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COASTAL COMMAND REVIEW

October, 1942

No. 6

HEADQUARTERS,
COASTAL COMMAND
ROYAL AIR FORCE

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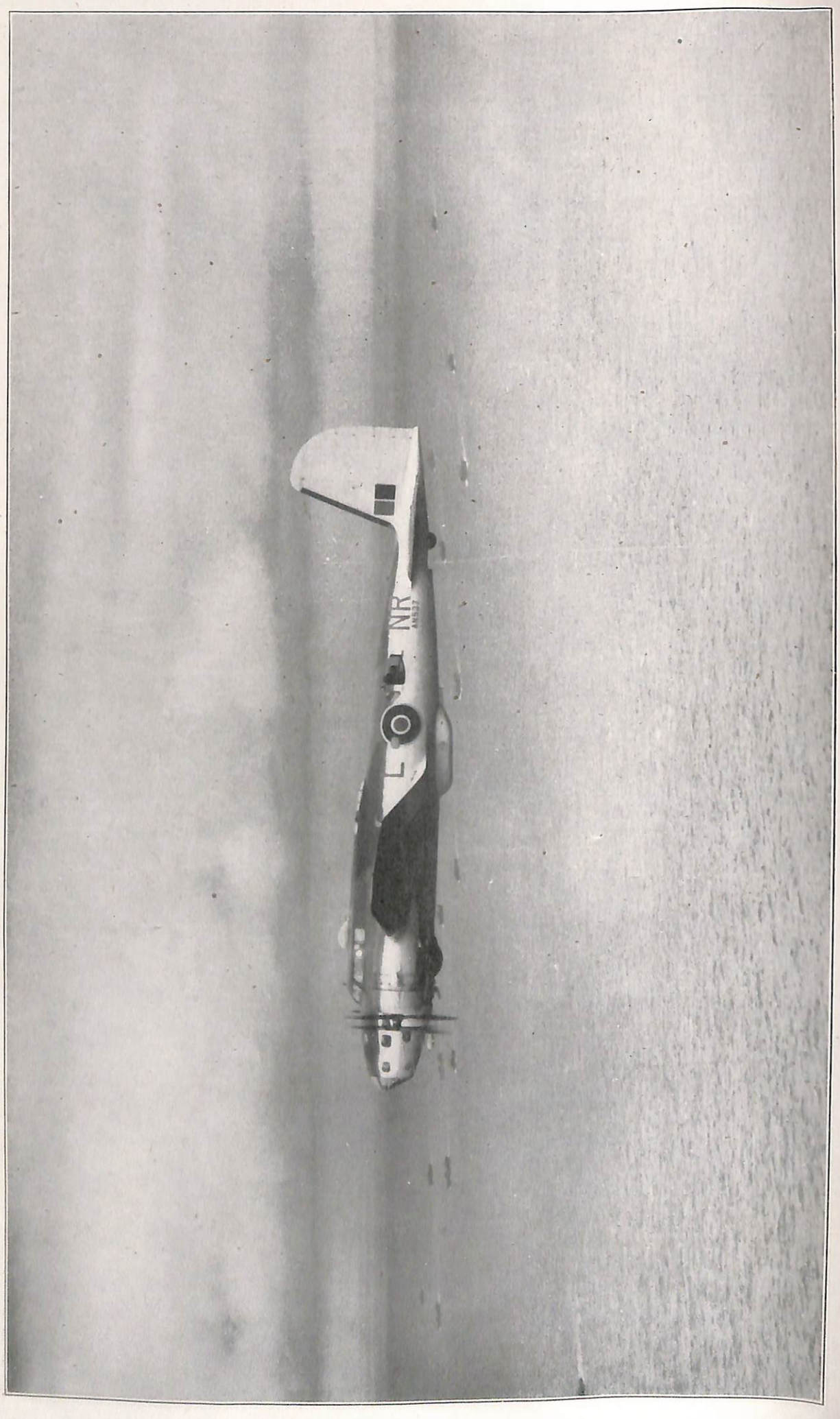
The Air Officer Commanding-in-Chief,
Coastal Command.



Fortress I over Atlantic Convoy. (220 Squadron.)

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COASTAL COMMAND

October, 1942

October has seen a fall in U-Boat sightings in comparison with September, when the number seen was abnormally high. This can be attributed to a variety of causes, including the more adverse weather conditions during the month and the emphasis placed by the U-Boat Command on the necessity for remaining submerged during the hours of daylight. A total of 68 U-Boats were sighted, 64 by armed aircraft with 39 attacks (61 per cent.) resulting. These totals exclude sightings and attacks made by No. 53 Squadron in America and during the passage of the PQ 18 and QP 14 (Russia) Convoys. The month's anti-submarine patrolling totalled 7,090 hours, ten hours more than in September (*see* Chart 1).

Considerable variation in the monthly sightings must be expected owing to changing tactics, hours of daylight and the disposition of our own aircraft and of the U-Boats themselves. This is not to say, however, that the effectiveness of aircraft has dropped in proportion, although obviously the chances of attacking will have been reduced. October again provides positive proof that they are a weapon greatly feared by the U-Boat crew. As much has been freely admitted by prisoners for the first time in many months: and the breaking up of U-Boat concentrations in convoy areas has confirmed this. For example on 4th/5th October the HX 209 when between 58° 30′—59° 30′ N. and 20° 00′—25° 00′ W. was beset by at least six U-Boats and serious losses appeared to be inevitable. The convoy was covered by 12 close escorts and sweeps in the convoy area found by 7 U.S.N. PBYs., 1 Liberator and 4 Hudsons from Iceland and by 3 Fortresses from 15 Group. Nine U-Boat sightings were made, leading to six attacks: as a result of which the gathering U-Boats were dispersed and the convoy arrived without a single loss. The histories of convoys SC 104 and HX 212, which also sailed during the month, are similar and demonstrate beyond doubt the value of offensive patrols in the convoy area when the concentration is building up and, when the convoy is actually threatened, of close escorts. Conversely, statistics show escort of unthreatened convoys to be an undue diversion of effort and uneconomical employment of aircraft which can be better used on offensive patrols against the U-Boat on passage or at sea.

An announcement was made towards the end of the month that records exist of "attacks on U-Boats which have resulted in the sinking or damage of over 530 Axis submarines." This figure does not include Russian attacks nor those of the French Navy before June, 1940. It may be of more than interest to know what the contribution of Coastal Command has been towards this achievement.

The following figures relate only to the Coastal Command area and, except where otherwise stated, to attacks by Coastal aircraft. They are correct up to 31st October, 1942. Between July, 1940, and October, 1942, inclusive, 843 sightings of U-Boats have been made, or virtually an average of one every day. Since the beginning of the war 626 attacks have been made, or an average of rather more than one every other day. During this period 124 U-Boats have been officially assessed (see *Monthly Anti-Submarine Report*) as sunk, probably sunk, or damaged in varying degree. This represents a minimum of 23 per cent. of the total of 530, and shows that approximately one attack in five has resulted in damage. In addition 103 attacks outstanding for September and October await assessment. Credit for sinking or damage goes to Bomber Command for 2½ attacks and to U.S. Navy aircraft for 3 attacks, while 7 attacks were made by Coastal Command aircraft in conjunction with H.M. Ships.

These practical results of the war against the U-Boat are a justification of the many hours spent on patrol and of the difficulties and hardships which aircrews know only too well and overcome so effectively: and they point to the excellent co-operation between the Royal Navy and the Royal Air Force without which this achievement would be impossible. Nor is the attack upon the U-Boat limited to its destruction only at sea. Aircraft of Bomber Command both in special raids on the submarine yards, and in those on seaboard towns, have added to the number destroyed and have held up construction, interfered with training and caused casualties among crews on shore. Heavy raids on the industrial towns of Germany have struck at factories engaged in providing U-Boat components. The recent attack by VIII Bomber Command U.S.A.A.C. on the base of Lorient caused very material damage and is, it is to be hoped, the precursor of many such raids. In addition, there is every reason to believe that the extensive mining carried out by Bomber Command and Coastal Command has not been without results where the U-Boats are concerned.

Photographic Reconnaissance sorties were slightly fewer than for September, but they included the usual proportion of notable flights. The successful reconnaissances of the Gleiwitz area on the German-Polish Frontier, and of Trieste, Rome and Palermo are examples. Conditions unfavourable for photography hampered the attainment of results on a number of occasions and led to a somewhat high rate of abortive sorties.

Anti-shipping activity was limited; 63 sightings of enemy convoys led to 29 attacks. One ship of about 4,500 tons was beached on the French coast as the result of R.A.F. and Naval action: and one vessel was hit by a torpedo off the Norwegian coast and at least seriously damaged. A feature of the month has been the activity of blockade runners in the Bay of Biscay. (*See* article on page 25.) A considerable diversion of anti-submarine aircraft to shadow and strike was necessary on this account.

Air/Sea Rescue has been on a small scale due to a reduction in the number of calls; 73 lives were saved in October, representing a high percentage of success.

The total flying for September, 48,324 hours, an increase over August (47,361), was divided into:— Operational 16,526 hours (August 15,576), and Non-operational 31,798 (August 31,785). Flying in Russia is included.

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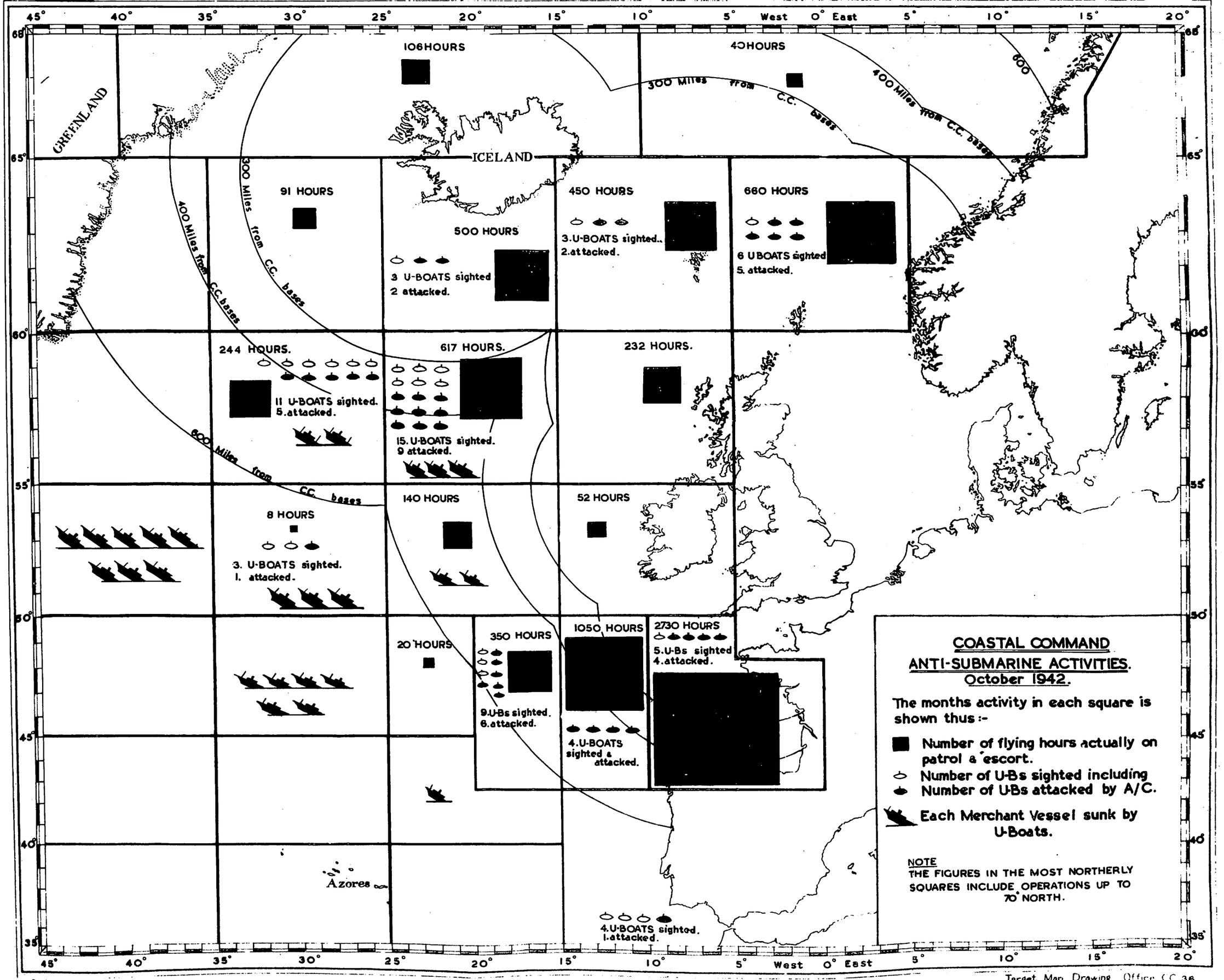


Outline A.S. (ORS)

CHART. 1.

Target Map Drawing Office C.C. 36.

I.—ANTI-SUBMARINE ACTIVITIES

Some Recent Attacks on U-Boats

Attack off the West Indies

Hudson P/53 was flying on an anti-submarine patrol east of Trinidad, when it sighted a U-Boat six miles on the starboard bow, at 1629 hours on 20th September. The pilot turned full to starboard, to make use of cloud cover, and then to port, while the U-Boat began to submerge when it was 1½ miles away. The final attack was made straight up the U-Boat's track from dead astern, four torpex depth-charges being dropped from 50 ft., while the top of the conning-tower was still visible. Two of the depth-charges were probably correct for range, but would have exploded at too great a depth to be lethal. A few seconds after the explosion, a convulsion 100 ft. across and 50 ft. high appeared 200 ft. ahead of the swirl. This was probably due to blowing the main ballast tanks, as a few seconds later the U-Boat reappeared, listing to port and turning to port in a tight circle. Photographs show that the U-Boat was leaking fuel oil, indicating damage, which, however slight, would be a serious matter for a U-Boat presumably 3,000 odd miles from base. (11° 00′ N., 56° 45′ W.)

Attack on Arctic Convoy Frustrated

The Norwegian-manned **Catalina Z/330** was escorting Convoy QP 14 north of Jan Mayen Island, at 0925 hours on 21st September, when a U-Boat was sighted moving north 10–15 miles from the aircraft and 20 miles from the convoy. The U-Boat was of the German type, and had a gun well forward of the conning-tower and a cannon at the rear end of the bridge. The aircraft dived to attack, but the U-Boat remained on the surface, and opened fire at 2,500 yards, with gun and machine-gun fire, hitting the aircraft with several 20 mm. shells and numerous machine-gun bullets. Two of the crew were slightly wounded, the radio set and port petrol tank smashed and the port engine damaged. As soon as it got within range the Catalina replied with its front gun, scoring many hits on the U-Boat's hull and two on members of the crew. The attack was pressed home with four T.N.T. depth-charges but they fell 30–45 ft. from the starboard beam of the U-Boat and probably did no more than shake it up. This however was enough to make it harmless for the time being. After the explosions the flak became erratic and feeble, and the U-Boat made off southward, away from the convoy. The aircraft made a forced landing on the sea, 1,000 yards from H.M.S. *Marne*, who rescued the crew. (74° 08′ N., 07° 00′ W.)

U-Boat Seriously Damaged or Sunk off South America

Hudson C/53 was patrolling off the mouth of the Orinoco on 22nd September, when a Special Equipment contact was received at a range of 15 miles; visibility was 10–12 miles at the time, 1230. The aircraft homed, and soon sighted a U-Boat dead ahead eight miles off. The U-Boat was travelling at six knots on a south-westerly course, and did not begin to submerge until the aircraft was very close. The Hudson attacked from the port quarter, releasing four torpex depth-charges from 30 ft. as the U-Boat was diving, while the pilot attacked the conning tower with the front guns. Two depth-charges exploded on either side of the U-Boat. Number 3 bounced off the bow and ricochetted to the starboard side close to the bow. The U-Boat then submerged, but very shortly afterwards resurfaced with a list of over 45 degrees to port, a large part of the conning-tower and the base of the superstructure showing above the water. It bobbed about as though trying to surface fully, then made a turn to port between 90° and 120°, and finally stopped, sinking again with a definite list to port about half a minute after the attack. As it was disappearing, a sudden spout of water enveloped the conning-tower, and some oil was observed. Already two large air bubbles had appeared in succession about 20 ft. ahead of the depth-charge scum, about ten seconds after the explosions; now two more large air bubbles appeared, a few seconds after the U-Boat had submerged. Two hours later an oil slick, one mile long, was seen, with various objects floating in it, one of which looked like a red rubber dinghy or life-jacket. This U-Boat was undoubtedly seriously damaged; at the very least it must have been badly holed in the port external main ballast and fuel tanks. This would make its passage home hazardous in the extreme, but in view of the debris in the oil slick, it is by no means impossible that it foundered. (09° 32′ N., 58° 53′ W.)

A U-Boat's Acrobatics

A flying-boat, **Catalina U/210**, flew a patrol east of Iceland on 23rd September to protect an SC. convoy. At 0653 hours, when the aircraft was at 600 ft. in visibility down to one mile, a conning-tower was sighted three-quarters of a mile off, on a bearing of 300 degrees. The U-Boat appeared to be a 517-tonner. The aircraft immediately turned to port through nearly 180°, and attacked from two points abaft the U-Boat's port beam. Six torpex depth-charges, set to 25 ft., spaced to 36 ft., were released from 50 ft. as the U-Boat was disappearing. They straddled the line of advance abreast of the conning-tower, three falling on either side. Immediately after the explosions the U-Boat reappeared on its side, and sank below the surface at once. Simultaneously, a mushroom 20 ft. across arose in the centre of the explosion mark, and what looked like a length of metal piping was thrown up some 50 ft. into the air, followed 15–20 seconds later by a violent rush of bubbles directly over this position. A further 20 seconds later the U-Boat reappeared on the surface, still on its side. After some five seconds in this position one end of the U-Boat rose clear of the water, exposing a double row of square vent-holes, and poised there for five more seconds. Then the U-Boat settled, rolling somewhat, and disappeared. The sea was very rough, so that no oil could be observed, in fact in a very short time the breakers washed away all traces of the incident. There is no doubt that this U-Boat was seriously damaged. (68° 19′ N., 13° 50′ W.)

Protecting a Battleship

On 25th September **Whitley K/58** was on escort duty to H.M.S. *Duke of York* in the Atlantic, north-west of the Hebrides, nearly an hour after sunset (at 1941 hours), when it saw 200 yards on the starboard bow a periscope feather and wake—some 10 yards long—with two-and-a-half feet of periscope showing. The battleship was ten miles away. The aircraft, which was flying at 1,100 ft., lost height in a tight circle to port, and attacked from the port quarter at an angle of 30° to the track, releasing five torpex depth-charges from 80 ft., one second after the periscope was last seen. Three of the depth-charges straddled the U-Boat between conning-tower and stem, well within lethal range. An oil patch appeared, which spread to 100 yards across, and persisted long after the explosion-mark had vanished. A line of four dark objects, about three ft. across and about four ft. apart appeared in the oil patch; the rear gunner fired at them and thinks that he hit them. After dropping a flame-float, the aircraft reported the attack to H.M.S. *Duke of York*, and a destroyer of the escort went to investigate. Ten minutes after the attack a second flame-float was dropped, 200 yards from the first; a large dark object about 10 ft. high and 20 ft. long was seen, and a thin pole standing up at about 75°, a few yards away. These objects may have been the after part of the bridge and the periscope of the U-Boat. Its destruction cannot however be proved. (59° 54′ N., 10° 27′ W.)

A U-Boat Lifted Bodily

Wellington Q/311 manned by a Czech crew, sighted a U-Boat two miles away on the port beam in the Bay of Biscay, at 1705 hours on 27th September. The U-Boat had a cannon forward and abaft the conning-tower, and a machine-gun on the bridge. In view of the armament this was probably one of the new 1,600-ton supply boats. As the aircraft dived to attack, the U-Boat opened fire with both cannon and machine-gun, wounding three members of the crew, in spite of evasive action taken by the pilot. The Wellington's rear gunner replied, and saw tracers hit the bridge superstructure. The aircraft straightened up at the last moment, and released six depth-charges from 70 ft., while the U-Boat was still fully surfaced. These straddled the U-Boat, and appeared to lift it bodily; after the subsidence of the spray it dived slowly, becoming completely submerged a minute after the attack. Owing to injuries to the crew and damage to the aircraft, it was not possible to stay and observe the results, but it would seem that at the very least the U-Boat must have sustained serious damage. (47° 00′ N., 05° 30′ W.)

