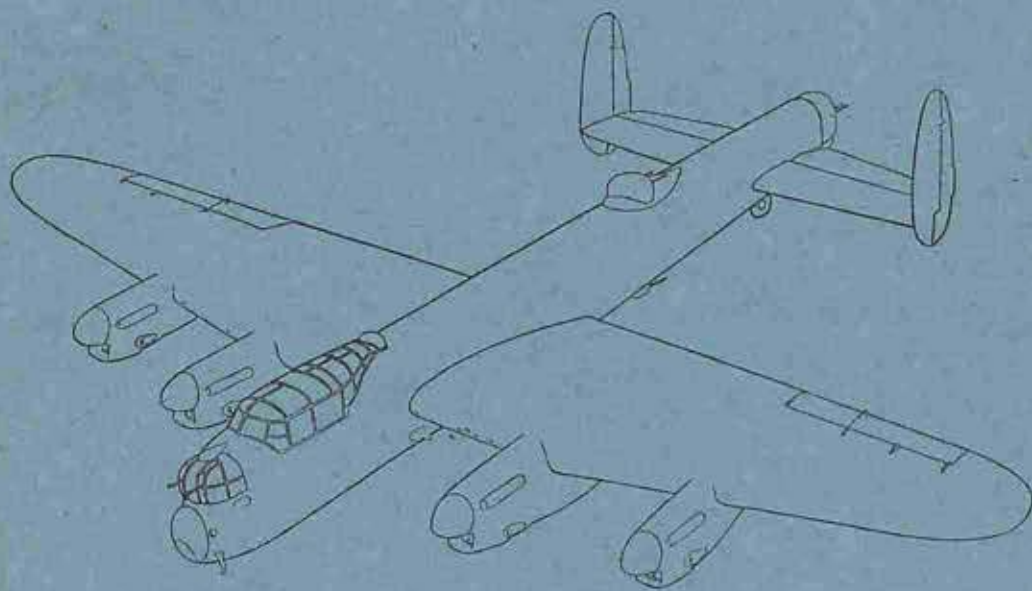


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SECRET

BOMBER COMMAND QUARTERLY REVIEW

October — November — December, 1942

No. 3



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DESTRUCTION AT THE EINDHOVEN RADIO WORKS

(See page 10)



FIG. 1.—A roof-top view showing many bursts of 30-lb. incendiaries and H.E. bombs enveloping the Valve Factory and adjoining Air-Liquefaction and Valve Storage sections.



FIG. 2.—Half an hour after the attack a Mosquito on reconnaissance took this photograph showing the Radio Assembly Shops burning fiercely at several points along their whole length, the Component Factory and other sections of the Works in a heavily damaged condition.

AN OUTSTANDING DAYLIGHT OPERATION

(See page 11)

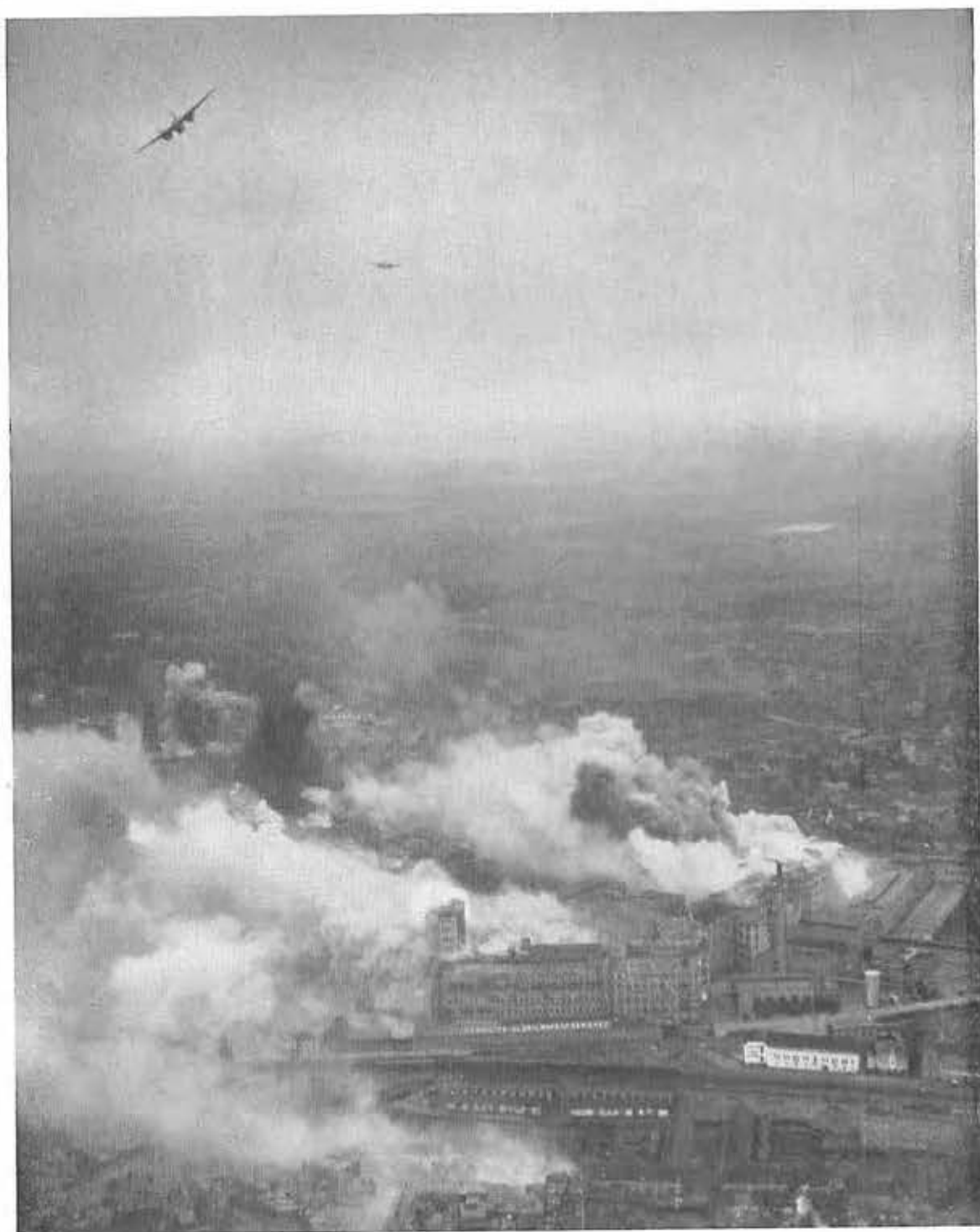


FIG. 3.—A striking impression of the very effective raid on the Eindhoven Radio Works by ninety-four light bombers of No. 2 Group: the first phase of the ten-minute attack showing Bostons over the Lamp and Valve Factory.

This vital works produced a third of all the radio valves manufactured in Europe under German control, and was a primary source of supply for the Nazi armed forces. As so much of the equipment and finished products were extremely delicate the internal damage must have been enormous, and some of the equipment is virtually irreplaceable. The multi-storey section in the foreground, used for the manufacture and testing of valves and drawing filament wire, was later enveloped by bursting incendiaries, as were the buildings to the right. (See Fig. 1.)

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**HEADQUARTERS
BOMBER COMMAND
ROYAL AIR FORCE**

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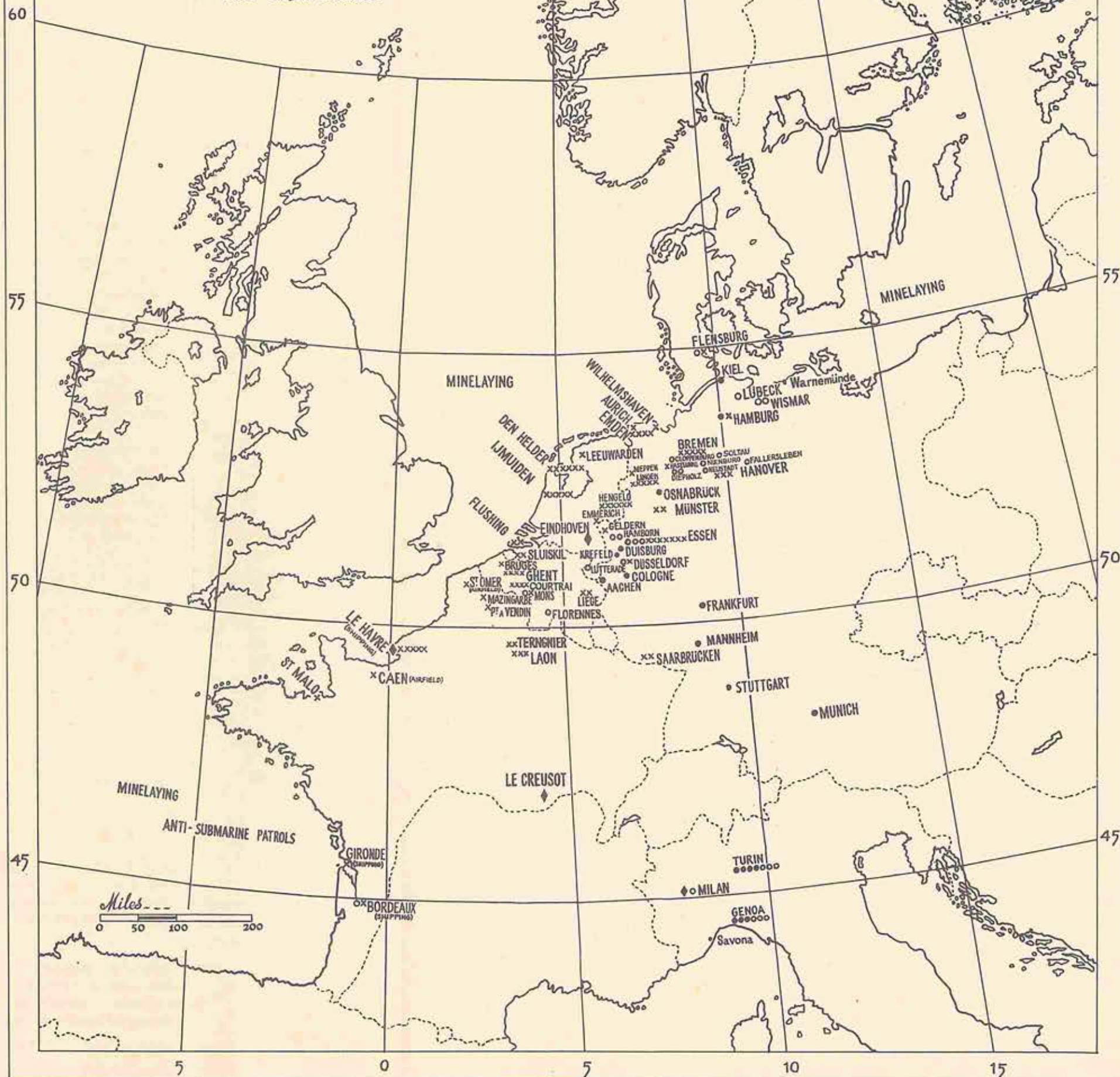
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DISTRIBUTION OF BOMBER OPERATIONS

1st OCTOBER ~ 31st DECEMBER 1942

- Night Raid by more than 100 aircraft
- Night Raid by less than 100 aircraft
- ◆ Daylight Raid by more than 20 aircraft
- × Daylight Raid by less than 20 aircraft

• Other Targets Attacked



ERRATA

Page ii (list of illustrations), Figs. 32–43 face pages 30–31.

Page 10 (para. 3, last line), *for* page 19 *substitute* page 18

Page 10 (para. 9, ninth line), *for* page 20 *substitute* page 19.

Page 14 (para. 5, last line), *for* on page 26 *substitute* at page 23.

I. REVIEW OF THE BOMBER OFFENSIVE, 1st OCTOBER— 31st DECEMBER, 1942

(a) Introduction

The operations carried out during the last quarter of 1942 offered a marked contrast to those executed earlier in what was, up to the present, the Command's most successful year of the war. The main weight of the bomber offensive, previously concentrated against German production and means of supply, fell suddenly upon the industrial north of Italy at the moment when the Axis army met disaster in Egypt and the Allies occupied nearly the whole of North West Africa.

Vast material damage resulted from the air bombardment of Genoa, Turin and Milan, as will be seen from the following pages ; yet the future may well show that the effect on Italian administration and morale has been even more decisive in determining the course of the war.

While Italy experienced for the first time the full weight of Bomber Command, Germany was not neglected during the three months. Far from obtaining a sorely-needed period of respite in which to recover from the violent summer raids the Nazis suffered a further 22 attacks by night, while Mosquitoes and Wellingtons harried German industry by day. The seasonal deterioration in weather conditions restricted the number of our bombing operations even more severely than last year, and also made some targets very difficult to locate. Cloud had a further effect in hampering photographic reconnaissance, so that the extent of the damage inflicted on some objectives is not yet known. Nevertheless the damage to those German targets already covered compares favourably with the results obtained during the corresponding quarter of 1941, when the Command's effort was primarily directed against Germany and the enemy-occupied ports. Therefore, if Italian damage is reckoned together with that in Germany and Occupied Europe, the effort of the last three months will be seen to have achieved no ordinary success. This comparison with the previous year reflects a notable improvement in operational performances as well as the increased bomb-capacity of our aircraft.

Though the numerical strength of the Command was actually less than at the end of the previous year, the combined total of bombing and minelaying sorties showed an increase of about 700 on the figure for the last quarter of 1941—some 6,700 sorties as against 6,000 in 1941. Moreover, the distribution and weight of the attack as shown in the following table presents some striking contrasts, particularly when it is remembered that the bombing sorties comprised less than 80 per cent. of the total—the balance being thrown into the intensified sea-mining blockade of the enemy.

TONNAGE OF BOMBS DROPPED ON ENEMY TERRITORY

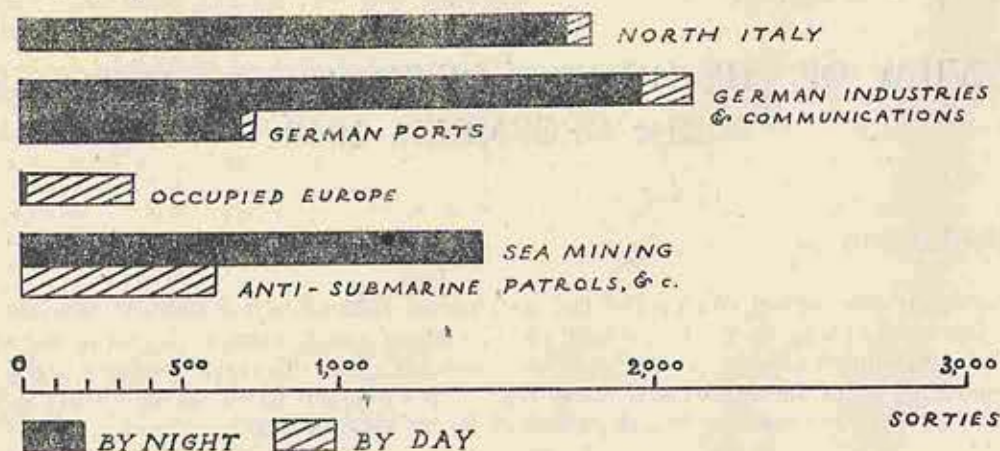
Quarter.	Germany.	Italy.	Occupied Europe.	Total.
October–December, 1941	4,344	Nil	2,330	6,674
October–December, 1942	5,657	2,826	444	8,927

Apart from the 14 night attacks on Northern Italy, the most remarkable feature of the three months was the execution, with relatively slight losses, of the heaviest daylight raids ever attempted by the Command: the attacks by unescorted heavies on Milan and the Schneider armament works at Le Creusot, followed by the light bombers' attack on the Philips radio works at Eindhoven.

Minelaying operations have become almost a matter of nightly routine, and more mines were laid in November than in any previous month since the start of the war. The Command is now responsible for nearly all the offensive mining carried out in European waters. Some of the results of this campaign and of other "naval" operations are referred to on page 12, in the section entitled "Bombers engage in Sea Warfare."

The distribution of effort during the three months is represented in the following diagram. In the case of German targets only has an attempt been made to distinguish between naval and industrial objectives. It should, of course, be realised that the results of operations against "naval" and "industrial" targets are so closely inter-related that it is seldom possible to draw any hard and fast

dividing line between them. For instance, minelaying at sea directly affects the supply of iron-ore to Nazi munitions industries; an attack on a German port included heavy damage to a bomber factory; while a mass raid on an inland industrial city seriously reduced the supply of essential parts for U-boat engines.



(b) The Offensive against Italy, October–December, 1942

More than 30 operations had been directed from home bases against Italian targets before last quarter's offensive, but only one of these took place within the previous twelve months. All were carried out by small numbers of aircraft. In the first three years of the war a total of 270 tons of bombs were dropped in our raids on Italy: more than ten times that weight was dropped during the three months now under review.

It is therefore not surprising that the Italians were completely unprepared for the colossal change in their experience of air warfare, which coincided with the most critical stage in the whole of their disastrous war.

The light losses sustained during the raids on Italian targets enhanced the great success which they achieved. Out of a total of some eighteen hundred sorties—including daylight ones—less than 2 per cent. were missing; while on four of these operations there were no losses whatever. This speaks highly for the reliability of our bombers, especially in view of the great distances flown and the bad weather encountered en route.

EFFORT DIRECTED AGAINST ITALIAN TARGETS

Target.	No. of sorties despatched.	Tonnage of Bombs Dropped.		No. of Operations.	
		H.E.	Incendiaries.	Night.	Day.
Genoa	635	485	465	6	—
Turin	1,015	806	825	7	—
Milan	159	79	122	1	1
Other Targets	—	8	6	—	—
Total Effort	1,809	1,378	1,418	14	1

Genoa.—While the R.A.F. in the Middle East were pounding the Italo-German army on the southern shore of the Mediterranean, Bomber Command launched its heavy attacks on the northern sector of the Mediterranean war zone.

The first blow fell upon the port of Genoa on the night of 22nd/23rd October, when 100 Lancasters reached the target in conditions of bright moonlight and clear visibility. The flares dropped by the Pathfinders were seen from 60 miles away, and the evidence of photographs taken at the time of bombing shows that the attack achieved an almost unprecedented degree of concentration around the aiming point. Large fires were started all over the town, especially in the harbour area and the centre of the city, one pilot describing the scene as "a miniature Cologne."

Although the Italian communiqué claimed the destruction of two of our bombers the defences were, in fact, entirely ineffective. Anti-aircraft fire was hopelessly inaccurate, and although two Lancasters sighted enemy fighters the latter made off without firing a shot. Not one of our aircraft was missing or damaged in any way. Even the smoke screen was ineffectual as the wind carried it out to sea.

The next night another force of more than 100 bombers (Stirlings and Halifaxes, with a smaller number of Wellingtons) set out for the same target. This time Genoa was found to be covered by low cloud which made positive identification extremely difficult, so that relatively few aircraft bombed the primary objective. Some further damage to Genoa was admitted by the Italians, but the town and docks at Savona suffered most and very considerable fires were seen here by crews who attacked it as an alternative target. Four others bombed Turin. Again the Italian defences failed to bring down any of our bombers, though relatively slight casualties were inflicted by German fighters over France.

A further four successful night raids were made on Genoa during the next three weeks when much fresh damage was caused especially in the centre of the city. On three out of the four occasions there were no losses due to enemy action and, although extremely poor weather was encountered as far as the Alps, the target area was clear of cloud and the customarily modest opposition enabled crews to bomb with deliberation. A cone of about a dozen searchlights was exposed on one occasion, but these were dowsed as soon as the bombs began to fall, and the inaccuracy of the defences inspired one pilot to suggest that they were "remotely controlled from air-raid shelters."

On the last of this series of attacks (15th/16th November) flares dropped by the Pathfinders illuminated the target area so well that a cinematograph film exposed during the early stage of the attack recorded the entire ground plan of the old town. The smoke-screen over the docks had been given up and one pilot saw his bombs hit a large ship which was later seen to be ablaze. A huge fire developed on the east side of the harbour with black smoke rising to a height of 5,000 ft.

Photographic reconnaissance showed that by mid-November the greater part of the centre of the city was in ruins, and nearly all of the docks and wharves which fringe the extensive waterfront had been hit with systematic accuracy. The Ansaldo fitting-out yards were hit repeatedly and many buildings of the works covering some 7 acres were demolished by incendiary or H.E. bombs; oil installations and railway property in the dock area were damaged, and the headquarters of the docks company were destroyed by fire. Many dockside warehouses and sheds were gutted, including 2½ acres of such buildings on the Molo Vecchio and about half of the free warehouses. The Mussolini Barracks were wrecked and the eastern railway station (the Stazione Brignole) was practically destroyed. (Fig. 5).

Shipping in the harbour was considerably damaged, and many lighters were sunk. Among the larger vessels hit were the two 30,000-ton liners *Augustus* and *Roma*. The latter, which was in course of conversion to an aircraft carrier, was hit in two places, while the *Augustus*, her funnel split in half, her upper decks severely damaged by fire, may well prove to be beyond repair.

Outside the city damage was practically confined to severe destruction in a multi-bay factory building of the Ansaldo Munition Works, at Rivarolo, and the demolition of another factory to the west of Genoa, at Sampierdarena.

The Italian press made no attempt to conceal the scale of the damage inflicted on the principal commercial port of the country, and newspapers contained many indications of utter disorganisation in the life of the city. Among the numerous "closing" or "removal" notices appeared the offices of the prefect, the electricity, gas and water offices, the telegraph and government offices, the Bank of Sicily, the Savings Bank, and branch post offices. The Law Courts suspended sittings, and telephones were out of order everywhere.

The public shelter in the Galleria della Grazie was also to be closed till further notice, and people were especially exhorted to observe "calm and order" in entering such shelters—"so that there may be no repetition of the lamentable incidents which occurred last night . . . due solely to haste in entering the shelter." This is a reference to the stampede which led to the death of no less than 354 panic-stricken Genoese during the second raid—when cloud prevented all but a few of our aircraft from finding the city.

Speaking at the beginning of December Mussolini himself admitted that over 6,000 houses had been hit during the raids on Genoa, 1,200 of which were seriously damaged or completely destroyed. He declared also that it was necessary to organise a semi-permanent or possibly a nightly exodus from all Italian industrial zones so that only military personnel would remain in the cities at night.

It is clear from these and other indications that Genoa's contribution to the Italian war effort had virtually ceased owing to the widespread disorganisation and demoralisation caused by the series of raids. But for these attacks Genoa must have been used for the transport of Axis troops and supplies to North Africa; in preventing this Bomber Command made a direct and immediate contribution to the success of the Allies' Mediterranean offensive at its most critical stage.

Turin: The first of seven attacks on the capital of Piedmont took place on the night of 18th/19th November. Although Turin is a city of ancient foundation and the seat of a university, it is now, with Milan, the centre of Italian industry, having a population of more than 700,000 inhabitants. The principal factories are those of the Fiat and Lancia concerns which produce aero-engines, aircraft components, military transport, A.F.V.s, tanks, railway rolling stock and other vital requirements for the Nazi war machine.

As in the case of Genoa weather conditions over Turin were with few exceptions favourable; and from the first the Italian news bulletins admitted the effectiveness of our raids. Many of the 77 heavy and medium bombers which initiated the series of attacks on 18th/19th November obtained particularly clear photographs showing that the Pathfinders' flares effectively illuminated ground

detail in the target area throughout the raid. Fifteen Lancasters ordered to attack the huge new Fiat works at Mirafiori found their target partly obscured by smoke from numerous fires in the town but were assisted by a flare dropped exactly over the main buildings. Many hits were reported, including one by a 4,000-lb. bomb which was confirmed by several crews. No aircraft were missing and there were no reports of damage from the enemy's feeble defences.

More than 200 aircraft took part in the second Turin raid on 20th/21st November, when the Italian communiqué admitted that "British aircraft operating in several waves dropped bombs and incendiaries in large quantities, especially on the central sectors of the city. Damage is heavy." This was indeed the heaviest raid the Italians had experienced up to that time. Reports show that the population lost their nerve and throughout the next day and night there was a panic evacuation of the city. Order was not restored until three days later.

Within a week from the date of this attack (28th/29th November) another force of equal magnitude evoked an even more striking tribute from the Italians: "British aircraft again raided Turin last night. The damage was enormous, particularly in the centre of the town. The number of victims has not yet been ascertained. The bearing of the population was calm."

Severe icing en route and much haze over Turin largely frustrated the attack by a small force of heavies detailed to attack the new Fiat works the next night, though some fires, possibly from the previous night's attack, were reported by crews who reached Turin.

Over 100 aircraft delivered a concentrated attack in cloudless weather on 8th/9th December followed by more than 200 the next night when pinpointing was made rather more difficult owing to haze or smoke lying over the city. In spite of this much fresh industrial damage was caused, especially in the later stages of the raid when fires in the centre of the target area were well alight.

The last of the Turin raids was on a smaller scale, and weather conditions were exceptionally bad. Severe icing was experienced with thick cloud up to 22,000 ft. all the way from the French coast to the target. Many aircraft were obliged to turn back before crossing the Alps and crews reaching the Turin area found that most cloud breaks were insufficient to permit accurate bombing.

It is the scale of damage to industrial plants that stands out as the striking achievement of the Turin raids. At least 70 factories and engineering establishments were affected of which many were very seriously damaged if not completely destroyed. The principal works included ten of the Fiat plants, two of the Lancia plants, and the State railway workshops. Among other vital industries affected by our bombing were machine-tool factories, manufacturers of propellers and aircraft components, iron and steel foundries, as well as important textile and glass works.

The chief Fiat plants are the older six-storey Lingotto factory and the giant one-storey factory at Mirafiori, which was still unfinished when Italy entered the war. The former now concentrates on the production of aero-engines, components for fighter and transport planes, tanks and military transport. Photographic reconnaissance indicates that a direct hit on the test-track on the roof of the building caused extensive destruction to the floors below, while another bomb scored a direct hit on a store yard damaging finished products and components awaiting assembly.

Reconnaissance also revealed several direct hits on the main block of workshops of the Mirafiori plant which is over a third-of-a-mile in length. A heavy bomb destroyed one whole and one half bay at the north-west corner, covering areas of 10,000 and 5,000 sq. ft. respectively; another heavy bomb wrecked a substantial part of the multi-storey bay on one side of the plant. Severe damage was done to buildings in the transformer and switching station, and the works' railway station was partly destroyed. Of many bombs which just missed the main workshops, several hit other buildings on the site and numerous workers' houses in the neighbourhood were demolished.

