bracket incorporates a differential toothed arrangement for large and small movements. An adjustable azimuth boresighting ring on the underside of the anti-vibration mount has 36 large teeth on its underside face which mate with the teeth on the top face of the mounting bracket. The ring also has 109 small teeth on its topside which mate with teeth on the anti-vibration mount. A movement of the sighting head and azimuth boresighting ring of one large tooth represents 10°. A movement of the sighting head alone of one small tooth represents 3.30°. Therefore, if the sighting head and azimuth boresighting ring are moved one large tooth, and then the sighting head alone is moved in the opposite direction three small teeth, a total movement of 0.1° of the sighting head is made. Since 0.1° is approximately 1.7 mils, the differential toothed arrangement permits adjustment in azimuth to within .85 mils.

No elevation boresight fittings are provided with the sight. These fittings are integral parts of the turret and therefore will be peculiar to different installations. The manner of adjusting the fitting will have to be determined by personnel making the boresight.

GUNNER'S CHECK

The most expert and painstaking maintenance of this gun sight, as of any gun sight, will not insure accurate results if the turret is operating badly. Make sure your turret is checked and serviced frequently.

PRE-FLIGHT INSPECTION

1 Test the sun filter's operation and the fixed reticle mask lever. Check that all glass surfaces are clean; use lens paper for cleaning. Make sure the range cable sheave does not rotate when the sighting head is moved back and forth on its sliders or when the guns are elevated or depressed.

2 Check the silica gel cell; its color must be BLUE. When the gel is dry, its color is blue. The gel begins to lose its blue color and turns pinkish white as it absorbs moisture. If the gel is not blue, it must be replaced. The moist gel may be dried out by removing it from the cell and heating mildly. Heat the gel in a metal container over a low flame until it regains its original blue color.

3 Inspect the light bulbs; if glass surfaces have blackened, replace them. Until service experience dictates otherwise, it is recommended that bulbs be replaced after each five hours of sight operation. Be careful to keep the light bulb reflecting cavities clean.

4 Examine the sheaves and range cables between the sighting head and foot pedals, making sure there is no interference with

smooth operation. Check that the fully depressed position of the left and right pedals against the stops corresponds to 2400 and 600 feet respectively on the range unit sheave. Check that the over-ride springs do not "give" before the pedals reach the stops. Check that 1250 feet on the range unit sheave corresponds to 1250 feet on the range cable sheave on the sighting head.

5 Examine the selector-dimmer unit pointer to see that it turns to each of its four positions. See that the dimmer ring rotates from dim to bright properly; check its action against the stops. Examine the altitude and airspeed unit pointers to see that they turn easily and cover the scales.

6 Examine all electric cables to the junction box and to the various units to see that they are secure.

PIPPER CHECK

Use the optical gage if there is no distant object to employ as a target. The figures that follow are not to exact scale, so the positions are relative. For clarity, the six diamond-shaped pips are not shown. The check will be easier to understand if you remember that the fixed cross is boresighted to the guns; therefore, the allowance between the fixed cross and gyro pipper illustrates the angle between the sight axis and the gun bore. Unless your plane is connected to an external power supply, operate the turret manually—do not use plane batteries.

ALIGNMENT

If the cross and pipper are not aligned, make the necessary adjustments. (See Boresighting Instructions.)

MAKE PIPPER CHECK AS FOLLOWS

SELECTOR-DIMMER UNIT

FIXED

1 Turn the selector to "FIXED."

2 Note the fixed reticle pattern. The ring may be blacked out by action of the mask lever. The gyro motor should not run. See Figure 2.

3 Run the dimmer ring from dim to bright and note the increase in reticle brilliance.

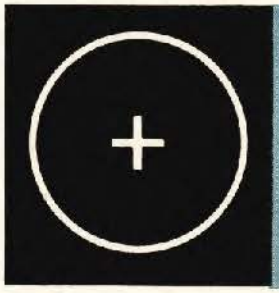


FIGURE 1

SELECTOR—**FIXED**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—ZERO
ELEVATION—ZERO

FIGURE 2

SELECTOR—**FIXED**
RING—BLACKED OUT
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—ZERO
ELEVATION—ZERO

FIXED & GYRO

1 Turn the selector to "FIXED & GYRO."
2 Both fixed and gyro reticles should be visible and the gyro motor should run. The gyro reticle pipper should be directly below the fixed cross; this is the gravity allowance. See Figure 3.