A Possible Kill

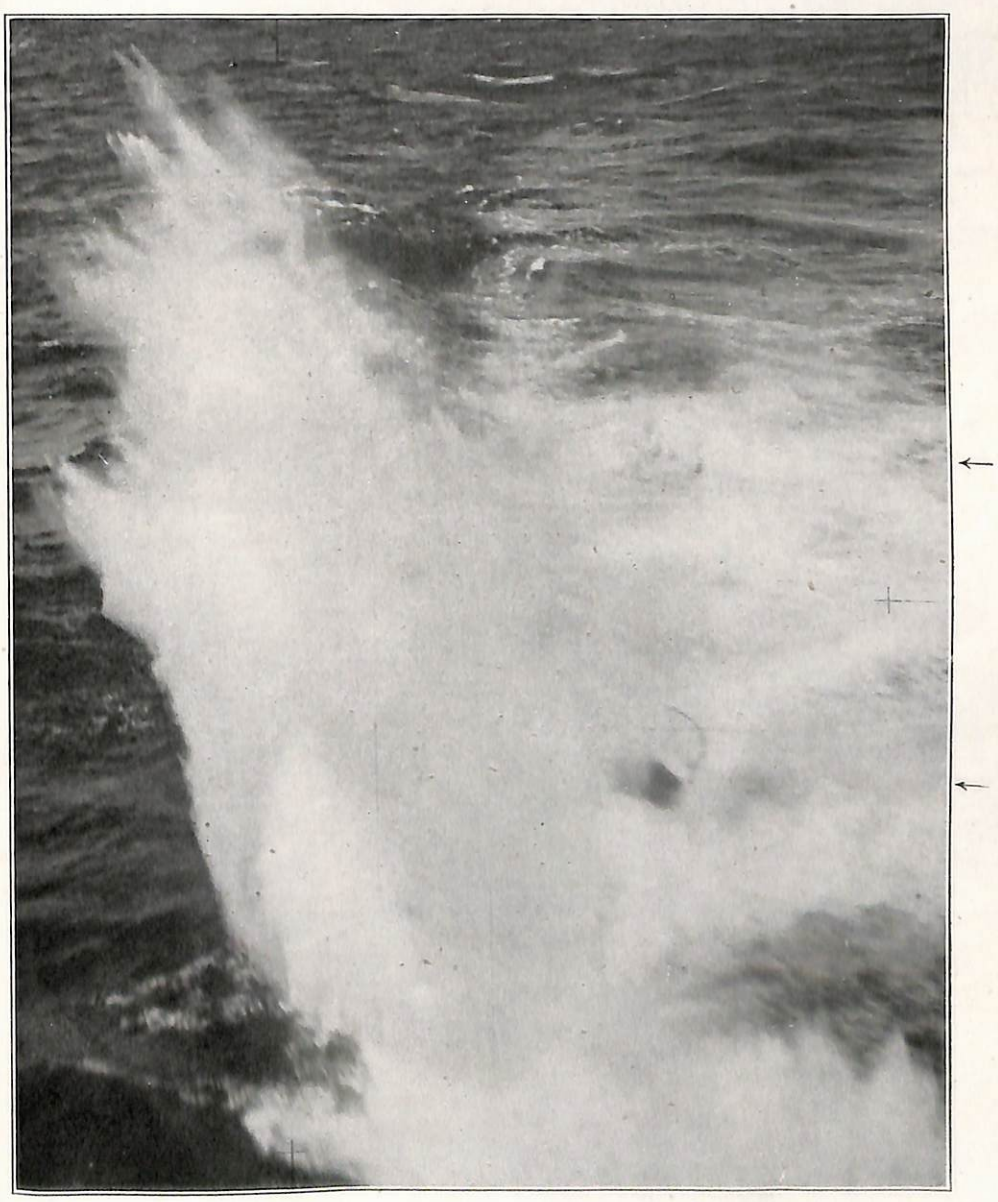
Whitley Q/10 O.T.U. was patrolling the Bay of Biscay at 1211 on 29th September in 12 miles visibility, when the wake of a homeward-bound U-Boat was sighted 10 miles on the port beam. The aircraft immediately turned to port, diving from 2,500 to 2,000 ft. to get up speed, and then turned to starboard to get into position astern of the U-Boat. Although the aircraft was approaching up sun, the U-Boat apparently failed to observe it, and became totally submerged less than five seconds before the attack, which was made with four depth-charges from 50 ft. Three of the depth-charges were right for line, and depth. A large part of the fore part of the U-Boat reappeared at a very steep angle about 20–30 seconds after the explosions and about 100 yards south-east of the marks. An object seen a little distance from the bows was possibly the top of the conning-tower breaking surface. The bows stayed above the water for 30–60 seconds—were fired on by the Whitley's rear-gunner—before disappearing again almost vertically. A patch of froth remained where they had been, and was still visible three minutes later from 1,600 ft. Baiting procedure for 2½ hours gave no results. The very steep angle of the U-Boat's reappearance and second disappearance, together with the froth, make it quite possible that this U-Boat was destroyed. (47° 00′ N., 12° 07′ W.)

Good Use of Cloud Cover

On 29th September, **Sunderland R/10,** flying at 4,500 ft. in 4/10 cloud over the Bay of Biscay, sighted, through a gap in the clouds, a U-Boat 10 miles on the port bow. The U-Boat was photographed and on examination it has proved to be of the 1,600 type, making 12 knots. The aircraft turned at right angles to port, and entered a large cloud, which it used to stalk the U-Boat (Plate 2). When the U-Boat was estimated to be 2½ miles away, the Sunderland broke cloud and immediately sighted it right ahead, so dived to attack, getting within a mile and a half before it began a crash-dive. It was in such a hurry that one-third of the after end came right out of the water, with both screws visible, and hung for about half a minute at an angle which looked like 50° before the screws submerged again. Immediately the U-Boat began a violent turn to port and rapidly disappeared. To counter this move, the aircraft, now very close, skidded sharply to starboard, and while turning released from 50 ft. six torpex depth-charges, three seconds after the submergence, but while the after part was still visible under the water. The U-Boat's turn to port probably took her right across the line of explosions. Two and a half minutes later, a burst of bubbles 20 ft. across, rose 50–60 yards ahead of the explosion area, followed by a second burst some 15 ft. in width still farther on, and a third burst of 9 ft. bubbles 15 yards still farther on. The whole bubbling process occupied about four minutes and suggests trouble with the trim. There were no definite signs of damage. (46° 03′ N., 12° 05′ W.)

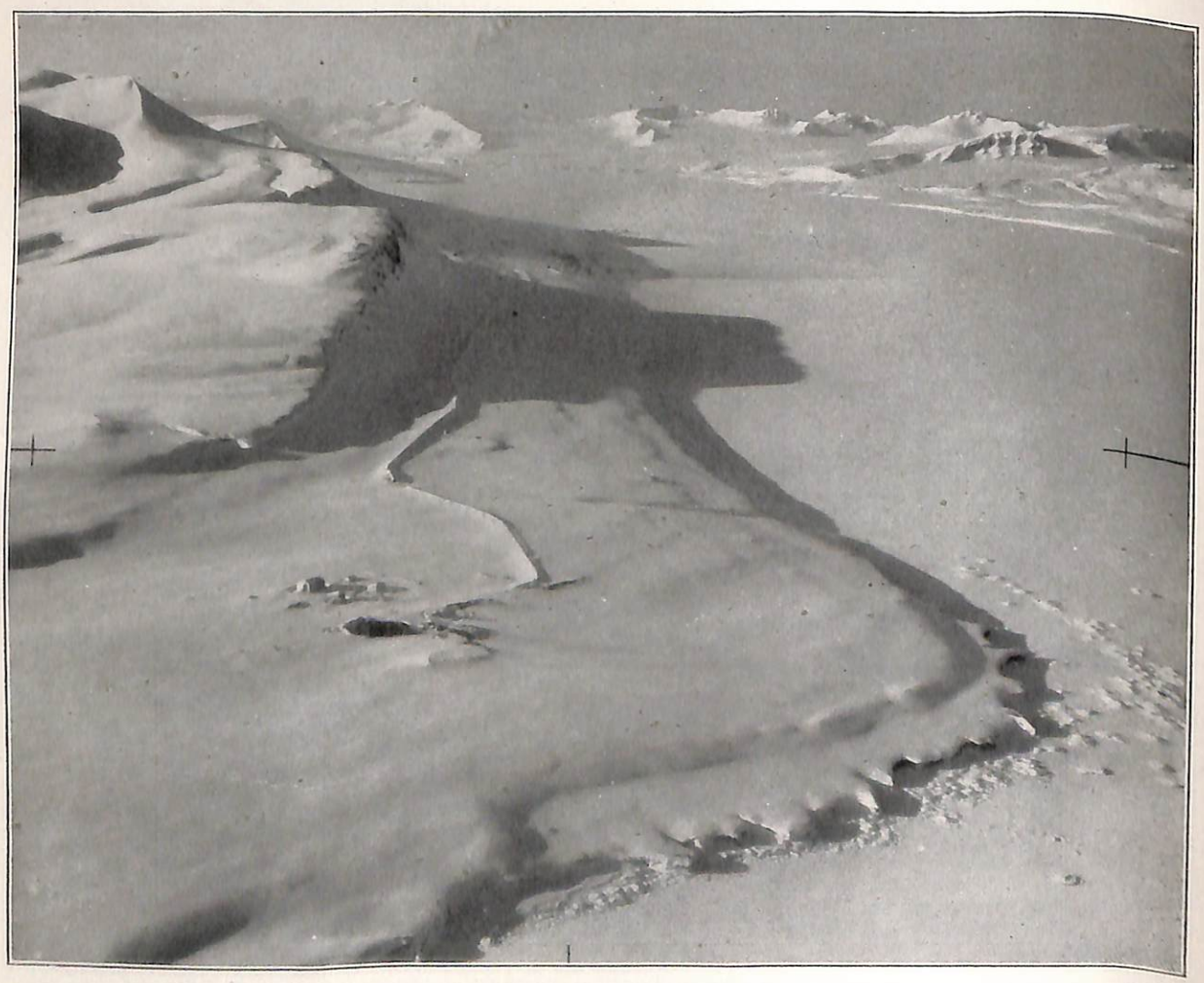
Sunk Without Trace ?

Sunderland H/461 sighted an outward bound U-Boat 8–10 miles dead ahead, at 1157 hours on 30th September. It attacked up-track, releasing six torpex depth-charges while 3 ft. of the conning-tower remained visible. The depth-charges burst almost simultaneously in a huge explosion half-way between the conning-tower and the stern, just as the conning-tower submerged. Nothing further was seen, apart from a large brown scum patch. Although absolutely no more evidence exists, the crew's statements are so conclusive as to the correct placing of the stick that it is claimed that this is a case of the complete rupture of the pressure-hull in more than one compartment and below and aft the blister fuel tanks, leading to the instant foundering of the U-Boat. This



(Top) Cloud cover used in the attack on a U-Boat by R/10 on 29th September. (*See* page 4.)

(Bottom) Attack on a U-Boat by N/269 on 5th October (*see* page 5) **; arrows indicate the conning-tower and jumping wires.**



Spitsbergen (210 Squadron) : (Top) Ice in Horn Sound, 6th June. (Bottom) Huts, Cape Linne, 12th May.

could leave no outside evidence other than the escape of air, which would be merged in the normal violent eddies of the explosion area in that moderate to rough sea. Other cases have been known of U-Boats foundering without visible trace. Some weeks ago an escort vessel attacked one with depth-charges, which the captain felt sure had been accurately placed ; seeing no trace he launched a boat, and after much fishing about with a fine-meshed net, collected tiny fragments of what was later identified as human flesh. (46° 45′ N., 15° 57′ W.)

Submarine with Bows Up

On 30th September, **Whitley F/502,** was returning from the Bay of Biscay with engine trouble, when at 1607 hours a U-Boat was sighted 8–10 miles away on the port beam. The aircraft, which was flying at 3,000 ft., turned to port and broke cloud at 1,500 ft., 5–6 miles from the U-Boat, which began to dive as it approached. Six torpex depth-charges were released, 5–6 seconds after it had disappeared, and straddled the track at right angles about 30 yards ahead of the swirl, just where the conning-tower should have been. No. 1 exploded to starboard, Nos. 2 and 3 on the track, and the remainder to port. Between half and one minute later, the U-Boat's bow reappeared at an angle of about 30°, followed by the top of the conning-tower, which just broke surface, and moved forward at that level. The bow stayed above water for a minute, and then disappeared, resurfacing half a minute later at a steeper angle. Finally it slid under water at the same steep angle, 10–15 seconds later, and was not seen again. The U-Boat was evidently in difficulties, and its final disappearance with bow up suggests serious damage. (46° 05′ N., 08° 46′ W.)

A Surprise Attack; Plunge to Destruction ?

On 1st October, **Whitley Q/502** was flying at 5,500 ft. over the Bay of Biscay, when an outward-bound U-Boat was sighted on the glassy surface of the sea ten miles dead ahead. The aircraft maintained course for one minute, and then lost height to starboard, approaching the U-Boat dead out of the sun, and achieving complete surprise. The attack was made at 1415 hours from the U-Boat's port quarter, and four torpex depth-charges (two more hung up) were dropped from 100 ft. while the conning-tower and stern were still visible. The front-gunner fired 100 rounds at the base of the conning-tower at close range, probably hitting one member of the crew, who was running along the deck and then fell into the sea. Photographs show that either the last depth-charge exploded plumb on the U-Boat forward of the conning-tower, or the last two depth-charges straddled the U-Boat at that point. Two small greenish-white patches of foam were seen just ahead of the leading edge of the explosion mark one minute after the attack, continuing for three or four minutes ; they were clearly visible from 100 ft. She must have been continuously blowing her tanks and was therefore in difficulties. She had begun her dive unusually steeply, and the explosion of the last depth-charge may well have so increased this angle that control was lost in a 45° plunge (borne out by another photograph), which continued till the level of destruction by pressure was reached at 700 ft. or so. (45° 58′ N., 11° 15′ W.)

Oil and Wreckage after an Attack

Hudson N/269 was flying about 300 miles south of Iceland, at 1157 on 5th October, when a U-Boat was sighted five miles on the starboard bow. The aircraft turned first towards the U-Boat, then slightly to port, and finally to starboard again, before attacking from the starboard quarter at 20–30 degrees to the track. The U-Boat was still fully surfaced. Four torpex depth-charges with shallow setting, spaced to 36 ft., were released from 20 ft., and straddled the U-Boat. No. 1 entered abreast the conning-tower on the starboard side, and No. 2 between the conning-tower and the port side of the bow (Plate 2). By the time the aircraft had circled to port, and the position of the attack could be seen again, 20 seconds after the explosion, there was no trace of the U-Boat, only a disturbed patch of water. Half a minute after the explosion a patch of thin oil spread from the explosion mark, and air bubbles two feet across appeared in it. After five minutes wreckage also began to appear, consisting of strips and fragments of wood about two feet long. Half an hour later the oil patch had increased considerably, to covering 600 ft. by 150 ft., and appeared to be still being fed from below. More air bubbles were also surfacing, and the quantity of wreckage had definitely increased ; the wind swept it into lines 300 ft. long. At this point **W/269** joined **N/269** and photographed the oil and wreckage ; unfortunately no prints have yet reached Headquarters and until they have been studied it will remain uncertain whether the U-Boat was seriously damaged or destroyed. (58° 41′ N., 22° 58′ W.)

Points from Recent Attacks

U.S.N. PBY D/73 thwarted three U-Boats in their designs on a convoy south of Iceland on 14th September. On arrival the aircraft was told by the destroyer escort that there was a U-Boat on each bow of the convoy. The aircraft first flew to the starboard bow, and sighted a U-Boat which submerged while it was still a long way off. Then it flew to the port bow and sighted another U-Boat which it attacked, with results impossible to estimate. Five minutes afterwards the aircraft proceeded to the rear of the convoy and sighted a third U-Boat, which it engaged with machine-guns. The U-Boat replied with cannon, but the gun-crew is believed to have been hit, for the U-Boat dived shortly afterwards.

* * *

When **Whitley J/612** was flying north-west of the Faroes at midday on 23rd September, the wake of a U-Boat was sighted about three miles off. In an excellent attack the U-Boat was straddled by six depth-charges, released three seconds after it submerged. The stick was correct for depth and for distance ahead of swirl, and should have been lethal. Owing to the very heavy sea, however, no after effects could be seen beyond the normal brown scum.

* * *

The value of baiting procedure was illustrated by the attack of **Whitley S/10 O.T.U.** on a U-Boat in the Bay on 30th September. The U-Boat was first sighted, and unsuccessfully attacked, at 1654 hours. After circling the scene of the attack, a two-hour marine marker was dropped, and baiting procedure carried out at 1710 hours.

On returning at 1758 hours, the U-Boat was sighted, trimmed well down, at a distance of ten miles, but unfortunately it submerged while the aircraft was still several miles distant.

* * *

A fortunate error led to the straddling of a U-Boat sighted by **Whitley N/77** in the Bay on 1st October. The six torpex depth-charges were accidentally spaced at 95 ft., but the fact that this mistake led to the U-Boat being severely shaken up is, of course, no argument for repeating it. Immediately after the explosions, about 15 ft. of the U-Boat's bow resurfaced at an angle of 20°, denoting loss of control.

* * *

While carrying out baiting procedure after an attack on a 500-ton U-Boat in the Bay on 2nd October, **Whitley E/10 O.T.U.** sighted a second U-Boat, a 740-tonner. The aircraft altered course to take advantage of the sun, and then turned to port and dived to attack with machine-guns. The front gunner opened fire as the aircraft approached the U-Boat's beam, and hit a man who was manning the U-Boat's gun so that he fell into the sea. The U-Boat did not open fire, but dived slowly, leaving a second gunner to drown.

* * *

On 5th October **U.S. Navy PBY I/73** was escorting a convoy south of Iceland when a U-Boat was sighted 10 miles away, at 1025 hours. The aircraft attacked up track, and released four 650-lb. depth-bombs, set to 25 ft., spaced to 40 ft., while the U-Boat was still on the surface. The conning-tower was visible at the time of the explosions, but the U-Boat had disappeared when the spray had settled, leaving a large patch of oil 150 ft. across. From evidence the attack was very accurate in plan, but the depth-bombs would have detonated at too great a depth, and the U-Boat would have been out of lethal range. Six and a half hours later **J/73** sighted a U-Boat in the same area. Photographs show that it left a large oil-patch behind after its crash dive 45 seconds before the attack, which might indicate that this was the one attacked by **I/73** and that damage had been inflicted.

* * *

Liberator K/120 demonstrated the value of baiting tactics on 6th October, south of Iceland. The U-Boat was first sighted three miles away at 1545 hours but submerged long before the aircraft arrived over its position. It was resighted three-quarters of an hour later, nine miles away. The aircraft immediately climbed into cloud, emerging again three miles from the U-Boat to make a depth-charge attack while 40 ft. of the stern was still visible in the swirl. Although the stick straddled the line of advance and the still visible stern only 25 ft. ahead of the apex of the swirl, no definite after results were seen.

* * *

At 1300 hours on 20th October, **Sunderland U/10** sighted two U-Boats together on the surface of the Bay, at a range of 12 miles. Cloud was only 1/10, but the aircraft succeeded in approaching the U-Boats down sun, and using cloud cover until 4–5 miles away. They signalled with a bright bluish light as the Sunderland approached. The further U-Boat crash-dived while the aircraft was three miles away, and the nearer one began to dive ten seconds later. The depth-charge attack therefore came too late.

* * *

An extreme instance of the importance of photographs as well as of practice in U-Boat attacks has been given by an inexperienced crew. After achieving a completely surprise approach by clever use of the sun, the captain called to the front gunner to "let it go," as the aircraft approached the bows of the U-Boat at 700–800 ft. The front gunner, thinking that depth-charges were meant and the aircraft was too high, did not release the depth-charges, nor did he fire. After passing over the U-Boat as it crash dived (with one luckless sailor still on deck), the pilot turned and approached from astern. The depth-charges finally dropped in a salvo, the second pilot having accidentally knocked the switch. The rear-gunner estimated the explosions to be 30–40 ft. ahead of the swirl and to starboard of the U-Boat's track, but such was the confusion apparently reigning in the aircraft that it is not surprising to find on the evidence of the photographs that the depth-charges exploded at least 250 ft. ahead. The swirl, moreover, looks as though the U-Boat had submerged at least five seconds earlier than the crew believed. The photographs also show that the attack was made from the U-Boat's port quarter at 45° to the track, instead of "practically dead astern," as was stated.

Sightings and Attacks by Squadrons, October

Squadron	Type	Base	U-Boats Sighted	U-Boats Attacked
10	Sunderland ..	Mount Batten	2	1
48	Hudson ..	Sumburgh ..	1	1
51	Whitley ..	Chivenor ..	1	0
73	U.S.N. P.B.Y.	Iceland ..	8	8
77	Whitley ..	Chivenor ..	1	1
84	U.S.N. P.B.Y.	Iceland ..	2	0
120	Liberator ..	Ballykelly and Iceland.	14	5
172	Searchlight Wellingtons.	Chivenor ..	1	1
179	Searchlight Wellingtons.	Skitten, Wick	2	2
202	Catalina ..	Gibraltar ..	3	1
206	Fortress ..	Benbecula ..	6	4
224	Liberator ..	Predannack	2	2
233	Hudson ..	Gibraltar ..	1	0
269	Hudson ..	Iceland ..	2	2
304	Wellington ..	Dale ..	1	1
311	Wellington ..	Talbenny ..	1	1
330	Northrop ..	Iceland ..	1	0
455	Hampden ..	Sumburgh ..	1	1
502	Whitley ..	St. Eval ..	2	2
612	Whitley ..	Wick ..	2	1
10	O.T.U. Whitley	St. Eval ..	7	4
1404	Met. Hudsons	St. Eval ..	1	0
1406	Met. Hudsons	Wick ..	2	1
	Transit aircraft	.. ..	3	0
	Civil aircraft ..	.. ..	1	0

Close Escort or Sweep

When the R.A.F. Port Liaison Officer reports on a visit to a merchant vessel arriving at a British port, he sometimes quotes remarks like these :

> " The officers and men felt very sore at not getting any air protection."
>
> " The Chief Officer (of an independently routed ship) expressed disappointment at not seeing an air escort off the Irish coast, though they had notified the ship's position to the naval authorities the previous day."
>
> " On the New York run, aerial escort is practically non-existent on both sides as far as visual evidence goes. It was expected that they would be well looked after on both sides of the Atlantic but this was not the case. The Chief Officer was not the only member of the ship's company to notice the poor escort recently. The Chief Engineer is said to have a habit of remarking ' We must be near land, here comes the R.A.F.' "

These remarks are typical of the criticisms which have been heard ever since aircraft were employed in battle. In the war of 1914–1918, when our fighter patrols were flying far into the enemy lines and driving the German Air Force out of the air, our infantry complained bitterly if one German aircraft flew over them, either for reconnaissance, or when spotting for the German guns. In this war, during the tragic period of our retreat through Belgium to Dunkirk, the absence of our aircraft over the battlefield led to bitter recriminations between airmen and soldiers. Memories of Crete and Libya were until recently a cause of ill feeling between the Services.