Among other ex-automobile works which were hit during the Turin raids, the Fiat S.P.A. factory was almost completely destroyed; the Ceirano motor works received two direct hits causing blast damage over 15 acres of roofing; the engine section of Lancia was also affected by bombing and the Michelin tyre factory was severely damaged. As 90 per cent. of Italian automobile production is concentrated in Turin the widespread damage inflicted by our attacks must have resulted in immediate interruption of the enemy's output of vital war equipment. Even before the raids the shortage of steel, coal and rubber was causing acute difficulties.

At the Fiat airframe factory, at Falegname, the whole of the sub-assembly shop was seriously damaged by blast, an area 70 by 60 yards being completely demolished, and aircraft evacuated from the building are shown on reconnaissance photographs. The machine shop was also damaged by blast over two-thirds of its length, and another building, containing the woodworking shop, suffered extensively.

Direct damage to railway installations occurred at three stations and in the main goods yards. But the most serious consequences to the Italian railway system are likely to result from the very heavy destruction in the important State railway workshops at a time when their maintenance and repair facilities are most urgently required. The Fiat railway workshops, also heavily damaged, used to employ 1,500 hands and ranked as one of the biggest constructors of rolling stock in Italy; this plant is doubtless producing armaments now, such as tanks and A.F.V.s, in addition to railway vehicles.

The tale of industrial damage is far from exhausted. Many public buildings suffered as well as public utilities and large numbers of commercial and residential properties throughout the city. Damaged areas ranged from 2 to 12 acres in extent, and in the aggregate amounted to approximately 500 acres.

RAILWAY AND SHIPYARD DAMAGE AT GENOA

(See page 3)

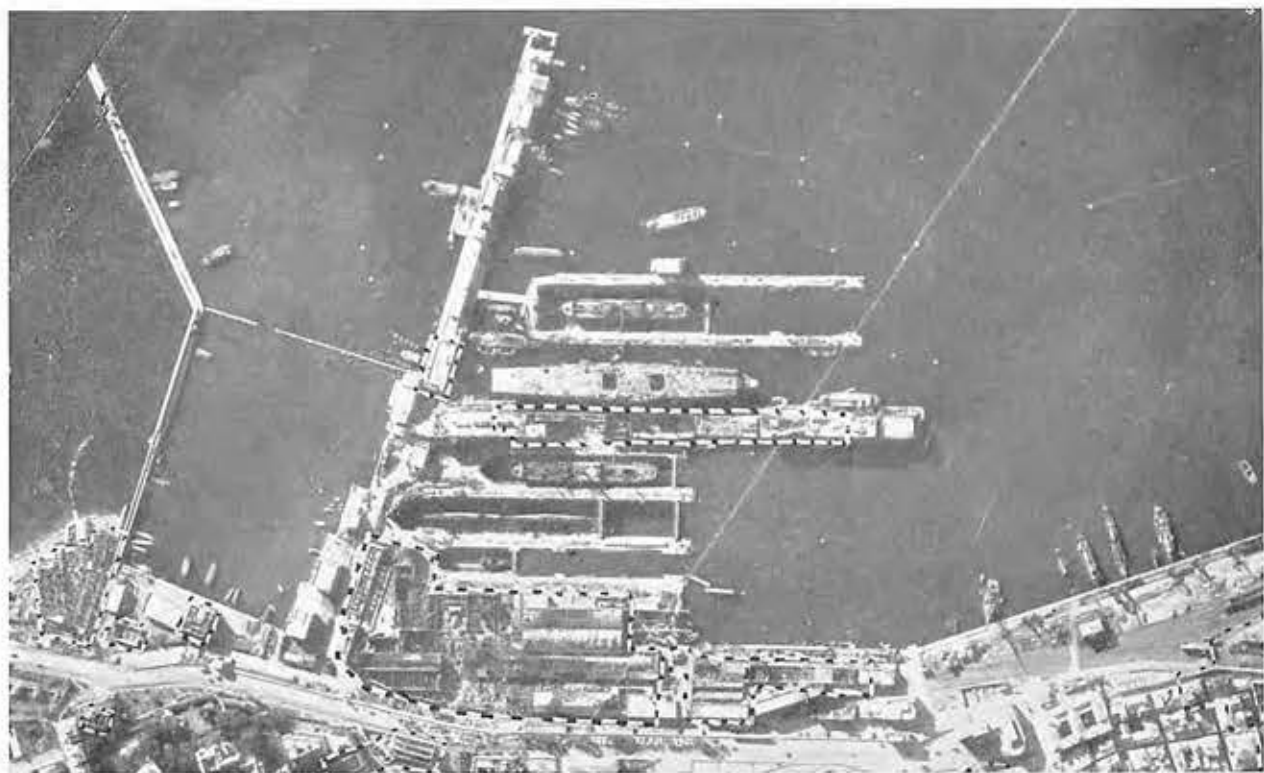


FIG. 4.—The Ansaldo Fitting-Out Yards were largely wrecked as a result of repeated hits during the October-November raids. Workshops, warehouses and sheds were demolished over an area of seven acres and the aircraft carrier *Roma* (seen above) was also damaged. One building over eight-hundred feet in length was three-quarters destroyed by fire.



FIG. 5.—The neighbourhood of the Brignole Railway Station in the east part of the city shows many ruined buildings. At the station itself the main block was almost completely burnt out and platform buildings and tracks heavily damaged, part of a train destroyed and trucks on the sidings burnt out.

GENOA: THE PRINCIPAL COMMERCIAL PORT OF ITALY





FIG. 6.—This photograph, taken on the morning after the last attack on Genoa, shows the Inner Harbour and the centre of the city. The majority of the buildings show signs of damage, many are completely destroyed. Particularly noteworthy are the 2½ acres of shattered warehouses on the quayside of the Old Mole, the 3-acre Deposito Franco (free warehouses) and the adjoining headquarters of the Docks Company (the battlemented S. Giorgio Palace). Many of the public buildings and the shopping and business quarters of the city are included in the large areas of destruction. (See pages 2-3.)

DAYLIGHT ATTACK ON MILAN

(See page 5)

On the afternoon of 24th October nearly 80 Lancasters dropped many heavy H.E. and incendiary bombs on the chief industrial city in Italy. Although photographs were taken in poor light below thick cloud they record many interesting features of the 25-minute attack.



FIG. 7



FIG. 8



FIG. 9



FIG. 10

FIG. 7.—(Above) shows a continuous line of dense black and white smoke rising from a stick of 30-lb. incendiaries which thus contrasts with the stick of 4-lb. incendiaries (left).

FIG. 10.—Taken shortly after, shows smoke spreading from the same 30-lb. incendiary stick and from another further to the south. In all cases the larger incendiary bombs were quickly hidden by smoke whereas the small incendiaries burned relatively unobscured. At the lower edge of Fig. 10 can be seen dispersed smoke from the burst of a 4,000-lb. H.E. bomb at the railway station (see Fig. 11 opposite).

FIGS. 8 and 9.—Lancasters cross the Alps on their route to Italy.

MILAN: AFTER THE ATTACK



FIG. 11.—Industrial buildings suffered more heavily than residential and commercial buildings in the daylight attack. Photographs taken during the raid showed a concentration of incendiary sticks near the Electricity Works where a large fire occurred (see outlined area above, lower right). A 4,000-lb. H.E. bomb was shown to have fallen at the Genoa Railway Station, which was also damaged by fire (upper part of above photograph).

TURIN: HEAVY DAMAGE TO ITALIAN WAR FACTORIES



FIG. 12.—More than a thousand sorties were made against Turin between 18th November and 11th December : damage to industry and the whole city was on a scale comparable with the heaviest yet seen in Germany. Ten of the Fiat plants and two Lancia works were among the casualties. A typical area is seen above. (See page 4.)

A.—Fiat Railway Workshops, 600-ft. block gutted.

B.—Fiat Motor Works (S.P.A.) employing about 3,000 workers on military transport and tank engines, extensively damaged.

C.—State Railway Workshops (railway repairs and military equipment) almost destroyed.

About an acre of the State Arsenal was destroyed while the Royal Arsenal and five military barracks were also affected by bombing, doubtless involving casualties among the armed forces. As in Genoa, there was an immediate "panic" evacuation of the city, so that 300,000 or half the total population had already fled to "safe" areas away from the towns after the second raid. Since no preparations had been made to provide for the nightly evacuation recommended by the authorities, industrial production must have suffered a catastrophic decline, quite apart from the effect of bomb damage on the plants themselves.

Turin now ranks among the most heavily damaged cities on the European continent, and its industrial war effort is probably reduced to less than half of its normal level. Such complete disorganisation as occurred during its three weeks of air raids is unprecedented in the annals of Bomber Command.

Milan.—The daylight attack on Milan, second largest city in Italy, containing nearly a million inhabitants, was one of the most remarkable raids of the war. A force of 88 Lancasters of No. 5 Group took part in this operation on 24th October, which involved a round trip of over 1,700 miles. The outward flight and the attack, which was over in 25 minutes, were both carried out in daylight. Darkness set in during the return across the Alps.

Spitfires escorted the bombers across the Channel but no enemy fighters were encountered and shortly after crossing the French coast cloud cover was reached. The Lancasters navigated individually to Lake Annécý, where loose formations were formed for the flight over the Alps to the target. Cloud covered the city down to 3,000 ft. in places and, as many 4,000-pounders were being dropped, few aircraft bombed below that level, though one went down to only 50 ft. above the roof tops. Crews claimed many hits on industrial premises and railway installations and obtained photographs at various stages of the attack showing over thirty incendiary and H.E. incidents, many of which developed into firm fires before the aircraft left the target (see figs. 7-12).

Italian fighters were seen occasionally over North Italy, but it is not surprising that the few which came in to attack generally did so in a very half-hearted manner. One Fiat CR.42 biplane fighter pressed home his attack with some determination and succeeded, at the fifth attempt, in inflicting slight damage to the wings of our aircraft. The latter replied effectively and saw his opponent diving into cloud with smoke coming from the engine, and it is probable that this fighter was fatally damaged. A Macchi 202 was destroyed by another Lancaster, which was not hit, but the other Italian fighters kept at a respectful distance from our gunners.

In view of the warm reception accorded to their air force when they tried to bomb London in 1940, the Italians must have been chagrined to learn that their own defences could only bring down one out of approximately 80 British bombers which attacked Milan in daylight. Two other Lancasters were lost on this operation, but these were claimed by German fighters on the journey over northern France. The cost was therefore extremely low for so daring a long-range operation, the successful execution of which reflected great credit on all concerned.

While the day raiders were landing at their bases in England another force of heavies was over Milan. Although thick cloud covered the whole area they could see the glow of fires started by the Lancasters five hours earlier. In the difficult conditions obtaining crews were unable to see their targets and some sought alternatives, but several others who managed to get below the cloud were able to bomb with deliberation, and undoubtedly added to the damage inflicted during the afternoon.

The Italian press gave an indication of the results of the two raids; some 30 large fires and 300 smaller ones were caused in the city, and about 5,000 families rendered homeless. Mussolini later admitted damage to nearly 2,500 houses, of which about 450 were completely demolished or heavily damaged. It also appears that most windows in the built-up areas were shattered within a radius of some 500 ft. of H.E. incidents, while such breakages occurred up to a distance of 1,200 ft. in squares or open spaces.

The *Popolo d'Italia* openly declared that "organisation of the rescue of victims of the raid on Milan, and of fire-fighting, last Saturday was certainly not easy." Referring to the "unflagging energy" of the firemen the paper continues as follows:—

"The fact that there were over 700 calls for assistance is enough to give some idea of the enormous difficulties these brave men had to overcome. Beginning work immediately after the raid, the firemen continued it unceasingly throughout the whole of the night, moving on from one place to another."

As Milan lies at the southern end of the main routes from northern Europe through the Swiss passes, and also on the east-west route from the Adriatic ports to western Europe, it is a vital junction for Axis rail communications. Apart from the flow of military supplies and personnel which is constantly passing through Milan it is equally busy with economic and industrial supplies, particularly German coal, without which Italian war production would be forced to rely solely on Alpine waterfall resources for electric power. It is therefore satisfactory that railway facilities suffered seriously. The main line at Lambrate was cut and blocked for 24 hours causing suspension of all traffic south to Bologna and eastward to Venice. Severe damage to a station on the St. Gothard route caused a complete suspension of railway services; as no traffic had reached Zurich up to noon on the 26th, two days after the attack, there was consequently a complete stoppage of coal supplies on one of the principal lines for this class of traffic. The Genoa station in Milan was heavily damaged by blast and incendiary bombs affecting the whole of the main building, several smaller railway buildings which were gutted, and the track was damaged by a nearby H.E. incident. The main station was also damaged by a heavy bomb which fell in the square outside it.

Reconnaissance showed that industrial premises had suffered more than commercial and residential property in the city. Among the many factories affected were the Caproni aircraft works, the General Electric Company, a wagon works, a steel foundry, a lorry works and the municipal tramways.

(c) Operations against Germany

North of the Alps weather conditions proved much less favourable for night bombing operations. Nevertheless, operations were carried out against Germany on 20 nights and 37 small-scale attacks were made in daylight. In addition 32 daylight attacks were made against targets in German-occupied territory in Western Europe, which are discussed on page 9.

TABLE II.—EFFORT DIRECTED AGAINST INDUSTRIAL OBJECTIVES AND COMMUNICATIONS, 1st OCTOBER–31st DECEMBER, 1942

Targets in	Sorties Despatched.	Tonnage of Bombs Dropped.		No. of Operations.	
		H.E.	Incendiaries.	Night.	Day.
<i>North-West Germany—</i>					
Duisburg	234	232	307	1	1
Krefeld	203	132	185	1	1
Cologne	289	245	359	1	—
Osnabrück	244	207	306	1	3
Aachen	257	183	301	1	—
Other targets	156	165	30	7*	20
<i>South-West Germany—</i>					
Stuttgart	222	133	236	1	—
Mannheim	272	234	346	1	—
Frankfurt	113	92	116	1	—
Other targets	3	—	—	—	—
<i>South Germany—</i>					
Munich	137	98	165	1	—
TOTAL	2,130	1,721	2,351	16	25

*Minor operations only.

Duisburg.—The strong attack delivered on the night of 20th/21st December was exceptional in that weather over Germany was excellent. Bright moonlight enabled many crews to pick out the huge Rhine docks and the surrounding industrial complex which they serve. As the force included nearly 200 heavy bombers as well as a smaller number of Wellingtons, a great weight of bombs was dropped on Duisburg and the immediate vicinity. This was admitted next day in the official German communiqué which announced that—

The enemy attacked places in Western Germany, particularly Duisburg. Severe damage was caused, especially to industrial and public buildings. The population suffered losses.

Such an unusually frank admission of raid damage may well have been intended to remind the Italians that the Germans have their air raid troubles too, and that reinforcements of A.A. guns and night fighters could hardly be spared for Italy.

Daylight photographs covering part of the Duisburg area were taken a month later and would thus include any additional damage caused by two small-scale raids in January. They reveal severe industrial damage and a great number of incidents among commercial and residential property.

“The principal feature is damage to the Kabelwerk factory (makers of torpedo nets, telephone cables, etc.). Here six acres of buildings are completely or almost completely destroyed by fire, and six-and-a-half acres of the remainder of the works have sustained roof damage (see Fig. 14).

“In addition, shops in two factories of the Vereinigte Stahlwerke have been destroyed or damaged, one having had an area of roof 480 ft. by 120 ft. stripped. Five large warehouses in the harbour have been wrecked or gutted and at Hochfeld 12 acres of built-up area have been damaged by fire.”

An eye-witness stated that one of the major incidents was the almost total destruction of the tramway dépôt (confirmed by the photographic reconnaissance). This was the main dépôt for the whole of the town and as it was night it was full. The adjacent tram repair dépôt was also almost totally destroyed. These incidents caused an almost complete traffic standstill for four days, and all works were affected by absenteeism and late arrivals, particularly those situated on the outskirts of the town. It was impossible to utilise relief trams from other towns as Duisburg had a non-standard gauge. A skeleton bus service was eventually established but this was insufficient to handle the traffic, and late arrival of workers at factories persisted for some time.

It is likely that this one attack did much to frustrate whatever recovery had taken place since the heavy raids of July, August and September described in the last issue of this *Review* (No. 2).

Krefeld.—The neighbouring industrial city of Krefeld, westward of the Rhine, was also once attacked in good weather during last quarter, and the enemy again admitted damage and civilian casualties, "particularly at Krefeld." On this occasion, however (2nd/3rd October), the absence of cloud was offset by very thick haze, and there was no moonlight to assist our bomb-aimers. As a result the attack was less concentrated and the weight of bombs which reached the target was not comparable with the best of the Italian raids.

Nevertheless daylight reconnaissance carried out at the end of December showed that severe damage had resulted from this attack, especially to factories on the north-western outskirts. Two very large factory buildings of an important weaving mill were destroyed, and three manufacturing plants were partly destroyed. A military barracks now occupied by the police received three direct hits and the Reichsbank was extensively damaged. An area of six acres in the centre of the town was devastated possibly as a result of a single H.E. incident. Here between 20 and 30 buildings were affected while some 500 houses were damaged in varying degrees in all parts of the town (see Fig. 13).

There are indications that much useful damage was inflicted also in the area of the Rhine harbour where fuel tanks, rolling stock, tugs and barges were either damaged or destroyed.

Cologne.—An attack designed to prevent the possible removal of Cologne's defences and to impede industrial recovery was carried out on 15th/16th October—four and a half months after the last devastating raid on the city. Cloud over the target increased the effects of navigational difficulties experienced on this occasion. Although there are indications that railway and dock facilities in the Rhine harbour were damaged and that the I.G. Farben chemical works at Leverkusen were also hit, night photographs taken with bombing show that the main weight of attack fell some miles to the south-west of Cologne in the Knapsack area.

As a result of the 1,000-bomber raid it appears that 450,000 tons of rubble remained for dispersal after salvageable material had been sorted and removed. A worked-out brickfield on the Dutch frontier was chosen as a convenient dumping site. River shipments were slow, barge owners being reluctant at first to handle this traffic in view of the more remunerative employment offered by the coal and coke trade to Rotterdam, returning with iron-ore. Latterly, however, coal exports have fallen. Bomb damage at Duisburg, Neuss and Düsseldorf has further reduced the possibilities open to inland water traffic, and shippers have been competing for debris-disposal business. Rhenania have contracted to take 150,000 tons. It is interesting to compare the quantity of rubble involved with that produced by German air raids on Britain. Our practice, which is presumably much the same as that adopted in Germany, has been to separate the hard core from the rubble and use it in road making and aerodrome construction. On this basis 450,000 tons of residual rubble represents six times the quantity removed from Coventry and about three-quarters of what was removed from the 677 acres devastated in London in the course of many raids.

Osnabrück.—This important centre of German rail communications, with its busy canal harbour and industrial and commercial town, had already received considerable damage during June and August. On the night of 6th/7th October it was the target for a force of more than 200 aircraft. Although haze and cloud were encountered in the target area the Pathfinders successfully identified the town and, by means of the flares which they released, about half of the main force were enabled to deliver a fairly concentrated attack on their objective. Photographs taken during the attack show large fires with clouds of smoke in the centre of the town and around the railway workshops. The German High Command communiqué admitted destruction and damage in Osnabrück, particularly to residential and public buildings. All available evidence suggests that, in view of the weather conditions prevailing, the raid was remarkably successful. It appears that four factories producing armaments were severely damaged; one of the two main petrol depôts was destroyed by fire and rolling stock and railway lines were extensively damaged. Photographic reconnaissance (which was incomplete) showed heavy damage to a copper and wire factory, a metal works, Hammersen's cotton yarn and weaving mills, a soap factory and to the Netterheide military barracks. Much incendiary damage and some heavy high-explosive incidents were seen, especially in the centre and south-east part of the town (see Fig. 16).

Aachen.—This town, the centre of which was largely burnt out by some 60 aircraft in July, 1941, was saved by the weather from a much worse fate on 5th/6th October—the night before the successful raid on Osnabrück. Indeed the Aachen raid provides an extreme example of the malevolent influence of bad weather on the course of a night-bombing operation. Severe electrical storms and icing conditions were encountered *en route* to the target and as a result nearly half of the Pathfinders were unable to reach it. Thus the plan of attack became disorganised and the greater part of the strong force which reached the hazy and cloud-covered target area were unable to recognise land-marks in the absence of moonlight and flares. The main weight of the attack fell to the north-west of Aachen, but part of the force undoubtedly succeeded in identifying the target correctly. These crews reported extensive fires in the town which are seen on some of the photographs taken during the attack. The extent of the damage cannot be estimated as reconnaissance photographs in the area are not yet available.

Other Targets in the North-West.—Throughout the three months many small-scale daylight raids were made by Mosquitoes of No. 2 Group and by Wellingtons of Nos. 1, 3 and 4 Groups on railway installations, and industrial objectives in north-west Germany. Some of the Mosquito raids were carried out at a high level far inside the enemy defences and photographs show that objectives were frequently reached. The Wellingtons made many sorties against Ruhr targets under cover of clouds, but one of their best attacks was made from a low level on Lingen (35 miles north-west of Osnabrück).

where there are important railway workshops. Bombs were seen to hit station buildings and the engine shops, and carriages were set alight by machine-gun fire. Besides the damage caused to the objective, actually attacked—which must have increased the already critical rail-transport problems of the Reich—these harassing raids are known to cause interruption in war work over wide areas. It is significant that the population of Essen have recently been reminded to take cover whenever the air raid warning sounds, as British bombers as well as reconnaissance planes can reach them by day. Similar harassing attacks were also carried out on two nights in December, one of the principal objectives being the Opel Works at Fallersleben.

South and South-West Germany.—The weather encountered in these areas was found to be unfavourable for identifying the four principal targets chosen for night attacks. Much cloud was encountered over *Stuttgart* on 22nd/23rd October, and also over *Mannheim* and *Frankfurt*, which were the objectives in early December. It is unlikely that any considerable concentration was achieved by aircraft which endeavoured to carry out their primary missions, and a number of crews bombed alternative targets, including *Karlsruhe*, *Mainz* and *Worms* on these nights. Damage was undoubtedly inflicted on a few useful objectives, but its extent remains unknown in the absence of photographic reconnaissance.

Several daylight attacks were also carried out in this south-west region, particularly on railway installations.

On 21st/22nd December over a hundred heavies took part in the first operation against *Munich* since the successful raid last September. Weather conditions on the long route to the Bavarian capital were excellent, but here again when the target area was reached thick cloud was encountered down to 4,000 ft. above the city. Notwithstanding this continued non-co-operation on the part of the elements a considerable proportion of the force felt confident that they had bombed the city, with the assistance of the flares dropped by the Pathfinders to illuminate an unmistakable landmark 20 miles from the target. As yet daylight photographs of the damage are not available and the German communiqué is not specific about the results of the raid; although the announcement that a hospital was hit rather suggests that at least part of the attack fell on the built-up area of the city.

TABLE III.—EFFORT DIRECTED AGAINST GERMAN SEA-PORTS

Targets	No. of Sorties Despatched.	Tonnage of Bombs Dropped.		No. of Operations.	
		H.E.	Incendiary.	Night.	Day.
Kiel	288	235	327	1	—
Hamburg	214	184	206	1	1
Wismar	137	105	153	2	—
Flensburg	30	59	5	1	1
Lübeck	25	43	5	1	—
Other ports	34	35	7	—	10
Total	728	661	703	6	12

Flensburg, Lübeck and Wismar.—These Baltic ports were the objectives for three operations, carried out on the first night of the quarter, 1st/2nd October. The U-boat building yards at the former places were attacked by small forces of Halifaxes and Stirlings respectively, while the Dornier Aircraft Works and town of Wismar were the targets for a somewhat larger force of Lancasters. Although the Wismar operation was marred by unfavourable weather it certainly achieved some useful results. Indeed it affords a good example of the value of dogged persistence in spite of every disadvantage. One squadron commander summed up the attempt as “a disappointing trip—pitch black night, poor weather and a small, difficult target.” That put the matter mildly since the whole coastal area and most of the western Baltic were covered by thick cloud with icing conditions almost down to the minimum safety height (4,000-lb. H.C. bombs were being dropped). Below this cloud haze was reported and at least one very extensive smoke-screen was in operation in the neighbourhood, concealing targets, built-up areas, and the distinctive outline of the coast. In these circumstances, the crews who attempted to bomb Wismar could do no more than estimate its position from half-obscured landmarks thought to be in its vicinity—yet a subsequent reconnaissance revealed damage in the town most if not all of which can be attributed to this small attack. On the other hand, the remainder of the force, finding it impossible to locate the Dornier Works, sought alternative targets further to the north-east in the neighbourhood of Warnemünde where visibility was a little better, though flak and searchlights were most active there. Reports indicate that the main bombing effort was in progress in that area, and night photographs prove that Warnemünde was correctly identified. One of these photographs, reproduced as figure 15, is especially interesting. It shows one sector of the formidable smoke-screen which was intended to conceal the Heinkel Aircraft Works south of the town, the seaplane base to the east, as well as several miles of characteristic coastline between Rostock and the shores of the Baltic. The flight commander who piloted this aircraft, “O” of 44 Squadron, observed that the smoke-screen made definite pin-pointing extremely hard in the target area but buildings were seen in the bomb-sight at the moment of release. The efforts of the crew were successful as their photograph also shows the 4,000-lb. H.C. and 30-lb. incendiary bombs which they had just released, falling across the airfield straight towards the Heinkel Works.

The Stirlings also found cloud over Lübeck, but the Halifaxes were more fortunate at Flensburg and considerable damage appears to have been inflicted here. Later in the month, on 27th October, three Mosquitoes carried out an excellent dusk attack on the Flensburg target. These aircraft flew over the docks at 50 ft. in the face of intense and accurate flak. Two crews report that their bombs scored direct hits on the U-Boat slips. Although the third Mosquito was unable to bomb the primary objective—it was caught in the slipstream of the leading aircraft—it attacked and set fire to a 2,500-ton merchant vessel anchored in the harbour. The leading aircraft was damaged by flak but succeeded in returning safely to base. It will be remembered that the Flensburg submarine building yards were severely damaged only two months previously.

