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CHAPTER II

TACTICAL FORMATION

In air-to-air combat, the primary purpose of tactical formation is two-fold: (1) To provide security against attacks by enemy fighters, and (2) To conduct offensive operations against enemy bombers and/or fighters. To gain security, any formation must be able to detect the attack and maneuver against it before the attackers achieve a lethal position. This means that the formation must be so constructed that attacking fighters with air-to-air missiles can be detected before they are within launch range. At the same time, this formation must possess characteristics of maneuverability and mutual support so that it can counter the attack as well as see it. These same characteristics are necessary in conducting offensive air-to-air operations.

To gain maximum lookout security against a rear-hemisphere attack, the flight must be so constructed that visual cross-cover is the maximum attainable. Two means by which a formation can increase its visual cross-cover are: (1) Increase the number of aircraft within the basic maneuvering formation, and (2) Place these aircraft line-abreast at definite intervals to increase the field of cross-cover. By increasing the number of aircraft, we provide more flight members covering the rear hemisphere. If we stack the flight line-abreast, we provide greater cross-cover, thus increasing the probability of detecting a rear-hemisphere attack. This means that we increase look-out security, but at the same time we decrease maneuveravility. To maximize maneuverability, a flight must consist of as few members as possible (a single aircraft is more maneuverable than any formation consisting of more than one aircraft) with these members stacked in-trail. From experience we know that when the number within the flight is reduced, it becomes easier for the members to keep track of and avoid one another during any maneuvering engagement. Experience also indicates it is much easier to maneuver in-trail as opposed to line-abreast formation.

In order to acquire security and maneuverability, we must compromise between maximum look-out security and maximum maneuverability. The extent of the compromise needed will determine the type formation flown in a fighter-versus-fighter engagement. The increased range of AIM-9B, as opposed to the 20mm cannon, forces us to construct a formation in which the compromise favors look-out security. This means that the formation will be flown very nearly line-abreast at a specified interval to pick up a missile attack at ranges of greater than 15,000 feet. To maintain maneuverability and mutual support, the size of the formation must be restricted to no more than four aircraft. If a number greater than four is employed, maneuverability and mutual support become difficult and complicated. On the other hand, if less than two aircraft are employed, the look-out capability is reduced and mutual support becomes impossible. Therefore, to provide look-out

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security and maneuverability, a formation of two, three or four aircraft must be employed.

The three-ship flight, with a leader and two wingman, has been evaluated many times throughout the history of fighter aviation. In spite of many attempts to propose a three-ship flight as a combat formation, it has never been extensively employed. The reason is that a three-ship flight, with flanking wingmen, provides excellent look-out capability in the rear hemisphere on a combat air patrol; however, when this formation detects an attack and maneuvers against it, the result has always been the same - chaos. The wingmen cannot keep track of and avoid one another while maneuvering in respect to their leader and their attackers. As a result, one or the other of the wingmen is forced out of the formation and flight integrity is broken. The attackers simply drive in and take the single, then maneuver after the element after having destroyed the single or having forced him out of the fight. On the attack, where hard combat maneuvering is necessary, flight integrity disappears just as it did when maneuvering on the defensive.

As indicated previously, the two-ship formation would be more maneuverable than any other type we may employ. Our problem in using this type formation is to provide extensive look-out security in order to detect a possible missile attack. If we stack the formation line-abreast, we must provide sufficient interval so the element can detect a missile attack at ranges greater than 15,000 feet. In order that this may be accomplished, the flight must spread about 2500 feet apart. A disadvantage of a spread of this magnitude is quickly apparent. Initial maneuverability is reduced after detecting the attack in the rear hemisphere. When the missile's limitation is known, this maneuverability disadvantage is not as great as it appears (remember, to defend against a missile attack at long range, we need angular velocity plus airspeed, not a small turn radius and a low airspeed). This means that maneuverability is not required to the same extent as in gun tactics. With this in mind, we can safely accept an initial maneuverability restriction; however, the real disadvantage of the two-ship flight concerns look-out security. With only two ships, the leader of this formation must spend a great deal of time looking to the rear, rather than looking for enemy targets. In terms of look-out capability, this means a loss in offensive potential. If this loss can be accepted, along with reduced initial maneuverability, the two-ship flight may be employed as a basic maneuvering formation.

To employ the element correctly, without sacrificing maneuverability beyond initial maneuverability, the wingman must know how to position himself during all maneuvers. On patrol, prior to initial contact, the wingman will maintain the position specified above - line-abreast and about 2500 feet out. During turns, the wingman will play the outside as well as the inside of the turn, in order to maintain position.

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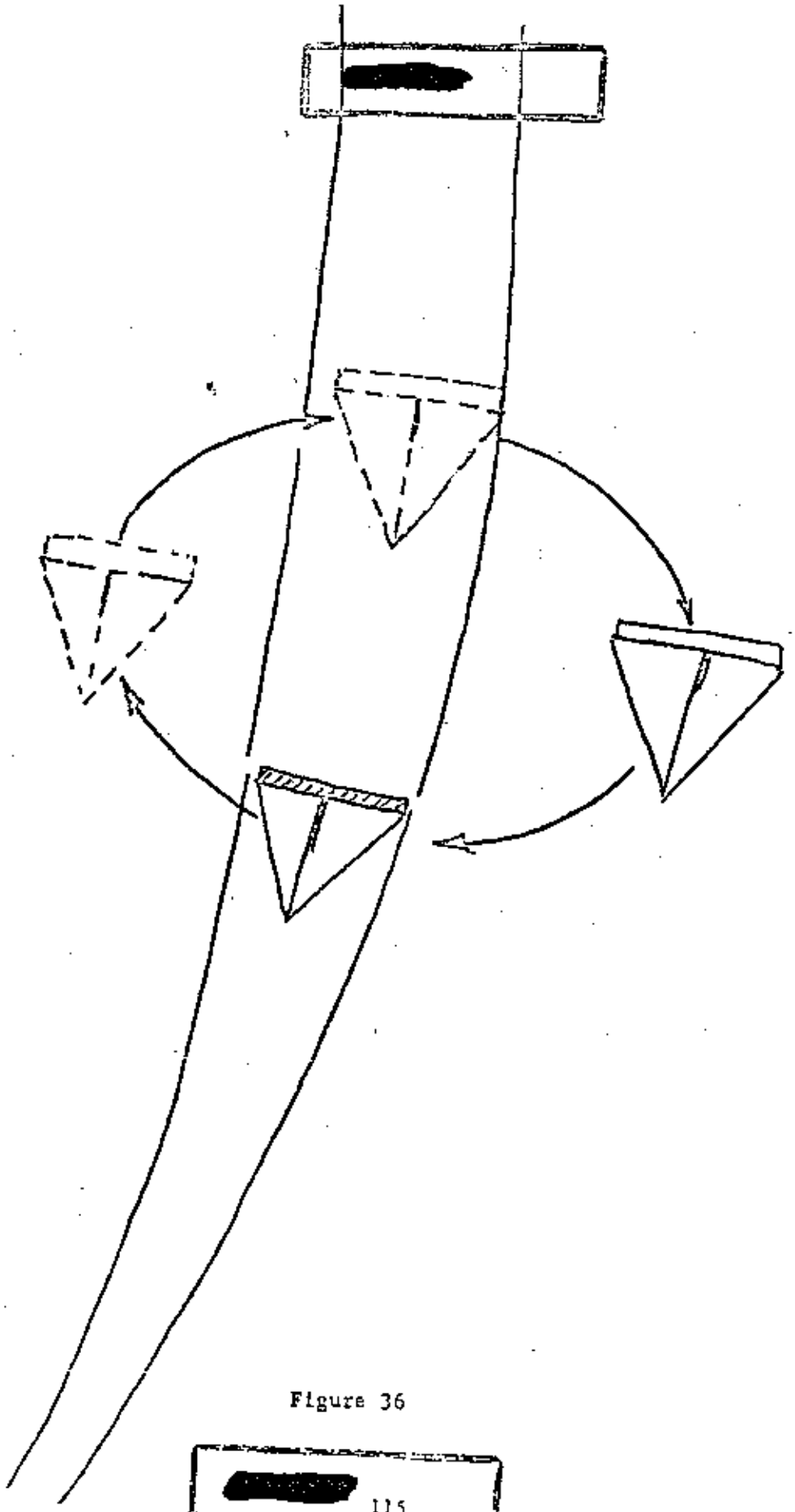
This will not be too difficult because the maneuvers executed, prior to contact, will not be of the maximum-performance variety. To allow the wingman to easily maintain his position and to provide adequate rearward coverage, the wingman must maneuver through both the horizontal and vertical planes. If the leader performs a turn away from the wingman, the wingman lowers his nose and cuts to the inside. This procedure allows the wingman to reduce his horizontal turning component and, at the same time, provides him a rate of closure so he will not be straggling behind his leader. As the wingman moves inside and low toward the leader's line-abreast position, he should playthis crossover so that he does not cross in front of his leader. He should cross to the outside, slide high and fly in the plane of the leader. If this crossover technique is employed during all turns, the wingman will describe a circular movement in the plane of the leader's aircraft, see figure 36. On the outside of this circle the wingman will lose airspeed and slide to the rear. On the inside, the wingman will gain airspeed and move forward. In effect, the wingman is employing the low-speed and the high-speed yo-yo as a means of maintaining position, and providing sufficient visual cross-coverage. At the same time, this maneuver will enable the leader to cover his wingman, whether he be on the outside or on the inside of the turn. If the initial turn by the leader is toward the wingman, the wingman will be unable to cross over behind and underneath his leader. In this situation, the wingman must pull up, play the leader's turn and cross to the outside, above and behind the plane of the leader's aircraft. After the initial crossover, the wingman employs the techniques specified above for the remainder of his crossovers.

When maneuvers approach maximum performance, the wingman will be unable to maintain the loose position implied in patrol formation. He will be forced into a fighting position, in a narrow cone, behind the leader's aircraft. In order to remain with the leader and, at the same time, provide rearward coverage he will be forced to assume a position closer to the tail of the leader's aircraft. As we define it, the fighting position is any place within a 60° cone with the wingman approximately 1000 feet behind the leader. To maintain position in this cone, the wingman employs the same maneuvering techniques which he used in patrol formation. He maneuvers through both the vertical and horizontal planes). During max maneuvers, if the wingman attempts to maneuver very much outside the confines of this cone, he will find it difficult to maintain position and also provide rearward visual coverage. The primary duty of the wingman while in fighting position is to provide visual coverage to the rear, while the leader is concentrating on maneuvering for an advantage. This is of extreme importance if the enemy is equipped with air-to-air missiles. Considering all factors, a two-ship is better than a three-ship formation. Although a two-ship element has an in flight lookout disadvantage, while in patrol formation, it has a distinct maneuvering advantage, and a somewhat better lookout advantage while fighting as a basic formation.