It is natural that the individual is interested in his own immediate surroundings, and cannot appreciate the wider issues that may be involved. There is so much space in the heavens, and an aircraft is such a small speck in the sky ; the battlefront on the ground is so restricted in its relation to deployment in the air, that until the end of time the land and sea forces will complain about those air forces which serve their needs.

In this matter of the close escort of convoys and the seeking out and attack of enemy submarines, there will always be divergencies of opinion, but on one point there can be no doubt : the defensive is the weaker form of war. The close escorting of convoys is a defensive measure, while seeking out and attacking submarines is an offensive measure, and must be the stronger form of war. Unfortunately, as black is never quite black and white is never quite white, there are variations in the relative importance of close escorting and offensive action.

To take the extreme case, if every convoy received close air escort an astronomical number of aircraft would have to be employed in this duty, and our offensive action in the land war as well as at sea would thereby be weakened. It is equally certain that if convoys were never escorted, we should lose ships by surprise attacks.

We come back, therefore, to the old principle that there must be a certain minimum of force allocated to defensive measure while the maximum is retained for the offensive.

There are three aspects of sea warfare which must always be borne in mind. The enemy forces can be intercepted and attacked at the point of departure, or in transit, or at the point of arrival. The U-Boats can be attacked at their point of departure, that is to say at their building yards and in their maintenance bases ; they can be attacked in transit areas through which they are forced to pass ; and finally, they can be attacked in their areas of operations.

Obviously, if the U-Boat can be destroyed on its building slip or the workmen prevented from constructing it, the menace it offers to our shipping is scotched at birth. If it can be sunk in transit, not only the U-Boat but its trained crew is destroyed, and even if it is only attacked and not destroyed, the morale of the crew will be affected. If a pack attack on a convoy can be broken up, then the safe and timely arrival of the convoy is assured.

The offensive, therefore, can be extended to all three aspects of the sea problem. How far then should we go in operations of a purely defensive nature ? It is very difficult to come to a true judgment as to when a convoy is sufficiently threatened to justify a close air escort. The position of U-Boats in open waters is only known within very wide limits. Estimations of probable areas of activity, and information from Intelligence sources may paint a general picture. But it is not until a U-Boat has actually been seen on the surface in the neighbourhood of a convoy that uncertainty gives way to a concrete problem.

There must be many times, therefore, when those concerned with the safe and timely arrival of convoys are inclined to " play safe " and ask for close air escort. These authorities feel that, although no definite threat exists, a convoy is passing through a U-Boat infested area, and the safety of that convoy is increased in some measure by the presence in its neighbourhood of an escorting aircraft. As the density of U-Boat patrols increases, so this tendency to ask for close air escort must increase. But the very fact that a given area of sea contains a large number of U-Boats lays emphasis on the need to search and strike.

There will never be enough aircraft in the world to give close escort to all convoys, and at the same time to seek out and destroy U-Boats in their bases and in their patrol areas. The conflict between these two requirements is endless ; it requires nice judgment and great firmness to set the proportions of aircraft to be allotted to these two duties, and there is only one sure guide to help those who are faced by this most difficult problem—the offensive is the stronger form of war.

The Psychology of Anti-Submarine Warfare

The hunting of the U-Boat is to the death : it sets out to achieve nothing less than complete destruction.

If this were possible in the great majority of attacks, secondary effects would be of no importance. In practice, however, the prospects of a high rate of success have not, in the past, been great, for reasons only too well known to those who study and participate in this very specialised form of warfare. The fact that the U-Boat can remove itself from the danger of aircraft attack in less than two minutes, the very precise bombing problem with which the aircrew are faced, the ineffectiveness of their weapons in the past and the superior look-out which the submarine is in a position to maintain, are some of the factors which have worked against the majority of attacks resulting in clean kills.

If the virtual impossibility of the aircraft obtaining concrete evidence of a sinking is added to the above, it is not surprising that the number of sunk or probably sunk U-Boats credited to the air appears small. It is true that a large number of U-Boats have been assessed in various categories as damaged, as reference to the *Monthly Anti-Submarine Report* will show. But taken all in all, the material damage caused is apt to produce feeling of disappointment and, when divided into the number of hours flown on patrol, to give a figure which is as unconvincing as it is misleading.

For the true measure of the success or failure of the air against the U-Boats lies not in statistics but in actual accomplishments in terms of control of the sea lanes.

A study of the Charts of Shipping Losses since the beginning of the war is illuminating. In 1939–40 sinkings took place almost up to the shores of this Island. In fact, until August, 1940, when the heavier explosive was introduced in depth-charges, it is quite clear that the U-Boat metaphorically cocked a snook at the air. As we now know, previous Marks of depth charges were not lethal save in the most exceptional circumstances : nevertheless, the heavier charge and the employment of aircraft offensively (as infrequently as possible on direct escort) led to the U-Boats being forced to operate further and further out into the open sea. By the autumn of 1941 the U-Boat were driven out to the 400-mile line : and the number of attacks in the 400–600 miles area were sensibly reduced. This last was all the more remarkable because, owing to the few Catalinas available to work this area and because of its extent, the density of flying was extremely low. This, too, was at a time when the U-Boat effort in the Atlantic was concentrated against British shipping and some 25–35 U-Boats were continuously at sea.

During the current year, the Atlantic has been flooded with U-Boats to an extent unknown before. The entry of America into the war provided a profitable hunting and training ground which, for a time, was rich in easy spoils and provided a much-needed stimulant to morale—for without doubt this was going downward at the end of 1941. None the less, respect for the air has increased in the area under organised air control and the U-Boat has on more than one occasion proved its dislike of the air threat even to the extent of abandoning convoys marked down for attack.

For example, 5–8 U-Boats contacted the H.G.84 in June last, sinking five ships when still out of range of the air. On the next morning a transit aircraft was diverted off its route to Gibraltar and spent some time with the convoy. Thereafter Liberators, Sunderlands and shorter range aircraft patrolled the area, both escorting the convoy and sweeping around it. This action, and the attacks resulting from it, led to the U-Boats breaking off their attack and denied them any further success.

Similarly S.C.97 on passage from Canada was contacted by U-Boats in 56° 40′ N., 36° 30′ W. on 30th August and shadowed until 4th September. Air escort was provided for the convoy from 31st August onwards and in addition offensive sweeps were carried out in its area. No less than 10 sightings were made and a number of attacks carried out. The convoy entered the Irish Sea on 5th September without loss. That this is no exceptional incident is shown by the passage of the H.X.209 which on 5th/6th October was picked up and surrounded by U-Boats. Combined action by air and surface escort enabled the convoy to be brought without loss through an area in which at least six and probably more U-Boats were concentrated for the attack and making every endeavour to press it home.

The conclusion is inescapable. The U-Boat has been forced to take up station outside aircraft range and to drop his quarry once that limit has been reached. And, what is more curious, this has been achieved, at least in the past, with a weapon which we now believe was rarely lethal. Either its effect has been under-estimated, which in view of experience with modern weapons is unlikely, or the psychological factor enters into the question more than is sometimes believed.

There is no doubt as to the dislike of the U-Boat for aircraft even in 1941, and today it is even greater since weight has been added to the attack. Interrogation reports are full of references to the constant strain imposed by aircraft.

> " A Petty Officer prisoner stated that after diving to avoid aircraft, U-Boats were instructed to proceed away from the locality at full speed. This prisoner added that British air reconnaissance was particularly dreaded by U-Boats. He said that if on the surface you see a plane, the plane has probably seen you and it is already too late : you are done . . . "
>
> " Survivors of *U 501* complained about the insistent British air reconnaissance which forced them to spend much time submerged . . . "
>
> " Prisoners of *U 131* stated that while in the Atlantic they were constantly forced to dive to avoid attracting the attention of aircraft patrols."

Nothing is more difficult to gauge than the state of morale : and too often generalisations are made from particular cases. The *U 570* fell into our hands because there was panic on board, due largely to the inexperience of the Captain and crew. On the other hand the morale of the seven survivors of the *U 701*, who spent some 50 hours

in the water under a blazing sun, was extraordinarily high. They kept up their Captain, cradling his head in the life jackets and escape apparatus: and proved under examination to be extremely security-minded. The first incident took place towards the end of a very lean period for the U-Boat: the second, when flushed with success. Examining officers make frequent comment on the high morale of prisoners who come before them: but it must be remembered that these men, having had time to get over the shock and to recover their balance, probably present a firmer front than they would at the time of the attack. After all, for better or for worse, they are out of the war and there is no fear of bravado being put to the test.

Unpleasant experiences fade rapidly from the memory and natural optimism dispels the fears and doubts which they raise at the time. But they tend to leave their mark and their effect is cumulative. Our own submarine commanders are in no doubt as to the unpleasantness of depth-charging. One, describing his first experience, said that from the noise he thought that he was being rammed, until the third explosion made clear the cause. Not long ago another of our submarines was attacked, the depth-charges straddling the submarine's stern on the level of the pressure hull. The lights failed and the steering gear was put out of action: a number of gauges were broken and there was much incidental damage, although not enough to cause the boat to founder. The boat dived to more than 350 ft. before being got under full control. It was saved by the skilful handling of an experienced Commanding Officer and eventually reached port. No one on board wanted the incident repeated.

There is no reason to believe that our own depth-charges are less effective than those of the enemy, nor that their crews are more immune to the wear and tear of attack. In fact, the evidence tends to the contrary. On the whole, U-Boat captains no longer have the training of a Prien or Endrass behind them. With the great expansion of their service, the crews are necessarily selected over a wider area and in some cases their officers are singularly inexperienced in underwater craft. The crews are treated with indulgence, given many privileges and at times fêted on return: there are advantages in belonging to the U-Boat service. But often it must be a case of "Ah, the brave music of a distant drum." It is a different tune when attack follows attack and the U-Boat is kept submerged, unable to make progress to its billet and at times only able to make the essential surfacing at great risk.

Consider what takes place in a U-Boat. When at sea, within aircraft range, it will be trimmed down and all the crew at their stations. Only four men will be on the bridge. The remainder will know nothing of what is going on above. An aircraft is sighted: the alarm klaxons are pressed. In the confined space of the U-Boat their din is intensified, and no one except the four lookouts knows whether it is just another alarm or whether depth-charges are to be expected at any moment. The men on the bridge hurl themselves down the conning tower: the hatches are closed: tanks are flooded, planes adjusted and the boat dives. She takes up a steep angle down by the bows and the unwary may slip on the steeply tilting deck, bringing others down with him. Those few seconds may seem an eternity and the recollection of previous attacks and narrow escapes will rush through the minds of the crew.

Perhaps it is a false alarm and all this energy, all this apprehension, is expended for nothing. Or perhaps an attack may follow. There is the explosion, a tremendous metallic clang; the hammer blow of the water striking the hull. The effect may be compared to a giant sledge-hammer striking on the sides of an empty boiler. It may leave the crew dazed and half-stunned. Lights go out, gauges break and clatter on the steel decks; water may start to drip, whether from a serious leak or a broken pipe, the crew have yet to discover. Hydroplanes and rudders may jam, and one or both motors may stop. There may be an ominous smell of chlorine gas—only a suspicion, but enough to raise fears of damage to the batteries. The boat may take control, assuming a steep angle up by the bows and surfacing involuntarily or diving equally steeply to a great depth. Loose articles will crash about inside, causing injuries to the crew.

And all this when the depth-charges are not within lethal range. The closer they fall the greater the shock, the damage and the confusion. The effect is cumulative and not likely to be forgotten. Each attack will seem a little worse than the last . . . until someone cracks. At best, he may shut the wrong valve or operate the wrong switch. At worst he may become hysterical and affect other members of the crew who may be nearing the breaking point. A state of panic may ensue, as occurred in the case of the U 570.

Those who seek to discount the moral effect of depth-charging—they include no submarine officers of this or the last war—do not attempt to explain how it was that in the earlier days of this war, when weapons left so much to be desired, the U-Boat was driven from these shores into the open sea. There can be but one conclusion: continual harrassing, forced dives, frequent attacks, lethal or even non-lethal, play up the U-Boat to a degree which human endurance cannot stand—the more so if the winnings are few, if dividends in the form of sinkings fall below a remunerative level.

Constant unexplained losses sap the morale of those who survive, in a way that nothing else can. The drum, no longer distant, beats day and night on the waterfront of the home ports and the attractions held out by the German High Command grow less and less real. Destruction is the aim of the offensive against the U-Boat; and by it alone, can the seas be freed. But if it takes time to reach the ideal there is no need to despair of what is already within grasp. Much has been accomplished in the past; more in the present; and if pursued with determination and intelligence, the full aim will assuredly be achieved in the future.

The Technique of Attacks on U-Boats: Direction of Approach

The aim of the pilot of an anti-submarine aircraft, on sighting a U-Boat, is to deliver his attack with the minimum possible delay so as to catch his target while still on the surface, or at least within a few seconds of diving. It is for this reason that the pilot is given a completely free hand to attack from any direction he wishes, and such freedom of action will continue in force. Under normal conditions then, he should go bald-headed for his objective from whatever direction presents itself and waste no time in jockeying for position. There are occasions, however, when the pilot can select the direction of attack, as for instance, when he has a lot of height to lose or when he can stalk his prey from behind cloud cover, and in such cases the question arises as to what method to choose. Considerable thought has been given to this matter by air crews, and by the Staffs at Coastal Command and Group Headquarters, and there is no doubt that with normal weapons an attack along the track from astern offers the greatest chance of success. The reasons for this choice will be discussed.

In the first place, by approaching from directly astern, the pilot has the wake and swirl to give him his line of approach and by making full use of this, line error should be eliminated. Then there is a growing tendency for U-Boats to make a last-minute alteration of course and to dive under helm. When approaching from astern such avoiding action will be clearly visible to the pilot who can take appropriate action up to the last minute. Further, there is a clear field of fire from the front turret not only to the U-Boat's A.A. gun but also to the conning-tower hatch, so that a determined front gunner will be able to prevent any return fire. Finally, if the stick is correctly placed it is possible to get all weapons within lethal range whereas in a beam attack only two can be so situated.

One point in regard to the aiming mark in the "up the track" attack may not have been considered. Owing to the forward travel of depth-charges or bombs under water, the whole stick moves forward some 40 ft. after impact and before detonation. The average length of a stick may be taken as, say, 150 ft. If, therefore, the first depth-charge is aimed to fall on the leading edge of the swirl, the last one will actually explode 150+40, or 190 ft. ahead of the swirl. In other words, the pilot can aim his first bomb at the leading edge of the swirl up to 15 seconds after submergence and still get one depth-charge within lethal range. It is not suggested that the pilot should normally aim to release on the swirl as in that case some of the depth-charges will be wasted, but if there is doubt as to the exact moment of submergence, or if the U-Boat has only just dived, this point of aim should produce results. Thus, in this form of attack, not only is the pilot given a clear line of approach, but also a definite aiming mark.

When considering the best direction of approach some might think that the down-the-track attack has advantages. It is admitted that the pilot has an even better view of the swirl and wake, but the point of release is far more difficult to judge. For example, with a stick of six depth-charges spaced at 25 ft., the aim must be to release it so that the first depth-charge strikes the water 250 ft. ahead of the swirl if the U-Boat has been submerged for only 10 seconds, and it is this estimation of distance which leads to errors for range. Even for a surfaced U-Boat the first depth-charge must fall 150 ft. ahead of the conning-tower.

If it is accepted that the up-the-track attack offers the best chances of success, it must also be appreciated that, without adequate training, there are serious risks of failure. For instance, a line error of only 20 ft. one way or the other will place the whole stick outside lethal range, whereas in a beam attack there is half the length of the U-Boat to play with. But the advantages of up-the-track are so great that, subject to sufficient training, there is everything to recommend it. Consideration should therefore be given to what special training is necessary. First, the pilot should take every opportunity of practising tracking over a motor-boat, and an observer in the boat should report on how accurately this is done. This should be done first from 50 ft., and later, when the pilot is proficient, he should start from operational height and come down to 50 ft. to finish his run. And this brings us to the second and most important part of the training. When a submarine is sighted from, say, 5,000 ft., the pilot puts his nose down and loses height as quickly as he can, but unless he has practised this manœuvre frequently, he will find that he reaches his bombing height in an impossible position to carry out an attack without delay. If he practises on every possible occasion, in varying strengths and directions of wind, the time will come when he finishes his descent directly astern of, and heading towards the U-Boat. Only constant practice will achieve this ideal and so constant practice must be carried out.

One last word: the aim, as stated above, is to catch the U-Boat on the surface or nearly there. Nothing that a pilot does must compromise this. For at whatever angle the attack is made, it must get home: and there must never be any question of an attack failing or being delayed until the U-Boat is out of effective range, because the captain has lost time in manœuvring his aircraft to obtain a position which is theoretically more favourable.

The Use of the Eye in Anti-Submarine Warfare

Doctor: "You see her eyes are open."
Gentlewoman: "Ay, but their sense is shut."
(*Macbeth* v, 1.)

Of all the many complicated pieces of machinery employed in anti-submarine warfare, the human eye is without question the most delicate and intricate. It is, therefore, worth taking a little time and trouble to know how it works, and how it may best be used in the unceasing battle against the U-Boats. Normally, we take our visual powers very much as a matter of course. We work with a large safety factor, and can see things in good time to be able to act. Even in peace-time, however, this safety factor is greatly reduced when we are motoring, especially at night. The high road-accident rate is largely due to the

fact that motorists do not see pedestrians or other vehicles in time to take avoiding action. Even more in wartime, and in aerial warfare, is the safety factor important. In flying at night, or at very high speeds, so little time elapses between sighting a U-Boat and reaching it that it is of the greatest importance to sight it at the extreme range of vision and to think and act rapidly once it has been sighted.

Time and illumination are not, of course, the only factors that determine whether an object, such as a U-Boat, is seen or not. Other physical factors, such as size and contrast, are involved, in addition to the important subjective factors, both physiological and psychological, which depend on the observer himself and are more complex and interdependent than the physical factors. The anti-submarine lookout should pay the greatest attention to these factors, which are to a large extent under his own control, whereas the physical factors are not. The remainder of this article is, therefore, devoted to a discussion, first of the physiological factors (the eye itself), then of the psychological factors (the interrelationship between the brain and the eye), and finally of the practical application of these considerations to anti-submarine warfare.

The eyes of man are the most highly developed sense organs found in the animal kingdom. Structurally, they are comparatively simple. The eyeball is essentially a hollow sphere, with an opening at the front, the pupil (*see* Fig. 1). The interior surface of the eyeball is called the retina, and is composed of a layer of cells, which respond to light waves by sending impulses back to the brain along the optic nerve. Just behind the pupil lies a small lens, which focusses the rays of light entering the eye on to the retina. This lens is surrounded by a circular band of muscle. When the muscle relaxes, the lens becomes flatter, and its focal length increases, so that the eye is accommodated for distant vision. Contraction of the muscle thickens the lens, and shortens its focal length, so that the eye is accommodated for near vision. When binoculars are being used, it is essential that the focussing muscles of the eyes should be at rest, to accommodate them for distant vision (*see* below, page 13).

The retina has two kinds of sensitive element, known as cones and rods. The cones are responsible for day vision, and the rods for night vision. The cones are concentrated at the centre of the retina, called the fovea (*see* Fig. 1); towards the sides they gradually thin out, and are replaced by the rods. There is no sharply defined boundary between day and night vision. During daylight the cones predominate; in twilight or full moonlight both are in action; and in starlight the rods alone are functioning. The fovea, where the cones predominate, is the area of greatest visual acuity, *i.e.*, the most sensitive area for the perception of detail. If attention is drawn to an object on the edge of the field of vision, the eye automatically tends to turn towards that object, so that its retinal image falls on the fovea.

Another characteristic of the day eye is the perception of colour. In full moonlight the colour of a postage-stamp can just be discerned, but at lower illumination all objects, unless self-luminous, appear either black, white or some shade of grey. The colour of objects is due to the different *sensations* set up by light of different wave-lengths. The night eye, although insensitive to differences of colour, nevertheless responds to light of different wave-lengths. It is, however, quite insensitive to the red end of the spectrum. For example, by day the red petals of geraniums appear lighter than green grass, but in the deepening twilight, when night vision has almost replaced day vision, the petals become almost black against the now lighter grass.

Thus the night eye is characterised by its low power of discrimination of detail, its insensitivity to red light, its lack of colour perception, and the fact that the area of the retina most sensitive to light is not at the centre, but lies in a ring about 6° from the fovea (*see* Fig. 3). This has important consequences for lookouts keeping watch at night (*see* below, page 13).

If you go out into the blackout after being in a lighted room, it takes about ten minutes for your eyes to get used to the low level of illumination provided by the night sky. This process is technically known as dark adaptation. How long it takes for the eye to become fully adapted depends, however, on the level of illumination to which it has been previously exposed. If the eye has been exposed to a very bright light, such as looking at the white clouds in a summer sky, and then goes into a dark cellar, absolutely complete adaptation may take as long as thirty or forty minutes. The adaptation of the eye after exposure to a bright light is illustrated in Fig. 4, which also shows the different effects of red and white light on the dark-adapted eye. Recovery from exposure to red light is quicker. These facts are of great importance, for by suitable lighting it is possible to carry out duties at night, say in the cockpit of an aircraft, with adequate illumination, and still when necessary become fully adapted to seeing in the dark in a matter of one or two minutes. The use of red light in such circumstances, while it has many advantages over white light, has the great disadvantage of making it impossible to see coloured lines and red markings on charts. Therefore, where colour recognition is of vital importance, orange light is used. Orange light is not as effective as red in preserving dark adaptation, but it forms a good compromise where the recognition of colour, especially red, is important.

The Brain and the Eye

What we see is by no means entirely determined by the image that falls on our retinas. It cannot be too often stressed that we see with our brains as well as with our eyes. An anti-submarine lookout must use a considerable amount of mental energy and effort; if he just contents himself with an aimless wandering of the eyes, he will see no submarine, except by a fluke.

