

20
13-6
SECRET

Downgraded to

UNCLASSIFIED

UNLIMITED

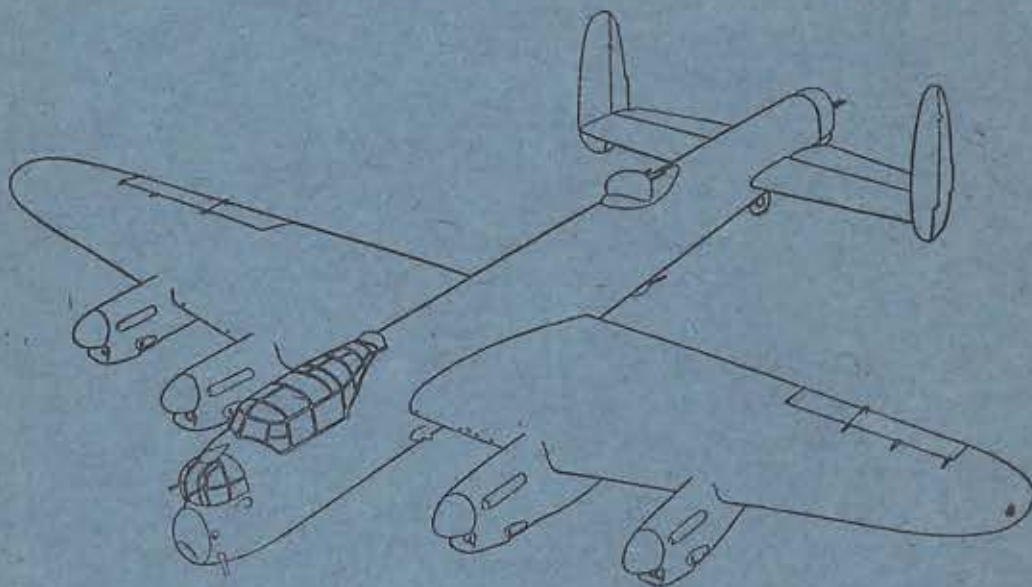
6M/31
144
K 538/1298
10 SEP 1944
SOSHAMPTON, U.W. 18

Downgraded Authority D/ANB(RAF)/5/12/352
dated 13 Feb 81

BOMBER COMMAND QUARTERLY REVIEW

January—February—March, 1944

No. 8



Any person other than the authorised holder upon obtaining possession of this document by finding or otherwise should forward it, together with his name and address, in a closed envelope to the Under-Secretary of State, Air Ministry, Kingsway, London, W.C.2. Letter postage need not be prepaid; other postage will be refunded.

All persons are hereby warned that the unauthorised retention or destruction of this document is an offence against the Official Secrets Acts, 1911-1920.

HEADQUARTERS
BOMBER COMMAND
ROYAL AIR FORCE

CONTENTS

I. REVIEW OF OPERATIONS, January-March, 1944

	<i>Page</i>
Introduction	1
(a) Targets in Central and North Germany	2
(b) Targets in South-West and West Germany	3
(c) G.A.F. Targets in Enemy-occupied Territory	5
(d) Other Factories in Enemy-occupied Territory	6
(e) Railway Centres in Enemy-occupied Territory	6
(f) Minor Raids	6
(g) Minelaying	7

II. FLYING INCIDENTS

(a) A Damaged Halifax Ditches in the Baltic	8
(b) A Crash-landing in Enemy-held Territory	9
(c) A Double Victory	10
(d) A Day Fighter Destroyed at Night	10
(e) Two Unseen Fighters Destroyed	11

III. MISCELLANEOUS ITEMS

(a) Bombing Factories at Night	12
(b) Some Medical Factors which Affect Bomber Operations	13
(c) Maintenance of 1,000 Aircraft	15

ILLUSTRATIONS

<i>Figure</i>		
1 ..	The City of Augsburg laid waste in a single attack	<i>Facing page ii</i>
2 ..	Heavy damage to the largest Diesel-engine Factory in Germany	<i>Facing page 1</i>
3 ..	Frankfurt: the Railway Workshops	}
4-6 ..	Berlin: damaged factories	}
7 ..	Damage to Business and Residential Districts of Berlin	}
8 ..	The Centre of Frankfurt in ruins	<i>Between</i>
9-10 ..	Amiens/Longueau Railway Centre	<i>pages 4, 5</i>
11-14 ..	Raids on Vaires and Trappes Marshalling Yards	}
15 ..	Night Attack on Needle-Bearing Works	}
16-20 ..	Aero-Engine Works wrecked by Twelve Bombers at Night	<i>Between</i>
21 ..	The Michelin Tyre Plant, Clermont Ferrand	<i>pages 12, 13</i>

This publication is *secret* and no extracts or quotations may be made from it without the authority of the Chief Intelligence Officer, Headquarters, Bomber Command.

Copies not required for record purposes should be destroyed as *secret waste* in accordance with A.M.O. A.411/41.

THE CITY OF AUGSBURG LAID WASTE IN A SINGLE NIGHT ATTACK



FIG. 1.—AUGSBURG, one of the chief industrial centres of South Germany, was the target for a highly successful attack on 25/26 February, 1944. Rarely has industrial damage on such a scale been achieved in a single attack; moreover, about 60 per cent. of the fully built-up business and residential area of the city was destroyed or severely damaged, so that industrial recovery will necessarily be slow. The above photograph shows the old town and neighbouring business and residential districts only. (See Fig. 2, overleaf.)