MANEUVERING IN THE FIGHTING POSITION

Figure 36

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When employed properly, the four-ship flight will give us all-around advantages in look-out, maneuverability and mutual support. To acquire these advantages without sacrificing one for the other, a flight of four must consist of two mutually-supporting elements. When on patrol, the elements should fly line-abreast from five to seven thousand feet apart. The wingman should maintain a position from line-abreast to no more than 20° back, at approximately 1500 feet out from their respective element leaders. A formation spread in this manner provides excellent look-out capability, because the wingmen can provide mutual crosscover at ranges in excess of 15,000 feet. Maneuverability in this formation is somewhat restricted. When the lead element turns away from the second element, the second element will experience considerable difficulty in regaining a line-abreast position, unless the turn is held for almost 180°. If the lead element turns into the second element, the second element will be forced to pull up and cross above the lead element. If this is not done, the second element will be forced to cross in front of the lead. In either case, if the turn is less than 90°, the second element will experience considerable difficulty in regaining a line-abreast position. To provide more maneuverability and flexibility, the second element must be given a greater field of maneuver. This field of maneuver should enable the second element to easily position itself, no matter what type of turn is performed by the lead element. A method of providing this freedom of maneuver is to spread the second element in both the vertical and horizontal planes. When this is done, if the lead element turns away, the second element can lower its nose, cut across the inside and quickly reposition itself, even though the lead element does not perform 90° or 180° turns. On turns into the second element, the second element can maneuver well above the lead element without fear of dragging the wingman through one another (remember, wingmen will be maneuvering through both the vertical and horizontal planes to maintain position on their respective leaders). The freedom of maneuver provided the second element leader enables him to devote less time to flying formation and more time to looking for prospective kills. At the same time, during turns, it allows the wingman to provide better rearward coverage, because the elements will not be strung out in extended-train. The only real objection to this formation is that, in straight-away flight, the second element must look through a greater distance to detect a missile attack against the lead element. Although this is true, it can be mathematically demonstrated that the additional distance through which both elements must look, is insignificant. (Less than 300' against a six-o'clock attacker if the fluid element is stacked vertically less than 3000' above the lead element). If the attack is directed from six-o'clock-low, the additional distance through which the second element must look is somewhat greater. However, the attackers must get in considerably closer along the horizontal plane before initiating a pull-up into an underside attack. This means that the second element will be afforded more of a plan view of the attackers, thus a larger target in perspective even though the additional distance is somewhat greater. Another reason cited for not

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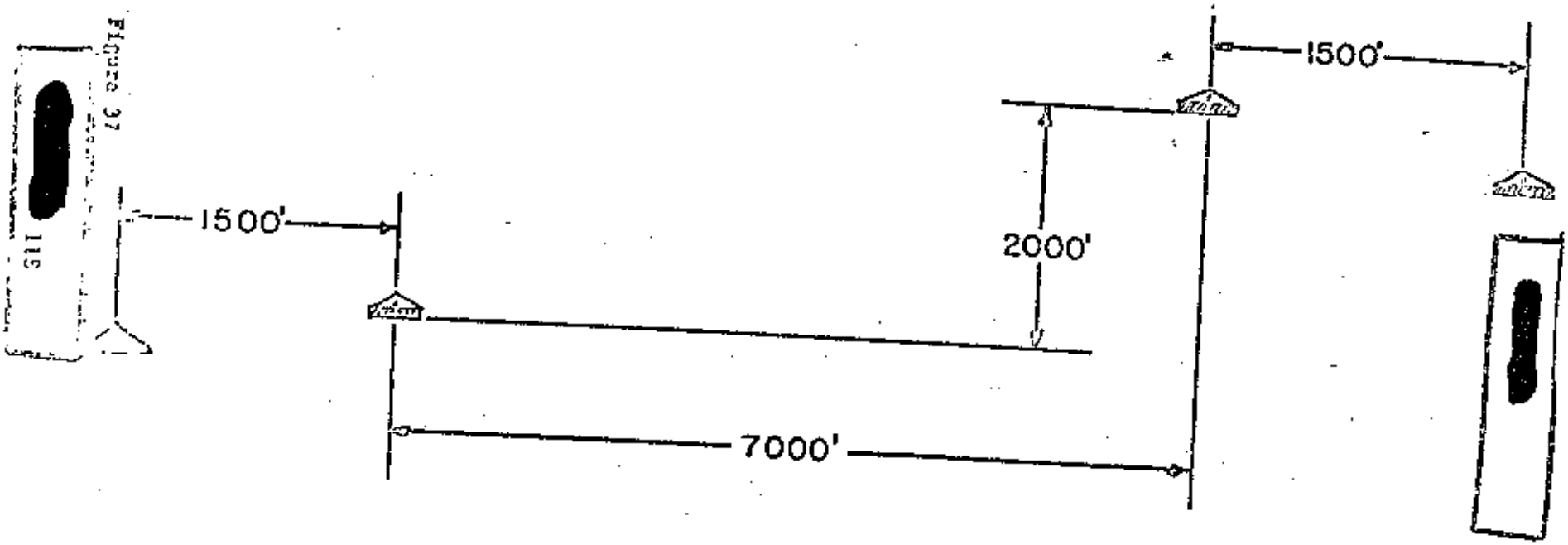
using the high element is the fact that the aircraft wing covers a considerable portion of the highly vulnerable six-o'clock-low attack area. This is true for both the high element and the level-stacked element. To surmount this difficulty, wingmen simply dip their wings occasionally to enable them to cover the vulnerable rear area.

In view of the maneuverability advant.ge offered by the fluid-four type formation (the formation in which the second element is stacked both horizontally and vertically) without significant look-out disadvantage, we consider it the best combat patrol formation. In fluid-four, the second or fluid element should be line-abreast, 5,000 to 7,000 feet out, and approximately 2,000 feet above the lead element. As in a normal tactical formation, the wingman will maintain a position from line-abreast to 20° back and 1500 feet out to the side opposite the other element, see figure 37. As indicated in the two-ship flight, the wingman will fly the vertical as well as the horizontal plane in order to maintain their respective positions. On patrol, the fluid element leader will maintain position on the lead element by flying through the vertical and horizontal plane during all turns and maneuvers. For a fighting position, the fluid element must operate as an independent unit during violent maneuvers in flight-versus-flight engagements (the reason for this will become apparent when we discuss flight tactics).

If the tactical situation indicates that not enough aircraft are available for area saturation with four-ship flights do not employ the fluid-four formation. Instead, use individual elements as basic patrol formations and as basic fighting formations. Although not as decisive as the four-ship flight in terms of look-out capability, maneuverability and mutual support, the two-ship flight will be much more effective than the three-ship flight. The only real advantage which a flight of four has over an element is initial look-out capability and initial mutual support. After the engagement is entered, the fluid-four, or the four-ship flight will become nothing more than individual fighting elements. If suitable tail-warning radar devices were available, four-ship flights would enjoy very little advantage over individual fighting elements in terms of combat capability. The dictum, "economy of force" would most certainly prevail. Tactical formation in fighter-versus-fighter engagements would probably be dominated by the element or even possibly the single ship. Without this needed radar gear, a four-ship flight is the best all-around tactical formation.

Three factors to consider when employing either the fluid-four or the element in combat or on a combat patrol are: (1) look-out capability, (2) maneuverability, and (3) fuel management. In the era of missile-equipped supersonic fighters with afterburner, these factors determine the best altitude for patrol in order to enter a given fighter-versus-fighter engagement. If the patrol is conducted at extreme altitudes (40,000 feet or above) the look-out problem becomes a liability which increases as altitude increases. The advantage of



FLUID FOUR FORMATION

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firing an air-to-air missile at greater range against a given defender is nullified by the possibility of an enemy attacker enjoying the same advantage. In addition, extreme altitude provides a maneuverability disadvantage in terms of indicated maneuvering airspeed. At extreme altitude, fuel management may be an advantage in some aircraft while in others (F-100) it can be a disadvantage. If the patrol is conducted at very low altitudes (10,000 feet or below) the look-out problem is considerably reduced and maneuverability, in terms of maneuvering airspeed, is certainly increased. However, this maneuverability is nullified somewhat by the fact that maneuvering becomes more restricted to the horizontal plane as opposed to the vertical plane. At very low altitudes, good fuel management is not possible with present-day jet engines and afterburners. The optimum altitudes, considering all three factors - look-out capability, maneuverability and fuel management - for patrolling and entering a fighter-versus-fighter engagement are the middle altitudes between 25,000 and 35,000 feet (even this is open for argument if one considers the possibility of surface-to-air missiles). The exact altitudes will depend upon look-out capability and maneuverability of the fighters employed. In the F-100, the best all-around altitude seems to be approximately 30,000 feet. At this altitude, maneuverability and fuel management are excellent. At the same time the look-out problem can be easily handled by a flight of four and handled adequately by an element. If the tactical situation dictates that elements must be employed, an altitude somewhere between 25,000 and 30,000 feet might be more appropriate to reduce the look-out problem. In any case, the medium altitudes provide a position from which an attack may be launched against aircraft at very high or very low altitudes.

Procedures for Flying Element Formation

1. Flying the Position of Wingman in Patrol Formation.

a. Maintain a patrol position off the leader's wing by flying line-abreast at approximately 2,500 feet out when in straight-and-level flight. If you fly closer, look-out capability will be sacrificed. If you fly further out, initial maneuverability as well as final maneuverability will be sacrificed after initial contact with the enemy.

b. Play the outside as well as the inside of the turn for mutual coverage. If an attempt is made to stay on the inside of the turn without a crossover, you will only fall back when the leader rolls out of his turn.

c. Maneuver through both the vertical and horizontal planes in order to fly a relative position off the leader. While on the inside of the turn, you will be in an extended-low position. On the outside of the turn, you will be in an extended-high position in the plane of the leader's aircraft.

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d. Lower your nose and cross to the inside if you are on the outside of the turn. If you are on the inside, sliding forward, cross to the outside then slide high and fly in the plane of the leader. If the intial turn is into you, pull up, cross over and behind your leader, then cross from outside to inside and vice versa in the manner just discussed. This technique will cause you to describe a circular movement in the plane of the leader's aircraft. You will be moving forward in the bottom half of the circle and backward in the top half. This will enable you to easily maintain position and provide mutual coverage during the entire turn.

e. Do not cross in front of your leader. Always maintain nose-tail separation.

