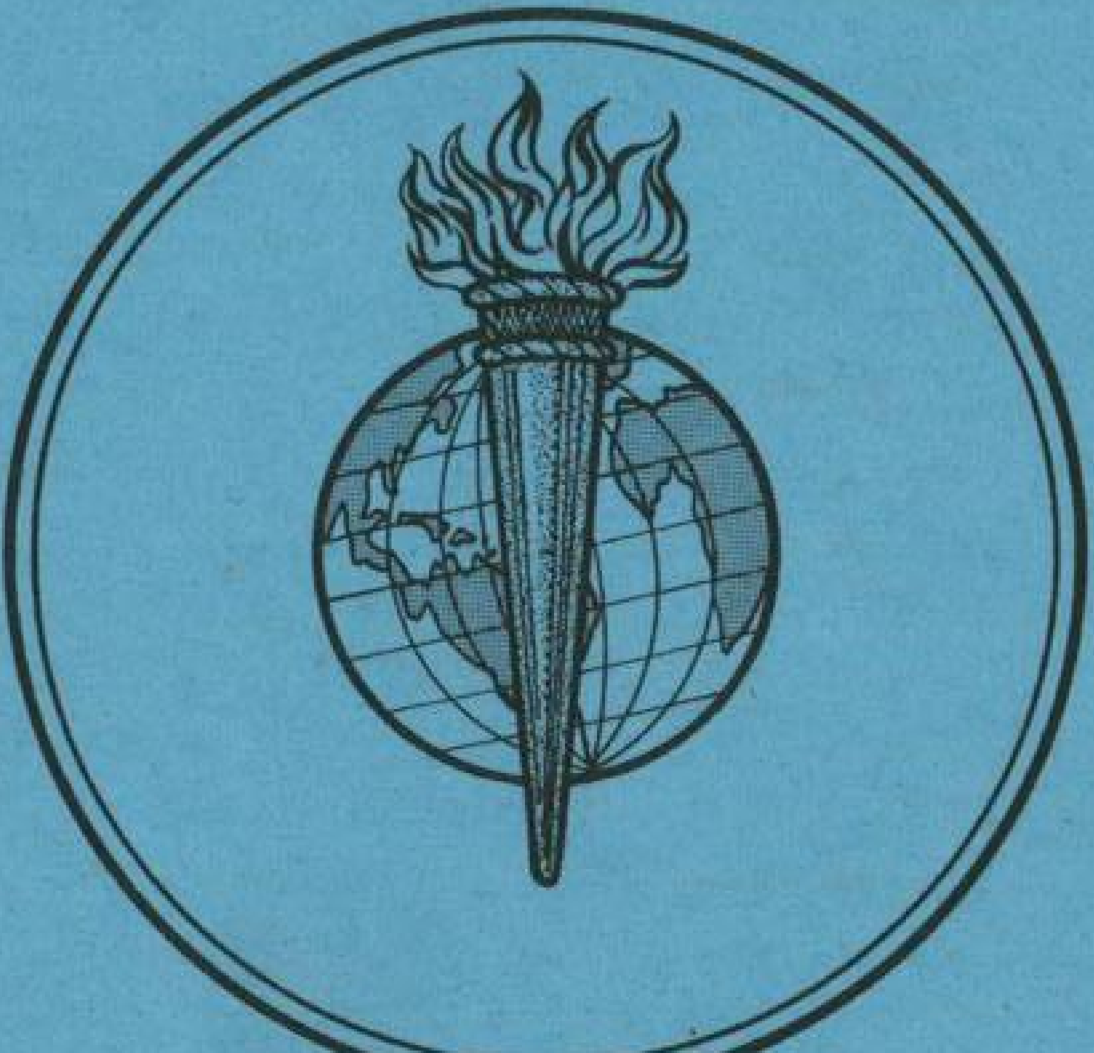
RESTRICTED

THE RCAF
OBSERVER



Vol 3 No 3 July 1957

Contents

This document is the property of the ROYAL CANADIAN AIR FORCE and is classified 'Restricted'. The RCAF OBSERVER is published quarterly at the CENTRAL NAVIGATION SCHOOL under the authority of the CHIEF OF THE AIR STAFF.

This information is furnished subject to the following conditions:

(a) It is to be used by the recipient and is not to be released to another without prior authority from the Chief of the Air Staff, Air Force Headquarters, Ottawa, Canada.

(b) It is to be protected to prevent disclosure to unauthorized persons;

IMPROPER OR UNAUTHORIZED DISCLOSURE OF THIS INFORMATION IS AN OFFENCE UNDER THE OFFICIAL SECRETS ACT.

$5.00

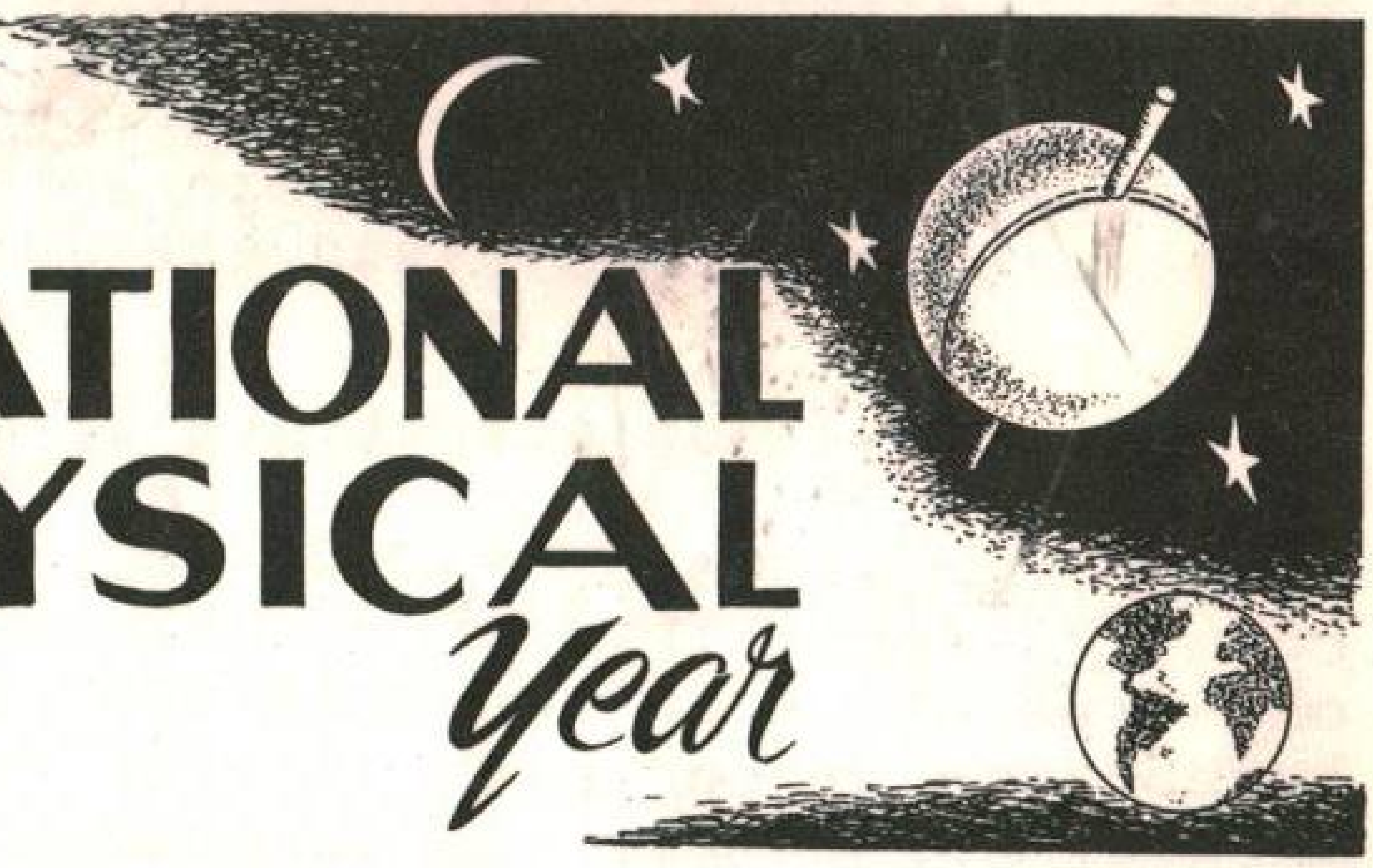
The RCAF OBSERVER

Incorporating the RCAF Navigation Bulletin

Founded 1949

Volume 3 No 3 **July 1957**

The INTERNATIONAL GEOPHYSICAL *Year*



For the next eighteen months thousands of people the world over will be engaged in the greatest assault on the secrets of the universe ever attempted by man. This period, to be known as the International Geophysical Year or IGY, will concentrate the efforts of scientists, engineers, technicians and observers in some fifty-five countries for the purpose of exploring our physical environment. The programme, sponsored by the International Council of Scientific Unions, will be a truly international enterprise; information gathered will be freely exchanged among the nations taking part.

Planning and preparation for the IGY has been in progress for the past several years. It has been estimated that the whole project will cost in the neighborhood of $500 million which will be contributed by the participating nations with some aid from UNESCO. Our readers have probably heard of some of these preparations; notably, the launching of "Project Vanguard" or space satellite by the US; or the extensive preparations for establishing bases in the Antarctic. These and many other projects are well underway by now.

The IGY - lasting from July 1957 to December 1958- will allow for an overlap in observations beyond the beginning and end of a twelve month period. Another major reason for choosing this period is that it covers a season of maximum sunspot activity. Beginning this year solar disturbances are expected to produce their greatest effects on the air around us and on airborne communications.

Why are we putting forth this great effort? The answer is simply that, by simultaneous observations over the whole world and by co-operatively sharing the results, scientists hope to accomplish more in 18 months than they could in uncounted years of independent research. Some of the more important fields to be covered include:a study of solar activity and its effects on the earth; an attempt to determine latitude and longitude more accurately, particularly over the ocean areas of the world; a study to determine accurate celestial co-ordinates; geomagnetism and its applications to earth and space; weather in all its forms; a study of the atmosphere and the ionsphere; and studies of the aurora, airglow, cosmic rays, meteors, gravity, seismology, oceanography, and glaciology.

Canadian scientists will be engaged on all of these projects in one way or another. Observing, recording, and measuring stations have been established throughout the country from Victoria to Halifax, from Ottawa to Alert and on ships off both the Atlantic and Pacific coasts. Naturally,because of our geographical position, we will concentrate much of our energy on investigations in the arctic regions.

One interesting point is that Canadian scientists in the northern arctic will work closely with scientists in the Antarctic, comparing observations,measurements and data, particularly on the atmosphere and the earth's magnetic field. This becomes particularly important when it is realized that our knowledge of the physical environment of the southern hemisphere is practically unknown when compared to the knowledge gathered about the northern hemisphere. For instance,we do not know whether the air masses in the southern hemisphere are similar to those in the north,or if different, why? Nor do we know whether atmospheric changes in the northern hemisphere precede those in the south, or vice versa.

To assist in the collection of this vast amount of weather and atmospheric data,four pole-to-pole world weather lines have been established. Of particular interest to us is the world weather line that starts at Alert,NWT and passes through joint Canada-US arctic weather stations and then through Canadian stations along Hudson's Bay. From there the line passes through a chain of American stations from Buffalo to the Gulf coast. The line crosses the Caribbean Sea to

Balboa on the Pacific Ocean, then down the west coast of South America and finally on into the Antarctic. These world weather lines, apart from helping to answer the problems mentioned in the preceding paragraph, will give valuable information on east - west weather movement, location and strength of jet streams and finally the actual movement of energy itself. In fact, it has been estimated that the average temperature difference between the tropics and the poles causes a daily movement of energy across the 40° latitude belt equal to the energy released by the explosion of four and a half million atom bombs.

Perhaps the most spectacular project of the IGY will be the launching of man-made moons,or space satellites. These little moons, which will weigh about 20 pounds, will be released from powerful rockets at heights of approximately 300 miles. They will carry instruments which will measure the intensity of gamma,ultraviolet,cosmic, solar and X-rays. They will also carry radio equipment with which to transmit data back to earth and automatic cameras with which to photograph the stars, sky, earth,and other satellites. The space satellites will allow man to penetrate to altitudes he has never been able to reach before.

In addition to the satellites, hundreds of rockets will be fired into our unsuspecting atmosphere from various parts of the earth. These rockets will be used to explore the atmosphere at altitudes ranging from 60 to 175 miles.

You may say that this is all very well for the benefit of pure science and national prestige, but what possible use is it to us as an airforce? The benefits, although not obvious, are there all the same. For instance, more knowledge of solar activity, the ionosphere, the aurora, geomagnetism, and cosmic rays should prove invaluable to us in the fields of navigation, radio and radar. Similarly, studies of the atmosphere, movement of air masses, temperatures, pressure and winds should result in vastly improved weather services and forecasts. Then again, the accurate positioning of terrestrial and celestial co-ordinates is the basis of all navigation. Finally, the sum of knowledge gained will materially assist us in our assault on space itself.

It should be obvious to our readers that nothing on this scale has been attempted before, and that results will more than offset the time and effort expended. If any of our readers are interested in additional information on the IGY we refer them to a pamphlet published by the Bureau of Current Affairs entitled "The International Geophysical Year" (Current Affairs for the Canadian Forces Vol 11, No 15 1 May 1957). For non-service readers this pamphlet may be obtained from the Queens Printer, Ottawa, for 20 cents.

30 SONI

18 February 1957 10 June 1957

Back Row

F/O DJ Mulligan F/O R Svendsen F/O JE Hennessey

F/O GT Lenton F/O RWJ Doncaster

Front Row

F/L DC McRae F/O JP Vaillancourt F/L LVR Chausse

The MOST PROBABLE POSITION

A subject which has provoked considerable controversy among observers from time to time is that of the Most Probable Position, or MPP. Argument has ranged over many aspects of the subject, touching on such points as the usefulness, or otherwise, of MPPs, the mathematical validity of various methods, or the ease of construction, to name just a few. Much has been written with a view to producing the perfect method of finding the MPP, frequently proving that other methods are unacceptable. There are even those persons who would have nothing to do with the subject and dismiss the MPP as a mere academic device retained to swell training syllabuses and to provide pitfalls at examination time. But any observer who has had to navigate for hours on end with no aid other than sun position lines knows that an MPP technique has been essential in maintaining a coherent navigation sequence; and in general the results prove to be surprisingly accurate.

What is an MPP

In its simplest terms an MPP is that position at which an observer judges himself to be, weighing the conflicting information from two or more sources. In general, the DR position is one of these sources and a fix or position line another. One could however, regard the fix taken from a "cocked-hat" as an MPP deduced from the several conflicting position lines being used.

Weighing the Evidence

It is in the weighing of the conflicting information that the first difficulty arises. To make comparisons it is necessary to use similar terms and units of measurement. For convenience, and quite arbitrarily, the unit normally used is the 50% area of probability; that is, the area in which 50% of a large number of similar random observations would fall. This area for a position line is a band of X miles on either side of it. For a fix, the area is likely to be approximately a circle of Y miles radius around the fix. Similarly with a DR position, the many errors that contribute to the final DR error will in general result in a 50% area of probability, circular in shape and of so many miles radius around the DR position.

It should be understood that the areas being compared need not necessarily be those of 50% probability; they could equally well be the 70% or 90% areas, and indeed, it can be argued that a navigator should be more interested in the area in which he has a 95% or 99% chance of being rather than in the 50% region. What is important is that all the position data should be assessed and compared using common terms.

Assessing the Error

The assessment of the 50% error of various types of information, including the DR position, is fundamental to the MPP technique. One individual observer carrying out one type of observation repeatedly in similar conditions will have a 50% error that could be determined from an analysis of results. But for a large number of individuals carrying out many different types of observation, in different aircraft, under varying conditions, it is not easy to select a 50% error figure that would be useful. The most one can hope for is to indicate the order of error to be expected and to ensure that this is modified according to the circumstances by the particular observer concerned, who will be better aware of the circumstances than any other person.

An example of this principle is the 50% error that one should associate with a DR position. Under well-defined conditions experienced in maritime operations during the last war it was concluded that the order of the 50% error in DR was 8 nm per hour of flying since the previous fix. It would be quite wrong to apply this figure rigidly to other types of navigation or to aircraft using different equipment and flying in non-maritime conditions. There is good reason to believe that at higher speeds and at higher altitudes where the winds are stronger and the wind vector correspondingly high, a better general figure for the 50% DR error would be 20 nm per hour rather than 8 nm per hour. However, it can only be stressed again that assessment of the error in the light of circumstances is the only sound method to adopt.

Criteria for a Practical Method of Obtaining an MPP

In a very general way we have seen that the MPP should be selected from a comparison of the 50% areas of probable position, which will frequently conflict in relation to one another. The midpoint of the overlap area, or of the shortest line between the edges of the two areas when they do not overlap, will be a close approximation to the mathematically accurate MPP.

Of the various techniques for reconciling the conflicting areas, any method selected for practical application should fulfill the following criteria:

(a) Be as simple as possible to construct or calculate.

(b) Be reasonably sound mathematically.

(c) Be flexible enough to allow the individual observer to apply his judgement and discretion to the factor involved.

(d) Preferably the situation should be graphically displayed on the chart, since this is the best form in which to assess this type of information.

Standard Method Used by RCAF Training Command

The standard method of determining the MPP as taught in Training Command was selected with the above principles in mind. Whilst emphasizing the need for judgement to be exercised, it recognizes the fact that many students confronted with the MPP technique at the training stage will have little experience of probable DR and other errors. As a guide to him at this stage the following general 50% error figures are assumed; they are considered to be reasonable for the type of aircraft and equipment in use and flight undertaken:

Class of Information	50% Area of Probability
DR Position	Circle of radius 8nm/hrs since previous fix
Astro and Pressure Pattern Lines	Band 5 nm either side of position line
Radio Position Line	Sector 2° either side of bearing

Visual Position Line	Sector ½° either side of bearing
Loran Position Line	Band 6 microseconds either side of observed reading
Any fix of 2 Position Lines	Circle of radius 10 nm

Having decided and plotted the 50% areas of probability the MPP is selected visually as the midpoint of the overlap area or the intervening space between the edges of the two areas at their closest point. The MPP will lie on the line perpendicular to a position line from the DR position, or on the line joining the DR position to a fix. A three-position-line fix will normally be accepted in preference to an MPP, but where there is uncertainty because of the size of the cocked hat or excessive distance between the DR position and the fix, an MPP is recommended along the line from the fix towards the DR position at a distance dependent on the weight given to the information involved. The following diagrams show how the above rule is applied in various circumstances.

