RESTRICTED

THE RCAF OBSERVER

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Contents

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The RCAF OBSERVER

Incorporating the RCAF Navigation Bulletin

Founded 1949

Included in this issue of the Observer is a regular feature of the January edition, namely the course photograph of the current SpecN course.

This photograph marks a significant event for RCAF Observers, because one of the students is by trade an Observer/RO. All three branches of observers have now been included in the SpecN course, an Observer/Al having been a graduate of 9 SpecN. It is to be hoped that this addition is a permanent one for the RCAF, and that all three observer branches will, in future, be eligible for specialist training.

The SpecN course has changed considerably during the past few years, developing from navigation "nuts and bolts" into a general upgrading and broadening of selected personnel in all aspects of the observer trade, plus training of students as command and staff advisers. In view of this change in the aims of the course, and the widespread selection of skills possessed by incoming students, it may seem something of an anomaly to call the course SpecN. It is considered, however, that the tradition behind the present name, and its excellent reputation abroad strongly commend its continuation.

A further change this year at CNS is the addition of the Staff Observer (Airborne Interceptor) Instructor course - SO(AI)I - providing post-graduate training for the third observer specialty. The need for this advanced training has been appreciated for some time and its introduction will be welcomed throughout the Service.

To ensure that all Observers are aware of the aim and scope of this new course and are brought up to date with the current contents of the 'older' courses, it is intended in this and succeeding issues of the OBSERVER to publish articles regarding the four post-graduate Observer courses in the RCAF. These articles will only be in general terms, and all personnel are reminded that issues of appropriate course syllabi are distributed to all RCAF flying units, and should be referred to by each and every observer who is eligible for advanced training.

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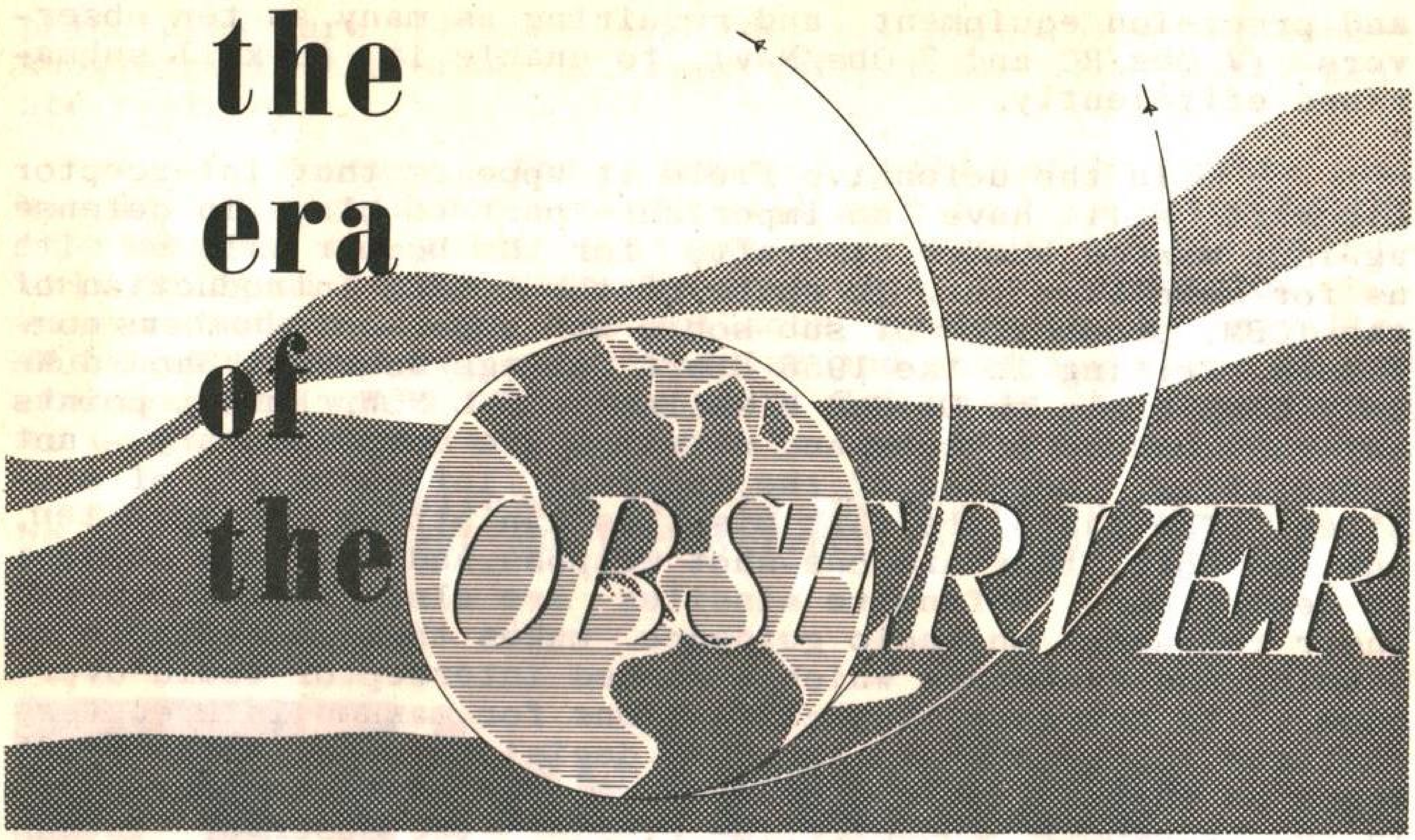
NO 10 SPECIALIST NAVIGATION COURSE

9 Sept 57 — 20 June 58

the era of the OBSERVER



By Squadron Leader C.L. Heide DFC CD
Air Force Headquarters

The increasing importance of missiles is leading to much speculation on the future of aircrew and often in evidence are worried faces which, at the mere mention of a missile, assume a "redundant" expression. There is no doubt that we are rapidly entering the era of missiles - families of missiles applicable to most roles that air forces previously accomplished with aircraft. But the end of aircrew is not yet in sight, and no one reading these words need worry about becoming redundant. The fact is that the missile era is not here yet, it is just beginning. But even with its arrival things look bright for observers.

A missile cannot yet carry passengers across the Atlantic, nor supply the weather stations in the Arctic archipelago, nor drop paratroops and supplies over a selected target. Although the day will come when missiles may accomplish all these feats, it is still a long way in the future. Hence, the RCAF has planned for the introduction of high-speed high-altitude transport aircraft. It seems reasonable to give these aircraft a life of fifteen years - that is until 1975 - and these aircraft provide the observer with a vital and challenging job if he is to master the complex equipment they will carry.

In Maritime operations the day when the missile will replace the long-range submarine detection aircraft is difficult to foresee, and the Argus aircraft too should have a service role until about 1975. Here is another challenging field for the observer -- in an aircraft packed with complex and precision equipment and requiring as many as ten observers (7 Obs/RO and 3 Obs/Nav) to enable it to kill submarines efficiently.

In the defensive field it appears that interceptor aircraft still have an important part to play in defense against manned bomber aircraft, for the bomber will be with us for some time yet. In spite of the coming introduction of the ICBM, production of sub-sonic and supersonic bombers continues. Writing in the 1956 Staff College Journal("Should We Rely Completely on Guided Missiles") S/L N.W. Emmott points out that manned bombers and missiles are complimentary - not competitive, because of the inherent inflexibility of missiles. The facts are that missiles can attack, or threaten, but not both, they are one-shot weapons,and they are subject to deception. Defensive missiles are also inflexible and their reliance on radio guidance makes them susceptible to jamming and avoidance which a manned interceptor could overcome. In any case, specifications for manned interceptors continue to appear and the RCAF decision to build the CF105 keeps us in this field for about another fifteen years. As in the transport and maritime fields, the observer in the CF105 will have a difficult and demanding job if he is to make himself the master of his equipment and not its servant.

It is not enough for the observer who will fly in these new aircraft to be merely operators, to consider themselves monitors of automatic or semi-automatic equipment, and to throw up their hands in horror and resignation when faced with partial failure of equipment or unexpected operating conditions. The observer must know and understand the theory and functioning of his devices if he is to be really efficient in the air. With the forthcoming complex electronic equipment in our aircraft, this is no mean task, and modern aircraft are not forgiving of mistakes.

Thus for the next fifteen or twenty years,at least, manned aircraft are with us and this is the era of the observer for he will be the most vital person in the crew. If he cannot find his target, be it a submarine, an aircraft,or a point in space, the aircraft need not become airborne.

What of the distant future? What will the observer become when missiles replace virtually all military aircraft?

With foresight and application the role of the observer is assured. The major problems confronting missile development appear to be metallurgy,propulsion,and guidance. Metallurgy and propulsion are jobs for the scientist and engineer. Guidance is the job of the observer. In fact, guidance is the raison d'etre for the observer's existence. It is simply a logical step for the observer to move from the guidance of aircraft to the guidance of missiles. The basic principles are the same and they are principles of common knowledge to the observer, especially those with post-graduate training.

However, the transition will not be quite that simple. The guidance systems will have to be adapted to the missiles, and the guidance expert will have to be able to consult on equal terms with the instrument and electrical engineers who must fit the guidance system to the missile. There is, therefore, much training and studying ahead of the observer who would fill this role. Yet he is the logical man to do it and must face the reality that it will not be easy.

The missile era will be the era of the observer if he has the foresight and perseverance to prepare himself for it.

AI Instructor training

January 1958 marks the beginning of advanced training in the Airborne Interceptor field at CNS. The Staff Observer (Airborne Interceptor) Instructor - SO(AI)I -course is comparable to the SONI and SORI courses, and is designed to further the capabilities of the Observer/AI in both his specialized field, and navigation generally.

The stated aims of the course are:

"To qualify aircrew list officers for appointment as instructors at the All Weather Fighter Operational Training Unit and at the Applied AI School"

"To provide a candidate with a knowledge of subjects common to the Observer AI speciality, beyond the level of instruction given on the Basic Observer, the Applied Observer AI and the AW(F) OTU courses, so that the graduate will be better qualified,to assume appointments on squadrons, and in staff positions".

In providing for these aims the instructional staff of CNS has been increased by one, the new staff member being an experienced instructor who has also completed an operational tour within ADC, and it is hoped that a second addition will be made in the future. The addition of staff members is not, however, everything required. There is the problem of providing trainers, simulators, and CF-100 aircraft, none of which are currently available at Winnipeg. It has been considered, therefore, that it would be more economical and convenient to move the course to 3(AW)OTU for the flying and synthetics portion of the syllabus. To cover non-flying days, and to simplify scheduling while at Cold Lake, the course will spend three weeks at the OTU with four of the academic subjects being taught during this same period.

Now that we have seen the problems associated with the course, and the solutions planned, perhaps the subjects and other aspects of the course should be examined. The course is identical in length to the SONI and SORI, namely seventeen weeks, of which the first two are spent at the School of Instructional Technique (SIT). The course is primarily academic,as for SONI and SORI,improving the student's background in his speciality, and, at the same time,giving him a general background in the fundamentals of mathematics, electronics, aerodynamics, and normal navigation subjects. The principal point is that the student is taught "how" his equipment and aircraft operate, as compared to his being taught to be a simple operator during earlier training.

Allocation of Hours

A detailed allocation of hours is shown in Table 1, and each subject will be summarized briefly to show the aims and scope of instruction. Full details of the course are given in the syllabus of instruction, CAP 464-E16, which is being circulated by TCHQ to all RCAF Flying Units in Canada.

TABLE 1 - ALLOCATION OF HOURS

SUBJECT	HOURS	SUBJECT	HOURS
ACADEMIC		FLYING AND TRAINERS	
Airborne Interception Techniques	26	Flying	37
Armament System Equipments	62	Trainers	12
Aircraft Control and Warning	8	Briefing and Analysis	27
Aerodynamics and Aircraft Performance Engineering	43	Total Flying	76
Aero Medicine	10	INSTRUCTOR TRAINING	
Electronic Theory and Equipment	78		
Electronic Counter Measures	13		
Navigation Instruments	35	Instructor Training Lectures	122
Mathematics	34	ADMINISTRATION	
Applied Navigation	43		
Maps	12		
Meteorology	24	Student Administration	76
Air Regulations	18	Total Hours (17 weeks)	680
Total Hours - Academic	406	Given during OTU visit	

Assessment

The student is only assessed academically, his flying being familiarization, and receives his mark out of a possible 1000 marks. Comments on the student's flying and simulator exercises are included in the narrative of his training assessment (PT4) at the end of the course. No examination is given in either aeromedicine or instructor training, but the latter subject is assessed in the training narrative.

Airborne Interception Techniques

The AI techniques training is designed to give the student a thorough knowledge in the handling of all types of air interceptions, and a broader comprehension of interception techniques and procedures. This subject involves 26 hours of instruction and examinations; with types of display, flight path recognition, turning circles, relative motion, speed control, evasive action, conversions, and multiple fighter operations being included among the topics covered. This is one of the specialist subjects of the course, and will provide the graduate with an improved background whether he be re-employed on a squadron, or assigned to instructional or other staff duties.

Aircraft Control and Warning (AC and W)

The eight lectures in AC and W will be given during the course's stay in Cold Lake. Topics included are AC and W organization, control techniques, tactics, and equipment.

Aerodynamics

Emphasis is being placed on aerodynamics and aircraft performance engineering for all post-graduate courses, and 43 hours are devoted to the subject for SO(AI)I students. The aim is to impress on the graduate the problems connected with flight, engines, cruise control, and special aircraft types to improve his background as an aircrew officer

Aero Medicine

High altitude flight presents many important physiological problems that man must overcome, and the ten hours devoted to the subject of aero medicine include physiology, personal and aircraft equipment, and future developments in "G" and pressure suits. This subject will be given during the stay at 3 (AW) OTU.

Armament System Equipments

The armament carried is the reason for the interceptor's existence, while the Fire Control System is the means of delivering the weapons. It is essential, therefore, that the post-graduate AI Observer understand the operation, capabilities, and limitations of his principal tool so that he can fill the role of "middleman" between the operator and technician. The subject of Armament System Equipments, which involves 62 hours of instruction, is intended to give the graduate sufficient background in present air weapons systems so that he can discuss them with a technician, and also be able to analyse new equipments and make an effective assessment of their operation and capabilities.

Electronic Theory and Equipment

Electronic theory is becoming the "stock-in-trade" of the observer, because of the ever increasing emphasis on electronics in every field of aircraft equipment and instrumentation. During the 79 hours devoted to this subject the following general topics are covered; fundamentals of AC and DC, vacuum tubes, amplifiers, communication systems, radar principles, antennae, and radar systems. In addition to the theory the following equipments are discussed; Radio Compass, VOR, TACAN, GEE, VHF/UHF, IFF, ILS, GCA, AGCA, and SARAH.

