PART 2 : SECTION 4

CHAPTER 10

FORMATION FLYING

Introduction

1. A formation consists of a number of aircraft, flying as an element, whose movements are controlled by an appointed leader.

2. There are two categories of formation flying :—

(*a*) *Close Formation.* This is used :—

(i) For take-offs, cloud penetration, and landings—mainly by fighter aircraft.

(ii) For bombing and defensive purposes by bomber aircraft carrying free guns.

(iii) For demonstration and show purposes.

(*b*) *Battle Formation.* This is used for all tactical fighter operations, and is designed to provide the best all-round search, the best mutual cross-cover, and the best mutual fire support.

Leadership

3. Successful formation flying is almost entirely dependent on good leadership. A formation is commanded by the leader who is immediately responsible for its security, for the heading flown, for the tactics adopted, and for its safe return to base.

4. The leader must fly in a position from which he can communicate with all his pilots or, in large formations, with leaders of sub-formations. He must be replaceable by a deputy leader, who flies in a pre-arranged position relative to the leader, and must be prepared at any time to take the place and assume the responsibilities of the leader.

BASIC CLOSE FORMATIONS

The Pair

5. The basis of all formations is the pair. A section consists of two or three pairs. A flight consists of two or three sections. A squadron consists of two flights. A wing comprises two or more squadrons. These are arbitrary figures that vary in practice according to the unit establishment and the tactical role of the units concerned.

Section Formations

6. **Section Finger Four.** Aircraft are disposed as shown in Fig. 1.

7. **Section Echelon.** Aircraft are disposed as shown in Fig. 2.

8. **Section Line Abreast.** Aircraft are disposed as shown in Fig. 3.

9. **Section Line Astern.** Aircraft are disposed as shown in Fig. 4.

10. **Section Box.** Aircraft are disposed as shown in Fig. 5.

11. The above formations are the standard section formations. However, in certain circumstances, a section can consist of three aircraft. A section of three can fly in *vic*, as shown in Fig. 6, or in *echelon*, *line abreast*, or *line astern*. For cloud penetration it is recommended that the maximum size of a close formation should be three aircraft. A three will invariably fly as a *vic*, and a pair as an *echelon*, as it is essential for the formating pilots to be able to see any hand signals made by the leader.

Flight Formations

12. A flight will usually fly as two or more sections. The sections comprising the flight can be disposed in various formations ; a typical formation is shown in Fig. 7. Within the section any of the formations mentioned in paras. 6 to 11 can be flown.

Squadron Formations

13. A squadron will usually fly as two flights which are split into sections of four. A typical squadron formation is illustrated in Fig. 8.

14. It will be seen that the whole system of formation flying is based on the *vic*, *finger four*, *line abreast*, *line astern*, and *box* formations.