Summary

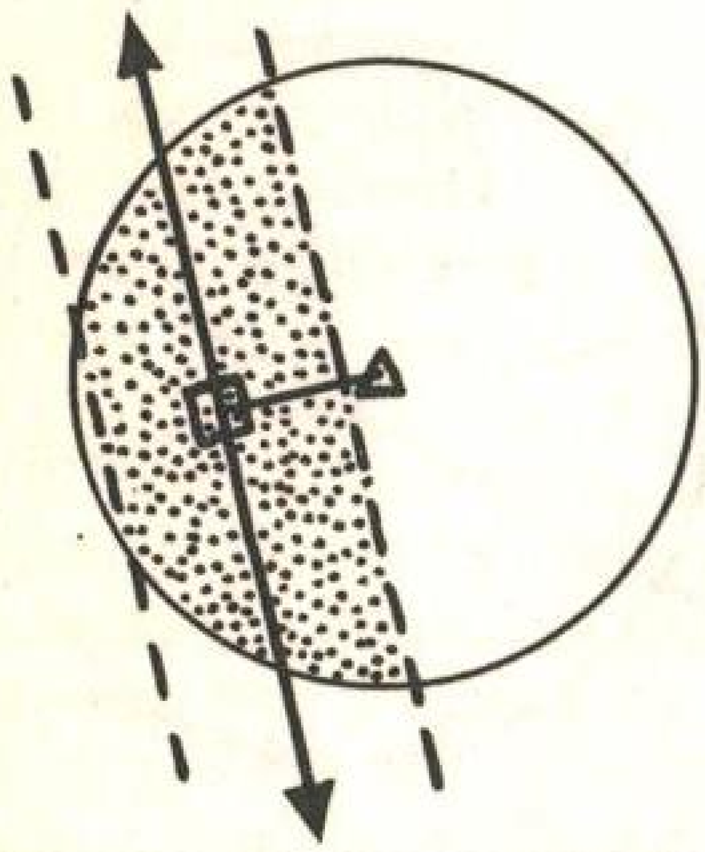
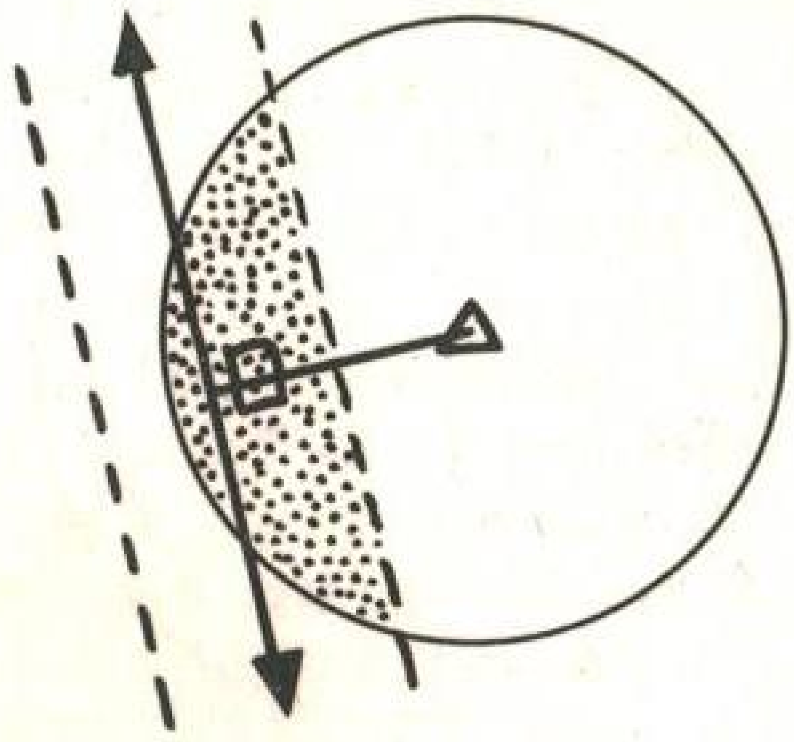
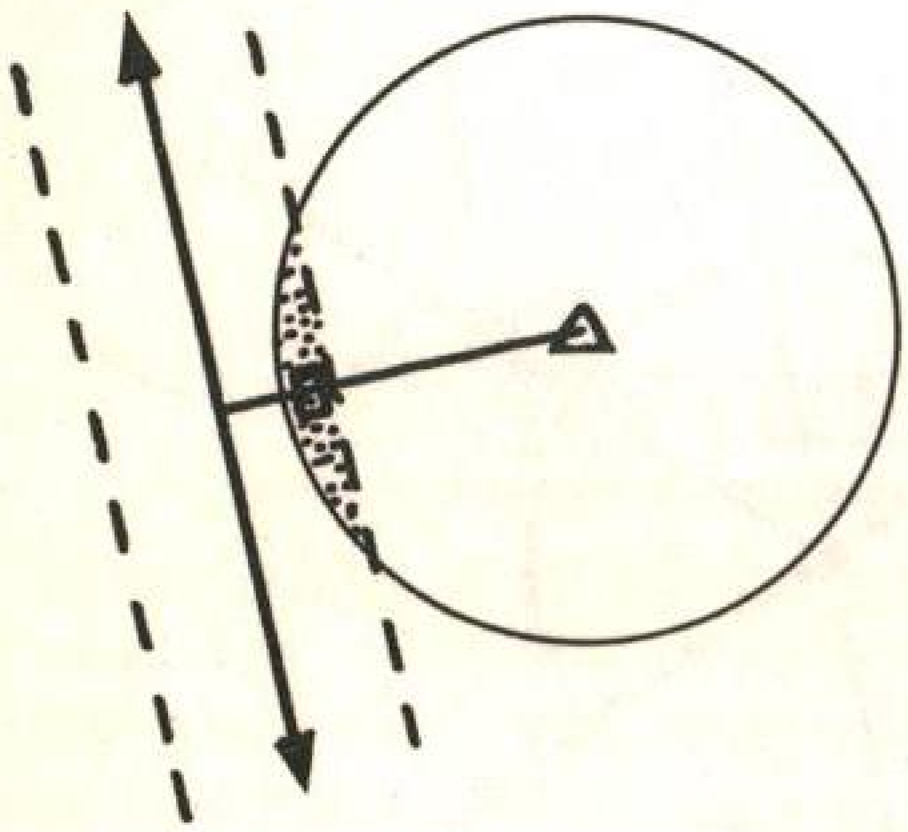
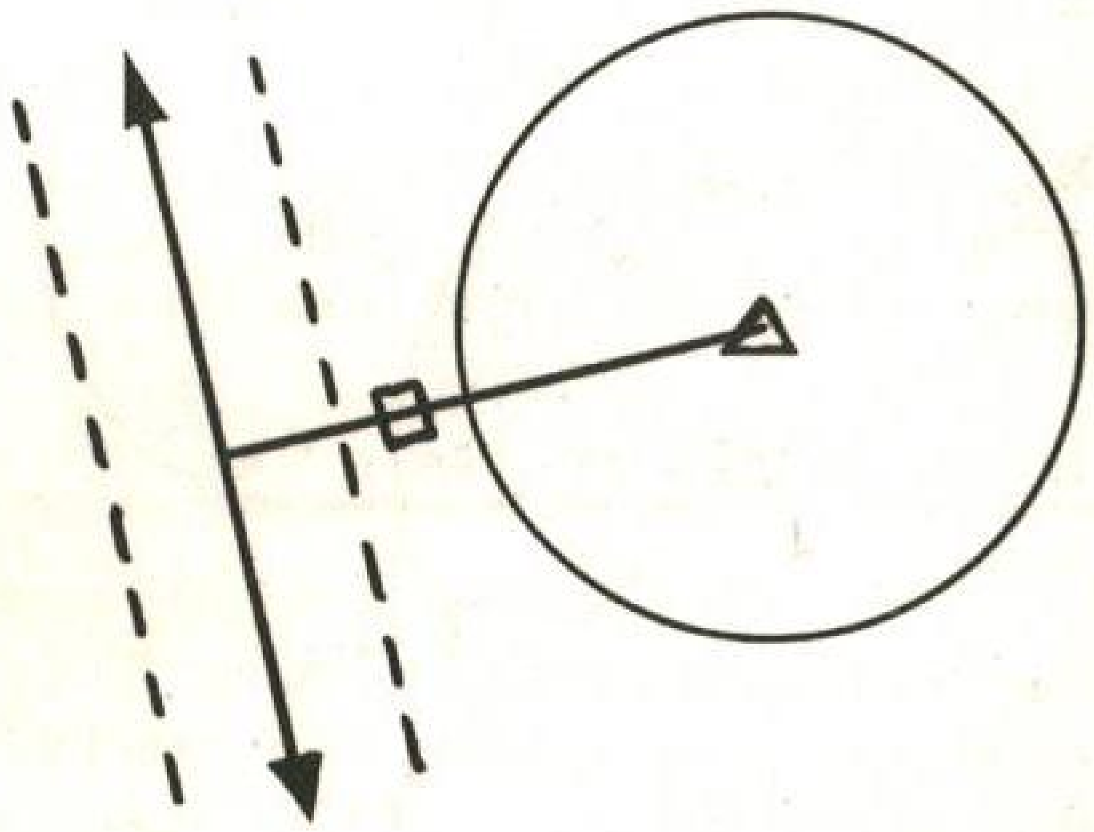
The method of obtaining an MPP taught in Training Command fulfills the need for a simple rapid solution that will be approximately accurate and easily understood by the inexperienced student. It serves as a basis for applying the fundamental principles according to varying circumstances when the observer has attained sufficient experience to warrant the exercise of judgement and discretion. It is not mandatory within the RCAF as a whole, individual Commands being free to use their own variations.

Future Applications

Already computers are being designed that will assess automatically in flight the likely errors of various types of position information; comparison of the errors and deduction of the MPP can also be carried out automatically by these computers. Thus the fundamental idea behind the MPP is likely to be with us for some time to come. So long as MPPs need to be determined by the human navigator, it will be necessary for him to understand the principles involved and also to revise where possible the data on which MPPs are based.

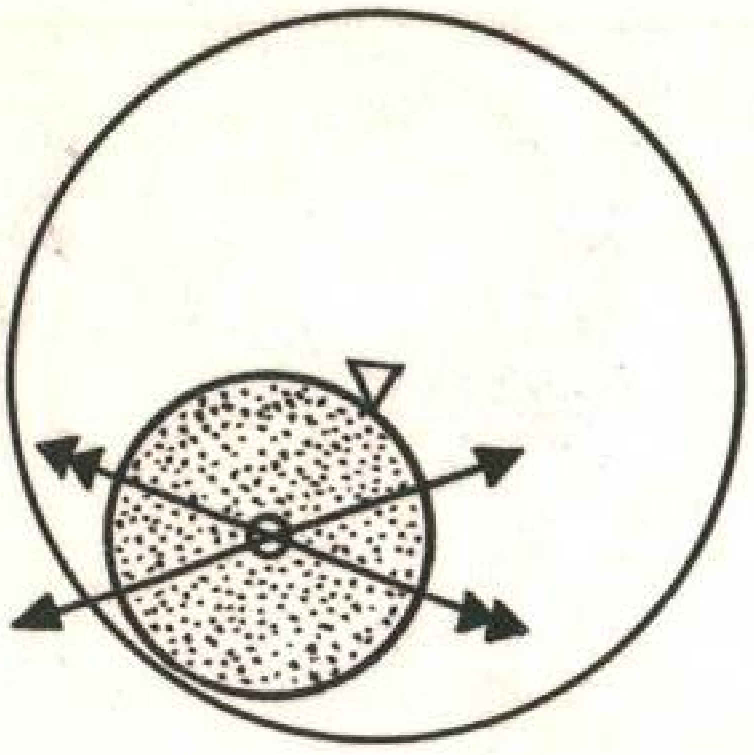
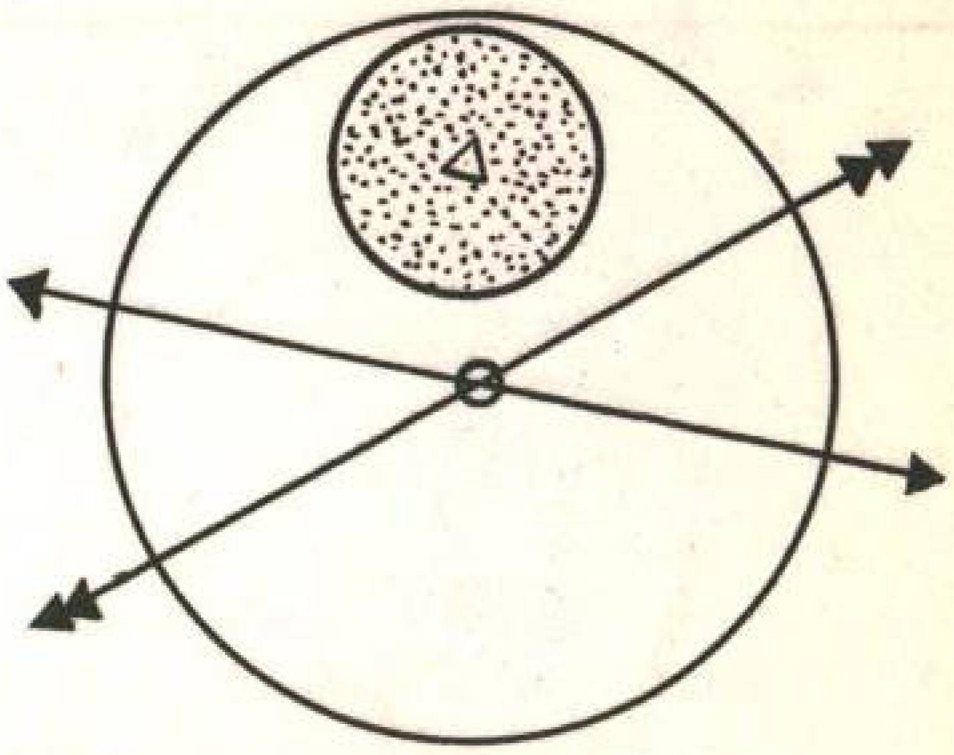
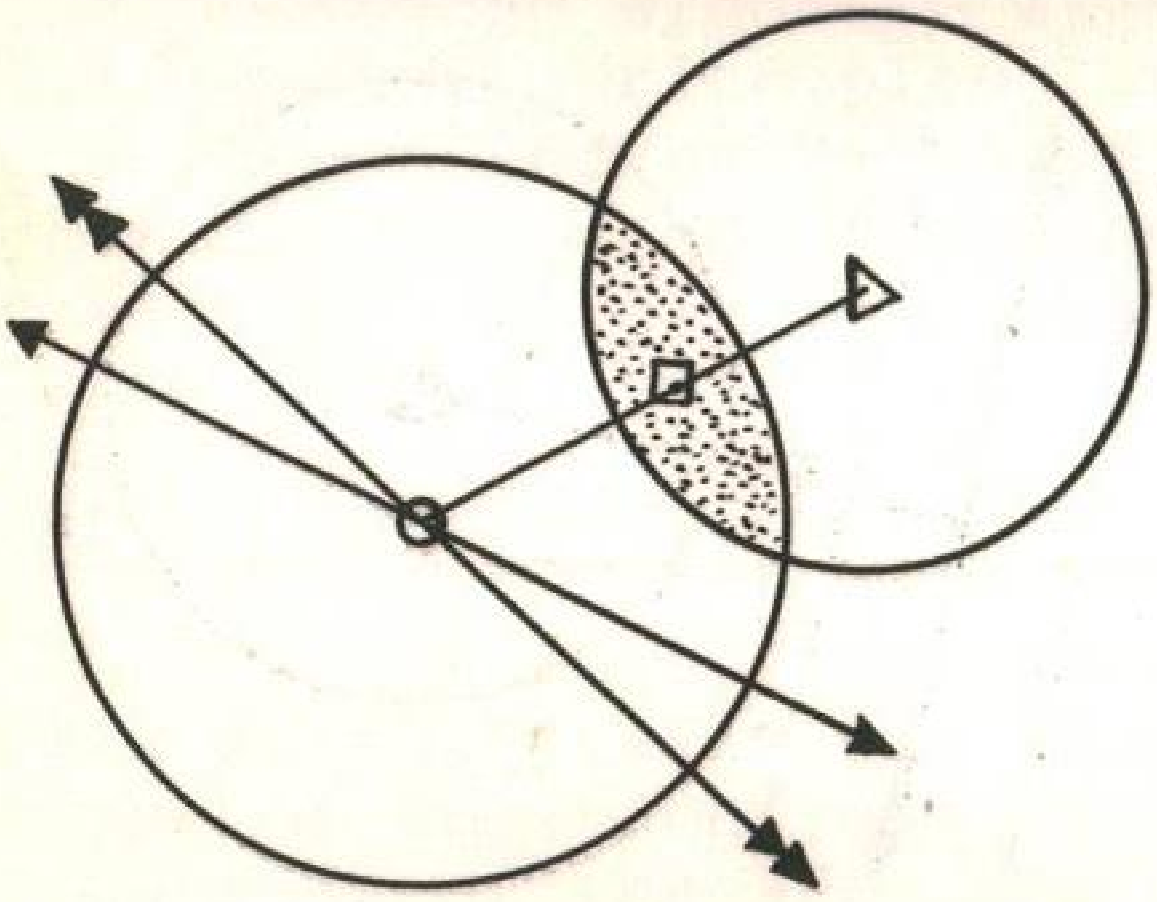
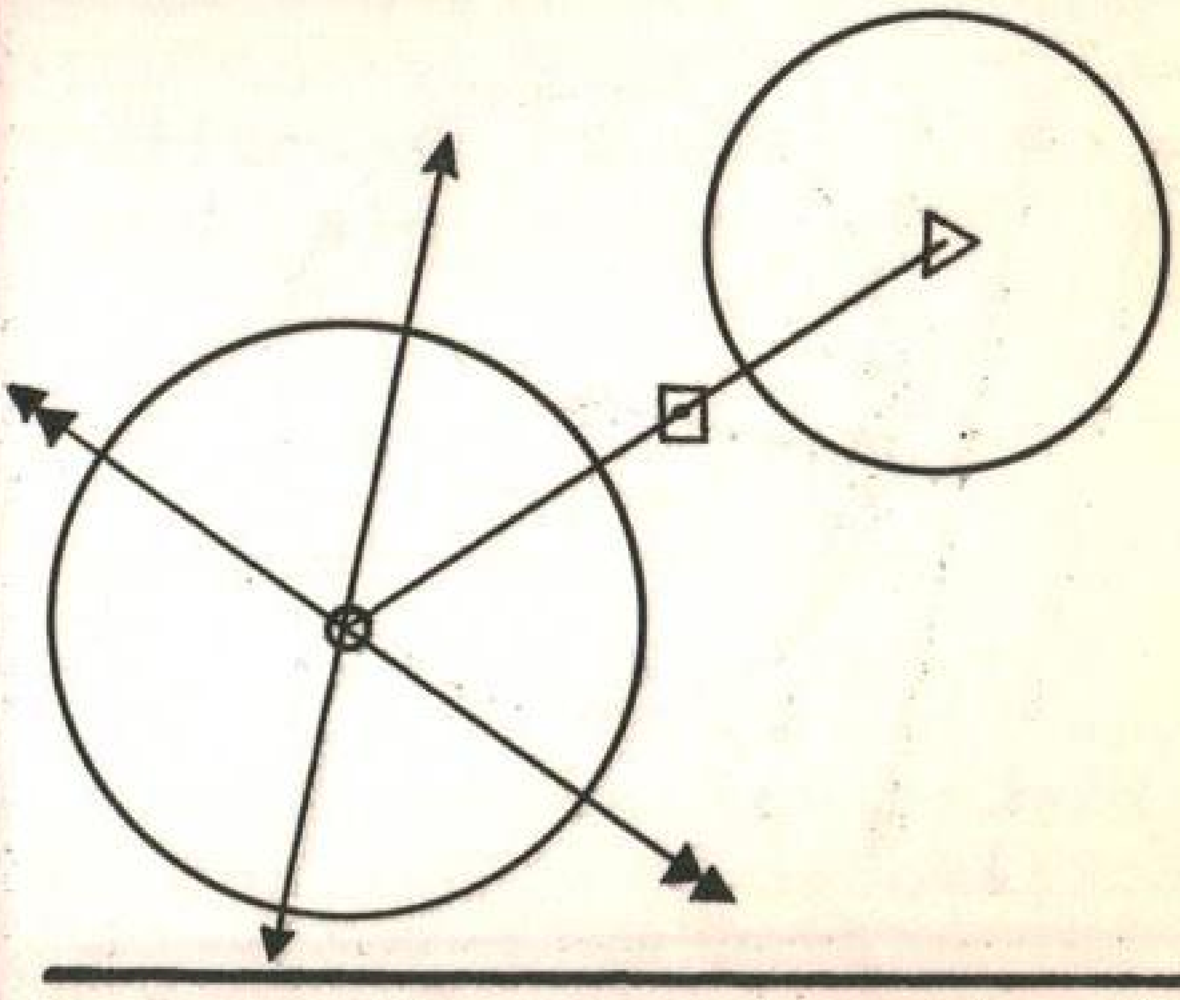
In particular there appears to be a need for more accurate information on 50% probable errors for DR and the various aids used in high-speed, high-altitude navigation. This information could probably best be obtained from carefully monitored flight trials with appropriate equipment in varying conditions.