2. Flying the Fighting Position as a Wingman in Element Formation

a. Fly in a 60° cone, in a fighting position, about 1,000 feet back.

b. Maneuver through both the horizontal and vertical planes to maintain position. Slide high when overshooting and drop low when falling back, in order to maintain position on the leader.

c. Attempt to keep your fuselage aligned with your leader's during all maneuvers. This will enable you to match your leader's maximum performance and will prevent you from becoming separated.

d. Attempt to stay out of the in-trail position as much as possible. By doing this, the leader may cover you more adequately.

Procedures for Flying the Fluid-Four Patrol

1. Flying Position of Fluid Element Leader

a. Position the element, line-abreast, about 5,000 to 7,000 feet out and approximately 2,000 feet above the lead element.

b. Maintain a relative position to your leader during turns. If you are on the outside of the turn, drop your nose and cross to the other side when you find yourself losing out and falling back. When being turned into, and you find yourself creeping forward, slide high and/or cross to the outside of the turn to maintain position. In other words, play the vertical as well as the horizontal plane in order to maintain supporting position.

c. Lower your nose to gain airspeed and position when you find yourself too far back after rolling out of a turn. When you regain your forward position you may pull back to the original fluid position.

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d. Pull your nose up and kill off airspeed if you find yourself too far forward after rolling out of a turn. You may also retard throttle, however this is not advised when at altitude. When you regain your correct relative position, lower the nose to maintain proper vertical separation. All maneuvers must be smooth to prevent over-correction.

e. Bank from side to side and look below when crossing from the inside high to the outside of the lead element. This will prevent you from losing the lead element during crossovers.

f. Cover the forward hemisphere, along with the flight leader, as primary responsibility in an effort to visually acquire a target so that an attack may be launched against it. As a secondary responsibility, cover the rear hemisphere behind the lead element in order to detect a possible missile attack.

2. Flying Position of Wingman in Fluid-Four Patrol

a. Maintain a position from line-abreast to 20° back and 1500 feet out on the side opposite the element.

b. Maneuver through both the horizontal and vertical planes to maintain position during turns. Fly high when overshooting and drop low to the inside when falling back.

c. Cover the rear hemisphere, behind the other element, at all times. This is your responsibility and your coverage is necessary to detect any possible missile attacks. Your opposite number in the other element, will be providing you the same coverage.

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CHAPTER IV

FLIGHT TACTICS

To employ a flight of four or an element of two in a fighter-versus-fighter engagement, only a few new basic maneuvers must be mastered. The previous maneuvers we have learned still apply in flight tactics. With this in mind, we will now concern ourselves with tactics when operating as a flight of four and/or as an element of two. We will objectively analyze offensive and defensive situations in which we have element-versus-element (two-versus-two) element versus a flight of four (two-versus-four) and a flight of four versus a flight of four (four-versus-four). For our first engagement, let's assume that we have an element of two attacking another element of two.

Two Attacking Two

To attack an element with an element, the maneuvers and procedures learned in the section on Fighter Maneuvers and Tactical Formation will be employed to gain an advantage. The attacking element will attempt to set up for a missile attack. The defending element will counter with a defensive turn in an effort to preclude this attack. The attackers will maneuver for a follow-up gun attack by cutting off or yo-yoing to the defender's angular velocity cone, or they will attempt to deliver a missile in a secondary attack by employing the roll-off or the barrel-roll attack. If the attackers are unable to set up for a missile launch but are able to set up for a 20mm cannon attack, the defenders will be placed in a precarious position. If the defending element continues to maneuver as a single element - without being able to shake the attacking element - the attacking element will simply move in and shoot down the wingman, then the leader. To prevent this possibility, the defending element may attempt a defensive split. This split may be executed so that the leader and the wingman turn in opposite directions through the vertical and horizontal plane or in the same direction with horizontal or vertical separation.

If the defensive split is executed with the defending leader and wingman turning away from one another, the attacking element can split and continue the attack as individual fighting units, or maintain element integrity and continue the attack on one member of the splitting element. If the attackers split, they retain offensive advantage against the splitting defenders. However, they incur a defensive advantage, in terms of look-out capability, against an attack from another enemy element. To maintain an offensive capability in terms of maneuverability, and a defensive capability in terms of look-out, the attackers should maintain element integrity. To continue the attack against one member of this splitting element, the attackers may select either member if the split is in the horizontal plane. The

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defender not selected must then continue the turn or reverse in an effort to provide his teammate mutual support. If the free defender continues the turn, he will meet his teammate and the attacking element from a nose-quarter position and will be in a poor position to provide effective support. If the free defender reverses he will be in a better position; however, he will still be unable to provide effective mutual support. The distance generated by splitting in opposite directions, plus the time needed to execute the reversal, will place the free defender at too high an angle-off to launch a missile and beyond effective range to deliver a 20mm cannon attack. The attacking element should select the high trailing defender if the split in opposite directions is conducted through both the vertical and horizontal planes. If the low, forward defender were selected, the free high defender would be able to roll off and move inside the attacking element's angular velocity cone for a 20mm cannon attack. On the other hand, if the high trailing defender is selected, the low free defender has the same problems in supporting his teammate as did the free defender in the horizontal split. By geometric inspection, we can see that a defensive split in opposite directions is not effective, because a permanent separation of the defenders is achieved with the free defender unable to drive the attacking element off his teammate.

If the defensive split is conducted with one defender executing a max-performance turn in the horizontal plane (or slightly nose-down in the vertical plane) and the other defender turning in the same relative direction, nose-high at less than maximum performance, the attacking element is faced with a defensive split difficult to contend with. See figure 38. In this split - with the defenders turning in the same relative direction, but separated in the horizontal and vertical planes - the free defender can more easily maneuver to support his teammate, since he will not be out of range, nor out of phase in terms of angular velocity. To maneuver against a split of this nature, the attacking element may employ one of five possible options: (1) Dive in and attack the low-inside defender, (2) Attack the high outside defender, (3) Split and continue the attack against each individual defender, (4) Initiating an attack against the low defender, and switch the attack to the high defender after the low defender is well committed in a defensive turn, and (5) Perform a fluid separation to drive the low defender out of the fight, then regain element integrity and continue the attack against the high defender.

If the attacking element drives in after the low-inside defender (option 1) the high defender will be in position to launch an attack against the attacking element's six-o'clock position. The attacking element will be sandwiched between the two defenders with an obvious loss of offensive potential, and a possible sacrifice of a wingman in an effort to destroy the low defender. If the attacking element attacks the high defender, the high defender can reverse-roll or roll underneath,

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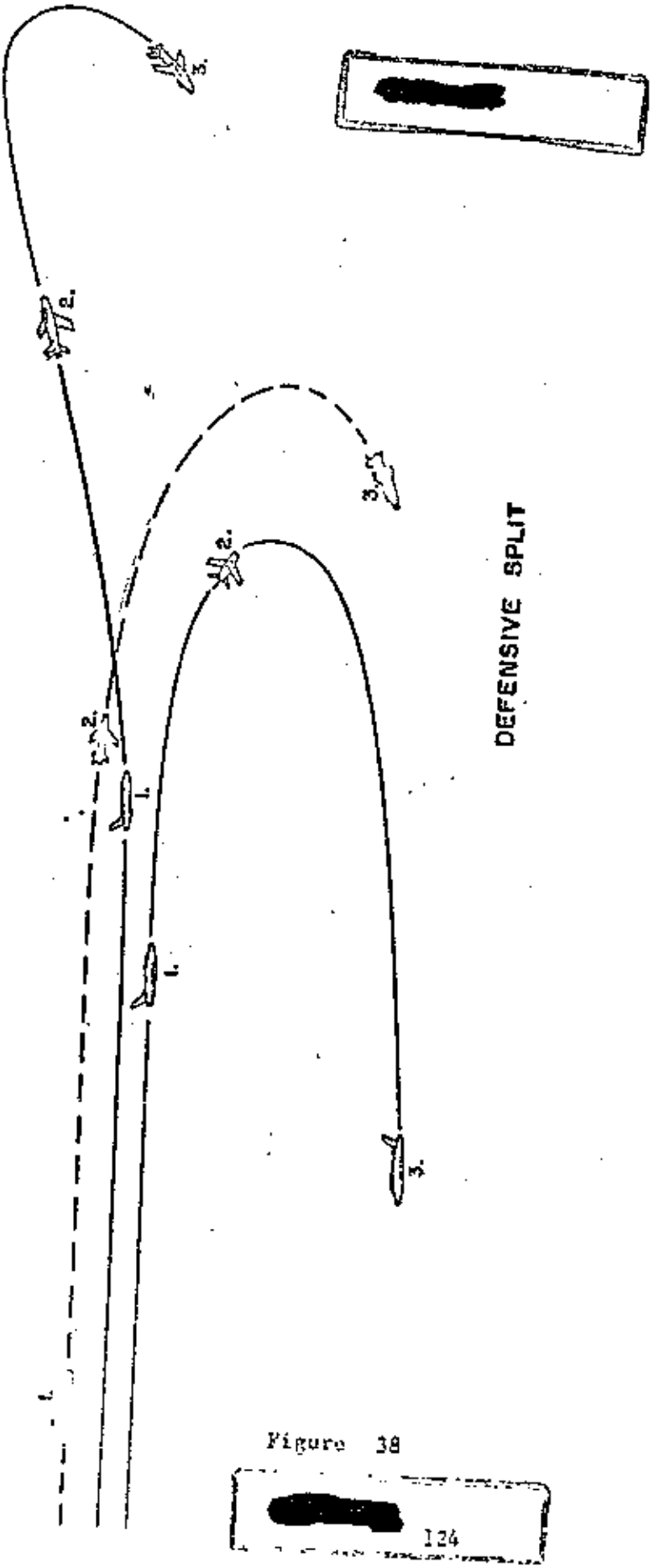