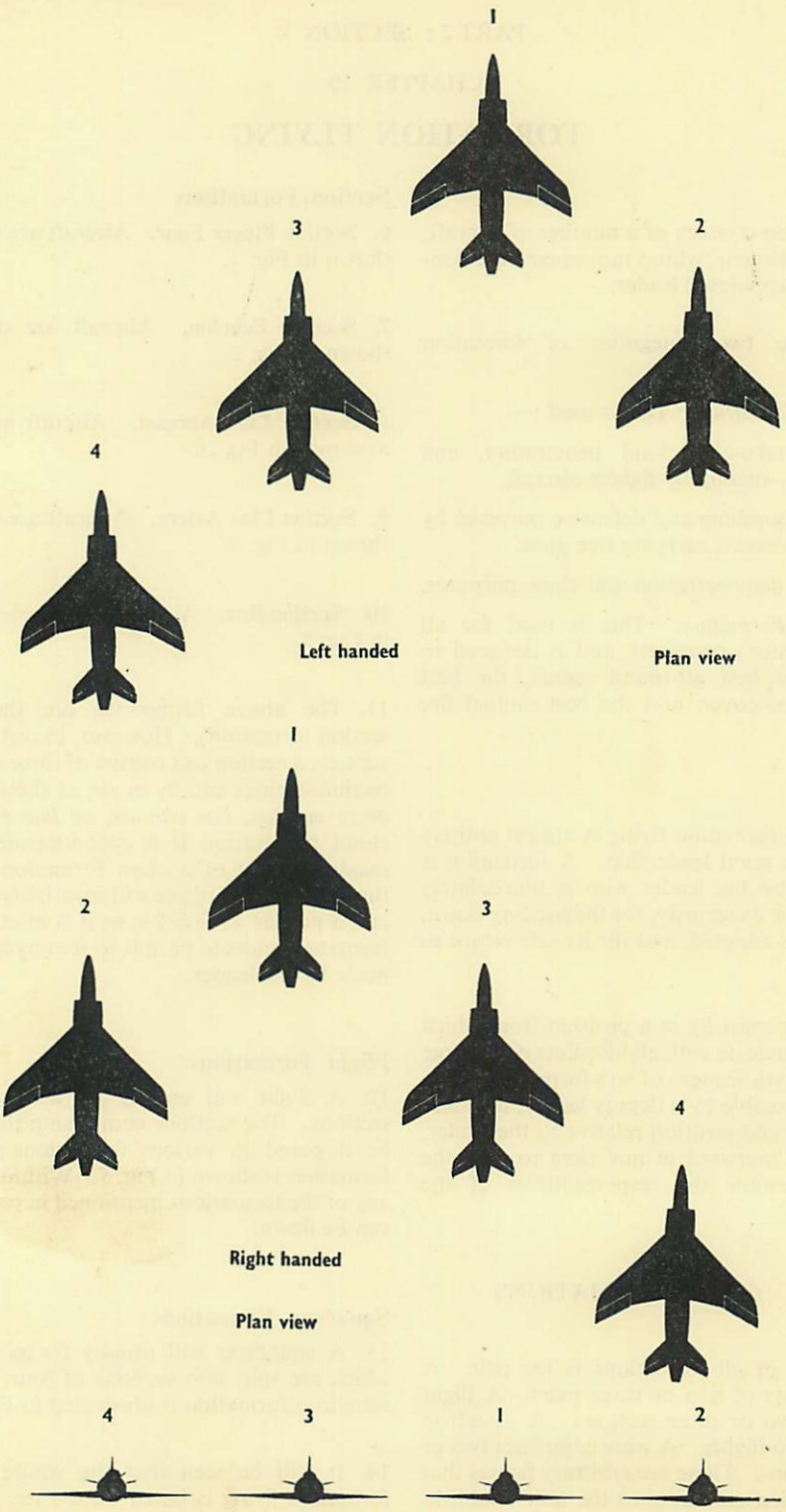

Fig. 1. Section Finger Four

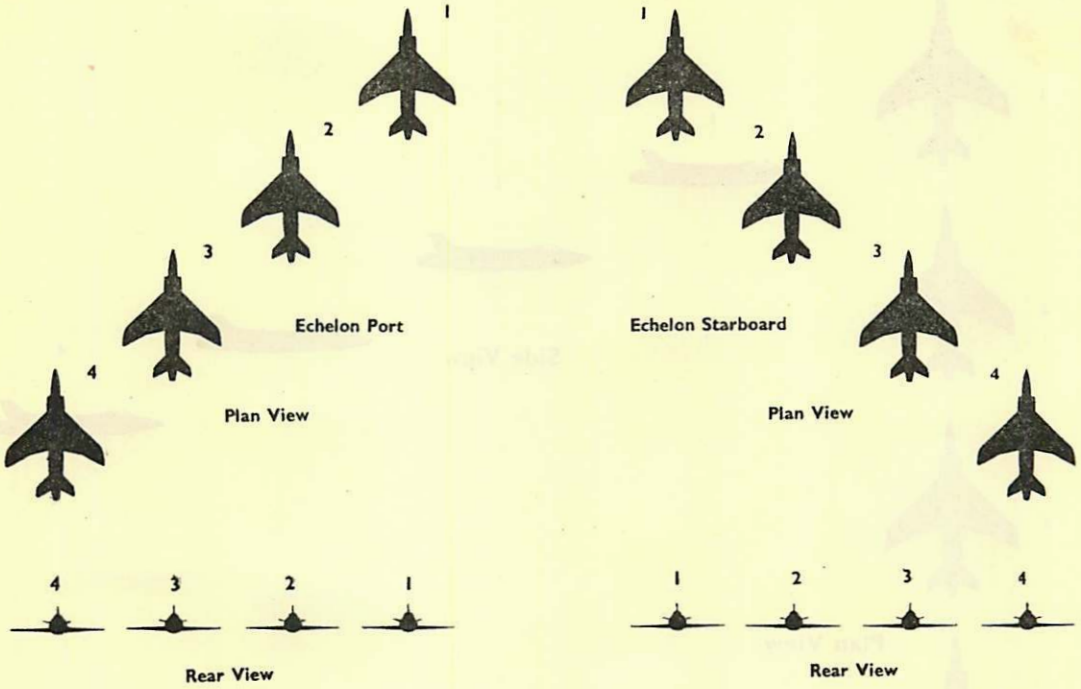

Fig. 2. Section Echelon

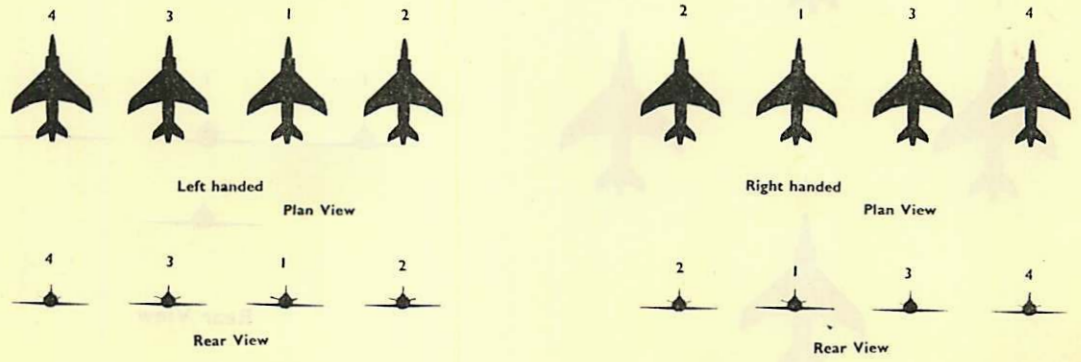

Fig. 3. Section Line Abreast

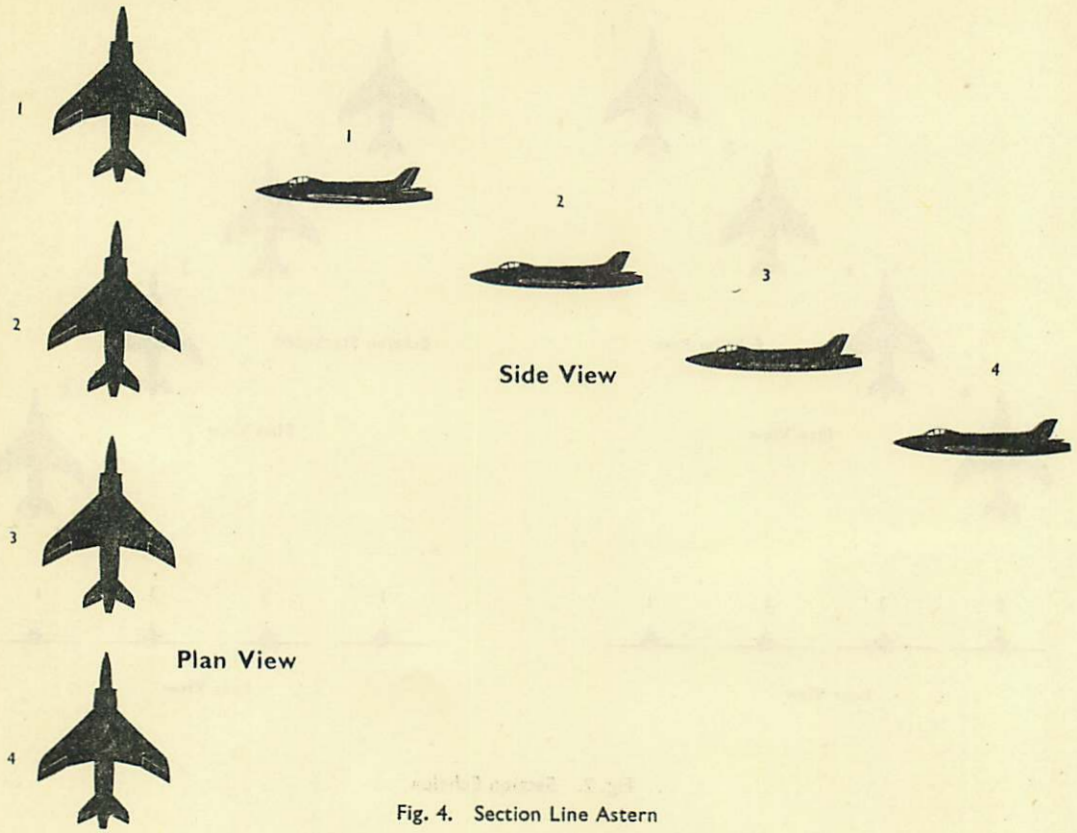

Fig. 4. Section Line Astern

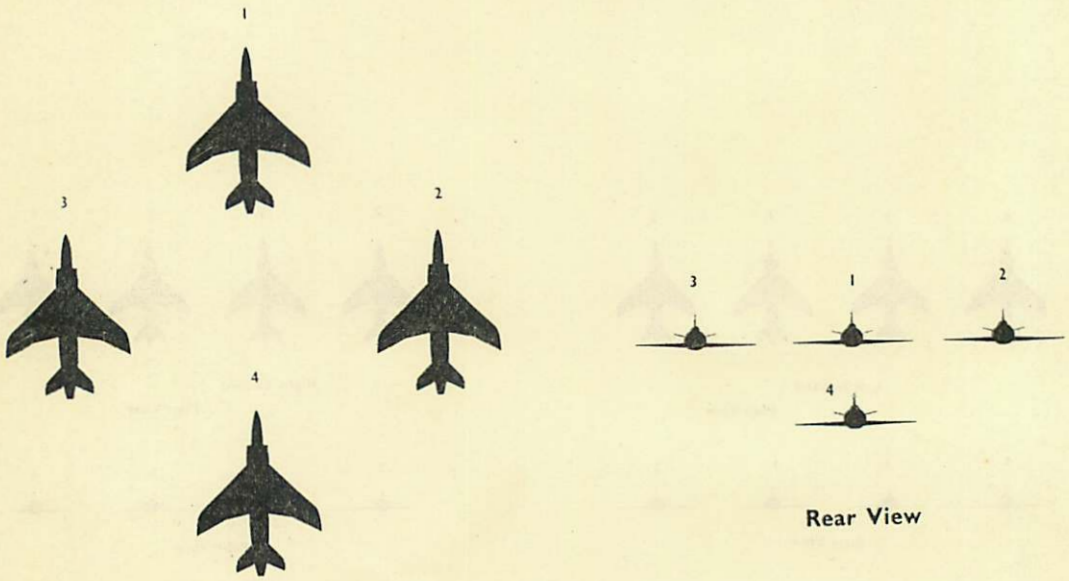

Fig. 5. Section Box

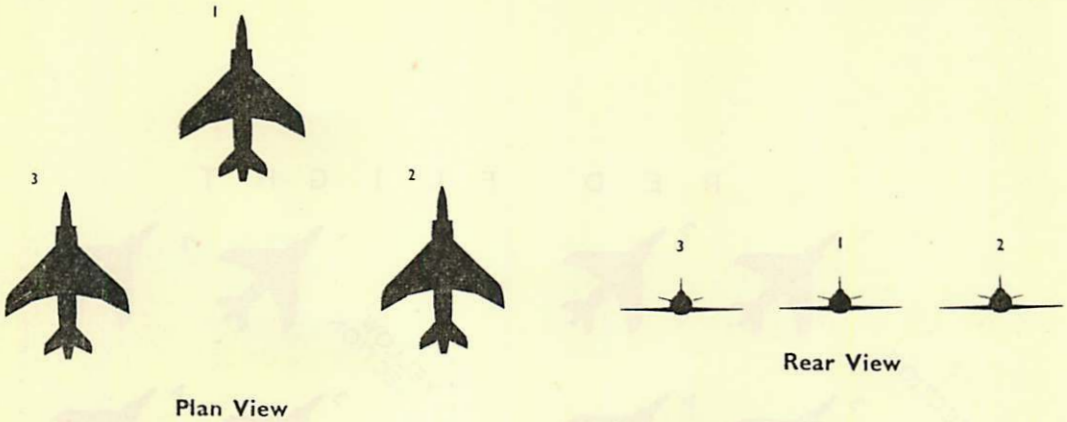

Fig. 6. Vic Formation

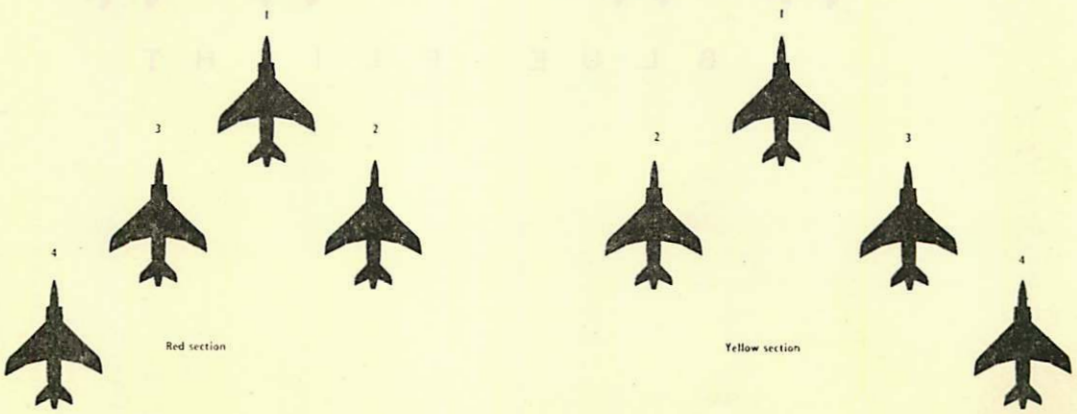

Fig. 7. Close Flight Formation

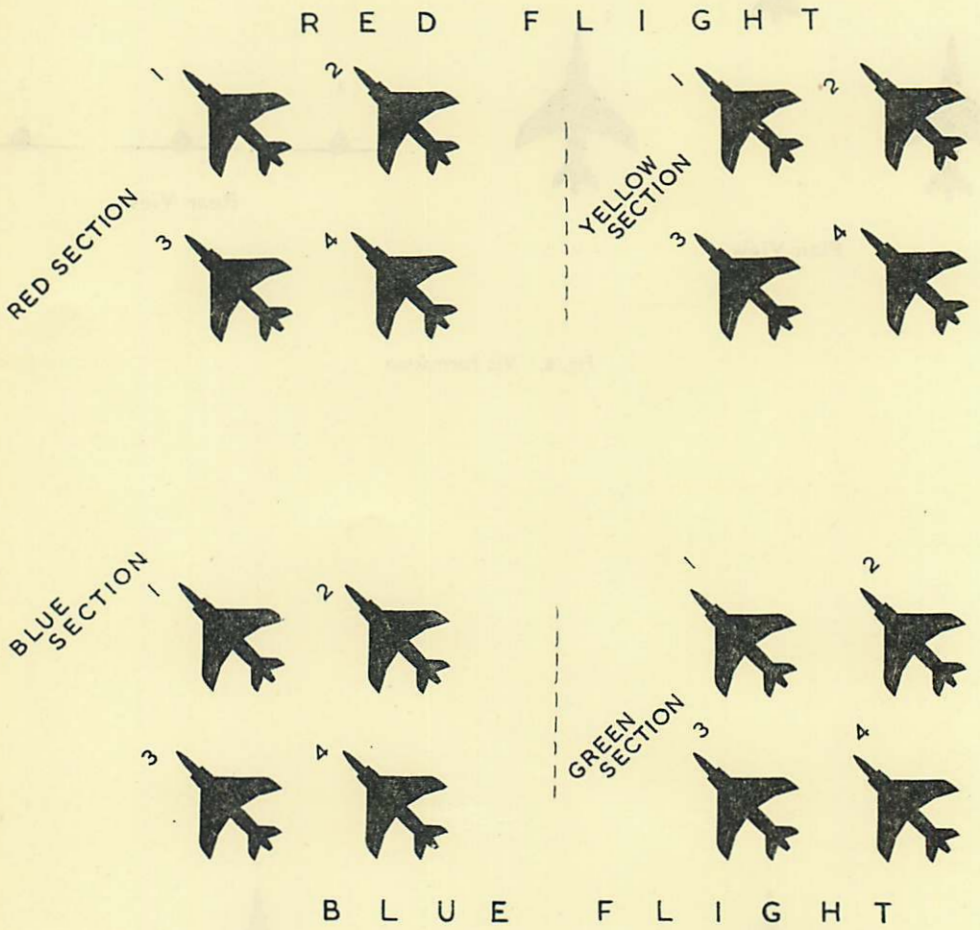

Fig. 8. Close Squadron Formation

CLOSE FORMATION FLYING TECHNIQUE —BASIC CONSIDERATIONS

Relative Speeds

15. The driver of a car subconsciously judges the speed of his vehicle in relation to others against a background of fixed objects—trees, houses, telegraph poles, etc.—which border the road. Such a background does not exist in the air, and the only way in which relative distances can be judged is by mentally comparing the actual size of an aircraft, as seen, with the size that it is known to be.

16. The difference in size of an aircraft viewed from six miles range and from three miles range is very small, but the difference in size of the same aircraft viewed from one mile and 800 yards is very noticeable. The effect of this is that when one aircraft is overtaking another, even at a high closing speed, the rate of approach appears very slow at long ranges (5 to 10 miles) and seems to increase almost imperceptibly until a critical range is reached, when the overtaken aircraft appears to grow rapidly in size, and the true speed of approach can be judged.

17. Judgment of distance in the air is a matter of experience and practice, but pilots can attain proficiency in the art more quickly if they realize that the tendency is to underestimate the rate of approach until the final stages. The leader of a formation should always fly at a constant airspeed that is known to all pilots in the formation. By comparing his own airspeed with that of the leading aircraft, a pilot joining a formation can determine his actual overtaking speed.

Joining Formation

18. The time spent in joining formation serves no useful tactical purpose, and the longer the time taken to assemble a formation the shorter will be the time that the formation can spend in the air. For this reason, pilots must join formation with the least possible delay.