Electronic Counter Measures (ECM)

The increasing importance of ECM in all phases of air operations demands its inclusion in all post-graduate observer courses, and particularly those for the AI observer. The thirteen hours devoted to the subject are intended only as an introduction to this highly specialized field, and are directed towards the bomber/air defence aspects of the problem in both jamming and defensive measures.

Maps

The instruction in maps is intended to teach the principles of map projections used in the RCAF, and involves twelve hours of instruction and examinations. This subject is of direct interest to the junior staff officer, potential instructor, and experienced observer.

Navigation Instruments

Thirty five hours are devoted to a study of navigation instruments, and the intention is to familiarize the student with the principle, construction, operation, and limitations of current aircraft instruments and compass systems, emphasizing those appropriate to the AI field. The subject is approached from a viewpoint of principles of heading measurement, compass systems, airspeed principles and instruments, finally combining these two inputs in position computers. Particular emphasis is laid on the principle and operation of the RΘ computer.

Mathematics

The thirty four hours of instruction in mathematics are intended to increase the student's knowledge of mathematics to the level required for an understanding of the navigation subjects of the syllabus. Topics included are algebra, measurement of angles, logarithms, and plane trigonometry. The mathematics portion of the syllabus frequently causes difficulty and personnel eligible for SO(AI)1, or other advanced observer courses, would be well advised to obtain an algebra or trigonometry text ,and do some preparatory work in these subjects.

Applied Navigation

The forty three hours devoted to applied navigation during the SO(AI)I course are intended to increase the students' knowledge of this subject to that required either for instructional duties at AOS and 3(AW)OTU, or a junior staff appointment. Several of the topics covered are not of direct interest to the observer/AI, but are part of the general upgrading and broadening of the students' background. Subjects such as fourth vector navigation, homings, flight planning, fighter navigation and mental DR are of direct interest to air defence crews and are emphasised during the course. Calculation of celestial risings and settings and star recognition are also included in this subject.

Meteorology

The meteorology portion of the syllabus is intended to consolidate the students' previous training, increase his knowledge of high level meteorology, and develop an appreciation of the problem to encourage closer cooperation between the air observer and forecaster. A total of twenty-four hours are devoted to the subject.

Air Regulations

In air defence command the observer is responsible for handling air traffic clearances and flight plans. This factor, and the necessity for all observers to be familiar with air traffic procedures and problems if they are to be effective aircrew members, necessitates eighteen hours of the syllabus being devoted to air regulations. Topics include, the scope of air traffic control, radio facility charts, division of responsibility, and visual, defence, special, and instrument flight rules.

Instructor Training

The subject of instructor training appears to have a large amount of time devoted to it, but eighty of the 122 hours are spent at SIT. The forty-two hours devoted to the subject at CNS include instruction in the organization of appropriate RCAF units, service writing, and RCAF observer training. Time is also allotted to student practice lectures in navigation subjects.

Flying and Trainer Exercises

The hours devoted to flying and trainer exercises are only intended as familiarization and no formal mark is given, but students are assessed in their training narrative. The allocation of hours is as follows:

B-25 AI Trainer Aircraft: 24 hours, familiarization and practice assessment.

CF-100 or T-33: 4 hrs Fighter navigation training.

CF-100: 9 hours interceptions and tactics.

Trainers: 12 hours on T1A, and CF-100 Operational Flight and Tactics Trainer. These hours are scheduled to precede each flying exercise.

Briefing and Analysis: 27 hours of briefing and analysis for both trainer and flying sorties.

Student Administration

Student administration hours provide time for drill and sports, signing-in and obtaining clearances at Winnipeg and Cold Lake, time-off after night flying, holidays, and tutorial hours in which students can complete practice problems in Mathematics and Electronic Theory under the supervision of the appropriate instructor.

OTU visit

The visit to 3 (AW) OTU will be normally for the fourteenth to sixteenth weeks of the course, and during this time the student completes the majority of the B-25 and CF-100 flying and trainer exercises plus lectures in aero medicine, AC+W, ECM, and air regulations.

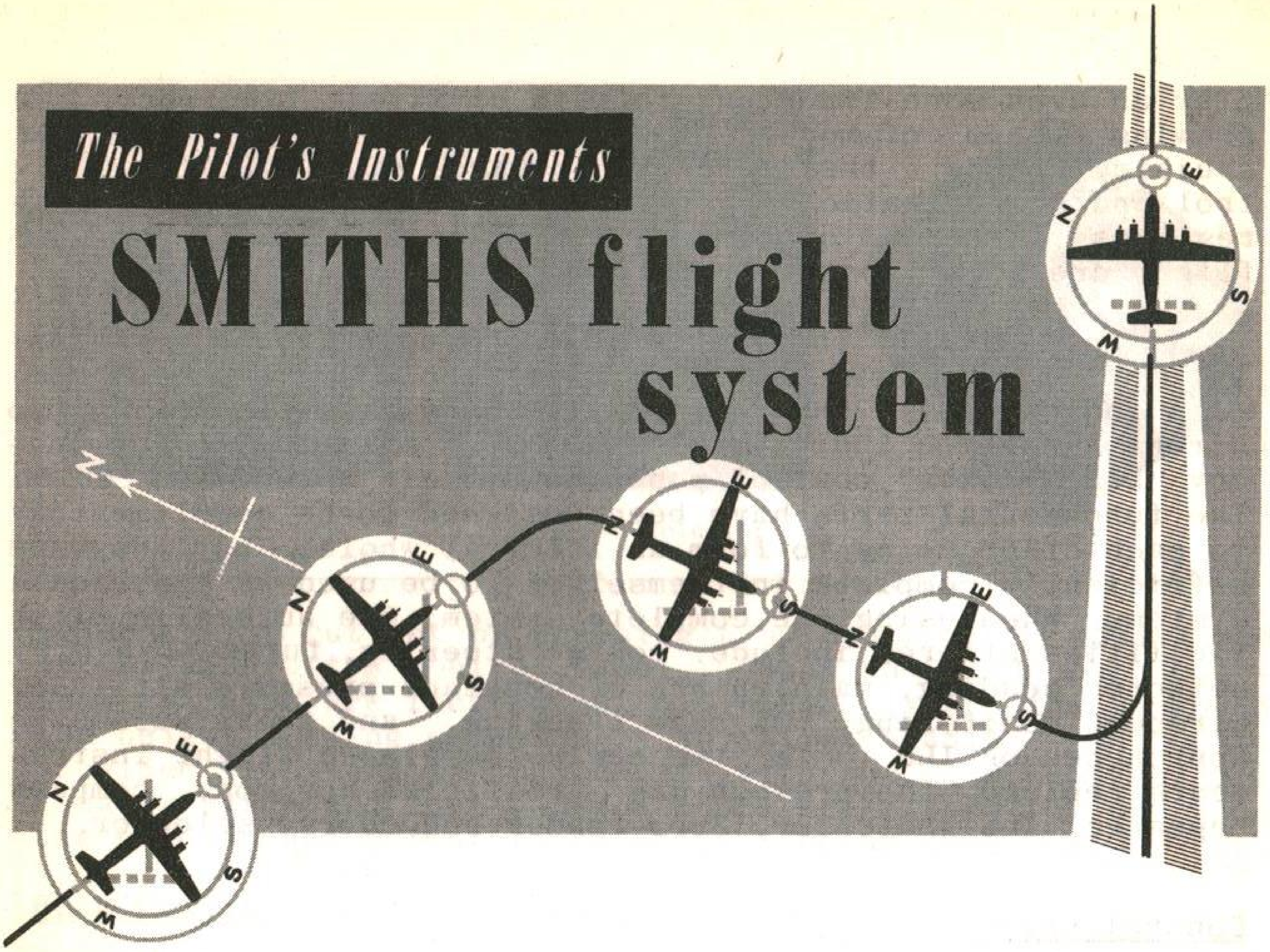
Conclusion

This brief introduction to the scope and aims of the SO(AI)I course is intended to give all observers some background to this third post-graduate observer course. It has been general because the course is new, and changes can be expected as experience is gained with the early courses. The syllabus has resulted from a great deal of thought and work put forward by the staffs of CNS, TCHQ, CFS, AOS, and ADC units, and every effort has been made to ensure that the course is useful and an important step in the career of the observer in the Air Defence Command.

Editor's Note: The April 58 issue of the OBSERVER will feature an article on the SONI course.

The Pilot's Instruments

SMITHS flight system



The Smith's Flight System, the fourth in our series on integrated instruments, was born of several instrumentation requirements made known to the industry independently by both British Overseas Airways Corporation and British European Airways. Using these requirements as a starting point, Smith's, in conjunction with their associate companies, developed a design philosophy for flight control systems. Application of this philosophy resulted in the Smith's Flight System (SFS) and was the first application to become commercially available. The SFS is being fitted, or is scheduled, as standard equipment on new aircraft going into service with British Overseas Airways, British European Airways, RAF Transport Command, Ministry of Supply, Canadian Pacific Airlines, Northeast Airlines and El Al Israel Airlines. In addition, component parts of the SFS are being supplied to more than fifteen major airlines to meet specific requirements when installation of the complete system would not be justified.

The system is designed to provide a complete, rationalized installation which will be available for use in all conditions of manual, flight director, or fully automatic operation. Emphasis has been placed on safety and simplicity in use; i.e., "fail-safe" principles have been applied throughout and switching has been reduced to a minimum. However, the design philosophy underlying this system is based on a number of operational premises, the most important of which is the belief that the automatic pilot will play an even more important role in civil air transport. The growing tempo of modern operations caused by the faster cruising speeds, the increasing demands of Air Traffic Control and communications procedures, the curtailment of fuel reserves in terms of time, and the trend toward smaller flight crews, all point in this direction.

Basically the system is composed of three fundamental parts; the Twin Compass system (including two Beam Compass indicators); the flight attitude system (including two Director Horizon indicators); the SEP 2 Autopilot; and sundry "black boxes",control panels and their associated cables. The fundamental parts have been designed to be complimentary to each other so as to form an integral whole, but they are sufficiently complete in themselves to be used as individual systems. When using the complete system, the automatic pilot facilities offered include: course steering, turns to a preselected heading, maintenance of constant pressure altitude, airspeed monitoring, VOR beam tracking, and fully automatic approaches on ILS. The two newly developed flight instruments replace the present-day artificial horizon, compass repeater, ILS indicator, Zero-reader and course selector.

Control Units

Although great ingenuity has been displayed in keeping switching down to a minimum in this system, a number of extra units are required to provide full control, autopilot facilities and navigational information. The first of these is the Annunciator Unit, one of which is provided for each Beam Compass. Each unit consists of a small selector (which may be turned to one of two positions, COMP or DG), a setting knob and an indicator. With the selector at COMP, the compass functions normally, while with DG selected, it functions merely as a directional gyro with no magnetic monitoring. (Fig 1)

The second of these is a small selector panel known as the SFS Selector which has two switches. The upper switch is marked RADIO 1, 2, or OFF and the lower PORT and STBD. The upper switch enables selection of the radio facility which is to be fed into the system. The lower switch allows selection of either port or starboard compass to be used for feeding heading control signals to the autopilot and flight directors.(Fig 2)

The third panel is the Autopilot Controller, which is a small unit fitted to the control pedestal of the aircraft between the pilots. The controller provides a push-pull power switch and amber indicator light which shows when the autopilot may be engaged, by means of the engage button. Separate switches are provided to cut out individual controls - rudder, aileron and elevator - while the whole auto-