Figure 38

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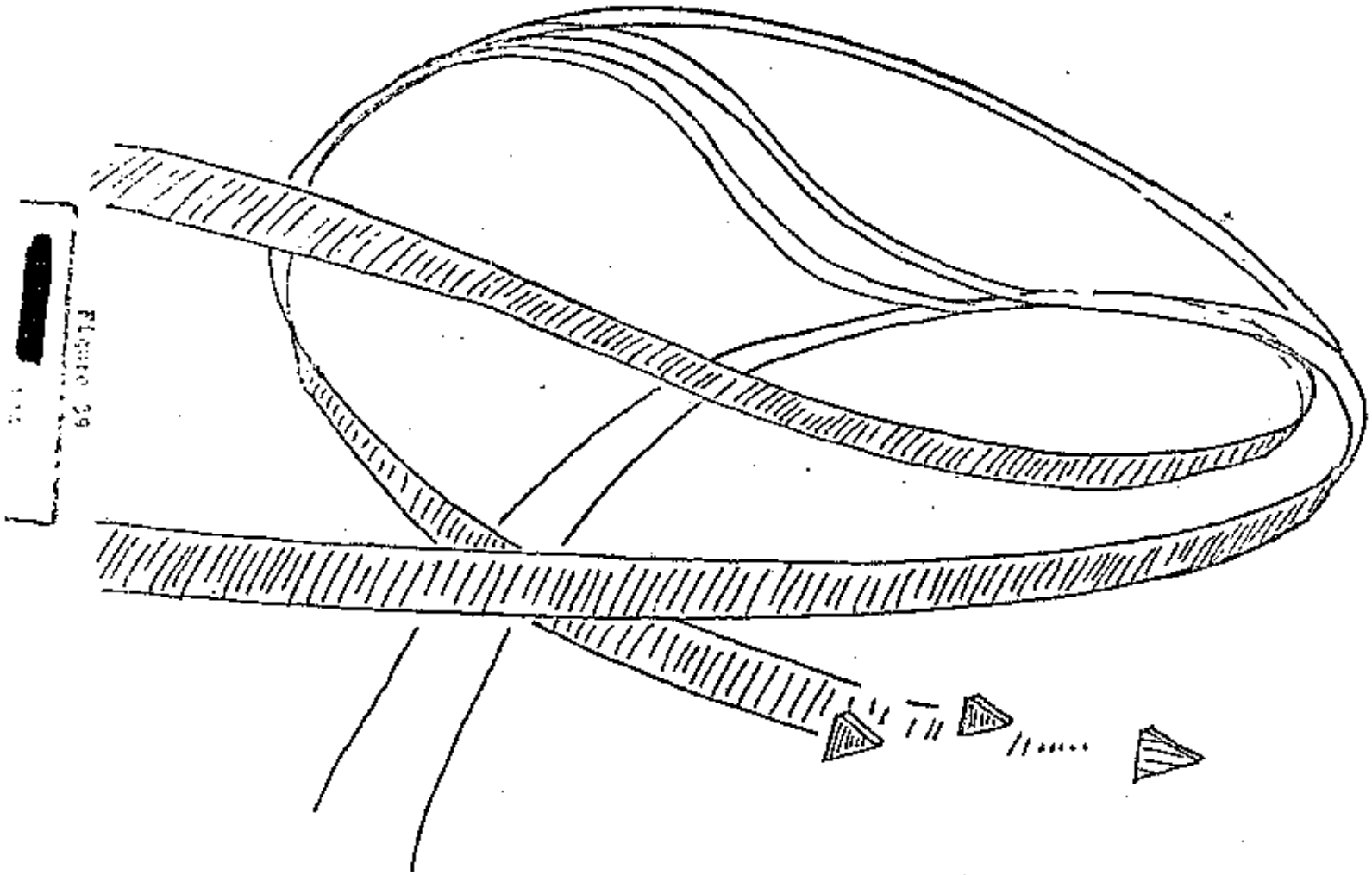
down and away from his teammate. The free defender can then simply reverse-roll and sandwich the attacking element between the two defenders. Once again, the attacking element's wingman will be placed at a severe disadvantage if this attack is continued. If the attacking element splits and continues the attack against each individual defender, the attackers have an immediate advantage since the defending element will be unable to effect mutual support. However, this advantage can be short-lived if the split attacking element is, in turn, attacked by another enemy. The attacking element will have sacrificed look-out capability and mutual support, thus becoming an easy set-up for the new enemy. For this reason, we do not advocate an offensive split as a means of countering the defensive split. If the attacking element initiates an attack against the low defender in a defensive split, then switches the attack to the high defender, the attacking element can maintain its offensive advantage without needlessly sacrificing a wingman. See figure 39. To employ this course of action correctly, the attacking element should drive in and select the low defender. When the low defender observes this action, he will be forced to tighten his turn to prevent himself from becoming an easy target. This action by the low defender will cause him to be driven further from his teammate, with reduced maneuvering potential. If the attacking element handles this initial maneuver correctly, the low defender may be driven completely out of the fight. The attacking element should switch the attack to the high man after the low defender is well committed in his defensive turn. The switch should be performed before reaching the high defender's line-abreast position and before zoom potential is sacrificed. If the attack against the low defender is prolonged, the attacking element will experience airspeed decay, hence a loss in zoom potential when the switch is made against the high defender. If airspeed decay reduces zoom to the extent where the high defender can counter with a zoom through a greater angle, the attacking element will be forced out front and below the high defender. A nose-high reversal by the low defender at this point will sandwich the attacking element in the vertical plane. To preclude this possibility, the attacking element should switch and zoom soon enough to force the high defender to turn into the attack. During the switch, the attacking wingman should closely observe the low defender's subsequent actions, to determine whether he is out of the fight or is reverse-rolling in an effort to maneuver into the attacking element's six-o'clock position. If the low defender is out of the fight, the attacking element can continue to engage the high defender. If the low defender is still a threat and reverse-rolls, the attacking element should disengage the high defender, roll wings-level and zoom in the vertical plane, while it still enjoys the airspeed advantage. As shown in our discussion of Fighter Maneuvers, a zoom under these conditions enables the attacking element to reduce its horizontal velocity component in relation to the defender. As a result, the defender is forced below and forward and the attacking element need only roll off and maneuver toward the trailing defender's six-o'clock position. During the roll-off, once again,



SWITCHING THE ATTACK TO THE HIGH DEFENDER

the attacking wingman must observe the actions of the defender not under attack to determine whether or not he will be a threat.

Another tactic that can be used to successfully counter the defensive split is the fluid separation. See figure 40. In a fluid separation, the attacking element initially drives after the low-inside defender. After this initial feint, the leader then resumes the attack against the high defender. Meanwhile, the attacking wingman performs a fluid separation to force the low defender down and out of the fight. The attacking wingman does not split from his leader to initiate a one-versus-one engagement. Instead, he simply checkmates a possible counter-move by the low defender, while providing the attacking leader visual cross-coverage during the entire maneuver. When the low defender has been definitely committed out of the fight, the attacking wingman rejoins the leader at normal interval. At the same time, he visually observes the down-and-out defender for a possible threat. After rejoining, the attacking element presses the attack with a two-against-one advantage over the high defender. To make the fluid separation a successful tactic, the attacking wingman must play the separation so that he is able to rejoin the leader after forcing the low defender out of the fight. If the attacking leader has an experienced wingman, and one whom he can trust not to split, the fluid separation is the best counter for a defensive split. If the wingman is inexperienced or lacks talent, the best tactic would be to maintain element integrity, attack the low defender (in an effort to drive him out of the fight) then switch and continue the attack against the high defender.

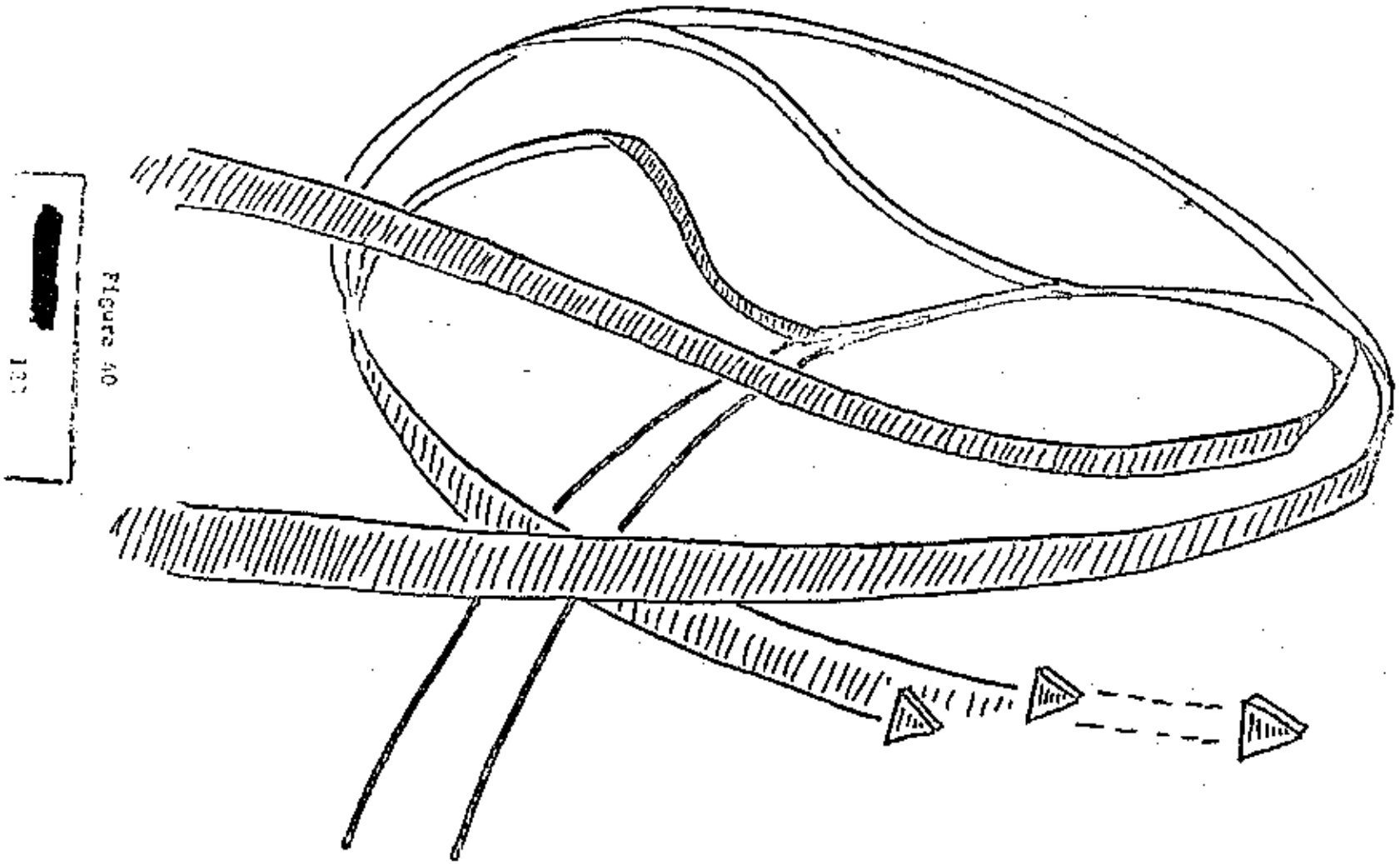
Procedures for Maneuvering Against a Defensive Split

1. Attempt to force the low defender down and out of the fight. You are trying to force the weakest man out of the fight to give you a two-to-one advantage. Normally the wingman will be the low defender with the least experience.