SINGLE P/L MPP

Case 1	Case 2
	
Draw perpendicular from P/L to DR posn. Place MPP on P/L at perpendicular which can be considered to be centre of common area.	Draw perpendicular from P/L to DR posn. Place MPP at centre of common area on the perpendicular.
Case 3	Case 4
	
Draw perpendicular from P/L to DR posn. Place MPP at centre of common area on perpendicular.	Draw perpendicular from P/L to DR posn. Place MPP midway between band of probability and area of uncertainty on perpendicular.

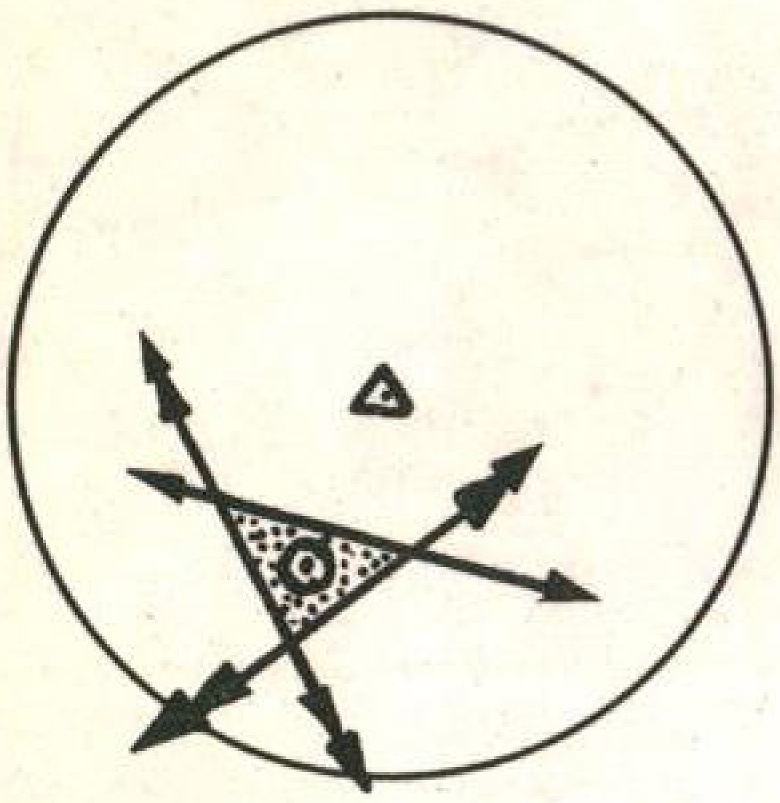
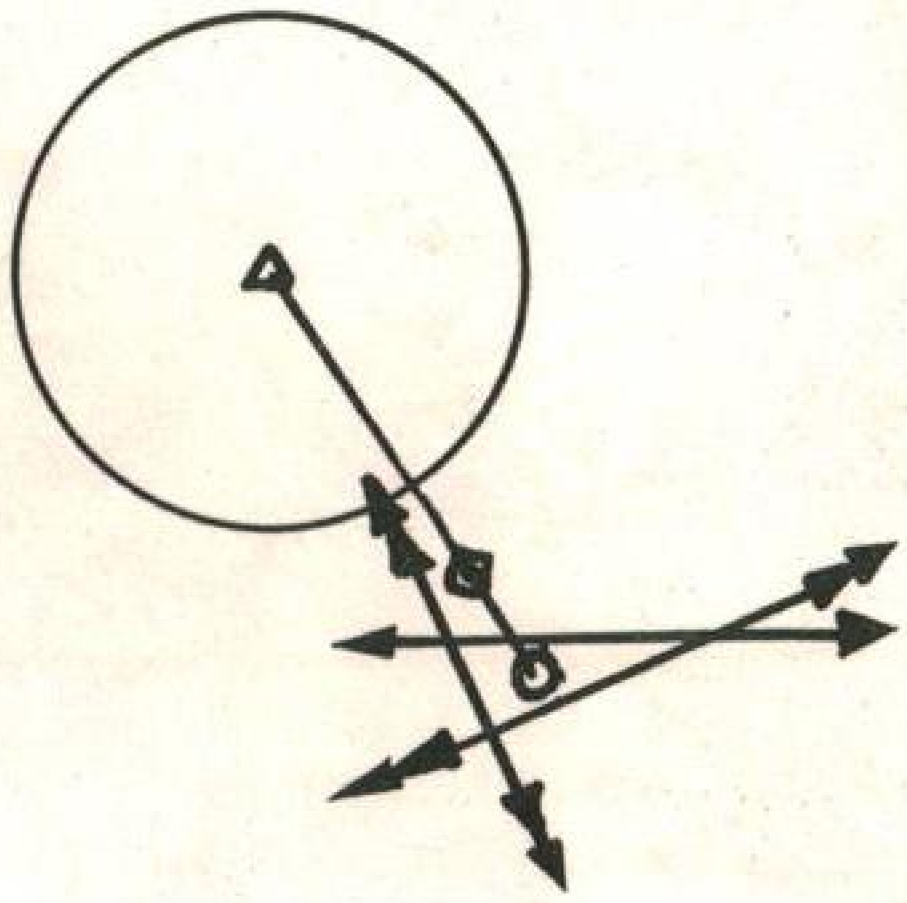
Rule: MPP's always fall on the perpendicular from the P/L to the DR posn., or on a line joining the fix to the DR posn., the position on the line being the centre of the common area of probability and uncertainty or midway between the two areas.

2 P/L FIX AND MPP

Case 1	Case 2
	
Accept fix if circle of probability is entirely within circle of uncertainty.	Accept the DR posn as MPP if circle of uncertainty is entirely within area of probability.
Case 3	Case 4
	
Draw line joining the fix and the DR posn. The MPP is on this line at the midpoint of the common area of the two circles.	Draw a line joining the fix and the DR posn. The MPP is on this line at the midpoint between the two circles.

Rule: MPP's always fall on the perpendicular from the P/L to the DR posn., or on a line joining the fix to the DR posn., the position of the line being the centre of the common area of probability and certainty or midway between the two areas.

3 P/L FIX AND MPP

Case 1	Case 2
	
Accept the fix.	Draw a line joining the fix and the DR posn. The MPP is on this line at the midpoint between the fix (centre of cocked hat) and the DR circle of uncertainty.

ADVENTURES IN CALCULUS

$$\int \frac{dc}{\text{CABIN}} = \log \text{CABIN} + C = \text{BOAT HOUSE}$$

$$d(\text{HI HO}) = \text{HI } d\text{HO} + \text{HO } d\text{HI}$$

16 SORI COURSE

15 April 1957 - 9 August 1957

Back Row

F/O RH Evans F/O JD Carroll F/O DA Ireland F/O DF Wheeler

Front Row

F/L EJ Snelling F/L DL Caldecott F/L LW Hart

Dectra

DECTRA, so-called from DECca Tracking and RAnging, is a ground based electronic aid designed to provide a position-fixing system along specific air routes, and particularly over long trans-ocean crossings. The system is designed and produced in the United Kingdom by the Decca Navigator Company. Dectra utilizes many techniques of the conventional Decca system as well as several portions of the Decca airborne installation (**RCAF OBSERVER** April 1957). The Dectra ground station can also be integrated with those of a standard Decca chain if the positions of the stations are convenient.

A Dectra system has recently been installed to cover the trans-atlantic route between Gander, Newfoundland and Prestwick, Scotland. A standard Decca chain has also been incorporated with this system to provide a similar navigation aid for Dectra equipped aircraft entering the Gander area. The station layout of the western end of this system is shown in Figure 1. The eastern end has been incorporated with the present Decca installation in Scotland, although some resiting of stations has been necessary.

The basic principle of the system is the installation of Master-Slave pairs of transmitting stations at each end of the air-route, with the aircraft carrying the Dectra or combined Decca/Dectra receiver and indicators. Each Master-Slave pair of transmissions provide hyperbolic position lines running along the air-route for tracking data. Range information is obtained by combining the transmissions from one station at each end of the route; or by comparing the signal from one station with a reference signal, obtained from a highly stable oscillator carried in the aircraft.

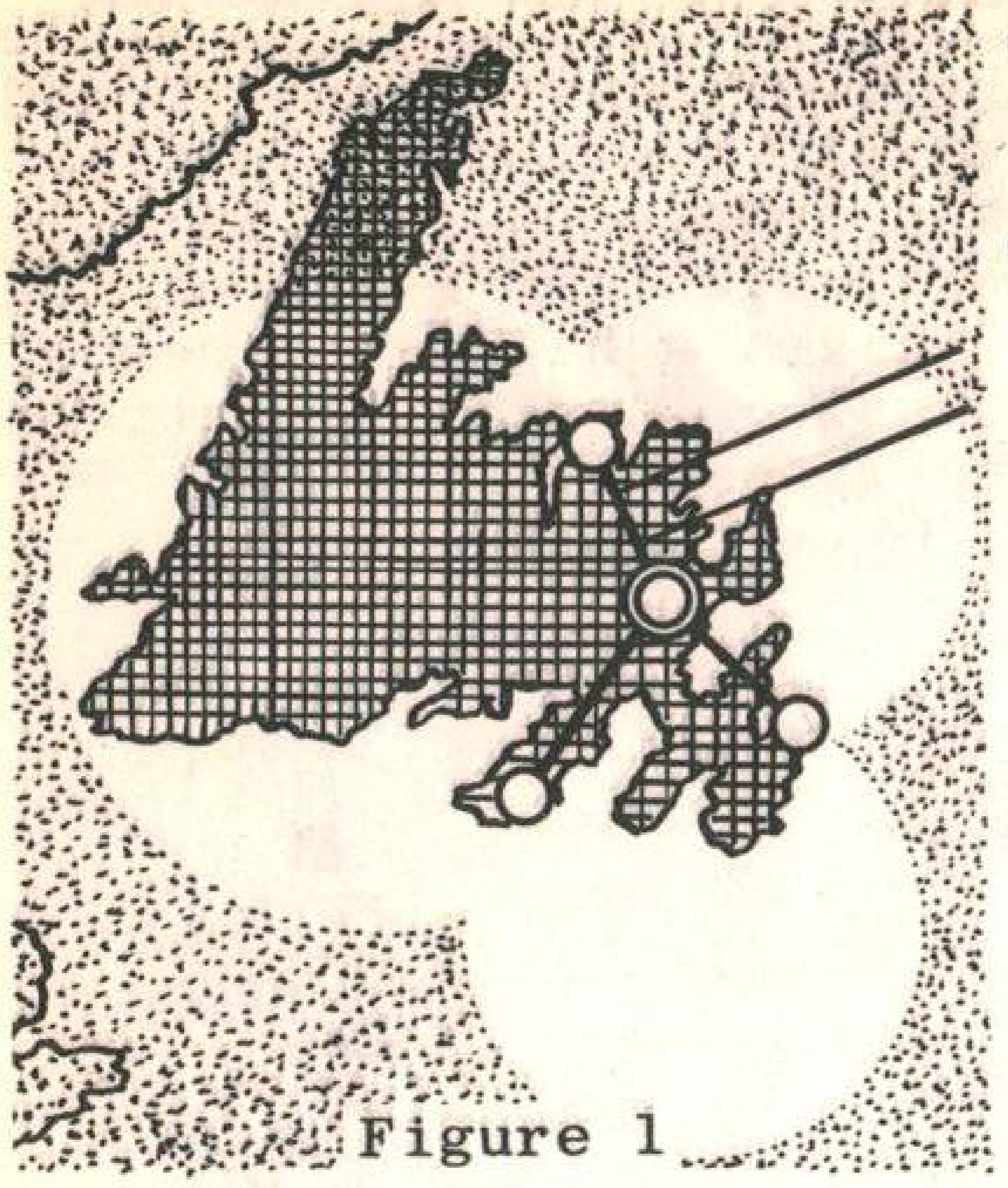


Figure 1

Characteristics

The principal characteristics of the Dectra system are:

Frequency - 70-130 Kcs

Maximum Route Length- 2000 nm

Accuracy -

Range:	Maximum error of 10 nm at 1500 miles.
Track:	Error varies from a maximum of 5 nm at 1600 miles range to yards at terminals.

The decometer indicator or flight log used with Decca may also be used to display Dectra information. Weight of the system varies depending on the type of installation; the Dectra receivers and indicators weigh 70 lbs, with the flight log adding a further 55-60 lbs. The combined Decca/ Dectra system, including flight log, weighs between 145-150 lbs.

Operation - Ground Station

The basic layout of the Dectra stations is shown in Fig 2. The station pairs are situated on a baseline of approximately 80 nm's (for a 1500-2000 nm route length) with the baseline aligned at right angles to the desired track.

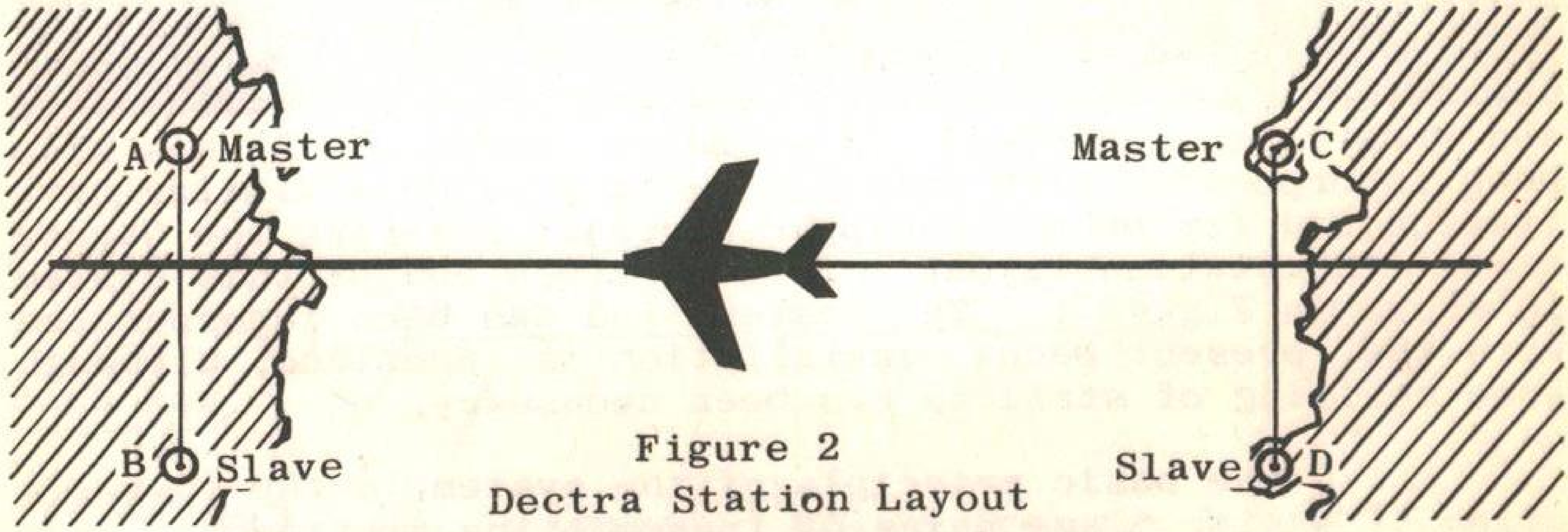


Figure 2
Dectra Station Layout

To produce the tracking hyperbola station A transmits a stable CW frequency F_1 as in standard Decca. According to a suitable time schedule its frequency is changed momentarily to $F_1 + x$ as a signal to the slave station and the aircraft receiver (as in the Decca Lane Identification signal). After a delay of a fraction of a second station A shuts down while station B radiates the frequency F_1 before closing down in turn. As soon as slave B has closed down the master station A resumes its signal as before, and one cycle of operation is complete. Thus the successive phase-locked signals from A and B produce a stable hyperbolic pattern around the stations at the comparison frequency F_1. This is the tracking pattern for the AB terminal portion of the route (Fig 3) and, as illustrated, gives a higher degree of accuracy with approach to the terminal. A similar pattern is produced at Master/Slave CD using frequency F_2.