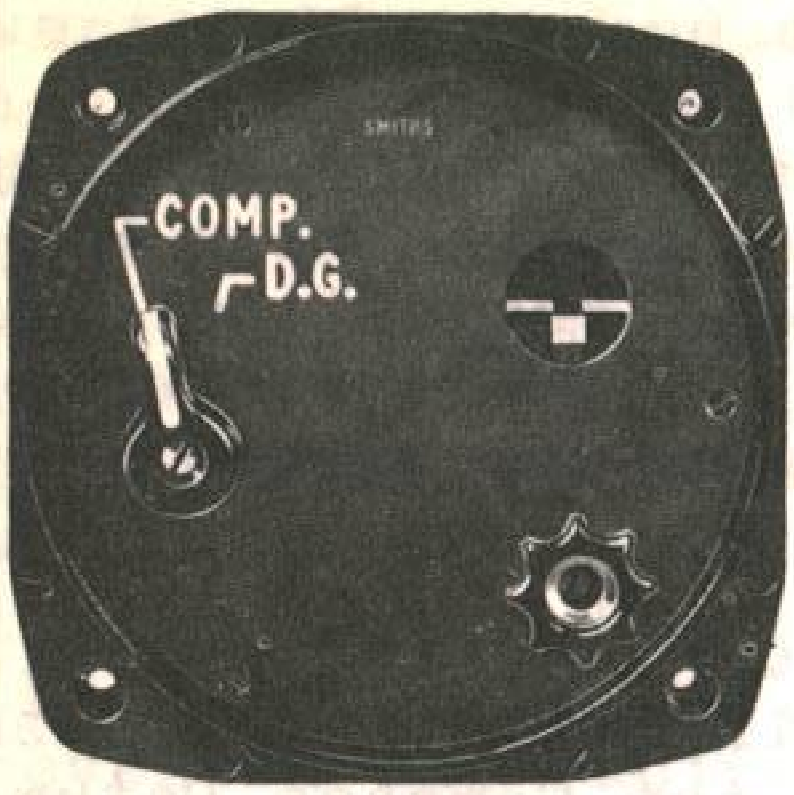


Fig 1 Annunciator Unit

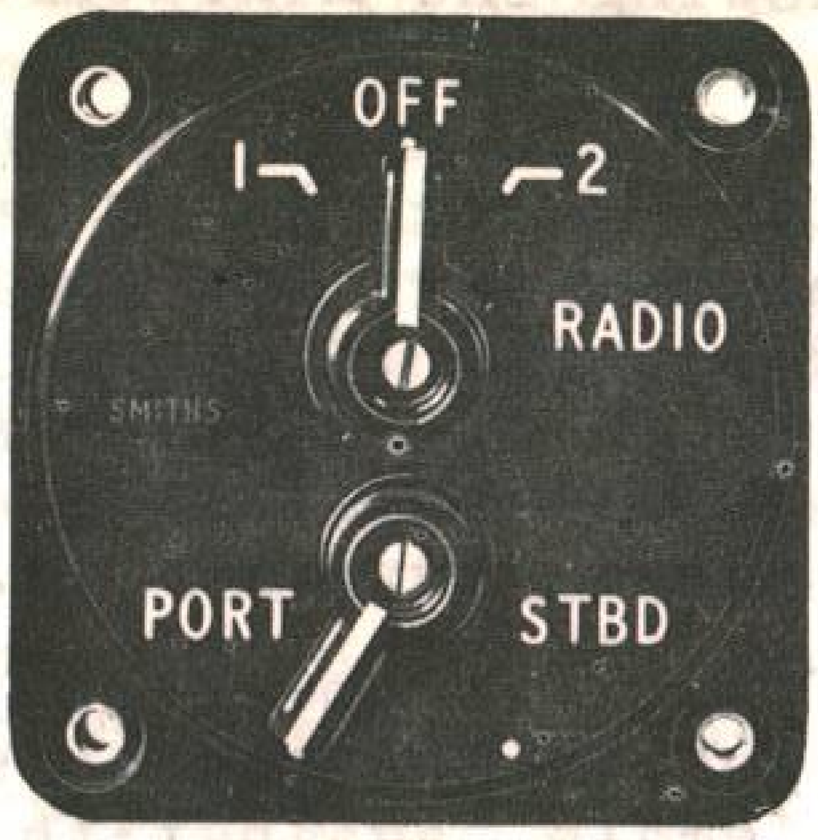


Fig 2 SFS Selector

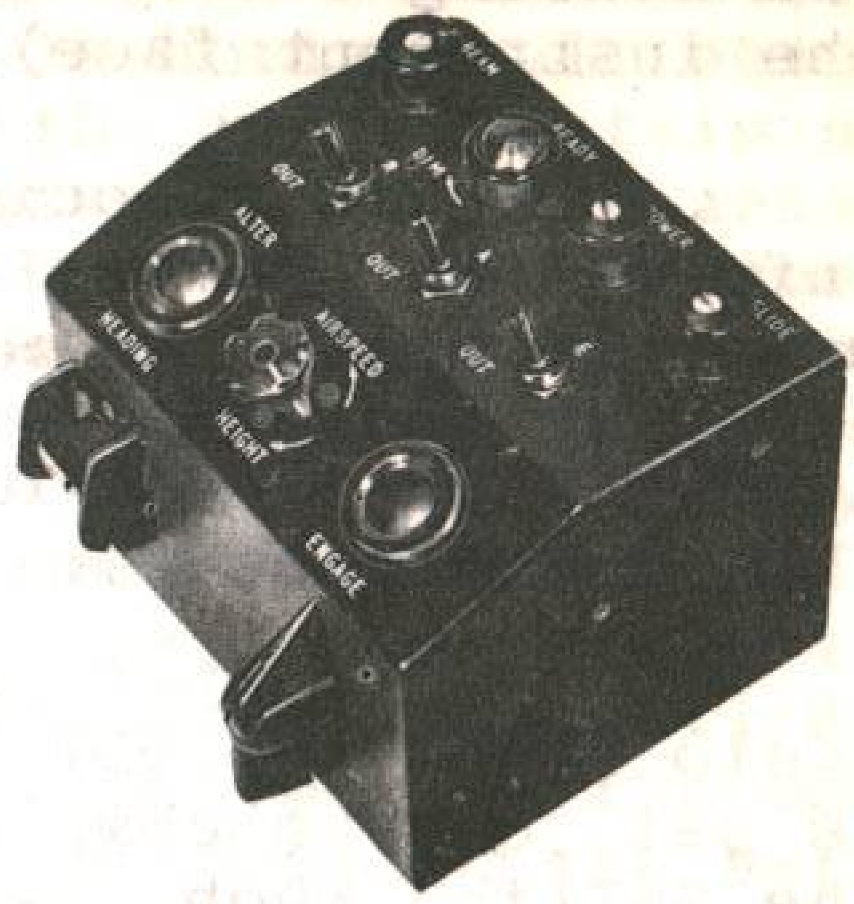


Fig 3 Autopilot Controller

pilot may be cut out by pressing a button normally positioned on the aircraft's control wheel. Beam and glide path coupling switches are located on this panel, as are the airspeed and height locking selector. An "alter-heading" button is provided, to work in conjunction with the Beam Compass, and finally pitch and turn control knobs are fitted for use when the heading and height locks are not being used.(Fig 3)

Beam Compass

The Beam Compass replaces the normal pilot's heading indicator in the Twin Compass System. Its primary purpose is to indicate magnetic heading, however, it also provides a number of additional facilities, and this has led to a general re-arrangement of the presentation (Fig 4). Magnetic heading is indicated continuously by the movement of the Heading Pointer over the compass scale. The central part of the Heading Pointer is made in the form of a miniature aircraft, indicating the orientation of the aircraft in relation to the magnetic directions shown on the compass scale.

The Setting Knob has a push-pull action, locating positively in either the "in" or "out" position. When it is pushed "in", and turned, it moves the compass scale in relation to the top and bottom compass datums. When it is pulled "out", and turned, it moves the Heading Index in relation to the same two compass datums. It is worth noting that the Heading Pointer will continue to indicate magnetic heading throughout any movements of the Setting Knob and that the Heading Index will not move except when operated by the Setting Knob.

When using the compass for normal enroute navigation the Heading Index is set to the top Compass Datum, and the Setting Knob is pushed to the 'in' position. To fly any required heading, the pilot then rotates the Setting Knob to bring the required heading on the compass scale to the Heading Index. The aircraft is then turned to bring the Heading Pointer into alignment with the top compass datum and the Heading Index (showing the miniature aircraft flying up the instrument face).

In association with the presentation of heading information, a vertical pointer, the Radio Displacement Bar, moves from side to side, with its lower end travelling over a conventional ILS meter localizer scale. This pointer is operated by radio displacement signals derived either from ILS or VOR receivers in the usual manner.

To operate the instrument in conjunction with a radio beam, the QDM(magnetic bearing to station) of the beam is set on the compass scale against the top Compass Datum. The Setting Knob is then pulled out, and the Heading Index is either retained at the top Datum, to fly the front beam QDM or set to the bottom Datum, to fly the QDR, (Magnetic bearing from station). Correct signals are then fed to both the autopilot and the Director Horizon. With this orientation of the Radio Displacement bar with respect to the compass scale and the correct direction of the radio beam, the pilot is presented with a clear plan picture showing the displacement and relative heading of his aircraft in relation to the beam by the movements of the miniature aircraft and the Radio Displacement Bar.

Radio signals will only be fed to the autopilot and Director Horizon for either front or back beam flying when the Heading Index is set within 30° of either the top or bottom Compass Datum. This angular range is indicated by the markings on either side of the two Compass Datums. If the Heading Index is set outside these two radio-coupled ranges, heading signals, without radio, will be sent to the Flight Director and autopilot.

A Sense Switch is provided at the top left-hand corner of the Beam Compass Indicator to facilitate control on instrument procedures. This switch, which has an arrow

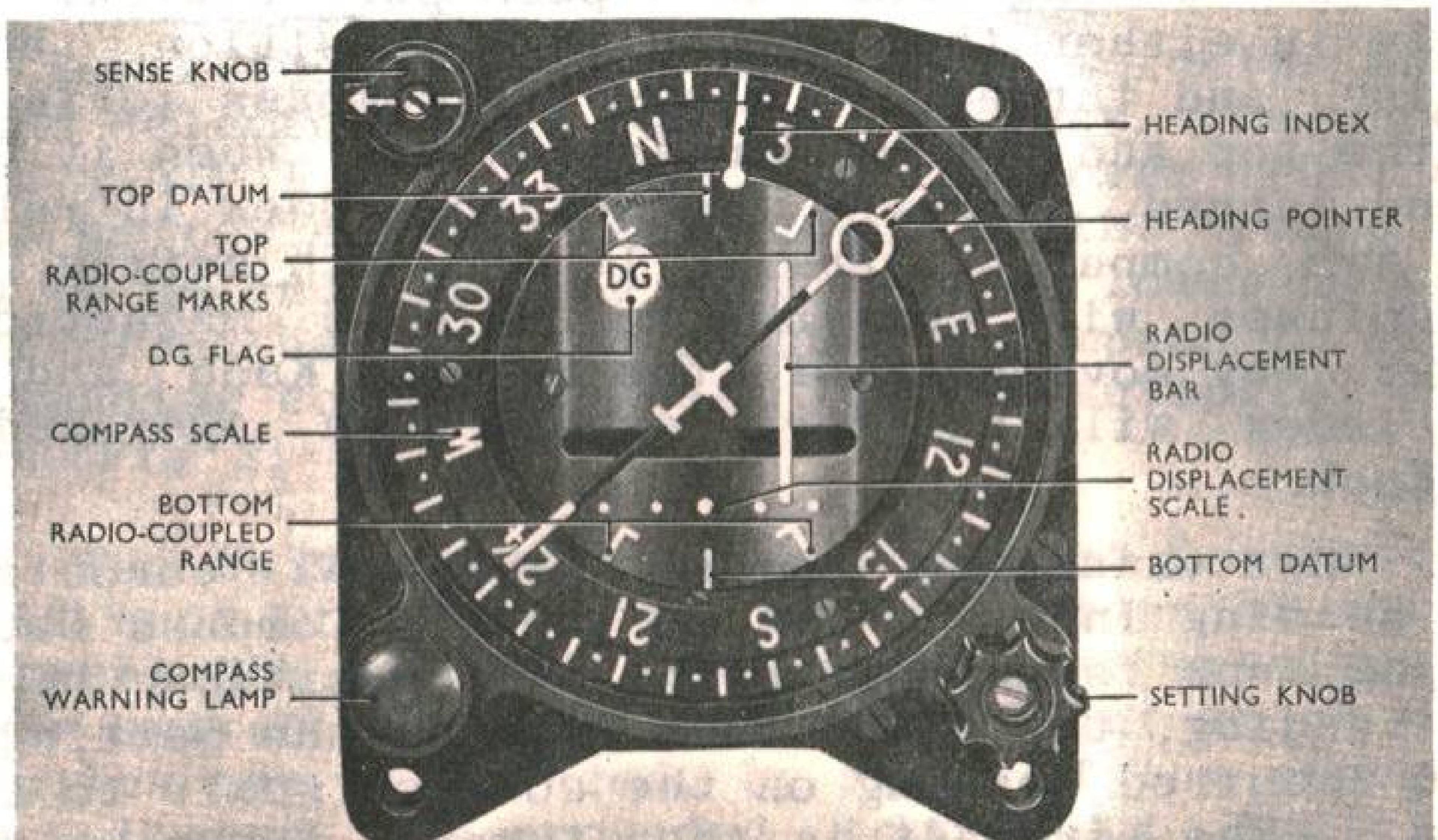


Fig 4 Beam Compass

engraved on it, can be set to three positions; horizontal,or vertically up and down. When the arrow is horizontal, which is the normal position, functioning of the instrument is as described above. When the Sense Switch is set with the arrow pointing up the case, radio coupling can only be achieved when the Heading Index is set within the top radio-coupled range. If it should be set within the bottom radio-coupled range i.e., for beam QDR, heading signals only will be provided to the Flight Director and autopilot, and beam coupling will not be achieved. If the Sense Switch is set with the arrow pointing down the case, then the condition will be reversed and radio coupling can only be achieved on the QDR of the beam, i.e.,with the Heading Index set within the bottom radio-coupled range. If the Heading Index should be set within the top radio-coupled range, heading signals only, without radio, will be sent to Flight Director and autopilot.

Corrections for wind drift can be made by off-setting the Heading Index from the top or bottom Compass Datums by the appropriate drift angle, up to a limit of 30°, ie.,by remaining within the radio-coupled range. If the drift angle is not known, it can easily be found when following a VOR radial, or ILS beam, using either the autopilot or the Director Horizon. In this case, the Heading Index is set to the appropriate Compass Datum, and the Heading Pointer will become established at some setting away from it, dependent on the wind velocity, the aircraft being somewhat displaced from the desired beam. If the Heading Index is then set over the Heading Pointer, the correct drift is set and the aircraft will move on to and track along the required beam.

Also provided on the Beam Compass Indicator are the warning light, indicating lack of coincidence between the two elements of the Twin Compass System, and a warning flag to indicate when the D.G. function is selected and magnetic monitoring is not operative on that half of the Twin Compass.

Director Horizon

Basically the Director Horizon is a repeating artificial horizon on which pitch and roll elements have been separated: however, the presentation as a whole remains conventional (Fig 5). The Horizon Bar rotates in the conventional sense about a fixed point of pivot at the centre of the dial to indicate bank angle. In association with the Horizon Bar, a Bank ringsight moves over a scale around the lower edge of the instrument face to indicate the precise angle of bank, the ringsight remaining always on a line normal to the Horizon Bar. The Pitch Pointer moves up and down over the central Pitch Scale to indicate nose up and nose down attitudes. The central datum of the movement of the Pitch Pointer is provided by the point of pivot of the Horizon Bar. The relative positions of the Pitch Pointer and the Horizon Bar provide a conventional statement of aircraft attitude, as shown on a conventional artificial horizon. In association with the Bank Ringsight, an Azimuth Director Pointer also moves over the Bank Scale, within prescribed limits of maximum bank angle.

To follow the Director signal, all the pilot has to do is to apply bank in the same direction as that needed to move the ringsight on to the Director Pointer, and then to control the bank angle to hold the Bank Ringsight over it, using control in the natural steering sense. In the absence of any radio facility selected, the Azimuth Director Pointer is controlled by a heading error signal derived from the difference between the actual heading of the aircraft, and the setting of the Heading Index on the Beam Compass. Compliance with the Director signal will turn the aircraft on to the heading to which the Heading Index is set.