2. Do not prolong your attack on the low defender. This may kill off too much airspeed and result in a loss of offensive advantage when you attempt to zoom behind the high defender.

3. Switch the attack to the high defender. This maneuver should be performed before you lose too much airspeed and before the high defender reaches your line-abreast position.

4. Perform a fluid separation and allow your wingman to force the low defender down and out of the fight. This maneuver should be performed only if the wingman is fairly experienced. He should not attempt to destroy the low defender, but should force him down and out of the fight as quickly as possible, while maintaining a visual look-out on the leader. If your wingman is relatively inexperienced,



PERFORMING A FLUID SEPARATION

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(and/or untrustworthy) you should maintain close element integrity and simply switch from low to high defender.

5. Rejoin the leader as soon as the low defender has been definitely committed out of the fight. Do not follow the low defender too far or element integrity and all mutual support will be sacrificed.

6. Complete the attack with a two-against-one advantage. The wingman should continue to closely observe the low defender to prevent any counter-attack.

Defending Two when Attacked by Two

The defending element should maneuver as a single unit to counter a missile launch and a follow-up 20mm cannon attack. The tactics illustrated in fighter maneuvers apply equally as well with an element as with a single aircraft. The defensive split should not be employed to counter the missile attack. To successfully deliver AIM-9B against a maneuvering defending element, requires a launch at ranges in excess of 5,000 feet. A launch under these conditions can be easily nullified by generating angular velocity. A split is not necessary. If employed, the defending element will be forced into a permanent separation, without the necessary mutual support to counter the follow-up gun attack. The attacking element, at its leisure, may move in for the kill against one defender without interference from his teammate. The defensive split should be employed when there is no possibility of shaking the attackers as they approach gun firing range (3,000 feet). To set it up, the defending leader should declare the split. On signal, the inside defender (usually the wingman) should tighten up his turn in the plane of the attack. The other defender (usually the leader) should maintain his turn and spread out, as well as up, to effect the split. If the split is conducted in the horizontal plane, this means that the inside defender will be turning level or in a slight nose-down attitude, while his teammate will be turning in the horizontal plane and also up through the vertical plane. See figure 41. At the time the split is declared, certain responsibilities exist between the inside and outside defenders. The inside defender no longer provides visual cross-coverage to his teammate. Instead, he devotes his entire attention to the attackers in order that he may play the attack and determine the attackers' subsequent action. The high-outside defender, on the other hand, determines the magnitude of the split by playing his position in respect to his teammate as well as to the attacking element. Confronted with the split, the attacking element must now make a decision as to whether to attack the low-inside defender, attack the high-outside defender, or split and continue the attack against each defender. In considering these three possibilities, the attacking element can initiate one of five possible courses of action: (1) Attack the low defender, (2) Attack the high defender, (3) Split and attack each individual defender, (4) Initiate or feint an attack against the

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DEFENSIVE SPLIT

Figure 41

[redacted]

low-inside defender, then switch and continue the attack against his high-outside teammate, or (5) Initiate an attack against the low defender and perform a fluid separation in which the attacking leader selects the high defender while the attacking wingman drives the low defender out of the fight, then rejoins the leader on the attack against the high defender.

If the attacking element drives in after the low defender (figure 42), the low defender fights as a single aircraft in an effort to gain an offensive advantage. At the same time, the high defender drives in after the attacking element in an effort to force them to break off the attack. During this process, the low defender does not compromise his position to set up his teammate in the attacking element's six-o'clock position. It is the high defender's responsibility to gain an offensive advantage without a compromising assist from the low defender. If the low defender can achieve an immediate offensive advantage against the attacking element, the high defender should immediately clear his teammate and allow him to set up for the kill. Mutual support of this nature enables the defending element to exploit any advantage with dispatch.

If the attacking element attacks the high-outside defender, the high-outside defender should immediately play the attack in an effort to acquire an offensive advantage. Once again, the defender under attack (high defender) should not compromise his position to set up his teammate to gain an advantage. This means that the high defender must force the attackers to overshoot. The overshoot may be generated by executing a max-performance turn into the attack or by employing the high-G roll underneath, see figure 43. Considering the geometric position of the two defenders, the high-G roll underneath would be the better maneuver. The roll underneath will not compromise the high defender's position, yet it will make it easier for the low defender to move into the attacking element's vulnerable six-o'clock position, because the final portion of the roll will be away from the low defender. The moment the inside-low defender observes the attacking element driving after his high teammate, he should pull out of his defensive turn and drive toward the attacker's six-o'clock position. If the high defender performs a high-G roll underneath, the low defender can achieve a lethal position by executing a simple reversal or a roll-off maneuver. (See figure 43) If the high defender turns down into the attack, toward the low defender, the low defender will be forced to execute a nose-high reversal followed by a roll-off to move into the attacking element's six-o'clock position within 20mm cannon range. In this position, the low defender either forces the attackers to break off or he clears his leader, in the event his leader gains an offensive position.

If the attacking element splits (each attacker taking a defender) to counter a defensive split the defenders must break element integrity and fight as single aircraft in an effort to elude the attackers.

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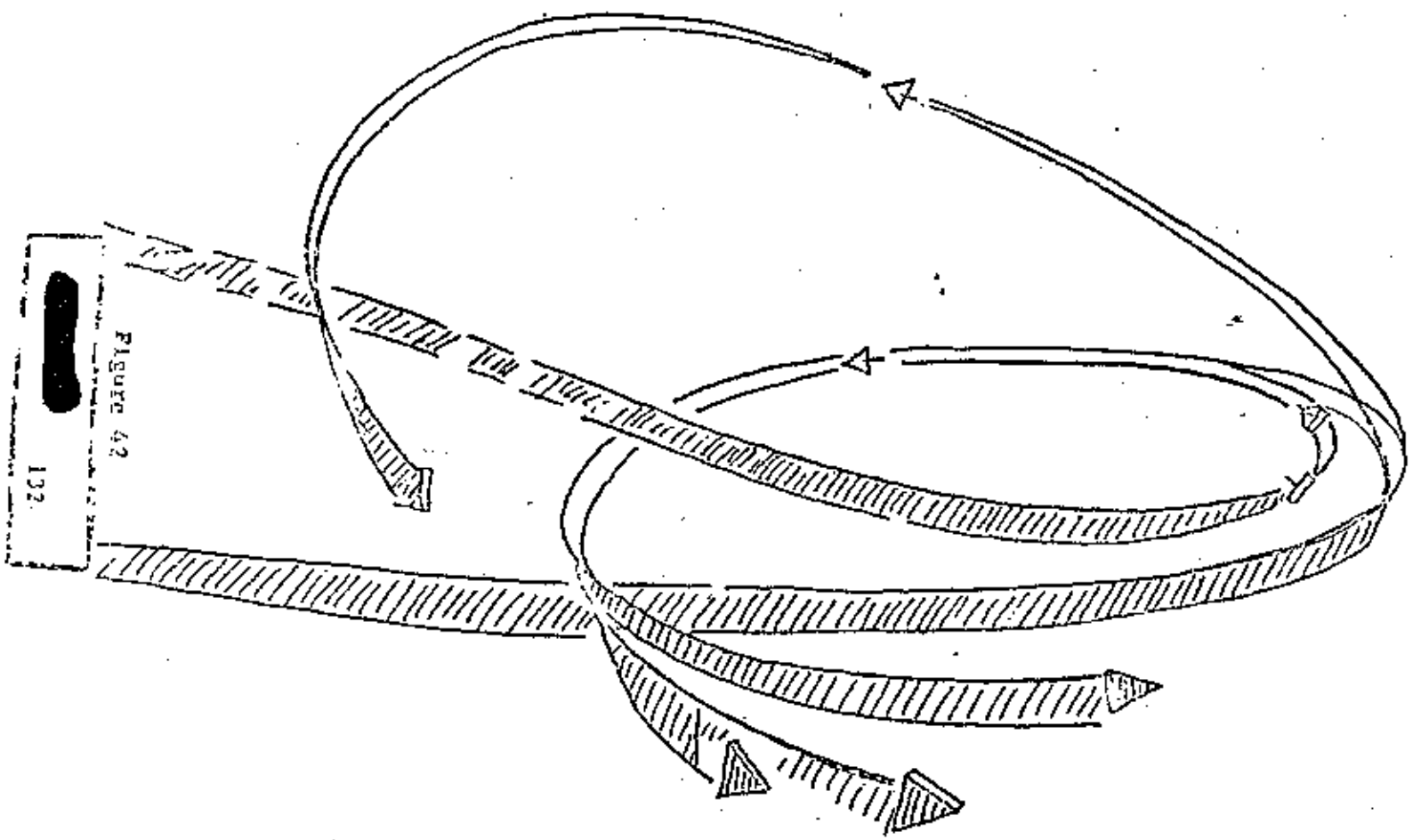
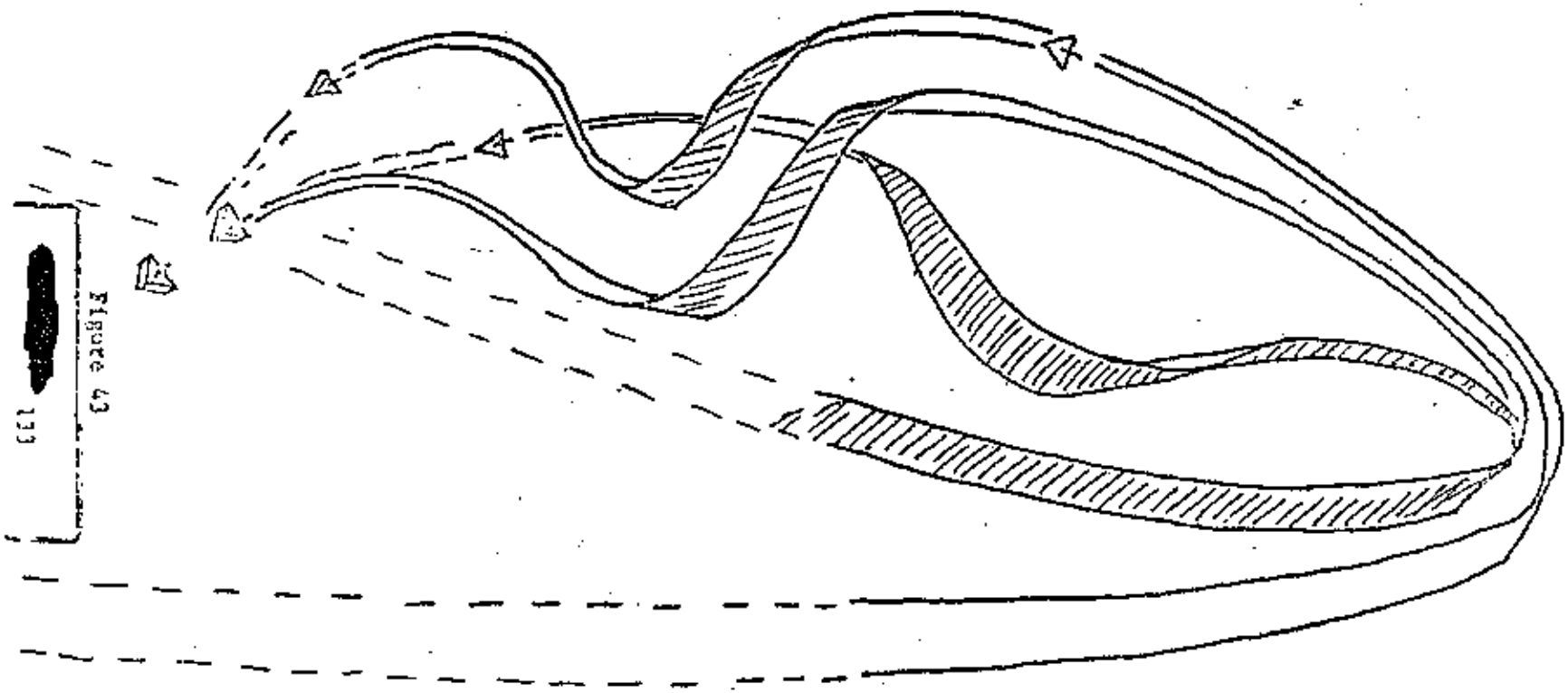