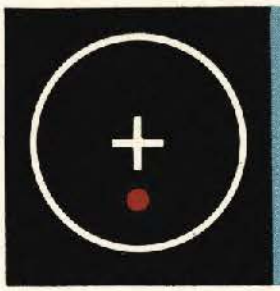


FIGURE 3
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—90°
ELEVATION—ZERO

3 Turn the turret slowly in azimuth to the right and note that the gyro reticle pipper lags the fixed cross. See Figure 4.
Continue to turn the turret at the same speed and shift rapidly to short range. Note that the lag effect is less at short range. See Figure 5. Repeat the above while rotating the turret in the opposite direction and at the same speed. The deflections should be the same as the above, but in the opposite direction.

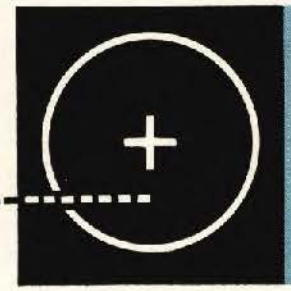


FIGURE 4
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—ROTATING CLOCKWISE
ELEVATION—ZERO

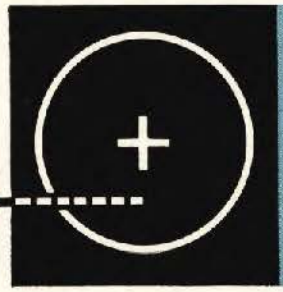


FIGURE 5
SELECTOR—**FIXED & GYRO**
RANGE—SHORT
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—ROTATING CLOCKWISE
ELEVATION—ZERO

GYRO DAY

1 Note the azimuth deflection, which indicates that the guns are pointing ahead of the sight axis. The fixed reticle disappears and the gyro reticle remains stationary when the selector is turned to "GYRO DAY." The faded reticle in Figure 7 is for reference only.
2 Note the difference between Figure 3 and Figure 6. Windage deflections are not generated when the airspeed is zero.

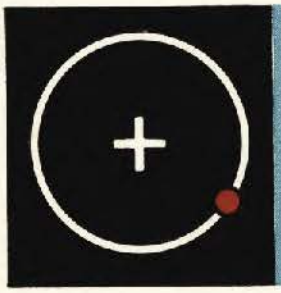


FIGURE 6
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—90°
ELEVATION—ZERO

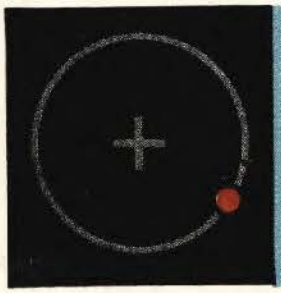


FIGURE 7
SELECTOR—**GYRO DAY**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—90°
ELEVATION—ZERO

GYRO NIGHT

1 When the selector is turned from "GYRO DAY" to "GYRO NIGHT" the gyro reticle pattern should shift to the left as in Figure 9. Faded reticle is for reference only. Movement can be observed by selecting a distant reference point in the field of view corresponding to the position of the fixed cross. No windage or gravity deflections are generated.

FIGURE 8

SELECTOR—**GYRO DAY**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—90°
ELEVATION—ZERO

FIGURE 9

SELECTOR—**GYRO NIGHT**
RANGE
ALTITUDE
AIRSPEED
AZIMUTH
ELEVATION
} POSITION HAS NO EFFECT

RANGE UNIT

1 Note that as the range is changed from maximum to minimum, the gyro pipper shifts to the left and almost touches the fixed cross. This illustrates the smaller allowance needed between the sight axis and gun bore at short ranges. Also note that at short range the allowance for gravity drop is less.

FIGURE 10

SELECTOR—**FIXED & GYRO**
RANGE—SEE FIGURE
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—90°
ELEVATION—ZERO

ALTITUDE AND AIRSPEED UNIT

ALTITUDE CHECK

1 Note that as the altitude control pointer is turned from zero to maximum altitude the gyro reticle pipper moves to the left toward the fixed cross. Its position is halfway between the fixed cross and the zero altitude position. This illustrates that at high altitudes, the air being less dense, the bullet travels faster, so a smaller allowance is needed. See Figure 11.

FIGURE 11

SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—SEE FIGURE
AIRSPEED—MAXIMUM
AZIMUTH—90°
ELEVATION—ZERO

AIRSPEED CHECK

1 As the airspeed control pointer is turned from maximum to minimum, the gyro reticle pipper moves to the left, and at zero airspeed it lies directly below the fixed reticle cross. This illustrates the fact that at zero airspeed no windage allowances are needed.