19. Fig. 9 illustrates the procedure for joining formation. After the leading aircraft has taken off, it should fly straight ahead for a distance varying from 800 yards to one mile, according to the type of aircraft, and thereafter commence a gentle turn. The second aircraft—No. 2 of the formation—will then turn inside the leading aircraft, so as to intercept it as soon as possible, and the third and fourth aircraft will carry out a similar procedure by turning inside the others. This method of "cutting the corner" can be equally well applied if the formation is composed of sections of aircraft taking off together, instead of single aircraft.

20. It is important that the leading aircraft should settle down to the agreed cruising speed as soon as possible. The following aircraft may then fly at the same airspeed, gaining position by the use of shorter radius turns. In this manner leeway is rapidly made up and individual aircraft are able to take up their positions without excessive changes in airspeed. If the following aircraft either fly the same flight path as the leading aircraft or make a turn of larger radius outside the leader's flight path, they will have to increase their airspeed in order to overtake, and will consequently be obliged to make a large alteration in airspeed before they can take up their stations. Moreover, a great deal of time and fuel will be wasted.

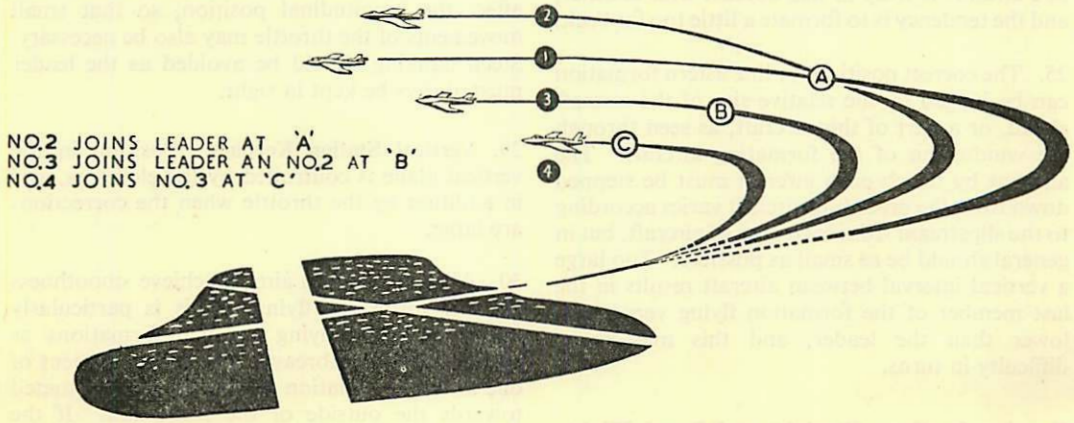

Fig. 9. Joining Formation after Take-Off

21. A useful hint, which enables the leading aircraft to be intercepted during a turn in the shortest possible time, is for the joining pilot to maintain a rate of turn such that the leading aircraft appears to be stationary in relation to himself. If the leading aircraft appears to move forward, the joining pilot should increase his rate of turn until the leading aircraft again appears to be stationary ; if it appears to move backwards the rate of turn must be decreased.

Positions in Basic Formations

22. The intervals between aircraft in formation are laid down in relevant air staff instructions, and must be strictly adhered to. No attempt should be made to practise formation flying in the air until the correct positions for each basic formation are thoroughly learned.