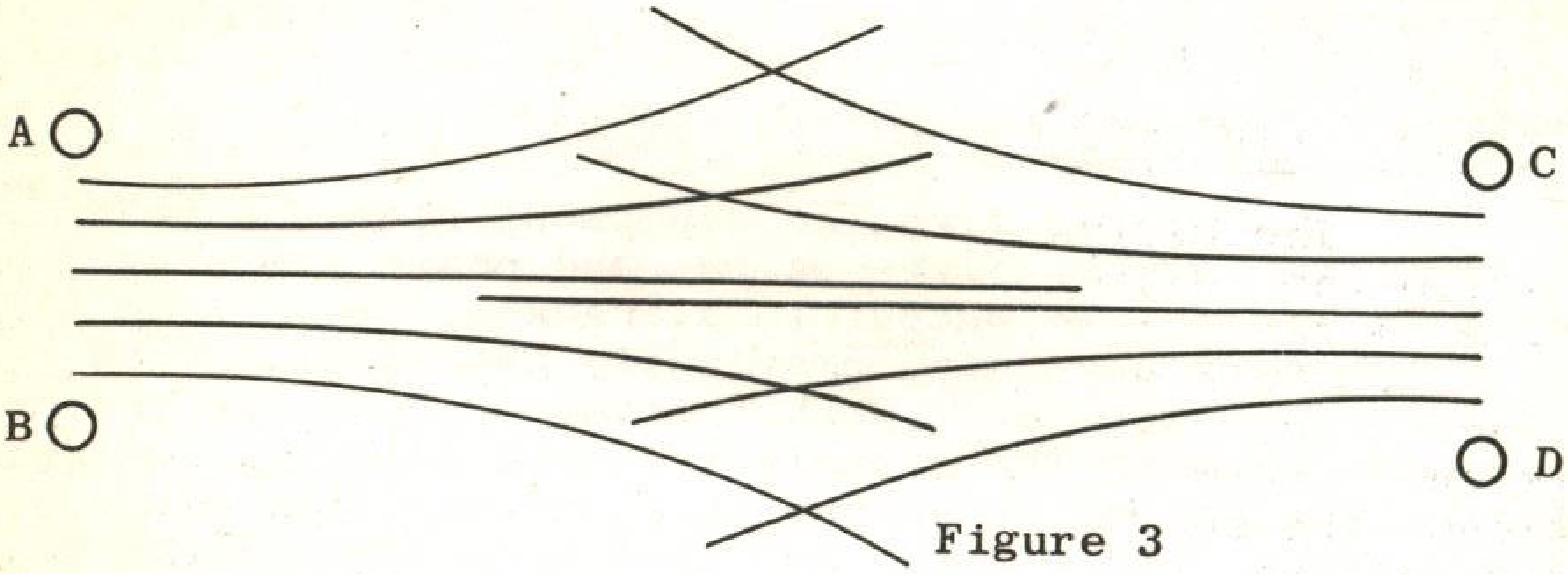


Figure 3

Form of the Tracking Patterns produced by Stations AB on frequency F_1 and CD on F_2

To provide range measuring information frequencies F_1 and F_2 are spaced by a difference frequency f $(f=F_1-F_2)$ which is a submultiple of each. The phase of the F_2 transmission from master station C is arranged at C to have a fixed relationship to the F_1 signal received from A at the common comparison frequency f. That is, the beat note F_1-F_2, as observed at C, is in phase with the f subharmonic of the F_1 signal received. There is, therefore, a hyperbolic pattern about A and C whose lanewidth corresponds to frequency F_2 (Fig 4).

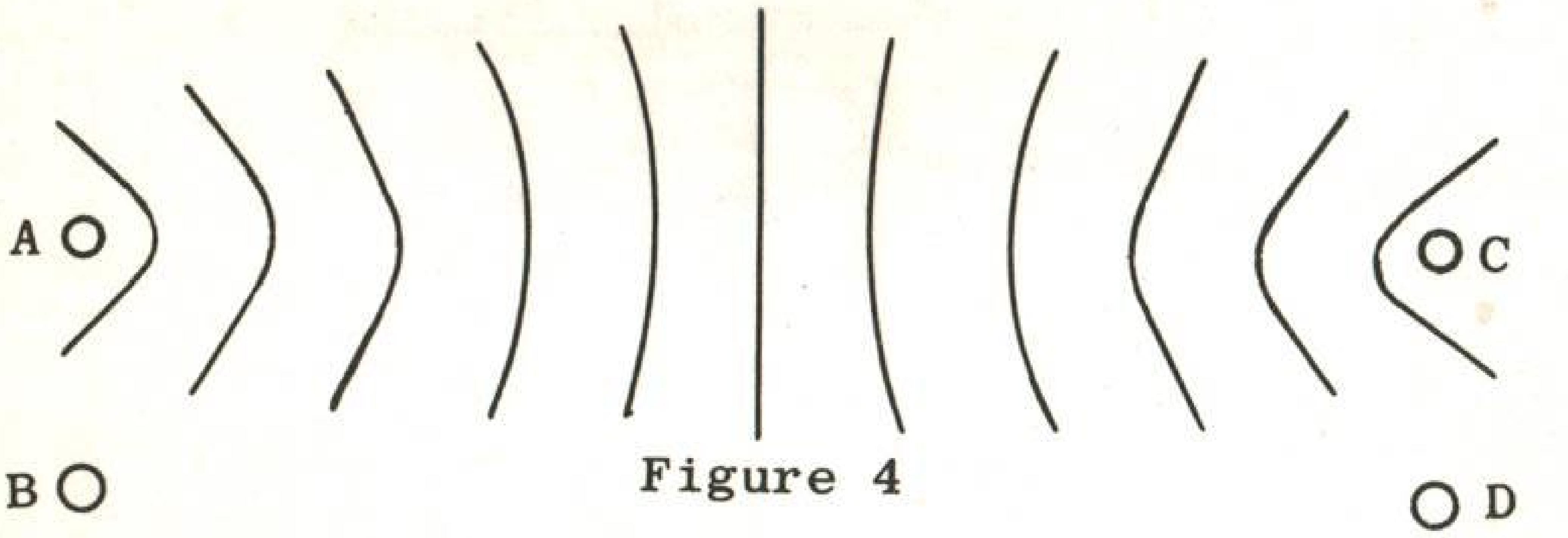


Figure 4

Form of Ranging Pattern about Stations A and C (effective comparison frequency F_2

The standard frequencies and mode of operation of the DECTRA master stations permits them, if required, to be used as DECCA master stations in a normal chain. Similarly, by radiating normal DECCA slave transmissions stations B and D could each become one slave of each chain in addition to their function as DECTRA tracking stations. The following frequencies may be considered typical for the DECTRA system:

F_1 = 85.100 Kcs (Decca frequency $5\frac{1}{2}$F)

F_2 = 84.915 Kcs (Decca frequency $4\frac{1}{2}$F)

f = 185 cps

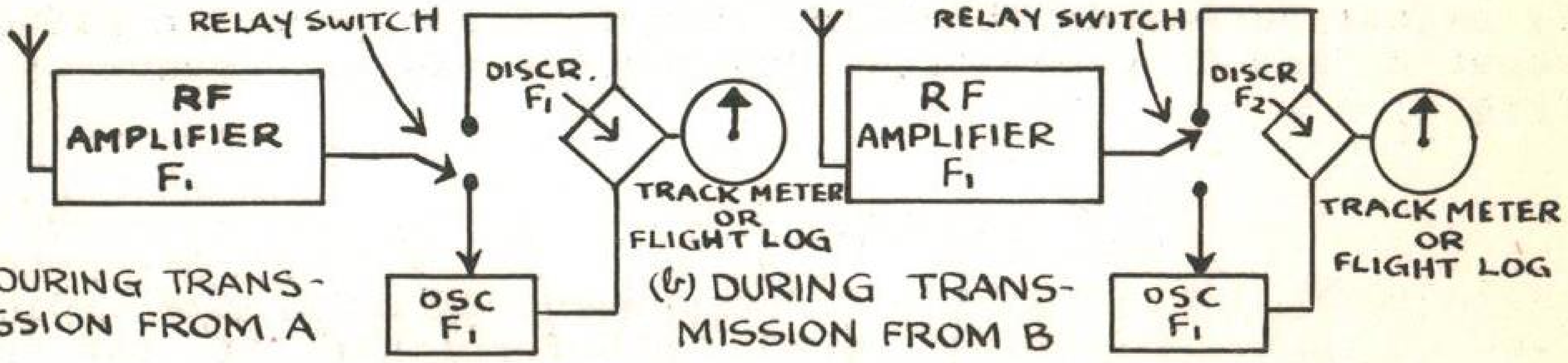
x = plus/minus 60 cps

Operation - Aircraft Equipment

The DECTRA airborne equipment receives transmissions from the Master/Slave pairs and phase compares these signals to provide an output to a tracking meter, or Flight Log. As has been mentioned previously two ranging techniques are available, the first method being to measure the phase difference between the signals received from the two master stations. The second technique is to measure the phase difference between the signal received from one of the ground stations and the signal generated by a very stable crystal oscillator (the crystal clock) carried as part of the DECTRA equipment.

The two pairs of ground stations produce their respective tracking patterns independently, and the user selects the desired pair merely by selecting the appropriate RF channel. The operation of the aircraft equipment when receiving tracking data from stations AB is shown in Fig 5. The manual selection of frequency F_1 also selects a channel for F_1 + x, which is the signal from the master at changeover. When this signal is received, a relay is operated which switches the output of the F_1 channel from the oscillator, whose phase it has been controlling during the master transmission directly to the discriminator. The discriminator then compares the phase of the F_1 signal from the slave with that from the oscillator, with the output being fed to the tracking meter or flight log. The process is at a repetitive rate sufficiently high to ensure continuity of indication.

Figure 5



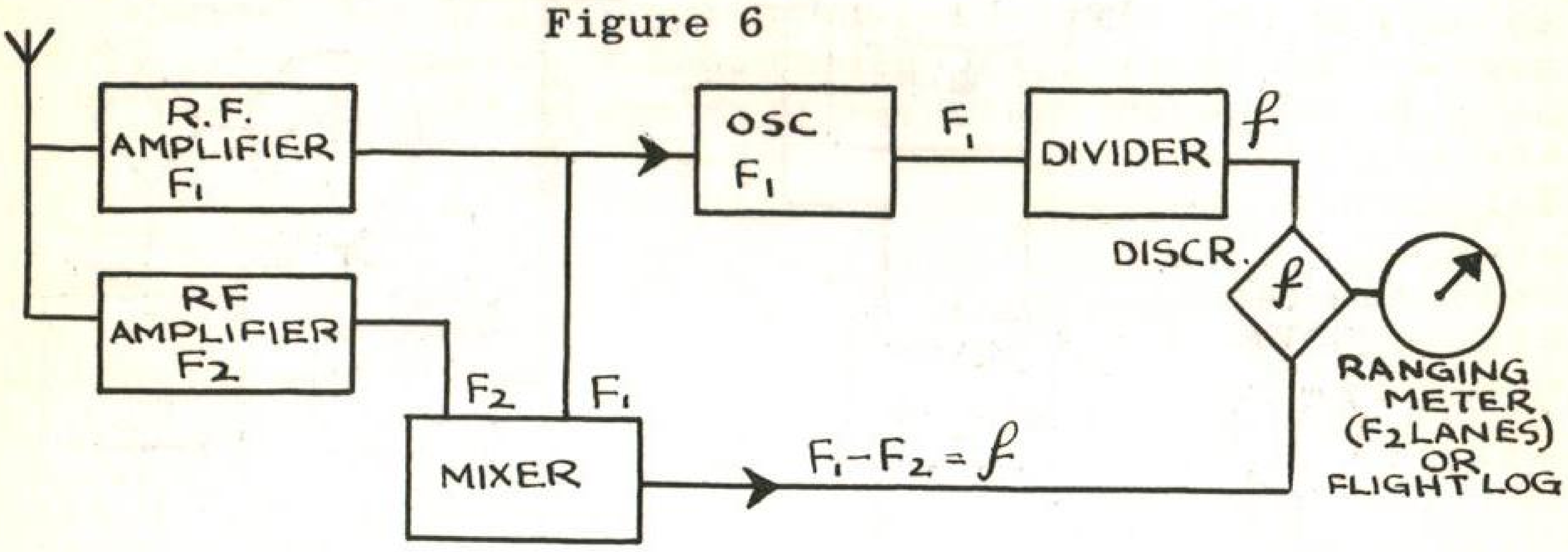
(a) DURING TRANSMISSION FROM A

(b) DURING TRANSMISSION FROM B

Elements of Tracking System

The operation of the **DECTRA** receiver when using the two signal ranging procedure is shown in Fig 6. The **RF** amplifier stages are manually selected, and the F_1 channel is fed to lock the output of the oscillator at F_1. (assuming that F_1 is the nearer station). At the same time frequency F_2 is fed to a mixer whose other input is F_1. The output from the mixer is the beat frequency f, which is fed to one side of a discriminator for comparison with the divided frequency from the oscillator. Since the discriminator compares a signal, frequency f, derived from both transmitting stations with that derived from one (master C on F_2), the hyperbolic pattern between A and C to which the discriminator responds has a lanewidth based on the frequency F_2, the undivided signal.

Figure 6



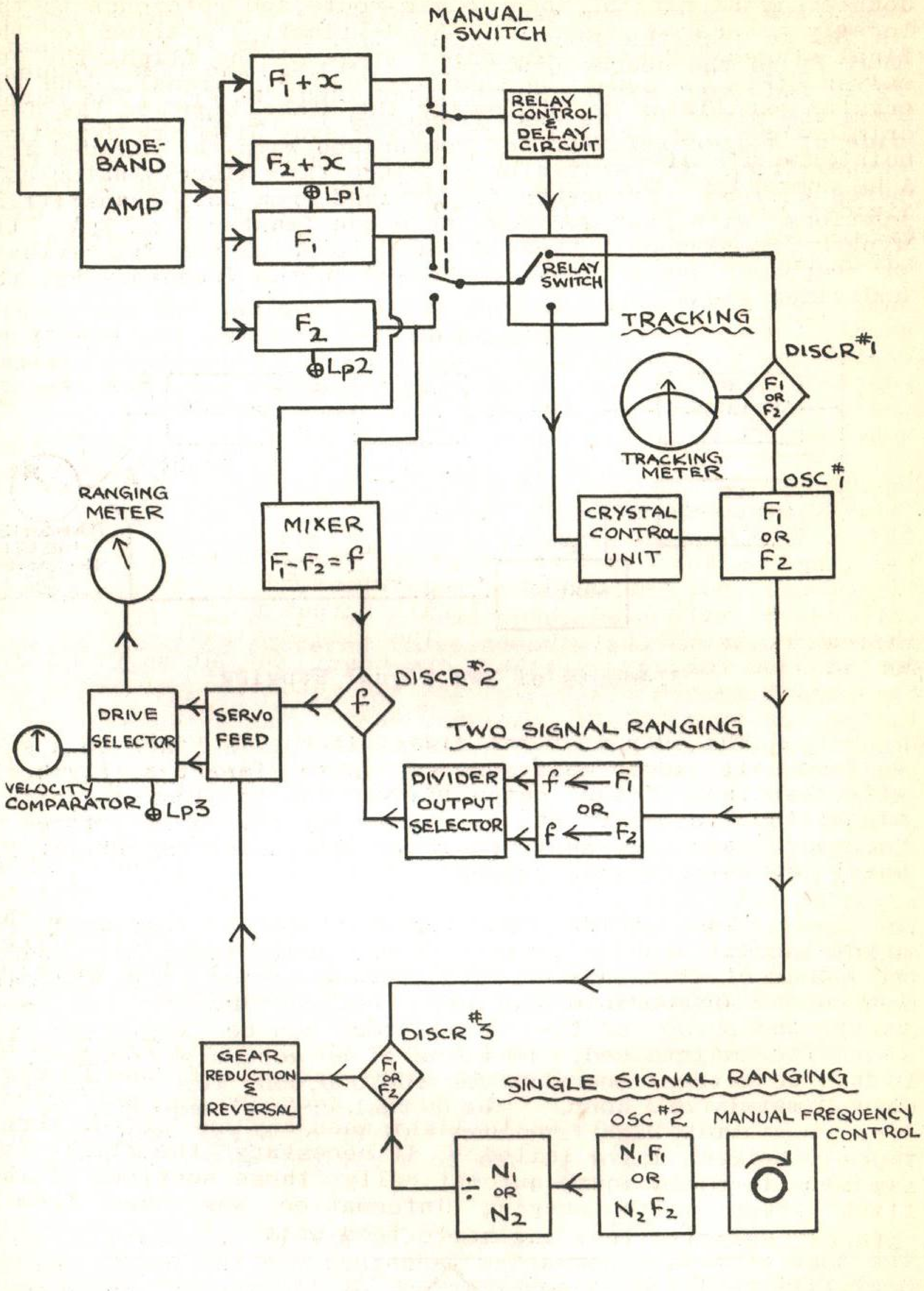
Elements of Two Signal Ranging

The output of the discriminator is taken to a servo feed unit, whose main purpose is to impart a "flywheel" effect so that if the output fails due to loss of either signal the velocity of rotation of the servo motor is "stored", and continues to drive the meter or flight log until the interruption ceases.

The **DECTRA** receiver includes a high-stability crystal oscillator (a crystal clock) whose phase is compared with that of station A or C to provide direct range indication to the appropriate station. Before take-off the frequency and phase of the oscillator can be adjusted, and thereafter maintained, by means of an accurately controlled oven, to within one part in 100,000,000 for a period of approximately one hour. The actual crystal employed is cut to a relatively high frequency (N_1F_1 or N_2F_2) with the output of the oscillator passed to a divider which produces the desired drequency F_1 or F_2.

The Decca Navigator Co. are of the opinion that the most effective operating technique for the **DECTRA** equipment will exist in a combination of the single and double signal ranging. The suggested procedure would involve reference to the departure terminal signal and the crystal os-

Figure 7



Dectra Receiver

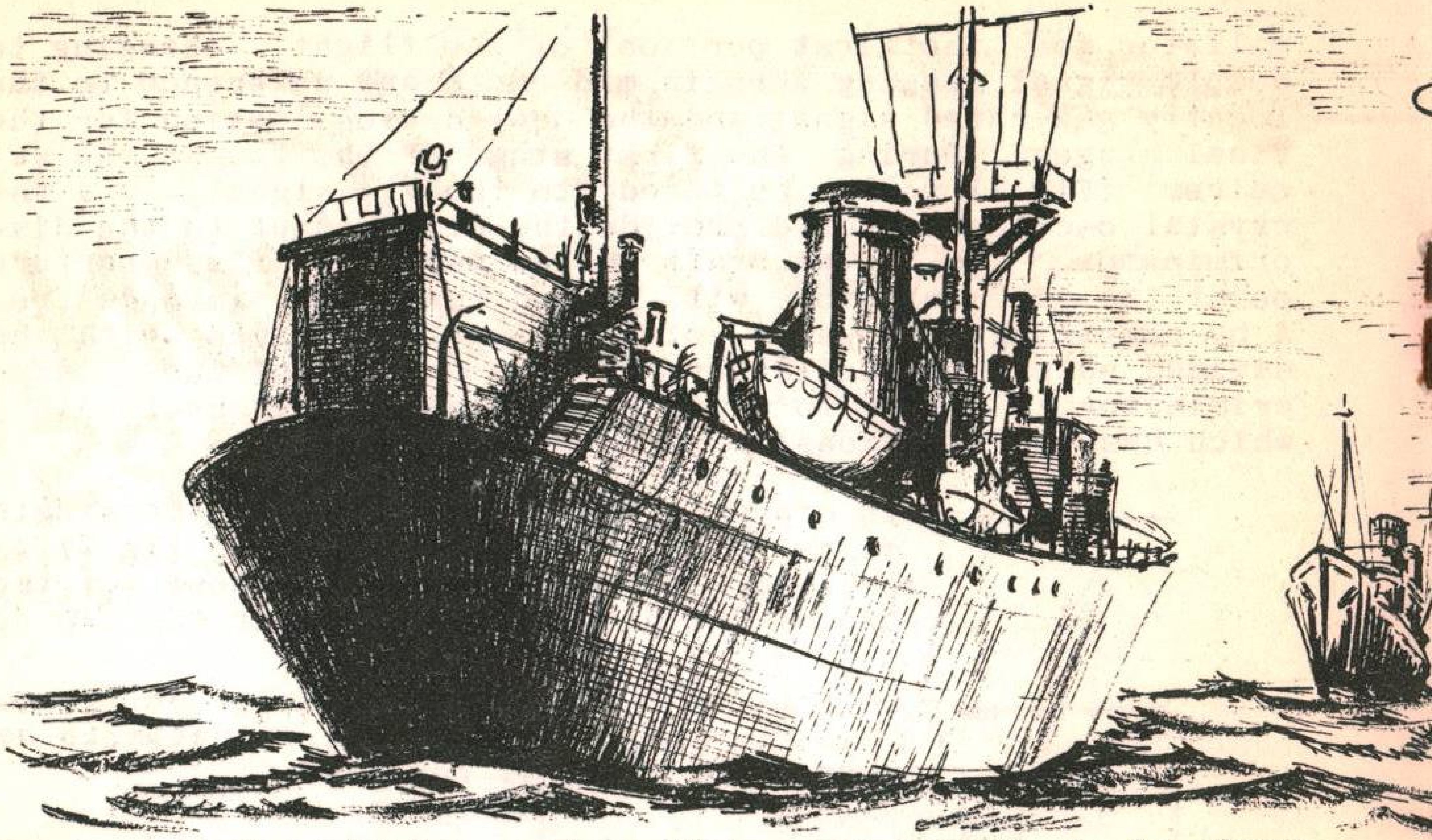
cillator for the first portion of the flight, changing to double signal ranging when in mid-route,and reference to the locally generated signal and the destination station for the final stages. During the first stage of the flight the receiver (Fig 7) would be tuned to the F_1 signal, and the crystal oscillator would provide the other input to the discriminator. As the aircraft moved away from its departure point the discriminator will record change of distance from A by comparing the phase of the signal received with the divided output of oscillator #2. The output of the discriminator is passed to a"gear reduction and reversal unit", which has two functions:

- It converts the revolutions of the single signal discriminator ("Discr #3, Fig 7) to the same sense and scale as those of the two signal discriminator (Discr #2, Fig 7)
- It also allows the indication of range from the single-signal discriminator to be changed in sign, if required.