Kiel.—A heavy night raid on this important naval base was carried out on 13th/14th October. It was expected that a smoke-screen would be operating over the docks, and the Pathfinders were accordingly instructed to illuminate the lakes five miles east of the city so that crews could obtain accurate bearings. This task was effectively performed, and most crews reported that their bombs fell near the Germania shipyards or the other aiming-point on the west bank of the fiord. Accurate observation was, however, greatly hampered by the presence of a particularly elaborate smoke screen which covered not only the docks but also the whole town and most of the inlet south of the entrance to the Kiel Canal. In these circumstances accurate aiming was extremely difficult after the screen had developed, as it did early in the attack. Doubtless some bombs fell in the water between the aiming points, and while night photographs show fires burning in the dock area they also show that many bombs fell in outskirts south of the docks. It is believed that far the most useful effect of this attack resulted from a direct hit on the lock gate at the entrance to the Kiel Canal. This was responsible for a serious dislocation of the important flow of traffic using that route to the North Sea ports, and the gate was not fully repaired until some weeks after the raid. Another interesting result of this attack was that two flak-ships in the port appear to have suffered bomb damage—one of these vessels was undergoing repairs at the time. It may also be mentioned here that on at least one occasion during the quarter shipping movements to and from Kiel were gravely hampered by our mines.

Hamburg.—During a month of constantly unfavourable weather over Germany, which obliged the Command to operate on a reduced scale, the Hamburg area alone on 9th/10th November seemed to offer hope of moderate weather conditions. Even here haze and a certain amount of cloud were expected; but in the event the weather deteriorated rapidly *en route* and northern Germany was found to be completely blanketed by several layers of thick cloud, in which icing was experienced. No sort of visual identification was possible. Crews bombed the flak defences in the estimated position of the target and the last arrivals reported a dull glow through the clouds.

Other Ports.—A number of small-scale daylight attacks on targets in Bremen, Wilhelmshaven and Emden were carried out under cover of cloud, and in a number of cases bombs were seen to burst on or close to their objectives.

(d) Targets in Occupied Europe

During the winter of 1941–42 nearly a third of the night operations of the Command were directed against the occupied ports in France and the Low Countries. During the last quarter of 1942, however, night bombing operations were reserved almost without exception for targets in the Axis homelands—and practically all objectives in enemy-occupied territory were attacked in daylight. Although many of these operations were in the nature of harassing patrols they also included the heaviest daylight attacks ever carried out by Bomber Command. Moreover the Germans in France were successfully bombed by units of the U.S.A.A.F., also operating in daylight.

Most of the targets attacked by Bomber Command fall into two categories:—

- (i) Industrial plants such as steel works and engineering factories, power stations and oil refineries working for the Germans; and
- (ii) The enemy's transportation system, especially locomotives and marshalling yards, as well as dock installations in the occupied ports.

Some airfields also were attacked with good effect.

TABLE IV—EFFORT DIRECTED AGAINST TARGETS IN OCCUPIED EUROPE

Targets in	Sorties Despatched.	Tonnage of Bombs Dropped.		No. of Operations.	
		H.E.	Incendiaries.	Night.	Night.
France—					
Le Creusot Armament Works	94	123	38	1	—
Railways, Docks and Industrial targets.	79	46	—	7	—
	173	169	38	8	—
Holland and Belgium—					
Eindhoven Radio Works	93	46	17	1	—
Hengelo Diesel-Engine Works	19	15	—	5	—
Railways, Docks and Industrial targets.	78	38	—	18	2
	190	99	17	24	2
Total	363	268	55	32	2

Le Creusot, 17th October.—The R.A.F.'s heaviest daylight raid of the war was directed against the Schneider Armament Works, the so-called "Krupps of France," situated deep inside German-occupied territory—less than 90 miles from Geneva.

Ninety-four Lancasters, without fighter escort at any stage, took part in this ambitious operation which appears to have achieved complete surprise. All the aircraft flew to the target well below 1,000 ft. so as to evade the enemy's R.D.F. plotters. Instead of heading straight across the Channel the whole force bore south-west right out over the Bay of Biscay. When they eventually roared over the west coast of France without meeting any opposition they still had to fly some 330 miles low-level over enemy territory before reaching the target at sunset. There they climbed to 4,000 ft. before releasing large numbers of heavy high-explosive bombs and showers of incendiaries on the rolling mills, forges and the heavy-gun factory. The whole attack was over within the space of seven minutes. Flashes of fire illuminated a vast pall of black smoke over the works as the Lancasters set course for home in the gathering darkness.

Seven of the Lancasters had as their special objective the transformer and switching station at Montchanin, some miles to the east, from which the Le Creusot Armament Works derive all their electric power. Owing to the acute shortage of transformers in France and Germany the destruction of this small but vital target was regarded as particularly important. The attack was made from a height of a few hundred feet and direct hits were reported by several crews. It was here that the only aircraft lost on the whole operation was seen to go down, and even this it seems was not due to enemy action. The Lancaster concerned was seen to release its bombs on the target from a low level before striking a building in the vicinity. A single engagement with enemy fighters was reported, and this was a remarkable triumph for our aircraft which had lost the use of an engine and was outnumbered by three to one—the full narrative of this combat will be found on page 19.

The Schneider Works, one of the largest steel works on the Continent, cover an area not far short of 300 acres and formerly employed over 10,000 men. Before the raid they were manufacturing heavy calibre guns for the German army, as well as locomotives for the enemy's railway system. Since the Nazi occupation the total output of the factories, including armour plate, heavy castings and forgings, has gone to feed the German war machine. The importance of the works to the Germans is shown by the fact that two flak trains were immediately despatched to defend them in the event of a repeat attack.

All available evidence bearing on the effect of the Lancaster attack indicates that very severe damage was inflicted, especially to the rolling mills, the heavy forging department and armour-plate bending shop. In the processing works the locomotive machine-shop and many other buildings are heavily damaged and in some cases utterly destroyed. Three direct hits on the general machine-shops of the Breuil Steelworks caused the partial collapse of the framework of the buildings (see Fig. 17).

Some of the widely dispersed workshops seem to have escaped direct hits and other sections are quite capable of being repaired, given time and materials. Undoubtedly the massive smoke clouds which enveloped much of the works during the attack saved some of the buildings. It would appear, however, that apart from the coppersmiths' and blacksmiths' shops, all the buildings of importance were damaged and the raid put an end to production for the time.

The bombs which struck the transformer plant at Montchanin put out of action the main section of the plant which acts as a connecting link in the supply of power from the French Alps to the Paris area. This is one of the most vital points in the whole electric-power system of France and the damage here is estimated at 150 million francs. Under existing conditions transformers are virtually irreplaceable, and it is considered that the Montchanin plant cannot be restored in less than two years.

Eindhoven, 6th December.—The last of the quarter's big daylight raids was also carried out by 94 aircraft: but the operation against the Philips Radio Works differed radically from the Lancasters' bombardment of Le Creusot and Milan. As Eindhoven lies well within the German fighter zone, only 50 miles from the Ruhr, the force was composed solely of fast light bombers—Venturas, Bostons and Mosquitoes of No. 2 Group, with a strong force of fighters patrolling off the Dutch coast to cover the withdrawal of the bombers. In addition aircraft of VIII U.S. Bomber Command attacked targets at Lille, and Mustangs of Army Co-operation Command carried out diversionary sweeps.

Although visibility was reduced to one mile in rain squalls and thick cloud was down at times to 200 ft., the whole force flying at very low level successfully located their target. The Bostons opened the attack on the two sections of the works at 1230 hours, followed two minutes later by the Mosquitoes, and the last of the Venturas—carrying incendiaries—bombed at 1240. As the remarkable cinematograph film taken during the raid was widely exhibited there is no need to describe here the inferno caused by this ten-minute blitz. Incidents from the film are reproduced as figs. 2 and 3. Half-an-hour later a single Mosquito circled the smoking ruins to carry out a photographic reconnaissance from 800 ft. There was heavy fighter opposition and many combats developed (reports on some of these appear on page 20). There was also considerable activity on the part of ground defences on the route across Holland. In all 13 aircraft were lost, but in relation to the results achieved by this raid these casualties were not heavy.

INDUSTRIAL DAMAGE IN GERMANY



FIG. 13.—The night raid of 2-3 October caused considerable damage to manufacturing plants at Krefeld in the Rhineland, part of which is seen above.

A.—The Taschmer Engineering Works, the large multi-bay workshop destroyed by fire.
B.—The centre portion of the United Silk Weaving Factory demolished.

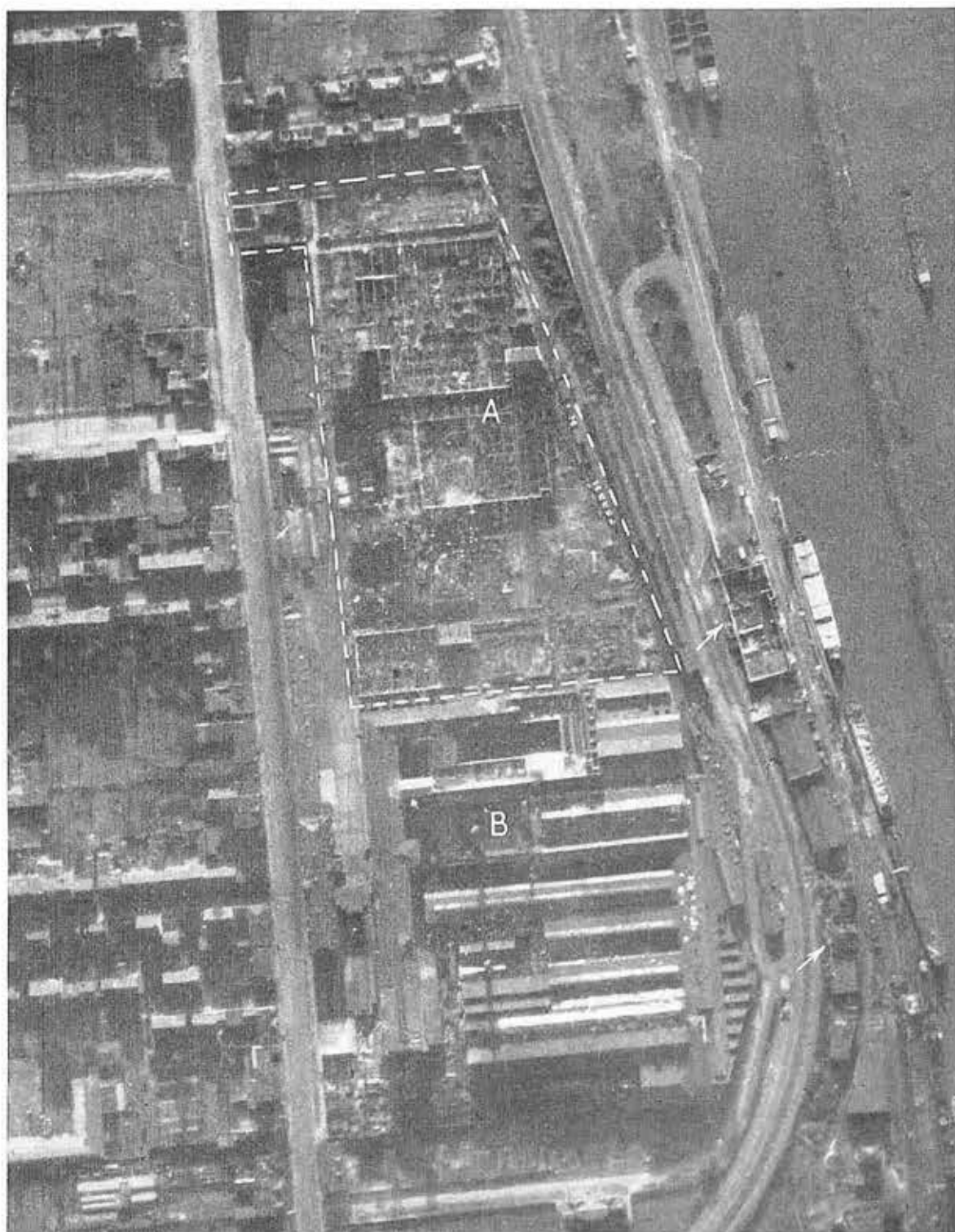


FIG. 14.—Duisburg: Part of the "severe damage to industrial and public buildings" which the Germans admitted after the night raid on 20-21 December. (A)—Six acres of the Kabelwerk-Duisburg factory destroyed by fire, and (B) the remaining workshops either roofless or patched. This important factory produced torpedo nets, telephone cables, etc. Arrows indicated gutted quayside buildings. (See page 6.)

NIGHT RAIDS ON GERMANY



FIG. 15.—30-lb. incendiaries and a 4,000-lb. H.C. bomb falling towards the Heinkel Aircraft Works near Warnemünde: a night photograph by "O" of 44 Squadron (1-2 October). The works and airfield were covered by an effective smoke-screen issuing from generators set about 80 yards apart. (See page 8.)



FIG. 16.—Osnabrück, an important junction in the German transportation system received further damage on the night of 6-7 October. The damaged goods station and factory buildings around the marshalling yards are seen above, including the large multi-bay workshop of the Klockner Metal Works destroyed by fire (lower edge of print).

Inset—The Hammersen Cotton Yarn and Weaving Factory, largely destroyed.

THE BREUIL STEELWORKS AT LE CREUSOT

(See page 10)

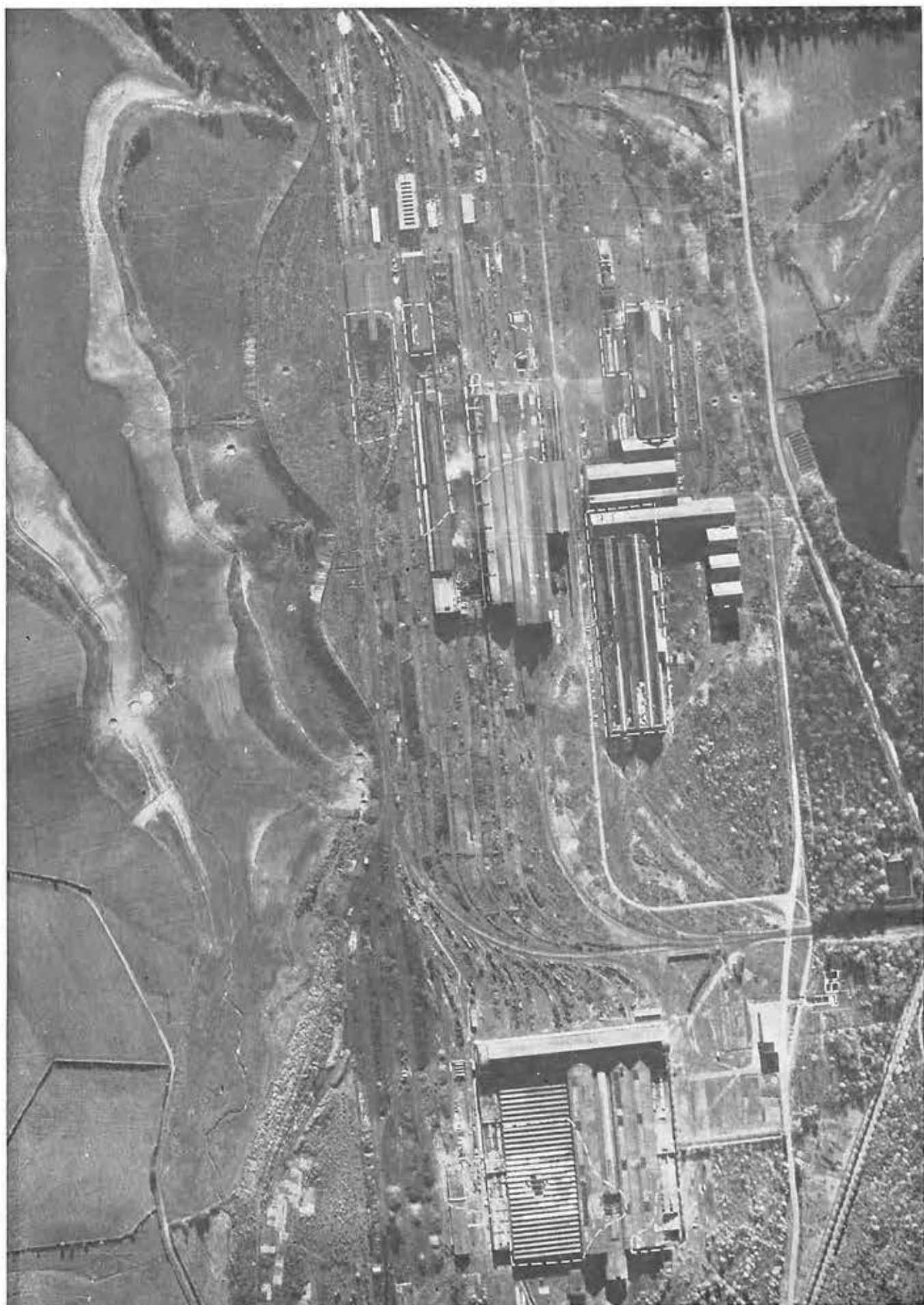


FIG. 17.—All the principal buildings of this section of the Schneider Armament and Locomotive Works were extensively damaged during the Lancasters' attack at dusk on 17 October. The General Machine Shops (lower edge of print), covering more than 600,000 square feet, were straddled by a stick of 1,000-lb. H.E. bombs three of which scored direct hits on the buildings causing partial collapse of the roof framework, as well as extensive blast damage over a wide area. Among other damaged buildings seen above are the Steel Manufacturing Plant and the Sheet and Bar Mills; and a 650-ft. warehouse of which the greater part was completely destroyed by direct hits. (See also Figs. 18—19.)

THE PROCESSING WORKS AT LE CREUSOT

(See page 10)

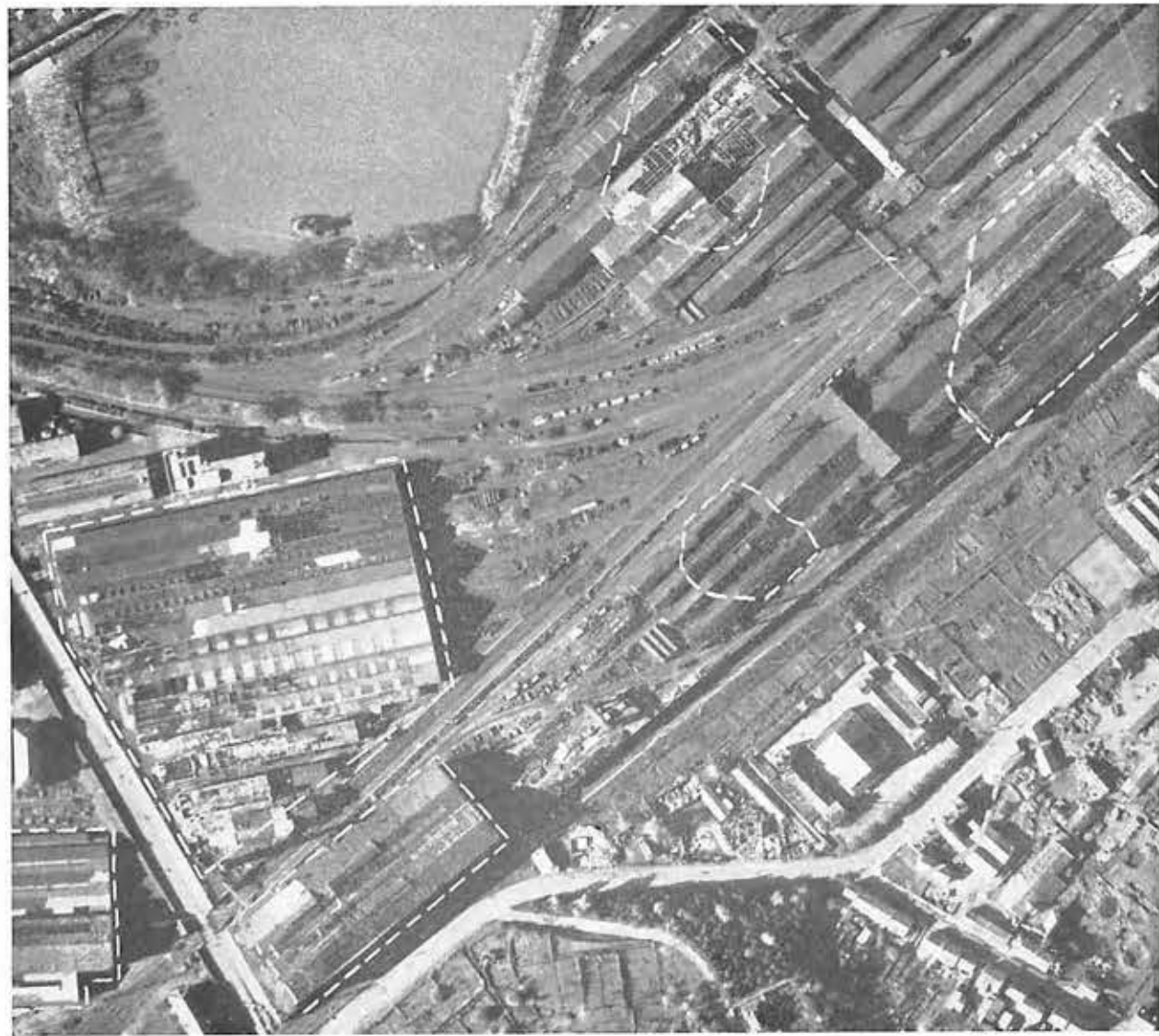


FIG. 18.—The Tank or Turbine Construction Shop shows fire damage over 100,000 square feet. The other damaged buildings are sections of the Forging Department.

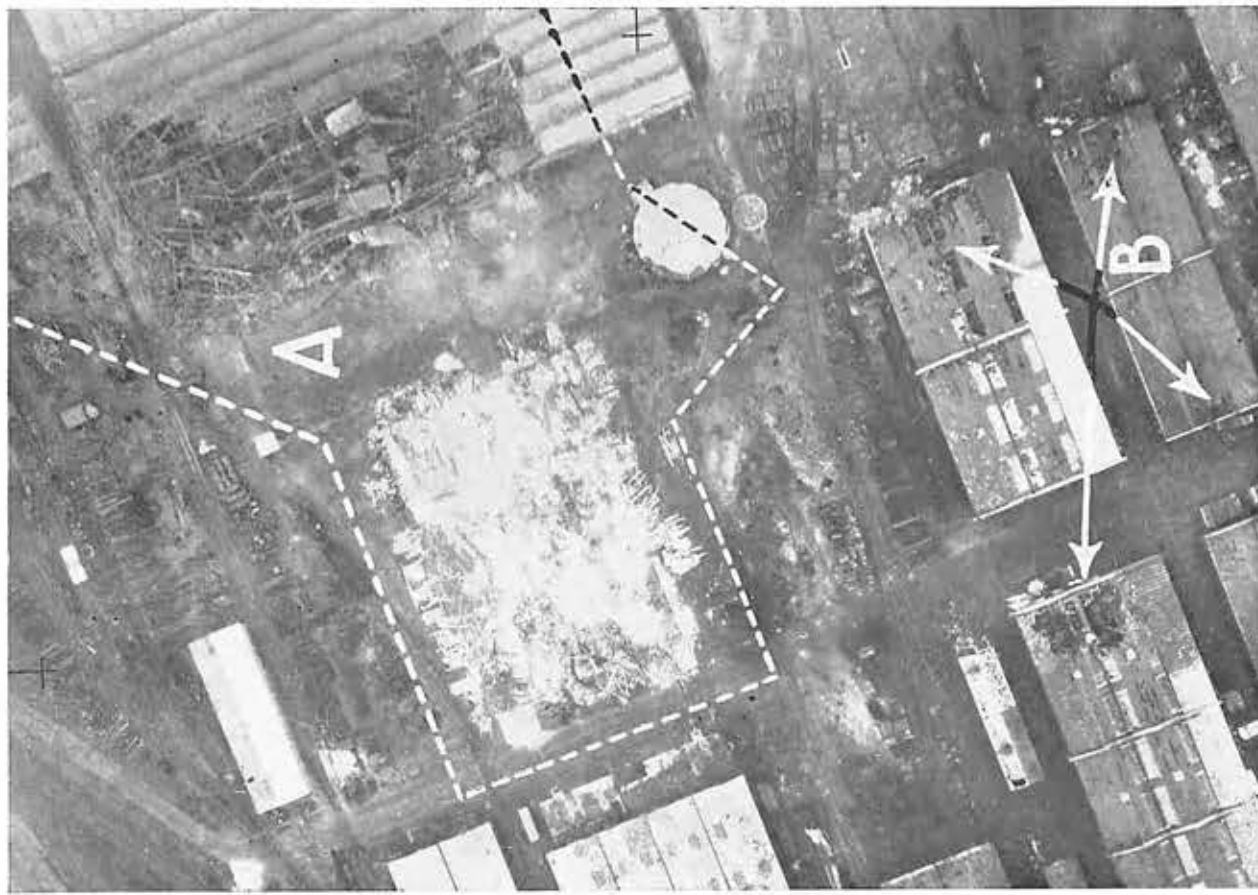


FIG. 19.—(A) Complete destruction was caused to an area of 30,000 square feet of the Locomotive Machine Shop, to an adjoining building 240 feet in length, and a storage tank was damaged by blast. (B) Other buildings damaged by H.E.

The Philips Works, which was entirely under German control, produced a third of the radio valves manufactured in Europe. As even the less important valve factories in France are obliged to work at full capacity to meet the insatiable requirements of the German armed forces, the loss of one of their primary sources of supply must have been a very severe blow. In addition to producing all types of radio valves, it is believed that the Philips factory was also engaged on experimental work on radio countermeasures to our bomber offensive.

The damage inflicted on both sections of the works was so far-reaching that production may even be transferred to a supposedly safer area: the Philips factory at Warsaw, which was new at the start of the war, is a possible choice. For a period Eindhoven was completely out of action, and the organisation of even partial production must be beset with extreme difficulties owing to bottlenecks in the output of particular components. It is important that the section in which the wire for filaments was drawn, and the machine shops where much specialised equipment was made, were among the buildings hit. The principal damage recognised on reconnaissance photographs is as follows:—

The Emmasingel Group

(The older part of the works, containing the important sections manufacturing valves and lamps for which very delicate and almost irreplaceable equipment is used.)

Head Offices } Fire damage to multi-
Commercial Offices } storeyed blocks.
Lamp and Valve Factory; numerous direct hits by incendiaries and H.E. bombs, several bays completely gutted.
A number of unidentified buildings destroyed or damaged.