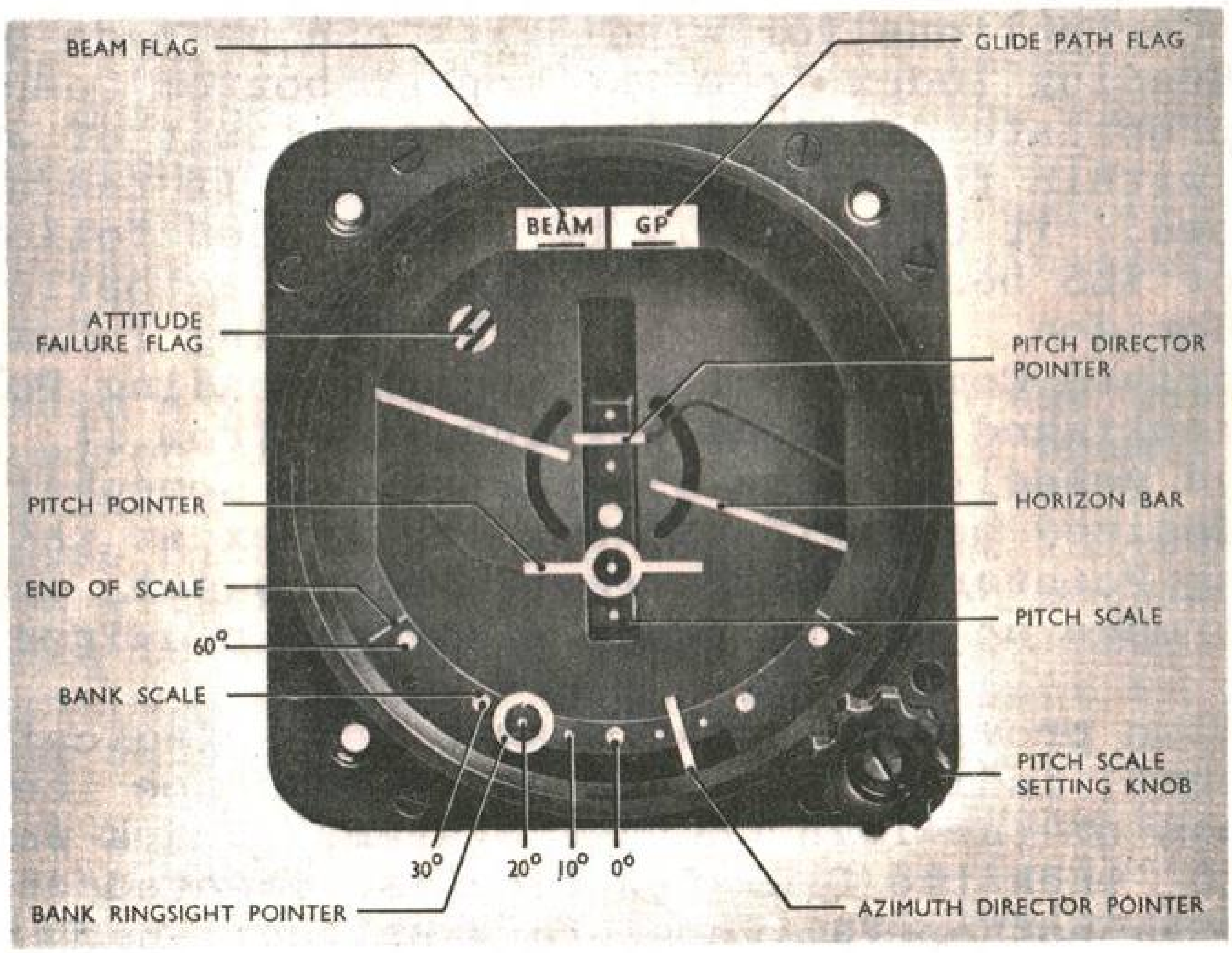


Fig 5 Director Horizon

In association with the Pitch Pointer, a Pitch Director Pointer moves over its own scale. In the absence of the necessary radio signal, the Director Pointer comes to rest over the centre of the scale. Both scale and Director Pointer can be moved up and down together, behind the Pitch Pointer, by rotation of the Pitch Scale Setting Knob. For normal flying, the centre of the Pitch Scale will, in general, be set over the point of pivot of the Horizon Bar. However, it can be set up or down to provide a fixed datum over which to hold the Pitch Pointer if the pilot wishes to maintain a given aircraft pitch attitude for any length of time. The Flight Director control on glide path is by a direct relationship between glide path displacement and pitch angle correction. The Pitch Director Scale and the Pitch Director Pointer, are, therefore, the conventional horizontal needle and vertical scale of the ordinary ILS crosspointer meter; the ILS Glide path radio displacement signal being fed direct to the Pitch Director Pointer. Not only does the latter provide the Director signals to the Pitch Pointer, but also, by virtue of its own movement over the scale, it provides the basic radio displacement information on a glide path in the conventional sense. To function as a Director needle,it is necessary for the centre of the scale to be set to the appropriate pitch angle needed during the glide path phase of the approach. This is achieved by turning the setting knob until the scale reaches a stop, set to the correct pitch angle.

To follow the Pitch Director Pointer, in the presence of the appropriate radio signals, all the pilot has to do is to move the nose of the aircraft up or down in the same direction as that needed to move the Pitch Pointer on to the Pitch Director Pointer, and then to control the pitch angle to hold the Pitch Pointer over it, using control in the natural sense.

Attitude is indicated to the pilot in pitch and bank by the Director Horizons. These indicators repeat pitch and bank information transmitted to them individually by two remotely mounted gyro verticals. These gyro verticals are carried on a common mounting,and the information transmitted to each indicator is monitored against that transmitted to the other. In the event of a discrepancy in pitch information of over 3°, or in bank information of over 5°, then warning of misalignment between the two systems will be given by the appearance of the Horizon Warning Flags on both captain's and co-pilot's indicators. These warning flags will also appear with a power supply failure of either or both systems. In the event of the Horizon Warning Flags appearing, the pilot should check each indicator in turn against his basic rate of turn and rate of climb indicators, to determine the nature of the failure. When it has been established which Director Horizon is in error, the flight should be continued with reference to the correctly functioning one only.

ILS and VOR Indication

As stated earlier, the SFS incorporates within the Beam Compass and Director Horizon indicators the two elements of the conventional ILS cross pointer indicator. The vertical needle, for use with localiser or VOR radial displacement signals, being replaced by the Radio Displacement Bar of the Beam Compass, and the horizontal needle, for glide path signals on ILS, being incorporated into the Director Horizon. It should be noted that the indications given by these two pointers are identical with the indications given by the needles of the conventional ILS cross pointer indicator, and that no computed signals or other changes are made to them.

Signal Indicator Flags for use with radio beam and glide path signals are incorporated into the Director Horizon Indicators. Normally, if the SFS selector is set to radio off, no flags will be shown on either indicator. If the selector is set to provide radio signals into the Flight System from one of the navigation receivers, then, in the presence of signals of appropriate strength, flags labelled "Beam" (for VOR radial or ILS localiser) and "G P" (for ILS glide path) will appear at the top of the indicator to show that adequate signals are present for use. If the signals coming from the navigation receiver are of inadequate strength, or if there is some fault in the radio system, then the flag will flicker in and out indicating the presence of a fault. In the case of the glide path flag, no signals will be indicated until the Setting Knob on the Director Horizon is rotated to set the glide path scale fully down against the set stop, in the position to which it must go for final approach.

It will be noticed that the conventional use of flags as warning indicators has not been continued in the Smith's Flight System. In this case the flags are used as signal indicators, coming up in the presence of a suitable signal. If no flags are shown at all, this is an indication that radio has not been selected to the system. If radio has been selected, but the signals are not sufficiently strong, or if there is a fault, then the appropriate flag will flicker, providing maximum warning to the pilot.

SEP 2 Autopilot

The SEP 2 autopilot makes use of its own stabilizing system, so that the Director Horizon attitude indications may be used to check the autopilot. Heading signals are fed to the autopilot from the Beam Compass selected; thus, the autopilot will hold any heading on which it is brought to rest by normal control. If the "alter heading" button is pushed for two seconds, the autopilot will turn the aircraft so as to align the Heading Pointer and the Heading Index of whichever Beam Compass has been selected for heading control. Once the turn has been completed, a new heading may be pre-selected and the autopilot will not commence turning until the "alter heading" button is pushed again.

For procedural and radio coupled manoeuvres, operation of the Beam Coupling Switch (Fig 5) selects the autopilot to be controlled by the heading signals from the Beam Compass, and in addition, when coupling to a radio beam, by signals from the receiver in use.

CONCLUSION

This is rather an involved subject to grasp at the first glance, containing as it does so many inter-related components. Nevertheless, it may be seen from what has been written that the SFS does in fact bring flight director, radio aids and autopilot all into a unified scheme. Moreover, the presentation to the pilot is simple and of a kind which allows him to monitor the working of the whole or its parts.

A Book Review
By Flight Lieutenant D.L. Munro
Defence Research Board

The book, "Arctic Canada from the Air", by Moira Dunbar of the Geophysics Section, Defence Research Board, and W/C Keith R. Greenaway CD RCAF, has recently been published by the Queen's Printer and will soon be available for general distribution. The authors have collaborated to produce a book primarily intended as an aid to map reading from the air and as a source of general information for airmen flying in the Canadian Arctic.

The authors are very well qualified to write on Arctic Canada. Miss Dunbar, a geographer, has spent the last ten years with DRB engaged on work directly connected with these regions. She has also done considerable travelling over this area by both aircraft and icebreaker and thus has acquired a well-rounded appreciation of the conditions that exist. In addition, her intense enthusiasm for everything to do with polar regions has resulted in extensive research into the manuscripts, diaries, and historical records of expeditions conducted in this forbidding and frequently hostile environment.

W/C Greenaway has had many excellent articles published in past issues of the OBSERVER and, I am sure, needs no introduction to OBSERVER readers. In addition to being one of the top navigators and Arctic experts in the RCAF, his book, "Arctic Air Navigation", has become a standard reference text in Canada, the US, the UK, and other western countries. W/C Greenaway's extensive knowledge of arctic aviation, gained while flying with the RCAF and USAF, has enabled him to give the reader of his latest book sound practical knowledge - knowledge which, by the hard school of experience, is frequently more hazardous to come by.

In 1948, the Joint Intelligence Bureau published "An Aerial Reconnaissance of Arctic North America", by F/L K.R. Greenaway, RCAF, and Lt. S.E. Colthorpe, USAF. This book was intended to give other airmen the benefit of the author's experience gained while flying over the Canadian Arctic at a time when maps were inaccurate and the air photography programmes were only beginning to reach the area. Now the position is completely changed; complete photographic coverage is available and the maps have either been revised or are in the process of revision so that the original book is now outdated. The present work, which was undertaken at the request of the RCAF, is in no sense a revision of the first but is intended to replace it. It is based on the personal experience of the authors combined with an exhaustive study of aerial photographs and all available literature on these regions.

The current book covers that part of Canada lying north of the tree line. This is an area of over a million square miles, about half of which is on the mainland and half in the Canadian Arctic Archipelago. The book is divided by area, with each region, island or group of islands occupying a separate chapter; however, more emphasis has been placed on the archipelago than on the mainland since aircrews are generally better acquainted with the mainland. Each island has been divided into physiographic regions - and in some cases this is the first time such a breakdown has been attempted - therefore it is hoped that the book may be of interest to geographers and others as well as airmen. Brief historical sketches are also included for general interest.

Water covers a high percentage of the Canadian Arctic and unless, as is too often the case, the seas are to be regarded as mere spaces between the land areas, they must be covered in any geographical description. Therefore, the authors have included chapters on the seas of Arctic Canada as well as on the Arctic Ocean.

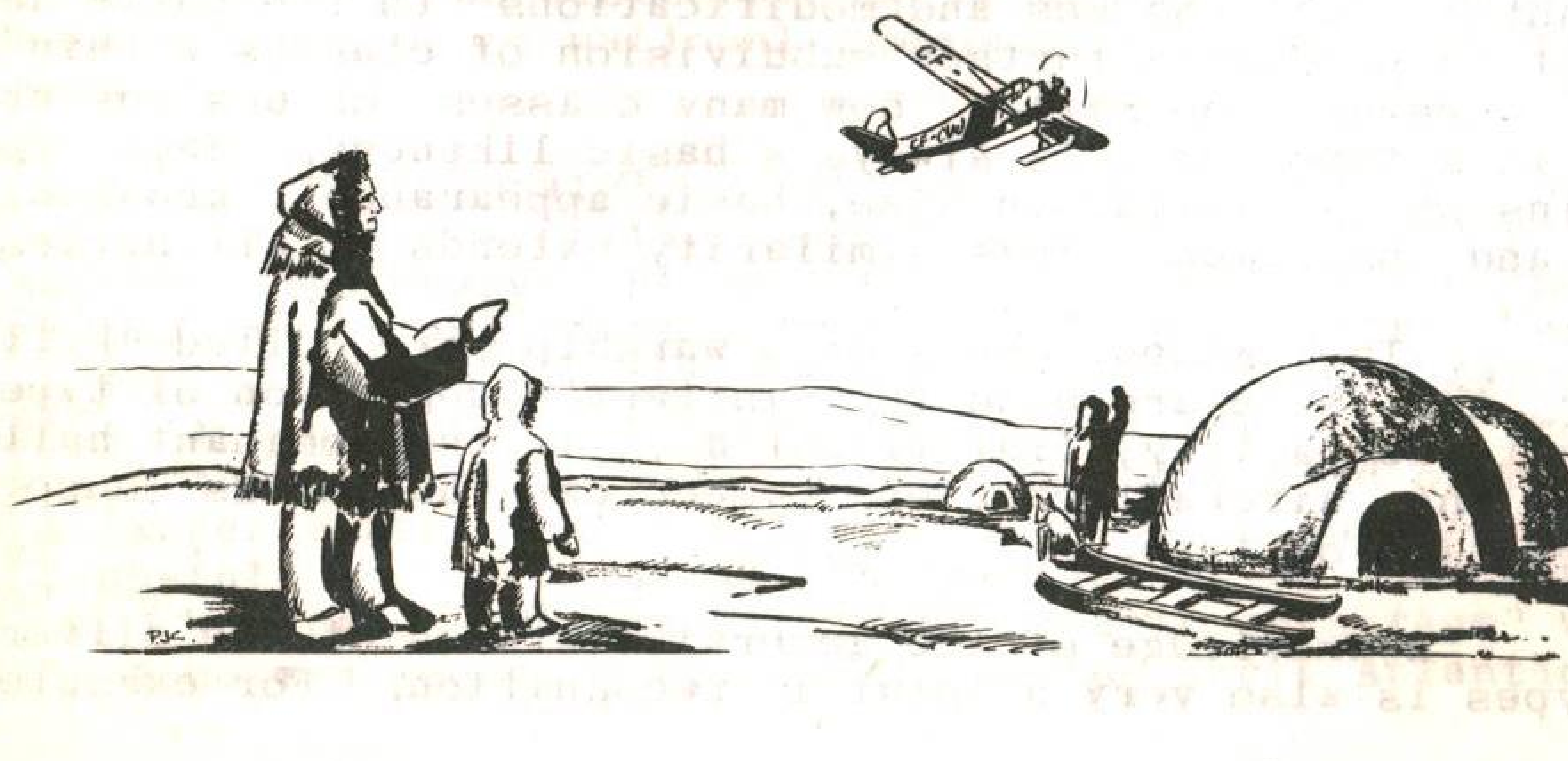
The Canadian Arctic is one of the last areas in the world to become accurately known. Although exploration has been going on since 1576, mapping was, until very recently, poor and incomplete. Major inaccuracies have been corrected within the last few years and as late as 1948 three islands in Foxe Basin, about 5,000 square miles in area, were added to the map for the first time. Indeed the period of actual discovery may be said to have ended only about 1953, with the completion of the RCAF photo survey programme; however, detailed exploration on the ground is certain to continue for many years.