The single-signal output does not drive a separate range indicator, but through the reduction and reversal unit is integrated with the two-signal output to drive a common indicator, or the flight log. The single-signal system will be adequate for approximately one hour, but at any time the two-signal system starts to work the velocities of meter rotation for both systems can be compared visually on a "velocity comparitor" indicator driven from the drive selector unit. As the flight progresses the oscillator will start to slip, and when this occurs the velocity indicator will show a discrepancy. When this occurs a small beat frequency is used to restore the velocity comparitor to zero and so adjust the drive to the divider to the correct value. If at any time during the flight the operator wishes to change to the opposite master station it is only necessary to move the manual switch and check the velocity comparitor to effect the change. Only the Tracking meter or Flight Log tracking component will alter at the instant of changeover.

The system warning lights are shown in Fig 7 as Lp 1, 2, and 3. Lp 1 and 2 would light when the F_1 and F_2 signals respectively were not being received in sufficient strength, while Lp 3 would light when any one of the three types of range drive failed. If necessary the flight log can be made to indicate automatically those sections of the flight over which ranging information was taken from a "stored" velocity from the servo feed unit.

◆

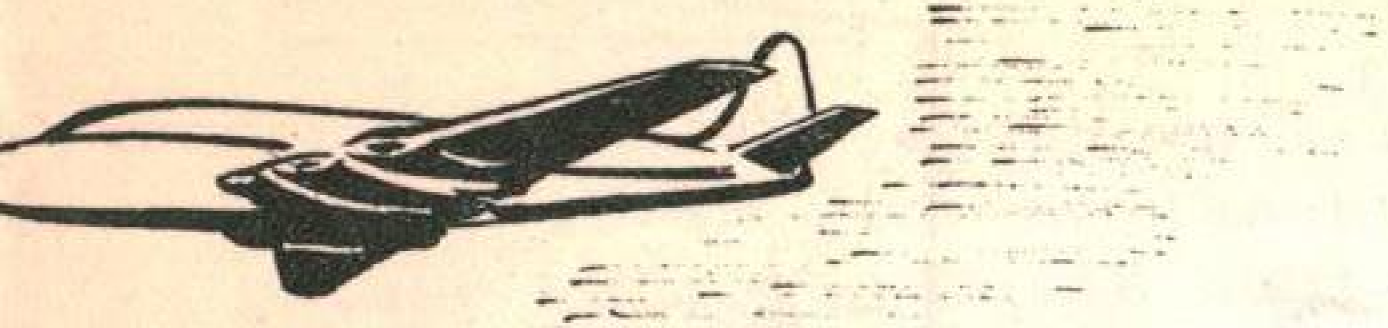


An article such as this may appear to be sheer heresy in an airforce magazine but I am sure many of our readers (including the author but excluding maritime types) have wondered how you tell one ship from another. After all a boat is a boat and they look more or less alike. However, we are all familiar with aircraft recognition and, if you recall, the study of this subject usually began by learning the component parts and from there we put the parts together and gradually learned to distinguish one aircraft from another. A similar system can be used for ship recognition; just remember the comparison between Ma Kettle and Marilyn Monroe - they both have the same equipment - it is merely distributed differently!

We do not intend, in this article, to give a complete and all-inclusive course in ship recognition; we will merely try to outline some of the basic steps. Then if you are interested in learning more you can carry on by yourself - constant practice is the only sure teacher.

Your first question, in all probability, is, "Why bother with ship recognition at all?" Well, there are three important reasons for proficiency in ship recognition. They are:

- To facilitate early identification of enemy shipping, particularly warships, so that appropriate counter-action can be taken in time.
- To identify friendly vessels and thereby prevent attack by our own forces.



SHIP RECOGNITION

MERCHANT SHIPS

To describe in accurate and understandable terms all vessels sighted for the benefit of our Intelligence.

Note well that all our efforts in other respects would be wasted if we were to attack a friendly ship, or mistake an enemy for friendly and not attack.

A more or less broadside view is necessary for recognition, therefore, ships must be studied in accordance with a definite plan. The observer begins at the bow and works aft noting the prominent features in their order of appearance. Normally, the first view you will obtain will be when the superstructure,masts and funnel appear above the horizon. This is termed the "distant view" and at this point the ship is said to be "hull down". As you get closer a full outline of the ship will be visible down to the waterline. This is termed the "medium view" and will allow details of the hull and other main features of the ship to be noted.

THE DISTANT VIEW

When reporting a ship it is most important that the principal features be noted in the correct sequence-from stem to stern. To facilitate reporting symbols are used to designate specific features. In the distant view the principal features to be noted are the masts, funnels, kingposts[1] hull form and superstructure[2]

Masts, Funnels and Kingposts

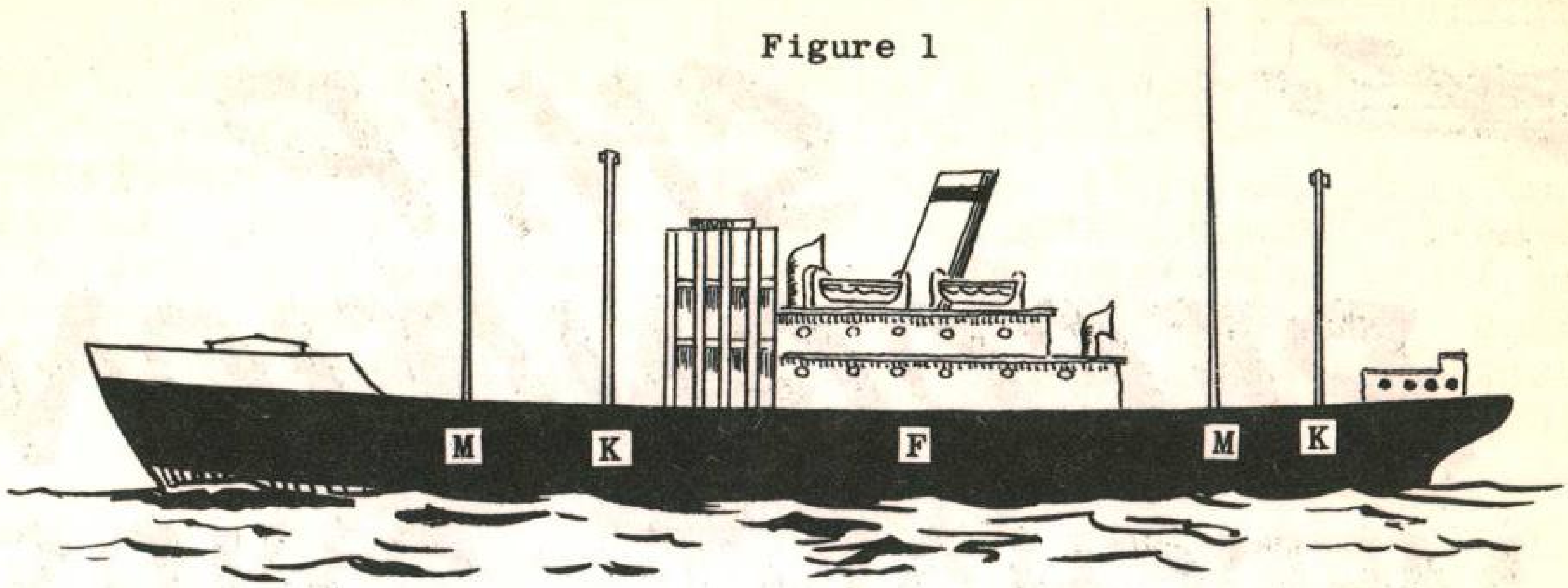
The position of the masts, funnels and kingposts are reported using the symbols M, F and K respectively. An example is shown in figure one.

---

[1] Kingposts or Samson Posts - Short vertical posts used to support derrick booms; may be single or in pairs.

[2] Superstructure - The structure of "houses" built on the upper deck of the hull.

Figure 1



Hull Form

In the distant view only parts of the hull above the level of the weather-deck[3] are visible. Most ships have raised "islands" or "castles" and these are classed as one, two or three island ships. Ships with no raised islands are known as "flush-decked" ships. The islands are known as the forecastle(1), the midcastle(2) and the aftercastle or poop (3). The spaces between the islands are termed wells or well decks.

A ship may have up to three islands and by numbering them, again from stem to stern, a clear indication of hull form can be given. The symbol for hull is H. For example a three island ship would be reported as H123, or a ship with fore and midcastle would be reported as H12.

The seven basic hull forms are shown below. It will be noticed that these islands vary considerably in length. Furthermore, two islands are often joined to form one, in which case they are reported as one.

Figure 2

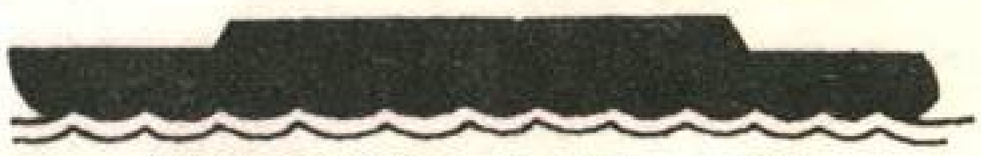

No Islands = H

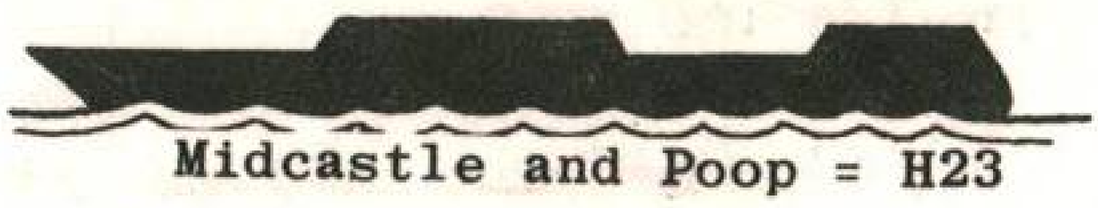

Forecastle Only = H1


Fore and Midcastle = H12


Three Islands = H123


Forecastle and Poop = H13


Midcastle Only = H2


Midcastle and Poop = H23

---

[3] Weather-deck - The topmost deck exposed to weather, excluding islands.

Superstructure

An island is a built-up portion of the hull, therefore, it is part of the hull itself. Superstructure, on the other hand, is built on the weather-deck after completion of the hull. Superstructure may often be enclosed, in which case it is most difficult to distinguish between what is an island and what is not. High bulwork plating may also be mistaken for an island, if it is so high as to have this appearance it is classed as much.

THE MEDIUM VIEW

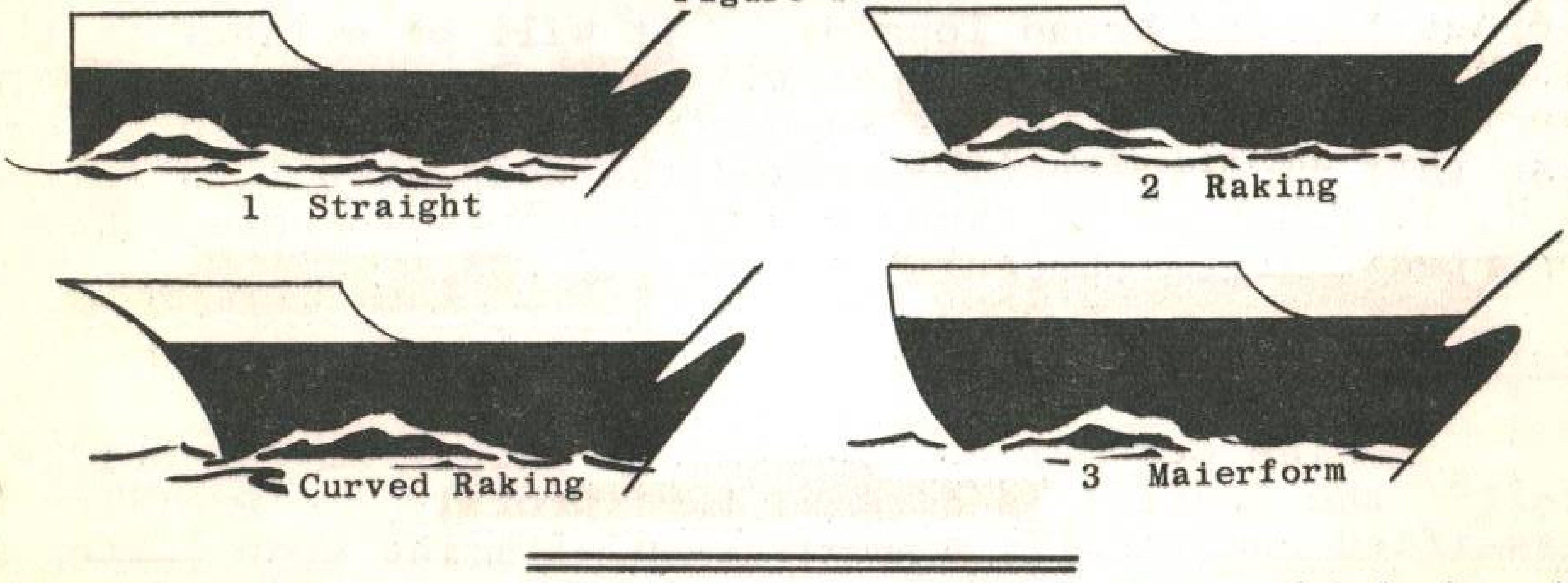
In the medium view the principal features to be noted are the type of bow[4] and stern, funnel size and general profile. At this time also, an estimation of length, tonnage and speed can be made, as well as determining whether the ship is laden or light (no cargo).

Bows

There are three distinctive types of bows(Fig 3): the code symbol used is B1, B2, or B3.

- Straight(1) - a very common type but gradually being replaced by the second type.
- Raking(2) - an increasingly common type with the amount of rake varying considerably. Introduced to minimize damage in the event of a collision and to increase speed by lessening the ship's resistance to water.
- Maierform(3) - All surfaces are rounded with variation in angle. It became increasingly popular at the start of World War II but seems to have lost ground to the raking type which is more easily constructed.

Figure 3



1 Straight

2 Raking

Curved Raking

3 Maierform

---

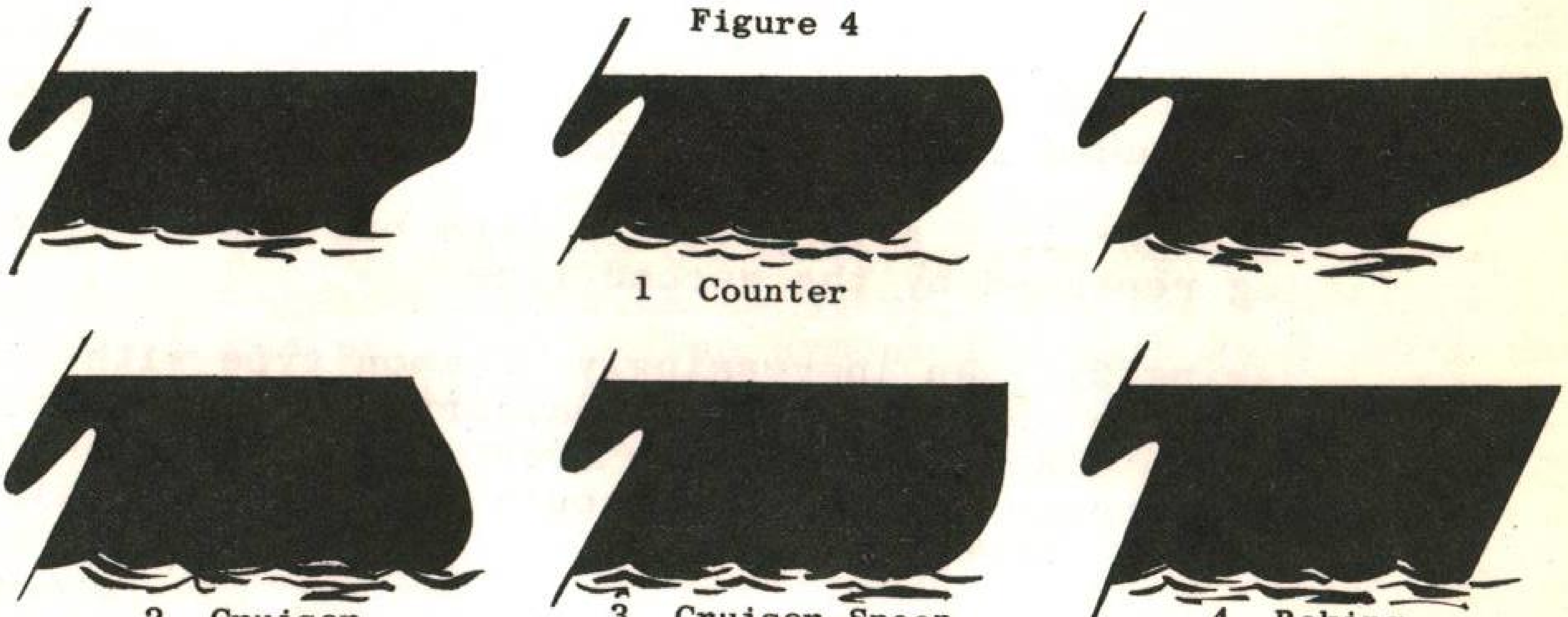
[4] This is more correctly termed the stem which is the foremost part of the ship's hull; the bow is the part of the hull adjacent to the stem.

Sterns

Sterns are classified in four numbered groups with the code symbol S.