The Stryp Group

(The larger and more modern section, engaged mainly in assembly, manufacture of components, and machine tools for the firm's use.)

Glassworks: severe damage.
Workshops: several buildings completely destroyed by fire.
Machine Shops }
Electro-Technical } Parts completely de-
Factory } stroyed, other build-
Radio Assembly } ings damaged.
Shops }
Storehouse: upper parts very badly damaged by H.E.
Mechanical glass works and many other buildings extensively damaged.

Hengelo.—The Stork Engineering Works, situated near the Dutch-German border, is one of the most important firms in Holland manufacturing for the Germans. Diesel engines, airframes and aircraft spares are here produced in considerable quantity. This works was five times the target for small-scale dusk attacks by Mosquitoes; bad weather prevented location of the target on the sixth occasion, when Venturas were employed. For the loss of a single aircraft a considerable amount of damage was caused on all five occasions. On 6th October the Mosquitoes came in very low and at least one scored direct hits on the power house which was at once enveloped in flames, followed by clouds of black smoke. Many bursts were seen on the target on 15th October, and the next day, despite some opposition from light flak gunners, the iron foundry, the diesel-engine store, the erecting shops and other buildings received direct hits, a pall of dark red smoke enveloping the works as the bombers set course for base. On 23rd October oblique photographs taken during the attack show three bursts on the machine and turning shops, while on 9th December a single Mosquito again hit the power station and other factory buildings in the vicinity. Thus, in return for a mere 20 sorties, the Mosquitoes inflicted a very creditable amount of damage on this important works and, by continually adding to the damage, ensured a serious loss of production.

Other Industrial Targets.—The Steel and Armament Works at Liege were successfully attacked by five Mosquitoes at dusk on 2nd October. Several direct hits were obtained on two sections of the works.

The Shell Oil Refinery at Ghent and the Chemical Works at Sluiskil were both successfully bombed from 50 ft. by single Mosquitoes—the Sluiskil Works on two occasions, the coke furnaces being badly damaged causing serious interruption of work.

On one day at the end of October Bostons carried out accurate low-level attacks on six power stations in the Lille area, on the aerodrome at Merville, and on two factories in Northern France. The Royal Dutch Blast Furnace and Steel Works at Velsen, near IJmuiden, suffered further damage on 27th November, when two Bostons scored hits on tanks of the benzol by-product plant, on the railway tracks and a near miss on a transporter crane.

Railway Objectives.—In addition to attacks on railway workshops, marshalling yards, locomotives and rolling stock in Germany itself, similar targets in the occupied countries were frequently bombed and machine-gunned by aircraft of No. 2 Group. There is no doubt that such operations increase the serious difficulties of the German rail transport system—the shortage of locomotives and rolling stock is one of the weakest points in the whole Axis war machine. These attacks were often pressed home from very low levels, and many direct hits were scored on marshalling yards, locomotive and wagon sheds in the Low Countries and Northern France. In the course of one railway patrol a Mosquito engaged in tunnel-bombing. The first 500-lb. bomb accurately dropped from a height of 200 ft. entered the western end of a tunnel on the Paris-Soissons line. Then a laudable attempt was made to close the eastern end immediately after a goods train had entered. Here the bombs overshot, but the pilot was gratified to notice before he set course for base that the train had not appeared again—at either end.

Dock Facilities.—Perhaps the most accurate medium-level bombing of the whole year was achieved by six Venturas, with fighter protection, which attacked the Torpedo Workshops and Naval Barracks at Den Helder on 23rd December. On photographs taken during the attack it is possible to distinguish at least 36 out of a possible total of 42 bomb-bursts in a single close group across the target (see fig. 20). No enemy aircraft were seen, ground opposition was slight, and all the Venturas returned without damage.

On the same day Bostons scored some hits in the dock area at St. Malo and a large explosion followed bomb bursts among earthworks nearby. The dock installations at Havre were bombed on 10th November by Boston crews who found that the *Neumark*-type raider, which was their primary target, had hurriedly left the port.

Attacks on German ships in French ports are referred to in the following section.

(e) Bombers engage in Sea Warfare

Aircraft of Bomber Command contribute in four ways to the struggle to maintain Allied sea communications and to blockade those routes which the Germans still endeavour to use.

In the first place the greatest possible bombing effort is directed against enemy sea-ports especially those which produce or serve as a base of operations for submarines and other naval craft. Building and repair yards, dock installations, stores of equipment, factories, the houses of the workers and all the elaborate organisation without which production, maintenance and handling of traffic will break down or cease to be efficient—all these are targets for our bombs. Much has been written on this subject and results achieved during a period of six months have been given in some detail in the preceding issues of this *Review*. There remain, however, three other ways in which Bomber Command crews directly engage in the battle of the seas:—

- (i) By laying mines with intent to destroy or obstruct U-Boats and other naval craft, military transports, and merchantmen on passage to or from enemy ports;
- (ii) By assisting in Coastal Command's offensive patrols of the Bay of Biscay and giving protection to our own convoys; and, finally,
- (iii) By bombing enemy ships in German occupied ports.

While the purpose of mass bombing attacks on the enemy seaports is widely understood, the nature and value of the three remaining types of operations is much less well known so that a brief survey may be of general interest.

Minelaying Operations

The scale of Bomber Command's sea-mining activities can be judged from the fact that it now lays more mines in one month than it did in the whole of the second year of the war. While Coastal Command has assumed the responsibility for bombing attacks on enemy coastwise shipping—a task in which No. 2 Group was most actively engaged in 1941—Bomber Command is now responsible for practically the whole of the offensive mining carried out in European waters. Heavy and medium bombers of all groups (apart from No. 2 Group) helped to make the effort of the October-December quarter of 1942 greater than that of any preceding quarter since the start of the war. More than thirteen times as many mines were laid than in the corresponding period of 1941:—

	No. of Sorties.	No. of Mines Laid.
1941 (October-December)	256	233
1942 (October-December)	1,464	3,125

To some people minelaying operations may appear rather unspectacular. Admittedly, from the crews' point of view there is no satisfying explosion in the target area to mark the completion of the task—there certainly should not be—but there is no truth in the idea that minelaying is generally speaking any less eventful or less useful than other types of night operation. One example of the excitements to be met with was published in the first issue of this *Review* (page 12); here is a further narrative which shows clearly the determination which may be required from crews engaged in laying mines—though few experiences are quite so drastic as those which befell a Lancaster of 61 Squadron last September.

This aircraft was engaged in minelaying operations in the Baltic when it unexpectedly came across an enemy convoy. Evasive action was taken immediately and no serious consequences resulted from the anti-aircraft fire encountered. The Lancaster proceeded to carry out its task, laid its mines successfully in the allotted area and set course for base.

After crossing the coast of Jutland the neighbourhood of Viborg was reached. Here our aircraft, then flying at 6,000 ft., encountered very accurate heavy flak. In the words of the captain: "The first shot hit us full in the rear bomb-doors and started a very serious fire as the flares and distress signals, hydraulic oil and the fuselage immediately burst into flames. At the same time another shot hit the nose of the aircraft, bursting the bomb-aimer's window and blowing him straight up beside me. It also blew most of the glass out of my cockpit, except the front windscreen.

"Then two fighters, which we had sighted previously—one was a Ju.88—fired at us and wounded the rear-turret man in the right leg. They also put a cannon shell into the mid-upper turret which burned the gunner and started off his ammunition.

"The plane filled with dense black smoke which nearly choked all of us and as I was unable to see my instruments I stalled the aircraft. Only when the smoke cleared could I regain control, by which time we were flying at about 4,000 ft. I then dived immediately for some clouds and lost the fighters and the flak."

The crew, despite their injuries and extensive damage to the aircraft, brought the Lancaster home from Denmark after three and a half hours and the pilot made a successful belly-landing on a Northamptonshire airfield not far from their base.

Minelaying is a highly effective form of warfare though it differs from most others in that crews seldom have the luck to witness the result of their efforts. Provided mines are correctly laid in the allotted areas (and this demands determination as well as skill) they can be more deadly than torpedoes since they are unseen by their victims. Some will undoubtedly be rendered harmless by the enemy's countermeasures; but our own experience of German efforts in British waters shows that, despite all precautions, mines effectively laid will both hamper and take their toll of shipping. Moreover, mining can close a busy port for days on end where this has seldom, if ever, been achieved by bombing. But the real proof of the value of our mining campaign does not rest on this analogy, but on the long list of German vessels and ships in German service known to have been sunk or damaged in our minefields. (These lists are published in the *Air Ministry Weekly Intelligence Summaries*, available in station intelligence libraries.) Among the casualties inflicted during the quarter under review the certain destruction of a U-Boat (and it was not the first to be sunk by our mines) serves to remind us just how important is this work of the Command. It may also be recalled that larger naval units are not immune and are known to have suffered in the past: both *Scharnhorst* and *Gneisenau* received considerable damage from our mines on their journey from Brest to a German port in February, 1942. If such incidents occur once they can happen again, but the Germans naturally remain discreetly silent about them.

An outstanding illustration of the effectiveness of the air-laid mine was afforded by the intensive mining programme carried out by our aircraft last October and November. This campaign achieved its primary object of interfering with U-boat traffic to and from the bases in Western France, thereby aiding towards the safe passage of the enormous convoys proceeding from England to the North African front. While this was only one of the defensive measures taken, the fact that no torpedo attacks were made on any of the convoys during their passage to Gibraltar is an indication of the value of Bomber Command's share in the combined effort which made this operation a success.

In addition to this special anti-submarine campaign in the Bay of Biscay, mining operations in other areas continued to pay their regular dividend. Movements of important German naval units have been hampered and no doubt the replenishing of minefields both in the eastern and western Baltic has led to further interference with naval training as well as interrupting the supply of war materials bound for Axis troops in Norway and on the North Russian front.

Two vitally important shipping routes supply rich iron-ore for German armament production. Over three million tons of Norwegian and Swedish ore pass each year from the Baltic, through the Kiel Canal, along the north German coast to Rotterdam, and there transferred to river barges for the last stage of the journey to the Ruhr factories. The other route is much shorter and less tortuous: from Bilbao in northern Spain to the Biscay ports of Bayonne and Bordeaux. Air-laid mines have caused sinkings and serious interruptions of both these routes during the quarter under review.

There are the best of reasons for believing that enemy convoys on the North Sea route are becoming more and more gravely embarrassed. As a concrete instance of this a Beaufighter of Coastal Command on patrol last October sighted one of the most notorious *sperrbrecher* employed in minesweeping and convoy escort on this route, being towed stern first and the photograph showed that the forward half of the ship was entirely missing—obviously blown off by a mine (Fig. 29). Owing to the very heavy mining in those waters the enemy can ill afford to lose even temporarily the services of a single one of these valuable escort ships. From four to six additional minesweepers have to accompany the convoys until a *sperrbrecher* is replaced. Many other *sperrbrecher* have been sunk or damaged by our mines.

During 1942 the Biscay ports became increasingly important for yet another reason—as the terminus for Axis ships attempting to run the Allied blockade by linking up Japan and Germany. Already the visit of a Japanese submarine to a German-occupied port has been announced by the Nazis—and confirmed by a Coastal Command aircraft which photographed the submarine while attacking it in the Bay. There are many commodities so greatly needed by Germany that the arrival of one of these blockade runners could provide (for instance) enough rubber to equip four armoured divisions with all their needs for a year. Considerable quantities of rubber are said to have reached Germany lately, and the tyres of captured German aircraft do in fact show an increase in the content of natural rubber. The arrival of 5,000 tons of vegetable oil would be enough to maintain the whole German margarine ration for a fortnight: such a cargo would be about half, or even a third, of a normal tanker's capacity. On the other hand Germany can supply the precision machinery, radio-location equipment and the like, which Japan urgently needs for the continuance of her war in the Far East.

During November three blockade runners reached Bordeaux (two of them under cover of bad weather) and others managed to slip out of the port despite constant attacks by Coastal Command aircraft. In the course of these operations mines laid by Bomber Command aircraft held up and may possibly have damaged some of the in-bound ships forcing them to remain outside the Gironde until the channel had been swept. Meanwhile the blockade runners were attacked by our Mosquitoes with results which are described below (page 15).

Patrolling the Bay.

Since May, 1942, Bomber Command aircraft made over 1,100 sorties on daylight patrols of the Bay of Biscay. The majority of these patrols conformed generally to Coastal Command's anti-submarine operations, but some were directed against enemy shipping, while escorts for Allied convoys were also provided from time to time.

Aircraft of the following squadrons, loaned for varying periods for service with Coastal Command, took part in the operations :—

Bomber Command Units on Anti-Submarine Patrols June-December, 1942.	No. of U-Boats Sighted.	No. of U-Boats Attacked.
51 Squadron (Whitleys)	9	7
77 Squadron (Whitleys)	9	6
*304 (Polish) Squadron (Wellingtons)	12	10
*311 (Czech) Squadron (Wellingtons)	12	12
61 Squadron (Lancasters)	3	3
405 Squadron (Halifaxes)	7	2
10 O.T.U. (Whitleys)	18	10
	70	50

* Since transferred to Coastal Command.

Where attacks by aircraft are concerned the total destruction of a U-Boat can very rarely be regarded as absolutely proven, since the crew can seldom obtain tangible evidence in the shape of bodies or wreckage. One of our aircraft did, however, produce unmistakable evidence in the shape of a photograph of the U-Boat crew in the water swimming away from their foundering ship (Figs. 21-22) and several others are credited with "probable kills."

In view of the fact that anti-submarine patrols differ fundamentally from bomber operations—and our crews had no intensive training in their new work—the above results do them great credit. Even to sight a U-Boat within 600 miles of our bases is by no means easy these days since they keep a close lookout for air attack and submerge immediately an aircraft is seen. To make a depth-charge attack before the target is too far submerged calls for a high degree of skill and vigilance. In one week (ending 4th October) Bomber Command aircraft made no less than five promising attacks on U-Boats during patrols involving only 38 sorties. A series of narratives illustrating some of the attacks made by our aircraft will be found on page 26. (See also Figs. 21-24.)

Our crews also acquitted themselves well in air fighting in the course of these daylight operations. Coastal Command's patrols have hampered the U-Boats so effectively that the Germans are obliged to put their fighters up over the Bay as a countermeasure: first the He.115's appeared and didn't like it, then Ar.196's quickly followed by Ju.88's in growing numbers. The enemy's best fighter, the F.W.190 is the latest development. Even these get roughly handled, as will be seen from the account of the brilliant engagements in which the Squadron Commander of No. 10 O.T.U., in a Whitley V, shot down one and damaged another out of the three F.W.190's which attacked his aircraft, already damaged in an otherwise successful combat with three Ju.88's (see page 20). Indeed the Bay patrols have shown in an unmistakable manner the ability of our bombers to stand up to daylight fighter attacks when handled by crews who know their job.

Attacks on Enemy Ships

Following the attack in which No. 2 Group Bostons heavily damaged the 12,000-ton *Solglimt* at Cherbourg last September (see *B.C.Q.R.* No. 2, fig. 13) five operations with fighter escort were directed against an armed merchant raider of *Neumark* type. At the beginning of the quarter the raider moved out of dry dock and appeared as if about to leave the port of Havre—where she had been damaged by Bostons six months earlier, as illustrated in the first issue of this *Review* (fig. 10). Owing to unfavourable weather the Bostons were obliged to abandon the attempt on two occasions. On 15th October the ship had returned to dry dock just before the attack, but a 5,000-ton merchant vessel in the Bassin de Marée was damaged by several near misses; photographs taken two hours later showed this ship apparently beached in shallow water on the opposite side of the basin with five tugs in attendance—evidently the damage below the water line was so serious that it was feared she would capsize at her berth (Figs. 30-31). A week later this ship was seen to be in dry dock, her prospects of blockade-running at an end for some time. On 9th November photographs show that at least one direct hit was scored on the *Neumark* raider but the damage was not sufficient to prevent her being hurriedly moved from Havre before the attack next day. The raider was then located at Flushing where she was attacked again, this time by two Mosquitoes. It is likely that this valuable ship, which our Bostons have already kept out of mischief for eight months, will need further extensive repairs before she becomes anything but a minor liability to the German war effort.

ACCURATE BOMBING OF A NAVAL TARGET

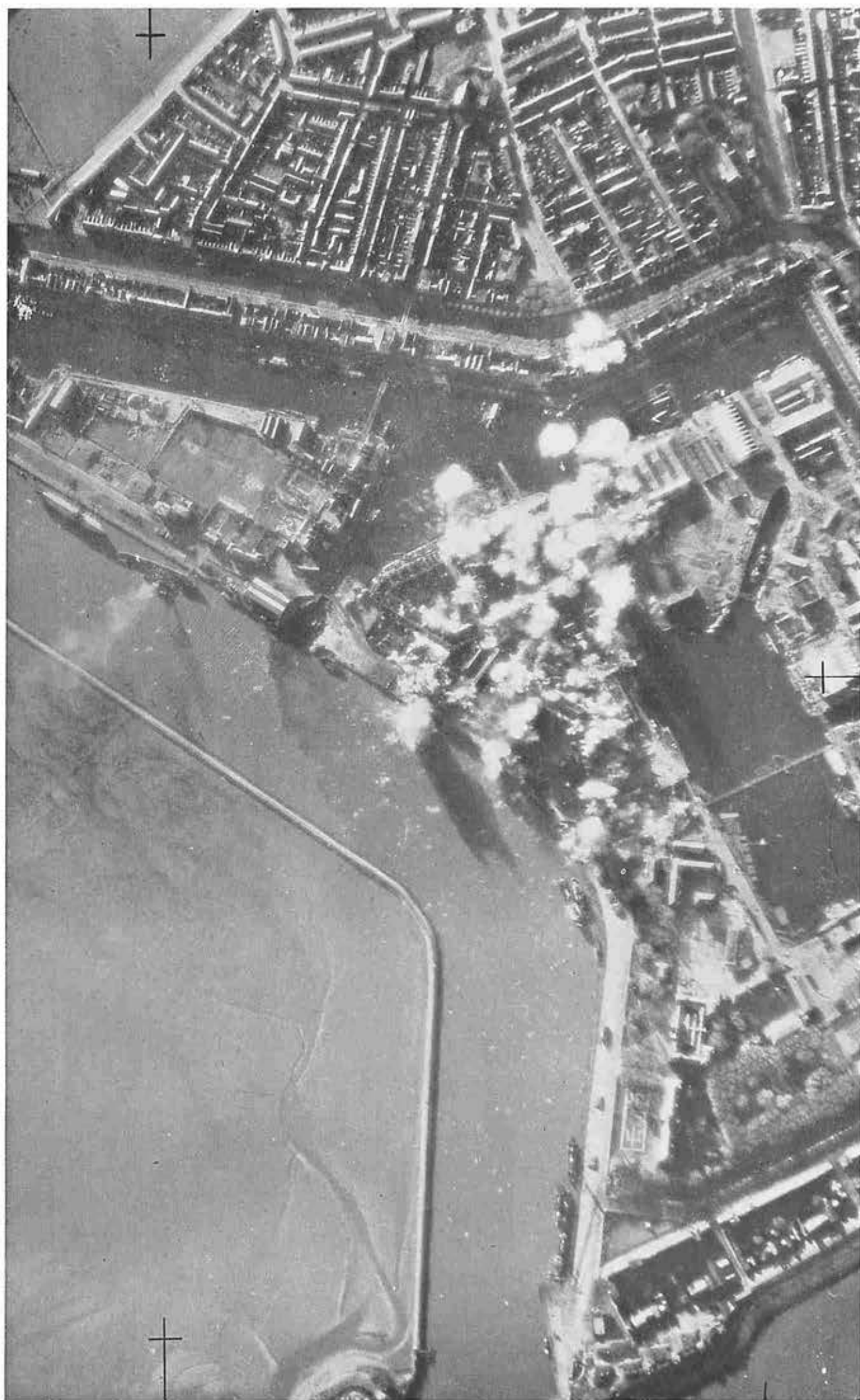


FIG. 20.—Six Venturas dropped forty-two 500-lb. and 250-lb. G.P. bombs in a single close group across their target, the Torpedo Workshops and Naval Barracks at Den Helder (23rd December). (See page 12.)

A LANCASTER DESTROYS A U-BOAT

(See page 23)



FIG. 21.—On 17th July, 1942, "F" of 61 Squadron, sank this U-Boat in the Bay of Biscay—the first to be destroyed at sea by Bomber Command. The submarine had previously been damaged by a Coastal Command Whitley and the Lancaster sighted it two hours later trying to get away.



FIG. 22.—The Lancaster straddled the U-Boat with a close-spaced stick of depth-charges released from 100 feet, which brought it to a standstill. After a further attack with A/S bombs, the crew abandoned ship, a minute before the U-Boat foundered stern first. This photograph shows the enemy crew in the water, enveloped in oil. *(See page 23.)*

ATTACK ON AN ITALIAN SUBMARINE

(See page 25.)



FIG. 23.—A photograph taken by a Wellington of 304 Squadron during an attack on the Italian submarine *Giuliana* in the Bay of Biscay. Four depth charges out of six fell alongside the submarine which was completely obliterated by the spray from their explosions. An oil-patch 400 ft. across spread over the surface of the water and the submarine soon came to a standstill. Then the Wellington attacked with two A/S bombs and also made five machine-gun attacks (as seen in the above photograph) when several of the enemy crew fell into the sea. When the bomber had to return to base the submarine remained stationary with a heavy list and well down by the bows.

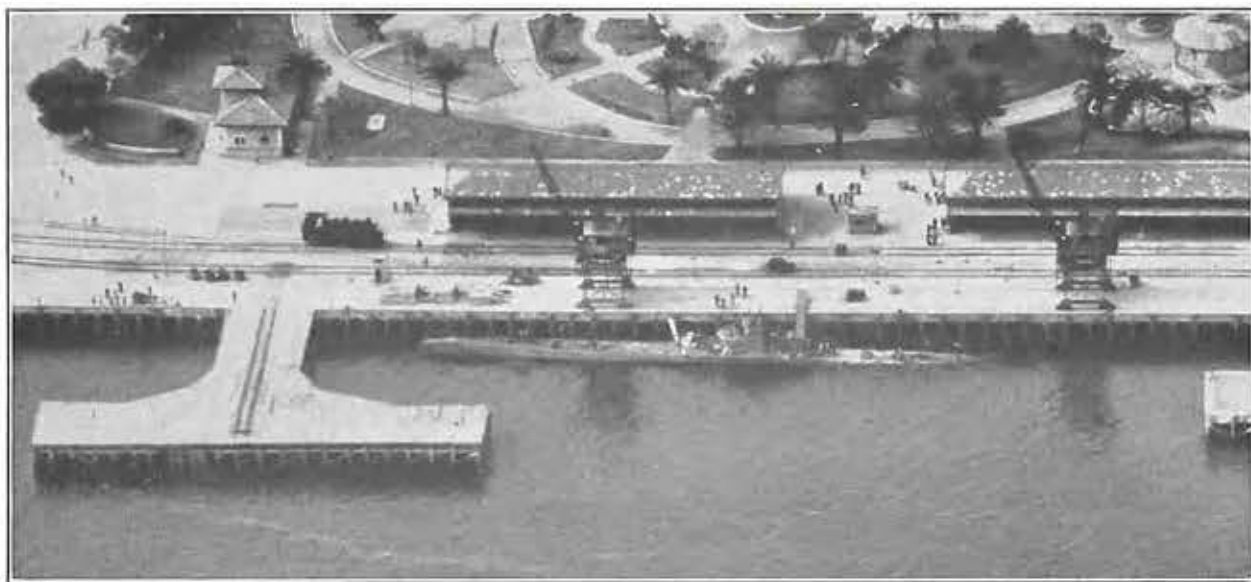


FIG. 24.—The crippled *Giuliana* was later towed into the neutral Spanish port of Santander, where she is seen in the above photograph. The Wellington's attack evidently inflicted severe internal damage to this enemy submarine. (See Fig. 23 above and page 25.)

NAZI BLOCKADE-RUNNERS AND "BARRAGE-BREAKERS"

(See pages 14-15)



FIG. 25.—The *Elsa Essberger* of 5,000 tons, was one of several enemy vessels evidently bent on running the Allied blockade between Europe and the Far East towards the end of 1942. This photograph was taken by one of six Mosquitoes of Bomber Command which attacked the *Elsa Essberger* at the mouth of the Gironde on 7th November. Note the gunners at the port flak position aft of the funnel. *Inset*.—Very near misses probably causing damage to the ship, which is still lying at Bordeaux.



FIG. 26.—Three of the Mosquitoes attacked the large heavily-defended *sperrbrecher* ("barrage-breaker") escorting the *Elsa Essberger*. This striking photograph by "F" of 105 Squadron shows a stick of bombs bursting close to the port bow, while Fig. 27 shows a direct hit from another stick a few seconds later. Note the swastika painted on the deck, and the gun positions on the forecastle, foremast, bridge, and aft of the funnel. (See page 15 and Fig. 27.)

THE SPERRBRECHER: THE ENEMY'S REPLY TO OUR MINES



FIG. 27.—A few seconds after Fig. 26 was taken this *sperrbrecher*, "A.T.," is seen to have received a direct hit aft of the funnel by a 500-lb. G.P. bomb, and three near misses to the stern. Note the light flak positions aft. (7th November). Another Mosquito is seen coming in to attack.