HEAVY DAMAGE TO THE LARGEST DIESEL-ENGINE FACTORY IN GERMANY

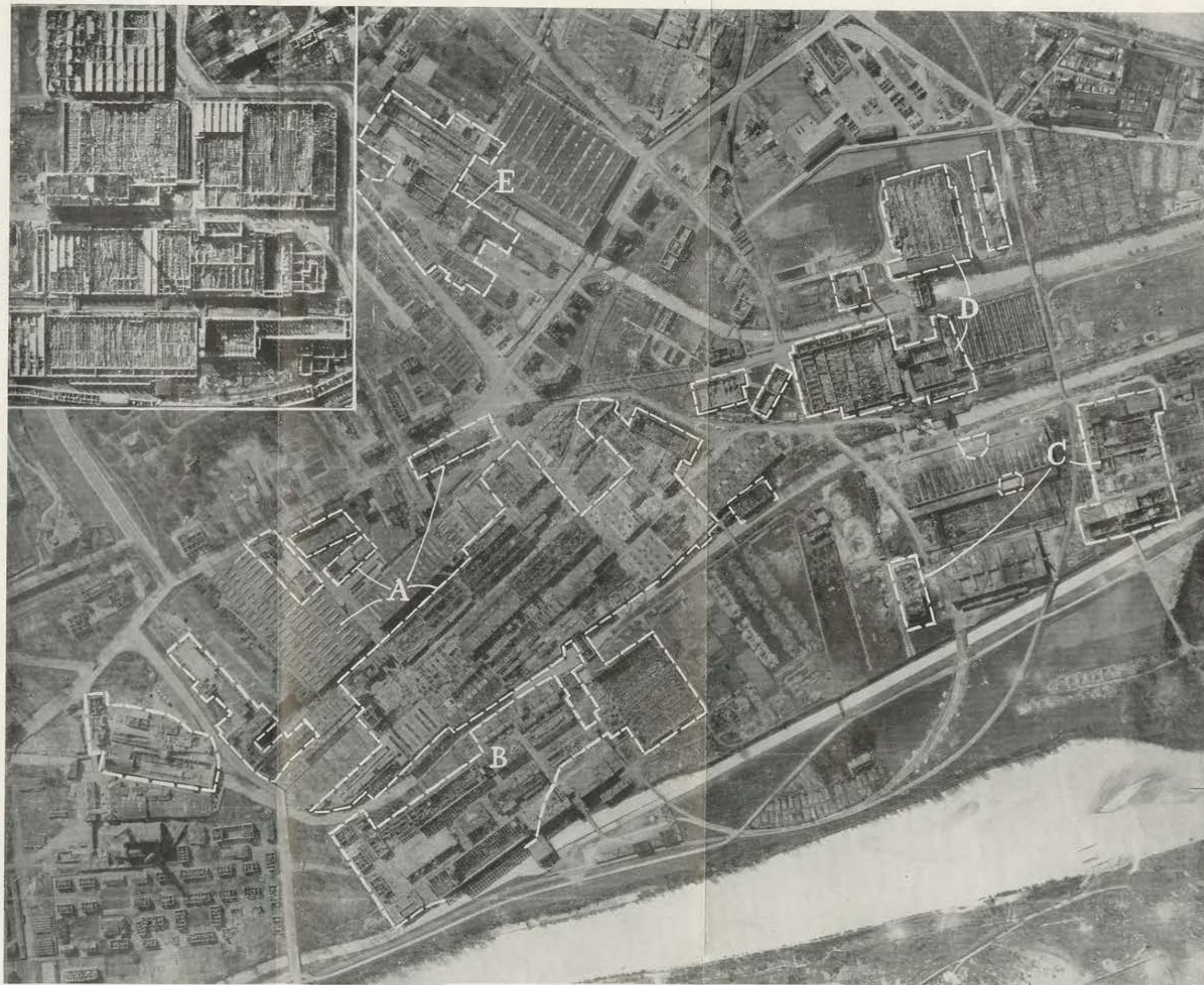


FIG. 2.—The north and east part of AUGSBURG consists of an extensive and vital industrial area which received a high concentration of bombs during the raid of 25/26 February. In one area a density of more than 500 tons per square mile was achieved. The MASCHINENFABRIK AUGSBURG—NURNBERG A.G. (M.A.N. Works), the largest Diesel-engine factory in Germany, had all its buildings damaged and some of its largest machine shops were completely gutted.

The original M.A.N. plant is indicated at A, above, and an extension at E. B, C and D are a neighbouring paper-mill, and two cotton-mills believed to have been taken over by M.A.N., the whole group of workshops covering some 260 acres. The principal areas of industrial damage are outlined.

INSET, top left.—The large textile works of Augsburg Kammgarn Spinnerei was completely gutted in the same raid.

BOMBER COMMAND QUARTERLY REVIEW

No. 8

I. REVIEW OF OPERATIONS

January—March, 1944

Introduction

During the first quarter of the year the Command continued to expand in numbers but more particularly in striking power due largely to the re-equipment of Stirling squadrons with Lancasters. At the same time a very rapid growth of the U.S. heavy bomber forces was taking place so that it became possible to make real progress with the plan long envisaged whereby the two forces would operate in accordance with a common policy. The two forces are of course designed to fulfil different functions and each has its own limitations as well as attributes. A common policy therefore means not that the two forces should carry out identical missions but that they should work together to accomplish specific but complementary tasks by the method best suited to each in accordance with operational and tactical considerations.

The overall objective of the bomber forces continued to be the reduction of the enemy's means to wage a successful war by striking at his sources of production. In particular, however, the German Air Force became a primary objective not only for the obvious reason that in itself it constitutes a powerful military factor, but also because its elimination as a force to be seriously reckoned with, would, by decreasing the rate of loss of our aircraft, make possible the bombing of other objectives on a much vaster scale.

The U.S. bomber force contributed its part of this programme by precision attacks on factories producing or assembling aircraft, and associated industries as well as by attacks on airfields. In addition, escorted by large numbers of fighters they sought to bring the enemy to battle in the air. Bomber Command attacked a number of similar factories in France with comparatively small forces and made large scale attacks on centres of German industry including the aircraft industry. Particular damage to important industries is shown in a number of photographs included in this review. General loss to the enemy's war machine is indicated by an assessment made by the appropriate Air Ministry branch which calculates that in the ten months—March to December, 1943, the industrial loss to the enemy was equivalent to the cessation of work for one whole month by 33,000,000 workers.

Most of the full scale attacks launched during the quarter were directed at the distant targets in Central and South West Germany as with the approach of shorter nights such targets would

soon be out of range. The choice of particular targets at any given time is governed largely by the prevailing weather conditions which during this period provided fewer nights of good weather conditions than might reasonably have been expected. As a result not many major attacks could be carried out with the use of ground markers and reliance had to be placed largely on sky markers. With few exceptions such attacks do not produce the same degree of concentration as with ground markers and it is essential therefore, if good results are to be obtained, that the target should be large so that any spread will do worthwhile damage. The truth of this is to be found in the enormous damage caused in Berlin by this type of attack which would have been largely wasted if directed against small targets. On more than one occasion the full weight of the attack did not fall very near the aiming point but nevertheless caused great destruction in other areas of the city of equal importance, whereas had the target been small, the greater part of the attack would have fallen in open fields or on targets of little or no military significance.

In February, two consecutive nights of excellent visibility enabled attacks to be made on Schweinfurt and Augsburg, both of which had been attacked the previous day by the U.S. VIII Bomber Command. It was known that the first of these targets would be an exceedingly difficult one to hit by night and the success achieved, though not outstanding, may be considered as satisfactory, bearing in mind the smallness of the target and the tactical difficulties. The attack on Augsburg achieved a high degree of concentration destroying or damaging nearly all the factories and practically eliminating the town.

Apart from full scale efforts, attacks on a substantial scale were carried out during March against railway targets and throughout the period a number of small but successful attacks were made on factories in France mostly concerned with the aircraft industry.

The weight of bombs dropped during the period was well up to the highest expectations. Despite the influence of the weather the total was greater than for any previous quarter and in March alone was in excess of the whole of the corresponding quarter in 1943. A comparison with the first quarters of 1942 and 1943 is very striking.

Quarter.	Total Sorties Despatched.	Tons Dropped.		No. of Mines Laid.
		Total.	On Germany Only.	
January-March, 1942	6,126	5,974	3,586	724
January-March, 1943	14,632	25,881	17,442	3,573
January-March, 1944	21,654	58,180	48,342	4,234
Percentage increase 1944 over 1943	Per cent. 48	Per cent. 125	Per cent. 177	Per cent. 18

(a) Targets in Central and North Germany

Berlin

Date.	Aircraft Despatched.	Aircraft Attacking.	Bomb Tonnage.		Total.	Aircraft Missing.
			H.E.	Incendiaries.		
1/2 January	421	386	772	629	1,401	28
2/3 January	383	311	658	458	1,116	27
20/21 January	769	697	1,164	1,237	2,401	35
27/28 January	530	481	1,067	694	1,761	33
28/29 January	680	596	1,086	868	1,954	46
30/31 January	540	489	1,069	892	1,961	33
15/16 February	891	806	1,230	1,413	2,643	43
24/25 March	810	726	1,070	1,423	2,493	95
	5,024	4,474	8,116	7,614	15,730	340

The above raids caused very severe damage to a large number of industrial plants. The hardest hit of all were the Daimler-Benz Works, producers of tanks, tractors and aero-engines; the important firm of Lorenz, manufacturers of blind-flying apparatus and military wireless equipment; and the two principal A.E.G. factories, one being the largest German cable works and the other a leading producer of steam turbines and diesel engines. Extremely severe damage was also caused to the huge complex of Siemens factories, the most important manufacturers of electrical equipment of all kinds. Damage to the various branches of this company exceeds 46 acres of actual building structure which is greater than that inflicted on any other factory complex with the sole exception of Krupps at Essen. Particularly severe was the damage to the Siemens factory turning out aircraft instruments. Another of the factories very severely damaged was the leading producer in Germany of telephone, telegraph and signalling apparatus of every kind.

A large number of firms connected with the aircraft industry sustained damage, among the most seriously affected being the B.M.W. aero-engine works, the Henschel factory manufacturing and assembling air frames, and the Flettner aircraft assembly and repair works.

Damage to factories in the Engineering and Armament group include severe damage to Ambi-Budd Presswerke, a key firm making press work for tanks and to Bussing, a large works manufacturing and repairing lorries, tractors and military transport. The huge Rheinmetall-Borsig works, most vital armament firm in Germany since the destruction of Krupps, was also damaged,

though less severely than in the previous series of attacks.

Altogether about 100 identified businesses were damaged but over and above these, scores of smaller plants engaged on war work of every kind have received direct damage, while every one of the thousands of industrial undertakings in Berlin have had their output seriously reduced by absenteeism, the stoppage of supplies from damaged factories, by the breakdown of communications, gas, water and electricity supplies and of general administration which is known to have occurred. In all, the calculable part of the overall industrial loss resulting from these attacks is estimated at 789,000 man months equivalent to a loss of 20 working days for every one of Berlin's 980,000 industrial workers.