SANDWICHING THE ATTACKERS IF THEY SELECT A LOW DEFENDER



GAINING THE ADVANTAGE IF THE ATTACKER SELECTS THE HIGH DEFENDER

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During this portion of the engagement, each defender must disregard his teammate's actions until he is able to successfully evade his opponent. The purpose of this action is to prevent the defenders from compromising their respective defensive position. The first defender able to elude his attacker should maneuver to support his teammate as soon as possible. If the attacker is an especially aggressive type, this may be impossible until the defender destroys him. The one-versus-one fight caused by the attackers' split is the only engagement which causes a permanent split of the defensive element. However, this is necessary to preclude loss of both members of the defending element.

If the attacking element initiates or feints an attack against the low defender (in an effort to drive him out of the fight) then switches the attack to the high defender, (figure 44) the defending element must maneuver initially as though the attack were directed against the low defender. During the initial portion of this engagement - before the switch is attempted - the high defender should note whether or not the attacking element attempts to prolong the attack against the low defender. To stay with the low defender too long means that the attacking element will experience considerable airspeed decay. If the high defender observes this sort of action by the attacking element, he should not turn or roll down into the attack when the switch occurs. Instead, he should roll wings-level and zoom in the vertical plane. Since the attackers have dissipated their maneuvering airspeed they will be unable to match the high defender's rotation angle and subsequent zoom (see section on Maneuvering after a Turn Overshoot, in Fighter Maneuvers). The attacking element will be forced below and in front of the high defender. During the switch, if the low defender has rolled nose-high out of his defensive turn, he will move toward the attacker's six-o'clock-low position and the attacking element will be caught, with little or no maneuvering airspeed in a vertical sandwich in front of both the high and low defenders. If they remain in this position, the high defender need only execute a roll-off toward the attacker's six-o'clock position. If the attackers attempt to dive away, they will position themselves in front of the low defender. In either case, the defending element now has the advantage. If the attacking element does not bleed off airspeed - by prolonging the attack against the low defender - prior to executing a switch, the high defender must turn down into the attack or perform a high-G roll underneath, to counter the switch. See figure 45. Although the high defender is provided less opportunity to gain an advantage by this action, the low defender is provided a greater opportunity. The reason for the low defender's greater opportunity is that he will not be forced to stay in his max-performance turn so long. This means that he will have more maneuvering airspeed, hence a greater opportunity to maneuver into the attacker's six-o'clock position after they perform the switch. As a result, the low defender can clear his teammate, in the event he gains an advantage, or he can quickly provide mutual support and force the attacker to break off his attack on the high defender.

[redacted]

SWITCHING THE ATTACK TO THE HIGH DEFENDER

Figure 44

If the attackers perform a "fluid separation" as a means of countering the defensive split, the defenders will be hard-pressed. To them, a fluid separation will appear as an offensive split. Therefore, they will be forced to initially treat this tactic as a split, and maneuver accordingly. The first indication that the tactic is a fluid separation, rather than a split, will be when the attacking wingman breaks off the inside defender and rejoins the leader in an attack against the high defender. The moment the attacking wingman breaks off and attempts to regain normal element integrity with his leader, the low defender discontinues the defensive turn. He will reverse-roll, nose-high and maneuver toward the attacking wingman's six-o'clock position. Meanwhile, the high defender should be turning down through the vertical plane into the attacking leader. A high-G roll underneath may or may not be performed, depending upon the circumstances. If there is considerable separation between the attacking leader and his wingman, a roll underneath may force the attacking leader to overshoot. However, because of the separation, it can easily place the attacking wingman at the high defender's six-o'clock position. To preclude this possibility, the high defender should turn down through the vertical plane to counter the attacking leader and let his teammate provide mutual support by driving in after the attacking wingman. If there is not considerable separation between the attacking leader and his wingman, the high defender may employ the high-G roll underneath in an effort to drive the attackers forward. At the same time, this will enable the low defender to more easily clear or provide mutual support. If the fluid separation is performed correctly, a great deal of pressure is exerted against the defensive split. The defending element must exercise skillful maneuvering technique along with excellent judgment and timing to counter the attacking element's advantage. It can be accomplished, but it demands a maximum in team coordination.

Procedures for Employing the Defensive Split

1. Performing the Defensive Split.

a. Perform a defensive split if unsuccessful in eluding an opponent by all other maneuvers. This split should be initiated when the attackers are approximately 3000 feet to the rear.

b. Declare the split to the wingman so that he may turn to the inside and play the attack.

c. Slide high and to the outside when maneuvering as a leader. You should play the pull-up to maintain a supporting position upon the wingman.

d. Do not kill off airspeed by abrupt or violent maneuvers. You are attempting to force the attackers to concentrate their efforts

on one defender, therefore you must maintain sufficient airspeed for future maneuvering.

2. Executing the Defensive Split when the Attacker Selects the Low Defender.

a. Continue a level or slightly nose-low maximum turn when maneuvering as the low defender (wingman). A low defender should not lower his nose excessively, since the attacking element is trying to force him down and out of the fight.

b. Attempt to sandwich the attacking element when maneuvering as the high defender. While you are performing this maneuver, the low defender will attempt to generate an overshoot and gain offensive potential.

c. Play the low defender's evasive maneuvering to achieve a firing position. If the low defender maneuvers onto the offense, you should support the attack.

3. Executing the Defensive Split when the Attacking Element Selects the High Defender.

a. Perform a hard turn into the attack or a high-G roll underneath when maneuvering as the high defender. This will prevent your attacker from being able to position for a kill.

b. Call the low defender to reverse and pull up after the attackers. The low defender should be alert and execute the reversal the instant the attackers select the high defender. This will force the attacking element into a sandwich.

c. Continue evasive action in an effort to gain an offensive advantage. If, as high defender, you gain this advantage, the low defender will support your attack.

d. Play the high defender's evasive action (when maneuvering as low defender) to achieve a firing position, if he is unable to elude the attackers.

4. Playing the Defensive Split when the Attacking Element Splits

a. Split into a one-versus-one situation.

b. Maneuver as necessary to elude your opponent (see section covering Fighter Maneuvers).

c. Disregard your teammate's actions until you are able to successfully evade your opponent. By doing this, you will not compromise your defensive position.

[redacted]

d. Attempt to rejoin and support one another as soon as possible. You may be forced to destroy your opponent before effecting a rejoin.

5. Executing the Defensive Split when the Attack Switches from Low Defender to High Defender.

a. Maneuver initially as outlined in the Section describing the attack on the low defender.

b. Observe to determine whether or not the attackers prolong their attack on the low defender. If the attackers attempt to stay with the low defender too long, they will lose airspeed very rapidly. If this condition prevails, the high defender should roll wings-level when the attackers execute their switch. If the attacking element has killed its airspeed, it will be unable to match the high defender's rotation angle and will be forced below and forward. During the switch the low defender should perform a nose-high reversal to catch the attackers in a vertical sandwich.

c. Turn down into the attack or execute a high-G roll underneath when maneuvering as a high defender, if the attackers do not decrease airspeed prior to executing the switch.

d. Execute an immediate roll-out when maneuvering as a low defender. This maneuver should be initiated after the switch to the high defender.

e. Play the high defender's subsequent action in order to gain a firing position or to support any offensive action taken by the high defender.

Attacking Four with Two

To gain maximum advantage, an attacking element should strike at six-o'clock-low in an effort to deliver AIM-9B. If the flight of four fails to detect the attack the attacking element should pick out the nearest target and launch a missile. If the flight of four wheels around in an effort to nullify the attack, the attacking element should re-position behind the defending trailing element. From here, the attacking element should drive in and set up for a secondary missile attack - by employing the barrel-roll attack - or a follow-up 20mm cannon attack, in the event it is impossible to reposition for AIM-9B. If the flight of four splits into two separate fighting elements, the attacking element should switch to the outside trailing element and continue its attack. During the switch, the attacking wingman should closely observe the defending element to determine if it will provide mutual support to the element under attack. If the free element can provide mutual support, the attacking element should roll wings-level,

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zoom in the vertical plane, and once again reposition behind the trailing element. See figure 46. When the defending elements are no longer able to provide mutual support, the attacking element should move in for the kill behind the trailing defending element.

Attacking a Flight of Four with Four

To attack a flight of four, AIM-9B-equipped attacking elements should maneuver into the defender's blind area in an effort to set up for a missile attack without being detected. If successful in this endeavor, each attacking element should line-up behind a respective defending element in the flight of four. On signal, the attacking element leaders should launch their missiles. If the defenders fail to maneuver, they will lose two aircraft (one out of each element) and be set up as individual defenders with a two-to-one disadvantage against their respective attacking elements. In describing this type of attack, a better method may appear obvious: To have each individual attacker launch AIM-9B against the individual defenders. This may be accomplished, however the coordination and timing needed before the defenders execute a counter-maneuver, make it appear unlikely. In addition, this tactic destroys the attacking element's look-out capability.