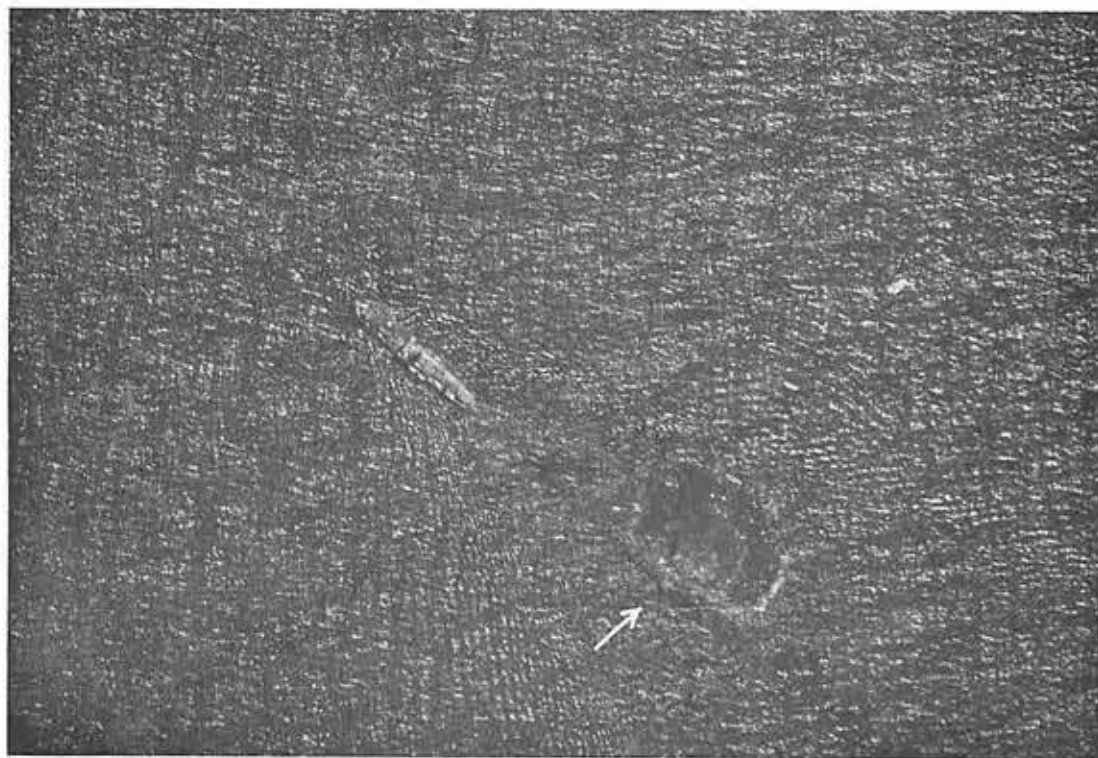


FIG. 28.—*Sperrbrecher* ships are the enemy's reply to Bomber Command's minelaying offensive: a large *sperrbrecher* is here seen proceeding at about 6 knots off the Ile de Groix, near Lorient, having detonated a mine (the swirl marked by arrow). It is calculated that the mine exploded about 150 yards ahead of the vessel. These vessels are also employed to escort U-Boats through our minefields.



FIG. 29.—Our latest mines cannot be disposed of with safety even by the *sperrbrecher*. This photograph, taken off Terschelling by a Beaufighter of Coastal Command, shows one of the most notorious *sperrbrecher*, "A.E." (5,000 tons), being towed stern first, the whole forepart of the vessel having been blown off by a mine. (Compare the silhouette.) This ship used to escort merchant convoys on the Cuxhaven-Rotterdam route, and such serious damage to these anti-mine ships directly benefits our minelaying campaign. (See page 13.)

A GERMAN MERCHANTMAN: DURING AND AFTER ATTACK

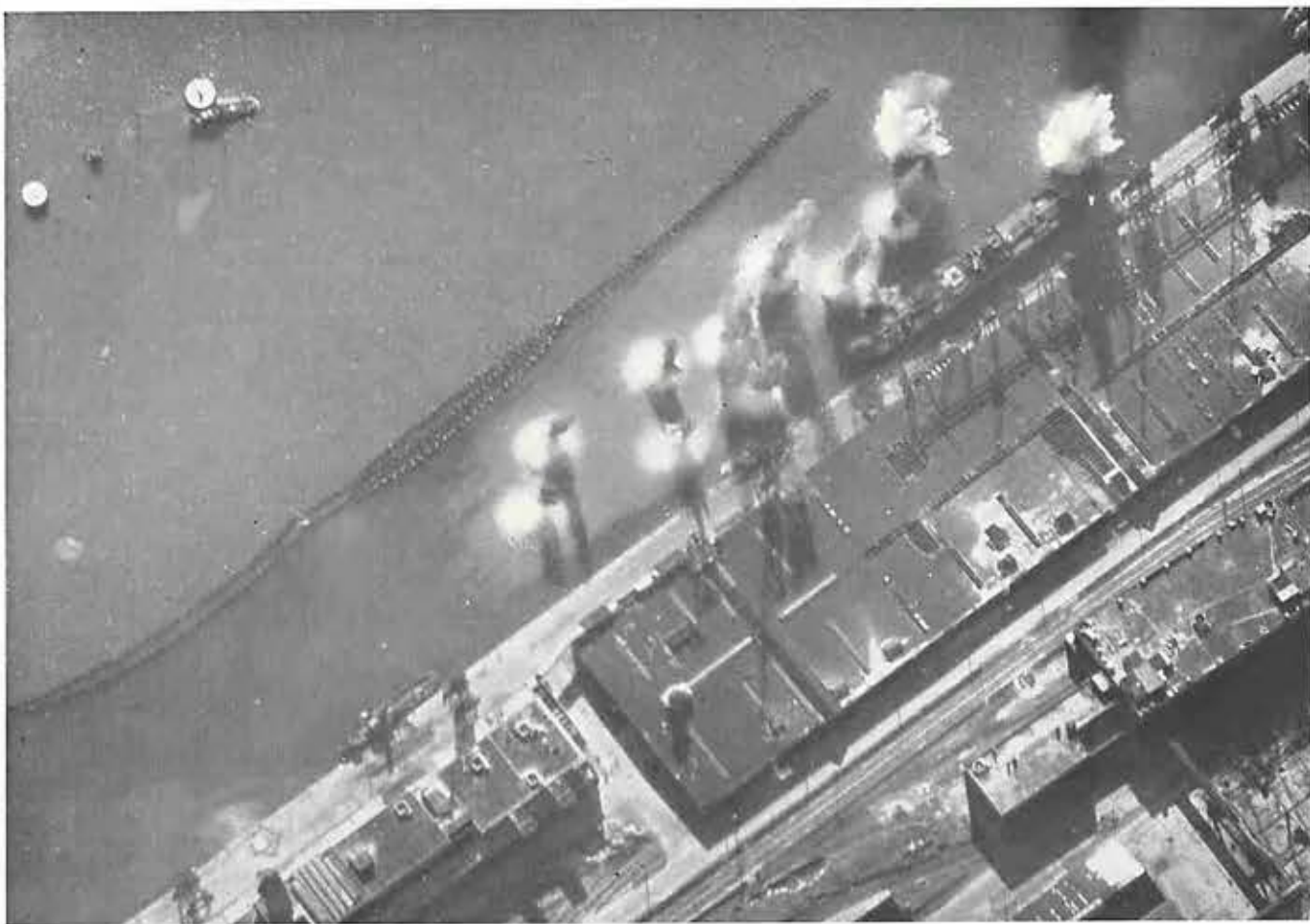


FIG. 30.—A 5,000-ton German merchantman was attacked at Le Havre by Bostons of the No. 2 Group, on 15th October. Thirteen bombs fell in the water near the ship, one causing serious damage to the starboard side forward of amidships. Two other bursts are seen on the adjoining warehouse. (See next fig. (31).)

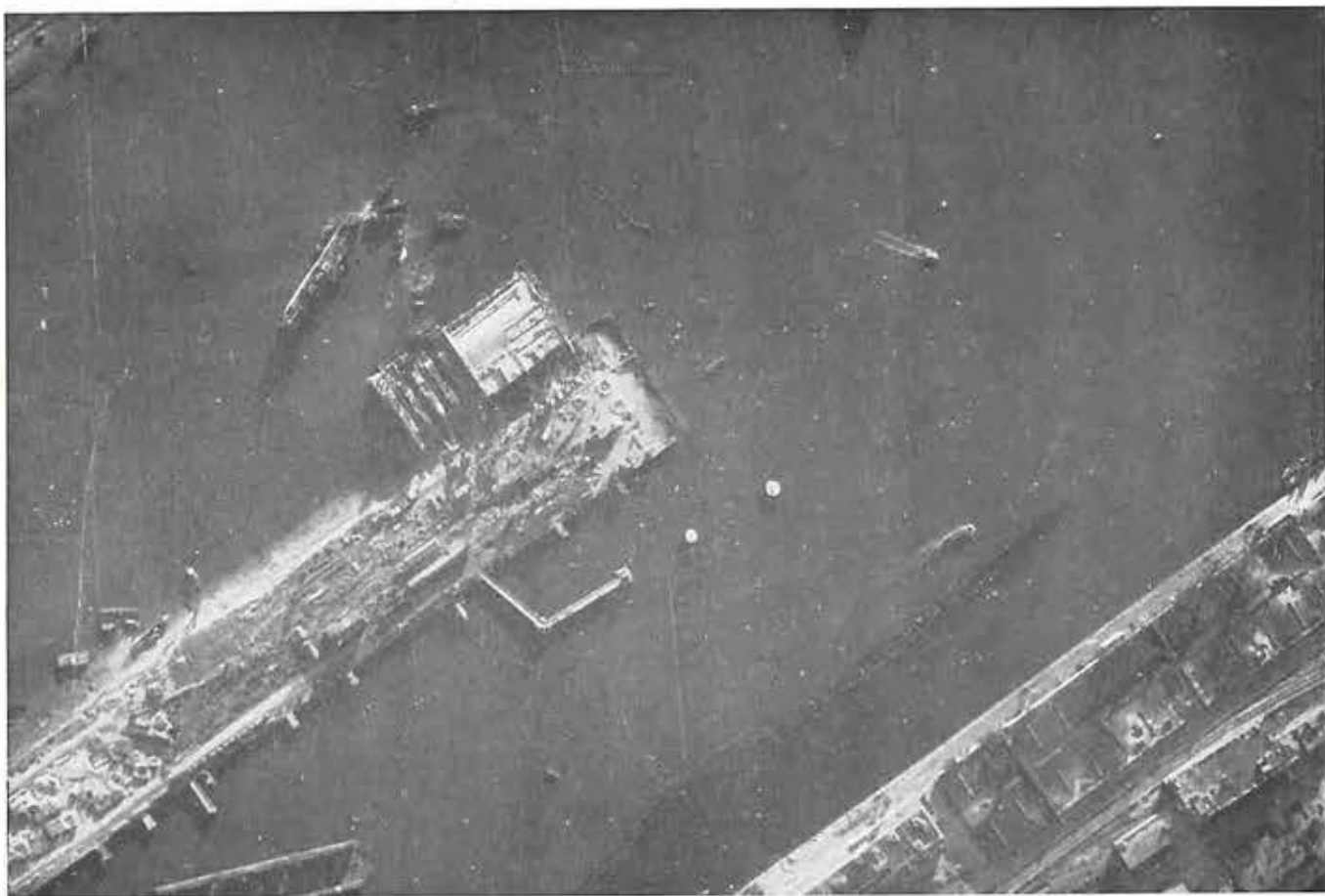


FIG. 31.—Within two hours of the Bostons' attack, reconnaissance showed the Nazi ship had been moved to the other side of the Bassin de Marée and beached in shallow water opposite the newly-built R-Boat pens, with five tugs in attendance. A week later she was in dry dock. (See page 14.)

Our aircraft have also co-operated in Coastal Command's efforts against the blockade-runner in the Bay of Biscay. The successful attack last August on the *Altmark*-class tanker, accurately bombed by a Lancaster of No. 61 Squadron, was a case in point.

The increased activity on the part of intending blockade-runners already referred to was a striking feature of the month of November. Our Halifaxes and Whitleys serving with Coastal Command took part in the numerous patrols directed against the 7,000-ton *Kulmerland* arriving at Bordeaux and other vessels outward bound from the same port. On 7th November six Mosquitoes of No. 2 Group also took part in the chase and attacked another potential blockade-runner, the 5,000-ton *Elsa Essberger*, lying with a large escorting *sperrbrecher* at the mouth of the Gironde. Photographs show that there were several very near misses on the former, and it is perhaps significant that *Elsa Essberger* has been lying at Bordeaux ever since. Moreover, one of our Mosquitoes scored a direct hit on the *sperrbrecher* aft of her funnel, as seen in Fig. 27. Although not the primary objective of the operation, this represents a most useful achievement as the disablement of one of these important vessels might well result in even greater success attending our mining operations; particularly in view of the fact that *sperrbrecher* in the Biscay area are also required to escort U-Boats when leaving or returning to their base.

II. BOMBER COMMAND AND THE RUSSIAN OFFENSIVE

Since June, 1941, Germany has been engaged on two fronts. In order to prosecute her land campaign in Russia to what she confidently hoped would be a victorious end, she was compelled to turn her back on the west, leaving in that theatre only the minimum air and land forces needed to hold this country in check. When this decision was taken, there can be little doubt that Germany expected to finish the war in Russia by the end of the year, and be free in the spring of 1942 to devote all her resources to finishing off the war in the west. Two things have gone wrong with her calculations. First, the Russians refused to be beaten, making use of their age old strategy of retreat into their illimitable country, followed by well-timed counter-attacks. Secondly, the bomber offensive has grown in power and effectiveness beyond anything on which the enemy calculated, and by the spring of 1942, had become the hammer that was beating him to death against the anvil of the Eastern Front.

It is not therefore surprising that the bomber offensive has been described by authoritative German speakers, including Goebbels himself, as the German second front, and this is no mere rhetorical flourish, but a simple statement of fact. Both Hitler and Goering have also frequently expressed their grief at the present inability of the Luftwaffe to retaliate in kind and have done their best to encourage their followers by highly coloured statements of what they will do to this country when the Russians are finally defeated. This attitude conceals a large part of the truth by suggesting that at present the Luftwaffe is wholly engaged on the Eastern and Mediterranean fronts, and is therefore unavailable for employment against Britain.

The actual distribution of the Luftwaffe tells a different story. In December, 1941, this was as follows :—

	<i>S.E. Fighters.</i>	<i>M.E. Fighters.</i>	<i>L.R. Bombers.</i>
Russia	375	39	792
Western Front ..	295	135	281

At the end of 1942 the corresponding figures were :—

Russia	459	90	635
Western Front ..	336	366	294

The Western Front in fact now absorbs almost half as many bombers and a greater number of fighters than the Russian campaign. Furthermore, it is important to realise that, although the disposition of the bomber force was at least to some extent optional, the fighters on the Western Front were an essential minimum to avoid disaster. For Germany must at all costs try to ensure that the price of night bombing to Bomber Command is kept high and that the bombing of German cities by day is too expensive to be practicable. If these conditions cease to hold, she will lose the war in a very short time.

There is thus a heavy call on German fighter squadrons which is the direct and unavoidable consequence of the bomber offensive and of which the effect both in Russia and Africa has been incalculable. To this must be added the considerable direct and indirect effects of the offensive on the productive power of the German aircraft industry. Directly the Heinkel works at Rostock and Focke Wolf works at Bremen are the chief victims. Indirectly, however, it is certain that the large scale destruction of the Rhineland factories has adversely affected production in this as in other branches of German industry.

From the standpoint of formed Luftwaffe units, therefore, the Bomber Command contribution to the Russian campaign has been two-fold. By containing a very substantial proportion of the German fighter force it has enabled our allies to gain air superiority at vital parts of the front and by seriously impeding production it has prevented the enemy from counteracting this handicap by expanding his force.

Even more important, though less precisely demonstrable, is the steady drain on man-power and productive resources which the maintenance of the German ground defence system has involved. The former is very roughly estimated as follows :—

- (i) At the end of 1941 it was considered that the total number of German flak personnel was about 1,000,000, of whom 60-70 per cent. were on the Western Front. A fair proportion of these are so-called Heimatflak, corresponding to our Home Guard. The total at the end of 1942 was perhaps 1,250,000, of whom 250,000-300,000 were Heimatflak personnel. Of these it was estimated that the Western Front accounted for 750,000-800,000, including the whole of the Heimatflak personnel.
- (ii) The number of persons involved in full-time employment with the German civil defence general services and national fire service is probably a further 250,000. To these, however, must be added a very large number of part-time volunteers and auxiliary police.
- (iii) It is hardly possible to give any numerical estimate of the resources locked up in the production and maintenance of flak weapons and ammunition, predictors, searchlights and ancillary equipment. Obviously they are very large.
- (iv) A vast effort in material and manpower also goes into essential repairs and demolition.

Apart from the necessity of maintaining a vast mine-sweeping organisation and the loss of shipping which the mining activities of Bomber Command inflict upon the enemy, the destruction of Germany's war potential has been very great. Although there is no direct evidence that the proved and serious interference of Bomber Command with Germany's production of coal and steel and with her overseas imports of iron ore before the Soviet offensive has yet compelled any reduction in the establishment or strength of her armoured divisions, artillery or anti-tank brigades, it is apparent now that her resources in all these spheres were inadequate, though only by a narrow margin, to enable her to carry out successfully the grandiose plan of the 1942 campaign. Her margin between complete success and disaster both in Russia and Africa was small. Whether it could have been eliminated but for the drain on air-power, productive resources and men which Bomber Command has imposed throughout the year must remain debatable—though in truth the answer is not seriously in doubt.

Now a further change has come over the scene. Failure to achieve success has given the Russian the chance to counter-attack, and the recent important successes of the Soviet armies have placed a new complexion on the situation. For Germany is now faced with the absolute necessity of stopping the rot in Russia and replenishing quickly the colossal quantities of equipment of all kinds which have been lost in the winter campaign. Even before the Stalingrad battle had assumed the proportion of a major military disaster, it was the considered view of the Ministry of Economic Warfare that Germany would have great and growing difficulty in maintaining economic stability through 1943 if the Bomber offensive was not allowed to slacken. If this estimate was correct the short-run position must now be so threatening as to be almost desperate.

In the first place it will be essential to fill the gaps in the ranks of the Eastern army. Man-power for this can be found only by withdrawing yet more men from industry and replacing them by unwilling and relatively inefficient foreign labour. This is the new "mobilisation for Total War" announced by Goebbels to a war-weary nation on 30th January, 1943, the tenth anniversary of the Nazi usurpation of power. These measures will increase the possibility of internal unrest and give greater opportunity for sabotage for which bombing attacks again provide excellent cover. Obviously police and Gestapo will need further reinforcements to deal with this position and to some extent a vicious circle is involved.

The air and ground defences of Germany will be strained yet further. Quantities of aircraft, tanks and vehicles awaiting repair have been lost in Russia. It is imperative to increase production of war material and replace and repair lost and damaged transport vehicles, and it must be done in the face of our bombing attacks. Hence, either the Wehrmacht must attempt to reorganise and reform without adequate air cover or the Western defences must be allowed to fall below the minimum necessary to give protection to German production centres.

Finally the shortage of consumer goods in Germany which was already serious will be rendered terribly acute by the new withdrawals of labour from industry and by the need to create a new front somewhere in Russia or Poland and equip all the ancillary depôts, hospitals, etc., behind that front without which an army cannot fight. The seriousness of this position is indicated by the decision virtually to close down all retail shops, except those purveying food, serving the home market. It will be interesting in these circumstances to see how the bombed-out fare when they try to replace their essential household goods.

The resulting situation is plain. Prior to the winter victories of the Soviet armies, Bomber Command was contributing an essential element to the failure of the enemy campaign in Russia by drawing off the German fighter force, reducing the productivity of German industry by bombing, and hampering it further by locking up very large man-power resources in flak and civil defence measures. Now that the Germans are in retreat and everywhere on the defensive they have to meet the bill for an unsuccessful blitzkrieg—which is as heavy as the rewards for success are large. In these circumstances the bomber offensive if concentrated on Germany will, in the immediate future, be not merely important but decisive in crushing the German power to wage war.

III. FLYING INCIDENTS

(a) Unescorted Bombers on Daylight Operations

The Le Creusot Raid

The sensations of the crews who formed part of the fleet of nearly a hundred Lancasters which roared 300 miles across France without escort in broad daylight on 17th October were quite unique. The salient facts of the celebrated raid are set forth on page 10, but a few incidents which occurred in the course of the operation may also be of interest.

The outstanding feature was the degree of immunity from enemy opposition which our crews—quite literally—enjoyed. In the words of one squadron commander "We went over the coast like a flock of great birds—it was a magnificent sight. For a little while we were expecting trouble but it never came, and the latter part of the trip to the target was more of a sight-seeing tour than anything else.

"At the height we were flying we disturbed the cattle in the fields and numbers of them stampeded. At one place we saw oxen bolt, dragging their plough after them. Many of the French peasants in the fields waved to us as we swept over. The only fighters we saw—it was on the way back—were two single-seaters in the distance which turned and bolted as we drew near. The whole trip was a real treat."

Not far from the target the Lancasters passed over a large internment camp consisting of wooden huts enclosed by barbed wire with crowds of men inside. One crew clearly saw two soldiers on patrol in German uniforms and jack boots and, as they passed over, the front gunner gave the Hun soldiers a good burst of fire.

At the target two or three heavy flak positions gave up firing after the first bombs had fallen, and a solitary light flak gun on the shore of the lake packed up after firing a few rounds. Two aircraft received slight damage from flak fragments, but not a single aircraft was lost through enemy action.

One Lancaster only reported damage from a fighter, and the combat is worthy of description.

"A" of 207 Squadron experienced engine trouble before reaching the target, and the captain regretfully decided to return to base. At 1700 hours this Lancaster was some 50 miles west of Brest, flying about 40 ft. above the sea. Cloud base was at 1,000 ft., but below that visibility was excellent. Suddenly three Arado 196 float-planes were sighted just above sea level and about a mile astern. They immediately came in to attack our aircraft, which was not only outnumbered but partially disabled as well since it had lost the use of one engine.

The first Arado attacked from astern, opening fire at 300 yards. The Lancaster's rear-gunner got in four short bursts. The enemy at once turned on his back with black smoke pouring from his engine and crashed straight into the sea.

At once the second float-plane came in from the port beam, but the bomber turned in towards the attack and as the enemy swung past the mid-upper gunner fired two short bursts at him; but this engagement was indecisive.

Meanwhile the third opponent approached from the port side and, passing around the rear of the bomber, attacked from the starboard beam. The front gunner immediately replied with a long burst and the enemy turned over and crashed into the water. Before it crashed, however, a bullet entered the bomber and killed the flight engineer.

The second and only surviving Arado then made a last attempt, attacking from the port quarter. Our mid-upper gunner again got in two short bursts, and the rear gunner also fired, before the enemy sheered off in the direction of the French coast. Our Lancaster, damaged but victorious, resumed its homeward journey.

Over Milan in Daylight

The untroubled afternoon performance of the Lancasters a week later over Northern Italy and the ineffectual behaviour of the Duce's fighter force have been reviewed already (page 5). Not all the fighters were afraid to press home their attacks; they were merely unable to compete with the tactics and experience of our gunners and the technical superiority of our aircraft. The following episode briefly illustrates the point.

On leaving the target one Lancaster climbed until it broke through the cloud tops at 12,000 ft. The rear gunner then saw a Macchi 202 also break cloud some 1,500 yards astern, followed by a second. Despite long bursts from both rear and mid-upper gunners, the first Macchi closed in to 150 yards, when it suddenly turned over on its side and dived straight into cloud apparently out of control. Although the fighter had opened fire at 400 yards the Lancaster was not hit. The second Italian fighter fired from 800 yards but soon desisted and disappeared into cloud. The encounter was seen by another Lancaster and the first Macchi 202 is considered as probably destroyed.

Mosquitoes on the Eindhoven Raid

As Mosquito bombers have no defensive armament they have to rely on their speed and especially on their manoeuvrability in any encounter with enemy fighters. Here are two examples of their performance on 6th December.

"J" of 105 Squadron was approaching Eindhoven at 1225 hours with its formation, when a FW.190 appeared in the port beam. "J" broke formation with intent to draw off the fighter which immediately came in to attack from the starboard quarter. The enemy opened fire at about 350 yards. The Mosquito evaded by turning in towards the attack and continued to circle round for about ten minutes at 50 ft. During this time the F.W. made three further attacks from port, starboard and port quarters respectively, and was evaded each time by the Mosquito turning in towards the attack.

At 1240 hours, when the raid was due to end, this Mosquito was still some 25 miles from the target, so the pilot decided to abandon his mission and set course for base. The enemy aircraft followed, but gave up the chase eight miles short of Flushing. The indicated airspeed of the Mosquito was then 330 m.p.h., and it soon reached the area patrolled by our fighters.

At that time (1245 hours) the single Mosquito detailed to carry out a photo-reconnaissance of the target after the raid was approaching Eindhoven from the north-west. Flying just below cloud at 2,000 ft. two Me.109s were sighted astern, slightly above, and closing in to about 800 yards. The Mosquito turned to starboard and made for patches of cloud at 1,000 ft. The enemy fighters followed and made three further attempts to close in, but were never able to obtain the correct deflection to open fire. After about 90 seconds the Mosquito succeeded in gaining fairly good cloud cover and the fighters were not seen again. Our aircraft continued to the target and returned with useful photographs of the burning ruins of the Radio Works (Fig. 2). Only one Mosquito was lost on the Eindhoven operation.

An Encounter during Submarine Patrol

The following narrative of a very successful daylight engagement between a single Halifax and three Ju.88s over the Bay of Biscay emphasises the point that, with systematic co-operation between gunners and pilot, combined with good shooting and evasive tactics, a bomber is a formidable opponent even when outnumbered.

While engaged on an anti-submarine patrol at mid-day on 9th December, Halifax "N" of 405 Squadron sighted three Ju.88s about 1,000 yards away to starboard, flying over a convoy. The Halifax was at 4,000 ft., visibility being generally misty below with cloud above.

The first attack came from the starboard quarter above our aircraft, the enemy opening fire at 600 yards. Evasive action was taken by turning into the attack and the rear gunner waited until the range had closed to 200 yards and then opened fire. He continued firing until the enemy aircraft broke away at 50 yards range on the port quarter below, and observed it dive vertically through low mist to the sea, black smoke pouring from the starboard engine. In the meantime the mid-upper gunner had been watching the other two Ju.88s.

The second attacked from the port quarter above and the mid-upper gunner fired a short burst. The enemy aircraft broke away directly above and then swung back to the port beam level with the Halifax. The Hun came in to attack for the second time but the mid-upper gunner opened fire again and the enemy broke away on the starboard beam.

He then gained height and manoeuvred for position. The next attack came from the starboard, bow above, and once more the mid-upper gunner opened fire at 600 yards range and continued firing as the Ju.88 passed overhead. Smoke was seen to be issuing from the enemy plane which kept going straight across to the starboard quarter losing height all the time. As it passed, our rear gunner fired a short burst at 100 yards range but the enemy was already spiralling down and was seen by both the mid-upper and rear gunners to crash into the sea. The crash seemed to be controlled ditching but was lost to view in the spray.