What we actually see is influenced not only by physiological factors such as bodily fatigue and the condition of our eyes, but even more importantly by psychological ones such as attention, expectation, general interest and morale. It is characteristic of the visual field that while every object within the scope of the eye is represented on the retina, very few of them enter our conscious mind at any one time. Many other objects we

are more or less vaguely aware of, while still others do not reach our consciousness at all. Attention is, in fact, highly selective, and jumps from one object to another. Concentrated attention in one field of consciousness greatly reduces the level of awareness in another. For instance, if attention is concentrated on a ham sandwich, and the various sensory stimuli associated therewith, it is unlikely that a U-Boat appearing at the extreme range of vision will stand the same chance of being spotted as if the whole attention were concentrated on scanning. From the lookout point of view, a lowering of the level of awareness in the visual field means that any object in that field must be more conspicuous in order to attract attention.

Equally important with attention is the general attitude towards the task that involves looking out. If a lookout does not think he will see anything anyway, then the chances of his seeing anything are greatly decreased. It is, therefore, of the utmost importance that aircrews should not be allowed to fall into the frame of mind where they feel that they will not see any U-Boats. The converse is also true; people see what they expect to see. Rockall, for example, has often been mistaken for a ship; when the lookout is set for seeing ships, an object must look very unlike a ship not to be mistaken for one when it first comes into view. Similarly, whales are often mistaken for U-Boats when lookouts are submarine-conscious.

Interest in the task in hand is of extreme importance. Nobody is very good at a task which does not interest him, and this applies as much to watching for U-Boats as to anything else. Keeping a lookout for U-Boats over an endless expanse of water, for hours on end, calls for a conscious attempt to overcome boredom and fatigue and maintain interest. The lookouts on a U-Boat have the additional incentive that their lives may well depend on spotting; it is safe to say that if aircraft that did not spot U-Boats were liable to be attacked by them the lookout kept for U-Boats would be considerably more efficient.

There are three useful mental aids to efficient lookout work:—

(1) A proper understanding of the relation of the individual task which is being performed to the total effort of anti-submarine warfare.

(2) A thorough knowledge of the methods employed to carry out the visual side of the task.

(3) A realisation that however good is the eyesight, it is the brain which ultimately determines what is seen, and that lookout duties call for active concentration of attention and expenditure of mental energy.

A good lookout must not only have good eyesight, but must know how to use his tools, in fact, how to see. He must be interested in his task, and conscious of its importance as an integral part of the war effort.

Night Patrols

A few words must be said about night patrol work in general. At night various factors become more critical, and as the night eye is in use, its distinctive properties must be taken into account. All night patrols should be carried out with the minimum of lighting in the aircraft, and this should preferably be red or orange so as to preserve the dark-adapted state of the aircrew's eyes. All lights should be shielded so that they do not directly illuminate the windscreen or other windows. The various windows of the aircraft should be kept scrupulously clean. Captains should recognise the importance of this factor in night flying, and insist that all windows are kept in good condition. In taking off in daylight for a night patrol, remember that a blurring that may make little difference to visibility in bright sunlight may make all the difference between seeing and missing a U-Boat in moonlight.

Scanning

The ability of the day eye to see small objects falls off very rapidly towards the edge of the field of vision from the region of maximum acuity at the centre; this is illustrated in Fig. 2. For an object just above the limits of visibility to be seen in a given area, the eye must move about continuously, so that the image of all parts of the area falls in succession on the fovea. This, in fact, is how we do search for an object like a U-Boat in the visual field, and this searching, if methodically done, taking the movement of the aircraft into account, can be made into a scanning routine. The two essentials of such a routine are determination to scan systematically, even though the chances of seeing anything are relatively small, and avoidance of blank staring.

The expanse of sea ahead of the aircraft should be divided into a near and a far area. If enough lookouts are available, each area should be subdivided into sectors, and one lookout should scan the far area *only*, using binoculars as much as possible. Another lookout should scan both areas with the naked eye.

At heights up to 5,000 ft., distances more than eight miles ahead are only a few degrees below this side of the horizon. For an aircraft flying at 1,000 ft. even four miles away is only about 2·5° below the horizon on the clearest of days. As U-Boats should be picked up at distances greater than four miles in average weather conditions, it is essential to scan for them at the most suitable angle below the visual horizon. If too much time is spent in scanning the sea within four miles of the aircraft, the average range at which U-Boats are sighted will be seriously reduced. (*See* Fig. 5.) Visual angles can be roughly measured from the fact that when the arm is extended the clenched knuckles subtend about 8° at the eye. Fig. 5 gives a rough guide to scanning with the naked eye under conditions of average visibility when flying at 5,000 ft. and 1,000 ft. At 5,000 ft. two horizontal sweeps at 2° and 8° are needed for scanning the distant area. At 1,000 ft., scanning should be confined to about 2° below the visible horizon in a single horizontal sweep. Scanning should be carried out at a rate of 5°–10° a second, otherwise objects will approach very near the aircraft in one direction while the lookout is scanning in another. Using binoculars it is essential to scan just below the horizon, or the full advantage of the additional range which they give will be lost.

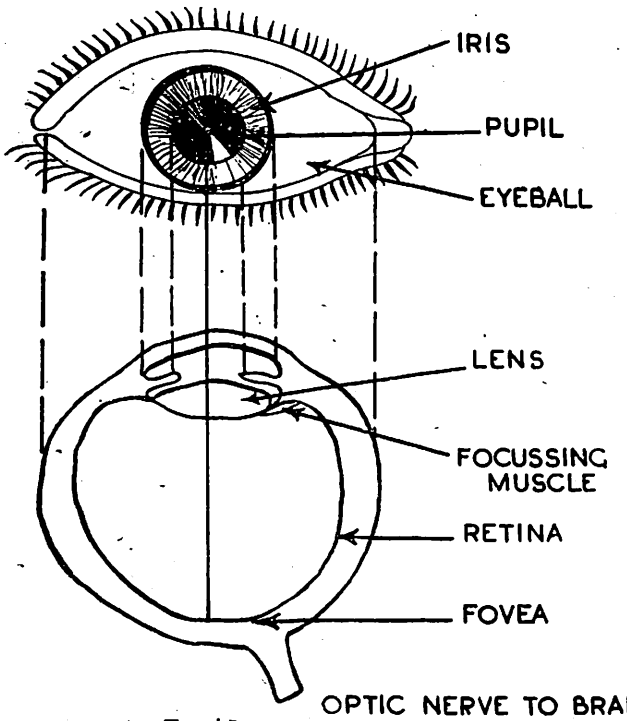


FIG. 1.—**Front View and Cross-section of the Eye.**

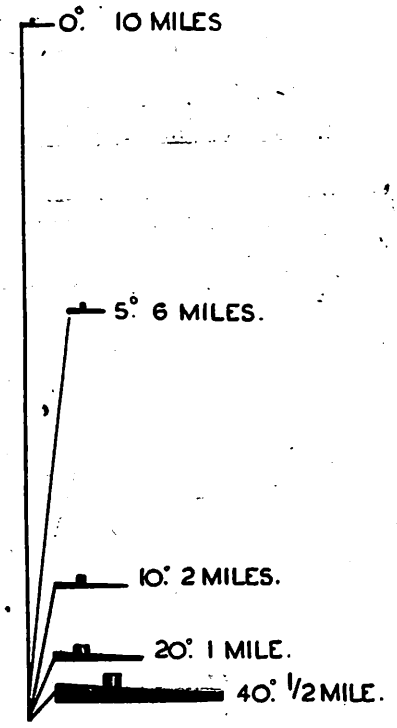


FIG. 2.—**Why Scanning is so Important.**—If the eyes remain fixed directly ahead, and a U-Boat comes into view at ten miles, then U-Boats on bearings of 5°, 10°, etc. will come into view at six miles, two miles, etc.

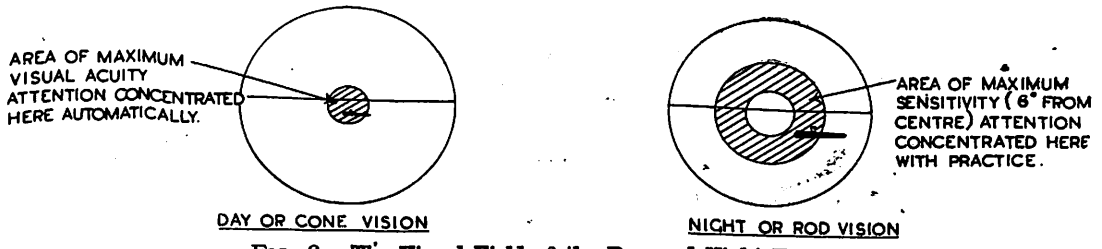


FIG. 3.—**The Visual Field of the Day and Night Eye.**

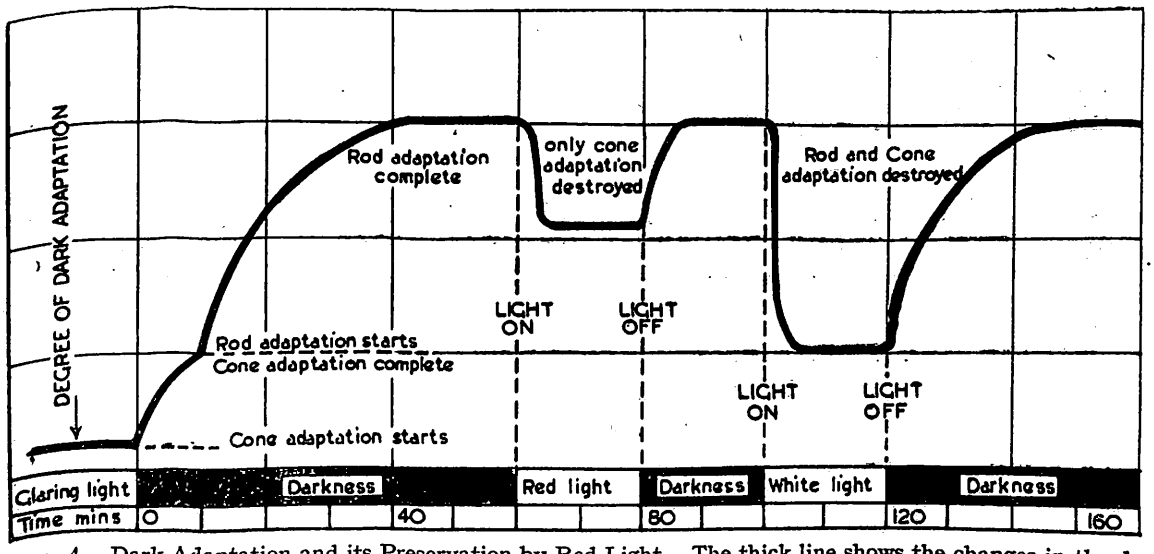


FIG. 4.—Dark Adaptation and its Preservation by Red Light. The thick line shows the changes in the degree of dark adaptation of the eye when exposed to various lighting conditions. The beginning of the curve shows the cone and rod adaptation on entering darkness after exposure to a bright glare. This adaptation is completed in 30–40 minutes. When a red light is switched on, cone adaptation is destroyed, but rod adaptation is unimpaired. Therefore, when the light is switched off, complete adaptation is rapidly regained. When a white light is switched on, both cone and rod adaptation are partially destroyed, and complete recovery takes some considerable time after the light is turned off.

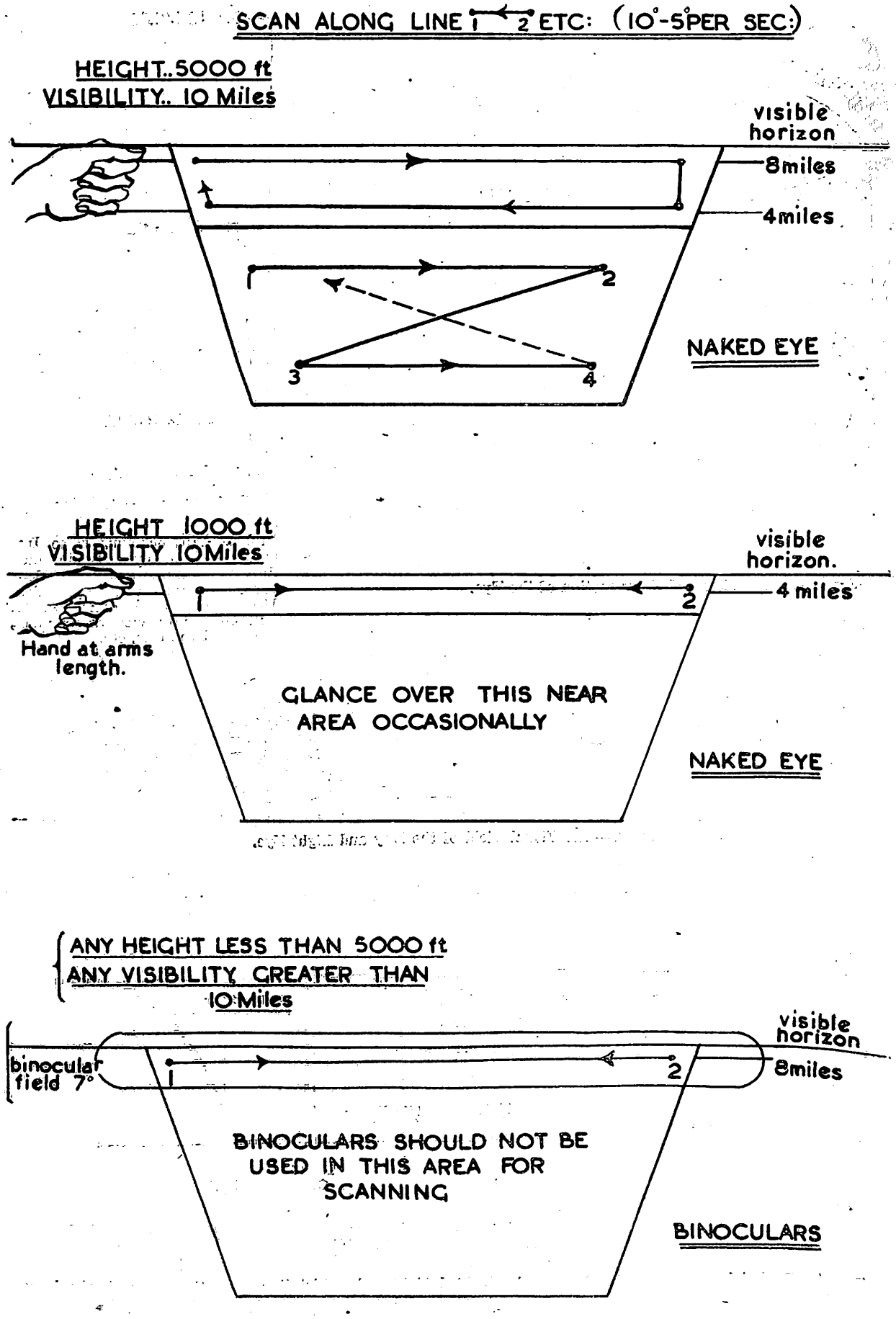


FIG. 5.—Guide to Scanning. When the arm is fully extended, the clenched knuckles subtend 8° at the eye. Flying at 5,000 ft. in good visibility, the horizon being at twenty miles, eight miles is at 4° and four miles at 11° below the visible horizon.

When scanning at night it is most important to overcome the daytime habit of looking directly at an object once it has been picked up in the field of vision. Fig. 3 shows that the centre of the retina of the night eye is insensitive, the region of maximum sensitivity, where the rods are concentrated, being about 10° off the centre. When on patrol in moonlight, full use should be made of the moon's path; if that is bright enough, the day eye can operate, and the daylight scanning routine applies. On moonlit nights the wake of a U-Boat can be picked up about two miles away. While it is very hard to scan at night, owing to the difficulty of judging distance, some routine should be adopted. The field of view should be scanned as for the near distance (*see* top of Fig. 5).

Binoculars

Binoculars, or field-glasses, are of two main types, day glasses and night glasses. The only difference between the two is that night glasses have a larger exit pupil to allow the maximum amount of light to enter the eye. The most suitable types have a x7 magnification and a field of view of about 7°. They are excellent for day as well as night use.

All good binoculars require two separate adjustments by any one individual. One is the setting of the two eye-pieces so that they are the same distance apart as the user's eyes. This adjustment must be accurately carried out, especially at night. The second adjustment is the correct focussing of the binoculars, and here the essentials are not only that the field of view should be clear, but that at the same time the eyes should be relaxed, *i.e.*, accommodated for distant vision. Most people look through binoculars with their eyes accommodated for near vision, and consequently are always having to refocus the eye-pieces. The best way to avoid this is to start with the adjustable eye-pieces screwed out, and turn them in until the correct focus is attained; if the binoculars are quickly removed, distant objects should be in focus immediately. The basic principle is that binoculars should be looked through not looked into. In the everyday use of binoculars, where they are used only for short periods at a time and to look at objects well above the threshold of visibility, these fine adjustments may not be necessary, but for the arduous task of an anti-submarine lookout, which involves the use of binoculars for searching as well as for recognition, they are essential for maximum efficiency.

Binoculars can thus be used for two separate purposes, In anti-submarine warfare the more important use is for picking up a distant U-Boat that is invisible to the naked eye. It hardly needs stressing that a U-Boat should be spotted at the maximum range possible so that the aircraft can make any necessary changes of course, speed or height preparatory to the attack. When these dispositions have been carried out, and the aircraft is approaching the suspected U-Boat, the second use of binoculars, the recognition of the object, comes into play. Binoculars can help in rapid recognition and save time being wasted on fishing boats, waves, whales, etc. The value of binoculars in increasing the range at which objects can be picked up depends on weather conditions as well as magnifying power. The clearer the atmosphere, the greater will be gain in visual range. Very little is gained by using binoculars for spotting in a visibility of less than five miles.

What Would You Do?

Everyone who takes part in U-Boat warfare knows how many hours a crew may fly without a sighting. It is equally common knowledge how often unforeseen circumstances can arise and force the pilot to make an instantaneous decision, upon which will depend the success or failure of an attack.

The only way a pilot can feel assured of making a correct decision, is to know his own limitations and the limitations of his aircraft. How many pilots, for instance, can say straight out, offhand, how long it takes them to get down to 50 ft. from 5,000 or 4,000 or 3,000 or 2,000 or even 1,000 ft., when it is a question of diving straight down to attack. Yet this knowledge is essential if a well-judged attack is to be executed on a U-Boat which has submerged.

The solution lies partly in constant practice in the air, and partly in theoretical study on the ground. Some of the best crews in Coastal Command make a habit of carrying out as frequently as possible a complete practice attack on an imaginary U-Boat, each member of the crew being detailed to a specific task, and the whole routine being rigidly adhered to. So much so that in a recent practice the W/T operator receiving a 485–472 sighting message in a moment of over-enthusiasm transmitted it to base, the sighting position being half way between the Scillies and the mainland! Better, however, to cause a minor flap at Area Combined Headquarters than to be caught on the wrong foot when a real sighting occurs.

Perhaps one of the best means of reaching maximum efficiency in the approach to the attack is to set oneself a series of theoretical problems on land, work out on paper the theoretical answers, and then, next time one is flying, see whether theory and practice are in agreement.

There are many such problems, but to go on with here are two or three involving a quick decision:

(1) *Aircraft at 125 knots on course 090° flying at 250 ft., visibility one mile, sights a fully surfaced U-Boat course 180°, distance 1,000 yds. dead ahead, 10/10 cloud base 500 ft.*

This is taken from one of a score or more reports of sightings under similar circumstances. The problem is a simple one, can or cannot the pilot get all set for release if he flies straight to the target? If he cannot, what alteration in course and height should be made to reach his target in the minimum

space of time, and from what bearing to the U-Boat should he attack ?

(2) *Aircraft at 150 knots on course 360°, flying 500 ft. above 3/10 cloud base 1,000 ft., sights a periscope of a U-Boat almost immediately below him, 20 miles from a convoy. Sea slight, time 1800 B.S.T. in November.*

This problem is one of the use of the sun versus overhead surprise. Which periscope is the U-Boat likely to be using, and what are their respective limitations ?

Either way—what should the pilot do to have a reasonable chance of attacking before the U-Boat submerges ?

(3) *Aircraft at 140 knots at 5,000 ft., clear sky, perfect visibility, on course 300°, sights wake of U-Boat 15 miles distant, bearing 270°. Time 1600 hours B.S.T. October. Sea choppy.*

As every pilot knows this is one of the occasions all too frequent when the odds are nearly all in favour of the U-Boat and against the aircraft. Should he crack straight in, or should he try and fox the U-Boat watch that they have not been seen, and if so how should it be done ?

These are but few of the dozens of problems which confront a pilot. He can never know the answers to all of them, but if he at least knows the answer to some of them, he is well on the way to a kill.

II.—OPERATIONAL FLYING

Spitsbergen

This article, the first detailed account of air operations in the Spitsbergen area, has been contributed by Lt.-Cdr. A. R. Glen, D.S.C., one of the British Liaison Officers, who took part in the majority of the flights described, as a special observer. The operations are noteworthy in that they combined in no small measure pioneer work and scientific exploration, long-distance flying in an almost unknown area and active operations of war. One aircrew was mainly responsible throughout. Success was due to their enthusiasm and high standard of team work, and, as all concerned will agree, to the fine leadership of their captain, Flight-Lieutenant Healy, D.S.O. (referred to as H. in this narrative). Their work was almost completed: one flight remained. The aircraft left a base in Russia for Spitsbergen but was forced to return owing to worsening weather conditions. The journey back was made with cloud cover until the Russian coast was almost reached. Here there was an area of clear sky: and here the aircraft was attacked by a Ju. 88. One burst of fire hit it, mortally wounding the captain. Characteristically he continued to fight his aircraft until the second pilot could take over. His loss has meant the breaking up of a fine aircrew: but it has given a tradition and inspiration, not only to the squadron to which he belonged, but to Coastal Command as a whole.