If the defending elements detect the attack and maneuver against it, the attacking elements will be unable to maneuver line-abreast and launch their missiles simultaneously. Instead, the attacking elements will be forced in-train (element behind element) to attack as a flight of four against one of the defending elements, or to attack as individual elements against the respective defending elements. If the attacking elements maneuver as a flight of four, against one of the defending elements, the free defending element will be provided an opportunity to maneuver behind the flight of four. If each attacking element selects a defending element, mutual support becomes almost impossible, since each defending element must maneuver against its respective attacker to counter a possible missile launch. Considering AIM-9B, this means that the defending elements can no longer maneuver in respect to one another, but must maneuver in respect to their individual attackers. As a result, the four-versus-four engagement becomes two individual two-versus-two engagements, with each attacking element attempting to set up for a missile attack or a follow-up 20mm cannon attack. If the attackers are forced in-train and the two defending elements attempt to separate for mutual support, the lead attacking element should attempt to drive the inside defending element into a permanent separation. Before the lead attacking element compromises his position and diminishes his airspeed, he should switch the attack to the high-outside trailing defending element. See figure 47. At the same time, the second attacking element should drive after the inside defending element. This double switch by the attacking element counters the defenders' possibility of setting up an effective sandwich on the lead element and the fight ends up in an element-versus-element engagement.

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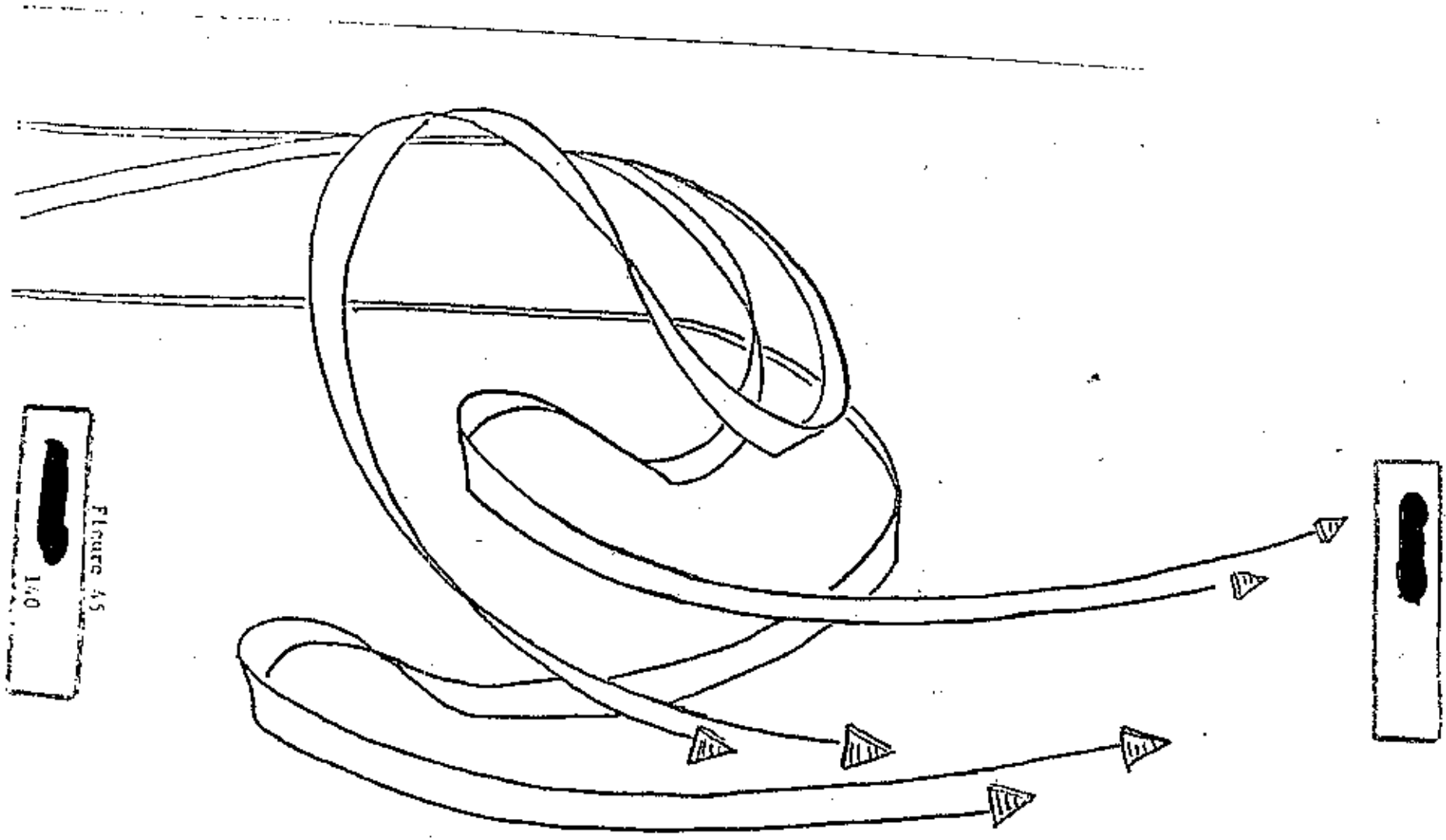


Figure 45

SELECTING THE OUTSIDE TRAILING ELEMENT

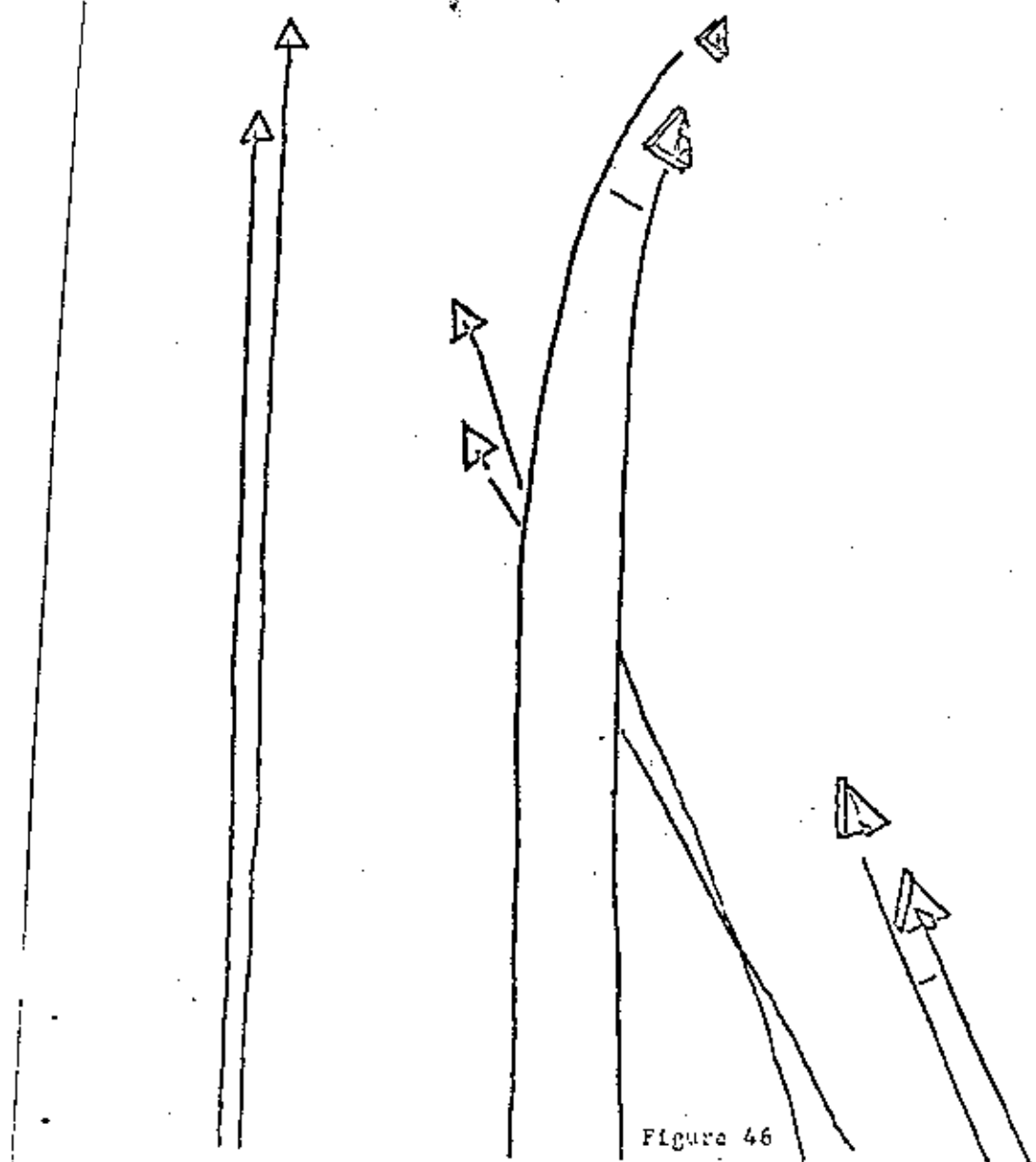


Figure 46

ATTACKING IN TRAIN

[redacted]

with the attacking elements enjoying the advantage. See figure 48. If the defenders maneuver as a flight of four, the attacking elements simply drive in after the trailing defending element, destroy it, then continue the action against the lead defending element.

Procedures for Attacking Four with Two

1. Begin your attack on the high element. If possible, at six-o'clock-low. This will position you in your opponent's blind area.

2. Switch your attack to the lead element after the high element is well committed in a defensive maneuver. If the high element should reverse, pull high and position yourself behind the trailing element while you still have an airspeed advantage.

3. Drive in again and attack the trailing element. If the defenders attempt (and are able) to provide mutual support, slide high once again behind the trailing element.

4. Continue this procedure until the defending elements are unable to provide mutual support, then drive in and attain a firing position behind the trailing element. Your wingman should keep you informed as to the whereabouts of the free element, to prevent any possible counter-attack.