The authors consider that, broadly speaking, the history of exploration in the Canadian Arctic falls into four phases, each associated with a specific motive which gave the impetus to exploration. These are: the search for the Northwest Passage; the attainment of the North Pole; the search for the missing Franklin expedition; and, exploration for its own sake, or what may be called scientific exploration.

Weather is always of the first importance in flying operations, and especially so in the Arctic, where scarcity of airfields and other facilities make the airman dependent on his own resources. As airman operating in this region are often based elsewhere and do not have daily experience of Arctic weather, it has been thought desireable to devote a chapter to its description. However, since whole books can be, and have been, written on the Arctic Climate, the present book does not attempt to cover the subject exhaustively, nor does it treat it from the weather experts' viewpoint, but solely as it affects the airmen.

Aircraft have played an enormous part in northern exploration and settlement. The mapping of arctic lands and the exploration of the inaccessible Arctic Ocean have been immeasurably speeded up since the advent of air transport, and so have the northward progress of settlement and development of resources. It is in this latter field that Canada has made aviation history. The book includes a chapter on the history of aviation throughout the Arctic; flying in Canada being dealt with in slightly greater detail.

In the reviewers opinion "Arctic Canada from the air" is a notable achievement. The authors have presented a great amount of valuable material in a way which is both interesting and informative. The ever increasing importance of the Canadian Arctic makes this book invaluable to both civil and military airmen and to planners in many fields. There is no doubt that it will become internationally accepted by airmen and others as a standard reference text on this region of Canada.



SHIP RECOGNITI

WARSHIPS

Here we are in another issue continuing our heresy. Luckily we haven't, as yet, been hung by irate readers nor even transferred by Sgt. Shatterproof's nemesis - THE BRASS. Therefore we can only assume that our last article found some interested readers or that it was dismissed as the ravings of an unbalanced mind (brought on, no doubt, by too many deadlines with not enough material to fill the OBSERVER). Ah well, on with our tale!

The process of distinguishing one warship from another is somewhat different from that described for merchant ships. You will recall that merchant ships were categorized by the size, shape, and position of various features, such as the masts, funnels, bow, stern, hull form and profile. Warships, on the other hand, are recognized primarily by determining the type and nationality of origin.

Determining the Type

All warships which are designed and built to perform a common duty make up a type. The most common of these are: the aircraft carrier, battleship, cruiser, destroyer, escort, minesweeper and submarine. The larger navies also employ many ships for specific purposes which are collectively called "auxiliaries". Each type of ship is normally built in quantity but changes and modifications to the basic design often produce a further subdivision of classes within a type. However no matter how many classes or designs are found in a type there is always a basic likeness. Each type contains ships similar in size, basic appearance, armament, speed and complement. This similarity extends to all navies.

The boldest parts of a warship are called "hallmarks" and these are used for instant recognition of type. For instance, a long, flat flight deck is the dominant hallmark of the aircraft carrier. Secondary hallmarks supply confirmation of type.

A knowledge of the general features of the different types is also very helpful in recognition. For example,

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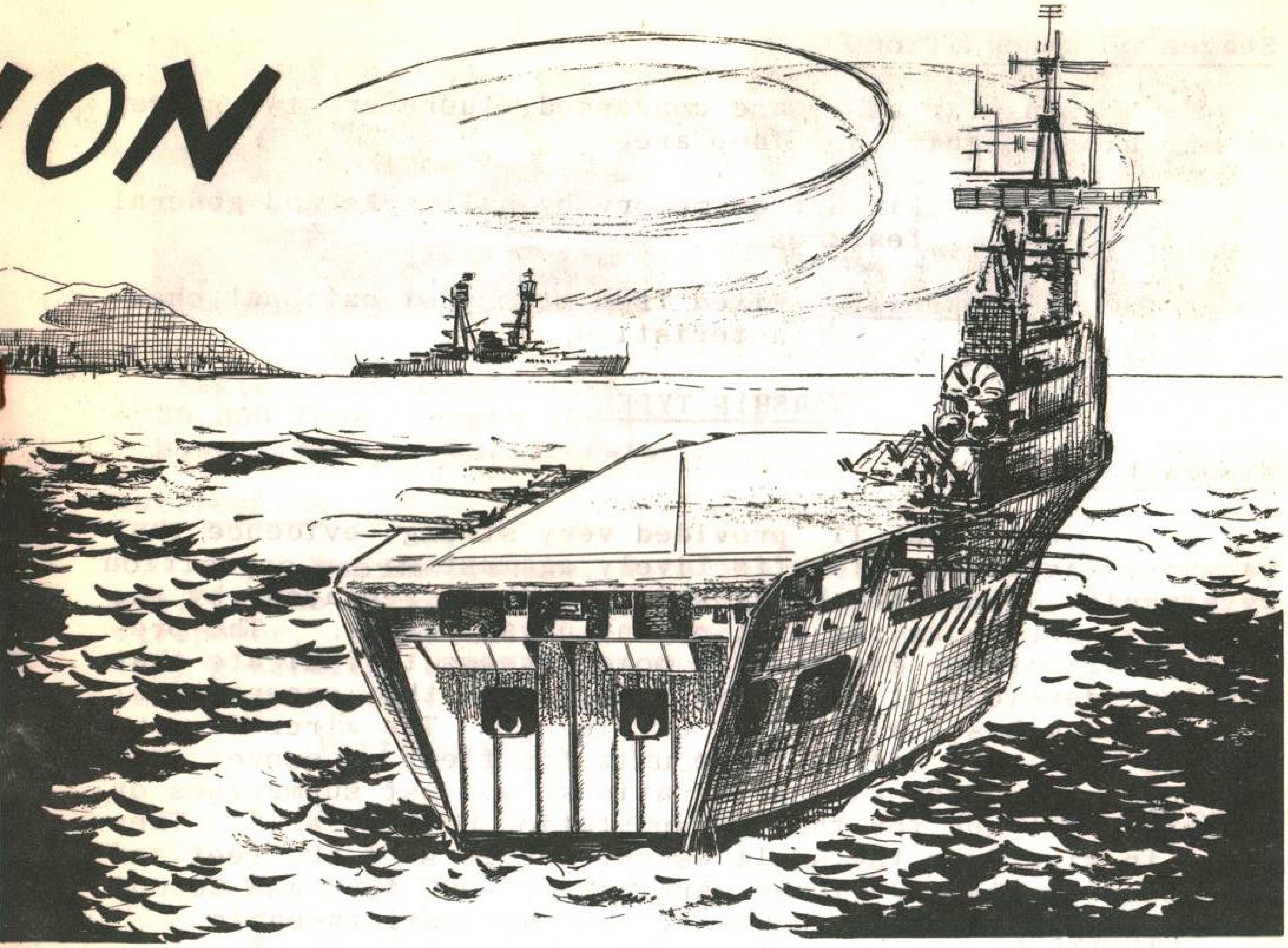


when you know that no battleship has more than two funnels, you will not make the mistake of identifying a three funnel warship as a battleship.

Determining the Nationality

The warships of the larger navies possess certain characteristics in outward appearance which allow the ships of each navy to be distinguished from those of other navies. These evidences of national identity are termed "national characteristics".

Unfortunately, national characteristics are not fool-proof for recognition purposes. Following World War II many warships changed hands; the victors seized the ships of Germany, Italy and Japan. In addition, Russia still possesses many US ships loaned during the war. Also, many small ships are on permanent loan to the smaller navies from the larger ones. Finally, many ships have been sold outright by the larger powers. This situation serves to nullify some of the usefulness of national characteristics as a recognition tool; however, they can still be used to advantage with a little common sense, particularly in the North Atlantic area.

Stages of Recognition

Insofar as we are concerned, there are two stages of warship recognition. They are:

TYPE - Fixed from memory by hallmarks and general features.

NATIONALITY - Fixed from memory of national characteristics.

WARSHIP TYPES

Aircraft Carriers

World War II provided very strong evidence that warships cannot operate effectively against strong opposition by aircraft, thus the battleship has been replaced by the aircraft carrier as the most potent naval vessel. The present policy of the major naval powers seems to indicate that carrier development will continue (with the exception of Russia which has few, if any, carriers). The aircraft carrier is used as a strike force unit,for fleet or convoy protection, in hunter-killer operations against submarines or surface craft and for the transportation of aircraft. They range in size from the small escort carriers of 500 feet and 8000 tons to the very large carriers of 1000 feet and 60,000 tons. Recognitionally, however, they are unmistakeable.

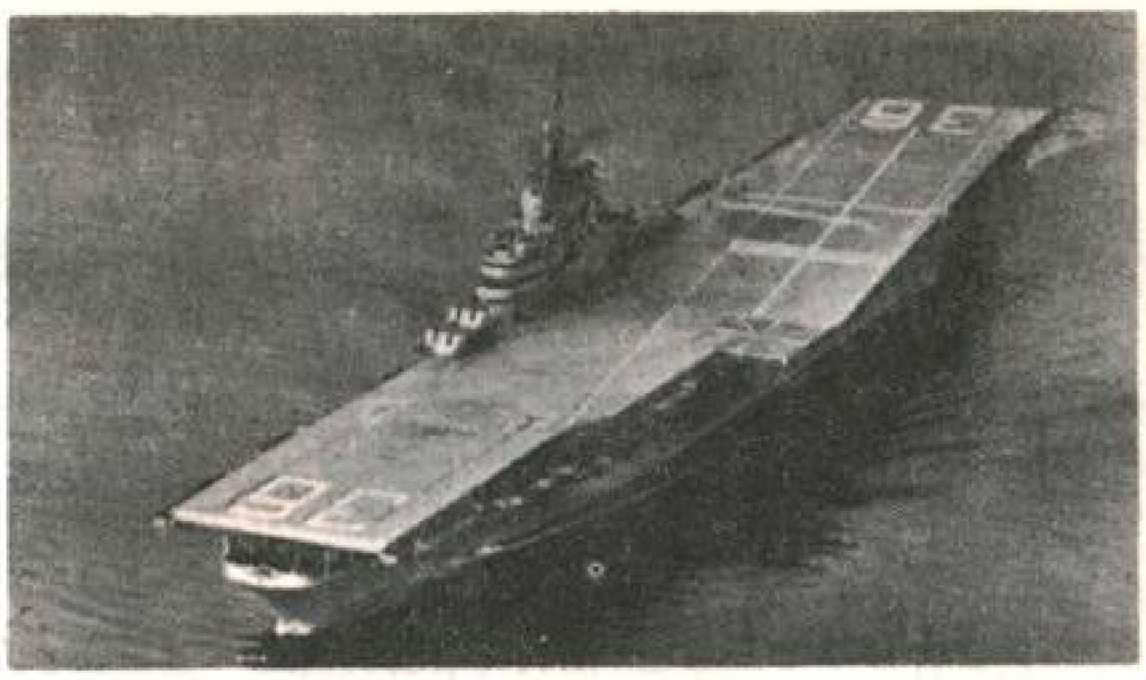
Carrier Hallmarks

- Superstructure is compact in an island which is always situated on the starboard side.
- Deck plan rectangular, or on newer carriers it may be "angled".
- Long, flat flight deck.
- Large freeboard.

General Features

- The flight deck is usually cantelevered or extended over the stem and stern, but it may be slightly shorter than the hull at the bow.
- The island superstructure ranges in length from 1/6 of the length in large to 1/12 of the length in smaller types. Some small carriers have no island at all.
- Funnels are usually integrated with island superstructure and in some cases may not be visible at all.

British
Eagle - Ark Royal Class
36,800 Tons Length 808 Ft
Beam 113 Ft 50 Aircraft



American Essex Class
33,000 Tons Length 888 Ft
Beam 147 Ft 93 Aircraft

Battleships

The Battleship, with the exception of a few carriers, is the largest warship afloat. It is designed for heavy firepower, outmatching all other warships in this respect. They generally displace 30,000 to 45,000 tons and range in length from 600 to 900 feet.

Battleship Hallmarks

- High massive superstructure, towering amidships.
- Long forecastle and quarter deck.
- Broad beam (ranges from 1/6 to 1/8 of length)
- Seen from above, sides curve continuously from bow to stern.
- Conspicuous large caliber gun turrets fore and aft.

General Features

- High freeboard with an unbroken deckline in most cases (French ships are an exception).
- Concentration of secondary armament along each side amidships.
- Aircraft catapult and crane located aft or amidships.
- Funnels vertical and never more than two.

Cruisers

Cruisers serve in various roles and outclass all other warships except the carrier and battleship. They normally range between 500 and 650 feet in length and displace from 4000 to 20,000 tons.

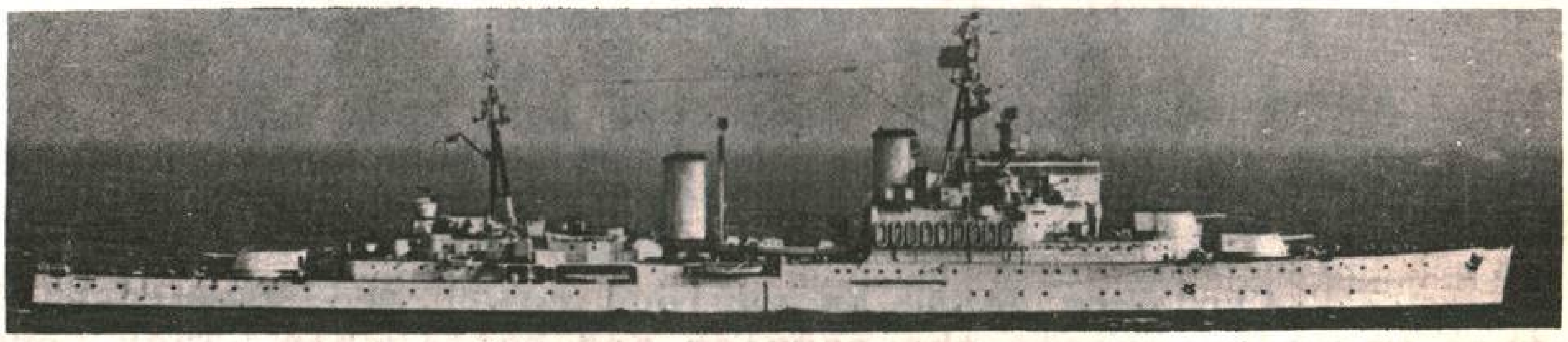
American
Iowa Class

Cruiser Hallmarks

- Superstructure spread out along the length of the ship.
- The superstructure is often found in two humps rather than one as in the battleship and there is usually a noticeable break between funnels.
- Forecastle and quarterdeck are prominent but not as much as on the battleship.
- The bridge is the dominant feature, usually square, but not too towering.
- The beam is normally 1/9 to 1/11 of the length and the sides generally curve continuously from bow to stern.
- Gun turrets are prominent but again not as much as on the battleship.