* * *

Since the sixteenth century the Polar Ocean has exercised a peculiar fascination on the minds of men. Commerce provided the original motive, the rich merchants of London and Amsterdam being eager to discover a safer passage to the riches of the Indies. Tiny ships forced their way far into the northern seas, finding a new wealth in whale-catching in the Spitsbergen bays, but baffled in all their attempts to penetrate the steel-like barrier of the pack ice. None the less, the legend of an ice-free Polar Sea persisted, perhaps fostered by those who were doing their utmost to maintain the secrecy of their own new hunting grounds. With the rapid fall in the number of whales, interest declined in the early 1700's, only to be revived at the end of the century by the start of that long and most romantic era—the initiation and development of polar exploration by the Royal Navy. By 1900 the major outlines of the polar lands were known, the remaining details being filled in during the subsequent years by the large number of expeditions, British, Russian, Norwegian, Canadian and American, which were carrying out intensive research.

The Polar Ocean, however, remained largely unknown. Peary first succeeded in conquering that terrible route over the moving sea-ice, heaped here into tumbled pressure ridges perhaps 30 or 40 ft. in height, and broken there by leads of open water as much as 10 miles in width. Nansen drove the *Fram* to past 85° N., then fought his way another few miles northwards until the never-ending obstacles forced him to return to Franz Josef Land, or rather as it is now most rightly named, Fridhtjof Nansen Land. Stefansson journeyed in the Beaufort Sea, living by his hunting and unhampered by the heavy weights with which the sledges of his predecessors had been laden. But all these journeys, herculean in their effort, had established merely the thinnest tracks across the vast ice-fields of the north. Then began exploration by air, first the flight of Roald Amundsen and Riiser Larsen to 88° N. where, forced to land, they succeeded in repairing their aircraft for a safe return to Spitsbergen. The flights of Byrd and Wilkins, and the later ventures of Amundsen and Nobile followed in quick succession. Promise was fair that the nature of the sea-ice and of its drift was now to be studied in detail, but interest lagged once the sensation value of the flight had been capitalised by the press, and the lean years of the 1930's were no encouragement to governments which might otherwise have been disposed to lend financial aid. It was not until 1937 that the U.S.S.R. established by air at the North Pole a research station, which in the following months drifted southwards on its ice-floe until its personnel were taken off by ice-breaker half-way down the eastern coast of Greenland. Simultaneously, a programme of trans-polar flights was carried through successfully, the only loss being that of Levanevski, whose aircraft crashed somewhere between the Pole and the north Canadian shore.

Thus it was that at the outbreak of war there was available in London only the scantiest knowledge of the limits and nature of the sea-ice at different seasons of the year. The significance of arctic weather and of its influence upon forecasting for north-western Europe was better understood. High latitude reports, however, depended upon only a few stations, the majority of which were situated in northern Scandinavia and the Russian islands, with others in East Greenland, Jan Mayen, Spitsbergen and Bear Island. The occupation of Norway by the enemy meant the loss to the United Nations of the most vital of the northern European reports, and the occupation of Denmark brought about the temporary loss of those from East Greenland. The personnel in Spitsbergen and Bear Island were evacuated by an Allied force in the summer of 1941. Accordingly, during the winter of 1941–1942 there were no high latitude observations regularly available to the Allies, a lack which became increasingly pronounced with the growing importance of the north Russian convoy route.

Attempts to meet this need were at first spasmodic. Sea-ice reconnaissances began to be flown by Coastal Command, first over the Denmark Strait, then steadily extending the range, until in April 1942, B/210 carried out a particularly fine flight from Shetland to Bear Island. Icing conditions were especially interesting on this flight, severe glazed icing being encountered at temperatures between —30° and —35° F. Heavy icing at an even lower temperature range was experienced during a similar flight in April, and it would appear that low temperature icing, caused by super-cooled water droplets, is a danger to be seriously reckoned with in high-latitude flying during the early spring. Valuable as were the results from these first flights, no scientific method of reporting either the type of sea-ice or

its limits had yet been evolved, and it was not until May that this was begun by the first of the remarkable series of flights by P/210 (captained by H.). Chart 2 shows the area flown over.

By the spring of 1942 a meteorological station had been established by the Allies on Jan Mayen, but there was still urgent need of reports from Spitsbergen. To provide these and to prevent the strategic points on the island from falling into enemy hands, an Allied force was fitted out in March. Air reconnaissance of Spitsbergen was a pre-requisite and Coastal Command were asked to arrange this for the beginning of April. No high-latitude flying had previously been attempted at such an early season and it was realized that severe weather might be encountered. J/240 was detached for this sortie, and was flown to Sullom Voe where final preparations were made, the boat being a Mark I Catalina of normal long-range type, fitted with short range Special Equipment, and the navigational instruments including a D.R. compass.

The flight was started on 4th April, the boat being airborne at 0540 after a somewhat anxious take-off caused by the heavy petrol load (1,800 gallons) and the addition of two special observers. Up to 70° N. the outward flight was uneventful, weather in the main being good with ten miles visibility except in the rain and snow storms which were met every few miles. Past 70° however, sea fog with heavy strato-cumulus above was encountered, the aircraft reaching clear air only after a climb of over 5,000 feet, during which medium to heavy icing at low temperature was causing some difficulty to both engines. For the next 400 miles a course above the clouds was maintained, the greatest height to which it was necessary to climb being 7,000 feet. As Spitsbergen was approached the headwind increased in force until in the vicinity of Horn Sound a velocity of over 90 knots was met, the aircraft being thrown about like a leaf. At 1733 the coast was picked up by Special Equipment, and at 1750 the aircraft was over the high mountains between Horn Sound and South Cape, but the thick clouds and flurries of snow formed an impenetrable blanket below. Course north-west was accordingly set so that an attempt could be made to find a break in the cloud and descend to some 50 or 100 feet above the sea, but after a few miles a general break up of the cloud took place. Below lay the snow-clad jagged peaks of Spitsbergen, with, at their foot, a jet black sea across which straight and parallel lines of dirty white showed the ice-floes streamed seawards by the violence of the wind. To the north was a more friendly scene, the black and white shades yielding place to gold and blue as the low sun touched the snow slopes.

As Ice Fiord was approached the wind fell to some 40 knots, cloud decreasing until visibility north and west was of the order of 100 miles. Cape Linne was passed and then the mouth of Green Harbour, with the desolate Barentsburg like a black scar across the blue hillside (Plate 10). To the east the flat-topped hills around Advent Fiord looked exactly like giant Christmas cakes, their sugar icing tops prodded by the finger of some greedy child (Plates 4, 6, 7). Below lay Longyearby, the old Norwegian settlement apparently lifeless and without sign of track or smoke. The snow on Advent Fiord lay unbroken, and neither there nor in Advent Valley (Adventdale) was there any trace of enemy activity.

At 1947 course was finally set for base. It seemed likely that the increasing variation would equalize the decreasing drift as the wind veered to head. The captain therefore decided to fly above the clouds hoping that star fixes would be obtained. All went well until after midnight, a good check on the track having been made from Pollux at 2315. At 0055, however, the aircraft was caught in a violent snowstorm, and with a temperature of 3° F. medium icing took place. From then until within 150 miles from base, the aircraft flew blind and deaf, M/F failing to make contact until well past 64° N. The operators worked frantically, only interrupting their transmissions every 20 minutes or so when the Special Equipment would be turned on to ensure against being blown into the Norwegian mountains. As the time passed, the starboard engine missed a beat or two, but picked up again and resumed its steady drone. At 0500 the storm began to abate, the moon broke through, and a series of sights on the Mark IX sextant showed that the aircraft was some 70 miles off Shetland. Rough bearings were taken from the Butt of Lewis beacon, and at 0545 Muckle Flugga was sighted. Nine minutes later the aircraft was over the coast, being waterborne at 0625 after covering some 2,500 miles in 24 hours 45 minutes.

This sortie indicated that there was no large-scale enemy force established either in Green Harbour or in Advent Fiord, although of course a small party might have remained undetected. As the force which was to occupy Spitsbergen was not due to sail until the first week of May, it would be necessary to repeat the sortie in early May. At the same time a large-scale investigation of the sea-ice in both the Greenland Sea and the Barents Sea was being planned with Headquarters Coastal Command, and it was decided that a special long-range Catalina should be detached for the whole programme of high latitude flying, H. being appointed captain.

The boat allocated was at that time undergoing extensive reconstruction at Greenock. It was essential that the reconnaissance be completed before 5th May, but continuous delays at Greenock seemed destined to delay the sortie indefinitely, the final blow falling when the boat failed to pass its acceptance air test. A hectic five hours ensued until late that same evening it was decided that N/210, then at Greenock, should be used by H. for this one sortie, after which a new boat would be made available.

N/210 finally took off from Sullom Voe at 1500 on 3rd May, the meteorological forecast being unfavourable and giving only the faintest hope of the Spitsbergen coast being open. 1,800 gallons of petrol and two special observers were again carried, the aircraft on this occasion also being fitted with a small sledge, a tent and some 200 lb. of food so that the observers could be landed on the west coast of Spitsbergen to act as an advanced spotting post for the main force which would arrive later by ship. Once again the flight was uneventful until 70° N., when visibility fell to some two miles. A height of around 500 feet was maintained, and progress continued good until near Bear Island, some ten miles to the south-west of which the ice was

GREENLAND

GREENLAND SEA

DENMARK STRAIT

Iceland

SPITSBERGEN

North East Land

BARENTS SEA

FRIDHTJOF NANSEN LAND

NOVAYA ZEMLYA

BELL SOUND

HORN SOUND

Hope Is:

South Cape

Bear Island

Jan Mayen Is:

BEERENBERG

SCORESBY SOUND

ANGMAGSALIK

AKUREYRI FIORD

NORTH CAPE

FAEROES

MUCKLE FLUGGA

SULLOM VOE

SHETLANDS

BUTT OF LEWIS

ICE FIORD

ADVENT BAY

LONGYEARBY

ADVENTDALE

CAPE LINNE

BARENTSBURG

GREEN HARBOUR

60° 55° 50° 45° 40° 30° 20° 10° 0° 10° 20° 30° 40° 50° 60° 65° 70° 75°

60° 55° 50° 45° 40° 35° 30° 25° 20°

75° 70° 65° 60° 55° 50° 45°

15° 10° 5° 0° 5° 10°

78°

CHART 2
SPITSBERGEN

SHADED AREA SHOWN IN INSET.

C.C. 212.

first met. Visibility then fell rapidly, in patches being as little as 200 yards and nowhere exceeding one mile in the Bear Island Channel, which was filled with thickly packed drift-ice. At South Cape there was a momentary clearing, but the fog soon closed down again. The only chance was to fly at a few feet from the water, relying on the Special Equipment to give warning of land ahead and so obviate some of the danger caused by the absence of a D.R. compass in an area where the action of the magnetic compass was somewhat slow. Visibility deteriorated still further, however, and it finally became evident that there was no alternative but to return to Iceland.

The return flight enabled one of the most interesting of all the sea-ice reconnaissances to be made. A course from near Horn Sound to Jan Mayen was followed, exceptionally heavy polar ice with unbroken fields as great as 50 miles in extent being met. At Jan Mayen the weather was ideal, the great volcanic mass of Beerenberg, with the crevasse-torn glaciers clinging to its lava slopes, dominating the scene and turning to insignificance the pimple-like hillocks which make the central part of the island so like the surface of the moon. The island was everywhere surrounded by ice, tightly packed to the west but looser to the east where the limits swung into a great curve to the south-west, looking for all the world like the scum of sour milk on tea. To the south, however, fog was again encountered, persisting to the Iceland coast, where steady rain decreased visibility to a minimum. There was little or no difficulty in making a landfall, thanks to the high quality of S.'s navigation, but to find the entrance to Akureyri Fiord was more tricky. For nearly two hours the aircraft cruised outside, finally making an entrance at a height of only a few feet above the sea. At 1410 the aircraft was waterborne, and half an hour later the crew were sitting down to a gigantic meal in the Norwegian Air Force Mess.

It was most unfortunate that no reconnaissance of Ice Fiord could be made, particularly as the main force was due to leave Akureyri by sea for Spitsbergen on 7th May. To delay sailing so as to await the result of another reconnaissance was out of the question, and the only solution was to proceed according to plan with the hope that another reconnaissance might be flown and its results passed by W/T. In fact N/210, this time with P. as captain, repeated the reconnaissance on 11th/12th May, and aided by maximum visibility experienced no difficulty in reaching Ice Fiord. Cape Linne and Barentsburg were seen still to be deserted, but on entering Advent Fiord ski tracks on a hillside were sighted (Plate 5, top). A few minutes later six men were seen running on the ice towards an He. 111 standing on a landing ground near the head of the bay. P. went straight in to attack, first firing some 1,200 rounds into the aircraft and then turning his attention to the men who by this time were vainly trying to bury themselves in the snow. After this most successful reconnaissance N/210 returned to Sullom Voe, and the intelligence was passed to London for outward transmission to the ships. Unfortunately, it was never picked up, and the force arrived in Ice Fiord on the 13th May oblivious of the presence of the enemy.

Although by this time the main basin of Ice Fiord was largely free from ice, the inner bays were still covered. The two ships of the Allied force had just begun ice-breaking in Green Harbour, when about 0700 on the 14th May the sound of aircraft was heard. A few minutes later a Ju.88 passed over Cape Linne, but appeared to take no notice of the ships and proceeded without altering course to Advent Fiord. Ice-breaking was continued with maximum power, but against a thickness of 2½ to 4 feet progress was slow, and by 2100 an advance of only two miles had been made. Then aircraft were again heard. Four FW.200's, flying very fast and low, were sighted coming down the fiord, the low sun behind them making conditions for attack perfect. Oerlikon fire was opened, but near misses did damage in the first and second runs while in the third run one ship received a direct hit and sank almost immediately. The F.W.'s then turned their attention to the remaining ship, which was soon burning furiously, after which they concentrated their attack against the survivors, some 40 of whom were huddling behind the tiny hummocks which offered the only shelter on the otherwise level bay ice. Despite a perfect target the enemy shooting, both with cannon and machine-gun, was gratifyingly poor, though the effects of bombing were more embarrassing, the 250-kilo bombs first bouncing on the ice to a height of 50 or 60 ft., penetrating on second impact and exploding immediately under the surface, so that one was constantly being shot skywards on a small platform of ice, rather like the jumping devil in a pantomime.

After maintaining the attack for about 45 minutes, the aircraft departed. The moment they disappeared round Cape Linne men seemed to pop up everywhere around the ships, and it was found that during the machine-gun and cannon attack only two out of over 40 had been hit, although of course there had been fairly heavy casualties as a result of the sinking of the ships. Everything had been lost, food and arms and clothing, but Barentsburg was only a mile away and there was every prospect of finding adequate supplies there. Within an hour the most comfortable house had been opened up, fires started, and great cauldrons of soup and coffee were boiling on the hob. Medical stores too were found, and the doctor did yeoman service in tending to his wounded. Clothing was rather more of a problem, but what was lacking in material was made up in ingenuity. Old Russian padded jerkins, discarded many years ago, were prized far beyond the value ever attached to the best-cut product of Savile Row. Dentist's coats and bed linen, wrapped around their stalwart wearers as camouflage, gave the appearance of a thug-like collection of discredited Arab sheiks, while footwear varied from huge felt boots to women's evening shoes.

Despite bombing and machine-gun attacks which were continued daily by the enemy against Barentsburg, morale remained high, and there was unanimous confidence that Coastal Command would fly another reconnaissance within ten days or a fortnight, that being the delay to be expected as the time required for an absence of W/T reports to cause anxiety. The essential was therefore to establish a station on the route certain to be followed by the reconnaissance, and yet at the same time capable of being concealed from enemy observation. After examination of various points, the station was finally established near the

entrance to Green Harbour on 20th May, being manned thereafter by four men (Plate 5, bottom).

Meanwhile in England H. had collected his new boat P/210, a Mark IB Catalina, fitted with long range tanks and long range Special Equipment. The aircraft was equipped with three magnetic compasses and two specially selected Directional Gyros. At the same time S. had been collecting data on polar navigation, and by the 20th May all was ready for the programme of polar flights. By this time however, the W/T silence from Spitsbergen was causing anxiety and on the 25th Sullom Voe were ordered to fly a reconnaissance. This was to be H.'s second flight to Spitsbergen and the first of his remarkable record of four sorties, entailing a total distance of over 10,000 miles and of 93½ air hours in 11 days, for which he was awarded the D.S.O.

On the 25th May P/210 became airborne at Sullom Voe at 1138, arriving off Cape Linne at 0035 after a flight which was almost entirely through fog and low cloud. The aircraft passed Cape Linne at about 400 ft. and proceeded up the middle of Ice Fiord to Advent Fiord where the wreckage of the He. 111 shot up by P. on 11th May, lay in the middle of the bay ice (Plate 5, middle). In Longyearby, tracks were seen around the houses, but no personnel were observed, and course was set to the entrance to the Ice Fiord. In the meantime, the aircraft had been observed by the survivors, concealed in the entrance to their coal-mine, but without binoculars it was impossible to identify her with reasonable certainty. As she returned out of Ice Fiord, however, there was no doubt, the wing tip floats and the blisters were sure evidence. Immediately the Aldis was brought into use, and a few seconds later an answering flash from the aircraft showed that contact had been made (Plate 5, bottom). A message passed and at 0145 P/210 left Green Harbour, arriving back at Sullom at 1427 on 26th May after a flight of 27 hours 10 minutes.

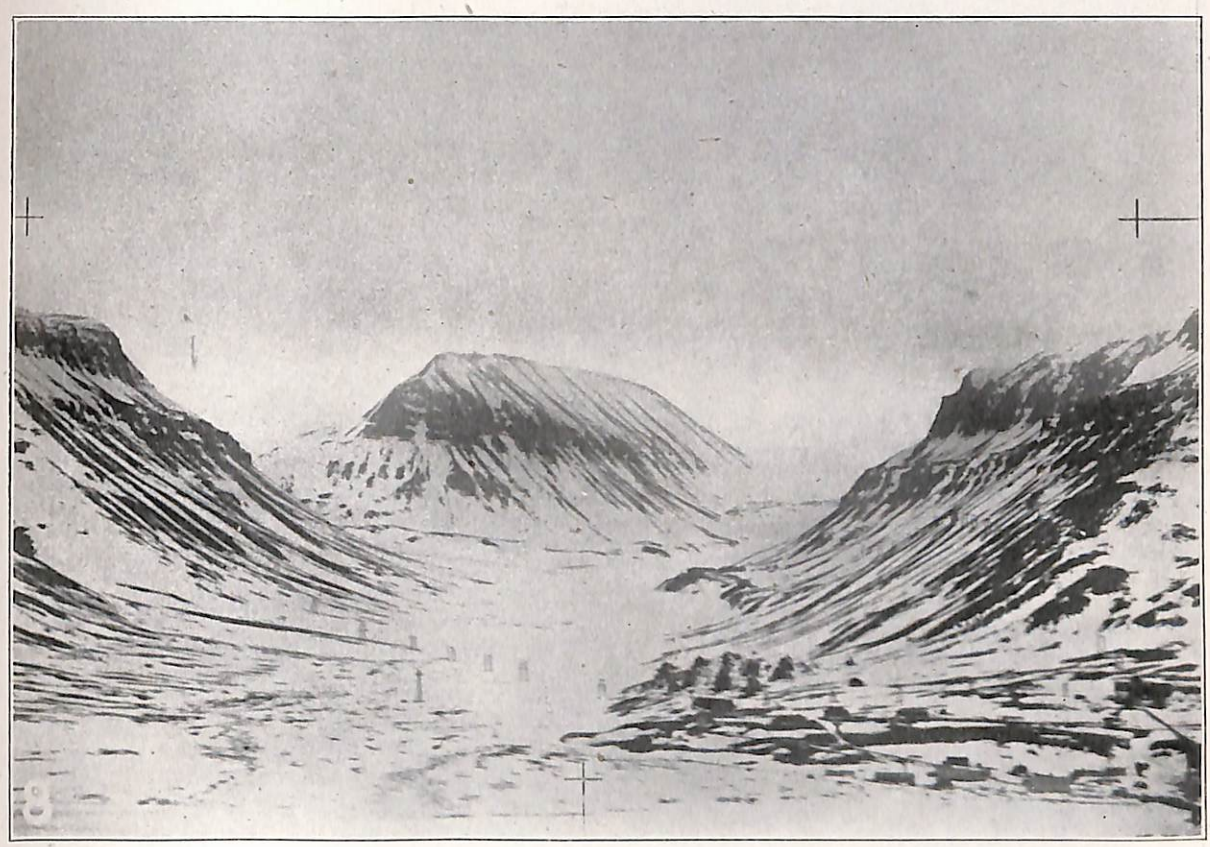
On the 28th May, H. began his next sortie, P/210 being airborne at 1630, this time carrying eight kitbags and four parachute bags filled with food, cigarettes and tobacco, blankets, clothing and medical supplies. On the following morning the enemy reconnaissance (a Ju.88) left Ice Fiord about 0520, and P/210 arrived only ten minutes later, both aircraft having been heard at the same time at the survivors' signal station. There was thick fog outside Ice Fiord and 10/10 stratus at 800 feet inside, however, so the chance of an interception was small. This time there was no delay in the recognition, and after passing several signals by Aldis to amplify the somewhat scanty information given in the first sortie, H. carried out a series of runs at low height across the signal station to drop his load.