It has always been known, however, that a vast amount of damage is inflicted by Bomber Command attacks which is not revealed by vertical photographs and which is difficult to assess accurately from the many reports from neutral sources which are constantly being received. Some indication of the extent of this damage to Berlin is obtainable from a statement made by members at a highly confidential meeting of the Ministry of Interior Reconstruction Department that an alarming proportion of buildings in Berlin would have to be wholly or partially pulled down after the war. Even buildings that from the outside appeared undamaged could not be left standing as their foundations had been weakened by the vibration of H.E. bombs. It was said that to rebuild Berlin to anything approaching its former condition would take from 20 to 30 years after the war.

Leipzig

Date.	Aircraft Despatched.	Aircraft Attacking.	Bomb Tonnage.		Total.	Aircraft Missing.
			H.E.	Incendiaries.		
19/20 February	823	730	1,202	1,353	2,555	78

This target had already received vast damage in two large attacks made in the last quarter of 1943, when severe damage had been done to industry in general and in particular to the aircraft industry housed in the Leipzig World's Fair.

Photographs taken of the city include the results of the attack on the 20th February by U.S. heavy bombers and damage cannot therefore be separately allotted to the two forces. Five out of the ten highest priority factories in the town have suffered severely including the Erla aircraft works at Heiterblock and Mockau and the Atag Assembly Plant at Mockau which were the

special targets for the U.S.A.A.F. The other two are the aero-engine works of Allgemeine Transport Anlagen and the Meier and Weichert works engaged on the production of tools, abrasives and grinding machines which were severely damaged almost entirely due to fire.

Altogether some 25 firms were affected including the largest wool spinning and dye works in Europe. The industrial loss is calculated at 205,000 man months, equivalent to 29 working days for each of the 176,000 industrial workers.

Other major attacks on targets in Central and North Germany were as follows :

Date.	Aircraft Despatched.	Aircraft Attacking.	Bomb Tonnage.		Total.	Aircraft Missing.
			H.E.	Incendiaries.		
Magdeburg 21/22 January	648	585	1,016	1,224	2,240	57
Brunswick 14/15 January	498	472	1,125	1,101	2,226	38
Stettin 5/6 January	358	348	633	490	1,123	16

The attack on Magdeburg was concentrated in the area S.S.W. of the centre of the town, containing many of the most important general and heavy engineering works which are the town's main industries. Major damage was caused to Krupp Grusonwerke, engaged on manufacturing medium tanks and to the engineering works of Maschinefabrik-Buchau R. Wolf A.G.

At Brunswick the heaviest damage was caused to transportation targets which included the important South Marshalling Yard, and major

damage was inflicted on the Wilkewerke factory producing boilers, pipes, benzine tanks and gasholders. At Stettin there was considerable industrial damage in the Silverweise district on the South Bank of the river where several industrial premises were gutted by fire and the main railway station was about 75 per cent. gutted. Over one half of the buildings of the Portland Cement Company were destroyed and many large warehouses in the dock area were destroyed. In the three towns the total industrial loss to the enemy is calculated at 117,000 man months.

(b) Targets in South-West and West Germany

Stuttgart

Date.	Aircraft Despatched.	Aircraft Attacking.	Bomb Tonnage.		Total.	Aircraft Missing.
			H.E.	Incendiaries.		
20/21 February	598	552	1,077	976	2,053	9
1/2 March	557	502	1,022	756	1,778	4
15/16 March	863	813	1,226	1,519	2,745	37
	2,018	1,867	3,325	3,251	6,576	50

Very valuable damage was done in these attacks, the heaviest occurring to Robert Bosch, Germany's biggest makers of sparking plugs and fuel injection pumps, where the new sparking plug factory and the main foundries were largely destroyed and several large workshops were completely or partly gutted; and in Bad Cannstadt where no less than seven factories of high priority received serious damage including the Ball Bearing Works of V.K.F., the largest

of such works outside Schweinfurt, and to Mahle, makers of aero-engine pistons, undercarriages, brakes, etc. In addition, the Daimler Benz factory at Unterturkheim producing aero-engines, and armaments also suffered severely. Altogether forty-four identified industrial premises were damaged and 99,000 man months were lost to the enemy, or 20 working days for each of the 123,000 industrial workers.

Frankfurt

Date.	Aircraft Despatched.	Aircraft Attacking.	Bomb Tonnage.		Total.	Aircraft Missing.
			H.E.	Incendiaries.		
18/19 March	846	769	1,367	1,820	3,187	22
22/23 March	816	774	1,318	1,915	3,233	33
	1,662	1,543	2,685	3,735	6,420	55

Tremendous damage has been caused throughout Frankfurt particularly as a result of the last attack. The centre of the city has for practical purposes been blotted out and considerable damage extends to almost every part of the built-up area, and the satellite town of Offenbach has been almost completely written off.

Included in the heavy damage to industry is Alfred Teves, a firm of the highest priority housed in three separate but adjoining works, producers of aircraft components of all kinds, brakes, oil pumps, valves, piston rings and especially crankshafts. All three of the works have been largely wrecked, about three-quarters of the buildings being destroyed or very severely damaged.

Severe damage was caused to two other high priority targets, namely Alder Werke, engaged in the production of armoured fighting vehicles and military transport and Hartmann & Braun, which chiefly served the German Navy making fuses and firing apparatus for submarine mines, but which also produced measuring and recording instruments of all kinds including aircraft navigation instruments.

Altogether this last raid was one of the most successful attacks ever delivered and there seems no reason to doubt the reports that the evacuation which proceeded the attack was not under control by the authorities and was comparable to the panic flight from Hamburg after the heavy raids last summer.

Augsburg

Date.	Aircraft Despatched.	Aircraft Attacking.	Bomb Tonnage.		Total.	Aircraft Missing.
			H.E.	Incendiaries.		
25/26 February	594	528	1,034	794	1,828	21

This attack, which followed the daylight attack by U.S. heavy bombers on the aircraft factory lying to the south of the town, achieved outstanding success. The north-east of the town comprises an industrial area of about 260 acres occupied mainly by the M.A.N. factory which, together with adjoining works taken over by the M.A.N. concern, is the leading German Diesel-engine works. The whole of this area has been ravaged by fire and nearly the entire

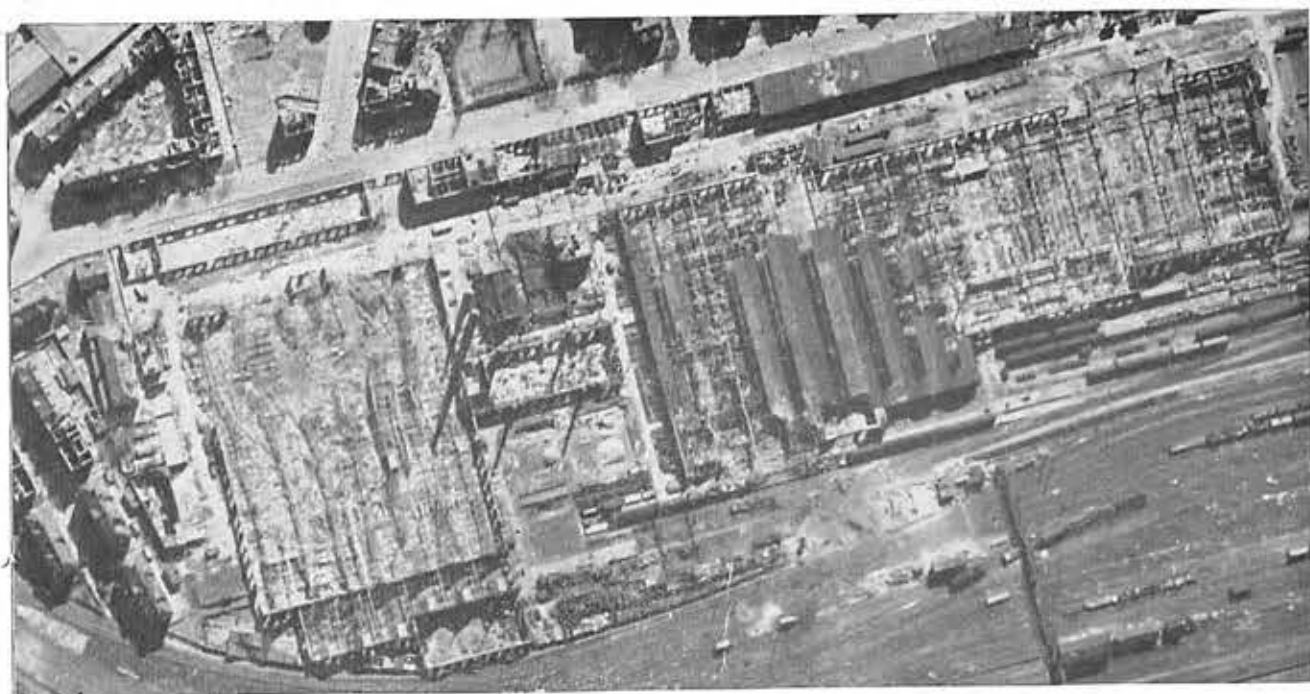
M.A.N. factory complex has been destroyed or severely damaged. No less than 20 identified factories in all, have been affected, including Messerschmidt A.G. and the important factory of Martin Schmittner, manufacturers of aircraft components which was very severely damaged. To add to the general disorganisation and interruption of industrial output, the electrical transformer station was heavily damaged.