The third Ju.88, after seeing the fate of his two comrades, evidently thought discretion the better part of valour and did not risk an attack.

A Whitley on Air/Sea Rescue meets three Ju.88s and three FW.190s

The Wing Commander of No. 10 O.T.U. (Detachment) ran into rather more than the usual amount of enemy activity when engaged in air/sea rescue on the afternoon of 18th December. The detailed narrative and diagram of the engagements which followed should prove of interest and value to all operational crews.

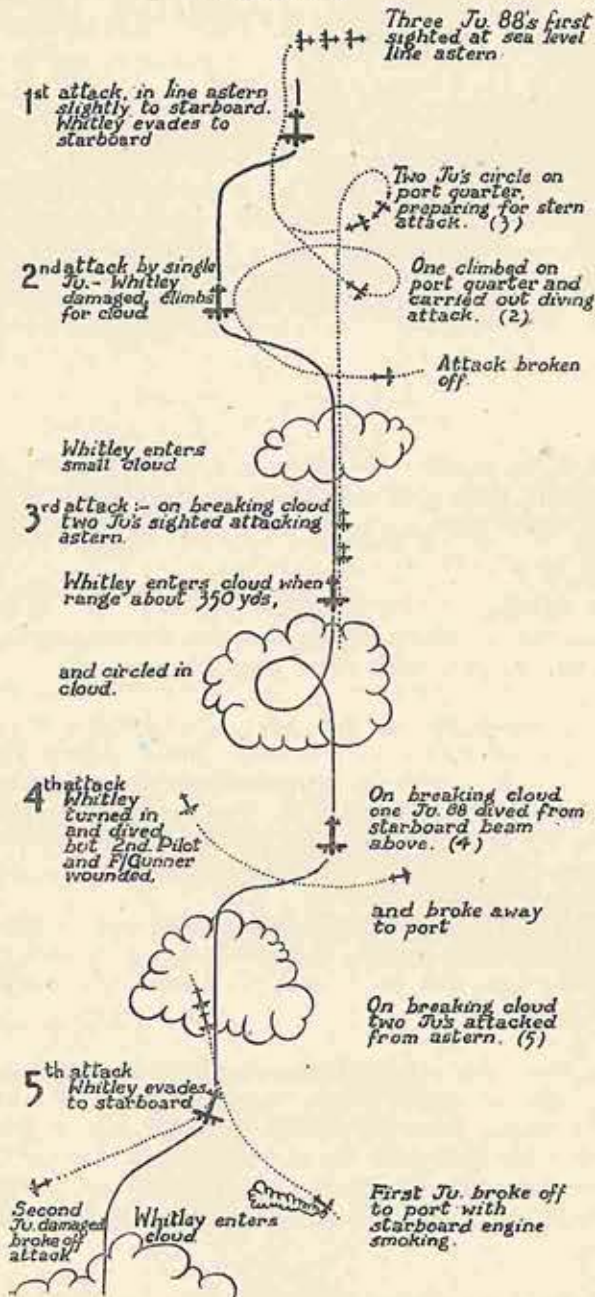
The First Encounter.—"E" of 10 O.T.U. completed its search at 1440 hours some ten hours after take-off and then, flying at 1,000 ft., set course for base. As it did so the rear gunner sighted three Ju.88s in line astern at sea level crossing the track of our aircraft 1,300 yards dead astern.

The Captain immediately started to climb for cloud-cover (there was 5/10 cumulus cloud at 2,000 to 2,500 ft., below which visibility was good), but the three enemy aircraft turned in to attack in line astern, slightly to starboard, opening fire with cannon and machine-guns from about 750 yards' range. Our Whitley took evasive action to starboard, diving and then climbing, and when the rear gunner opened fire at 400 yards the fighters broke off the attack to port at 300 yards. No hits were scored on the Whitley.

Then one of the fighters climbed, on the port quarter, while the remainder circled to make a stern attack. But before this developed the one which had climbed carried out a second attack from the port quarter above our aircraft and, opening fire at about 750 yards, scored hits on the tailplane, fuselage and port wing. Our rear gunner replied at 400 yards, and at 300 yards the enemy broke off the attack to port. The Whitley then entered a small patch of cloud and took evasive action to port.

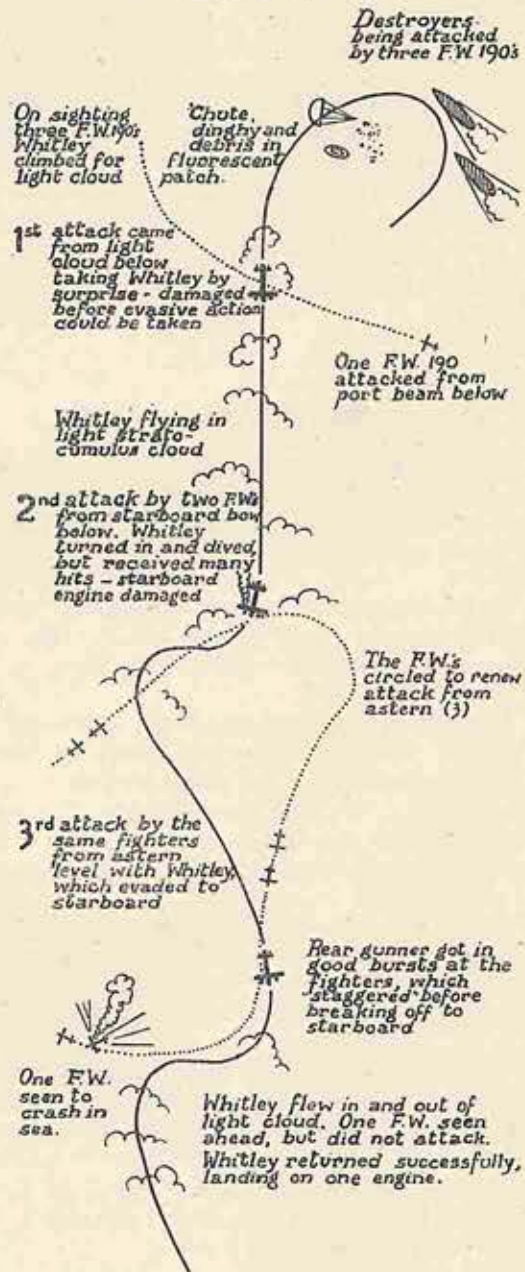
FIRST ENCOUNTER

1440 hours



SECOND ENCOUNTER

1550 hours



The other fighters then renewed their attack from astern and level with the Whitley. They opened fire from about 750 yards' range; our gunner returned fire from 400 yards and almost immediately the Whitley re-entered cloud and completed one turn in the limited cover thus provided.

As the Whitley broke cloud the single fighter was sighted 1,000 ft. above, on the starboard beam. This aircraft dived on the bomber, which turned in toward the direction of attack, diving to starboard. Nevertheless, the enemy scored a number of hits on the Whitley, wounding the second pilot and the front gunner. (During this attack the rear gunner was unable to bring his guns to bear, but he fired several bursts as the fighter broke away on the port quarter, slightly above; the front gunner fired 100 rounds.)

The bomber again entered light cloud but, on emerging from it, the pair of fighters were seen approaching from astern, slightly above. Both fired from about 750 yards, and our gunner again held his fire, until they came within 400 yards' range. The leading fighter broke off the attack at

300 yards to port and our navigator, who was in the astrodrome, saw smoke coming from the enemy's starboard engine. The second fighter broke off his attack to starboard at 250 yards, the rear gunner getting in several good bursts and reporting hits on the enemy. The Whitley evaded to starboard, and the fighters were at last shaken off.

The enemy planes were clearly identified by all members of the crew as Ju.88s, with their twin radial engines, green and black mottled camouflage, and black crosses on white markings. They fired cannon from the nose, and machine-guns from the wings using red trace. Ranges were generally so great that hits on the enemy could only be observed in the final attack. Both the fighters engaged in that attack are believed to have been damaged.

The Second Encounter.—An hour later (1545 hours) the damaged Whitley was flying at 5,000 ft. when the wake of a ship was observed ahead on the port bow. An explosion which was thought to be a bomb-burst was seen a couple of miles to the port side of the ship. Some minutes later the wake was seen to be that of two British destroyers proceeding on a southerly course. Simultaneously an orange dinghy was sighted in a patch of green fluorescence, and the captain lost height and approached the destroyers in an effort to divert them towards the dinghy. The Whitley flew close to the destroyer at 1,000 ft., identified itself, and flew back towards the dinghy about 5 miles away. The rear-gunner then reported three enemy aircraft attacking the destroyers with cannon fire from sea level. The captain climbed for cloud-cover above the dinghy. (There was 5/10 strato-cumulus at 2,500 ft., below which visibility was clear.) Débris and an open parachute were seen close by the dinghy which was now presumed to be from an aircraft shot down by the destroyers. The Whitley then set course for base, using cloud cover which was unfortunately very thin and patchy. The rear gunner reported three enemy aircraft at sea level in broken formation, passing astern and forward on the port beam, and told the crew to watch for them. As the Whitley entered a thin layer of cloud nobody else saw them. The enemy aircraft gave no indication of having seen the bomber and it was hoped that the daylight camouflage was effective against the thin cloud cover.

Thus the first attack came as a complete surprise. It took the form of a steep climbing attack from the port beam, cannon shells hitting the bomber. One enemy plane was seen breaking away astern and below our aircraft. As the attack was so sudden, coming out of light cloud underneath, no evasive action was taken and no shots were fired at the enemy.

The second attack repeated the same surprise tactics, two enemy planes making a climbing attack out of light cloud underneath on the starboard bow. Evasive action was taken in a diving turn to starboard, but many hits were scored on the Whitley: the starboard engine emitted heavy blue smoke, and the pipe-line to the rear turret was hit. The enemy planes, now seen to be FW.190s with long-range fuel tank underslung below the fuselage, broke away on the port quarter and circled to make a third attack.

They came in, in line astern, opening fire from about 650 yards with cannon and machine-guns. The rear gunner opened fire on the first aircraft at 400 yards continuing until, at 150 yards, it broke away to starboard below the bomber. Immediately the rear gunner turned his attention to the second FW.190, firing from 300 yards until this fighter in turn broke away at 150 yards, likewise to starboard and below. Both fighters came well within the gunner's sights and seemed to stagger as if undecided which way to turn before breaking-off their attack. One was seen to crash into the sea by both the captain and wireless operator. The second was certainly hit and is believed to have been seriously damaged.

The Whitley then flew in and out of light broken cloud taking evasive action. One fighter was seen following but it never attacked. Then the damaged starboard engine picked up at 1600 hours, and it was decided to attempt to reach base. Next, the W.T. receiver became unserviceable and at 1627 hours the starboard engine finally gave out, but height and speed were maintained. Contact was made with an escort of two Hurricanes and at 1710 hours the Whitley made a successful wheel-down landing at an airfield near its base.

FW.190s Evaded in Daylight over Holland

The Whitley's encounter with the Ju.88s showed the value of turning in towards the direction of the attacks while making for cloud cover. In the following narrative the same tactics evidently proved successful.

On 6th November the Squadron Commander of 49 Squadron took part in a small-scale daylight operation directed against Osnabrück in north-west Germany.

At 1250 hours the Lancaster was about 80 miles short of the target flying at a height of 7,000 ft. with 10/10 cloud some 2,000 ft. below. Two FW.190s were seen to break cloud tops about 2,000 yards away on the starboard quarter.

The fighters immediately climbed into the sun on the starboard beam, one of them breaking away rapidly to attack from the starboard quarter. The enemy opened fire from 600 yards but our rear gunner waited until the range closed to 300 yards, when he opened up and at the same time gave the pilot instructions to turn in and dive to starboard. He continued to fire until the enemy broke away to port. The mid-upper gunner also fired a short burst at the fighter.

Meanwhile the other FW.190 had kept its original course and was therefore in a position to attack from the port quarter. But before this attack could develop the Lancaster, still undamaged, gained thick cloud cover and the fighters were seen no more.

The rapidity with which the attack developed after the fighters broke cloud was emphasised by the pilot. He considered that to fly 2,000 ft. above cloud tops in daylight leaves insufficient time for gaining cover prior to the development of an attack.

A Wellington Destroys a Me.109 F over Germany

About an hour after the combat just described a Wellington of 425 Squadron was leaving Wilhelms-haven, the objective of another attack. After flying in cloud for some time the captain decided to come down in order to get a pinpoint on the enemy coast.

The Wellington broke cloud at 300 ft. and immediately the rear gunner reported three Me.109 Fs in "vic" formation a 1,000 yards dead astern. The range closed rapidly to 500 yards and the rear gunner opened fire at the centre aircraft which dived vertically down with smoke pouring from its engine. (Later in the engagement the pilot noticed thick black smoke in a spiral from this aircraft going down, apparently out of control, its destruction being confirmed by the wireless operator.)

The other two fighters at once broke formation and delivered simultaneous attacks from each quarter, level with the Wellington, firing from 400 yards. At 300 yards they broke away above, both having hit our aircraft although the pilot was corkscrewing vigorously before he managed to regain cloud cover. He then set course for base.

The Wellington had suffered considerably—a petrol tank was holed, the rear turret was put out of action, the wings and fuselage were hit by cannon shells, and the wireless operator was badly wounded. Nevertheless, he successfully extinguished a fire which had started below the astro-hatch.

As the inter-comm. had failed the pilot asked the navigator to find out if anyone else had been injured. On his back along the aircraft the navigator stepped into the emergency escape-hatch, unaware that it had been blown off by the fighters' cannon fire, and fell out up to his waist. The wounded wireless operator immediately grabbed him and managed to help him back into the aircraft. After these experiences the crew returned safely to their base, having bombed their target in daylight and destroyed a Me.109 F.

(b) Encounters with Night Fighters

A Pathfinder Hits Back

A Halifax II of 35 Squadron was hit by flak at 17,500 ft. over Duisburg on the night of 20th/21st December. The Halifax was actually on its bombing run when it was damaged and, as two engines and the mid-upper turret were put out of action, its nine 1,000-lb. bombs had to be jettisoned in the target area, and the captain set course for base.

The bomber lost height while trying to make the Dutch coast which it succeeded in crossing at Overflakke, at 6,000 ft. Some 10 miles west of that island, with bright moonlight on the port quarter, the Halifax crew sighted a Ju.88 approaching rapidly on the port beam. The fighter closed in and our rear gunner gave him a burst at about 80 yards' range. Fire was returned but no hits were scored on the Halifax, as evasive action was taken on the rear gunner's instructions by turning in towards the attack. The fighter passed beneath the Halifax and climbed up on the starboard quarter.

The fighter then came right round the bomber from starboard quarter to port bow and delivered a second attack. Again the Halifax turned in towards the attack and no fire was experienced from the enemy.

The rear gunner next saw the Ju.88 climbing on the port quarter; it turned at about 300 yards range and dived on the Halifax without firing. At about 150 yards the rear gunner gave it a two-second burst and observed hits on the enemy aircraft. Both mid-upper gunner and flight-engineer confirmed hits between the nose and port engine of the fighter which then fell away below and was probably destroyed.

The Halifax suffered no damage from the fighter and, although weaving and turning on two engines, only lost 300 ft. during the combat. The captain continued on course and made a good landing on an airfield near the Suffolk coast.

Two Ju.88s in Flames

In clear visibility on the moonless night of 6/7th December, Halifax "N" of 102 Squadron approached Mannheim at 15,000 ft. above 10/10 cloud.

Just as the Halifax was turning to port to run up to the target a single enemy aircraft approached from astern, slightly above, and attacked immediately. The first indication of the attack was bright red tracer seen by the captain, who closed the throttles and the enemy, now seen to be a Ju.88, overshot above the bomber. The enemy immediately afterwards passed in front of the Halifax from starboard to port and, at a distance of 150 yards, the enemy's rear-gunner fired a short burst from machine-guns which passed ahead of the bomber.

The Halifax rear-gunner then reported two more Ju.88s flying in close formation at 800 yards astern, but immediately the first Ju.88 came in again from astern and slightly above, opening fire at 600 yards. Although evasive action was taken the Halifax received slight damage to the fuselage and rear turret, and the rear gunner was slightly injured in the left hand. Both rear and mid-upper gunners opened fire at 300 yards and the fighter broke off the attack to port below the bomber.

The Ju.88 then came in again from the starboard quarter, slightly above, opening fire at 600 yards, but shooting wide owing to the evasive action taken by the Halifax. Our rear gunner opened fire at 300 yards and gave him a five-second burst. The enemy's port engine blew up, the port wing burst into flames and then broke off, and the aircraft was last seen diving in flames.

A few seconds later, while the Halifax was in a tight turn to port observing the destruction of the first opponent, the two Ju.88s in close formation approached from the port beam, slightly above. One broke away to attack from astern, the other carrying on the attack from the port beam. The Halifax evaded by a steep diving turn to port while the mid-upper gunner opened fire at 300 yards with a five-second burst. As the enemy passed to starboard his starboard wing and engine were seen to be in flames. The Halifax was diving steeply when the fighter came in again on the port quarter with its wing still aflame. Our rear gunner gave it two long bursts, the port wing burst into flames and then, in a mass of flames, the fighter fell away out of control. Several members of the crew saw it hit the ground.

Meanwhile the third Ju.88, which had still not come into attack, was again sighted some 800 yards astern. The bomber took evasive action, losing height, and the enemy was not sighted again. The Halifax returned safely to its base, having certainly destroyed two Ju.88s and evaded a third, with only slight damage to itself and no serious injury to the crew.

A Stirling encounters three Italian Night Fighters

Stirling "B" of 7 Squadron was between Genoa and Spezia on 23rd/24th October, at 2116 hours. The aircraft was heading north-west with the moon astern and slightly to port and visibility was good above unbroken cloud below.

Owing to the fracture of an articulating pipe, which had occurred earlier in the trip, the rear turret hydraulic system was out of order and in the attacks which followed the gunner was only able to operate one gun manually.

The first fighter, a Breda 88, was sighted at a thousand yards, about 500 ft. above the Stirling on the starboard beam. The Breda at once made a diving attack, firing at about 800 yards with machine-guns and cannon. While turning in towards the attack our aircraft was slightly damaged in tail plane and mid-fuselage, but the fighter continued its dive and disappeared before the Stirling was in a position to open fire.

Directly afterwards a Macchi 200 was sighted dead astern and some 3,000 ft. above our aircraft. This fighter made four diving attacks from slightly to starboard, breaking off to port level with the Stirling, then climbing to the original height for the next attack. On each occasion the enemy fired with two machine-guns at about 800 yards range, but our aircraft skidded to port as soon as the fighter dived so that all his fire passed to starboard. Both rear and mid-upper gunners replied with short bursts, and strikes by incendiary bullets were observed during the last attack, when the enemy immediately broke off the combat and disappeared.

The third and last fighter, a bi-plane subsequently identified as a C.R.42, then came in from the port quarter and opened fire at about 800 yards. The Stirling turned to port and both rear and mid-upper gunners immediately replied with several good bursts, and both gunners observed strikes on the enemy, which then broke away and was seen no more.

Despite the initial handicap of the inoperative rear turret system our aircraft sustained no injuries apart from the slight damage caused by the Breda, and before shaking off its three opponents had succeeded in damaging two of them.

An Unprofitable Decoy

Lancaster "N" of 103 Squadron was returning from Frankfurt on the night of 2nd/3rd December. At 0500 hours at 9,000 ft., visibility was good apart from some ground haze, when a Ju.88 with lights flashing in the wings was sighted on the starboard quarter. It was at about 400 yards range and slightly above the bomber. Another Ju.88, without lights, was then sighted on the port quarter slightly below and at about 500 yards range.

The "decoy" aircraft closed to 300 yards, when the rear gunner directed the captain to do a climbing turn to starboard, thus placing the decoy between the Lancaster and the second fighter. When the range closed to less than 100 yards the rear gunner fired 400 rounds into the decoy fighter, and a further 150 rounds as it passed under the tail of the bomber. The mid-upper gunner got in a burst of 200 rounds. The lights went out and the fighter burst into flames, going down into a dive towards the port side. This Ju.88 was claimed as destroyed and the unscathed Lancaster successfully shook off the second.

(c) Bombers versus U-Boats

The considerable part played by our bombers in the war at sea is outlined in Part I (e) above. There a short account is given of the work of Bomber Command squadrons and units loaned to Coastal Command during the second half of 1942 for the purpose of harrying enemy submarines in the Bay of Biscay. A/S patrols are long and arduous, but not always uneventful as the following incidents show.

Our first "Kill" at Sea (see Figs. 21-22)

A Coastal Command Whitley inflicted serious damage on a U-Boat in the Bay of Biscay on 17th July. It might have got away but for one of our Lancasters which successfully finished it off two hours later. This Lancaster, "F" of 61 Squadron, was flying at 1,500 ft. when the crew sighted an oil-patch several hundred yards long, six to eight miles away. The pilot altered

course to investigate, and at 1422 hours a track was sighted some four miles off, about half a mile from the oil-patch. A moment later the conning-tower of a U-Boat was seen, moving very slowly. The pilot immediately climbed into cloud, altering course to get on to the U-Boat's starboard beam. The Lancaster broke cloud at 2,000 ft. a little later, and found the U-Boat one mile away on its port beam. The pilot dived to attack, circling to port, but as the U-Boat was altering course to port he extended his own track forward. The final run up was made at an angle of 45° to the U-Boat's course from its starboard bow, and ten 250-lb. depth-charges were released from 100 ft. (set to 25 ft. spaced to 35 ft.) while the U-Boat was on the surface.

The stick straddled the U-Boat halfway between the bows and the conning-tower. When the foam and spray which completely hid the U-Boat had settled it had stopped, so the Lancaster climbed to 800 ft., and approached to make a bombing attack. The U-Boat's gun opened fire and tracer passed fairly close to the aircraft, whose front-gunner immediately replied, hitting some of the U-Boat's gun crew. At 1430 hours two 250-lb. A/S bombs were released from 800 ft., and they appeared to fall very near the starboard side of the conning-tower. The pilot circled and attacked again but the two remaining bombs hung up. All three gunners fired heavily at the U-Boat which did not reply. The U-Boat was now very low in the water, and members of the crew jumped or fell overboard. The Lancaster circled again and made a further attack with the two bombs, which overshot by about 20 yards. At 1444 hours the crew abandoned ship; a minute later the bow lifted slightly and the U-Boat foundered stern first.

F/61 had been attached to Coastal for less than a week, and its crew were entirely new to anti-submarine warfare. Their T.N.T. depth-charges could not be lethal to a U-Boat on the surface, and a close miss by an A/S bomb is also not lethal in itself. But the first two attacks by F/61 on a U-Boat already seriously disabled undoubtedly completed the collapse of the strained pressure hull. This was the first enemy submarine certainly destroyed at sea by an aircraft of Bomber Command.

A Halifax straddles a U-Boat and defies the Flak

On the morning of 27th November a Halifax of 405 Squadron was patrolling off the Basque coast of Northern Spain when a U-Boat was sighted in the wake of two escort vessels. The U-Boat, which was of the 500-ton type, was travelling at ten knots.

As our aircraft altered course to attack down sun from the U-Boat's starboard beam, the escort vessels fell back on the U-Boat's quarter and opened up with intense flak. The Halifax came in at right angles to the track and released six torpex depth-charges from 200 ft. while the submarine was fully surfaced. Immediately before release the U-Boat turned away and the stick fell towards its stern. It was impossible to observe results as the escorts were putting up an intense barrage of flak.

The Halifax turned and made a second attack from the port side, releasing three depth-charges from a height of 50 ft. The U-Boat was still fully surfaced and this stick was seen to fall across the conning-tower: the first depth-charge fell a few feet short, the second was on or below the conning-tower. The fall of the third was not observed and the U-Boat was lost to sight in swirl and explosions.

Meanwhile the bomber was evading the flak from the escorts, which were now very close. The trailing aerial was shot away before cloud-cover was gained, but none of the crew was injured. They returned later to make reconnaissance but were unable to locate the enemy vessels.

Six hours after this incident a Liberator sighted and attacked a fully-surfaced U-Boat of the same type near a destroyer and three U-Boat tenders which were heading out from Hendaye Bay. It is believed that this was the same U-Boat which had put back towards Hendaye on account of the injuries undoubtedly inflicted by the Halifax's second and very determined attack.

Good Work by O.T.U. Crews

On 10th September, Whitley "N" of No. 10 O.T.U. patrolling the Bay of Biscay at 1,500 ft., sighted a U-Boat at a distance of 1½ miles. It was making 10 knots. The aircraft dived steeply to attack from the starboard quarter and released four 250-lb. depth-charges from 30 ft. while part of the conning-tower was still visible. They dropped in a salvo, exploding 12-15 ft. ahead of the swirl, and as spray subsided, 10-12 ft. of the bow came out of the water at a very steep angle; this appeared to hang for a moment and then gradually sank, still at a steep angle, and finally disappeared quickly. A stream of air bubbles lasted for two to three minutes. The depth-charges probably exploded close under the bottom of the U-Boat and blew the bows upwards, but as no photographs are available, a claim to a kill cannot be proved. This was a very good unorthodox attack.

* * *

Another Whitley of No. 10 O.T.U. was carrying out baiting procedure after an attack on a 500-ton U-Boat in the Bay on 2nd October when it sighted a second U-Boat, this time a 740-tonner. The bomber altered course to take advantage of the sun, 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 one of the crew who was manning the U-Boat's gun so that he fell into the sea. The enemy did not open fire but dived slowly, leaving a second gunner to drown.

* * *

At midday on 29th September another aircraft of the same unit was patrolling the Bay of Biscay when the wake of a homeward-bound U-Boat was sighted 10 miles on the port beam.

The Whitley immediately turned to port, diving from 2,500 to 2,000 ft. to gain speed, and then turned to starboard to get into position astern of its target. Although the aircraft was approaching up sun, the U-Boat apparently failed to observe it and only became totally submerged less than five seconds before the attack. This was made from 50 ft. with four depth-charges, three of which were right for line and depth.

A large part of the U-Boat reappeared at a very steep angle about 20-30 seconds after the explosions and about 100 yards away from the surface marks. An object seen a little distance from the bows was possibly the top of the conning-tower breaking surface. The bows themselves remained above the water for nearly a minute and were fired on by the Whitley's rear gunner before disappearing again almost vertically leaving a considerable patch of froth. Baiting procedure for 2½ hours gave no results. It is believed that this U-Boat was destroyed.