23. Normally, when flying in vic, finger four, or echelon formations in aircraft having wings with no sweep-back, the pilots of the formating aircraft align the tips of their mainplanes with the elevator hinge of the aircraft next to them on the port or starboard side, as the case may be. With piston-engined aircraft a more forward position is used ; here the wingtip of the formating aircraft should be between the trailing edge of the wing and the tailplane of the next aircraft. When flying in the same formations in aircraft having sharply swept-back leading edges, the formating pilot should position himself so that he is looking along the line of the leading edge of the aircraft on which he is formating.

24. In line abreast formation, the correct position can best be judged by reference to the cockpit of the next aircraft. It is difficult to judge whether one aircraft is truly in line abreast with another, and the tendency is to formate a little too far back.

25. The correct position for line astern formation can be judged by the relative size of the aircraft ahead, or a part of this aircraft, as seen through the windscreen of the formating aircraft. The amount by which each aircraft must be stepped down from the preceding aircraft varies according to the slipstream from each type of aircraft, but in general should be as small as possible. Too large a vertical interval between aircraft results in the last member of the formation flying very much lower than the leader, and this may cause difficulty in turns.

Keeping Station—Straight and Level Flight

26. To keep his position constant in relation to the leader of the formation, the formating pilot may be required to adjust his position :—

(*a*) Longitudinally, *i.e.* backwards or forwards.

(*b*) Laterally, *i.e.* inwards or outwards.

(*c*) Vertically, *i.e.* upwards or downwards.

A keen sense of anticipation must be developed so that correcting movements are kept to a minimum.

27. **Longitudinal Station Keeping.** Changes of position in the longitudinal direction are made by using the throttle, and this in turn necessitates a movement of the elevators to maintain position vertically ; thus co-ordinated movements of the two controls are used throughout. To maintain a constant position longitudinally, the throttle should be moved in the appropriate direction immediately any change is noticed or anticipated. The throttle must be moved smoothly, and no more than is necessary to correct errors. Rough movements of the throttle generally result in over-correction ; they are usually quite unnecessary, and the formating pilot will find that much more is achieved by early, small corrections made as smoothly as possible. A much more serious result of excessive throttle movements is that fuel consumption is increased, which might be critical on a long sortie. It must be remembered that a clean aircraft usually accelerates quickly and decelerates slowly because of its low drag, and due allowance must be made for this. Jet-engined aircraft may have poor acceleration, especially at low airspeeds, and also decelerate slowly ; both effects must be anticipated.

28. **Lateral Station Keeping.** Changes in lateral position are made by gentle use of aileron and rudder. Any adjustment of lateral position may affect the longitudinal position, so that small movements of the throttle may also be necessary. Steep banking should be avoided as the leader must always be kept in sight.

29. **Vertical Station Keeping.** Position in the vertical plane is controlled by the elevators, and in addition by the throttle when the corrections are large.

30. All pilots should aim to achieve smoothness in their formation flying. This is particularly important when flying in such formations as echelon and line abreast, since the movement of one aircraft in relation to another is accentuated towards the outside of the formation. If the second aircraft in the formation is flown roughly, the pilot of the aircraft on the outside of the

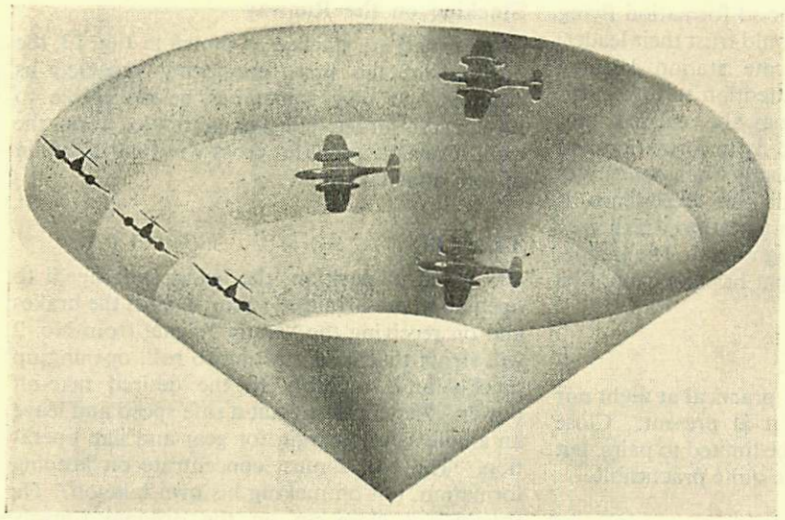

Fig. 10.

Comparison of Turning Paths in Horizontal Formations

formation will have an extremely difficult task. This may be simplified, however, by keeping station laterally on the leader instead of on the aircraft in between, and the "whip" effect is thereby reduced.

Keeping Station—Turns

31. Fig. 10 shows how, during a turn, the outside aircraft describes a turn of larger radius, and the inside aircraft a turn of smaller radius, than the leading aircraft. To maintain the correct position relative to the leader, it is necessary for the outside aircraft to increase speed, whilst the inside aircraft must reduce speed. When a turn is initiated the formating aircraft should endeavour to anticipate an alteration in power. The greater the lateral distance between the leader and the formating aircraft, the greater will be the necessary speed adjustments. It is this factor which limits the manœuvrability of large formations.

32. Fig. 11, showing three aircraft carrying out a turn in line astern, shows that each aircraft flies a longer distance than the aircraft above it. The necessity for stepping down only the essential amount, especially when large numbers of aircraft are flying in this formation, can be plainly observed.

33. The sensations experienced during turns in vic formation, especially on the outside of such turns, may at first be disconcerting. It will be quickly learned that the outside aircraft is in no danger of slipping in onto the leading aircraft. The control movements required for keeping station, as described in paras. 26 to 30, apply during any manœuvre—even during inverted flight.

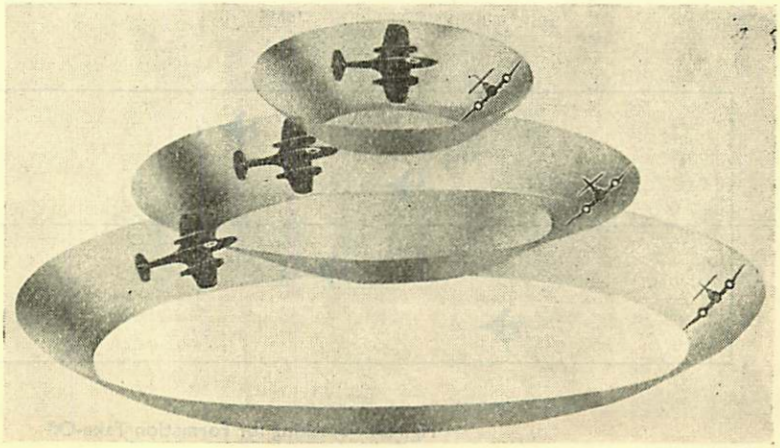

Fig. 11.

Comparison of Turning Paths in Vertical Formations

34. It is a prerequisite of good formation flying that the formating pilots should trust their leader, and concentrate on accurate station keeping without giving too much attention to any particular manœuvre which may be carried out. Experience enables pilots to fly in formation and at the same time to realize exactly what manœuvres are being executed ; until this experience is gained, any temporary disorientation which they may experience should be ignored. The importance of a thorough pre-flight briefing cannot be over-emphasized.

Night Formation

35. Battle formation is not practical at night nor is there any real call for it at present. Close formations must normally be limited to pairs, but in good conditions fours are quite practicable.

36. If dim/bright navigation lights are fitted, the dim setting should always be used but, when available, resin lights are much better. The problems of station keeping in the dark are greatly increased if the leader's lights are in the least dazzling. For safety, Nos. 2 and 4 should show their navigation lights.

37. On moonlight nights normal take-off in pairs presents no difficulties but No. 2 should stagger himself about 50 yards behind the leader. A second pair can roll after the normal ten-second interval.

FORMATION TAKE-OFF

General

38. Sections of three can take off in formation, but when larger numbers are concerned it is recommended that a formation take-off is carried out in a series of pairs.

Stacking on the Runway

39. Aircraft are stacked as shown in Fig. 13, the position of the first four being repeated as required. It may sometimes be preferable to reverse this order, starting with No. 1 on the right. Considerations are cross-wind and direction of turn after take-off.

Take-Off

40. When in position, the leader will signal to open up to pre-arranged r.p.m. against the brakes and on receiving the "ready" signal from No. 2 will signal that he is starting to roll, opening up quickly and smoothly to the desired take-off power. He will unstick at a safe speed and leave an ample safety margin for gear and flap operation. The No. 2 must concentrate on keeping formation, not on making his own take-off. He should not close up on the original runway spacing until safely airborne. This reduces risk of collision if a tyre bursts or, in a twin-engined aircraft, if an engine fails. It is also important not to lag when carrying external stores, bombs, rockets, etc. If they are lost on take-off for any reason, they cannot harm a correctly positioned aircraft.