Schweinfurt

Date.	Aircraft Despatched.	Aircraft Attacking.	Bomb Tonnage.		Total.	Aircraft Missing.
			H.E.	Incendiaries.		
24/25 February	734	662	1,226	1,036	2,262	33

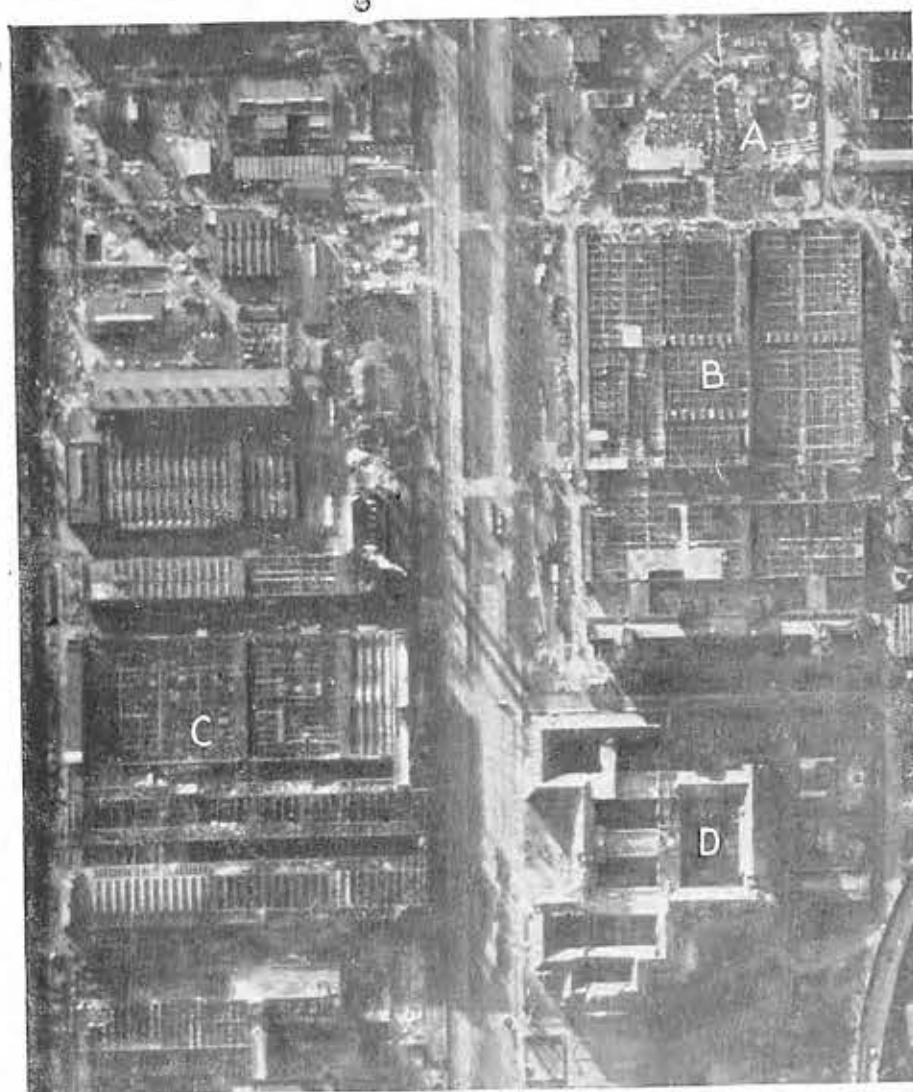
Photographs taken cover the result of the above attack and also that of the U.S. heavy bombers made on the day of the 24th February. Four of the five ball-bearing factories which were the

particular objective of the U.S. bombers have been affected and damage is spread throughout the town.



FRANKFURT

FIG. 3.—The Railway Workshops at this important centre of German communications have been almost completely wrecked.



BERLIN

FIG. 4.—The SIEMENS & HALSKE ELECTRICAL WORKS were again heavily damaged during the attacks in the first quarter of 1944. (A) Warehouses, (B) Switch-gear Works, (C) Dynamo Works, and (D) Offices and Research Laboratories.

FIG. 5 (lower left). — The LORENZ WORKS (blind landing equipment) in Tempelhof district, and—

FIG. 6 (lower right). —The ZEISS IKON optical works, were among the important factories damaged during the Berlin raids.



PART OF THE DAMAGE TO BUSINESS



FIG. 7.—Berlin is important as the location of many vital war factories, especially in the field of engineering. The Reich mechanical engineering industry, including more than 10 per cent. of German output of aero-engines, machine-tools and are estimated as equivalent to the loss of labour of 789,000 industrial workers for one month. Some idea of the disorganisation

AND RESIDENTIAL DISTRICTS OF BERLIN



An area of about 280 acres in the west-central district of Berlin.

Practically all these buildings, mainly business and residential property, are gutted by fire.

LUTZOW PLATZ

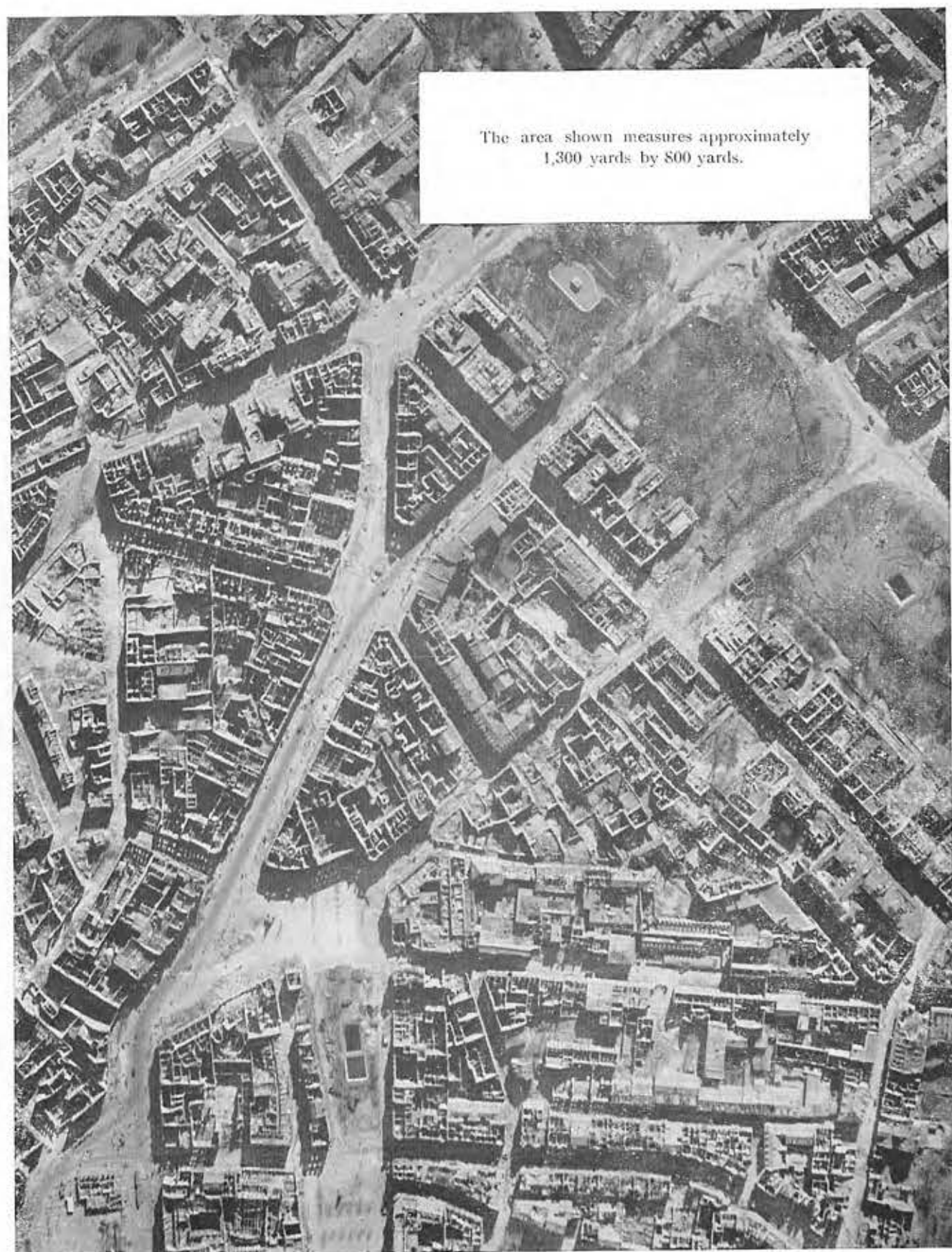
capital is responsible for more than a third of German electrical engineering output, and also nearly 10 per cent. of the precision instruments. The industrial effects of Bomber Command raids between the end of December and mid-February caused by these attacks can be obtained from the above photograph which shows only a small part of the damaged areas.