An Italian Submarine Damaged

At 1140 hours on 2nd September Wellington A/304 came across an Italian submarine travelling at 8 knots, in the Bay. An attack was made up track, and four out of the six depth-charges fell alongside the submarine, which was completely obliterated by the spray. On the run up, the aircraft machine-gunned the U-Boat and several of the crew collapsed on the deck. The submarine did not reply, except by firing two five-star red cartridges. Immediately after the explosions an oil-patch 400 ft. across appeared, and the submarine soon lost way and came to a standstill. The aircraft circled again and made two bomb attacks, releasing one 250-lb. A/S bomb on each occasion but missed by 10 and 20 yards respectively. The Wellington circled again and made five machine-gun attacks, expending 2,500 rounds. As a result ten men in bathing costumes dived off the submarine, and three or four more collapsed on the deck and fell into the sea. The submarine now had a heavy list to port and was well down at the bows; part of the starboard forward hydroplane showed. When the aircraft had to return to base at 1230 hours the submarine was still stopped and down by the bows, and the oil-patch had grown to about 500 yards across. This attack evidently inflicted severe internal damage on the submarine and temporarily crippled it. Photographs reveal that the fore hydroplanes were turned out and presumably jammed in a "hard to rise" position. Subsequent information shows that this submarine was the *Giuliana*, which arrived in the Spanish port of Santander in a damaged condition the next day (See Figs. 23-24).

* * *

Several further attacks have been made on U-Boats with promising results. For instance there was the case of a Wellington crew of 311 Squadron which sighted a submarine from 15 to 20 miles away: the U-Boat dived at once but the Wellington dropped a sea-marker and went away up-sun. When it returned the U-Boat had resurfaced and six depth-charges were released while the stern and conning-tower were still above water. Three D.C.s straddled the target which was then enveloped in spray. The pilot did a tight turn to port and was back over the site of attack within 30 seconds. Foam was seen rising some feet above the surface at the leading edge of the explosion mark, another smoke float was dropped and the aircraft circled for 20 minutes. Ten minutes after the attack a series of large gouts of oil some three yards in diameter rose to the surface forming a circular patch. When the Wellington was obliged to set course for base this oil-patch had attained a diameter of 60 yards, while air bubbles continued to rise intermittently. This very creditable attack certainly caused serious and perhaps fatal damage to the submarine, while the same may be said of another attack by this squadron later in the same month. At the moment of sighting the enemy, this Wellington was over three tunny-fishing craft one of which turned towards the U-Boat immediately after the first attack. The U-Boat made no attempt to submerge and instead opened fire from twin guns as the depth-charges were released across it. Fire was returned, some of the enemy crew being hit, and the U-Boat remained almost stationary with a slight list. A second accurate depth-charge attack, made from a height of only 10 ft., caused the target to list heavily to starboard and a few seconds later it went under without any forward motion. Yet another Wellington, this time of 304 Squadron, caused certain damage to a U-Boat. Although the latter was able to submerge 20 seconds before the attack was delivered the centre of the stick of six D.C.s exploded 50 yards dead ahead of the swirl. The third and fourth D.C.s should thus have been right on the U-Boat's tail and set at the correct depth. An oil patch was seen between the explosion marks and air-bubbles three feet across were still rising ten minutes later when the aircraft had to set course for base.

Our aircraft have also helped to break up "wolf packs" massing to prevent the passage of allied convoys, as on 15th June last when a Lancaster of 44 Squadron opened the counter-attack. The stick of D.C.s should have exploded just abaft the conning-tower of the first U-Boat within five seconds of its submergence, and three extensive oil patches appeared on the surface at intervals until a column of water shot up some 30 ft. and the conning-tower momentarily reappeared. Nothing further was seen although the Lancaster circled the area for nearly an hour.

It is particularly interesting to see how well the O.T.U. crews have acquitted themselves on these long-range daylight operations which entail careful engine-control and good navigation often in very poor weather over miles of featureless ocean. Vigilant scanning is called for throughout each ten-hour patrol and prompt co-operation between all members of the crew as soon as a target has been sighted. Our crews have also stood up well to the attentions of the Luftwaffe in daylight, within reach of its shore bases and, although 10 O.T.U. flew nearly 500 sorties during the quarter October-December, involving 4,542 operational hours, only nine aircraft were missing.

IV. MISCELLANEOUS OPERATIONAL ITEMS

(a) Homing after Night Attacks

The Problem

No one is likely to underestimate the difficulty of locating targets under black-out conditions or of bombing them in the face of intense flak and night fighter defences when they have been located. It is natural that those aspects of the bomber offensive should occupy the first place. There remains, however, the business, less spectacular but hardly less important, of returning the aircraft successfully to their own bases, or of directing them to others if these have been rendered unserviceable by weather conditions. This would be difficult enough to manage with large numbers of aircraft over a short period under any conditions. It is made immensely more so when pilots and crews are already tired out by a long flight over hostile territory and frequently have not enough fuel left to enable them to remain in the air for a further long spell. To meet this situation development along two lines has taken place. There have been great advances both in the instruments designed to assist navigation and in the ground staff devoted to organise diversions and landings of all types of aircraft. The common purpose of both lines of development is to make the whole process as nearly as possible automatic for the pilot and navigator. This process, in fact, was already under way well before the outbreak of war, but the expansion and development of it under war conditions is little appreciated considering the difference which it has brought about in the chances of a safe and speedy landing.

Expansion and Development of Flying Control

A system of regional control to provide navigational assistance to aircraft in difficulties was initiated in 1937. Restricted means of all kinds then made it out of the question to provide staff for this duty at all R.A.F. aerodromes. Seven stations were therefore selected for the purpose. Their geographical position was chosen to ensure that aircraft flying over any part of the country would be within W/T range of one of them. The idea was that no occasion would arise in which an aircraft could not be safely landed at one of these stations. This scheme at once justified itself and a 24-hour watch at each station was soon a necessity.

To make diversions possible, constant records of weather at all stations were maintained throughout the chain and each station maintained its own D/F station. Aircraft in need of help could obtain it by changing to this frequency.

This simple system was enough to deal with the small number of aircraft operating under peace conditions. On the outbreak of war, however, the need to expand and develop it was at once apparent. Additional stations of the existing type (Type "I") were urgently required and others on a smaller scale (Type "II") at every aerodrome were clearly needed as soon as personnel could be found to man them.

Thus the crying need was for a large increase in the number of Regional Control Officers. Ex-flying personnel were naturally most suited for the purpose, but the supply of these fell short of requirements and it was inevitable that candidates should be accepted, provided they were temperamentally suited to the job, wherever they could be found.

The build-up of the Type "II" stations was gradually completed. Bomber and Coastal Commands were first, then Fighter Command, commencing with night fighter control but rapidly expanding to 24-hour control; then, finally, Army Co-operation and Flying Training Commands were successfully equipped. To meet this expansion of control activities, a complete organisation had to be evolved to supersede the rudimentary peace-time system. Flying control, in fact, became inevitably a fundamental part of the whole R.A.F. organisation, without which the sending out and bringing home of large and increasing numbers of aircraft by night would have been operationally impossible.

The provision of suitable personnel to cope with this increase in scope and responsibility was no easy matter. Two training centres were in turn abandoned as offering insufficient accommodation, and at length the Flying Control School has settled down at Bridgnorth.

The tempo of expansion has indeed been remarkable. Some idea of it can be gained from the fact that in January, 1942, there were in all 132 Control Officers. In November, 1942, there are 433 in Bomber Command alone.

Integration has naturally been called for to deal with this rapid growth of officers and stations. At the beginning of 1941, Regional Control became Flying Control, and at about the same time it became clear that some form of centralised control at Group Headquarters was an essential to co-ordinate activities of station officers and control diversions and other contingencies within individual groups. In addition, the Central Flying Control organisation was created and placed in the Operations Room at Bomber Command Headquarters. This in itself indicates the vital operational importance which the control possesses. The contribution which it has made to the operational success of great undertakings like the "1,000 raids" is impossible to assess statistically, since the feat of landing forces on this scale in safety at their bases requires the co-operative effort of most the Home Commands of the Air Force, and the contribution of various branches to its success is incapable of analysis, even if this were desirable. The part which Flying Control has played, however, is undoubtedly very large and the efficiency of it as a system is confirmed by the extent to which it is now called upon to function in areas other than the British Isles. Middle East, Canada, Gibraltar and Iceland have now their Flying Control Stations, while the Transatlantic Air Ferry is controlled from Prestwick.

Development of Radio Aids

This expansion and organisation of Central Flying Control would have been impossible without a correspondingly rapid development of radio aids and R.D.F. technique. In 1939 it was more or less taken for granted that in time of war aircraft would be forced to maintain wireless silence except in emergency, and in the absence of air-to-ground communication, no satisfactory signalling technique for the diversion and landing of aircraft as a matter of routine appeared practicable. The standard G.P. set (T.1082 R.1083) was the only apparatus available in the aircraft. Pilots could obtain weather reports, homing bearings and instructions on course to be steered. Controlled descent through cloud, and V.H.F. Beam Approach were also available, though to make contact with the Control Station it was necessary for the aircraft to change to the appropriate frequency.

The general policy which has governed the adoption of successive radio aids has been to restrict to the minimum the amount of air-to-ground signalling required and at the same time to give every possible assistance to homing aircraft.

The first major development was the improvement and extension of the existing civil M/F D/F safety organisation. A chain of stations covering the eastern and southern approaches to the country was established. These stations, by greatly improving the facilities for identification and emergency navigational assistance, made the extension of ground control already described technically practicable.

Next came the development of R.D.F. Primarily, this was a matter which concerned Fighter Command, but the rapid expansion of ground-to-air control of aircraft had far wider applications. Essentially, it made such control a practical possibility without the necessity for transmission from the aircraft itself.

Parallel with this development, however, has gone the improvement of the apparatus carried by the aircraft, and the introduction of the Marconi T.1154 R.1155 G.P. set has vastly improved communication in this direction.

The latest improvements in signals technique have enormously increased the effectiveness and in particular the range at which assistance can be given. Another radio device now in use will bring an aircraft into the area of its base with a high degree of accuracy; radio beacons enable it to be navigated by D/F loop bearings taken on known points and transmitting continually for this purpose; Coastal Track Guides (Jay Beams) may be used either as "Tram Lines" or as position lines for navigation purposes. None of these methods require any signalling from the aircraft and all may be used by an unlimited number of aircraft at the same time.

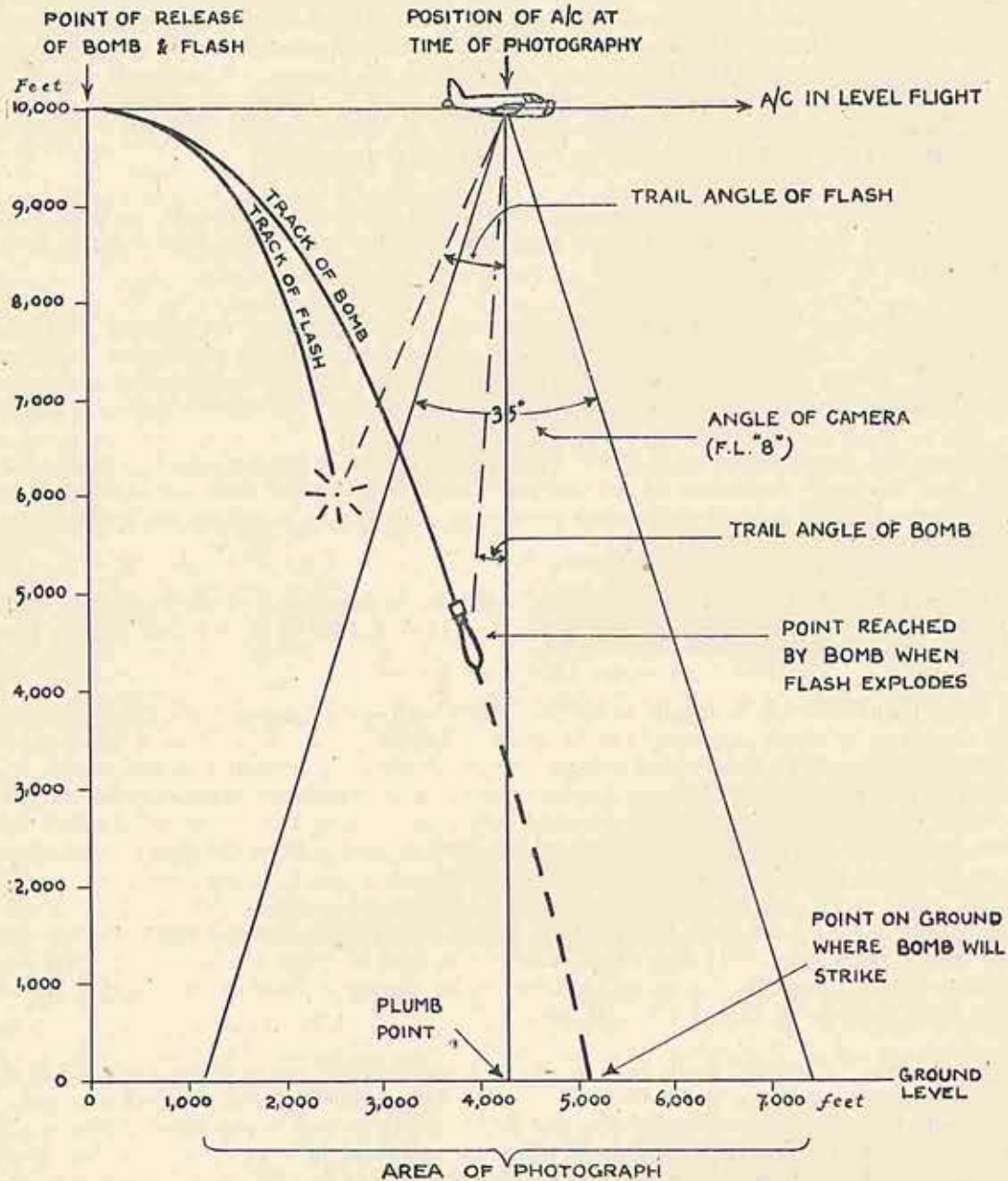
More specific assistance is given by H/F D/F, which will bring an aircraft right over the required aerodrome from a distance of 100 miles. This, however, is more restricted in its scope in that considerable signalling from the aircraft is required to make its use effective. Further, no one H/F D/F station can handle more than about 12 aircraft in an hour.

Finally, there is "Darky." Early in 1941, an R/T organisation was instituted using T/R 9 radio sets and with a listening watch maintained at Bomber Command Regional Control Stations. This, which has been extended to cover beacon sites and R.O.C. posts, as well as practically every serviceable aerodrome, now enables a distressed aircraft using its standard R/T equipment as an emergency navigational aid to find where it is simply by asking for its position, whereas in earlier days it could discover its whereabouts only by laborious means, such as circling country railway stations in order to find their names. This roundabout method would in any case be defeated by the cloak of anonymity which our railways and villages have had imposed upon them.

(b) Night Photography—Its Operational Importance

Night photography on operations has grown from small beginnings in 1940. Up to the end of that year few aircraft carried night cameras, while a total of only 150 operationally successful photographs was achieved in the first six months. Since then the scale of night photography has increased out of all proportion until at present it is the rule for each aircraft to carry a camera, and photographic results now obtained in one night often exceed those of the first half-year. The quantity of material available for interpretation is sufficient on some occasions to enable a reasonably complete analysis to be made of individual large-scale operations. Indeed, night photography has contributed no small part of the knowledge available about the progress of our bomber offensive, permitting comparisons of the success of different tactics and methods of attack. Thus a night photograph taken with bombing, that can be plotted on a map, gives the crew taking the photograph positive evidence (and it is the only positive evidence) of where their bombs were dropped. If this proves not to be the intended target, then all relevant factors can be checked and the necessary corrections in procedure made the next time. Night photography is thus playing a most important part in getting more bombs on to the target. No doubt the development of a competitive spirit between squadrons, as reflected in the interest shown in the "squadron raid assessment table," has also played a part in the general improvement in the success achieved in night operations during the past 12 months.

In order to appreciate the value of the information night photography has provided, it is necessary to understand something of the conditions under which the information is recorded, *i.e.*, the operation of the camera, as well as the methods of interpretation employed.



Night photographs are taken by means of an intensely powerful flashlight, which is fused to explode at 0.6 of the aircraft's height as shown in the above diagram. The camera cycle is so synchronised with the fuse-time that the shutter is open for a short period designed to include the moment of explosion.

Two types of photographic image may be present on the film :—

- (i) Images formed by the light of the photo-flash *reflected* from land or water, from haze, smoke or cloud. Light from flares, the flame of a heavy bomb, or the muzzle-flash of a gun may also be reflected in a similar way.
- (ii) Images formed by *direct* light, whether from fires burning on the ground, from flares, flak or searchlights, and sometimes from the photo-flash itself.

The evidence provided by an open plate camera such as is in use in Bomber Command, is essentially a continuous record like a navigator's log. Just as a navigator may use his instruments to obtain a "fix," so from time to time a flash of light by illuminating ground detail may register position on the film. Some pages of the photographic log may be full of symbols crossing and recrossing, recording visible lights that have passed within the field of view, while others may be almost blank.

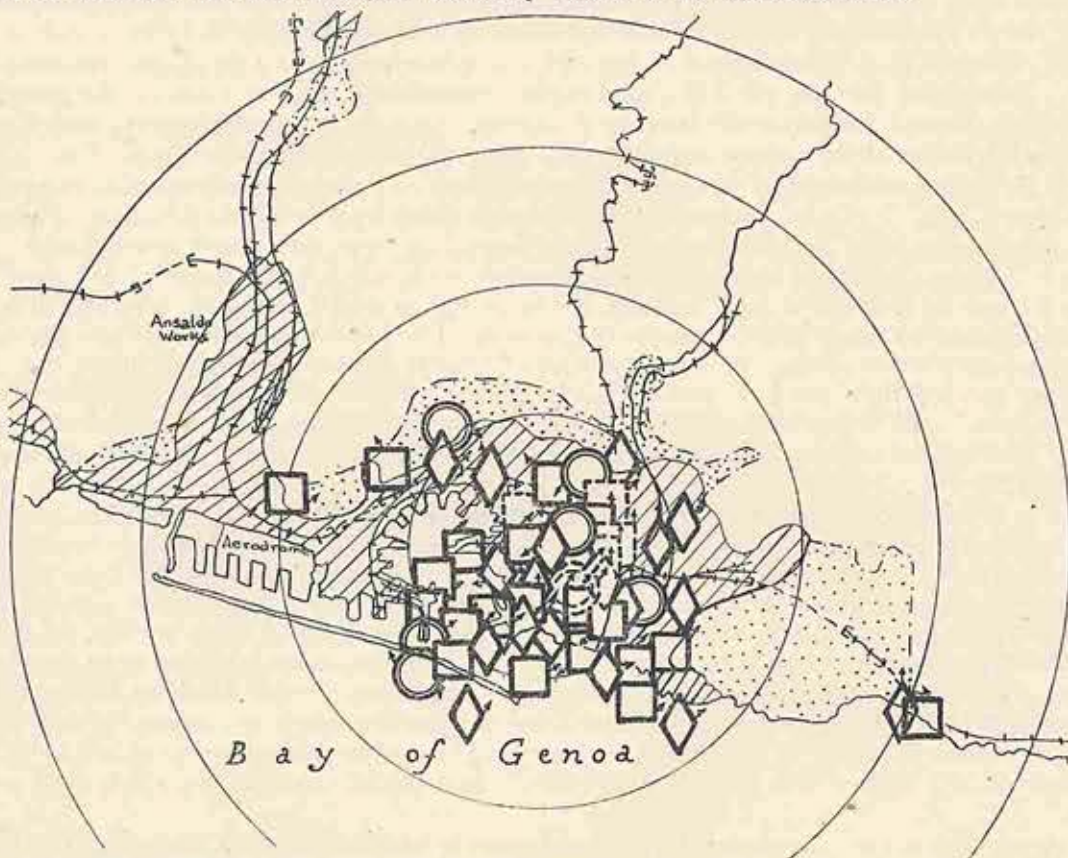
The films are examined first at stations to learn whether ground detail has been recorded, and later at Group Headquarters and the Command Photographic Interpretation Section for immediate plotting purposes, while more detailed analysis is undertaken at the Central Interpretation Unit.

Photographic Images formed by Reflected Light

These present essentially the same problems for interpretation as daylight photographs and they provide the important information of where an aircraft was at a known time. This is obtained by plotting or identifying the position of the ground features recorded on the film, which is generally done by comparison with a photographic mosaic of the region in which the film was exposed. The presence of light-tracks fogging the print, of cloud, haze or smoke, may make this no easy matter—though with experience a very small amount of ground detail may prove sufficient to plot a print. The primary object is to obtain a photograph at the time of bombing, and a plot of such photographs indicating where individual aircraft have bombed provides a first approximation to the distribution of attack around a target. The larger the size of the sample that is plotted (and it is on the average over 35 per cent.) the more valuable is the first approximation.

Recent modifications have been designed to make the camera operation entirely automatic with bombing. The bomb-aimer has ordinarily only to carry out normal bombing procedure and the camera and flash will be operated as the bomb-firing switch is pressed. Providing the aircraft is level, both laterally and fore and aft, the resulting photograph, which may embrace 2 square miles of country, will include the area on which the bombs will fall. Allowance for tilt, judged approximately from the distortion in scale of ground detail, or from the shape of fire-tracks, can be made in plotting the positions of aircraft, but the majority of successful photographs are in fact taken under conditions of not more than slight tilt. A photograph showing more than 20° – 25° of tilt is very unusual.

With the great increase in the proportion of aircraft returning successful photographs, especially since the early part of last year, particular care has been taken in the preparation and study of accurate plots of the results. Indeed, it is not too much to say that only since the development of night photography has it been possible to measure with any degree of certainty the extent to which our attacks reach the targets they were intended to damage. While it had long been realised that target location was extremely difficult on nights of indifferent weather, we now know from analysis of photographic plots to what extent our attacks may be frustrated by the presence of haze and cloud. Even the absence of moonlight alone may be sufficient to prevent the visual identification of a big industrial city, since the human eye is a far from perfect instrument for night vision. These analyses revealed for the first time the magnitude of the tasks confronting our crews. While they proved that excellent results can be obtained under favourable conditions of weather and illumination, they also proved that the old navigational methods were not enough if Germany was to be hit hard and often.



Plot of Night Photographs taken with bombing during a concentrated attack under favourable weather conditions (Genoa, 15/16 Nov., 1942). The scale is indicated by circles drawn at one-mile intervals around the aiming point.

Photographs by aircraft of the Pathfinder Force are shown by double circles, squares and diamonds represent those of No. 4 and No. 5 Groups respectively. Symbols with broken outline indicate photographs plotted by fire-tracks. Small arrows show aircraft heading.

The new bombing tactics and the best use of the radio-aids introduced during 1942 were studied and developed in the light of the vital evidence provided by night photographs. Photographic plots have given information of great operational importance on such matters as any tendency to bomb short in the direction of approach to a target; the effectiveness of decoys—whether artificial lighted systems or the exploitation by the enemy of natural features; and especially the tendency for a concentration of bombing to build up where incendiaries are already burning. This has resulted sometimes in the growth of self-created diversions when a number of crews have attacked fires started by one or

two aircraft which went astray ; or the building up of a great weight of attack off-centre in one sector of a target area where early incidents occurred, instead of achieving an even distribution around the aiming point. These instances serve to emphasise the great responsibility which rests with bomb aimers and the necessity of particularly careful training in all aspects of the problem of target location. By revealing the possible pitfalls, and by proving success in known conditions, night photographs have played a valuable part in the great all-round increase in the proportion of bombs which actually reached their intended targets in 1942.

Apart from negatives exposed with bombing, useful information may also be provided by photographs of ground detail taken by an aircraft at some other stage in its flight. Such information is helpful, for instance, in the analysis of navigators' logs, especially in investigations of routing problems, the best approach to a particular target and so forth. Indeed, with a low-lying target likely to be obscured by mist or smoke which it is planned to approach by a D.R. run from some easily identifiable landmark, it is possible that photography of the last turning point, at the beginning of the run-up, might yield more useful results than an attempt to photograph the target itself.

The interpretation of the ground features recorded on night photographs (as distinct from the process of plotting) is similar to the interpretation of daylight prints—except that night photographs will seldom compare in sharpness of detail or quality of illumination. Nevertheless, they are sometimes of reconnaissance value in indicating enemy activity, whether by revealing a new flak battery, search-light position, decoy or smoke-screen, or by providing information about the movements of shipping.

Photographic Images formed by Direct Light

These have presented many problems of interpretation, the solution of which calls for considerable experience. With an open-plate camera, such as the simplified night camera, a brief flash of light within the field of view will produce a point image on the film ; but a continuous light which traverses the field of view as the aircraft moves forward will cause a track across the film from the leading to the trailing edge. These "light-tracks" depend for their shape and pattern principally on the nature and movement of the source of light, the movement of the aircraft, and the duration of the exposure. This type of photographic image may occur together with images of the first type (by reflected light) so that in certain conditions it is possible to tell not only where an aircraft was at a given time but also what sources of light were then within the camera's field of view. It often happens, however, that images produced by direct light occur unassociated with any ground detail ; in which case the location of the source may be more difficult or even impossible. But it cannot be too strongly emphasised that both classes of photograph may contain information of much operational value.

Sources of light may be *instantaneous*, for example a bomb-flash or a gun-flash ; *transitory*, such as a tracer ; *intermittent*, for example a flashing beacon ; or *enduring*, such as a fire on the ground or a flare above it. Except for tracer all these light sources will normally be stationary, and if several are in the field of view of the camera together, they will produce parallel tracks on the film.

The F.24 night camera yields exposures of several kinds : "momentary," in which the exposure time is usually half-second or less, 8-second exposures and exposures of indefinite duration. The present cycle of camera operations involves five negative frames : (a) in position, an "intermediate" frame of indefinite exposure, is wound away and a second frame (b) is exposed momentarily, and then wound on, leaving frame (c) in position for 8 seconds, in the middle of which period the photo-flash is timed to explode, lighting up the ground for a tenth of a second. Two further operations of the camera motor follow—frame (c) is wound away, the next frame (d) is a momentary exposure, and frame (e) is wound into position and left there until the camera is operated again from the bomb-firing-switch when the sequence of frames will be repeated. This further operation ensures that frame (e), which may contain a valuable photograph taken by the flash from a heavy bomb, is not fogged, but preserved in safety in the magazine.