- Counter(1) - A common type stern on older ships but offers more water resistance than newer types.
- Cruiser(2) - Increasingly common but with considerable variation in actual shape.
- Spoon or Cruiser Spoon(3) - A common type, particularly on German, Scandanavian and American ships.
- Raking(4) - Not very common, introduced during World War I for economic reasons since it was easier to finish a ship with flat plate rather than round it off.

Figure 4



1 Counter

2 Cruiser 3 Cruiser-Spoon 4 Raking

Funnels

Funnels are classed in six numbered groups prefixed by the code symbol F. These groups are narrow short(1), narrow average(2), narrow long(3), broad short(4), broad average(5) and broad long(6). It will be evident that the classification of the funnel will depend on its size relative to the wheel house or superstructure. It should be noted also that if the funnel is raked the code symbol is followed by R, ie F5R, or if there are two or more funnels they are reported using a numeral for each, ie F33.

Profiles

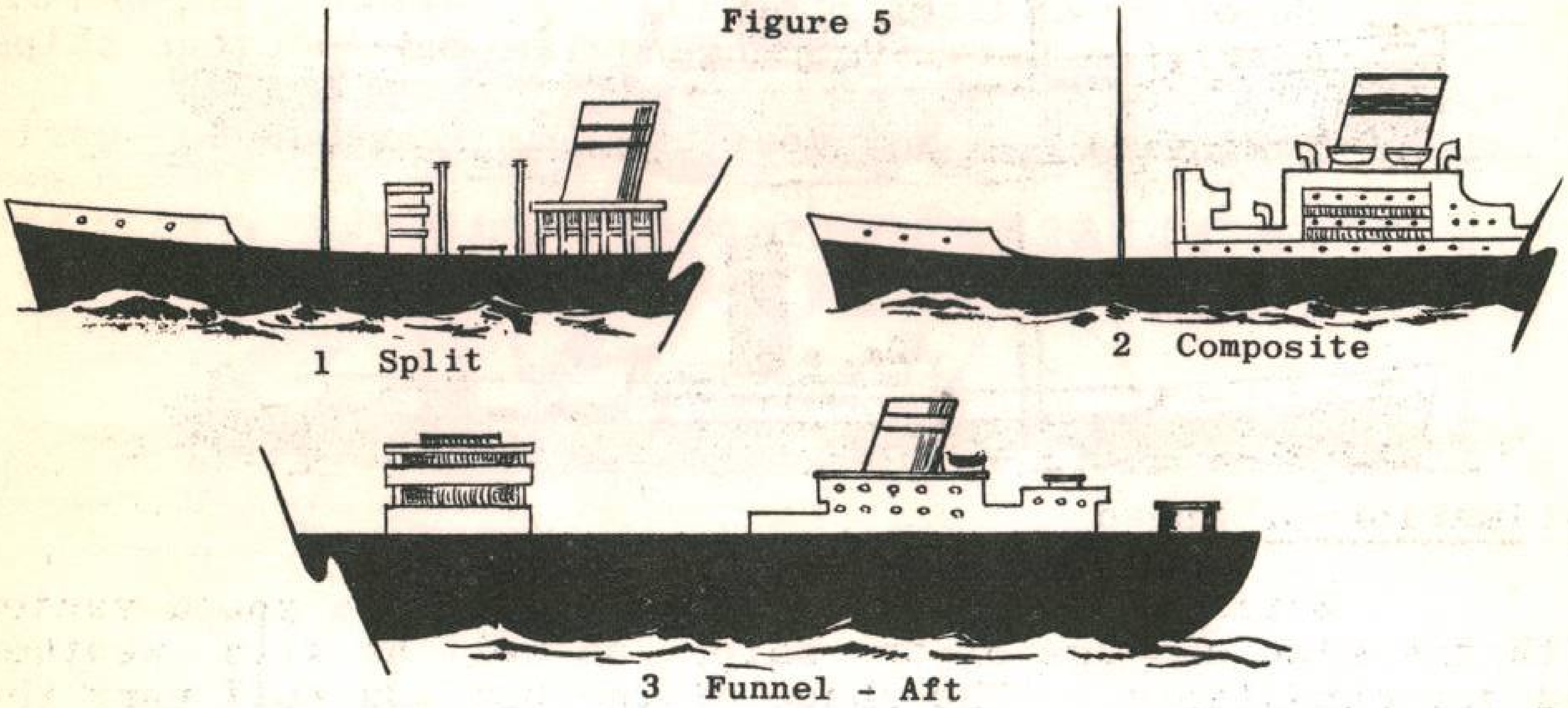
The general outline of the ship from the bridge to abaft[5] the funnel is termed the "profile". Profiles are classified numerically and prefixed with the code letter P.

---

5. Another of those queer nautical terms meaning "towards the stern from any part of the ship".

- Split(1) - the bridge structure is separated from the funnel. The space between is almost invariably taken up by a hatch with derricks or kingposts for working the hatch.
- Composite(2) - The bridge structure and funnel are merged into one single structure.
- Funnel(or engines) aft(3) - Quite distinctive and easily recognized. Characteristic of Tankers.

Figure 5



1 Split

2 Composite

3 Funnel - Aft

Estimation of Length and Tonnage

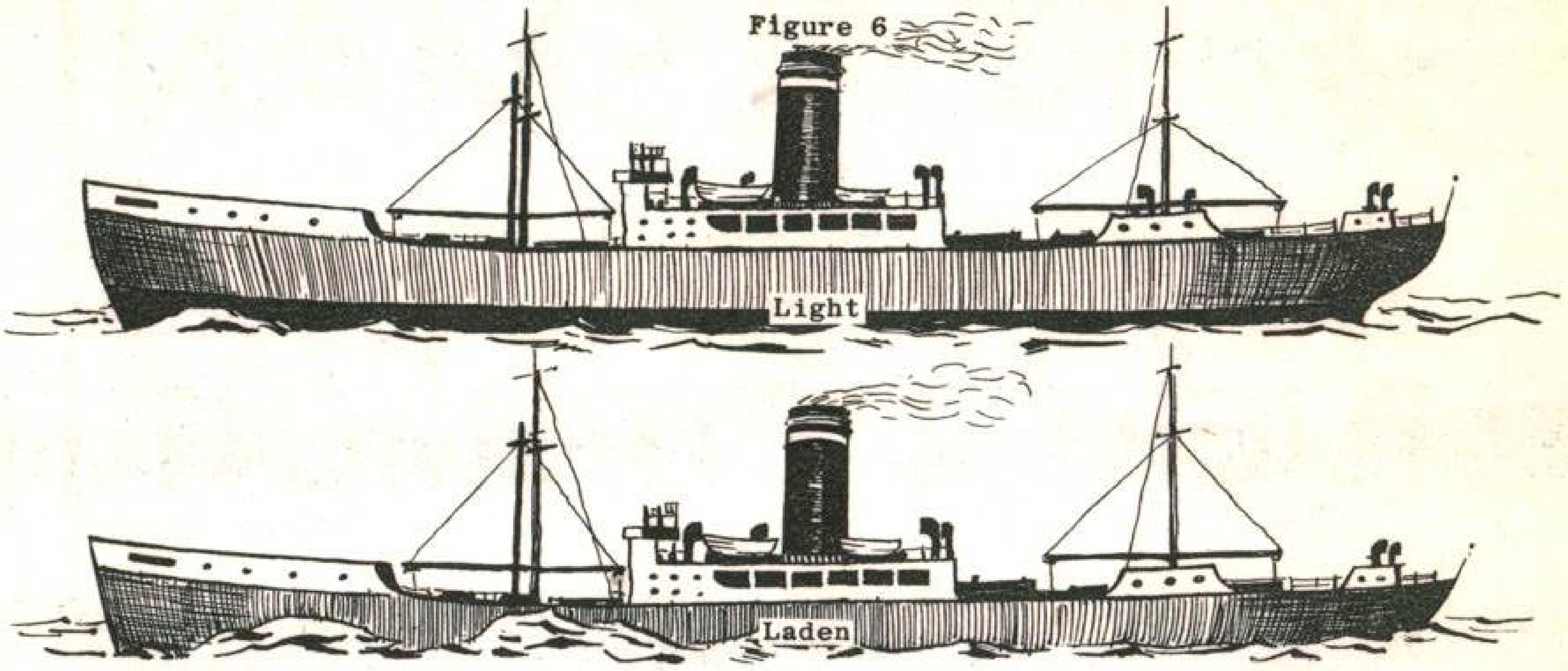
So many ships have the same general outline, but vary so vastly in dimensions that it is extremely difficult to arrive at any absolutely reliable estimation of length and tonnage of the ship. This is particularly noticeable at sea where there is nothing by which the ship can be measured or compared.

There are however, two aids to estimation of length which are sometimes quite useful. Taking the average length of a ship's lifeboats to be approximately 40 feet for passenger liners and 35 feet for all others, it is often possible to determine a rough length by dividing the length of a lifeboat into the total length of the ship. This is often a most accurate method in post-flight photographic analysis, but is understandably difficult in the air. The other rough method is to take the height of the navigation bridge and divide it into the ships length. The height of the bridge varies of course, but an average of 30 feet for freighters and 40 feet for passenger vessels might produce good results.

Laden or Light

Accuracy of reporting the characteristics of a ship may often depend upon whether the ship in question is carrying cargo or not. An unladen or light ship rides high in the water. How high, may be determined at close range by looking to see where the dividing line between hull paint and boot-topping[6] is in relation to the water's surface. For instance, in the diagrams below the same ship is shown laden and light. Laden, the ship could be reported as having a raking stem and cruiser spoon stern while light it could be reported as having a Maierform bow and Counter Stern.

Figure 6



Estimation of Speed

Estimation of speed is not easy since speed varies with the size and age of the ship, as well as with weather and sea conditions. The shape of the bow and hull vary the amount of water being pushed aside as the ship moves along, so that a big bow wave is not necessarily an indication of high speed, in fact, the reverse is often true. A better estimation of speed can often be made from the wake - the longer the wake the greater the speed.

CONCLUSION

Many other points, such as, age, colour schemes, national flags, house flags or emblems, signal flags etc may be used in ship recognition. However, it is not possible to give details on these points in an article of this length.

Finally, should you ever be called upon to report merchant vessels remember the proper sequence. The distant view calls for the mast,kingpost, funnel(MKF) sequence along with the hull form (H). The medium view calls for the bow, stern, funnel and profile(BSFP) sequence along with an estimation of tonnage and length, plus the name and home port.

In the October issue of the **OBSERVER** we will attempt to give you a few hints on warship recognition, providing of course that we havn't been hung in the meantime by either irrate airmen or insulted sailors.

---

[6] Boot-topping - That part of the underwater protective paint that is visible at the waterline.

The Pilot's Instruments

The KOLLSMAN INTEGRATED FLIGHT INSTRUMENT System

To fit the needs of jet transport aircraft operating at high altitudes and near-sonic speeds a high degree of accuracy is required from instruments such as the airspeed indicator, mach meter, and sensitive altimeter. Check points also occur more frequently at these altitudes and speeds, allowing the crew less time for decisions. Consequently, complete, reliable and accurate flight information is a must so that problems of cruise control, altitude separation, and navigation may be solved promptly.

Any discussion of instrumentation for jet transports must also consider that these aircraft will operate up to 40,000 feet or higher, therefore they must be operated at peak efficiency to obtain the lowest possible fuel consumption. Furthermore, at take-off,the fuel carried will account for a sizable portion of the aircraft weight, while on landing fuel carried will be at a minimum. This will result in a rapidly changing angle of attack during flight and consequent errors in the static source.

To overcome the deficiencies inherent in present instruments, the Kollsman Instrument Corporation have produced an Integrated Flight Instrument System. This system is relatively simple as far as integrated systems are concerned, in fact it is not really an integrated instrument system but an air data computer system. It is designed to take the information supplied by the conventional pressure instruments and integrate it electronically with supplementary data supplied by electromechanical sensors. The integrated output, corrected for instrument error, is then fed back to the dials of the pressure instruments.

Operation

There are five sensing units in the system; three pressure instruments and two electromechanical sensors. The pressure instruments are an indicated airspeed indicator, a mach meter and a sensitive altimeter. The electromechanical sensors are an angle of attack indicator and an outside air temperature probe. Integration is accomplished by feeding the outputs from the sensing units to the Control Chassis - the nerve centre of the system. It correlates the information received and sends out correcting signals and supplementary information not available without integration.

A conventional instrument presentation is used to supply the pilot with the integrated information from the system. This information includes true outside air temperature, ram air temperature, indicated airspeed, mach number, computed true airspeed, maximum allowable airspeed, minimum safe airspeed, most efficient cruising speed and accurate pressure altitude up to 45000 feet (Fig 1).

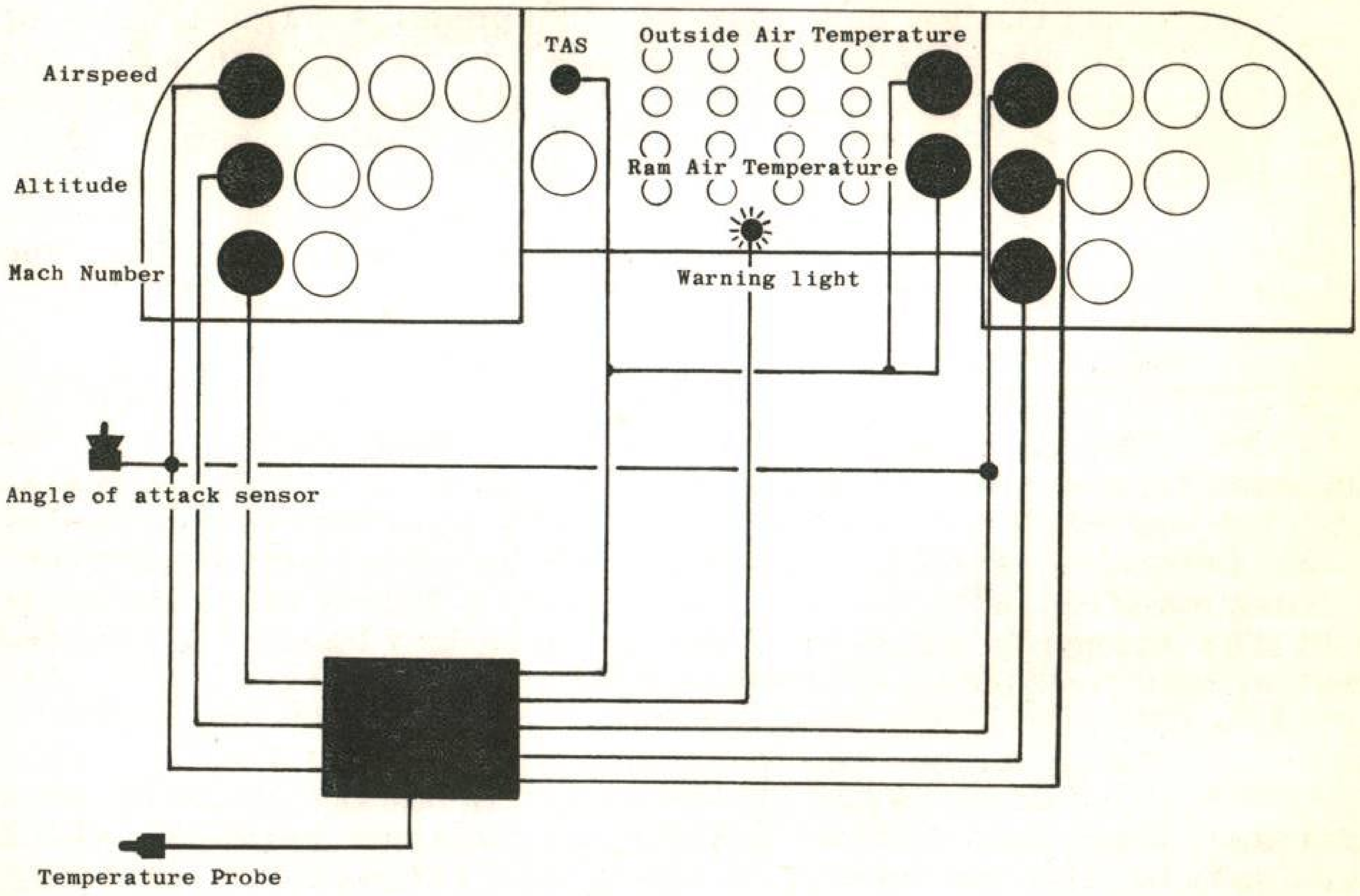


Figure 1

Integration of Kollsman System with Conventional Instrument Panel

With all this information and only five sensing units, it is obvious that each sensing unit carries out more than one function. For instance, by combining outside air temperature with mach number, true airspeed, true outside air temperature and ram air temperature are obtained. By combining angle of attack data with mach number the altimeter can be corrected for the inherent error in the static pressure system. Or, by feeding angle of attack data to the airspeed indicator, it can be used to show minimum safe airspeed and most efficient cruising speed.

Control Chassis

The Control Chassis (Fig 2) incorporates the pilot's and co-pilot's computer units, the scale error correctors for each altimeter, amplifiers and the warning light mechanism. There are two windows in the panel showing the serial numbers of the scale error correctors, insuring that the proper corrector is used with its mating altimeter. The entire assembly is designed to permit easy removal of the various parts.

Figure 2. Panel of Control Chassis

Figure 3 Air Speed Indicator

Airspeed Indicator

The Kollsman system uses a conventional type instrument to show indicated airspeed, that is, the indicated airspeed and maximum allowable airspeed pointers are actuated by the pressure sensing mechanism of the instrument, however, it incorporates several new features (Fig 3). A movable angle of attack segment extends 120° around the dial; a striped pointer shows maximum allowable airspeed at all flight levels; and the low speed area on the dial has been expanded.

In addition, the indicated airspeed pointer also indicates angle of attack on the long narrow segment which moves around the periphery of the dial. The segment is positioned by an electric signal from the computer and shows angle of attack in degrees, stalling speed, landing angle, or maximum L/D angle. With angle of attack indication, the pilot has more direct information from which he can attain his most efficient cruising speed for different gross weights. On landing he is also provided with a continuous indication of minimum safe speeds, again without computing gross weight to reflect the fuel he has consumed during flight.

The maximum allowable airspeed pointer may be calibrated to show "never exceed" speed (Vne) or "normal operating" speed (Vno) depending on the aircraft or the preference of the operator. It presents the structural limitation of the aircraft in terms of either, indicated airspeed, a mach number limitation or an equivalent airspeed limitation. For instance, from sea level to 5000 feet the pointer may be fixed reflecting a limiting indicated airspeed. From 5,000 to 30,000 feet the pointer may move to lower indicated airspeeds reflecting the mach number established as the limiting factor of the aircraft. If the aircraft continues to climb above 30,000 feet, the limiting factor changes to equivalent airspeed, the pointer reverses direction and, moving at a slower rate, shows increasing indicated airspeeds.

Machmeter

By definition, mach number is the ratio of true airspeed to the speed of sound (measured in the same units and under the same conditions) therefore, the machmeter furnishes the pilot with a direct indication of his speed in terms of mach number. Also, the close relationship between mach number and such factors as shock wave, and consequently aerodynamic stability of the aircraft is well known.