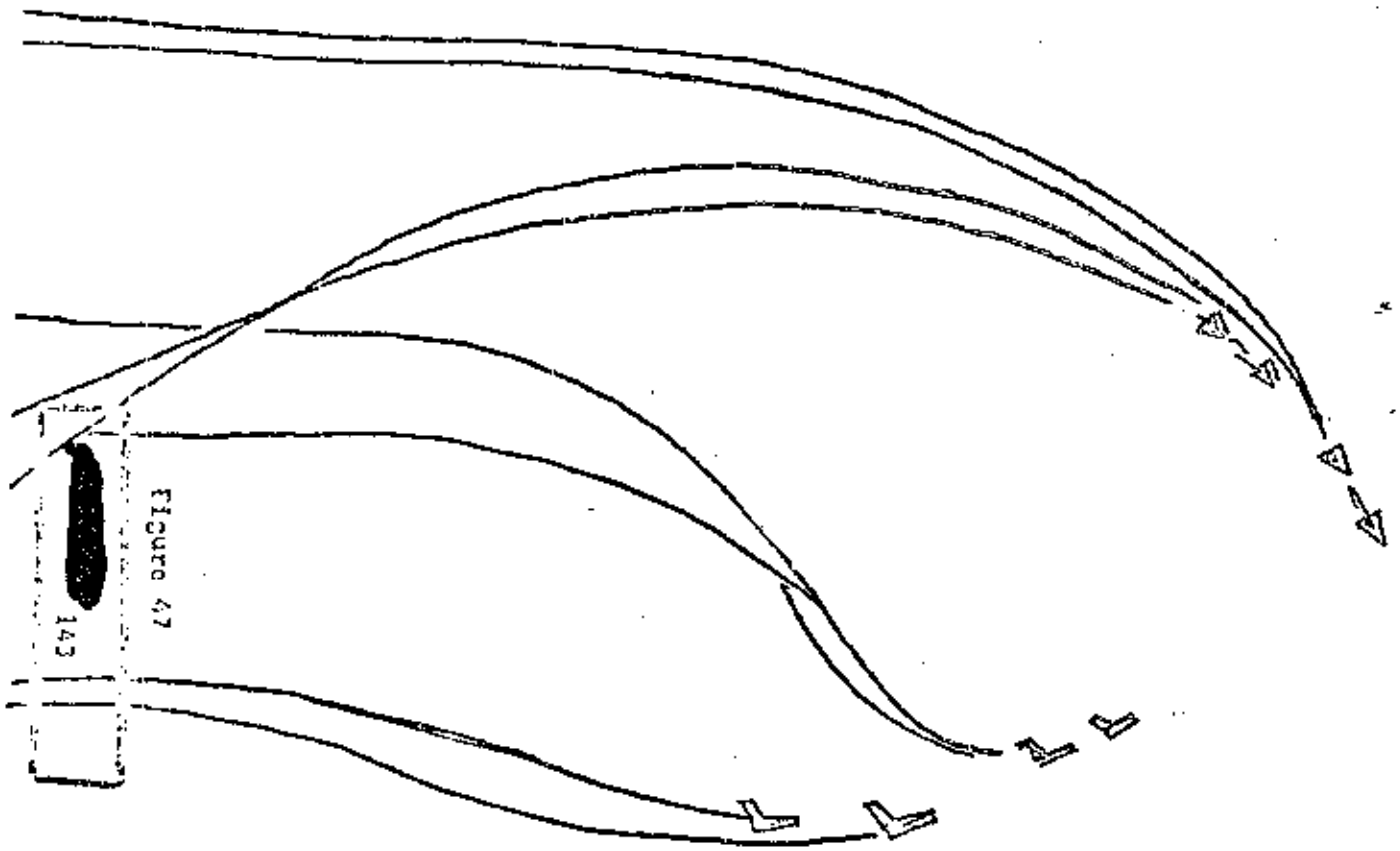
Procedures for Attacking Four with Four

1. Attempt to maneuver your flight into the defender's blind area without being detected. If successful in this endeavor, line up each attacking element behind a defending element. On signal, the attacking element leaders will launch missiles to eliminate two of the defenders. If the defending elements observe this attack and maneuver to counter it, employ the following procedures.

2. Continue the attack, element against element, in an effort to prevent the defending elements from setting up a mutual-support situation. If the defending elements' maneuvers force you to attack in-train, they may separate the elements and attempt mutual support. To counter this tactic, employ the following procedures.

3. Drive in (as lead attacking element) after the inside defending element, in an effort to force the defending elements into a permanent separation.

4. Switch your attack to the high outside defending element before you compromise your position and diminish your airspeed. At the same time, switch your fluid element (second element) behind the defender's free element. This double switch prevents the defenders from setting up mutual support in order to sandwich the lead attacking element.



ELEMENT VS ELEMENT AFTER AN ATTACK IN TRAIN

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5. Press the attack as separate elements. This allows each element to take advantage of its superior position. Also, it prevents the defenders from effecting a re-join and subsequent mutual support.

6. Maneuver behind the trailing element if you have the whole flight breaking in the same direction.

Defending Four when Attacked by Two

To successfully defend a flight of four, the defenders must detect the attack and determine the number executing the attack. If the defenders are certain there is only one element performing the attack, their course of action is simple. The moment they pick up the attacking element, they must determine against which defending element the attack is being executed. The element being attacked turns away from its supporting element. This means that if the attack is directed against the high element, it turns down and away from the lead element. If the attacking element continues to press its attack against the fluid element, the lead element simply rolls in behind the attackers. If the attacking element switches its attack to the lead element, the lead element turns into the attack and the free defending element reverses nose-high, then follows through with a roll-off to move into the attacking element's six-o'clock position. See figure 49. The attacking element, caught in a sandwich, will now be forced to maneuver against the attacking defending element of face the possibility of being destroyed.

Defending Four when Attacked by Four

If the attacking elements drive in and line up behind each defending element, the defending elements must fight separate element-versus-element engagements. If mutual support is attempted, one of the defending elements will be forced to maneuver in respect to the other defending element. Such a tactic, with an attacking element in lethal position, would be disastrous. If the attacking elements maintain flight integrity, mutual support may be initiated. The element under attack turns away from its supporting element. If the attackers continue this attack, the supporting or fluid element drives in and sandwiches the flight of four. During the attempt for mutual support, if the attacking lead element switches the attack to the outside defending element, and the attacking fluid element drives in after the inside defending element, the defending elements must maneuver as separate elements.

Procedures for Defending Four when Attacked by Two

1. Check to be sure there is only one element performing the attack.

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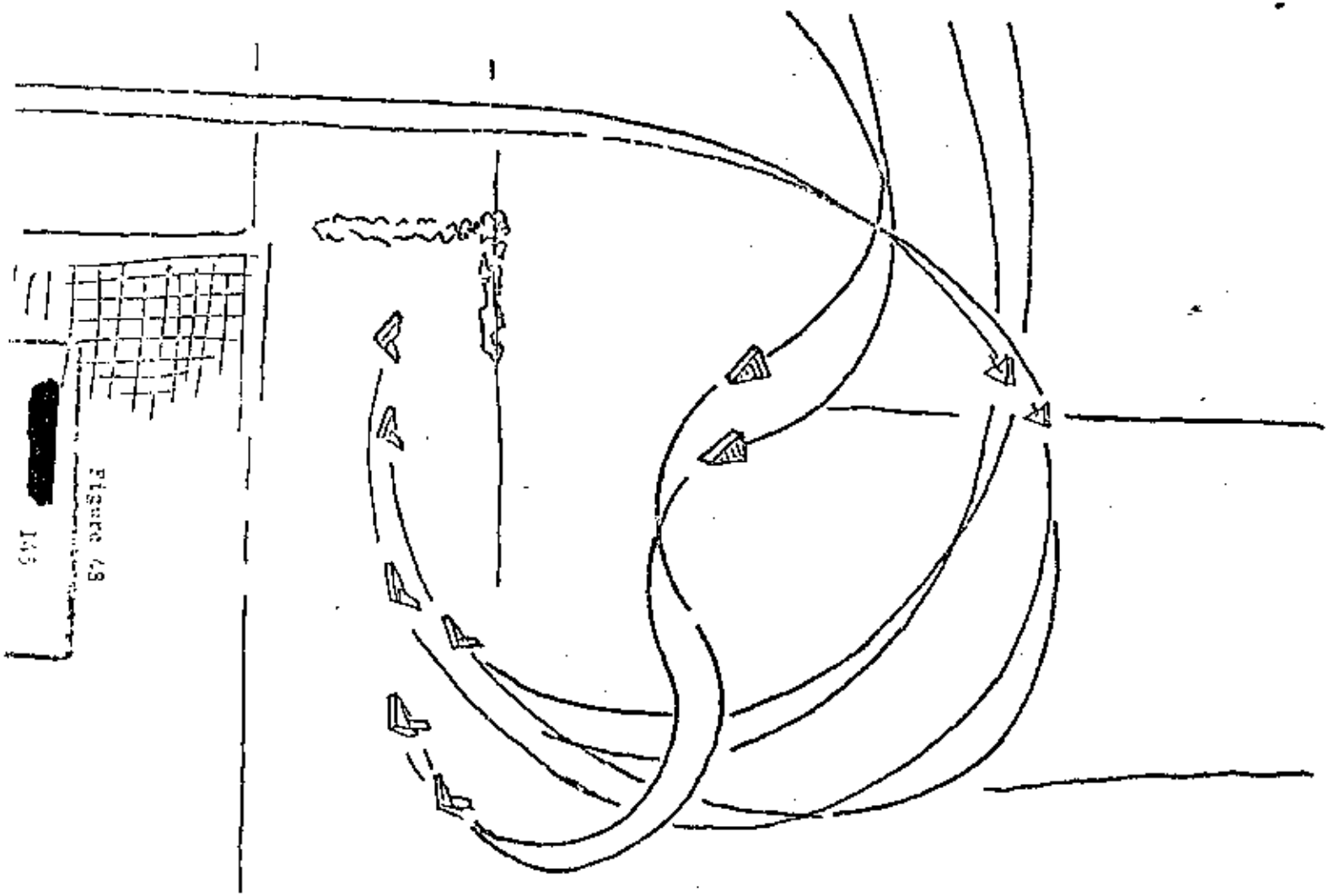

ROLLING OFF BEHIND THE ATTACKING FREE ELEMENT

2. Turn the element under attack away from the supporting element.

3. Turn the supporting element in on the attackers, if the attack switches to the supporting element. The attackers are sandwiched once again, but in reverse order.

Procedures for Defending Four when Attacked by Four

1. Fight as separate elements, if the attacking elements initiate simultaneous attacks against each defending element. Mutual support, attempted against this tactic, will only compromise the position of one of the defending elements.

2. If the attackers maintain flight integrity and attack either one of the defending elements, employ mutual support and sandwich the flight of four.

3. If the attacking lead element switches the attack to the supporting element, and the attacking fluid element drives in after the inside defending element, maneuver as separate elements.

SUMMARY

In discussing fighter-versus-fighter combat we have emphasized the importance of turn and velocity during all maneuvers. A pilot under attack will not be able to simply outrun his opponent - he must generate sufficient angular velocity to prevent a successful missile launch and/or a 20mm cannon attack. This means that "high-speed tactics" cannot be distinguished from "low-speed tactics" since the entire field of maneuver and capability must be considered. As long as fighter pilots are committed to rear-hemisphere attacks, the concept depicted in this study will hold true. New weapons such as the F-104 and F-105 aircraft and the AIM-9B missile may change the maneuvers per se, however the principles involved will remain the same.

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