THE CENTRE OF



FIG. 8.—During March, Bomber Command dropped about 6,000 tons of bombs in two night raids on Frankfurt, these attacks resulted in the devastation of the centre, shown above, and serious damage to a third of all buildings ALFRED TEVES (piston rings, hydraulic brakes) and ADLER WERKE (armoured fighting vehicles).

FRANKFURT IN RUINS



The area shown measures approximately
1,300 yards by 800 yards.

the commercial centre of south-west Germany. Together with a further thousand tons dropped by the U.S.A.A.F., in the city. Over a hundred factories, including many important for war production, were damaged, among them

AMIENS MARSHALLING SIDINGS



FIG. 9.—Enlarged view of area " B " on Fig. 10 (*opposite*). The turntable and engine sheds have been severely damaged, together with much of their contents. All tracks were cut in many places and few wagons escaped damage. The whole area of the railway yards was plastered with bomb-craters.



THE AMIENS/LONGUEAU RAIL SIDINGS AND WORKSHOPS

FIG. 10.—Bomber Command made two attacks on this rail centre in March. Damage was very heavy in all parts. In the north-east area (A, above, see inset) the large railway workshop was almost completely destroyed, and much rolling stock wrecked.

NIGHT ATTACK ON VAIRES MARSHALLING YARDS



FIG. 11.—During the early part of the attack on this rail centre east of Paris on 29/30 March, many crews reported an enormous explosion (*see inset photograph*). Later aircraft were able to bomb accurately on the markers although drifting smoke made visibility difficult. Above, a Halifax is seen on its bombing run, while smoke rises from bomb-bursts on and around the target. The light tracks are caused by target indicators and flares.



FIG. 12.—Reconnaissance showed that the great explosion in Vaires forwarding sidings resulted from the detonation of two munition trains. The area of complete devastation (B) measures about 250 yards by 150 yards.

The main line (A) was completely cut by craters. Loaded military trains were damaged throughout the yards, and among those shown in this photograph is one of about forty trucks carrying medium tanks.

THE BOMBING OF TRAPPES MARSHALLING YARDS



FIG. 13.—An excellent night photograph showing the progress of the attack on an important railway centre south-west of Paris, on 6/7 March. A good concentration of H.E. bombs is bursting on the north-east end of the yards around the Engine Sheds (A), which can be seen to be damaged. Columns of smoke are rising from fires started among parked rolling stock. The light tracks in the photograph are caused by target indicators, one of which fell on a frozen reservoir. (See Fig. 14, overleaf.)

TRAPPES : AFTER THE RAID

FIG. 14.—The same section of the Marshalling Yards as shown in Fig. 13. At least six locomotives (see arrows) are lying wrecked in and near the Engine Sheds. More than 50 bombs fell on lines of rolling stock, and over 190 direct hits were scored on tracks.



Nuremburg

Date.	Aircraft Despatched.	Aircraft Attacking.	Bomb Tonnage.		Total.	Aircraft Missing.
			H.E.	Incendiaries.		
30/31 March	795	710	1,069	1,391	2,460	95

No concentration was achieved in this raid and only slight damage was caused to the target.

Essen

Date.	Aircraft Despatched.	Aircraft Attacking.	Bomb Tonnage.		Total.	Aircraft Missing.
			H.E.	Incendiaries.		
26/27 March	705	677	1,035	1,799	2,834	9

Damage from the above and a later very successful attack on 26/27 April, when nearly 2,000 tons were dropped, is concentrated in the works area of Fried. Krupp A.G..

Heavy damage had been inflicted on the Krupps works in the spring and summer of 1943 but the importance of this target—the largest single armament and heavy engineering plant in Germany—had caused the enemy to make widespread and extensive repairs. The target was therefore ripe for a further attack.

Tremendous damage was caused throughout the works in these attacks. No fewer than 91 identified buildings, or nearly half of the total, received new or further damage. The position of Krupps now is that not one of the larger buildings remains undamaged and only a few of the small buildings have escaped. So far as the town is concerned over 75 per cent. of the fully built-up area and 35 per cent. of the partly built-up area have been destroyed or damaged.

(c) G.A.F. Targets in Enemy-occupied Territory**Limoges, Gnome and Rhone (Aero-engine Factory)**

Date of attack, 8/9 February

This modern plant was equipped after the fall of France for producing Gnome-Rhone engines which are used by the Germans for communication and transport aircraft including probably the M.E. 323.

Extremely heavy damage was inflicted by this attack. The machine shops, housed in buildings with a total of 48 bays, have all suffered very severely, 21 bays being completely destroyed, three severely damaged and 17 having roof displacement. Several other buildings are destroyed or damaged including the assembly and experimental shop, the boiler house and transformer station.

Meulan Les Mureaux (Aircraft Factory and Airfield)

Date of attack, 2/3 March

This factory, makers of components for M.E. 109 and assemblers of the M.E. 108 (communication aircraft) had been attacked six months previously by U.S. bombers, but most of the damage then inflicted had been repaired.

Over one half of the factory buildings were destroyed in this attack, including the electric power plant, the main assembly shops, the machine shops and the factory testing hangers.

Albert S.N.C.A. Du Nord (Aircraft Factory)**Cie Mecanique D'Albert (Aero-engine Factory)**

Date of attack, 2/3 March

These factories are engaged on the repair of B.M.W. aero-engines which are used in the F.W. 190 and also probably in the manufacture of components. They had been attacked by aircraft of No. 2 Group, on the 1st December,

1943, but photographs show that most of the damage to the factories was caused by the Bomber Command attack.

The aircraft factory has been heavily damaged, almost every building being affected and several being completely destroyed or gutted. Severe damage was also caused to the aero-engine factory and several small buildings were destroyed.

Marignane S.N.C.A.S.E.

Date of attack, 9/10 March

This plant was mainly employed on the conversion of French Leo 45 aircraft into troop carriers, of which the Germans were very short following heavy losses of J.U. 52 on the Russian Front.

All the buildings of the plant have suffered, there being particularly heavy damage to the assembly shops, heat treatment shops, stores and flight and repair hangers.

Clermont-Ferrand/Aulnat (Aircraft Factory)

Date of attack, 10/11 March

These works were engaged on the repair of B.M.W. aero-engines used in the F.W. 190. The large six-bay workshops were severely damaged, two bays being completely destroyed. Five workshop huts were destroyed, two others gutted and considerable damage done to the works at the entrance.

Ossun (Aircraft Factory)

Date of attack, 10/11 March

This factory was engaged on repair of F.W.190's and the construction of the Dewoitine 520, a French fighter aircraft.

The two largest factory buildings were severely damaged by direct hits, several smaller buildings were destroyed and others damaged.

Chateauroux Aircraft Factory (S.N.C.A. du Sud-Ouest)

Date of attack, 10/11th March

Very severe damage was inflicted on the machine shops, M/T maintenance shops, and other buildings of this works, and the flight hanger was completely destroyed.

Lyons S.I.G.M.A. (Aero-engine Component Works)

Date of attack, 29/30 March

This was a highly successful attack, no less than 16 out of the 22 buildings being damaged. In addition a hutted camp was virtually destroyed.