The mach meter (Fig 4) is a conventional unit with a differential pressure diaphragm and a static pressure diaphragm as the principle sensing elements. Attached to the mach meter is a synchrotel that feeds mach number to the control chassis.

Figure 4 Machmeter

Figure 5 Altimeter

Altimeter

To obtain accurate altitude information, mach number and angle of attack are fed through a servo circuit to a three dimensional cam in the pressure error computer of the Control Chassis. There, a correcting signal is produced and sent to a differential synchro in the scale error corrector. The scale error corrector contains an adjustable cam which is set when the cam is installed so that it will correct the altimeter's calibration error at each altitude. The calibration error correction signal is combined with the static pressure correction signal in the differential synchro and fed to a servo mechanism attached to the altimeter. The combined signal rotates the mechanism of the altimeter by the amount required to provide a precise altitude reading, with maximum error of 50 feet at sea level and 100 feet at 40,000 feet (assuming perfect static correction data is available for the cam). The barometric pressure adjustment is made, as in previous altimeters, by turning an external knob on the front of the instrument (Fig 5).

True Outside Air Temperature Indicator

True outside air temperature (Fig 6), when intelligently interpreted, can be used to make better use of meteorological data in the upper air. For instance, it can be used to sense and fly, or avoid, jet streams.

In the true outside air temperature indicator, a transistor-magnetic amplifier drives a servo motor which balances a resistance bridge to obtain true outside air temperature and position the indicator pointer. Two potentiometers, which give the correct function for temperature for the true airspeed and ram air temperature indicators, are also incorporated in this instrument. A synchro for driving a slave repeater is provided where more than one true outside air temperature indicator is required.

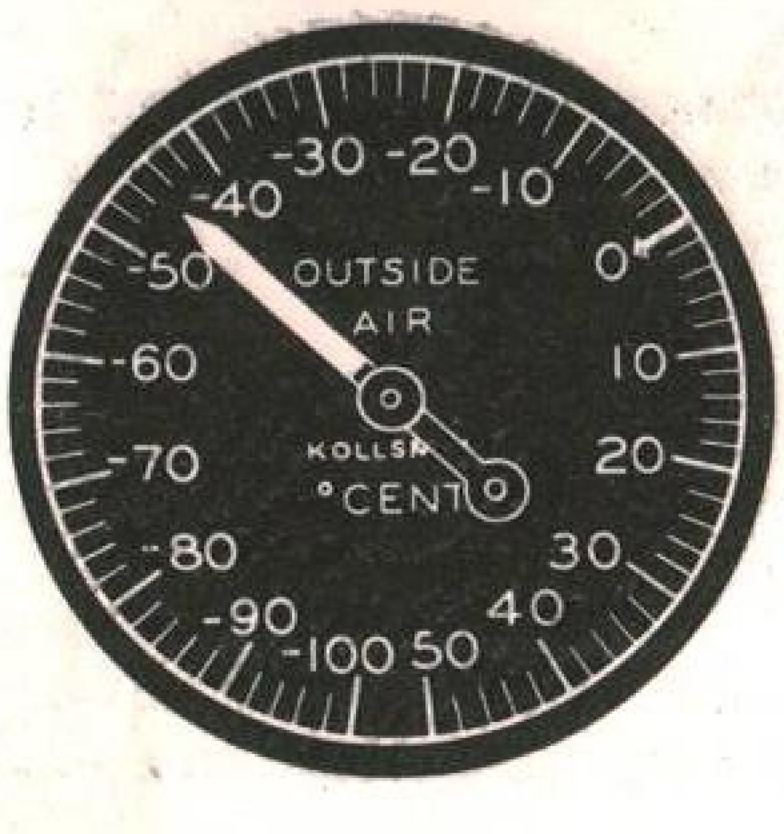


Figure 6
True Outside Air Temperature Indicator

True Airspeed Indicator

On most aircraft today, aircrews compute true airspeed by using computers or tables to apply corrections for pressure altitude and temperature to their indicated airspeed. At the high speeds of jet aircraft, check points occur so frequently that the time required for these calculations becomes an important factor. To reduce the workload on the crew and to eliminate the chance of human error the Kollsman system provides continuous indication of true airspeed on a small digital type instrument (Fig 7).

In this unit the true airspeed equation is solved by combining the functions of mach number and true outside air temperature in a servo balanced resistance bridge circuit. A self-contained transistor-magnetic amplifier drives the servo motor which in turn drives the counter. A synchro for driving slave repeaters is also included.

Ram Air Temperature Indicator

To establish the proper ratio for efficient jet engine performance, altitude and the temperature of the ram air (air entering the engine scoop) must be measured. Where the use of probes within the engine air scoop is not feasible, the temperature of the ram air can best be determined by computing this value from the outside air temperature probe and the appropriate function of mach number. A servo motor powered by a transistor-magnetic amplifier positions the pointer which moves around a -70°C to +80°C dial(Fig 8). As in the other two electromechanical indicators, a synchro drives a slave repeater.

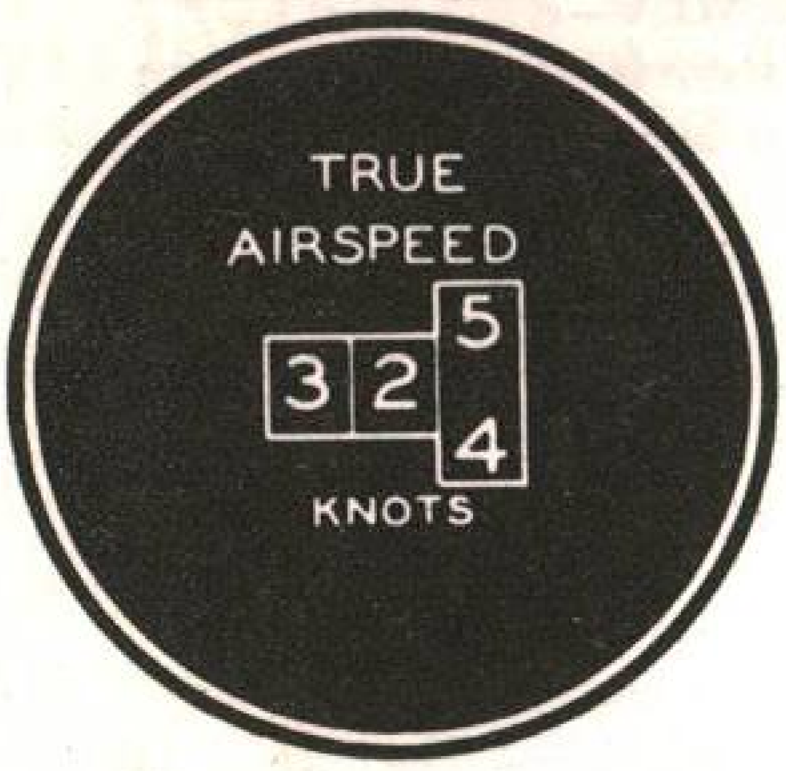


Figure 7
True Airspeed Indicator

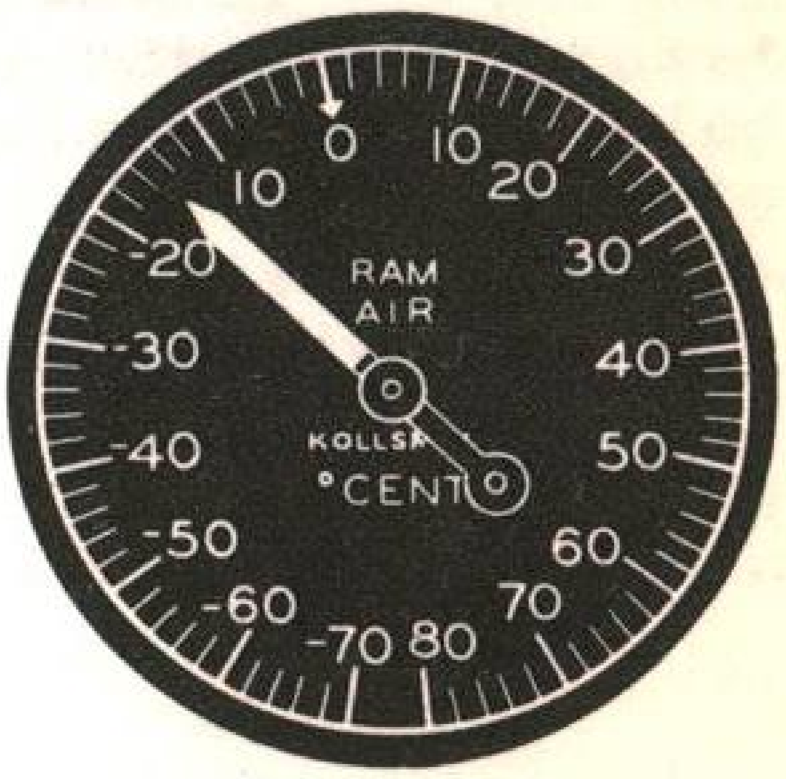


Figure 8
Ram Air Temperature Indicator

General

Finally, it is worth noting that, in the event of electrical failure, the pressure actuated instruments will continue to function with present-day accuracy.

The system as a whole appears to fulfil the requirement for which it was designed. It has been selected by the Douglas Company for installation in the Douglas DC-8.

Some Views on AI conversions at Equal Speeds

BY F/O WC HENDERSON
428 AW(F) SQN

The purpose of this article is to discuss a few principles of AI conversions, and to disprove some of the principles that are now in use. For instance, the old theory of "double the error" which has been used for all conversions is entirely false when applied to interceptions flown at a one to one speed ratio.

A one to one speed ratio setup is shown in Figure 1. If, assuming a contact of 65 starboard and an error of 20 degrees, we double the error and turn 40 degrees toward the target a new triangle is created. It can be seen that the angle between the fighter's heading and the target's heading has increased to 130 degrees while the relative bearing of the target has decreased from 65 starboard to 25 starboard. However, the relative bearing of the fighter from the target has remained unchanged at 25 degrees. Since both bearings from target and fighter are equal, then the distance to the interception point is also equal. We have created a collision course.

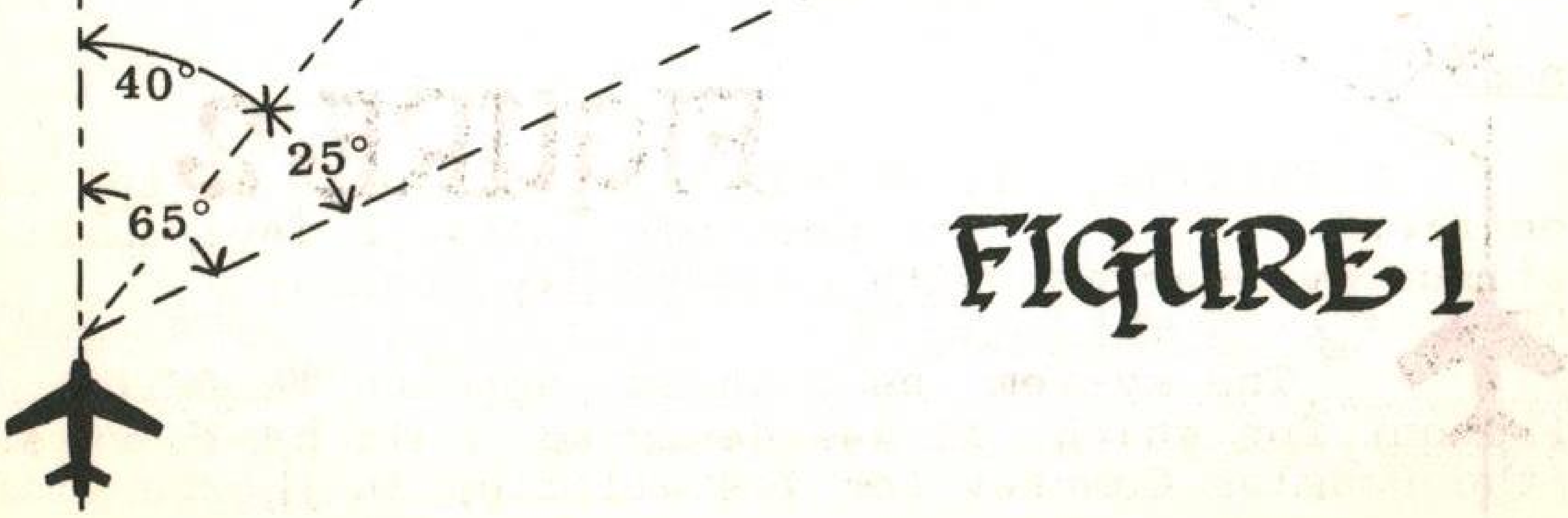


FIGURE 1

A question may now arise on the effect of turning error which has so far been overlooked. During any turn, no matter how sharply executed, we will continue to pass along some line which will pass us in front of the target until we reach the collision course line. If we continue to turn past this point we will tend to pass behind the target. Applying this to the foregoing and considering that we are moving the fighter a predetermined number of degrees, we find that we are on a line parallel to and in front of the collision course line. Turning error, therefore, further discredits the use of "double the error" for conversions.

This situation, however, does not hold true for all conversions. If the fighter has a speed advantage, a collision course will occur at something less than double the error. However, this is of no practical value.

With errors of more than 10 degrees from the head-on position, my suggestion is to multiply the error by four. This, in conjunction with maximum rate turns gives very satisfactory results. Now, once established on a conversion course the only problem left is to judge when to initiate a turn back.

Figure 2 outlines a simple method for accomplishing this. Here we have a one to one speed ratio setup with the original pickup at 60 starboard and an error of 15 degrees. Therefore, multiply the error by four and turn 60 degrees toward the target. When the target has drifted to 15 port the aircraft is turned back 60 degrees. The relative

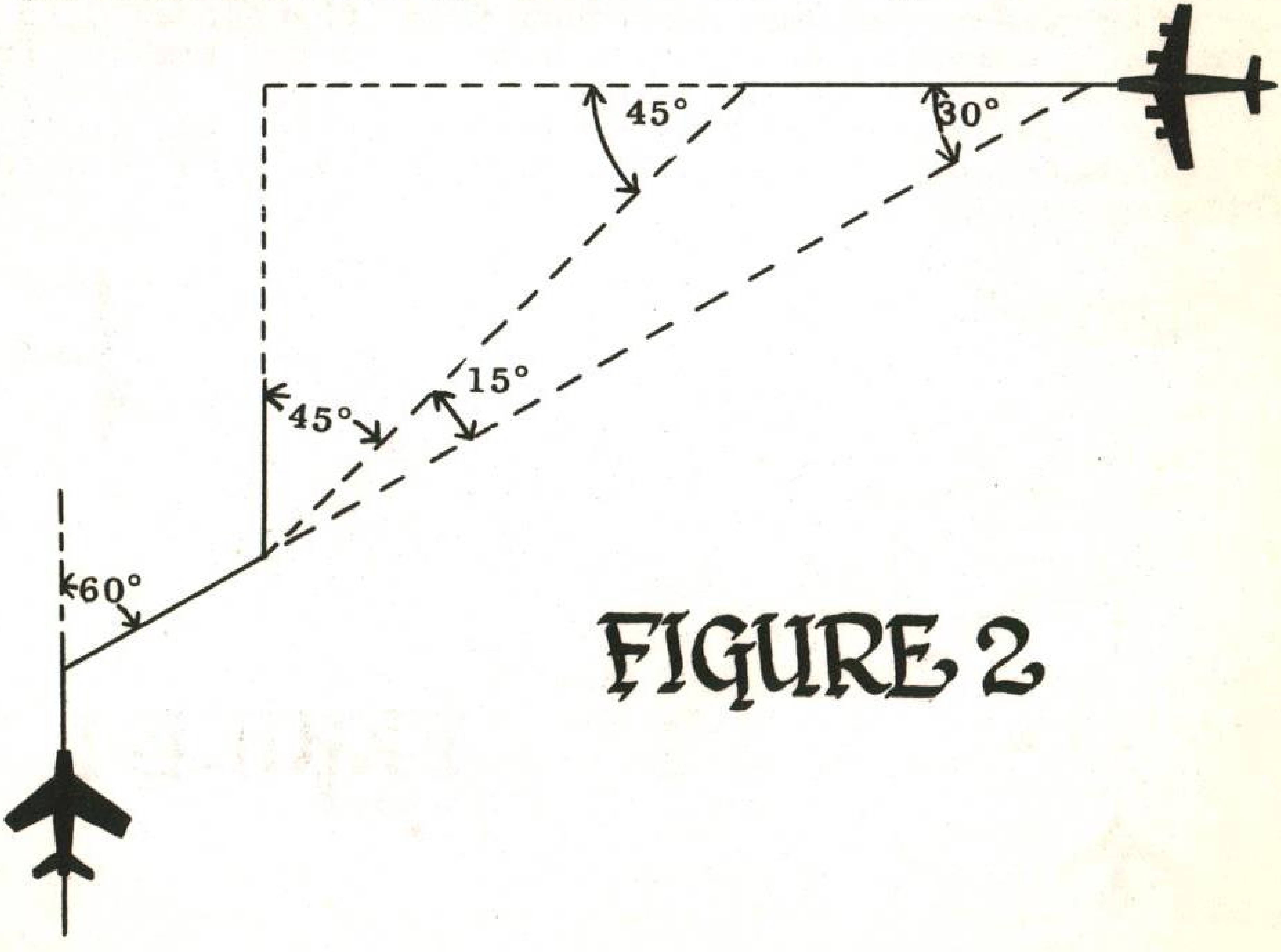


FIGURE 2

bearing of the target will now be 45 starboard with the fighter on an attack vector 90 degrees removed from the heading of the target: ie

Degrees to turn - Relative Bearing = Final Attack Bearing

60° - 15 P = 45 S

However, because of the limitations imposed by altitude and turning radius, it is suggested that errors of 10 degrees or less be handled by multiplying the error by three rather than four.

How much to lead the target on turn back? This is a difficult question to answer since it varies with the crew, altitude and range. However, at 25,000 feet I have found, that when starting the turn back at six to seven miles range, one degree per 10 degree compass change is sufficient. The lead required increases with altitude and decreases with range.

In cases where altitude is excessive or range insufficient to carry out a complete conversion, turn into the target until half the range between contact and turnover point has passed, then turn back and hand over the interception to the pilot while still in the turn.

Occasionally a situation arises where a very short range contact at excessive azimuth occurs. In this case, no conversion is possible, however, a quick turn twice the error will place the fighter on a collision course with the smallest possible cross over angle.