General Features

- One to three funnels, but usually two. They may be raked or vertical, and are often of different lengths and dimensions. The foremast funnel is sometimes broad, trunked or combined.
- Fairly high freeboard. A break in the deckline is quite common in British cruisers.
- Aircraft catapult and crane amidships or at stern.



Canadian Colony Class (HMCS Quebec) Length 555 Ft Beam 62 Ft

Destroyers

The destroyer can correctly be called the "work-horse" of any navy. Although they cannot be classed as capital ships they do carry very effective armament, usually five and three inch guns,plus torpedo tubes and AA batteries Their speed is generally greater than other ships; 30 to 35 knots can be expected from most, and some new destroyers exceed 40 knots. These ships are seldom operated independently but form "flotillas" that provide a screen for the protection of larger ships. They range from 600 to 2500 tons and from 250 to 430 feet in length.

Destroyer Hallmarks

- After part of ship very low in silhouette.
- Bunched up bridge superstructure placed well forward.
- Gaps aft of bridge to accomodate torpedo tubes on the main deck.
- Beam is 1/10 of length,pencil shaped with straight sides for part of the length.
- Small gun turrets.

General Features

- Very noticeable freeboard foreward but very little aft of the bridge. The break in the deckline usually occurs about 1/3 of the length from the bow.
- One or two funnels, rarely three. Foremost funnel is close to the bridge sometimes trunked. They are usually raked and may not be of the same size or dimensions.
- Often only one mast. of either the pole or tripod type, situated immediately aft of the bridge.
- Miscellaneous gear, such as depth charges and torpedoes, near the stern.

American Gearing Class - 3500 Tons, Length 390 Ft,Beam 41 Ft

Large Escorts

This type includes nearly all ships that are about the size of a destroyer and that were designed or converted for convoy escort duties. Included are destroyer escorts, frigates, and converted destroyers. In general, they differ from the destroyer in having less prominent gun turrets, a box-like superstructure and comparatively unpleasant lines. They are 250 to 350 feet long and since their target is the submarine their main armament consists mainly of anti-submarine weapons.

Large Escort Hallmarks

- Box-like bridge placed at the end of a short forecastle.
- Generally one, but sometimes two funnels situated halfway along the ship's length.
- Gun turrets are small and inconspicuous and sometimes not noticeable at all.
- Freeboard often quite high.

General Features

- There may or may not be a break in the deckline. But if so it is often 2/3 of the length from the bow.
- Masts light and of varying construction.
- Unclean appearance created by the anti-submarine gear fore and aft.

Small Escorts

This type includes minesweepers and corvettes that do not run more than 250 feet in length. The small escort is lightly armed, slow, and a poor opponent for the modern submarine.

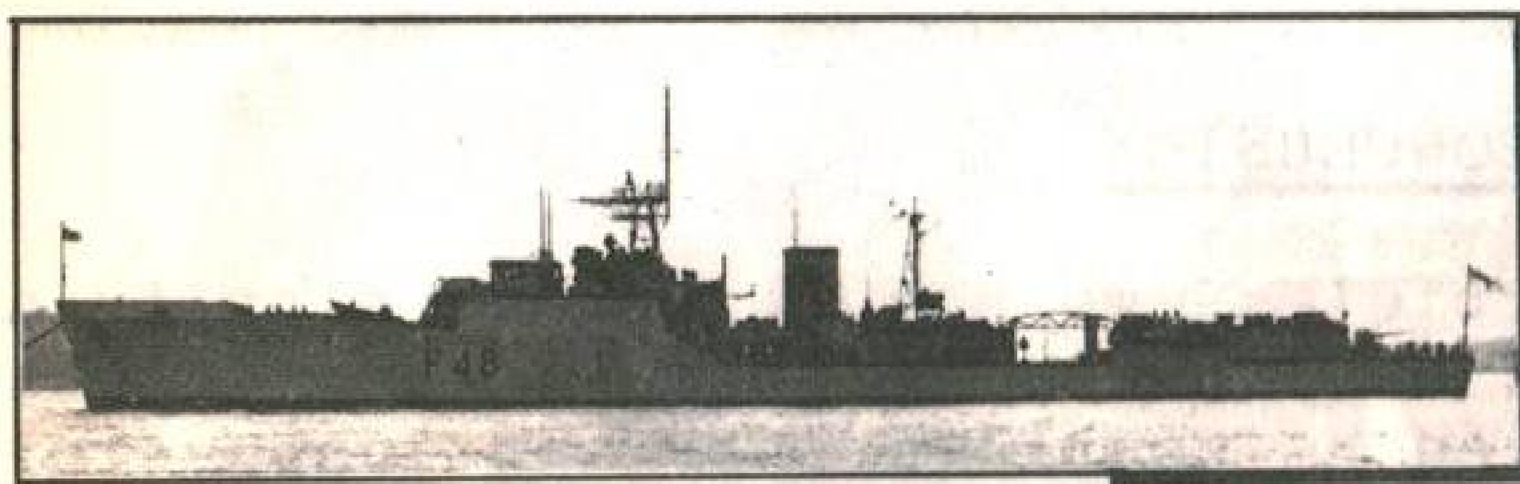
Small Escort Hallmarks

- Square and prominent bridge.
- Dumpy appearance and cluttered decks.
- High bows.

General Features

- Usually a break in the deckline amidships or 2/3 of the length.

- Single funnel amidships or slightly forward of that point.
- Limited armament (often only one deck gun).
- Depth charge gear or minesweeping apparatus on stern.
- Light pole masts.



British Blackwood Class
Anti-Submarine Frigate
Length 310 Ft Beam 33 Ft

British Coniston Class
Coastal Minesweeper
Length 152 Ft Beam 29 Ft
360 Tons

Submarines

The submarine is unmistakeable but the problem of determining size and nationality is extremely difficult. They are generally 150 to 325 feet in length and displace 250 to 2500 tons.

Submarine Hallmarks

- Prominent streamlined conning tower amidships.
- Little or no freeboard - conning tower appears to sit on the water.
- Forecastle and aftercastle usually of the same length and awash.
- View from above -pointed at both ends with a broad beam.
- Little or no deck armament.

General Features

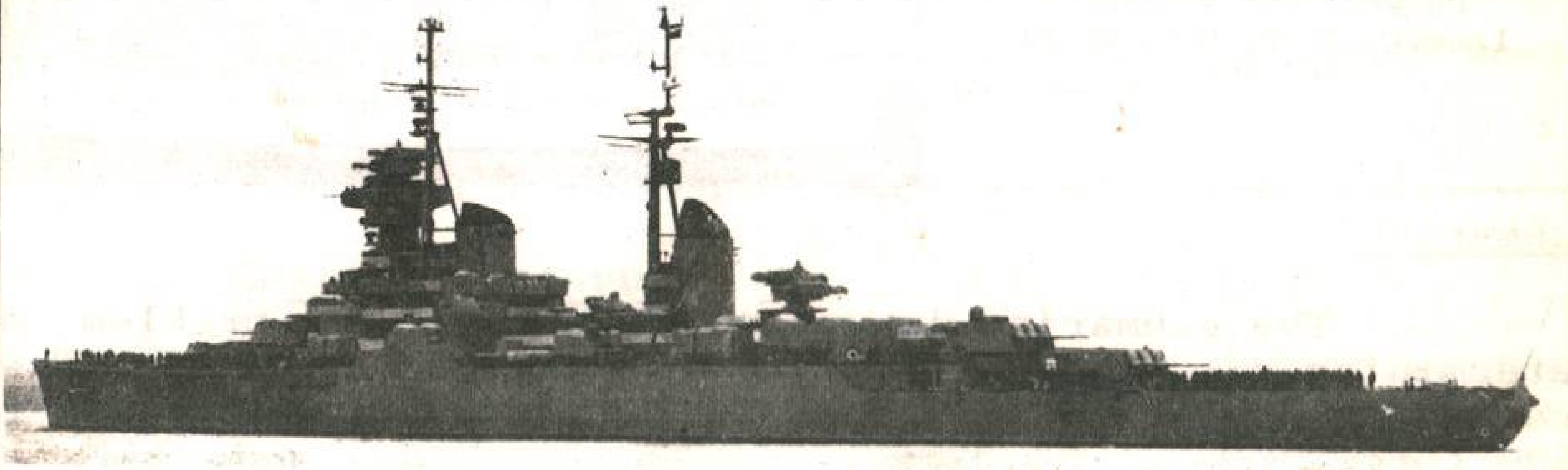
- All masts, periscopes, radar masts, snorkels etc project up through the conning tower.
- Guns, if any, mounted in the conning tower or immediately adjacent to it without shielding.
- Deck clean and uncluttered.

Auxiliaries

The larger navies employ many ships designed to fulfil a specific purpose or function, usually to do with logistics. Although these ships may vary greatly in size and purpose they are known collectively as "auxiliaries". Some of the ships in this category are: salvage and repair vessels, tank and troop landing ships, hospital ships, tenders and supply ships, transports, tugs, icebreakers, minelayers, etc, etc.

CONCLUSION

In these two articles we have tried to clarify a few of the basic points of ship recognition. The descriptions should neither be considered as complete nor all-inclusive; but should be used as a basis for building a sound knowledge of the principles of ship recognition.



Soviet Sverdlov Class Cruiser
Length 690 Ft Beam 65 Ft

Soviet Skory Class Destroyer
Length 420 Ft Beam 41 Ft
3000 Tons

HMCS St Laurent
A/S Destroyer Escort
2600 Tons Length 366 Ft
Beam 42 Ft

17 SORI

12 NOV 57 - 28 FEB 58

Back Row

F/O JS Cliffe, F/O DAH Bentley, F/O CB Fletcher, F/L JA Pulfer

Front Row

F/O HE Jones F/O ED Teiman F/O DAA Hache F/O EE Boyd

DELRAC, meaning DEcca Long Range Area Coverage, is the third of the ground based electronic fixing systems developed by the Decca Navigator Company.[1] It is designed to provide high-accuracy position fixing coverage for ships and aircraft throughout the world. It uses the VLF frequency band, and transmits from Master/Slave pairs placed on a 1,000 nm baseline to produce families of hyperbolae representing equal phase relationships. The readings may be displayed on decometers or a flight log.

Each pair of stations has a 3,000 nm range, even in regions of high atmospheric noise, using a 5KW output. The accuracy for the system is expected to be 10 nm or better at the 95% probability level. The time and frequency sharing techniques employed in the system permits the use of a very small number of frequencies, and 21 pairs of DELRAC stations can be accomodated in the VLF Navaids band of 10 - 14 Kcs. An interesting feature of the equipment is the form of lane identification, in which the ambiguity inherent in the fine hyperbolic pattern, on which the system accuracy depends, is resolved in two or three stages by superimposing successive patterns three, nine, and possibly twenty-seven times coarser. This process, according to the Decca company, gives the high accuracy of the continuous wave hyperbolic technique with a virtually unambiguous fix.

Principle

DELRAC is a long-range fixing aid using time and frequency sharing transmissions on a group of three, or possibly four, frequencies in the VLF band by stations in Master/Slave pairs. The bursts of CW from each pair are phase

1. Editor's Note: The other systems DECCA and DECTRA appeared in the April and July 1957 issues of the RCAF OBSERVER.

locked so that the receiver is merely required to phase compare the signals received to provide inputs to a decometer or flight log.

Transmissions. The groups of frequencies transmitted in turn are bursts of CW, first from the Master, then from the slave. As each successive burst is received its frequency and phase is separately "stored" by local crystal oscillators in the receiver for subsequent comparison. The initial burst would be on frequency F (approximately 12 Kcs) and each station would then transmit, in turn, on the following frequencies:

$$F_1 = F(1+\frac{1}{n}); \; F_2 = F(1+\frac{1}{n}2); \text{ and possibly } F_3 = F(1+\frac{1}{n}3)$$

Where 'n' is the "tolerable ambiguity ratio" between one pattern and the next. The Decca Company have proved by experience that 'n' should not exceed 3, and sample frequencies transmitted would, therefore, be as follows:

$$F = 12 \text{ Kcs}; \; F_1 = 16 \text{ Kcs}; \; F_2 = 13\ 1/3 \text{ Kcs}; \; F_3 = 12\ \frac{12}{27} \text{ Kcs.}$$

Time-Sharing Techniques. The transmissions of the second pair of stations for a particular fixing lattice are interlocked with those of the first station pair. The second pair of stations would use transmitting frequencies of the same values as the first pair, but staggered in time to give the second position line. This time sharing could result in a fast moving aircraft, on occasion, noticing the decometers moving in small jerks, but this would present no operational limitations and would not impair operation of a flight log. A possible transmission schedule for a three frequency, six station scheme is shown in Fig 1.

FIGURE 1

TIME →

PERIODS →		1	2	3	4	5	6	1	
MASTER	A	F	F1	F2				F	→ and so on →
SLAVE	B		F	F1	F2				
MASTER	C			F	F1	F2			
SLAVE	D				F	F1	F2		
MASTER	E	F2				F	F1	F2	
SLAVE	F	F1	F2				F	F1	

Note:- If four frequencies used, F3 should be added after F2 in each horizontal row.

It will be noted that only one frequency is transmitted from any station at a time, though in each period of transmission all three frequencies from various sources are on the air simultaneously. After six periods (approximately 30 secs) the schedule is repetitive. The start of the transmission sequence could be determined by the coded length of the guard periods which are required to allow for switching changes within the receiver or to allow a tolerance on a simple clock to carry out the same function.

Station Layout. The layout of the stations can be arranged to meet operational requirements, with baselines varying between 750 and 1,000 nm. Station layout and radiation patterns are similar to those for Loran, but cover a larger area.