(d) Other Factories in Enemy-occupied Territory

One of the outstanding achievements of accurate night bombing was the almost entire destruction of the Nadella works at La Ricamarie measuring only about 170 yards by 90 yards. This factory produced some 80,000 complete bearings and 3½ million needles each month. Needle bearings constitute a comparatively new development and are widely used in the automobile industry, in aero-engines and in variable pitch propellers.

Two successful attacks were made on explosive plants, that at Angoulême being almost entirely

destroyed and severe damage being done to the plant at Bergerac.

The Michelin tyre plant at Clermont-Ferrand was the second largest rubber factory in Europe and the Catroux section which was the most modern produced each month about 24,000 car and truck-tyres equivalent to about 70 per cent. of the output of similar tyres in Germany. This section was almost completely destroyed.

(e) Railway Centres in Enemy-occupied Territory

Vaires

Work in the marshalling yard and engine shed was brought to a complete standstill. There was great destruction of rolling stock, including much of military importance, and about 60 locomotives were immobilised. Apart from the devastation wrought by an explosion in the Down Reception Sidings, no great damage was caused to points and crossings in the Down side of the yard, but considerable replacement will be necessary at the western end of all three groups of Up sidings.

Amiens

Damage was extremely heavy in all parts of the marshalling yard and workshop sidings. All the main line tracks near the workshops received direct hits and movement of traffic through Amiens to the S. & S.E. became impossible with the exception of one line to Arras. It is known from Intelligence sources that after the first attack on this target, two special repair trains were sent by the Germans to deal with the situation. Both were wrecked by a second attack. As only four such trains are reported as available altogether, the loss must be regarded as very serious.

Le Mans

The large roundhouse was directly hit and 10 bays almost completely destroyed. The transshipment sheds also received direct hits and there is severe damage throughout the marshalling sidings and sorting sidings. Although little damage has been caused to the Northern entrance the existing position presents a repair problem of great magnitude.

Trappes

The greatest concentration of craters was in the up reception and down sidings where every track was put out of action at least at one point. The western exit was rendered impassable by numerous hits though no damage was seen to the eastern exit. Much damage was done to valuable electrical equipment and the control tower was damaged.

Considerable damage was also done to the railway centres at COURTRAI, AULNOYE and LAON, although not on the scale of the above four targets, all of which were especially successful attacks.

(f) Minor Raids

During the quarter, Mosquitoes carried out 1,937 sorties which is easily a record for any quarter. Owing to the tremendous weight of attack of major raids, Mosquito operations are liable to be regarded as insignificant. They are, however, now able to carry the 4,000-lb. bomb and they can no longer be considered as purely

nuisance raids. Their effort was very nearly equivalent to the number of enemy aircraft which attacked this country during the same quarter and their targets ranged far and wide over all areas of the Reich, whereas enemy attacks were directed mainly against London and South East England. In addition, whereas the

enemy's attacks were inaccurate and achieved no worthwhile damage, there is no doubt that the Mosquitos hit many useful targets although in only a few cases is it possible to pick out the particular items of damage inflicted by them owing to the considerable damage caused in major attacks. Instances of such damage are

the destruction of one-third of the finishing shops of the August-Thyssen Hütte A.G. at Hamborn and hits on the important blast furnaces and rolling mills of the Gute-Hoffnung Hütte A.G., the rolling mills, cement works and office buildings all being damaged.

(g) Minelaying

The minelaying offensive has been on a particularly heavy scale; indeed, the previous record of 4,191 mines laid during any quarter was beaten by 43. Aircraft of Bomber Command have now laid 29,408 mines in enemy waters.

Since the beginning of the year, a new technique, which enables mines to be dropped accurately from high altitudes, has been developed and put into operation. In conjunction with H2S and the Mark XIV bombsight, it is now possible for mines to be laid successfully over heavily defended areas either visually or through 10/10ths cloud. Kiel Bay, the Belts, the Heligoland Bight, the Sound, the Kattegat, Oslo Harbour, the Rade de Brest and the Gironde have all been mined by the new method. The exercising areas and swept channels in the vicinity of Kiel alone have received 1,111 mines.

It is of interest to note that during the quarter which held the previous record for the number of mines laid by aircraft of the Command, losses amounted to 3.1 per cent. of the sorties flown. In spite of penetration into heavily defended areas, losses for the quarter under review amount to only 0.8 per cent.

This intensified minelaying offensive has been directed against focal points of enemy sea communications in the Heligoland Bight, the Kattegat and the Baltic, and against U-Boats exercising off their Baltic bases or on operational passage in the approaches to the French West Coast ports. Full advantage has been taken of the long winter nights, and in distant areas extending from the Skaw to the Gulf of Danzig 694 aircraft have laid no less than 1,351 mines.

There is every reason to believe that this large and well distributed effort has caused the enemy many casualties and much embarrassment. The main channels for his sea-borne traffic, although continually swept, remain unsafe and hazardous, and many of the most convenient U-Boat exercising areas have been rendered far too dangerous for trials and practices. This is confirmed by recent photographic reconnaissance of Kiel Bay, which shows that merchant shipping and U-Boats are kept strictly to the main swept channels and proceed astern of sweepers. Otherwise the bay is void of traffic.

Also, there is every indication that the offensive is now swamping the enemy's sweeping organisation which is becoming over-worked and strained. Indeed, a Danish tug captain, recently captured by our M.T.B.s has paid the offensive a compliment by bringing to light a new disease affecting the German Mercantile Marine; this has been termed "Minephobia." He states that "Minephobia" seems to be on the increase, particularly among sperrbrecher crews. These men have now to be taken off duty after a six months' spell, after which they get three months' leave; many of them are sent to hospital with nervous breakdowns.

The intentions of the minelaying offensive are to bring existing disorganisation and dislocation of the enemy's mercantile marine to a rapid climax, which must materially benefit the immediate conduct of the war, and to render ineffective the "come-back" he is now preparing for his U-Boats.

The effort for the quarter, compared with the previous record which was during the quarter April/June, 1943, is as follows:—

	Present Quarter.	April/June, 1943.
Number of mines laid	4,234	4,191
Number of sorties flown	1,661	1,485
Number of miles flown	1,465,845	1,367,135
	Per cent.	Per cent.
Percentage lost of aircraft despatched	0.84	3.09

The following message received from the First Sea Lord is testimony to the important part that minelaying operations have played in the sea warfare:—

"The extensive and deep penetration into enemy waters made on the night of 9/10 April is typical of the skill and determination shown by the aircraft that take part in minelaying operations. The work of the minelaying aircraft of Bomber Command during the past four years has paid a rich dividend. Shipping

losses have been inflicted on the enemy and the sea traffic has been impeded and delayed to an extent which has seriously dislocated their general communications. Results such as these will be of increasing importance in the next few critical months and in this respect it is encouraging to see that minelaying operations have reached a new high level in the first quarter of this year. I should be grateful if you would convey to those concerned the Navy's appreciation of their fine work."

II. FLYING INCIDENTS

(a) A Damaged Halifax Ditches in the Baltic

Halifax "V," of 405 Squadron, whose crew were on their third operation, took part in the first of the recent series of attacks on the Reich capital but were obliged to ditch in the Baltic. All the crew are now back in this country. Their narrative is as follows :—

The Halifax took off at 2100 hours as one of the aircraft of the Pathfinder Force briefed to bomb at the beginning of the attack in support of the marker aircraft illuminating the target.

The moon had not risen and it was very dark when the target area was reached, at 2343 hours. While our aircraft was on its bombing run, from south to north of the city, a Pathfinder was seen to be coned by searchlights for a few seconds a short distance ahead and, after releasing a single flare, was shot down by an enemy fighter. The Halifax itself was then coned by a number of searchlights shortly before E.T.A. The pilot carried out "corkscrew" manoeuvres and the searchlights spread out around the Halifax, which then resumed its bombing run. When about to bomb it was held once more in the searchlights and, just as he started to corkscrew again, the pilot ordered the air bomber to release the bombload. Height was a little above 20,000 ft. and the navigator confirmed by "H2S" that they were over the city. It was impossible at the time to check whether bombs had actually released because of the manoeuvres which were maintained to evade the searchlights.