Interval Between Pairs

41. In clear weather, five seconds between pairs is sufficient. If the join-up cannot be made below cloud, a ten-second interval should be used.

Slipstream During Take-Off

42. To minimize slipstream effects, pairs should be briefed to pull high or hold low immediately after take-off. The low pairs aim to unstick beyond the point where the preceding pair became airborne.

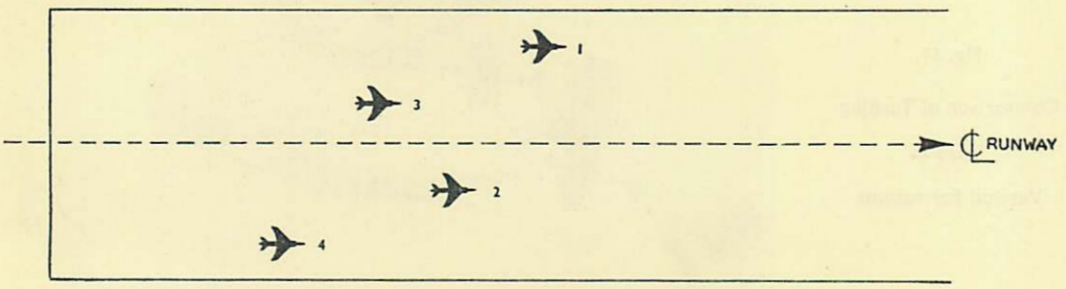

Fig. 13. Stacking for Formation Take-Off

FORMATION LANDING

General

43. Formation landings are usually carried out in pairs during straight-in G.C.A. approaches. They can also be carried out by pairs or sections of three in clear weather. The same considerations apply in both circumstances.

44. Formation landings should be attempted only by pilots who have attained a high standard of formation flying. Absolute confidence in the leader is essential.

Technique and Procedure

45. After joining the circuit in the usual manner, the leader turns down-wind and tells the formation that he is throttling back. This should be done smoothly and gently, so that the formating pilots do not overshoot the leader. At the correct speed, the leader should then give the order to lower the undercarriages. The formating pilots must do this and make any necessary trim corrections without looking away from the leading aircraft, as position can easily be lost at this stage. When the formation has settled down after the undercarriages have been lowered, each pilot must check that his warning lights indicate that the undercarriage is locked down and check visually that the undercarriage of the other aircraft in the formation appears to be locked down. Before turning across wind, the leader should confirm with the formation that these checks have been carried out.

46. The leader should make his cross-wind turn so that the final approach will be long and straight. The turn should be gentle and made at the highest practical airspeed, so that the formating aircraft will not be required to make large adjustments of speed. As soon as the formation has settled down after the turn, the leader should order flaps down. This is the most critical part of the procedure. The formating pilots must lower their flaps immediately on receipt of the order or they may overshoot the leader and be unable to regain the formation. The leader himself will lower up to three-quarters flap only according to prevailing conditions. Trimming should be carried out as quickly as possible and the formation should prepare itself for the turn onto the final approach. The airspeed at this stage will be very much lower than normal cruising speed, and pilots must expect some sluggishness and lack of response from the aircraft. On the other hand, the response to throttle movements will appear to be greater and this control should be used gently. If a formating aircraft overshoots the leader at a low airspeed, the pilot should regain formation by turning away from the formation and then back towards it again, rather than by throttling back completely and raising the nose of the aircraft to lose speed. The latter procedure may lead to a stall.

47. The turn onto the final approach should be as gentle as possible, and the leader should use as much power as possible so that the formation can keep station comfortably. The final approach should be made with the leader reducing power gradually until the required airspeed is attained. However, he should not throttle fully back until on the ground, or, with a small airfield, until the runway threshold has been crossed.

48. When the formation crosses the threshold the leader should land normally. The formation should keep station on the leader and not attempt individual landings—in effect, the leader should land the complete formation. Formation should be maintained on the ground, the leader warning the other pilots when he is about to apply brake. The temptation to relax at this stage should be strongly resisted, as a formation landing is not complete until all the aircraft are stationary.

LANDING A LARGE FORMATION

In the Circuit

49. It is important that each section of a large formation should spend a minimum of time in the circuit for the following reasons :—

(*a*) To allow return to base with a small fuel margin.

(*b*) To clear the circuit for any following formations.

(*c*) To get back to dispersal without delay for quick turn-round.

Minimum circuit time is achieved by employing the stream landing technique.

The Break, and Stream Landing

50. If the weather is suitable for a visual circuit the leader of the first section should approach on the heading of the runway in use at circuit height, slightly on the dead side, with his formation in echelon starboard (left-hand traffic). On crossing the runway threshold he should bank and pull away sharply to the left, followed in order by the rest of his section. Each should throttle well back, open the airbrakes and partial flap,

maintaining a continuous turn and selecting undercarriage down at circuit height, opposite the runway controller. It is important that each member of the formation maintains the same height as the leader on the down-wind leg. A descending curve of approach should then be started, flaps going fully down on the call "Finals". Approximate spacing between aircraft should be 800 yards. Other sections following should approach up to 1,000 yards astern during the run-up to the runway and time their break-off to fit in behind the last aircraft of the preceding section, thus making a continuous stream.

51. If a left-hand circuit is in force, the leader usually lands on the left side of the runway and No. 2 on the right, etc., but with a strong cross-wind from the left he might land on the down-wind side so that his slipstream would be blown clear. In this instance, succeeding aircraft would, as before, land on alternate sides of the runway. It is most important to avoid the use of high power, particularly on the last part of the approach, as this makes it very uncomfortable for succeeding aircraft. The speed over the threshold should be slightly higher than usual and all aircraft must run to the end of the runway before turning off.

52. The leader must consider the state of the runway surface and if necessary instruct his formation to increase their spacing. Some considerations are :—

(*a*) Braking conditions on wet and/or slippery runways.

(*b*) Short runways in light wind or very hot weather.

(*c*) Partially obstructed or very bad surfaces.

53. A landing formation must know of any unusual conditions of runway or cross-winds and the leader should always ascertain these from the ground controller who will normally pass this type of information as a matter of routine. Controllers should realize that there is much they can do to help formation leaders.

CHANGING CLOSE FORMATION

General

54. Rapid and efficient changes of formation may be required operationally (*e.g.* for the run-in and break) or for the purpose of air drill. They are an essential part of formation flying, and all pilots should aim at the highest standards of promptness and skill in their execution.

Intercommunication

55. A prerequisite for the efficient control of a formation in the air is a reliable system of inter-communication. Normally R/T is used by the leader to give orders to his formation, but for pairs or threes a pre-arranged system of visual signals (para. 79) may be used when R/T is not available.

56. **Formation Code-Names for R/T Identification.** A formation of aircraft is controlled by the formation leader, and to enable him to pass messages to or receive them from any particular sub-unit or individual in the formation, the following system of R/T callsigns has been adopted :—

(*a*) *Squadron Callsign.* The squadron is allocated an R/T callsign, *e.g.* "Dekko". When the squadron is flying as a formation, the leader is called "Dekko Leader".

(*b*) *Section Callsign.* Each section is allocated a colour : "Red", "Yellow", "Blue", and "Green". The leader of each section is called "Dekko Red One", or "Dekko Yellow One", etc., as the case may be.

(*c*) *Aircraft Designation.* In each section the aircraft are numbered one, two, three, and four. If the section is "Blue Section", the aircraft are named "Dekko Blue One", "Dekko Blue Two", "Dekko Blue Three", and "Dekko Blue Four".

Lookout during Formation Changing

57. Changes of formation are made on the commands from the formation leader, as detailed in the following paragraphs. *During all changes of formation, it is vitally important that each pilot should keep the rest of the aircraft in the formation in view. It is extremely dangerous for any pilot to lose sight of the other aircraft during formation changes.*

Section Formation Changing

58. **Introduction.** It is not intended to list all the various combinations of formation changes, but merely to give examples which illustrate the principle involved.

59. **Changing from Section Finger Four (Left-Handed) to Echelon.** The command is "DEKKO BLUE SECTION—AIRCRAFT ECHELON

PORT—AIRCRAFT ECHELON PORT—GO". On the word "GO", Nos. 3 and 4 move out to port. When No. 2 sees that his way is clear he drops back and down, then moves across below the leader and comes forward into position. Nos. 3 and 4 then close up.