Before considering a discussion on conversions from behind the line, we must first prove that it is possible to regain a 90 degree Lead Collision Course without a

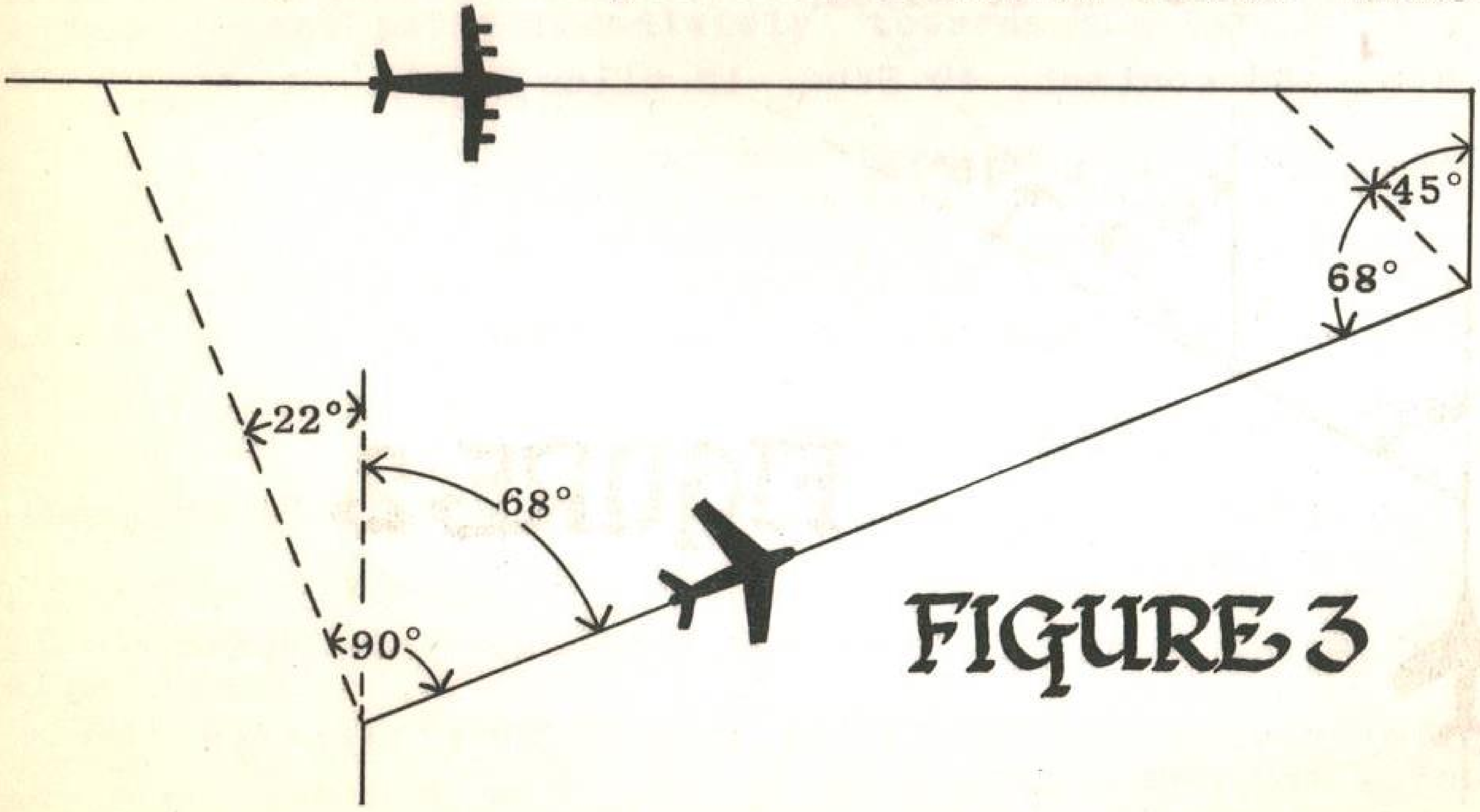


FIGURE 3

speed advantage. For example, in figure 3 we have a contact of 22 port at 28 miles. Now if GCI turned the fighter so that the bearing increased to 90 port and this course was held, then the fighter would regain a 90 degree Lead Collision Course at a range of eight miles.

When handling conversions from behind the line on a one to one speed ratio it is more difficult to regain position, therefore, an error of 5 degrees must be converted 20 degrees. Furthermore, because of equipment limitations, an error of more than 5 degrees must be taken to the limit of the scope, and, as the target begins to drift, a gentle turn to keep contact must be made. When the degrees off heading has been reduced to 25 degrees a turn back to the 90 degree vector may be made. In cases where insufficient range makes it difficult to accomplish the above, turn the interception over to the pilot for "dot steering" at 10,000 yards.

In any case, when attempting a conversion it is most important that it be completed as soon as possible, so that the pilot will be given every opportunity to settle down on his final attack vector and thus reduce "dot steering" problems to a minimum.

To terminate our discussion and consolidate our findings let us run a mock interception (figure 4).

Target heading - 270°

Speeds - Equal

GCI Red Lead, vector port 360, when steady target 45 Stbd. 27 miles.

GCI You are hot, roll out on a heading of 020, when steady target 35 Stbd. 27 miles.

Obs Red Lead contact, 40 Stbd. 12 miles; Judy out.

Obs Stbd. hard as possible.

Obs Make that turn 40°.

Pilot Steady 60° towards.

Obs Target dead ahead 11 miles.

Obs Target 10 P 7 miles; port hard as possible to original attack vector.

Obs Target 45 Stbd. 10,000 yards, take over the dot.

The pilot places the dot at the side of the reference circle and waits for phase two.

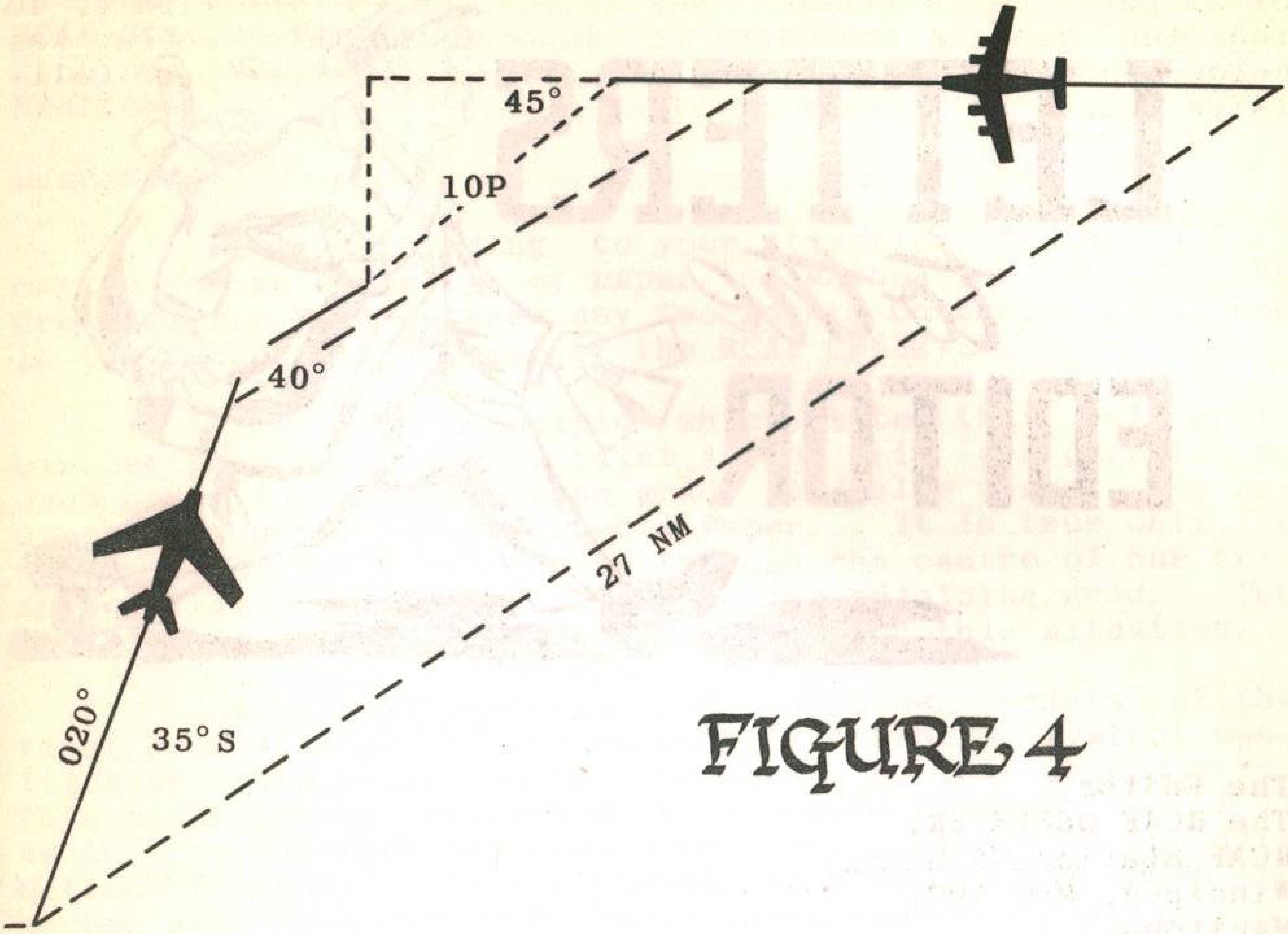


FIGURE 4

Before contact is made the Observer knows (Figure 1) that if a collision course is set up the contact will be 35 starboard, he also knows that in order to convert from this position a further turn towards the target of 20 degrees must be made. If the contact is 25 starboard a turn back to 360 must be made immediately (Figure 2). At contact a turn is initiated immediately towards the target to avoid any delay.

During the turn the Observer calculates that a further turn of 20 degrees must be made in order to convert the extra 5 degrees of error. In effect, this set up is identical to one with a contact of 60 starboard if the heading were 360, thus the Observer requested a further 40 degrees.

At 10 Port 7 miles (allowing 5° for turn) the Observer initiated his turn back onto a heading of 360.

The Observer turned the interception over to the pilot immediately so that the dot could be positioned and eliminate an "S Course".

Any other views from the AW(F) Squadrons? Editor

LETTERS *to the* EDITOR

The Editor,
The RCAF OBSERVER,
RCAF Station Winnipeg,
Winnipeg, MPO 400,
Manitoba.

Dear Sir:

I have recently read your January 1957 OBSERVER (which, if I may say so, is excellent in all respects) and I was drawn to Squadron Leader McAllister's article on the High Speed API.

Whilst still young in navigation lore, the grease pencil - plastic system seems to me a recollection of days gone bye, and as an ex-student of 2 ANS Winnipeg (NOC 19 WB), I must disagree that here is an accurate aid! If all fails we all know that DR is there to be applied, but with a grease pencil even an expert's application on a half-million would still be approximate.

Having tried this system on a series of (reasonably) high speed flights, I found that DR navigation is self-contained and accurate, but with grease pencils it is at best approximate and a pencil sharpener's delight.

Radar Recce Flight,
Royal Air Force.

H. J. Shaw F/L

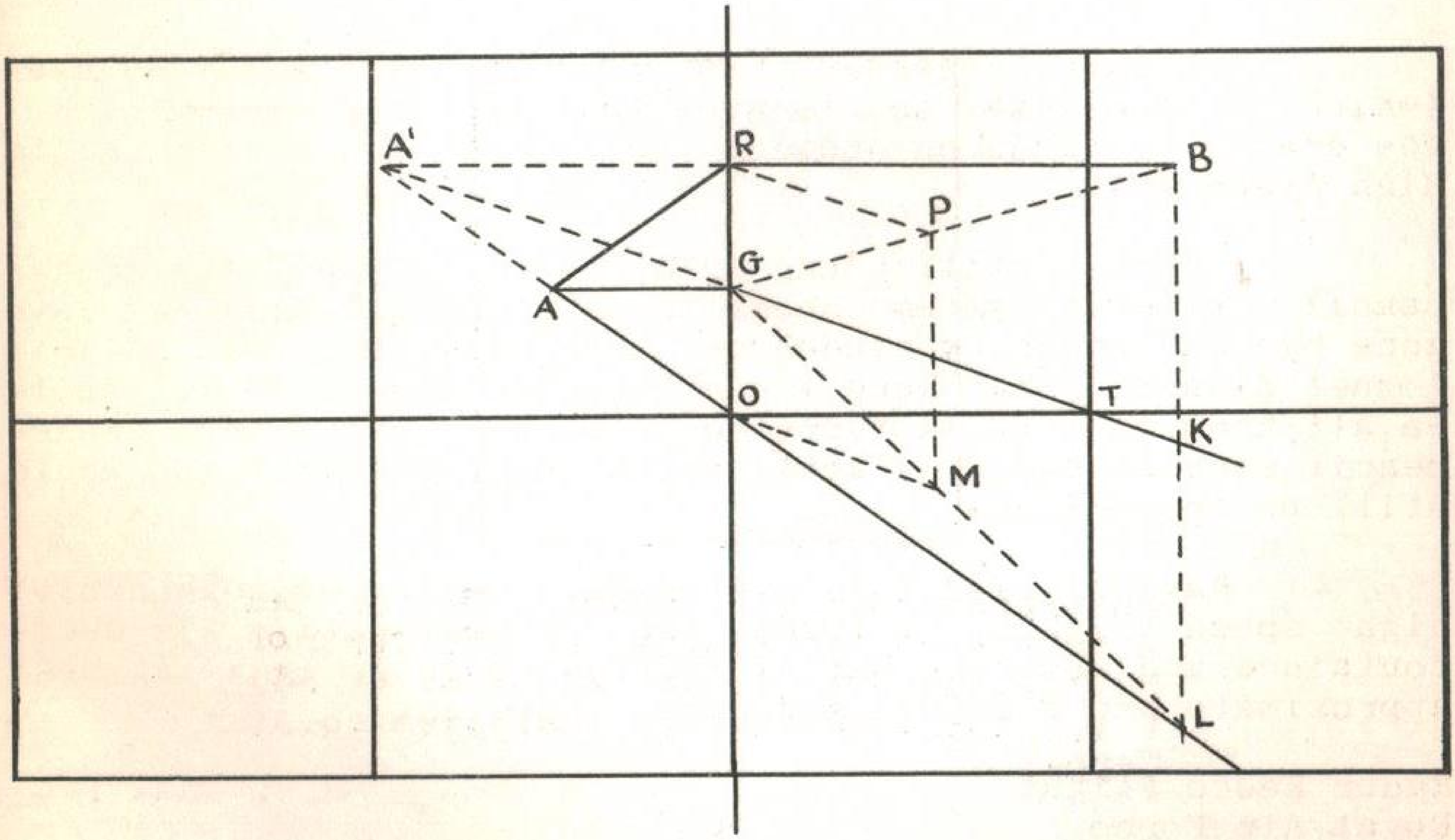
The Editor,
The RCAF OBSERVER,
RCAF Station Winnipeg,
Winnipeg, MPO 400,
Manitoba.

Dear Sir:

I wish to bring to your attention further information on an error in my paper "A Method for Drawing the Great Circle Path Between any Two Points on Earth" published in the January 1957 issue of the RCAF OBSERVER.

The basic principle which states that "all great circles passing through a point in one grid are parellel to each other in a neighbouring grid, and vice versa" was incorrectly quoted from Turner's Paper. It is true only for points along the great circle through the centre of one grid and parallel to the side common to the adjoining grid. The construction described is correct only for this situation.

The great circles from any other points of the first grid diverge in the second grid from equivalent position of that point on the extension of the second grid. This point can be determined by a simple construction if it is not too far from the common boundary, otherwise the direction of the great circle from A through point B in the second grid is found by a proportional construction.



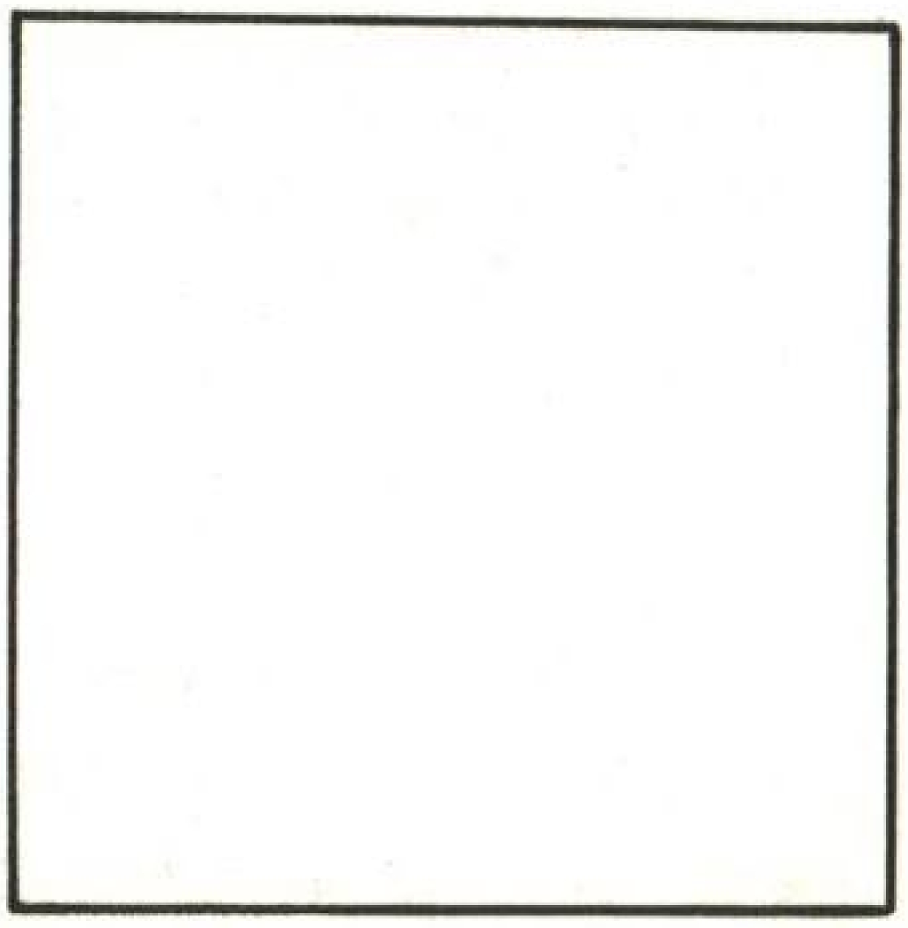
Construction

From point A drop a perpendicular to the common boundary. Join its point of intersection (G) to the centre of the second grid (T). Join A to the centre of the common boundary (O) and produce into the second grid. The intersection of OA and TG produced (A') is the position of A in the second grid. A'B is the required great circle line in the second grid.

If A' is too far off the chart for construction purposes the direction of A'B may be found as follows. Drop a vertical line from B cutting GT and AO produced at K and L respectively. Join GL, GB. Through O draw a straight line parallel to GT cutting GL at M. Draw the vertical from M to cut GB at P. Draw a line through P parallel to TG cutting GO produced at R. R is the point of intersection of the required great circle on the common boundary of the two grids. If point A is on the left hand half of the grid, the lines GT and AO will converge to the point antipodal to A, to the right of the second grid. Construction must be made to equivalent points on the right hand boundary of the second grid.

J.H. Meek

Defence Research Board,
Ottawa, Ontario.



Photograph of an ELECTRON taken in the Electronics Department of the Central Navigation School, May 20, 1957 (1/500 f 1.5 and with sincere apologies to Al Capp).

The opinions expressed in the contributions to the RCAF OBSERVER are those of the writers and do not necessarily represent official RCAF views. The Editor reserves the right to make any editorial changes in manuscripts which he believes will improve the material without altering the intended meaning.

All correspondence and contributions should be sent directly to:

The Editor,
The RCAF Observer,
RCAF Station Winnipeg,
Winnipeg, MPO 400,
Manitoba.

**PLEASE ADVISE PROMPTLY
OF ANY CHANGE OF ADDRESS**