A few minutes later, at 2346 hours, when the Halifax was just getting free of the searchlights, the mid-upper gunner reported that an enemy fighter, believed to be a Me.109, was about to attack. It opened fire as it came in from above on the port quarter, crossed astern of the bomber, and broke away on the starboard bow. While the pilot continued to corkscrew, the mid-upper gunner opened fire with a two-second burst with unobserved results. About a minute later the fighter came in again, firing as it dived on the bomber from dead astern, and broke away to port. This time both gunners replied to the enemy's fire and believe they scored a number of hits. The fighter was not seen again.

The Halifax was now down to about 18,000 ft., and, as a result of damage sustained during the two attacks, it stalled and went into a spiral dive. The pilot regained control at about 8,000 ft., by which time they were clear of the searchlights. To prevent stalling the navigator and air bomber had to lash the control column forward, using the dinghy rope for the purpose. With the ailerons heavily trimmed and the wheel over to port, the Halifax was still flying starboard wing down and nose up. One member of the crew was injured during the attack, namely the rear gunner, who was wounded in one arm and evidently lost consciousness for a short period. The air bomber went back and brought him to the rest position while the wireless operator took his place in the rear turret. The mid-upper gunner took the flight engineer's seat while the latter attempted to remove the inspection panels of the bomb bay.

The known damage to the aircraft included : starboard rudder completely stripped ; top part of port rudder stripped, and port elevator damaged ; rear turret unserviceable. A tank in port wing was holed, but most of the fuel had been used already, and no. 4 tank, starboard wing, was also believed to have been holed. With +7 boost and about 2,650 revs. the Halifax was making about 70 knots using about 50-55 galls. per engine per hour, and still losing height.

During the combat the flight engineer's and the navigator's logs and other loose equipment became mislaid. By the time the Halifax was down to 6,000 ft. the navigator had recovered his log, plotting charts, two of his maps, and had also found his sextant which was broken. He maintained a course by *Polaris*, occasional visual pin-points on lakes, and by P.4 compass, which eventually brought them to the Baltic coast west of Stettin. Height was then about 3-4,000 ft. and, when a number of flak guns opened up for approximately two minutes, the aircraft was lifted by several near bursts. It was impossible to do more than turn to starboard to evade the flak. The starboard wing was holed between the nacelles, and fragments peppered the fuselage. The tail was hit again and it was no longer possible to rotate the turret even manually. However, the fresh damage had the effect of reducing the tail heaviness of the aircraft. The pilot was then able to keep the control column sufficiently far forward with his knees.

The engineer and navigator calculated that there was only enough fuel left to get to within about 200 miles of the English coast, so the pilot decided to make for Sweden. The injured rear gunner then went back to his turret and the engineer returned to the lengthy task of removing the inspection panels of the bomb bay with an axe. (The engineer was about to remove the panels when the aircraft was coned on the bombing run. After leaving the target area the screws could not be unfastened owing to the loss of tools during combat manoeuvres.) With assistance from other members of the crew the panels were at last removed and the bombs were found to have hung up. They were manually jettisoned over the sea. The bomb load included four 500-lb. H.E.s on the wings, but it was not possible to tell whether these had released at the target.

The Halifax was by this time down to about 1,500 ft. but, after jettisoning the bombs, was able to climb to about 3,000 ft. However, the pilot decided to ditch the aircraft (one reason for the decision being that the air bomber had caught his parachute ripcord accidentally) and the wireless operator sent a signal informing base. He then sent out an S.O.S. hoping for an acknowledgment from Sweden ; but the only reply received was a fix from England. As much ammunition as possible was jettisoned, all secret radio equipment detonated and most of it further smashed with the axe.

The Swedish coast was crossed with all lights on at about 1,000 ft. Inaccurate A.A. opened up so the pilot altered course and followed the coast of Skåne eastwards as far as Ystad. Conditions were favourable with moonlight, a calm sea, and a wind of barely 10 knots. At about 0300 hrs. the pilot ordered the crew to ditching stations and, waiting until there was only enough fuel for about 10 minutes flying, he brought the aircraft down into the wind with all engines running, like a normal Halifax landing. He used 30° of flap and cut the throttle just before hitting the water. The position was about 2 miles east of Ystad lighthouse.

The Halifax came to rest after the first impact—there was no bouncing at all—and the whole

crew got out onto the wing within 12 seconds' according to the navigator, who timed them. The dinghy was released and inflated satisfactorily and they got in. The nose of the aircraft had smashed in on impact with the water and, within about 12 minutes, the wings were submerged. However, the Halifax did not sink until about an hour after ditching, and by that time the crew had been picked up by a Swedish rowing boat which landed them at dawn.

It is evident that the discipline of this crew was of a high order. The other members of the crew spoke highly of the captain's handling of the damaged Halifax and described the ditching as a "perfect landing."

(b) A Crash-landing in Enemy-held Territory

The captain of a Lancaster of No. 1 Group ("P" of No. 103 Squadron), missing on the night of 25/26 February, 1944, has also returned safely to this country.

It seems that aircraft "P" reached Augsburg, the target for the night, later than intended owing to the fact that the "H2S" set had not been working as well as usual. Augsburg was already ablaze when the Lancaster made its bombing run at 23,000 ft., and it appeared that the raid was highly successful.

After bombs had been released on the markers, course was set for base along the briefed route. A belt of searchlights was encountered, and it was necessary to carry out considerable manoeuvres to avoid being coned. Once through the searchlight area the pilot ordered the flight engineer to check the fuel. He had just received the assurance that the fuel supply was ample when the Lancaster was suddenly engaged by heavy flak and was hit by the first burst. The Lancaster was thrown violently upwards by the flak burst and fragments passed through the bomb bay and entered the fuselage just behind the pilot's seat. The bomb doors fell open and the hydraulics were clearly unserviceable. A fire started on the underside of the aircraft and flames rose into the fuselage behind the pilot. Later it was found that the straps of the pilot's harness were burnt away. The controls and engines were, however, quite undamaged and the captain at once renewed evasive manoeuvres, making frequent changes of height and airspeed.

Smoke and a strong choking smell filled the fuselage and the fumes, evidently from burning hydraulic fluid, overcame the engineer who remained unconscious for some time. His oxygen supply was working satisfactorily. The second pilot and wireless operator worked hard to put out the fire and used up all the extinguishers without success; it continued to burn fiercely, though it remained localised. Meanwhile the navigator continued with his own job and at the same time kept up a running commentary on the progress of the fire-fighting for the information of the captain. The latter gave the order to prepare to abandon the aircraft when the last extinguisher had been emptied. He had already ordered the gunners to leave their turrets, and

now sent the wireless operator to help the rear gunner, who was unable to get out on his own accord owing to the hydraulic failure. The navigator bound up the second pilot's wrists, which had sustained burns during the fire fighting. It was found that one of the parachutes had been destroyed by the fire.

The captain now dived the Lancaster steeply from 20,000 to 10,000 ft. and in the course of the dive the fire went out. Just after this the navigator reported that "H2S" (now working much better) showed they were over a built-up area and no sooner had he said this than they were engaged by flak again. No further damage was sustained, however, and the Lancaster climbed to 15,000 ft.

The flight engineer had by this time recovered consciousness and the pilot ordered him to check the fuel gauges. He found that the level had fallen greatly, and it became obvious that there was a serious petrol leak. As the engineer was still in a dazed condition the navigator carried out a careful examination to determine which tank was holed. He ran the engines on all possible combinations of tanks for short periods, noting down the readings of the gauges on each occasion. As the petrol supply decreased rapidly all the time it was concluded that a main pipe must have been holed. There was no possibility of reaching the coast, so the navigator gave the pilot the shortest course by which they could reach occupied territory. After flying for about an hour the port inner engine began to splutter and the fuel pressure warning light came on. The captain ordered the crew to bale out. They expressed the wish to remain with him as he had no parachute, but the captain repeated his order, and they baled out from about 8,000 ft.

Then the port outer engine gave out, followed by the other three in rapid succession. The captain feathered the propellers and glided down, maintaining a speed of about 150 m.p.h. From 4,000 ft. he could see the ground covered with snow against which the woods stood out clearly as dark patches. The navigator had warned him before leaving that he was over wooded country with hills rising to 600 ft. He switched on the landing lights for a few seconds, but the glare from the snow was blinding. He levelled out

above a small town and, passing close over the roof-tops and a small wood beyond, came down on an open patch with several feet of snow. The Lancaster touched down gently, bounced forward and came to rest against a fence. As his harness straps were partly burnt away the captain was

thrown forward against the windscreen but soon recovered. He then went back into the fuselage and detonated all the secret gear, smashed the sets further with the butt of the axe, and started a good bonfire in the fuselage with maps, charts and logs, before making his get-away.