It will be seen that there are three frames linked together with the bombing operation, an 8-second exposure isolated between momentary exposures. This sequence renders the film easy to read and at the same time tends to increase the chances of plotting the position of the aircraft at the time of bombing. The operation of the camera with bombing will normally give an exposure on which any light-tracks present are "complete"—that is, they begin and end within the field of view (see Fig. 36), isolated between two exposures of the kind seen in Fig. 37, where the lights are pinpointed owing to the shortness of the exposure. With straight and level flying, each light-track on the bombing frame will cross about one-third of the film, since at a height of 2 miles some 30 seconds are required for the field of vision of the camera to pass over a light on the ground. The contrasting exposures of indefinite length on "intermediate" frames will yield "incomplete" light-tracks crossing the whole field of view (Fig. 42).

The direct-light images recorded on these frames provide information about the position and growth of fires ; the fall of bombs ; the position, duration and height of burning of flares and target markers ; the appearance and effectiveness of lighted decoys ; the position and method of operation of search-lights ; types of flak and their intensity ; aerodrome lighting-systems and flashing beacons ; and they also indicate the evasive action undertaken by our aircraft.

(i) THE POSITION AND GROWTH OF FIRES

Each fire produces a track on the film, which if "complete" runs through one point on the photograph corresponding to the ground position of its source. Figs. 34 and 35 show the same area of Bremen at different stages of attack during a heavy raid last September. It will be apparent that between 0155 and 0212 hours, part of the weight of attack spread over this area of the city. Many new sticks of incendiaries were dropped and started fires. A glance shows the approximate position in which incendiaries were alight. Each fire will have been burning at some one point on its track relative to



FIG. 32.—Two sticks of incendiaries burning near Krupp Works, Essen (top right). Light from the photoflash is reflected from snow-covered ground, while direct light from each fire produces a track varying with movement of the aircraft. (Z/12; 9/10.1.43.)



FIG. 33.—A very clear view of part of the harbour at Genoa, showing ships in dock: a photograph of reconnaissance value. (Q/49; 7/8.11.42.)



FIG. 34. Two photographs of the centre of Bremen showing the development of a heavy raid. The earlier exposure at 0155 hours shows flare-tracks only. Fig. 35 was taken 17 mins. later and records tracks of at least 5 incendiary sticks burning at the positions marked (I). Day reconnaissance showed fire damage to the areas within the dotted lines. (The same rectangular area is marked on each photograph to assist comparison). (P.49 and M/83; 4/5.9.42.)



FIG. 36.—Three incendiary sticks and isolated fires burning among the docks at Neuss (Düsseldorf); an 8-sec. exposure illustrating "complete" fire-tracks. The column of smoke rising from one end of a group of fire-tracks establishes the position of the other fires. (QNB/28 O.T.U; 10/11.9.42.)

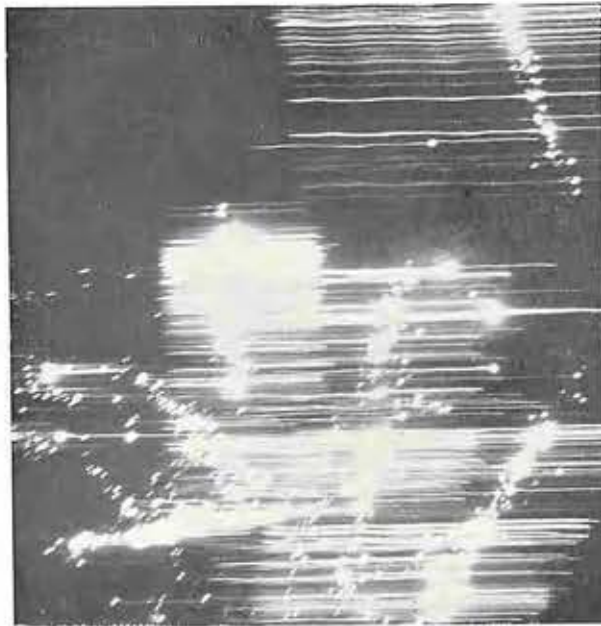


FIG. 37.—A dozen sticks of 4 lb. and 30 lb. incendiaries pinpointed across the centre of Genoa by a momentary exposure. A small area of ground detail is lit up by flare light. (The "tails" from each point of light are due to removal of the night blind from the camera.) (V/57; 22/23.10.42.)



FIG. 38 The left-hand print, an 8-second exposure with bombing, has been plotted in the town of Kiel, indicating the position of fall of a 4,000 lb. bomb. The next print (Fig. 39) shows light from the bomb-flame reflecting from roofs which can be identified in the area outlined in Fig. 38. (L/49; 13/14.10.42.)



FIG. 39



FIG. 40.—A decoy in action: Dortmund 1 (Holthausen). The position of the fire-site is marked by the column of smoke. (Compare with typical appearance of incendiaries Figs. 32, 35-36.) (D/144; 14/15.4.42.)



FIG. 41.—Searchlight over Düsseldorf. The curtain-like image is caused by the beam striking haze or mist, the "hem" is the track of the bowl. The beam has moved while the aircraft flew over. (R/83; 31.7/1.8.42.)

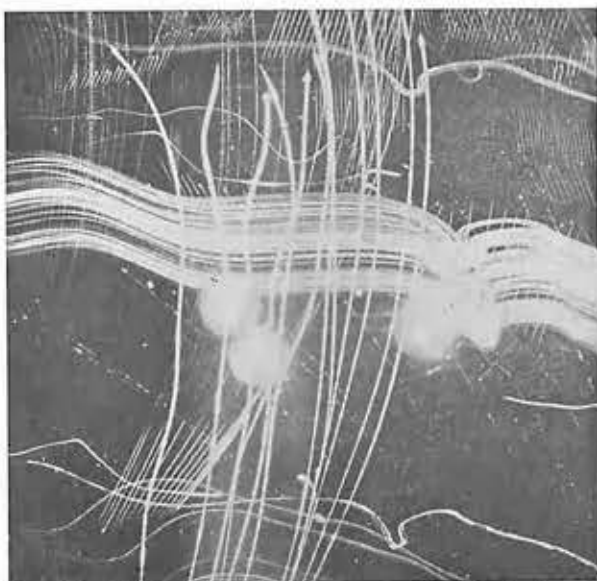


FIG. 42.—Light Flak: An exposure of indefinite length recording "incomplete" fire-tracks. There are many bursts of tracer from small guns, the length of each burst being clearly indicated. Three heavy flak gun-flashes are seen near the centre of the photograph. (G/419; 26/27.4.42.)

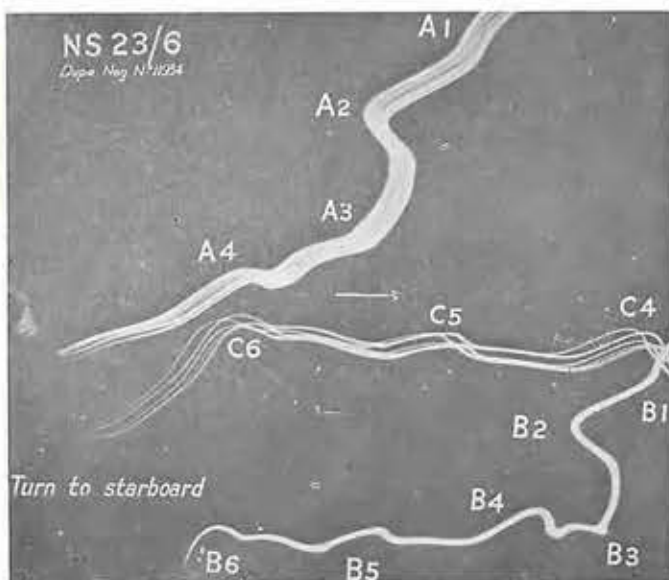
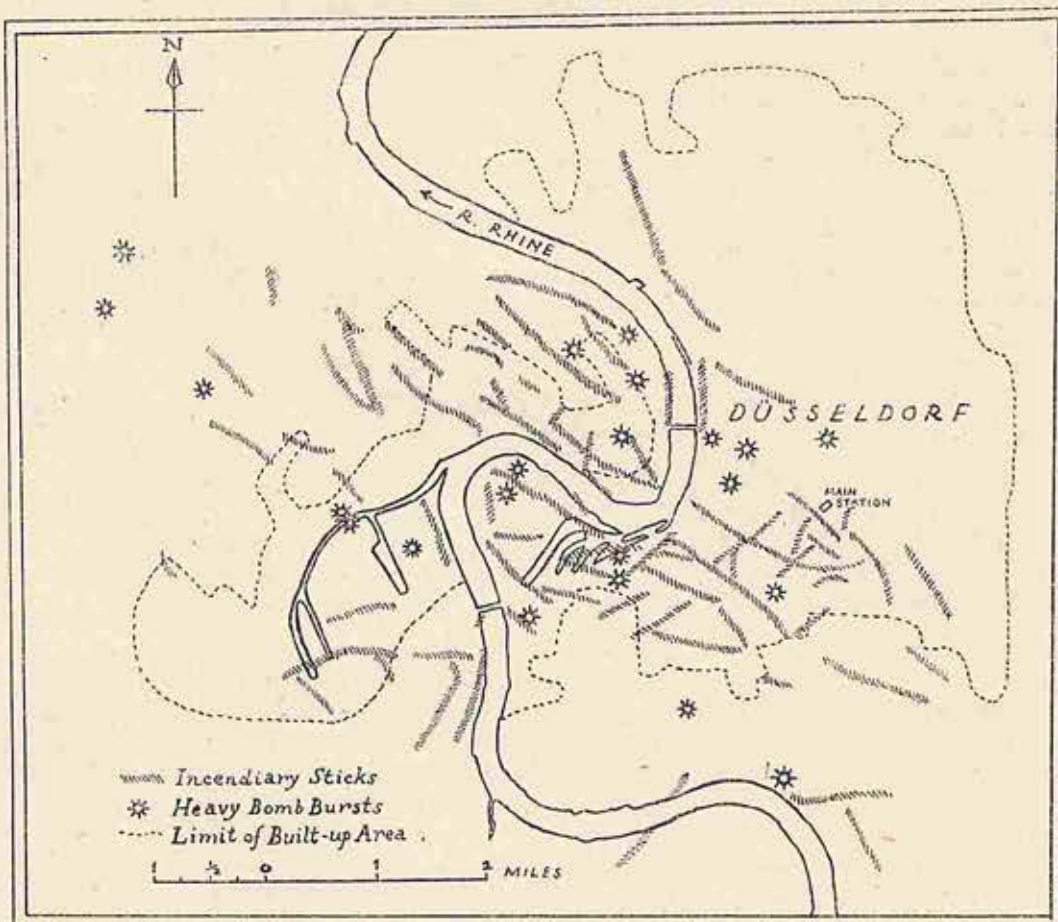


FIG. 43.—Evasive action shown by tracks of three fires, A, B and C. Corresponding points on the three tracks are numbered. Distances between successive points on track A are greater than on track B; thus fire A was on the outside of the turn, and the turn was to starboard. (See page 32.) (8-sec. exposure, G/115; 13/14.9.42.)

ground detail, and two or more fires will be at corresponding points on their several tracks. Fig. 36 indicates one method by which the exact position of fires may be established. The column of smoke on the left is photographed together with ground detail, by the light of the photo-flash. The smoke arises from the fire which had caused the broad band of fogging across the centre of the print, and the actual position of the fire amongst the docks at Neuss is clearly towards the upper end of the trace; every fire is then at a corresponding position on its own track. A number of different aircraft sometimes obtain photographs of one area showing the same fires; it may then be possible to fix the position of these fires, which will be at the points of intersection of different sets of traces. Two, or perhaps three, photographs which follow fairly closely in time may be required, since the configuration of fires may change. This principle can be used the other way round—to plot the positions of aircraft from the fire-track patterns alone, when no ground detail happens to be recorded on the film. Thus, it will be seen that the plots of night photographs ordinarily give only a minimum picture of the result of a raid, proportionate to the number of aircraft obtaining photographs with ground detail. Again, momentary exposures of the camera effect the pinpointing of lights and fires, as in Fig. 37 which gives an impressive picture of some 12 sticks of incendiaries lying across the centre of Genoa.

(ii) BOMB FALL

The release of the photo-flash with the first bomb and the fusing of the flash to explode at 0.6 of the aircraft's height will normally result in a photograph being taken before the bombs reach the ground (see page 28). But bomb flames, especially the great flash of light from a 4,000 lb. H.C. bomb, not infrequently illuminate the ground sufficiently for the point of impact to be registered on the night film. When such a photograph chances to be preserved from fogging by a subsequent operation of the camera, it indicates the actual point of impact. Incidentally, comparison with the 8-second (bombing) exposure shows that the ground detail on the two frequently overlaps, thus indicating that the 8-second bombing picture is in fact a reliable guide to the distribution of attack. Subsequent day photographs may reveal the damage caused at that point and in this way most valuable information is obtained concerning the effects of various types of bomb against different kinds of built-up area.



A "FIRE PLOT" OF A RAID ON DÜSSELDORF.

Showing the distribution of those sticks of incendiaries and explosions (probably 4,000 lb. bomb bursts), which could be plotted from photographs taken on the night of 31st July-1st August, 1942. The photographic coverage is necessarily incomplete but even so 52 sticks and 19 large explosions have been recorded within the built-up and industrial area.

Moreover, from the analysis of fire-tracks, as described in (i) above, "fire-plots" can be constructed, which indicate where incendiaries and H.E. fell. The lengths of sticks of incendiaries, their duration of burning, and the growth of fires from individual incidents, may be studied from a diagram of this kind along with the night films from which it is constructed. Such a diagram, again, gives only a minimum picture, which will be more reliable the more complete the photographic coverage over the target.

(iii) FLARES

The position of flares, their duration and height of burning, may sometimes be judged from night photographs. On the film, flare-tracks may be recognised as broad bands of fogging, varying somewhat in width owing to the irregular burning of the flare. The concentration of flares over the target has sometimes been such that photographs of ground detail by flare-light, alone, have been obtained with momentary exposures of the camera. These may permit the position of an aircraft at the time of bombing to be plotted when the 8-second exposure with bombing has failed to register ground detail. The cinematograph film exposed over Genoa on 15th/16th November and subsequently released to the public, best illustrates the degree of illumination that can be achieved over a target by flare-light under exceptionally clear conditions. This film, and two of Turin during the same month, give a most impressive picture of a target under heavy attack.

Besides flares, other target-markers may be identified on the night photographs, which can provide a far more detailed record of their appearance than any verbal description. The 4,000-lb. incendiary produces a very striking photographic image and would seem to form on the ground a broad band of burning substance 80 to 100 yards wide. The photography of target-markers becomes especially important when sky-marking above cloud is employed. Under such conditions, the inclusion of the marker-flare within the field of vision of the camera at the time of bomb release might be the only possible indication of correct aiming in the attack.

(iv) ENEMY DEFENCES

(a) *Lighted decoys* are recorded quite frequently on night photographs. They may appear as a broad band caused by the fogging together by a number of tracks from small light sources, perhaps arranged together in compartments to simulate burning buildings (see Fig. 40). Night photographs afford information about the position and method of operation of decoys and also provide a means of estimating their success. While it is from the results of day reconnaissance that decoy sites have mainly been studied, night photographs alone can record their appearance in action. The difference between known decoys which have been photographed alight, and the appearance of sticks of incendiaries is very striking. A particular decoy may be photographed both inactive and alight on the same night. Again, night photographs alone can provide information of the amount of incendiary attack diverted by decoys, since, unlike H.E. bombs, incendiaries leave no trace on day reconnaissance photographs.

(b) *Searchlights* are regularly seen on night photographs which may reveal their position, mode of operation and effectiveness. Fig. 41 shows the typical appearance of a searchlight, the curtain-like effect being caused by the beam of the searchlight reflected from haze or mist, while the "hem" of the curtain is formed by the bowl of the searchlight. The image of the bowl will correspond to those of any other fixed lights on the ground, except that a searchlight may expose or drowse while in the field of view. The folds of the curtain record the passage of the beam across the field of view. Searchlights may be shown in clusters of two or three, or in groups, up to as many as 14 being recorded together. Clusters of more than two have been noted with increasing frequency during 1942. Searchlights have been recorded catching an aircraft, and when this happens the beam has no length across the field of view.

(c) *Flak* activity is recorded on the film by three distinct types of image: the gun-flash, which may illuminate ground detail; the track, if tracer be employed; and the burst. Night photographs may disclose the position and nature of flak batteries, the rate of fire, and comparative figures of flak intensities over different targets. Fig. 42 shows well some of the characteristics of tracer, especially the flecked appearance, due perhaps to the irregular burning of the tracer composition. There are in the picture several bursts of tracer from small calibre guns, some of which came appreciably nearer the aircraft than others. Three gun-flashes of heavy flak are also seen about the centre of the photograph. It will be seen that with a moving source of light, such as tracer, the light tracks are not parallel to those caused by stationary sources.

(v) LIGHTING SYSTEMS

Flashing beacons, and aerodrome perimeter and boundary lighting with visual-Lorenz approach-systems, are photographed from time to time, usually on "intermediate" frames and not relative to ground detail. Two or three types of beacon site have been distinguished, and photographs may give the symbols flashed, as well as the pattern of fixed lights around the beacon with an unquestionable accuracy.

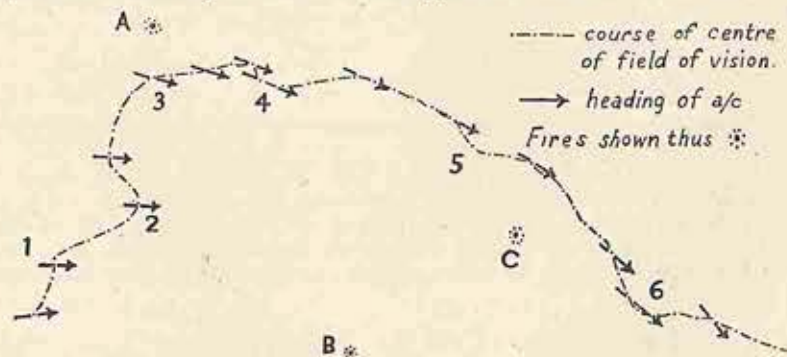
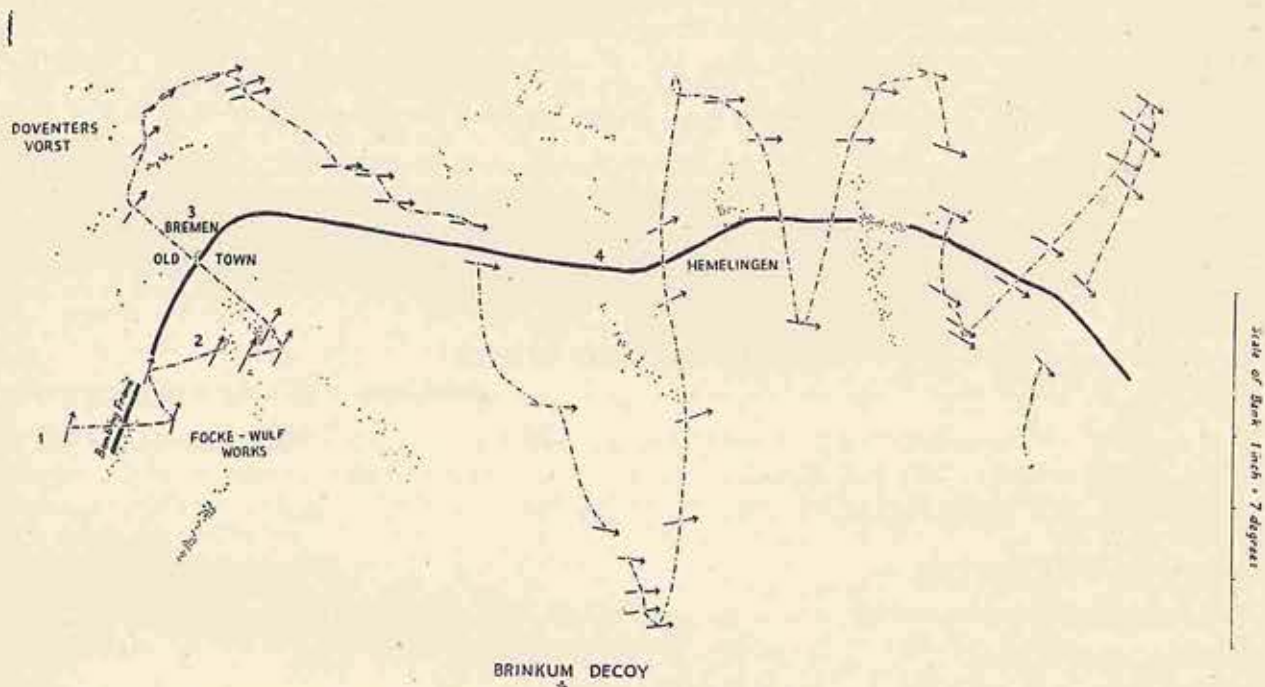


Diagram of the starboard turn recorded by the fire-tracks in Fig. 43. The line through points 1 to 6 represent successive positions of the centre of the field of vision relative to the three fires A, B and C during the 8-second exposure. The turn, shown by the change in aircraft heading, began with a bank, marked by points 1 to 3.

(vi) EVASIVE ACTION.

It is possible to determine the evasive action undertaken by an aircraft from a careful analysis of the shape of light-track patterns when the aircraft flies over stationary lights on the ground. With straight and level flying, each light-track will be a straight line from the leading to the trailing edge, limited only by the edge of the frame or the action of the shutter. Departure from straight and level flying will be registered by deviations in the light-tracks. For example, bank causes a deviation up and down from the straight. Climb and dive, involving as they do change in movement or attitude, make the tracks move apparently faster or slower across the field of vision. With a change of heading the tracks are no longer parallel, but only corresponding (*see* Fig. 43). Thus it is possible to construct a diagrammatic picture giving the track, the bank, and attitude of an aircraft, provided always that there are two or more stationary sources of light within view of the camera and that as some lights disappear, so others come within view. At the best, such diagrams (*see* below) will give a picture of aircraft movement over several miles of country and for several minutes together. This permits not only a more accurate assessment of where bombs fell, but useful information of whether the evasive action undertaken was the best against predicted fire.



A WELLINGTON'S FLIGHT ACROSS BREMEN, SHOWING THE EVASIVE ACTION TAKEN

An example of the way in which fire-tracks may reveal the progress of an aircraft over several miles of well-defended territory. The Wellington's track (thick line), and the course followed by the centre of vision of the camera (thin broken line), have been plotted from fire-tracks on the bombing frame and two subsequent frames. Established fires are shown by dots.

"F" of 301 Squadron flew in heading N.E. The bombing frame (points 1 to 2) shows the aircraft over the Focke-Wulf Works, where a stick of incendiaries was burning on the aerodrome. When nearly over the centre of Bremen (3) he made a sharp diving turn to port (4), followed by a quick succession of fairly sharp banks. (4th/5th September, 1942.)

At present more than 60 per cent. of sorties reporting attack in a single operation are obtaining successful photographs of ground detail with bombing, or of cloud or mist. Of the remainder, many have recorded light-track patterns, the study of which may enable the position of the aircraft to be plotted. Photographic failures due to incorrect action of the camera, to faults in the camera electrical circuit or to faults in processing and developing are down to a very small figure. Failure to register ground detail is due rather to the weather, to evasive action, to fogging by flarelight (which may be too bright for an 8-second exposure) to faulty synchronisation due to bombing being carried out at a height other than that set on the control and fuse, or to these causes in any combination. The main limiting factor of all is the weather, but photographs which for this reason fail to show ground detail may provide useful information about the weather conditions.

Work on all other matters limiting photographic results is well in hand, so that further improvement is to be looked for, and as the slogan "*better photography—better bombing*" implies, this will contribute in its own way to ensure that more bombs find the target.

V. A COMPARISON BETWEEN 1941 AND 1942

The table printed below brings out a number of telling comparisons between 1942 and the preceding year. In the first place it will be seen that the increase which occurred in the weight and effectiveness of the bomber offensive was not achieved by any great numerical increase in the strength of Bomber Command such as was confidently expected at the beginning of 1942. Those expectations were not realised, and practically all American-built aircraft allocated to the R.A.F. were sent to other Commands. Moreover, in the course of the year many of the existing squadrons of the Command were either loaned or transferred to Coastal Command or despatched for service overseas.

However, the composition of the force has greatly altered, especially in the substitution of heavy for medium bombers. The steady increase in the proportion of heavies made possible a substantial improvement in the tonnage of bombs dropped on enemy territory. The improvement will be seen to be even more striking than at first appears when it is recalled that, in addition to the 44 per cent. increase in their bomb load, our aircraft laid eight times as many mines as in 1941. The composition of the bomb load also provides a contrast, since incendiaries made up 42 per cent. of the total weight in 1942 as compared with 12 per cent. in 1941, and more than ten times as many bombs of 4,000 lb. or over were dropped than in the previous year.

It will also be noticed that operations were undertaken on 16 more nights than in the preceding year, while there was a substantial increase in the number of large-scale operations.

These facts, coupled with the introduction and development of new aids and tactical methods, are responsible for the striking fact that, without numerical expansion, our bomber force was able to inflict far greater damage on Germany in 1942 than ever before.

TABLE OF COMPARISON

	1941	1942	Increase
Number of Squadrons (at 31st December)	56	60	8%
Proportion of Heavy Squadrons	27%	54%	100%
Total Operational Sorties despatched	32,260	36,430 (includes 2,936 by O.T.U.s)	13%
Number of Nights operated	240	256	7%
Number of Operations involving more than 150 Sorties ..	64	86	34%
Total weight of Bombs dropped	31,700 tons	45,560 tons	44%
Proportion of Incendiaries to Total (by weight)	12%	42%	250%
Bombs dropped per Bombing Sortie despatched	1.03 tons	1.52 tons	48%
Number of Heavy Bombs dropped (4,000 lb. or over) ..	402	4,055 (includes 28 of 8,000 lb.)	915%
Number of Sea-Mining Sorties despatched	1,250	4,743	280%
Number of Sea-Mines laid	1,055	9,574	807%
Number of Sorties against U-Boats, Shipping, etc ..	252	1,119	304%
Number of Leaflet Sorties despatched	252	635	152%