The full glory of the scene that followed could not be properly appreciated from the air. Dirty, bearded ruffians darted out on skis to seize half-buried kitbags, tearing them open and thrusting mixtures of chocolate and boracic powder into their mouths with one hand while with the other they pulled off their tattered bed sheets to parade back in the full glamour of an Irvin suit. Perhaps the best of all was the sight of a most respectable colonel of the Royal Corps of Signals sitting on a coal-heap oblivious to all else as he devoured large spoonsful of apricot jam and coal dust out of a 4-lb. tin which had burst open on impact. The party which followed that day prompted one of the survivors to write: "The signal station has the great advantage that two yards away there is a friendly coal-mine, festooned with icicles, and forming a perfect air-raid shelter. Inside the house is a corking great dynamo with a ventilator shaft which gives armoured protection. It's a bit chilly, but we've built bunks, the Catalina has dropped cigarettes, lashings of jam and chocolate; we have our roast pork from the pigs killed by the Canadians last year, we eat sticky Russian sweets all day, and in fact could the Ritz in wartime offer more?"

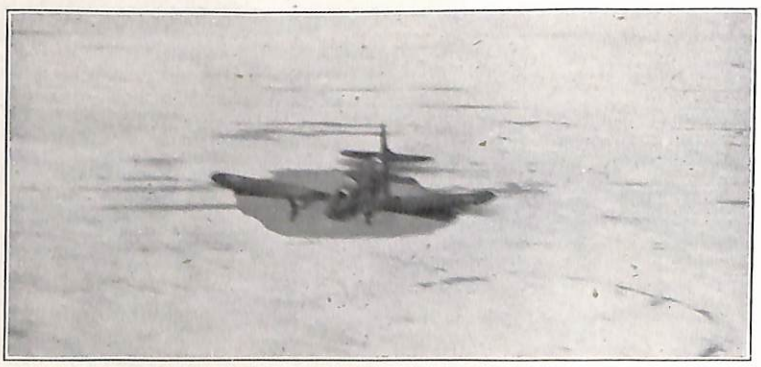
This sortie lasted 24 hours, 40 minutes, P/210 being again waterborne at Sullom Voe at 1710 on 29th May. At 2330 on 31st May the third sortie was started, the load this time consisting mainly of arms and ammunition while the flight had the additional purpose of landing in order to embark the six wounded for return to Shetland. Iceing fog was met about 71° N., growing thicker towards the north until at 73° 40′ further progress became impossible. Course was therefore set for base and the aircraft was waterborne at 1705 on 1st June. Weather conditions prevented another attempt until 6th June, when P/210 was airborne at 0721 and arrived at Cape Linne at 1723. Once again much low cloud and fog was encountered on the outward route, perhaps fortunately, as an He.177 attempted an attack which was evaded in cloud cover. In Green Harbour landing conditions were only fair, with many small floes and a multitude of brash, but H. chose a perfect track, the aircraft being waterborne at 1832. With the utmost care he then proceeded to bring her inshore, weaving his way between the ice-floes until they became so tightly packed that it was necessary to shove them apart with the boat-hook (Plate 6, top). At 1852 the boat was anchored some 400 yards from the shore, and the dinghy launched, H. and Sergt. T. paddling a somewhat erratic course ashore (Plate 6, middle). Meanwhile, the wounded were being brought off in a skiff, and within three-quarters of an hour had been comfortably installed. At 1945 H. returned to his boat and by 2010 P/210 was airborne, to be back at Sullom Voe ten hours later, a total flight of 23 hours.

On 14th June a fourth sortie was made by P/210, this time returning to Akureyri after a flight of 25 hours, and on 26th June a fifth sortie, of 24 hours, 50 minutes, in the course of which a Ju. 88 was shot up on the ground (Plate 8). There were no more relief flights, as shortly afterwards the force in Spitsbergen was strongly reinforced and the strategic points placed in a proper state of defence. Further supply flights were made, however, on 7th July by H/210 (P.), on 26th July by P/210 (H.), and on 29th September by A/210 (D.).

In the course of all these flights sea-ice reconnaissance had been made, and increasingly accurate methods of reporting had been steadily evolved. It might therefore be appropriate to give a general description of the mechanics of this ice as a background against which the value of the flights can be assessed. The great mass of the polar ice first forms off the north Siberian coast, mainly east of Cape Chelyuskin, whence it is drifted northwards and westwards by the winds and currents. For this transpolar journey the ice



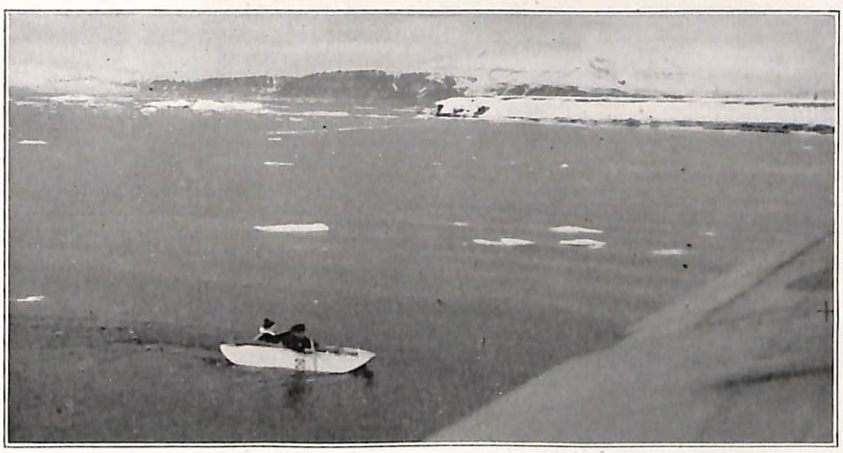
Spitsbergen (210 Squadron) : Longyearby, 12th and 25th May.



Spitsbergen (210 Squadron) : (Top) Tracks of Heinkel in snow, and shadow of Catalina, Advent Fiord, 12th May.

(Middle) He.111 wrecked on bay ice, Advent Fiord, 25th May.

(Bottom) Survivors waving from hut, Advent Fiord, 25th May.



Spitsbergen (210 Squadron) : (Top) Fending drift ice off the Catalina at anchor in Advent Fiord, 6th June.

(Middle) Captain of aircraft going ashore, Advent Fiord, 6th June.

(Bottom) Jetties and boats, Longyearby, 27th June.

Spitsbergen (210 Squadron) : Longyearby, 27th June.

may require two to three years before it approaches the Atlantic side, where it divides into three main branches, one drifting into north Barents Sea by the channel between North East Land and Fridhtjof Nansen Land, the second into the Greenland Sea and later the North Atlantic, and the third continuing westward around north Greenland to emerge southwards either through Kane Basin and Smith Sound, or into the Beaufort Sea.

It is the sea-ice in the Barents and Greenland Seas which affects the convoy route to North Russia. In this area the cold current from Fridhtjof Nansen Land sets south-westerly, continuing past Hope Island and Bear Island and also trending around South Cape up the west Spitsbergen coast. This current causes much drift-ice to be carried between February and June from the north Barents Sea south-westwards around Bear Island and in a narrow belt up the west Spitsbergen coast. An extension of the North Atlantic drift also plays a role in this area, dividing near 70° N. and 10° E. to send one branch northwards along the same meridian and a second north-eastwards between Bear Island and North Cape. Thus it is that to the west of Spitsbergen the zone immediately west of the 100-fathom line is usually ice free throughout the year, in the spring forming an open bay between the Greenland ice-stream to the west and the narrow Spitsbergen coastal belt to the east. Similarly, the seas immediately north of the Murman coast remain open throughout the year.

In studying these sea-ice conditions it is important that as much as possible be reported not only of the limits of the ice but of the density and type well inside those limits, so that the effect of wind and current in the subsequent days and weeks can be assessed. To meet these requirements the following simple coding method was used :—

Type of Ice.	*Code Letter.*
Pack Ice	(a)
Drift Ice	(b)
Brash Ice	(c)
Bay Ice	(d)
Icebergs	(e)

Drift ice (b) had the following sub-code to indicate the average size of floes :—

Size of Floe.	*Code Number.*
Up to 20 ft.	1
20–200 ft.	2
200–600 ft.	3
600 ft.–1 mile	4
Above 1 mile	5

Reports included an indication of the amount in tenths of the sea covered, as well as a figure for visibility.

In addition to the sea-ice reconnaissances carried out in the course of the Spitsbergen sorties, which in themselves finally covered the greater part of both the Barents Sea and the Greenland Sea at regular intervals between March and September, two special reconnaissances were also made by P/210 (H.). The first, on 25th June, covered the Greenland coast between Scoresby Sound and Angmagsalik, benefiting from perfect weather with maximum visibility along the coast itself. The second was more ambitious, and had as its object a return flight from Akureyri to as near the North Pole as possible, the purpose being the combined one of a high-latitude test of navigational instruments and a reconnaissance of the sea-ice in the Polar Ocean. Comprehensive preparations for this flight had been made with a number of authorities, including the Astronomer Royal, the Admiralty Compass Observatory, the Naval Hydrographical Department, the Laboratories at Farnborough, the Royal Geographical Society and others.

A long series of delays, unavoidable in themselves, put back the start of the flight from May, as had first been intended, to late August, and it was realised that weather unfavourable to the navigational test was likely to be met. Forecasts continued unfavourable, and other operational requirements made it impossible to delay the start beyond 22nd August. Early morning departure was most desirable, if not essential, but at 0600 on that day visibility was 500 yards and a stiff breeze would have made take-off, in the steep sea then running, hazardous for such a heavily laden boat. By mid-day, however, local conditions had improved, and it was decided to make the attempt, P/210 being finally airborne at 1315. Conditions as far as 77° N. were ideal, visibility being at its maximum, and consumption the best yet experienced on any of the sorties, lending hope that the Pole might be reached. Some few miles farther, however, dense fog began to roll in from the east, the ice-cap wind being apparently too weak to keep it away from the coast. Near 78° N. the coast itself was enveloped, and heavy strato-cumulus was piling up above so that when at a height of 7,000 ft. at 79° N. no clearance overhead could be seen.

To attain the object of the flight it was essential (*a*) to set course from an established landfall in north-east Greenland ; (*b*) to check the magnetic variation by astro-compass at that position, and (*c*) to be able to check the true course by sun observations after setting course from that position. Weather conditions at 80° N. made it certain that these essentials could not be fulfilled and there was nothing for it but to set course for base. A few minutes after turning there was a cough from the starboard engine, repeated ten minutes later and then more frequently. H. switched to auto-rich, throttling back, but the trouble continued and the aircraft was flown virtually on one engine. The most likely explanation seemed to be water in the carburettor, and there was thus no logical reason why the port engine should not develop similar trouble. To put down as soon as possible therefore appeared essential, and course was set for Scoresby Sound, where it was hoped there would be open water, a more friendly landing than the ice-bound coast farther north. Local midnight, however, brought a low fog creeping in from the sea, above which the electric blue glaciers with their jet-black skeleton peaks loomed threateningly to the west. When Scoresby Sound was reached, landing was out of the question, so course was set for Akureyri, 280 miles farther on, which was reached without difficulty or incident. It was only later that it was found that the trouble owed its origin to the effects of the nine previous sorties, on which the mixture settings, in order to conserve fuel, had been excessively lean, thus scorching down the valveheads of both engines.

Some time elapsed before H. undertook his next Spitsbergen sortie, this time in S/210. During the middle of September he had been

operating with his squadron from north Russia, making several long sorties in the eastern Barents Sea and in the vicinity of Novaya Zemlya. On 25th September he left north Russia for Spitsbergen, but bad weather at Bear Island forced the aircraft to return. When approaching Kildin Island a Ju.88 was sighted which closed and came up the beam at high speed. Fire was opened from the blister guns, but the forward gun jammed, enabling the enemy aircraft to pass ahead unopposed and to get in a burst with its after guns from some 300 yards. In this burst H. was mortally wounded. The 2nd pilot, J., took over control at once and, as the enemy aircraft came in to a second attack, it was hit by ·5 fire. This caused it to break off action, and J. landed the boat just inside Kildin Island, the crew later being taken off by a Russian M.T.B.

In five months H. had made no less than seven successful sorties to Spitsbergen, and altogether a total of 14 high latitude sorties. In all but the September flights he had the same crew, S. and M. being respectively navigator and second pilot. The flights in their scale and consistency constitute a record in high latitude flying unequalled by any nation and surpassing all previous attempts. They were made possible by H.'s ability and determination, greatly aided by his quality of winning the utmost loyalty and respect from all with whom he came in contact. So much the more tragic was his loss on what was to have been his last operational flight, a loss not only of an outstanding captain of aircraft but of an exceptional and most lovable character.

Performance of aircraft

In concluding this account it has been thought best to summarize briefly some of the technical aspects of the flights, each under its own heading:

The distance from Shetland to Cape Linne, Spitsbergen, is about 1,200 miles, a range within the compass of the normal long-range Catalina provided no excessive head-winds are met. The flights were undertaken with a full petrol load (1,800 gallons) and in addition pay loads varying from 200 to 1,000 lb. With the heavier loads the take-offs with light winds (10–15 knots) were from 60 to 80 seconds, and in the initial stages the aircraft was somewhat unstable in flight.

An airspeed of 102 knots, T.A.S., was found to be the optimum cruising speed for P/210, and required an average fuel consumption of 54 gallons per hour. The fully laden consumption was normally 63 gallons per hour, and the lowest recorded consumption with settings of 28½ in. (Hg.) boost and 1,400 r.p.m. (auto lean) was 38 gallons per hour. The mixture settings required to give this consumption, however, finally proved excessively lean, causing severe scorching of the valveheads. A number of the flights included operation in auto rich with high boost and r.p.m. settings for a maximum of two hours. In several cases a landing and take-off was made in Green Harbour, the return flights being made with payloads of up to 1,500 lb. The maximum time taken on the round flight was 27 hours 10 minutes and on no flight did the aircraft land finally with less than 240 gallons of fuel.

Navigational

P/210 was fitted with three magnetic compasses and two specially selected Directional Gyro. The magnetic compasses were

(1) a D.R. compass,

(2) a P.9 specially balanced for latitude 68° N.,

(3) a P.4 specially balanced for latitude 80° N.

On two of the flights the D.R. compass broke down and in each case the return journey was made using the magnetic compasses.

It is of interest that at 78° N., although the strength of horizontal force of the earth's magnetic field is half that at 68° N., the P.9 (HL) compass worked satisfactorily. The acceleration and turning errors were considerably increased, but it was possible to fly a sufficiently accurate course on the P.9 compass alone. The P.4 served as a double check, but even in high latitudes was found to be too lively for use on its own. This was to be expected as it was intended for use in latitudes above 80° N.

The drift recorder was used in preference to the Course Setting Bomb Sight on all flights. It was found to be a very real improvement, and also preferable to the Tail Drift Sight because of its position. Long Range Special Equipment was carried on all flights by P/210 and proved invaluable. It was particularly useful in making blind landfalls in fog, and in giving warning of the presence of icebergs.

Straightforward D.R. was used, checks being made by sun sights and W/T bearings. On the greater part of the routes, however, much cloud was encountered, the normal cover being 10/10 st. or st. cu. at 1,000 ft. As a rule a height below 1,000 ft. was maintained, frequently 400 ft. and often as little as 50 ft., the object being to avoid flying within range of the Norwegian R.D.F. stations and to continue accurate readings of drift. Plotting sheets were used up to 71° 30' N., to the north of which Admiralty Chart 2282 was employed.

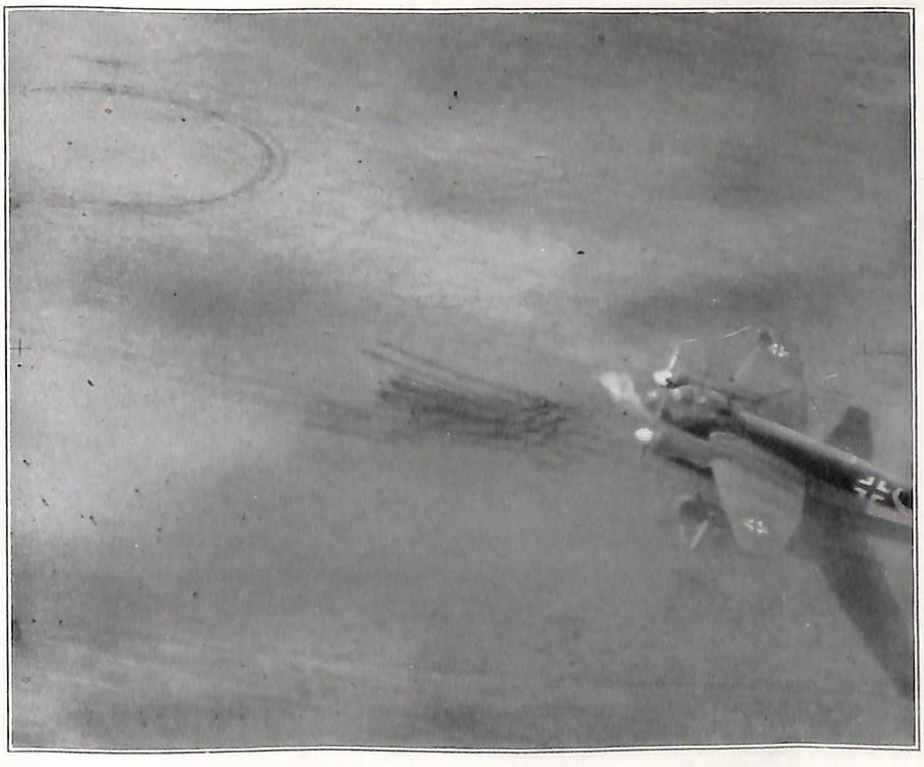
A detailed report on the high latitude navigation is being prepared by S., the navigator.

Weather

From May until early September winds of light to moderate force should be expected, exceptionally powerful winds only being met in the Spitsbergen area between mid-September and the end of April. A high degree of cloudiness is usual over the greater part of the route, and during the summer months there is a preponderance of fog between Bear Island and South Cape, continuing as a bank northward along the west coast of Spitsbergen as far as Bell Sound. The entrance to Ice Fiord is normally open, however, and there is a strong tendency for a clear zone to be found to the west and north.

One point of exceptional interest would seem to be the medium to heavy icing encountered between temperature of –30° and –40° F. at high latitudes during April, probably illustrative of generally dangerous conditions below the normal icing danger range in these latitudes in spring.

Significant also was the tendency for fog at temperatures near 32° F. to be encountered near and over the limits of the sea ice. One example of this is worth recording. The aircraft passed over the ice edge at a height of 50 ft., the air temperature falling from 34° F. when over water to 30° F. when over ice, light sleety precipitation taking place. Immediately on passing the edge the fog became so dense that it was impossible to



Spitsbergen (210 Squadron) : Landing ground with Ju.88, Adventdale, 27th June.

(Top) Spitsbergen : Bell Sound, 27th June (210 Squadron).
(Bottom) The Alps (P.R.U.).

see the ice 50 ft. below, and glazed ice began to form very rapidly on all parts of the aircraft except the fuselage. The airscrew de-icers and the carburetter heater were turned full on. In nine minutes all protruding parts were covered with 2½ inches of glazed ice. The boost fell quickly and with full throttle it was possible to maintain only 33 in. (Hg.). With this setting and high r.p.m. the maximum air speed was 80 knots.

Personnel

It was impossible for the captain, second pilot, or navigator to obtain any rest during the flights, while of the remainder of the crew one at a time was able to lie down for a short period. In view of the length of sortie and the frequent occurrence of bad weather, this entailed a very great strain on all members of the crew and particularly on the captain and second pilot. The effects of this were perhaps most pronounced after the four sorties flown in late May and early June.

In offsetting fatigue and strain, good food and continuous hot drinks, particularly of Bovril, Ovaltine and sweet tea, played a most important rôle. Cooking was allowed only after the fuselage tanks had been emptied and the vents well blown, normally seven hours after take off. For that period thermos containers were used and cold meals served, but later eggs and bacon, steak and potatoes and stews were cooked. Rations were good and the cook provided meals of consistently high quality.

Most important of all, however, was the high morale of the crew, each member of which showed the greatest personal enthusiasm for the success of the flights. This was largely due to the inspired leadership of the captains of the aircraft concerned, and reflected the greatest credit on 210 Squadron.

A Round Trip

The following account of a Photographic Reconnaissance flight to Malta via Venice, and back via Gibraltar, is published, not only as an extremely interesting account of a trip of some difficulty, but also as a reminder of what can be achieved by intelligent navigation, even in the cramped cockpit of a Mosquito. The story clearly illustrates the effect of good team-work, as well as the value and limitations of map-reading.

At first sight it may appear surprising that the Maltese islands, 25 miles wide altogether, could be missed after only twelve minutes' flying in a visibility of five miles. The aircraft left Sicily for the first time flying at 24,500 ft., and it was not worth while descending through the clouds to pinpoint the position, especially in a fighter area. The Mosquito then lost height rapidly—nearly 20,000 ft. in 70 miles, so that its ground speed fluctuated and there was no means of discovering to what extent. In the circumstances, the E.T.A. could only be a rough approximation. Besides, any error in the bearing would involve wrong measurement of the coast to coast track. All this, aggravated no doubt by minor deviations of the compass course while travelling at six miles a minute, could bring the crew past the islands without seeing them and without immediate realisation of the fact. If anyone should be tempted under such circumstances to fly without constant reference to a compass course, to a stop-watch and to a time-scale on the map, he should reflect on the consequences of overshooting a small target with only a limited supply of petrol.

Outward Bound to Malta

"We took off in fog at 0915 hours. It was ground fog only and we were soon climbing steadily above it in clear sunshine. We set course directly for Venice, our first target, and levelled off at 24,000 feet just after crossing the French coast north of Cayeux. Ground mist and low cumulus cloud made map-reading impossible, so we flew on a compass course, watching for breaks in the cloud to check our track. At about 1000 hours we found we were south of track and altered course accordingly. The low cloud was now dispersing, and map-reading became easy. About the Mulhouse area the Alps became visible and we flew on towards them in brilliant sunshine. They were a breath-taking sight and we took a good run with the oblique camera to ensure it would not be wasted on us alone. (*See* Plates 9 and 10 and other magnificent photographs reproduced in *Evidence in Camera*, No. 2, pp. 72, 73.)