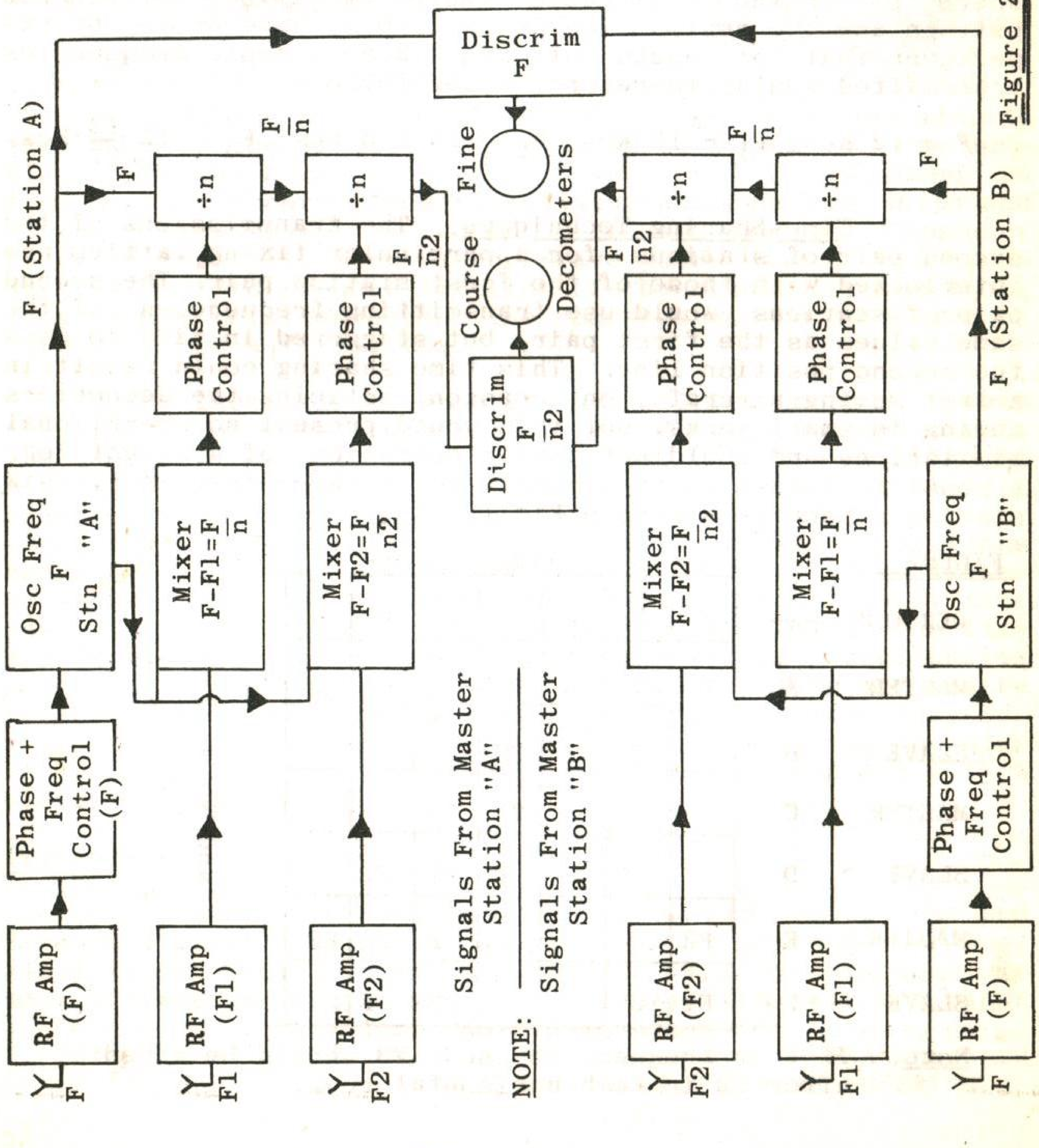


Figure 2

Operation - Receiver

A block diagram of the DELRAC receiver is illustrated in Fig 2. In considering the receiver's operation it is easiest to consider reception from a single Master/Slave pair of stations.

The successive signals of frequency F(12 Kcs) are amplified and fed to control the frequency and phase of stable oscillators A and B, whose outputs are in turn phase-compared in an F frequency discriminator. The "fine" decometer pointer responds to this signal and indicates the fine position-line,while the lanes are counted in the standard Decca manner by a geared integrating pointer. The outputs from oscillators A and B are also pulsed to divider trains containing two or possibly three 'n' dividers (dividing by three).

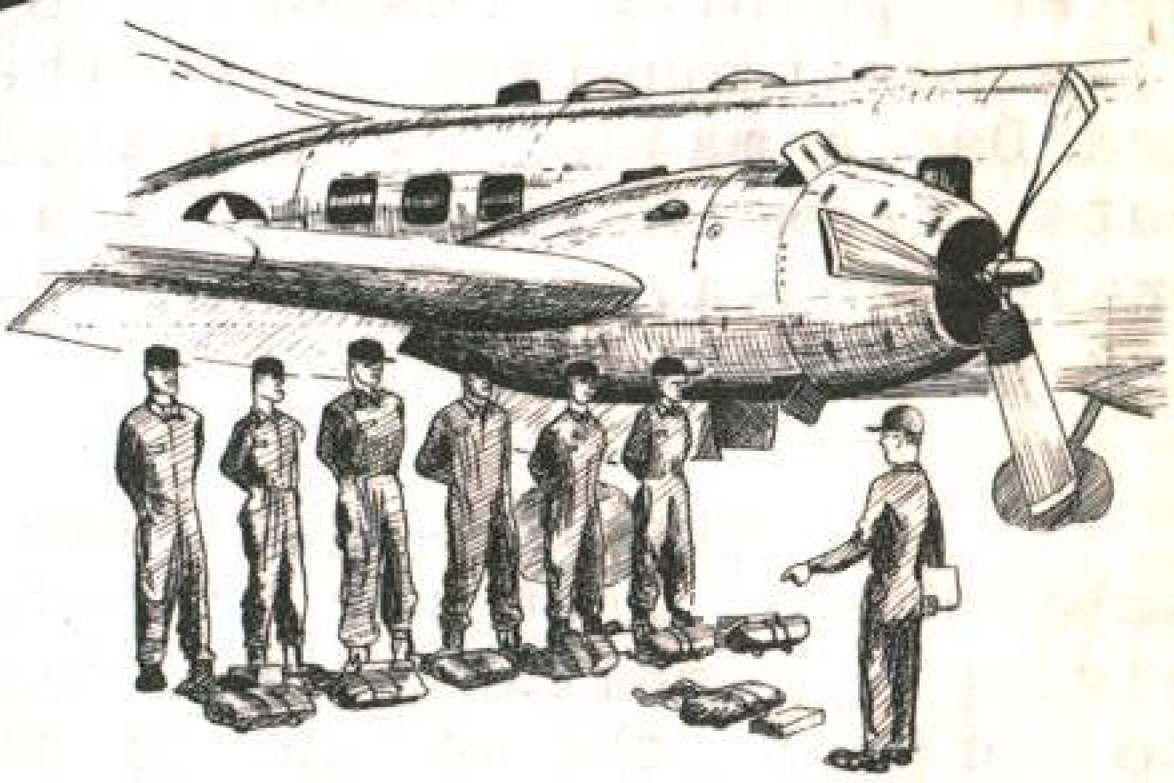
The F_1 signal (16 Kcs) received from the master is subtracted from the F output of the master oscillator A, giving a resultant 4 Kcs beat note. This beat note is used to control the phase of the 4 Kcs signal produced by the first 'n' divider, whose output is effectively three times coarser than the initial F signal. This pattern could be displayed, but instead is again divided by three, controlled by the F_2 signal in a similar manner, giving a pattern nine times as wide. Similarly, should a coarser pattern twenty-seven times as wide be required this can be added through a further 'n' divider, monitored by the F_3 transmissions. These master outputs are phase compared in a discriminator with those from the slave, which have been divided in the same way, and fed to the 'coarse' decometer.

The fine decometer is, therefore, giving a lane-width of approximately 7 nm, while the coarse pattern is either 9 or 27 times as wide,depending whether the two stage (three frequency) or three stage(4 frequency) Lane Identification is used. The use of a double needle decometer should permit fast, accurate reading with the fine needle falling within the sector described by the coarser pattern.

Conclusion

This is DELRAC, a long range, highly accurate system. It appears in theory to be highly prone to jamming, yet in the past considerable difficulty has been encountered when attempting to jam systems such as DECCA. Considering the area of coverage possible using the system world-wide coverage can be attained with approximately two dozen three station chains. It is because of these advantages that the DELRAC system will be one of the systems given serious consideration at the forthcoming ICAO conference on radio aids.

NAVIGATION TRAINING at the USAF ACADEMY



Text and Illustrations
By Flight Lieutenant D.J. Connolly
USAF Academy, Denver, Colorado

The graduate of the USAF Academy is something of a superman. In four years he has accumulated a Bachelor of Science Degree, Navigator's Wings, and the pose, physique, military savvy, and motivation of a twentieth century Prince Valiant. I mention this only to place what follows, a description of the Navigation Training, in its proper perspective. This training is but a part of the overall scheme -the production of a career officer and potential air commander. In fact, one has to look closely at the Academy syllabus to realize that woven within is a navigation course.

If the value of a navigation course is measured in terms of the number of hours of training involved, then this one, at first glance, appears to be built on shaky ground. Although a healthy 175 flying hours are listed, only 475 classroom hours, 20% of them study periods, are scheduled. This apparent deficiency is more than compensated for by the co-operation of the academic faculty. Wherever practicable, the academic training has been flavoured with an aeronautical taste. The celestial sphere, gyro dynamics, coriolis, the geostrophic wind, and cartography are just a few of the topics that are disguised under the veneer of such subjects as mathematics, physics, and graphics. The logical reasoning behind this is: if you are going to teach the students spherical trigonometry, why not use the PZX triangle? And certainly no harm can be done by relating the subject to the practical requirements of the student's career.

With the foundations so solidly laid, the navigation training per se is begun at a fairly advanced level and the flow of knowledge is faster because the students have already been conditioned towards the subject. The momentum attained by this faster pace carries the cadets to a level of training roughly on a par with SONI, and in some topics, even above SpecN level. He lacks the experience of these two august bodies, but his theoretical training leaves him with a fast-growth potential.

This by no means implies that the flight training is weak. On the contrary, the 175 hours are spent very profitably. In keeping with the navigational policy of Strategic Air Command, and the USAF generally, much emphasis is placed on celestial navigation. The cadet also becomes adept at radar navigation using the APQ-24 Radar/Automatic Navigation system. In his final year at the academy, he flies for 112 hours on missions designed to exercise all the techniques and skills he has learned in the previous two years. One highlight of this final flying phase will be a trip to Bermuda or Florida, on which he will practice pressure pattern techniques and loran fixing.

Although the cadet graduates as a rated navigator, much emphasis is placed on his ultimate training as a pilot. All those who are still physically qualified upon graduation from the Academy (and it is eyes that will no doubt be the biggest stumbling block) will proceed to a pilot training school. As a means of motivation towards this end, the cadets spend two weeks of their second summer training period at a pilot training school. They do not solo during this period, for the flights are mainly for orientation and motivation purposes, but they do amass about 10 - 11 flying hours in T-28 and T-34 aircraft. They are also encouraged to maintain interest in piloting during the remainder of their tour at the Academy. To lend a hand, the Academy supplies four Schweizer sailplanes and a tow aircraft for the use of the Cadet Soaring Club. As the student body grows in size this number will be increased to ten. Cadets are also allowed to fly rented light aircraft when time and money permits.

The aircraft used for the navigation training is the Convair T-29C. On a typical mission the crew consists of two pilots, a flight engineer or crew-chief, one staff navigator, an instructor navigator, and six students. The staff navigator works independently, keeping accurate track of the aircraft's position by using radar and pinpoints. This information is later used by the instructor in grading the student's logs and charts. Because the students' plotting can therefore be validly assessed for accuracy, the onus is on effective navigation as well as on procedures and log keeping.

On each leg one student is designated as lead navigator. His only liaison with the other students is to announce the time of any proposed alterations of heading and of his final ETA. The "follow" navigators then establish DR positions for these times. Since all the students are using identical fixing aids and establishing DR positions for the same times, the job of assessing the log and charts is greatly simplified

This system works well; it teaches the students to organize and schedule their work and to co-operate with the other crew members. Since each one is carrying a complete plot and essentially working alone, only one aircraft is needed for the mission. No second navigators are carried along for a joy-ride. Another major benefit of this method is that the work can be instructor supervised at all times. Mistakes in procedure and any weaknesses in equipment manipulation are detected and nipped in the bud. Since the instructor is responsible for marking the students' logs and charts, he is likely to come up with a more valid grade than would his earthbound and remote contemporary in an analysis section. All and all (as if it wasn't already obvious) this system of flying training impresses me very much. It seems economical and effective.

I have also seen much to admire in the way that the USAF approaches the subject of crew discipline and co-operation. Prior to each flight the crew lines up in front of the aircraft for a briefing by the aircraft commander. At this time, safety equipment is inspected, harnesses fitted, and safety procedures are reviewed. The crew is also introduced to the students who are then further briefed on crew discipline, use of the interphone, safety equipment, etc. Throughout the flight the pilot keeps the crew informed of what's happening up front, helps out with the safety drills - which are frequent - and generally inspires co-operation through good leadership.

Now some details on the aircraft itself.

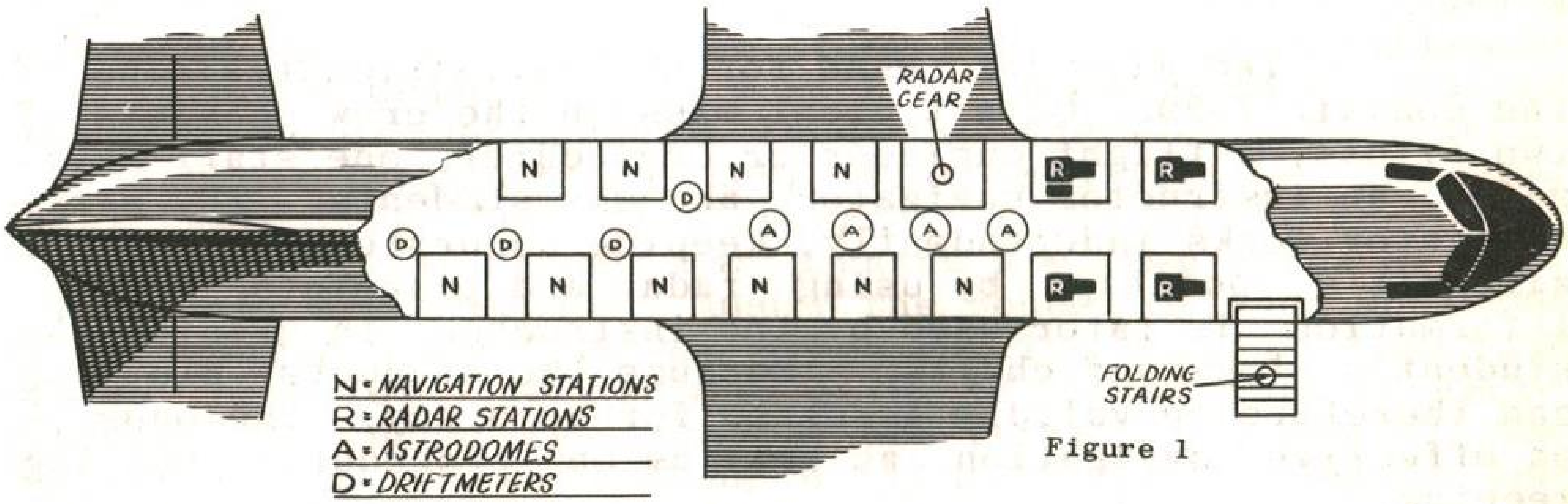


Figure 1

The T-29 is the answer to an instructor's prayer, especially to one who has been weaned on a diet of noisy North Stars and doddering Dakotas. This aircraft can carry fourteen students in pressurized comfort at 200 knots for five to six hours. It has four positions fitted with search radar scopes and ten positions equipped for routine navigation. See Figure 1.