60. **Changing from Section Echelon Port to Section Finger Four.** The command is "DEKKO BLUE SECTION — AIRCRAFT CLOSE FINGER FOUR — AIRCRAFT CLOSE FINGER FOUR—GO". On the word "GO" Nos. 3 and 4 move outward. When No. 2 sees his way clear he will drop back and down, then cross over and take his position on the leader's starboard wing. Nos. 3 and 4 then move into position.

61. **Changing from Section Finger Four to Section Line Astern.** The command is "DEKKO BLUE SECTION — AIRCRAFT LINE ASTERN — AIRCRAFT LINE ASTERN—GO". On the word "GO" Nos. 3 and 4 move out and start dropping back, No. 2 does the same and when he sees his way clear moves over into close line astern. When he is in position, No. 3 moves in followed by No. 4.

62. **Changing from Section Box to Section Echelon.** The command is "DEKKO BLUE SECTION—AIRCRAFT ECHELON STARBOARD — AIRCRAFT ECHELON STARBOARD—GO". On the word "GO" Number 4 moves first, well out to starboard. When he is clear No. 3 moves across below Nos. 1 and 2 and takes up his position. No. 4 then moves in.

Flight and Squadron Formation Changing

63. Changes of formation are made in accordance with the principles described, whatever the number of aircraft in the formation. In order to avoid danger of collision, however, certain additional rules must be observed for larger formations.

64. When a flight is flying as two sections of four, the flight leader passes instructions to the leader of the second section. If the command given by the flight leader involves a change in formation within the sections themselves, the aircraft of the leading section change on the executive word. The second section moves to its new position as ordered, but normally retains its original section formation until the section leader orders the change.

65. A squadron or wing leader can call flights or squadrons into any formation and the same principle applies. Each section leader must call the change of his own formation. The reason for this is that the formation leader often cannot judge the most favourable time for the change of formation within the individual section.

66. The following details of a change in formation from flight echelon starboard, sections close finger four to flight astern, sections echelon port, are given as an example of the procedure and words of command adopted. The flight leader orders: "DEKKO BLUE FLIGHT —FLIGHT ASTERN, SECTION ECHELON PORT—GO". Blue Section moves into echelon port on the word "GO". Green leader then orders: "DEKKO GREEN SECTION — ECHELON PORT, ECHELON PORT—GO". On the word "GO", Green Section moves into echelon port, and the change of formation is complete.

67. In certain circumstances it may be desirable for the leader to call change of formation in section, flight, or squadron positions at the same time as change in aircraft position within the sections themselves, *e.g.* "DEKKO SQUADRON —FLIGHT LINE ASTERN, SECTION LINE ASTERN, AIRCRAFT ECHELON STARBOARD—GO". This departure from the principle described in the previous paragraph must, however, always be covered by a thorough briefing.

BATTLE FORMATION

Purpose

68. The object of battle formation is to provide the best all-round search, the best mutual cross-cover, and the best mutual fire support. A single aircraft, no matter how good the view from the cockpit, can never give itself complete all-round cover. A pair of aircraft, flying a suitable distance apart, can give each other complete cross-cover. It follows therefore that the minimum self-contained fighting element consists of two aircraft. In certain circumstances, however, *e.g.* when No. 1 engages a target, his attention is completely devoted to that target, and while he continues to receive cover from No. 2, No. 2 is vulnerable.

The Pair

69. A pair must fly line abreast to give mutual support, sufficiently separated to give complete rearward cover of each other but not so wide as to lose flexibility (Fig. 12). This is the basic element of all battle formations.

Fluid Four

70. Here the two pairs fly line abreast covering each other (Fig. 14). Normally Nos. 1 and 3 search forward, Nos. 2 and 4 to the rear. No. 3 positions himself stepped slightly up and looking towards the sun, the point from which an attack is most likely to come.

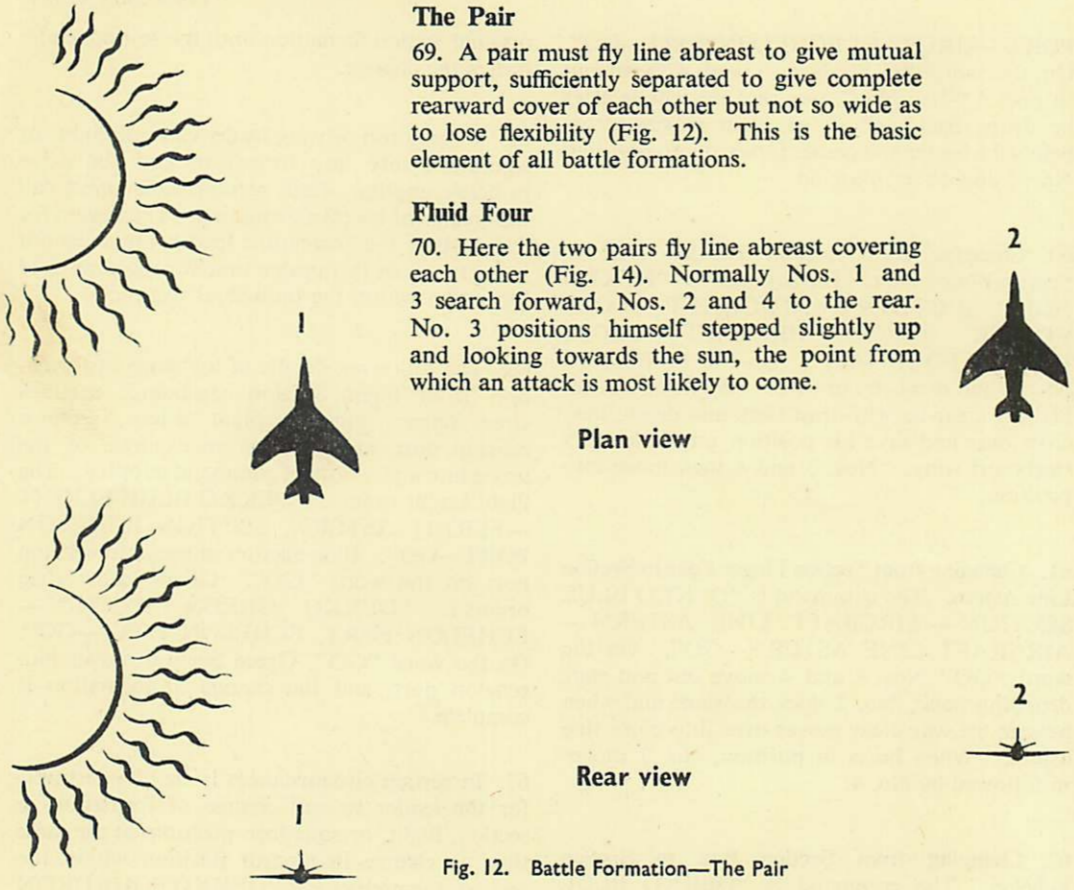

Fig. 12. Battle Formation—The Pair

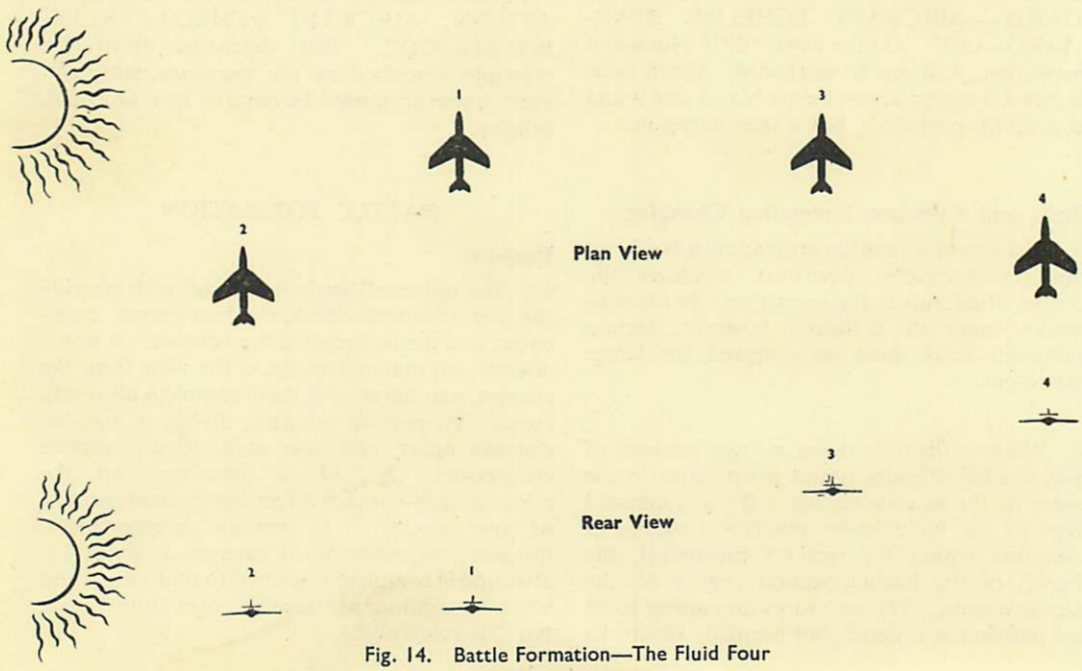

Fig. 14. Battle Formation—The Fluid Four

Fluid Six

71. Pairs may be flown closer than a fluid four, without loss of cover, as there are more searchers (Fig. 15). The down-sun section are again stepped slightly up. The No. 2 usually takes his position down sun.