We had now been flying over two hours and were approaching our target in good visibility, a little south of track. At 1145 we sighted Venice and prepared for photography. We did two runs over the city, harbour and aerodrome, paying particular attention to the industrial area of Marghera. From 22,000 feet we could clearly see a large battleship and a many-decked passenger liner. At this height we were now encountering thin altostratus cloud and came down under this as we headed north-east along the coast towards the aerodrome and shipbuilding yards at Monfalcone. This area was concentrated along the narrow mouth of the river Isonzo, so we covered it in one run at 17,500 feet with all the vertical cameras on (as we had at Venice). This run headed us directly towards Trieste, our third and most important target, which we covered in two runs at 18,000 feet. Quite a number of large naval vessels could be seen in the main harbour area and we concentrated on these as being of first priority. These two runs included the shipyards at Muggia, where, however, little activity was to be seen—probably because it was the lunch hour! I wondered if we had caused an air-raid alarm and rather hoped we had.

Our next target was Fiume, and this presented little difficulty as it lay on a straight stretch of coast running almost due east and west along the Gulf of Quarnero. The northernmost Dalmatian islands were clearly visible and the weather was still good for photography. We did a second run over this target at 20,000 feet as it was on track to our next target, Pola, a small port on the southern tip of the Istrian Peninsula. This target required only one run, at 18,000 feet again as the cloud was coming lower. From Pola we set course for Rome, our final (though unofficial) target. We kept in fairly thin altostratus cloud at 20,000 feet, made a good landfall after the short crossing of the Adriatic Sea and flying over rain clouds across the Apennine Chain picked up the river Tiber without much difficulty. This

cloud cleared as we approached the target and, clearly showing amid the modern and well-planned streets of this ancient city, we saw the Coliseum. Keeping this well in the centre of my sights, we did a long run over the target to cover the marshalling yards, aerodrome and city. A flat turn to port brought us over a large industrial and factory site which we covered in one run, all at 22,000 feet. Almost on track we could see the small port of Anzio ahead, so covered this on all three vertical cameras in one short run. Our final course was now set for Malta, a distance of 420 miles, with Sicily to cross from north to south. We left the Italian coast at 1335 at 23,000 feet, in good visibility with little cloud cover but also little fear of being intercepted after the uneventful way we had been received thus far by the Italians.

Cloud now began to thicken and visibility distance decreased with every mile further south. Our track was 178° True and we climbed a little to 24,500 feet to increase our visibility as far as possible. Soon Sicily was looming up ahead with Mount Etna easily visible to port. As we approached the northern coast we altered course and steered for Palermo and at 24,500 feet we let all the vertical cameras run in order to use up all the remaining film to facilitate changing camera magazines at Malta. We were slightly to starboard of track and, as we left the south coast of Sicily, altered course directly for Malta. Visibility was now down to ten miles and decreasing as we lost height. We were coming down at a fairly long gliding angle and our ground speed I calculated to be in the region of 350 m.p.h. With only 70 miles of sea to cover we were soon looking out for Malta in the gathering haze. It was now 1430 hours and terrifically hot at 5,000 feet. We now sent out wireless signals but picked up no reply apart from undecipherable key clicks. On E.T.A. Malta was still not in sight, so we turned to port and flew due north to pick up the Sicilian coast again. We followed this to the south-east tip of the island and then flew on 222° Magnetic as instructed when we were briefed. We were now at 3,000 feet and visibility less than five miles in thick haze. We had about an hour's petrol left so were not unduly worried, except for the failure of the wireless. We could not continue to send out signals for any length of time owing to our proximity to Sicily. While I was busy on the wireless the pilot had been doing some neat navigational flying and turning to port once more one minute after E.T.A. soon sighted Malta ahead and slightly to starboard. We lost height, steered for Filfla Island and came in at the correct speed, height and course as instructed. We soon spotted Luqa, the only aerodrome on the island with runways, and made a perfect landing at 1540, just 6 hours 25 minutes after leaving base in England.

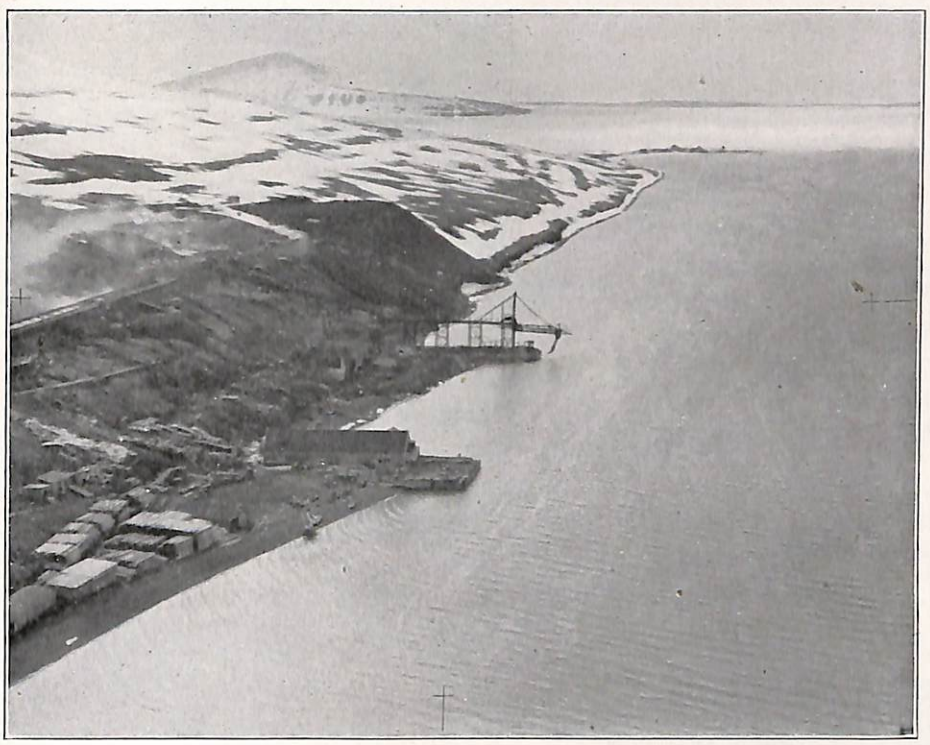
A False Start

After an uneventful night at Malta, we got away with very little trouble next morning at 0750 hours. Considering the terrific and sustained bombing all Malta's airfields have had, the efficiency when dealing with a strange " bird of passage " like ourselves was amazing. We were soon climbing steadily away from this grim little island in the clear morning air, but already could see a fair amount of cloud ahead. We were steering almost due west towards Africa where we had certain targets to photograph on our way to Gibraltar. After an hour's steady climbing we saw the coastline ahead through about 5/10 cumulus cloud and levelled off at 22,000 feet for our run in. We were nearly on track but altered course slightly for our first objective. There was plenty of scattered cumulus (or gremlin) cloud about, and we hotly debated whether we should get anything or not. But it was not to be. We made three runs over our first target with all cameras on, but persistent cloud gremlins foiled all our efforts. So we set course for our second target area to find the same conditions, though we attempted one run without success. We carried on to the third area but as cloud was now 9/10 we had no alternative but to turn back for Malta and try again the next day. So at 0945 we turned on to an easterly course still at 22,000 feet and made for Malta. As they were not expecting us back we sent off a coded message by W/T, but getting no reply repeated it once again. Still no reply from Malta so as we were now just south of Pantelleria, an enemy fighter squadron base, we put her nose down and " went like a dingbat." We sighted Malta at 1100 hours and were soon " down and out." Time 3 hours 15 minutes.

Return via Gibraltar

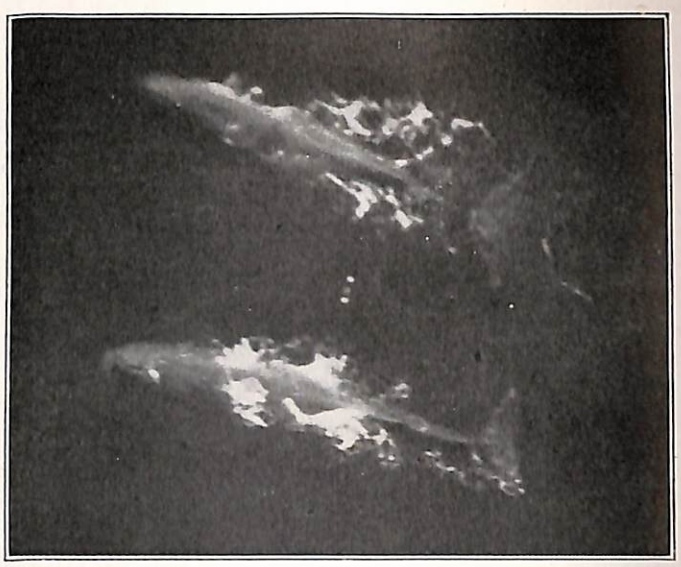
Once again we had a quiet night and rose at an unearthly hour to try to get over our targets before an expected front had covered them with clouds. We were airborne at 0600 (G.M.T.) and climbing almost immediately, took some obliques of the island before we left. Once again we were over our first target in an hour and were able to make three runs at 22,000 feet with all vertical cameras on. Our second target was a large area and we did five runs at 22,000 feet before we were satisfied we had completely covered it. During the course of these runs the rear camera " ran away," *i.e.*, commenced to take pictures with hardly any time interval between, thus giving a very large overlap. We continued to use this camera by leaving the control on and connecting and disconnecting the power lead as and when required. This resulted in pictures of inferior quality but nevertheless got a certain amount of required detail. We covered the remaining target areas with little trouble and at 1000 hours were on track for Gibraltar at 21,000 feet. The front we had been warned about now began to show itself, so as we were well out over the sea we started to lose height gradually. At 1125 we contacted Gibraltar on the W/T and sent our E.T.A. in code. This was acknowledged and soon afterwards we sighted the Spanish coast north of Cape Gata. We were to north of track and at 7,000 feet, so we continued to lose height and " coast crawled " in ever thickening weather till the Rock loomed through the mist at 1225 hours. With the cloud base at 250 feet we fired a signal cartridge and came in to land on what is reputed to be a very tricky runway. But the pilot rose nobly to the occasion and put her down with never a bounce. Malta to Gibraltar—5 hours 35 minutes.

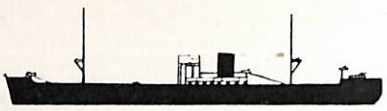
Our reception here too was amazingly efficient. Within 25 minutes of touching down we were washed and fed and on our way to be briefed. Actually we never left the aerodrome at all and in 90 minutes were back in our machine, completely briefed, loaded with letters and parcels (the recipients of many envious looks but hearty good wishes), and also flying rations consisting

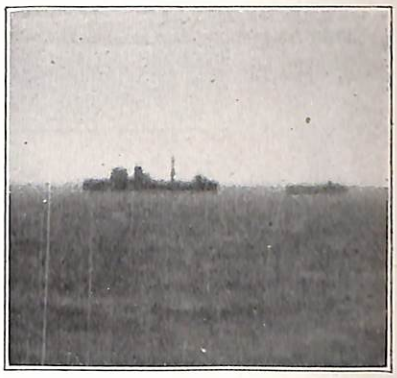


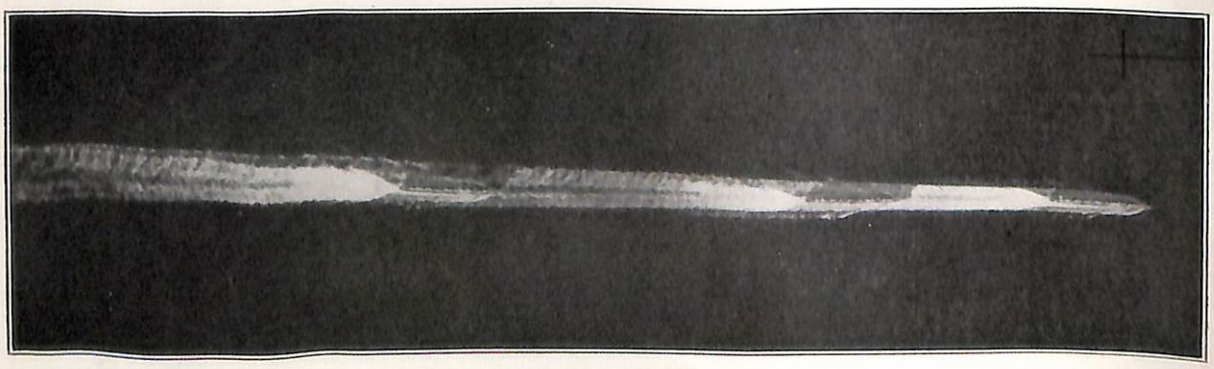
(Top) Spitsbergen : Barentsburg, 27th June (210 Squadron).
(Bottom) The Alps (P.R.U.).

Some errors in the article on whales which appeared in the fourth issue of the *Review* may be corrected here. On page 12, right column, the reference to the " Fin whale (up to 60 ft.) " should have read " Fin whale (up to 85 ft.), the Sei whale (up to 60 ft.)." The photograph on Plate 6 labelled " Slick " is of a Fin whale, and its slick has been cut out. In the top left-hand photograph of Plate 7, the whale is a rorqual, not a killer, for the dark object showing in the white patch is not a dorsal fin, but the lower part of the back, uncovered by the subsidence of the splash ; the small dorsal fin shows grey, above and near the right edge of the white patch.









(Top) Pair of whales of unidentified species, about 35 ft. long (10 O.T.U.).

Enemy Shipping (2nd line). The *Belgrano* Class. An oblique photograph of *Sperrbrecher AE* was published in the previous issue (No. 5, Plate 8, top *right*) ; she had several times been seen escorting convoys off the Frisian Islands. She was again seen by 236 Squadron on 23rd October, but the photograph (right) caused some mystification till it was compared with the outline of a *Sperrbrecher* converted from the *Belgrano* type of merchant vessel of 6,000 tons (centre). It was then realised that she was being towed stern first and that the bows and almost all the forepart had disappeared—no doubt as a result of a mine. Another vessel of the type was also seen in October, an outward-bound blockade runner (left). She was sighted and photographed by 461 Squadron on the 2nd. Next day she was attacked by 10 Squadron, and perhaps damaged, though not enough to prevent her continuing her journey after spending a few days in a neutral port. The *Belgrano* type vessels thus serve a number of useful purposes for the Germans.

(3rd row) Enemy Convoy off Holland, 30th September (236 Squadron).

(4th, bottom, row) Three enemy destroyers, 21st October (P.R.U.).

of sandwiches, lemonade and grapes! We took off exactly two hours after landing and were almost immediately in 10/10 of cloud. At 19,000 feet we were in and out of towering cumulus clouds but managed to make a landfall before turning north for home. The clouds ahead looked extremely unpromising, so we altered course to avoid the worst patches but it was of no avail. At this height we now ran into 10/10 cloud and iceing conditions. Ice began forming on our leading edges and the cockpit glass in front of the pilot, but this latter dispersed when we put the de-iceing equipment into action. We now dropped down to 14,000 feet, but the cloud remained unbroken and the ice refused to go. So we climbed slowly back again to 20,000 feet, with the port engine missing occasionally to keep us alive to the fact that we were not home yet. But at 1545 hours we finally came out above 10/10 cloud and began climbing a little to keep there. The ground now came into view through rare gaps in the cloud, but not sufficiently to pinpoint ourselves. However at 1630 hours we saw vaguely through this cloud layer the coastline of north Spain, and pinpointed our position.

From this fix we set course for Portland Bill at 22,000 feet, over 9/10 to 10/10 medium and low cloud. This cloud continued for some considerable time, but thinned out appreciably as we approached the coast of Brittany. We crossed this south of Lorient on track and flew steadily on, keeping a sharp look-out in all directions. We could not afford to lose height too soon as the Channel Islands were on our track, so we stayed at height until we had left these behind. Cloud was now increasing again and we were soon nosing down through it as we approached the English coast. We now sent out the required W/T signals to Control as we would have to cross it at a low height and this was not a healthy proposition owing to the efforts of Jerry sneak-raiders. We finally emerged through stratus cloud at 600 feet over the sea and soon the English coast was faintly visible ahead. We were west of track and heading into Lyme Bay, so we altered course approximately for base and climbed to 3,000 feet where we broke cloud and levelled off. We now got in touch with our base H/F D/F station and got an immediate reply to our request for Q.D.M.s. We steered these, still over 10/10 low stratus cloud, meanwhile obtaining over the W/T the barometric pressure at aerodrome level and the height of the cloud base. With these facts we were now able to decide that it was safe to descend below cloud and at the right moment down we went and below us was base, right where it should have been. Never was there a more welcome sight since our take-off from Luqa that morning. After a magnificient shoot-up (fully authorised) we touched down at 1835 hours, just four hours after leaving Gibraltar, having covered nearly 4,000 miles, taken nearly a thousand photographs—and forgotten to eat our grapes."

Ocean Landing and Take-off

On 23rd September a Sunderland of 423 Squadron, R.C.A.F., made a forced landing 12 miles west of St. Kilda, and took off again in a heavy sea. The Captain's account should be of value to others who may find themselves in a similar position. Incidentally he had had about 150 hours on Sunderlands.

"We were recalled from convoy escort owing to adverse weather conditions. On leaving, the cloud base varied between 100 and 1,000 ft., with rain, bad visibility and low iceing-level. The wind from N.N.E. was about 45 knots. As we flew south, conditions improved; the sea, however, was rough with a heavy swell, the wind created a violent cross-sea.

"Prior to the engine failure I was operating the S.E., and on a signal from the second pilot I took over. Both the port engines had cut. At this stage we were about 500 ft. I could not maintain height on the starboard engines. We sounded 'bombs out' and the emergency signal. At 200 ft., being almost into wind, I throttled back and glided down, at 1910 hours. Flaps were not used. Our landing was successful, and there was no apparent damage to floats or hull.

"During these few seconds of landing we prepared to abandon the boat. Dinghy drill was completed; bombs rendered safe, and depth-charges jettisoned on the water. We did not have time to do this in the air. The navigator completed his log and checked up the dinghy preparations.

"All the time we were on the water the radio operator was sending out an S.O.S. and the position on four frequencies.

"Just after touching down we managed to re-start the port engines. Although darkness was falling, we could see St. Kilda as we rose on the crest of the waves, and we tried to taxi towards it. The sea was too rough, and progress was slow, if any. Whenever we headed the boat out of the wind the starboard float submerged and the outer air-screw was chewing the sea.

"Heavy seas continually broke over us, water pouring in through the front turret, pilots' windows and astro hatch. One of our front windows was cracked.

"We were amazed at the punishment our Sunderland was taking. The boat was pitching and plunging violently—it is little wonder two or three of the crew were sick. After about half-an-hour of this we realised that we were shipping more water than we could pump out, and sooner or later the boat would sink. We could get no reply to our S.O.S., and not knowing whether it had been picked up, we were reluctant to abandon and take to dinghies. Launching these would have been hazardous if not hopeless. We should not have survived long in that sea, which was becoming more violent. We were obviously getting no nearer to St. Kilda, and the situation was not encouraging. At this stage I asked the crew how they felt about my taking-off. We agreed it was worth it.

"The crew remained at dinghy stations. Our first attempt was along the length of the swell. This was unsuccessful, the wind was too strong. I tried opening the four throttles together, but a wave doused the inners. Finally, leaving the outboards wide open, and following up with the inners, we managed it. A bucking bronco had nothing on the Sunderland in that take-off One second we were surfing down the backside of a swell burying our nose in the trough, the next we were bounced into the air. The pounding the

boat took was phenomenal. The floor boards were buckling, crockery was flying around the galley with one of the navigators vainly trying to catch the cups as they ricocheted on the walls. On each bounce the boat gained a little more airspeed, finally becoming airborne about 65 knots. Beautiful smiles broke out on the faces of the crew.

"So heavy was the beating our boat had taken, that the bows were bent upwards, the sides of the hull creased and longerons strained from the bows through to the galley bilge. The tailplane was bashed in on the leading edges and underneath, and the airscrews were pitted and bent. We had been on the water nearly an hour. Throughout this period the radio operator stuck to his set. No sooner were we airborne than the navigator thrust a course for base in front of me. It was the perfect course.

"Our thanksgiving feast consisted of hot tea and chocolate. Base was made a couple of hours later, and we were a very relieved crew. On our return we learnt that our S.O.S. had been picked up, and the Air/Sea Rescue was in full swing."

The main lessons to be learned from this incident, in the opinion of the captain, are:—

(1) The paramount importance of efficient dinghy drill, which cannot be performed too often; in an emergency like this, speedy and correct action are essential.

(2) The landing should be stalled, with the nose very high into the wind, and the aircraft kept level; if one wing is down, it is liable to catch in a wave and go under.

(3) When on the water, let the motors idle, and face into the wind.

(4) Taking-off into the high wind, and across the swell, was more effective than along the length of the swell; the strain was borne more easily on the fore and aft axis of the aircraft. Here again it is important to keep the aircraft level, to prevent one wing catching in a wave.

III.—OTHER MATTERS

Blockade Runners and Tankers

During October there was considerable activity among vessels that had long been suspected of being blockade runners, and at least five of them were seen from aerial reconnaissance to have left Bordeaux. Coastal Command aircraft sighted three of these soon after they had left port.

The first vessel sighted was later identified as the German " Belgrano," a vessel of 6,095 tons (*see* Plate 11). She was attacked on the 3rd by three Sunderlands of No. 10 Squadron, R.A.A.F., and while no definite claims of damage were made, there is some evidence for supposing that superficial damage was inflicted. She certainly put into a Spanish port where she remained for several days, and there were even reports that she had wounded aboard. It is possible that she was the unidentified vessel attacked on the 11th by a Sunderland of 461 Squadron, after she had set out again for the Atlantic.