FIGURE 12
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—SEE FIGURE
AZIMUTH—90°
ELEVATION—ZERO

NOTE: In some turrets the guns cannot be positioned at cardinal points of azimuth and/or elevation. Example: The depression of the guns in an upper deck turret is very small. In such cases, follow the check throughout the allowable positions; i.e. the pipper should be in the direction indicated on the figures.

AZIMUTH UNIT

1 With turret at 0° or 180° the gyro reticle pipper should be directly under the fixed cross as in Figure 13. When firing directly fore or aft, no azimuth windage allowances are needed.

FIGURE 13
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—0° OR 180°
ELEVATION—ZERO

2 With the turret at 90° azimuth, the gyro reticle pipper moves to the right of the fixed cross as shown in Figure 14. With the turret at 270° azimuth, the gyro reticle pipper moves to the left of the cross as shown in Figure 14. Both positions illustrate the guns pointing ahead of the sight axis.

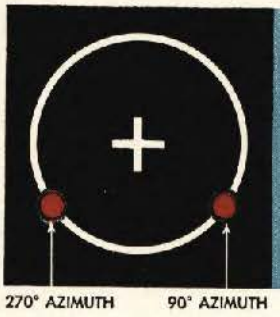


FIGURE 14
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—90° OR 270°
ELEVATION—ZERO

ELEVATION UNIT

In the early production units, there is a dead zone beyond 82½° elevation and depression; so, the pipper deflection will drop to zero. If this condition exists, only elevate or depress 82½° when making the test. In later units there is no dead zone.

1 With the turret at zero azimuth and guns at zero elevation, the gyro pipper should be directly below the fixed cross.

FIGURE 15
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—ZERO
ELEVATION—ZERO

2 With the turret at zero azimuth, 90° elevation, the pipper shifts to a point directly above the cross. If the guns are swung to maximum depression (90°), the gyro pipper will shift to a point considerably below the cross. The positions are illustrated in Figure 16. Note that in both positions the guns point ahead of the sight axis.

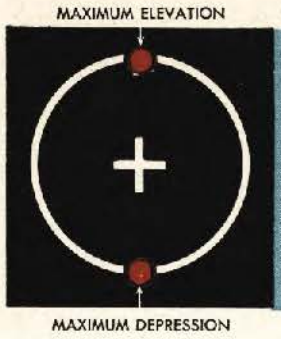


FIGURE 16
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—ZERO
ELEVATION—SEE FIGURE

3 With the turret at 180° azimuth and the guns at 0° elevation the pipper shifts to a point directly below the fixed cross.

FIGURE 17
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—180°
ELEVATION—ZERO

4 With the turret at 180° azimuth and the guns at maximum elevation (90°), the pipper shifts to a point directly below the fixed cross. If the guns are swung to maximum depression (90°), the gyro pipper shifts to a point directly above the fixed cross. Positions are illustrated in Figure 18. Note that in both positions the guns are pointed ahead of the sight axis.

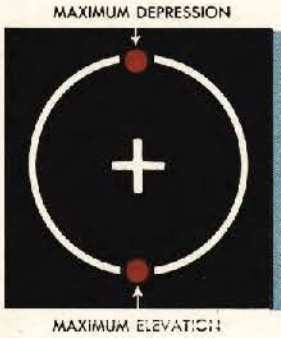


FIGURE 18
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—MAXIMUM
AZIMUTH—180°
ELEVATION—SEE FIGURE

5 With the control positions as indicated under Figure 19, there is the allowable gravity deflection but no azimuth windage allowance.

FIGURE 19
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—ANY POSITION
ELEVATION—ZERO

6 As the guns are elevated or depressed, the gyro pipper moves toward the center of the fixed cross. At 90° elevation or depression, the pipper should be at the center of the cross. This action indicates that the gravity shunt is working properly.

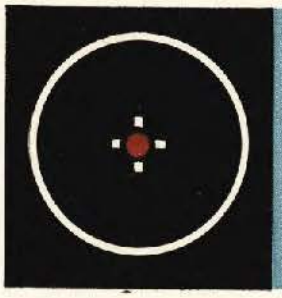


FIGURE 20
SELECTOR—**FIXED & GYRO**
RANGE—2400 FT.
ALTITUDE—ZERO
AIRSPEED—ZERO
AZIMUTH—ANY POSITION
ELEVATION—ELEVATED OR DEPRESSED 90°