Squadron Battle Formation

72. Circumstances dictate the precise deployment but the example illustrated in Fig. 16 is typical.

73. When two or more sections are flying together the Nos. 3 position their pairs, whenever possible, so that they are not between their section leader and the next section.

Cross-Over Turns (Fig. 17)

74. If the leader turns 90° to the right, the inside pair crosses under his flight path, the outside pair over. Should the turn be continued to 180° the same procedure would be repeated in a continuous movement, the inside pair again crossing under and the outside over. *This rule is invariable to eliminate risk of collision.* It is important to note that in a perfectly executed turn each pair has the same distance to cover and need make no change in throttle setting. If a turn has put one pair of a section up sun it should then cross over to the other side.

Turnabouts (Fig. 18)

75. A formation may turn through 180° by using the double cross-over method shown above, or by turning with each pair in place as shown below. This is known as a turnabout. In this manœuvre pairs inevitably lose sight of each other during different parts of the turn. For this reason, when the order to execute a turnabout is given, the inside pair initiates it and is kept in sight by the other sub-section leaders as long as possible until, after about 120°, the original outside pair must set the pace for the remainder of the turn. It is most important that the Nos. 2 fly round the turn in such a way as to give the maximum cross-over during the turn.

Defensive Breaks

76. If attacked from the rear the formation should turn towards the attacker as fast as possible to give a maximum deflection shot. On the order to break right or left all aircraft turn at maximum rate and full throttle. This can usually be kept in the form of a hard turnabout but in dire emergency it becomes necessary for each aircraft to turn individually at its limit. This is inclined to split up a formation and invariably leads to loss of vital combat speed which can be recovered only by sacrificing altitude which may well put the formation at a further disadvantage ; a "panic" break of this sort is most undesirable and its necessity almost always arises from lack of alertness in the formation concerned.