The second vessel was seen on the 11th by Wellington O/304. This aircraft, which had gone to investigate, was fired on by the vessel, and replied with machine gun. A photograph taken during the brief encounter enabled her to be identified almost certainly as the German " Bürgenland," of 7,320 tons.

The last of the three was seen, photographed and attacked by Whitleys of 502 Squadron on 11th October, and was probably a vessel of the Silvaplana type, of some 5,000 tons. Both she and the " Bürgenland," must be assumed to have made good their escape, and together with the " Belgrano," are now probably well on their way to the East.

Throughout the 11th and 12th October, a tanker, of some 9,000 tons was harried by a series of individual attacks carried out by a mixed force of Whitleys of 502 and 51 Squadrons, and a Sunderland of 10 Squadron, R.A.A.F. Several distant photographs were taken, from which it was possible to identify her, somewhat tentatively, as an ex-Norwegian vessel, originally known as the " Krossfonn," but whose name has by now doubtless been changed. One of the attacking aircraft obtained some very near misses, and whether damage was inflicted on her or not, the fact remains that she was back at Nantes a few days later.

The function of these outward-bound tankers has not been determined with any certainty. The most reasonable guess is that they act as supply ships to U-Boats, carrying fuel and ammunition, and as such are an integral part of the U-Boat campaign. Another suggestion is that some may be engaged for fetching vegetable oils from the East. Certainly Germany is very short of these oils, and a tanker load or two might enable her to maintain, or even increase slightly, the margarine ration, with a resultant rise in enemy morale. Whatever their function, it is hardly likely to be an unimportant one, and may well include both U-Boat supply and blockade-running with vegetable oils, on a two-way basis.

Crew Training in Squadrons

With the increase in squadrons equipped with multi-engined aircraft, which are of greater complexity and carry larger crews, the subject of crew training in operational squadrons becomes more important. Intensified training within each squadron is essential to produce, not only the team spirit, but also a rational division of the tasks which have to be performed.

One Liberator Squadron has evolved a good system which is here outlined; it may not be in all respects applicable to other types, but it will serve as a guide for planning a systematic syllabus.

The crew of a Liberator consists of :—

The captain.
The second pilot.
The navigator.
The flight engineer.
One wireless operator/mechanic.
Two wireless operator air gunners.

Training falls into two stages.

Stage I

As soon as the requisite bodies arrive at the squadron, they are formed into provisional crews.

The captain is usually a fully qualified Hudson captain or an experienced Liberator second pilot.

The second pilot normally arrives direct from the School of General Reconnaissance.

These two commence their training together, apart from the remainder of the crew, under an instructor who is one of the more experienced captains of the squadron. Together they are taken over the aircraft, whose working controls are pointed out and explained in detail. They are taught the cockpit drill on the ground, and in general familiarise themselves with all the details of the aircraft.

The instructor then gives the captain dual in circuits and landings, and during this time the second pilot acquires a knowledge of his functions.

As soon as the captain has been passed as qualified to take control, the second pilot is then given a few circuits by the instructor to give him practice as a pilot and to allow him to become acquainted with the feel of the aircraft and its controls. The captain and the second pilot then carry out some 10 hours circuit and bumps, to get thoroughly at home in the flying of the aircraft.

In the intervals of flying during this phase, they are given lectures on the fuel, oil, hydraulic and electrical systems by experienced flight engineers.

While the captain and the second pilot are doing their flying training, the remainder of the crew are also undergoing simultaneous training as follows :

The flight engineer designate is taken in hand by an experienced flight engineer, who explains his duties and instructs him in the maintenance of

the aircraft, and the location and working of the fuel, oil, ignition, hydraulic and electrical systems, the layout of instruments and control cocks, the running of the engines, and the layout of their controls. This is done both on the ground and in the air. To qualify for aircrew the new flight engineer, must pass a test by the Squadron Engineer Officer.

The navigator may arrive at the squadron either from an O.T.U. with the rest of the crew, or from a G.R. School, in which case his training will be more comprehensive. He is attached to an operational crew as 2nd navigator to gain experience in navigating for long periods and under actual operational conditions.

As a rule, wireless operator mechanics and wireless operators arrive with little knowledge of the Bendix and R.C.A. Equipment and they are therefore attached to the Squadron Signal Section, where they gain knowledge and experience in the handling and maintenance of this. When they are considered fit for aircrew, they are given a test by the Squadron Signals Officer and if they pass this, they are joined up with the rest of the crew for Stage II training.

For the benefit of those who are not familiar with the handling of large multi-engined aircraft, it may be as well to explain that in the act of taking these off and landing them, it is essential that the captain shall be free to concentrate on those actions. The task of the 2nd pilot is therefore to watch every incident during the take off or landing and be prepared to act instantaneously on any order from the captain; when the aircraft is airborne he will adjust boost, pitch, flaps and under-carriage, will watch as ordered any particular instrument, and report speed, etc. When the Liberator is losing height preparatory to landing he constantly tells the captain the readings of the altimeter and airspeed indicator.

Until the aircraft is airborne, and directly after it has ceased to be so, A.M.O. A.946/41 specifically lays down that no member of the crew other than the first pilot may manipulate any controls. The second pilot will, of course, take over the controls at the captain's discretion, but only in the air. After a period as second pilot, he will go back to an O.T.U. for further training as a captain.

When this Stage I training has been completed by all, it is considered that they are ready to begin Stage II, in which they are trained as a crew. This Stage is divided into two parts: Ground Training and Air Training.

Stage II—Part I—Ground Training

This is run to a carefully prepared syllabus and a monthly chart records the progress of each individual member of the crew in each section.

It includes:

Gunnery.—Tactics, aircraft recognition, range estimation, turret manipulation, operation and maintenance of M.G. and cannon, preparation of ammunition in belts or magazines, viewing of instructional films, range and clay-pigeon shooting and harmonisation.

Armament.—Types and fusing of bombs, loading and care of bomb racks, pyrotechnics, bombing drill, Sperry bombing teacher, and general armament maintenance.

Intelligence.—Coastal Command procedure and operational control; knowledge of technical operational and flying order books, and of intelligence summaries; contents of aircraft wallets, and instructions on coding and security.

Navigation and Signals.—Practical and theoretical instruction as detailed in the syllabus.

Crew Drills.—Ditching, dinghy, abandoning aircraft, and action stations drill, and daily maintenance checks by the airscrew.

Photography.—Use and maintenance of cameras by day and night, compilation of reconnaissance reports, etc.

Part I also includes, in spite of its name, some local flying, circuits and landings, procedure for descent through cloud, use of S.E. beacon and D/F for fixing and homing, and practice in the use of radio compass and naval beacons, together with air firing and bombing exercises.

Stage II—Part 2—Operational Training

This is also carried out in accordance with a planned syllabus. It includes night training, which begins by the captain undergoing night dual, after about 20 hours day flying; this is followed by 5 hours night solo (accompanied by the second pilot). In addition, members of the crew are taught to carry out each others' functions with the exception of piloting, so that in emergency they can take over any duty. This latter training virtually amounts to a post-graduate O.T.U. course and should continue indefinitely, not only as new members join the crew, but also in respect of the whole of the crew. A crew cannot become and remain operationally efficient, even after all their previous extensive training, unless they are continually keeping up their standard.

It may be thought that, once such a scheme of planned training in the squadron has been worked out, it would be a simple matter to put it into effect. In practice, however, it will be found a matter of very considerable difficulty, and demands a lot of drive, combined with much patience.

Operational commitments will constantly interfere with the availability of instructors from amongst the experienced crews. The incidence of weather which is unsuitable for training, while possible to an operational crew, will often cause serious delays. The squadron which produced the scheme outlined above reports that at one period only on 15 of 60 consecutive nights was the weather fit for giving night flying dual.

Again, some aerodromes at which it has been necessary to locate squadrons of heavy aircraft have only one runway adequate for night work, and it may be necessary to wait relatively long periods for suitable winds and weather.

In conclusion, it must be borne in mind that while the foundations of crew training are laid in the O.T.U.'s, the high standard of efficiency demanded for successful operations can only be achieved by means of a carefully planned system of training in the squadron. The latter part of the training must, under the guidance of Flight and Squadron Commanders, be the responsibility of the captain of the aircraft. In addition to furthering efficiency, it will also serve to tighten the bonds existing between the captain and his crew, and between the various members of the crew themselves.

Planned Flying and Planned Maintenance

A good deal has been heard recently on some Stations and in some Squadrons about Planned Flying and Planned Maintenance. The subject is at once simple, and in its detailed application to the varying needs of the Royal Air Force, complex, so that necessarily only the broad outline can be dealt with here, within the compass of the *Review*.

It is a truism to say that in order to get the best out of any human effort, it must be planned. This is equally so on a farm, in a multiple store, or in a great industry. Even when there is no planning in the sense of written papers and diagrams, none the less a plan exists in the organiser's mind. Talk to any successful farmer, and you will find that he has a very clear picture in his mind not only of the crop history of his fields in past years, but also of the cropping programme for next year and for some years ahead. He will tell you from his past experience what yield can be expected from each field, and just how they must be cultivated to ensure that he gets the maximum. True, his forecast is subject to certain variables, notably the weather, but you will find that he has made provision for this, and balanced his available land to cover the hazards which he cannot control.

It is strange, therefore, that Planned Flying should appear as something new and unprecedented in the Royal Air Force. Obviously, there has been planning in the past but the point is that it has not been based hitherto upon a ruthless analysis of what is required. Planned Flying means no more than getting the best out of a squadron or any other unit, and Planned Maintenance means providing as economically as possible, whatever is necessary and economically requisite to get that best.

Now the basis of any plan is what you want to get out of it; so that before you can start to formulate it you must be perfectly clear exactly what you want. Consequently, if we are planning for a squadron, we must first ask: "How many sorties per aircraft per week or month are called for?"

The answer to this question will obviously depend upon the type of work it is engaged on; and for this purpose squadrons may be divided into two types. The first is Patrol Squadrons employed on routine work, such as anti-submarine patrols, which they are required to carry out regularly day after day to a given density, and the second is Strike Squadrons; these are called on to make a full-out effort spasmodically, perhaps at short notice, in as great numbers as possible, after which they relapse into relative inactivity until the next strike is called for.

These two types of squadrons present very different operational and maintenance problems. Suppose we take a Whitley Squadron on anti-submarine work and a Hampden Torpedo Bomber Squadron set aside to attack enemy naval units or specially important convoys. We may decide that for the former eight sorties per aircraft per month will suffice; or a total of 160 sorties in a 30-day month. Dividing 160 by 30 we find that 5·3 aircraft are required per day, but call it five. So long as we have our five aircraft serviceable we are not concerned on that day with the state of serviceability of the remainder; tomorrow we shall want five more, and it is the job of the maintenance staff to produce them.

Turning to our Hampden Squadron, we may calculate our chances of making an attack to be not more than three times per month; and on these occasions we shall need every possible aircraft. But if our estimate is correct, we shall not expend more than 48 sorties, and, assuming that the strikes occur in the most favourable way, i.e., on the 1st, 11th and 21st of the month, we shall have an interval of ten days in which to make good the repairs and to carry out inspections.

It will be seen, therefore, that these two types of squadron call for different establishments, different maintenance and different handling, but to decide what these should be, the amount of effort required from them must be laid down in advance.

Now let us go a stage further and see what the effect of this knowledge will be, first in the case of the Patrol Squadron. We require from it a constant, sustained effort up to the given amount, and to achieve this we must have sufficient ground staff to produce at least five serviceable aircraft per day, if it is kept normally busy. The number of aircraft must never be less than five, though sometimes it may be more. When this occurs, the powers at Command and Groups must not rub their hands with glee and "go a bust"; their contract is for five and five only should they use. For if they use the extra aircraft they will face the maintenance crew with the impossible task of picking up on the maintenance caused by the additional flying. More than likely the Engineer Officer knows that in a few days' time he will have two or three aircraft in for inspection, and is counting on the surplus he has gathered to tide him over that period which will absorb a greater number of hours. He is entitled to the smooth as well as the rough; and no one must rob him of his reserve against the lean time.

In effect, we are aiming to get the best regular effort out of a given number of aircraft and a given number of ground staff in an overall period of time; and experience has shown that an orderly way of setting about it does in fact, pay. An experiment with a Whitley squadron has shown that 1,263 flying hours (1,033 hours operational) were flown in October despite the fact that operations were cancelled on ten days and curtailed on three. When this is compared with the previous record for this particular squadron (935 hours), the highest record for any Whitley squadron (1,041 hours) and the average for all Coastal Whitley squadrons (614 hours) it will be agreed that there is at least something in planning ahead. When one makes allowance for smoothness of running, technical and operational, and for absence of uneven effort and panic at dropping serviceability the advantages will be seen to be very great.

What can be expected from a Patrol Squadron depends naturally on the type of aircraft, the amount of maintenance involved, and the number of staff which can be put in to back it up. These are predictable, and it is quite possible to assess the maximum output and what input of ground

staff is required to produce it. Much, of course, will depend on the working conditions. If night shifts can be worked, and hangar accommodation and black-outs are available, then the rate of serviceability is limited only by the average time taken to effect repairs and carry out inspections, and on the number of men available in the squadron. You cannot get more aircraft out of any squadron day by day than there are men to produce them; but if the men are in sufficient numbers, if spares are available and if there are no external hold-ups, then the trouble will not be serviceability of aircraft, but the number of aircrews to fly them.

There are, of course, a number of other considerations which follow on from this. Obviously it is more economical to maintain a relatively large unit than a number of small ones. The overheads are less and the number of higher grade technicians available to supervise the work is greater. Further, in a small unit, the one or two indispensable tradesmen such as electricians, may elect to go sick on the same day; and work will come to a standstill; while in a larger one nothing short of a direct hit from a bomb is likely to demolish all the electricians at once.

Thus the Patrol Squadron making a regular and known effort, calls for a relatively large ground staff working steadily and on schedule each day.

The Strike Squadron, on the other hand, works on a contrary principle. It has its big effort, and then subsides, leaving time to prepare for the next strike and, therefore, the ground staff can be small in relation to that of the Patrol Squadron, for time is on their side and they have no regular commitment. Further, it is reasonable to suppose that the damage rate may be higher and that the ground staff (not the aircrews) may be lucky enough to have an odd aircraft or two replaced by new ones. This is not universally true, for 210 Squadron, when in North Russia, were really operating as a strike squadron and did so without loss. The fact that 13 aircraft of that Squadron flew over 900 hours on this duty was due to their flying and maintenance for that operation having been planned. There is, however, one point about the ground staff of the Strike Squadron which must be borne in mind. While it is possible to run it on a much smaller establishment, this will not provide for unforeseen eventualities, such as sudden and unexpected calls. To meet all possibilities, one Strike Squadron operating alone on a station will require an equivalent staff to a Patrol Squadron; but if it is associated on the same station with a second Strike Squadron, or better still a Patrol Squadron, their pooled resources will suffice to cover any crises which may arise.

This then is Planned Flying and Planned Maintenance in the barest outline—thinking ahead to determine first that is needed, and, second, how it can be obtained most efficiently and most economically. It is the rationalisation of war flying. As a peace-time measure it is nothing new—as a visit to the London Passenger Transport Board or travel on the American air lines will disclose. Nor is it entirely new in the Service, as those will know who have had to prepare aircraft brought ashore from carriers during the leave period for the next cruise. But, in general, it has not been considered in relation to war flying, probably because it was felt that the needs of the moment must outweight any regular planning. Scientific investigation has shown, however, that at least in many instances it is not only applicable but advantageous.

There is one last consideration. Total warfare means the all-out utilisation of all the resources, including man-power, of the nation. Not even a population of 46 millions, nor, as the Germans find, one of 88 millions, can provide enough workers for industry as well as for the Services. The avoidance of unnecessary or wasted effort frees man power for service elsewhere, and enables the offensive to gather greater weight, or the tools needed for it to be produced in greater volume. Not the least gain from the scientific and orderly planning of maintenance is the conservation of the national potential and its direction into those channels in which it can be put to the best possible use.

To Migrants

There is a story of a stoker who, owing to the changing vicissitudes of life, reached the end of his tether and applied to see his Commanding Officer. His persistence was rewarded by the request being at last granted; at the interview he was asked what he wanted. Leaning over the Captain's desk he planted upon it a large and a none too clean hand. "I'm fed up, sir," he said confidentially, "I've come to chuck in my —— hand. Take it." The feeling is not unknown in other spheres of life; perhaps in our Service it reaches the high-water mark when a squadron has moved from Caithness to Cornwall and from Stornoway to Suffolk with bewildering rapidity and without any apparent justification or cause.

But you can bet your bottom dollar that there is a reason for it, though often enough one that cannot be broadcast. It may be based upon fact; or it may be based upon appreciation, intuition or a hunch. Take the case of the *Prinz Eugen* which was damaged and lay in Trondheim. Photographs showed the progress made in repair. At last she seemed about ready to make the journey south. The date of sailing probably depended on certain weather conditions—for example, bad visibility, a moonless period or the contrary. From time to time there may have been indications of her intention to leave—movements of destroyers up the coast, or an increase in fighter protection. The initiative lay with the enemy; it was for the Admiralty and the Command to anticipate it. And so squadrons would be moved to meet the probability with what may well have appeared as a glorious aimlessness to those who were uprooted and forced to leave their household goods behind in the rush and hurry.

The *Scharnhorst* and *Gneisenau* might have broken out weeks before or weeks after they in fact did. On the day before they did, a squadron was moved from the North to the East Coast, more on the assessment of possibilities and a "feeling in the bones" than any direct evidence. Owing to the move, this particular squadron was

enabled to take part in the attack; but equally well departure might have been delayed and the squadron's journey down would have been just another fruitless expenditure of effort.

Conversations with aircrews show that there are still some who think that they are sent on vague errands to search wide tracts of ocean for a microscopical and evanescent U-Boat, on the principle that luck will make up for informed direction. If that were so, sightings would not be what they are. In point of fact, no sortie is ever ordered without a reason—as good a reason as circumstances allow, but none the less a reason.

Much cannot be explained; secrecy inevitably demands a measure of blind confidence. "There are more things in heaven and earth, Horatio, than are dreamt of in your philosophy"; and often they provide the motives from which action springs and the foundation that underlies a decision which seems incomprehensible to the recipient.

For He's a Jolly Good Fellow!

In the yard of a deserted farm house three miles east of Voronezh on the Moscow road, Lieutenant Mikhail Stepanovitch stood to attention. The first snow was falling. He couldn't see it but he could feel it flake by flake on his forehead. He shivered, but he wasn't cold. Why couldn't they get it over with? They seemed to be arguing about something. Talk, talk, talk! Oh, well, after all that had been the trouble with him too. Had to talk, always talk and then you got excited and the other fellows contradicted you and the new comers straight from the training camps in the Urals kept firing eager questions at you. You couldn't resist the temptation to tell them a thing or two, you who had seen so much; first on coastal convoys down at Batum and then ground strafing in front of Moscow and afterwards protective patrols over Leningrad. You knew a thing or two all right, and wasn't it the most natural thing in the world to shoot a bit of a line? And then one day something goes wrong and instead of a surprise the Huns are waiting for your tanks—half a division had bought it. And why? Simply because some fellow gets shot down and under interrogation gives away a lot he ought not to have even known. And Mikhail Stepanovitch alone could have told him.

"Fire!"

For he *was* a jolly good fellow!

The world is very full of Mikhail Stepanovitches —and of Michael Stephensons. They live in neat little houses in rows and they exchange news of the consignment of oranges that has just come into the greengrocer's and of the new baby on the way at Number Seven; they live in the bar parlours of Swansea and Newcastle and exchange news of the ships that come and the ships that go and the ships that sometimes never come back; and they live in Air Force messes. They are "good types", always with the "hot gen"; they get around and know the boys who know what it's all about. But unlike Stepanovitch, Stephenson usually lives to a ripe and distinguished old age. That is because "though he might have been a Roosian, a French or Turk or Proosian . . . he remains an Englishman". Even when he is fighting to preserve personal freedom and liberty of speech, he is not prepared to sacrifice his vanity, his pathetic little ambition to be thought a good fellow, in order to ensure the immediate security of others.

"I am always very glad" a Victorian politician once remarked, "when Lord Salisbury makes a great speech. It is sure to contain at least one blazing indiscretion which it is a delight to remember." Non-security is not confined to bograts, but bograts need not flatter brass-hats by imitation. Brass-hats know more and bigger secrets than bograts, so that they are like the little girl in the nursery rhyme—"when they are good they are very, very good; but when they are bad, they are shocking!" But enemy intelligence, like our own, is not based on the occasional spectacular coup but on the fitting together into a single and significant mosaic of a thousand and one tiny and apparently unimportant pieces of knowledge. Those thousand and one pieces of knowledge reach the enemy from the vain tongues of a thousand and one apparently unimportant bograts.

We in this country do not shoot our Stepanovitches. Too often we do not even expose them to the ridicule and contempt of their fellows whose lives and aircraft and tanks and ships they have imperilled. We have fallen into the dangerous and luxurious habit of regarding Security as "hush-hush". We hold our Courts of Enquiry, we hold our Courts Martial, but we shelter our vainglorious and oafish criminals behind the impenetrable screen of the phrase "The sentence of the Court will be promulgated."

In future that will not be so. From time to time examples of the grosser indiscretions spoken and written by members of this Command will be published together with full details of the punishments with which they were rewarded. The attack of hardened fighting men, the bounty of fast fat-bellied ships, the roar of squadrons soaring to the victorious skies can no longer be sacrificed on the too nice altar of jolly good-fellowship.

You have been warned.

ERRATUM

The figures relating to the number of combats in July, August and September, 1942, in the *Review* for September (page 13) should read: Total encounters 126, of which 75 without result, enemy aircraft destroyed or damaged, 51.

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