The master radar station is equipped with a complete APQ-24 Radar, Navigation, and Bombing system, similar to the type used in the B-45 Tornado Bomber. Bomb runs can be flown from this station. The navigation desks further aft are fitted as shown in Figure 2. Each desk is equipped with a J2 compass repeater, a pressure altimeter, an outside air temperature gauge, a radio compass indicator, and a TAS meter. In addition, each pair of students can share the use of an APN-70 Loran Set, an ARN-6 Radio Compass, and an SCR-718 Radar Altimeter. These are pivoted to face either fore or aft. There are also four B6 driftmeters and four astrodomes in the aircraft. One astrodome is fitted with a periscopic sextant mount.

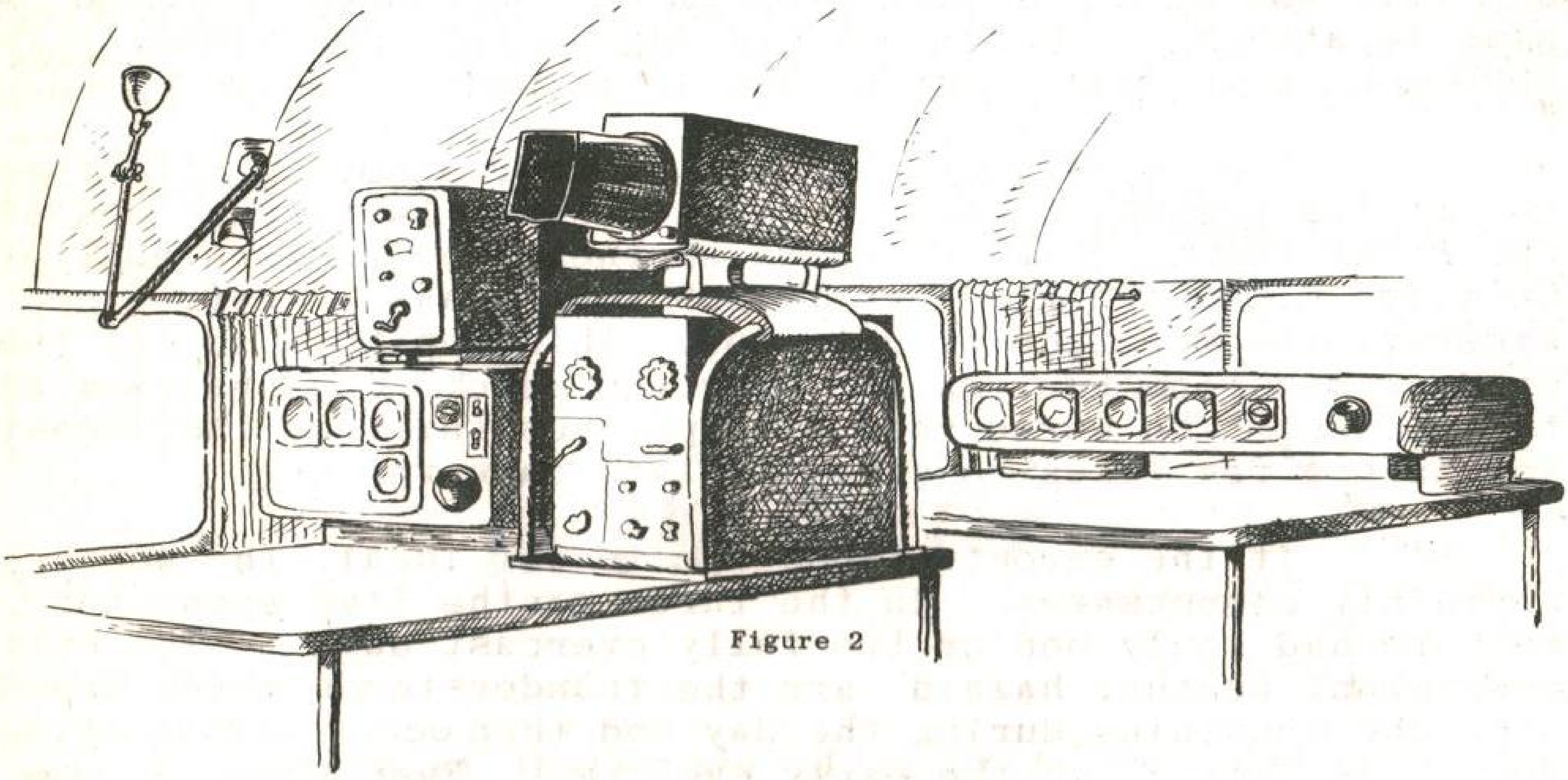


Figure 2

The interphone system is cleverly engineered. A primary system serves all positions; a second network inter links all the aft navigation positions; and a third system connects the four radar positions. Lip mikes are used throughout. The low incidence of laryngitis amongst instructors testifies to the wisdom of this layout.

As an astro platform, this aircraft is in a class far above the humble Dakota and Expeditor. I flew several times this month with students attempting their first astro mission -a sunline-MPP exercise. In every case the results were satisfactory, with average position line errors of five to ten miles. I recalled with humiliation my own pathetic attempts in a wallowing Dakota, some seven years ago.

In order to ennance further the training value of these aircraft, the following modifications are being considered.

- An additional astrodome will be fitted with periscopic sextant mount so that the aircraft will have two such installations.
- The driftmeters will be removed and an operational Doppler radar navigation system will be installed. This equipment is currently fitted on some USAF reconnaissance aircraft, notably the RB - 50, and doubtlessly will be standard equipment on many of the new breed century series fighters and their bomber counterparts.

Although the T-29 has a good single engine performance under normal conditions, the thin air (5400') and hot runways of Denver on a summer day combine to make take-off conditions a bit marginal. However, by reducing flight time to about 5 hours, and by avoiding take-offs during the hot day time hours, the flying program has continued unabated. A plan to attach a lightweight jet engine (of approximately 1-2000 pounds thrust) to each wingtip is under consideration.

The local geography has another annoying effect on the flying program. Denver rests on the Eastern slopes of the Rocky Mountain range which smothers the Western half of Colorado with several dozen 14,000 foot peaks. Safety considerations preclude flights over this region, so all the student missions must range over the monotonous prairies of the midwest. No worse than Winnipeg you say?; well at least you have a few lakes to give the landscape variety.

If the enroute landscape is not ideal, the weather certainly compensates. In the three months I've spent here, we have had only one or two fully overcast days. The only consistent weather hazard are the thunderstorms which breed over the mountains during the day and then occasionally slide down over Denver in the early evening. Even these storms rarely curtail the flying program, for they can be easily circumnavigated by using the search radar.

Now back to earth to examine the ground training program. I already mentioned that very few hours are spent on navigation lectures. It is interesting to see how maximum value for money is achieved during these sessions. At the beginning of each semester students are issued with Study Guides, one for each lesson to be taught. These are essentially precis of the lectures including questions and exercises. The "must know" material is differentiated from the "background" material so that the student does not study unnecessarily. To reciprocate this kindness, the student must study the lesson before coming to class. The instructor's job is then to repeat, clarify, and elaborate on the subject material. Frequent questions and quizzes termed "recitations," are given in these lectures and the results contribute towards the student's final mark in the subject. This system keeps the cadets alert and, it is hoped, abreast of the instruction.

Nor are the instructors allowed to slump, for their lectures are frequently monitored, on occasions by the superintendent, a Major-General. In addition, all new lessons, are given trial "dry runs" in front of a friendly, but critical audience of fellow instructors.

Training aids are abundant and well maintained, but this is a subject in itself and if my resolve doesn't disintegrate I will report on some of these devices in another article.

We cannot know until the spring of 1959 how well this program will succeed. Certainly the cadets are receiving topnotch instruction; the problem is, how well will they retain it over three hectic years of constant activity. I will be in a position to answer that question when I leave here in 1959. At this time, with the first class halfway through, their navigation course, there seems to be no cause for pessimism.

Letters to the Editor

Dear Sir

As Chief Instructor of No. 1 A.N.S., Topcliffe, I was privileged to read the article on the Most Probable Position in the July number of the RCAF OBSERVER. I agree that the subject of MPPs has been very controversial in the past, but, nevertheless, I would like to write a few comments now about it.

One of the criteria laid down in the article is that the method of construction should be reasonably sound mathematically. I would suggest that a circle of 10 nm radius around a two position line fix takes too great a liberty with the statistical theory. By this arbitrary rule no account has been taken of the nature of the position lines involved, the distance from their source (where applicable), and, what is very important, the angle at which they cut, which so vitally affects the accuracy of the fix. If it is worth finding an MPP at all, it is worth doing it properly, so I feel that there is no real alternative to using the theoretically correct ellipse. After all, in areas in which one would normally wish to find an MPP, speed is not usually necessary and, with practice, the ellipse around the fix can be constructed very simply.

When the navigator has drawn his DR circle and band of probability, or his DR circle and ellipse of probability, the criterion which should always be used to find the MPP is as follows. The MPP is at the point of tangency when the DR circle and band of probability the DR circle and ellipse of probability are expanded or contracted proportionally to a fresh probability level so that they touch one outside the other.

When using a single position line this point is easily found by the so-called Gibson method which merely divides the perpendicular from the DR position to the position line in the ratio of the radius of the DR circle to the band of error of the position line. It is easily determined by exactly the same method whatever the relative positions of the circle and the band around the position line.

When using two position lines it may be possible to estimate the MPP by visual inspection. If not, then bisecting that length of the perpendicular to the common chord which is contained in the overlap area or bisecting the shortest distance between the areas if they do not intersect, will give a reasonable position.

With a three position line fix I should normally take the centre of the cocked hat as the aircraft's position but if you wish to take into account the DR position and effect the compromise of the two sets of information available, then it is immaterial whether the cocked hat is in the DR circle or not as the area within the cocked hat cannot be directly compared to the circle as it is not defining a probability error.

To sum up, any method of determining an MPP which allows a true compromise between the two sets of information is sound mathematically. In many cases, with experience, it is possible to estimate the point by visual inspection after only a little construction. Thus it is a simple operation. Most of the views expressed above are my own and do not necessarily represent the official policy of the R.A.F. concerning this small, but very debatable, topic.

Yours faithfully,
J.L. Nunn W/C

1 Air Navigation School
Royal Air Force

Dear Sir:

The article, "Radar as a Meteorological Instrument" by Dr. Pauline M. Austin, published in the October edition of the OBSERVER, gives a very good outline of the uses of radar in meteorological research and weather observation. It might be of interest to OBSERVER readers to know that considerable work has been done in Canada in this field.

Investigations concerning the radar observation of weather were initially started in Canada during the second world war by the Canadian Army Operational Research Group (CAORG). Upon the formation of DRB this research was taken over by them. However, as the programme was primarily basic research, it was decided in 1948 to transfer the work to a university. McGill University was selected and a group of scientists known as the Stormy Weather Group have since that time carried out research projects under DRB sponsorship and support. This Group is headed by Dr. J.S. Marshall, a professor of physics at McGill, who was previously associated with the CAORG programme.

Research has been carried out by the Group for DRB and the USAF on many aspects of the subject, however, the primary concern has been the use of radar to advance the scientific knowledge of precipitation physics. Several outstanding papers have been written by Dr. Marshall and his associates, one of which was quoted as a reference in the OBSERVER article.

It is not my intention to belittle the work done by MIT and the US Weather Bureau but rather to point out that Canadian scientists have contributed greatly to existing knowledge and have in many cases provided the lead in the study of meteorological phenomena by the use of radar.

D.L. Munro F/L

Directorate of Physical
Research (Geophysics)
Defence Research Board

Dear Sir:

In reply to F/O Norenius' letter in the October issue of the OBSERVER I wish to submit the following rebuttal.

In my article in the July issue of the OBSERVER I outlined a method of completing a conversion to the 90° Beam. Since then the CF-100 simulators of Station Cold Lake have proved in their trials on LCC attacks that turns of less than quadruple the error will not produce sufficient drift to enable the fighter to regain the 90° Beam before Phase II.

When operating at the higher altitudes and speeds where turning radii are increased, it is obvious that greater ranges will be required to do a full conversion and that a greater allowance will need to be made for the larger turning radii. It is realized, too, that excessive manoeuvering is difficult but methods which do not attempt to aim for the ideal 90° Beam attack are not acceptable since they:

- Reduce the hit probability by reducing the target surface exposed.
- Reduce the miss distance.
- Place the fighter in the precarious position where any further error could bring the attack into an increasing head-on.

F/O Norenius' suggestion of double the error is not new. It is extremely useful as a short range procedure to set the fighter on a new collision course. However, considering the accuracy with which an observer can read his scope, the difficulties which pilots have with compass lag and the amount of error introduced in the turn, it would be a little presumptuous to expect any worthwhile results from a +30° correction.

I fail to understand where the "S" curve should enter into any conversion. The "S" curve is produced by the computer being saturated during Phase I and, thereby, computing erroneous steering information which, because of its nature, will give a larger turn towards the target than necessary to complete a LCC. It will then, as the range decreases, reduce the degree of error and steer the fighter back until, at Phase II, the computer will uncage and give correct steering information. Under no circumstances will "S" curve occur, unless the dot is centered and steered during Phase I. To steer the dot during Phase I is contrary to good AI techniques; in fact the dot should not be centered until Phase II has commenced.

I assume that F/O Norenius' suggested method is not meant for conversion from behind the beam and that he is happy to quadruple the error in such cases.

3 AW(F) OTU
RCAF Station Cold Lake

WC Henderson F/O

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.

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