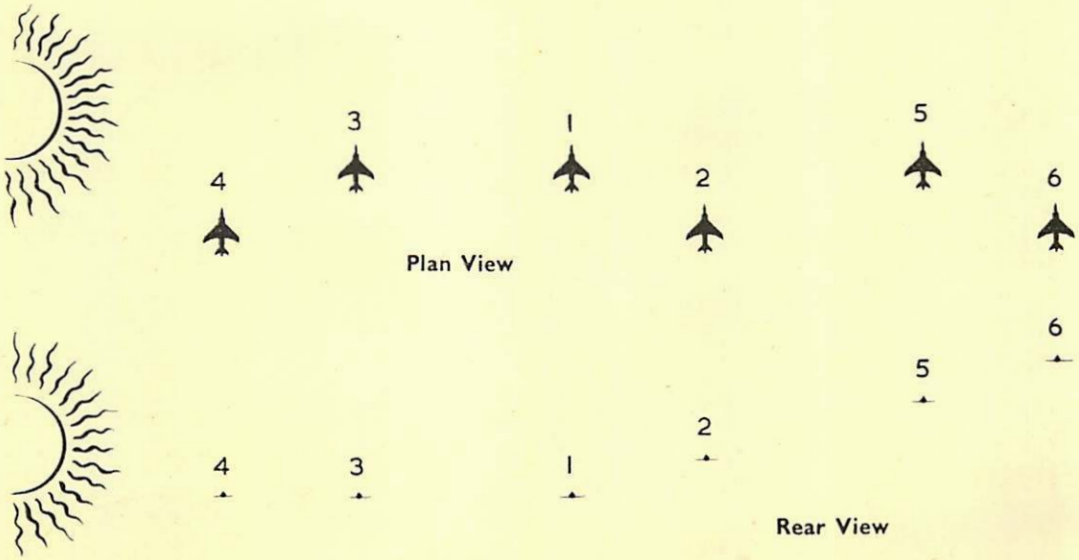

Fig. 15. Battle Formation—The Fluid Six

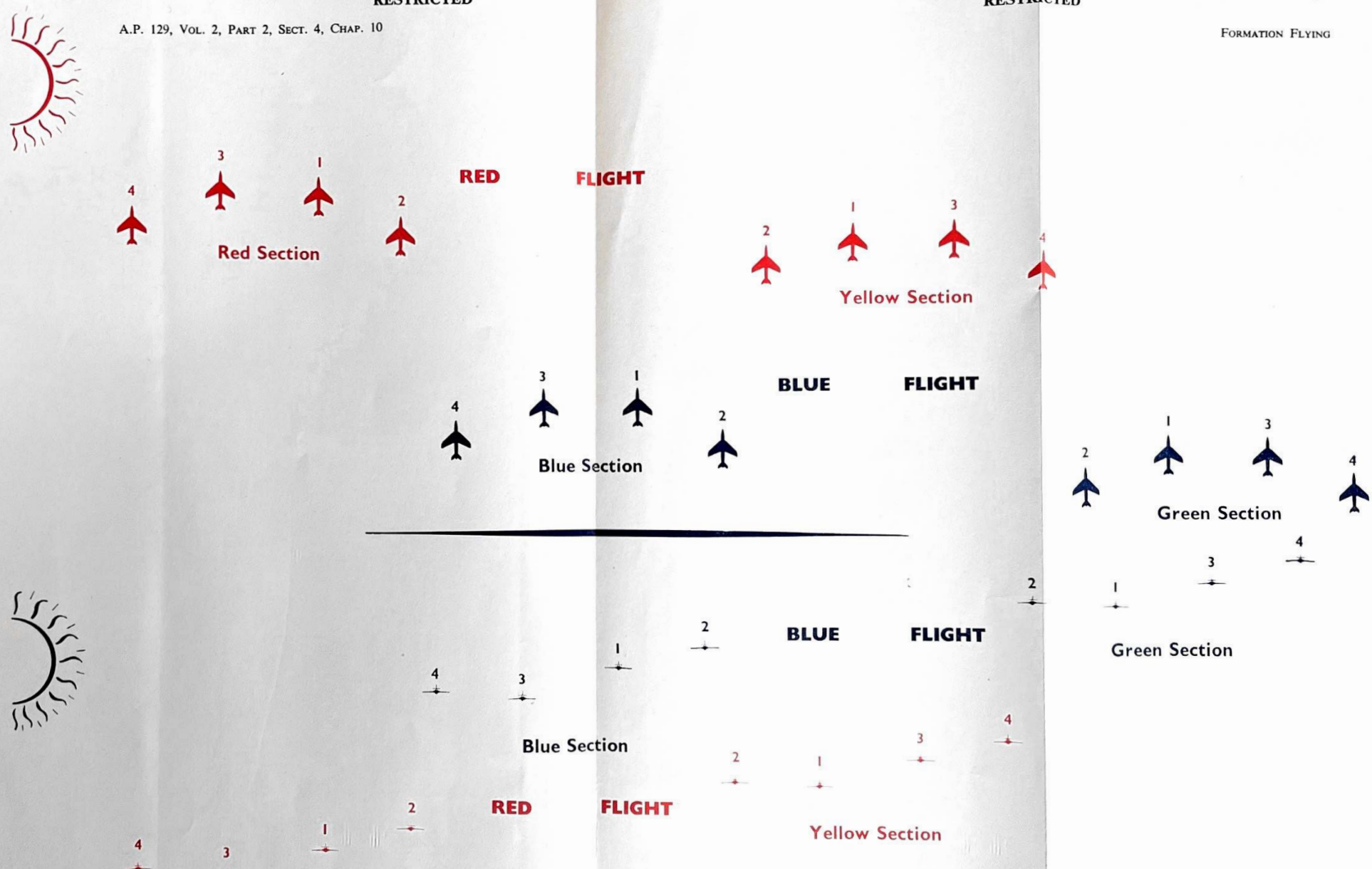

Fig. 16. Typical Battle Formation—Squadron Formation

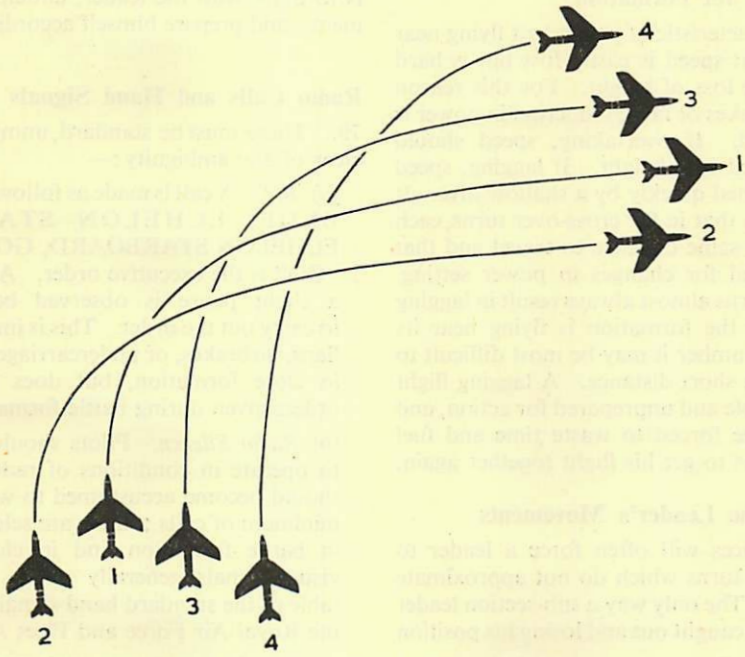

Fig. 17. Cross-Over Turns

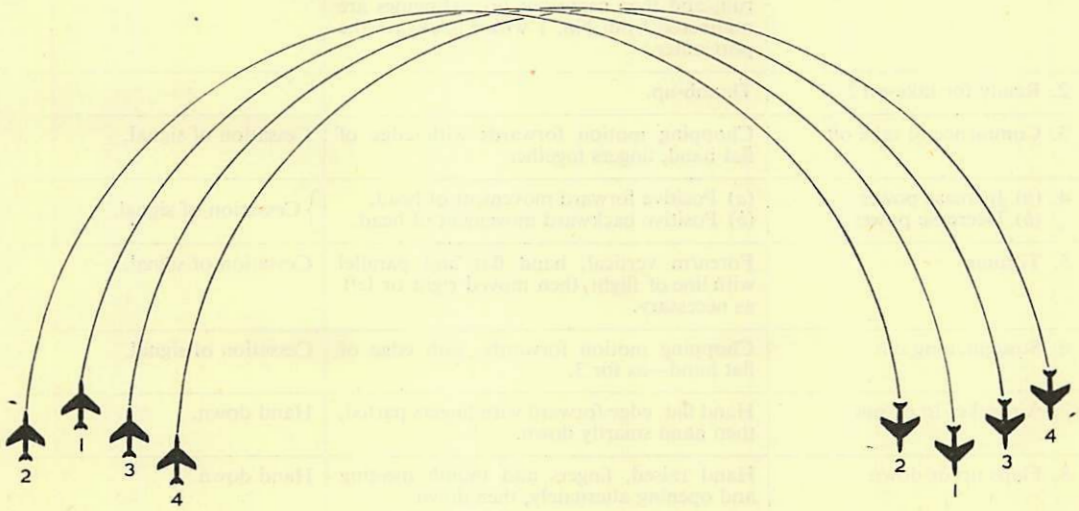

Fig. 18. The Turnabout

High Altitude Jet Formation

77. It is a characteristic of jet aircraft flying near their ceiling that speed is easily lost but is hard to gain without loss of height. For this reason the use of airbrakes or large reduction in power is seldom justified. If overtaking, speed should always be turned into height. If lagging, speed can only be gained quickly by a shallow dive. It has been shown that in 90° cross-over turns, each aircraft has the same distance to travel and that there is no need for changes in power setting. Badly judged turns almost always result in lagging aircraft, and if the formation is flying near its limiting mach number it may be most difficult to catch up even a short distance. A lagging flight is both vulnerable and unprepared for action, and a leader may be forced to waste time and fuel by making turns to get his flight together again.

Anticipating the Leader's Movements

78. Circumstances will often force a leader to make awkward turns which do not approximate to 90° or 180°. The only way a sub-section leader can avoid being caught out and losing his position is to think with the leader, anticipate his movements, and prepare himself accordingly.

Radio Calls and Hand Signals

79. These must be standard, unmistakable, and clear of any ambiguity :—

(*a*) *R/T.* A call is made as follows : "DEKKO BLUE, ECHELON STARBOARD, ECHELON STARBOARD, GO". The word "GO" is the executive order. After it is given a slight pause is observed before starting to carry out the order. This is important where flaps, airbrakes, or undercarriage are called for in close formation, but does not apply to orders given during battle formation.

(*b*) *Radio Silence.* Pilots should be prepared to operate in conditions of radio silence and should become accustomed to working with a minimum of calls ; these are seldom necessary in battle formation and in close formation visual signals generally suffice. Below is a table of the standard hand signals used in both the Royal Air Force and Fleet Air Arm.

STANDARD HAND SIGNALS

Action	*Description of Signal*	*Action to be Taken on*
	EXECUTIVE SIGNALS	
1. Running up	(*a*) Hand raised, forefinger extended upwards and revolved in horizontal plane. (*b*) In M.E. aircraft, hold up the number of fingers corresponding to the engine to be run, and then carry out (*a*). (Engines are numbered from No. 1 which is always the port outer.)	Commencement of signal.
2. Ready for take-off ?	Thumb-up.	
3. Commence to take off	Chopping motion forwards with edge of flat hand, fingers together.	Cessation of signal.
4. (*a*) Increase power (*b*) Decrease power	(*a*) Positive forward movement of head. (*b*) Positive backward movement of head.	Cessation of signal.
5. Turning	Forearm vertical, hand flat and parallel with line of flight, then moved right or left as necessary.	Cessation of signal.
6. Straightening out	Chopping motion forwards, with edge of flat hand—as for 3.	Cessation of signal.
7. Airbrakes in or out	Hand flat, edge forward with fingers parted, then hand smartly down.	Hand down.
8. Flaps up or down	Hand raised, fingers and thumb meeting and opening alternately, then down.	Hand down
9. Undercarriage up or down	As for "pulling the chain", clenched fist moving up or down, forearm vertical.	Hand down.
10. Take over as leader	Point to new leader ; then raise hand, forefinger extended upwards, to indicate No. 1 position.	Cessation of signal.

Action	*Description of Signal*	*Action to be Taken on*
11. Go into battle formation	Clenched fist on forehead, hand in fore-and-aft line of aircraft.	Hand down.
12. Close formation or reform basic formation as briefed.	Lateral rocking of the aircraft.	Cessation of signal.
13. Relax close formation	Hand raised with palm outwards, fingers together, palm against perspex on the appropriate side.	Cessation of signal.
14. Go into echelon, port or starboard.	Forefinger pointed at aircraft concerned then moved across the face to indicate the new position.	Cessation of signal.
15. Line astern— (*a*) Close (*b*) Extended	(*a*) Clenched fist, thumb extended to rear, moving back and forth. (*b*) Clenched fist, tapping back of head.	Cessation of signal.
16. Abandon aircraft	Both fists clenched and moved downwards in front of the face as though pulling an ejector seat blind.	
17. Climbing	Forefinger pointing upwards.	Cessation of signal.
18. Descending	Forefinger pointing downwards.	Cessation of signal.
19. Levelling out	Sideways movements of either hand, palm down, fingers extended at face level.	Cessation of signal.
20. Escort me to base immediately.	Continuous lateral rocking of the aircraft followed by thumbs down signal.	
21. Break formation	Rapid sweeping movement of the open hand, palm forward, fingers upwards in front of the face.	Cessation of signal.
22. I am returning/you are to return to base.	Point at self/aircraft concerned then point downwards.	
	INFORMATIVE SIGNALS	
23. Your aircraft is on fire	Fly alongside and rock the wings to attract the attention of the other pilot, then draw the edge of the hand across the throat in a cutting motion, afterwards pointing to the area of fire. Continue this until acknowledged by a thumbs-up signal.	
24. My electrics have failed	A map, Pilots' Notes, or any piece of paper held against the perspex.	
25. My R/T has failed	(*a*) For an unserviceable transmitter tap the microphone and give a thumbs-down signal. (*b*) For total failure (receiver) tap an earphone then give a thumbs-down signal. If in open formation porpoise the aircraft.	
26. Fuel state— (*a*) *From Leader*. What is your fuel state ? (*b*) *By other Aircraft*. My fuel state is low. (*c*) I have sufficient fuel (in reply to leader's query). (*d*) My fuel gauges are unserviceable.	(*a*) Clenched fist, thumb to mouth, head back as though drinking. (*b*) As for (*a*) above. (*c*) Thumbs-up. (*d*) Make signal (*a*) followed by thumbs-down signal.