(c) A Double Victory

In quick succession three German fighters attacked Lancaster "H" of a 5 Group squadron returning from a target in eastern France on 15/16 March. Bad weather had prevented positive identification of the target so it had not been bombed. There was a layer of 4/10 low cloud at 6,000 ft., and above this a clear starlit sky, with no moon. The Lancaster was flying at 12,000 ft. when the wireless operator picked up an aircraft on instruments at a range of 1,200 yards. When the rear gunner first sighted it, he thought it was another Lancaster, but then saw that it was actually two Ju.88s flying in formation. One Ju.88 broke formation and, coming in rather below the Lancaster on its starboard quarter, opened up with cannon and machine-guns from 800 yards. The cannon fire was seen to pass over our aircraft, but hits were scored with machine-gun bullets on the rear turret, injuring the rear gunner in the left hand. At the same time the bulb in the rear turret gun sight fused, so that the gunner was without a sight during the ensuing combats. Meanwhile, the captain had corkscrewed on the rear-gunner's instructions and the enemy broke off to port. The second Ju.88 held its position to the rear and made no attempt to join in the combat. The first fighter then

renewed its attack, coming in level on the port beam and moved back to port quarter while the Lancaster corkscrewed and returned the fire. When the range closed to 300 yards the fighter's starboard engine burst into flames, and three members of our crew watched the Ju.88 go down and crash on the ground.

The second Ju.88 now began firing from about 800 yards on the port quarter below the Lancaster, but its fire came nowhere near. It then made a second attack starting from the port beam and following around to dead astern, firing all the time and closing in to 250 yards. While the bomber again took corkscrew action both gunners returned the fire, and eventually the Ju.88 went down in flames.

Before it had reached the ground a Me.109 came in below on the starboard quarter and opened fire at 600 yards with machine guns in the wings, but turned away at 450 yards after experiencing fire from both rear and mid-upper gunners and did not return. Throughout all five attacks the Lancaster had been carrying a full bomb-load. Having sustained only slight damage to the rear turret in the first attack, "H" now resumed course for base with two destroyed Ju.88s to its credit.

(d) A Day Fighter Destroyed at Night

On the same night Halifax "X" of 76 Squadron was attacked just at the start of its bombing run over Stuttgart, at 20,000 ft. Although the sky was dark above the bomber, cloud below reflected fires in the target area and made downward visibility fairly good. The flight-engineer warned the captain that there was a single-engined aircraft on the starboard beam flying a parallel course at about 800 yards range. The engineer told the gunners that he would watch this aircraft while they continued their search. The captain meanwhile turned the Halifax slightly to port to make the bombing run, and immediately afterwards the engineer saw the fighter bank and, reporting this to the mid-gunner, told him to take over. The latter warned the captain to prepare to dive to starboard and gave him the word to do so when range had closed to about 500 yards. The fighter came in very fast, dived below the bomber, and broke away on the port quarter. The fighter did not open fire, the speed of its approach and the bomber's manoeuvre doubtless making it impossible to do so. The mid-gunner, also, had no time to fire, but was able to recognise his opponent as a Me.109.

In all, four unsuccessful attempts were made by the fighter to get into position to fire at the Halifax.

Each time it came in the gunners and pilot co-operated skilfully to make it impossible for the enemy to carry out an attack.

The Messerschmitt came in for the fifth time on a "curve of pursuit" attack, on starboard quarter rather above the Halifax. At 300 yards range the tail gunner opened fire with two fairly long bursts. Strikes were observed on the fighter's fuselage. The fighter also fired as it started to close in, but scored no hits. The mid-gunner maintained his fire, and the enemy suddenly went down in a steep dive with smoke streaming from its engine. Its smoking descent was watched by captain, engineer and air-bomber, until it was lost to view as the Halifax turned to resume its bombing run.

During this engagement the Messerschmitt had come within 20 or 30 yards of the Halifax and while the mid gunner was firing at it he was able to see plainly the black crosses on the undersides of the wings, and the rest of the aircraft was coloured egg-shell blue. Thus it seems likely that "X" of 76 Squadron had encountered and destroyed a day fighter which had been ordered to take part in the night defences of the Reich.

(e) Two Unseen Fighters Destroyed

A Halifax ("K" of 429 Squadron) was returning from Essen at 21,000 ft. on the moonless night of 26/27 March, in rather poor visibility, when the rear gunner reported yellow tracer coming from three unseen aircraft positioned dead astern and on each quarter. The Halifax was attacked more or less continuously throughout the next half hour.

The rear gunner immediately asked for "corkscrew starboard" and at the same time opened fire towards the estimated position of one of the enemy aircraft. They were evidently equipped with heavy calibre armament, judging from the large flashes observed by our crew, but the Halifax sustained no damage. Following one long burst from the rear gunner one of the fighters was seen to explode in the air and four members of the crew, including the pilot, saw it fall earthwards followed by a further flash when it hit the ground.

The mid-upper gunner was in the under-blister look-out position at the time, and the wireless operator had just entered the mid-upper turret when he saw tracer coming from the starboard beam. He immediately fired in the direction of the attacking aircraft. The enemy appeared to move round to the starboard quarter, still firing, and was then engaged by both wireless operator and rear gunner with long bursts directed at the source of the tracer. Suddenly there was a burst of yellow flame, followed by a red glow which outlined the single-engined aircraft as it plunged towards the ground. It was impossible to watch it the whole way, but very shortly after it was lost to view three members of the crew observed a red glow on the ground. The destruction of two fighters in this area was confirmed by other crews on return. The third fighter failed to renew the attack, and the undamaged Halifax resumed its homeward course.

III. MISCELLANEOUS ITEMS

(a) Bombing Factories at Night

Although the great majority of our bombing sorties have been employed in mass attacks on the chief industrial areas in Germany, attacks on individual factories and military targets have always formed an interesting feature of our small-scale operations.

Until the end of May, 1943, when No. 2 Group was transferred from this Command to Tactical Air Force, these operations were normally carried out in daylight by small forces of light or medium bombers. Low-level attacks on targets, such as Philips Radio factory at Eindhoven, and the molybdenum mines at Knäben (Norway) were notable examples of their work. However, the small number and limited bomb-capacity of the aircraft suitable for these daylight operations—and particularly the limited range of all but the few available Mosquitoes—made it impossible to achieve important results by this means. On four occasions in 1942, Lancasters went out in daylight to attack the Augsburg M.A.N. factory, the Danzig U-Boat yards, Le Creusot steelworks, and the Italian industrial centre of Milan. The resulting damage was considerable, but the arrival of the U.S. Air Force equipped with heavy bombers specifically designed for daylight work enabled Bomber Command to concentrate its efforts on night bombing.

During the past nine months much profitable experience has been gained in the bombing of small targets at night. Quite early in the war it was found nearly impossible to knock out individual factories at night except in the very best conditions of visibility and moonlight—and, in order to search for the target, the attack had to be made from a relatively low altitude. There were naturally few worth-while German targets open to such methods of attack. Apart from the really outstanding night attack on the Paris Renault works on 3/4 March, 1942, successes were rarely achieved on these lines and we adopted more profitable tactics. Meanwhile Radar aids to navigation and target-marking devices developed rapidly. These are not yet sufficiently precise to make non-visual bombing of small targets a practicable proposition, but they do enable aircraft to navigate directly to the vicinity of their objective regardless of visibility on route. Having got there, to find and mark the exact aiming-point should, theoretically, be fairly simple. But at this stage good visibility is absolutely essential and really accurate marking is very far from simple. Nevertheless, the results achieved in recent months show a remarkable advance in this direction.

The evolution of the new methods can be traced from last June, when 60 Lancasters of No. 5 Group attacked the Zeppelin Radar factory at Friedrichshafen. This operation achieved notoriety because it happened to be the first

"Shuttle Raid" of the war—our aircraft landed in North Africa and returned later by way of Spezia. A more significant feature, however, was the procedure whereby the leader, or "Master Bomber,"* assessed the markers placed around the aiming-point and then gave bombing directions to the rest of the force. The signals procedure employed by the "Master Bomber" was similar to that devised for the attack on the Mohne and Eder dams the previous month.

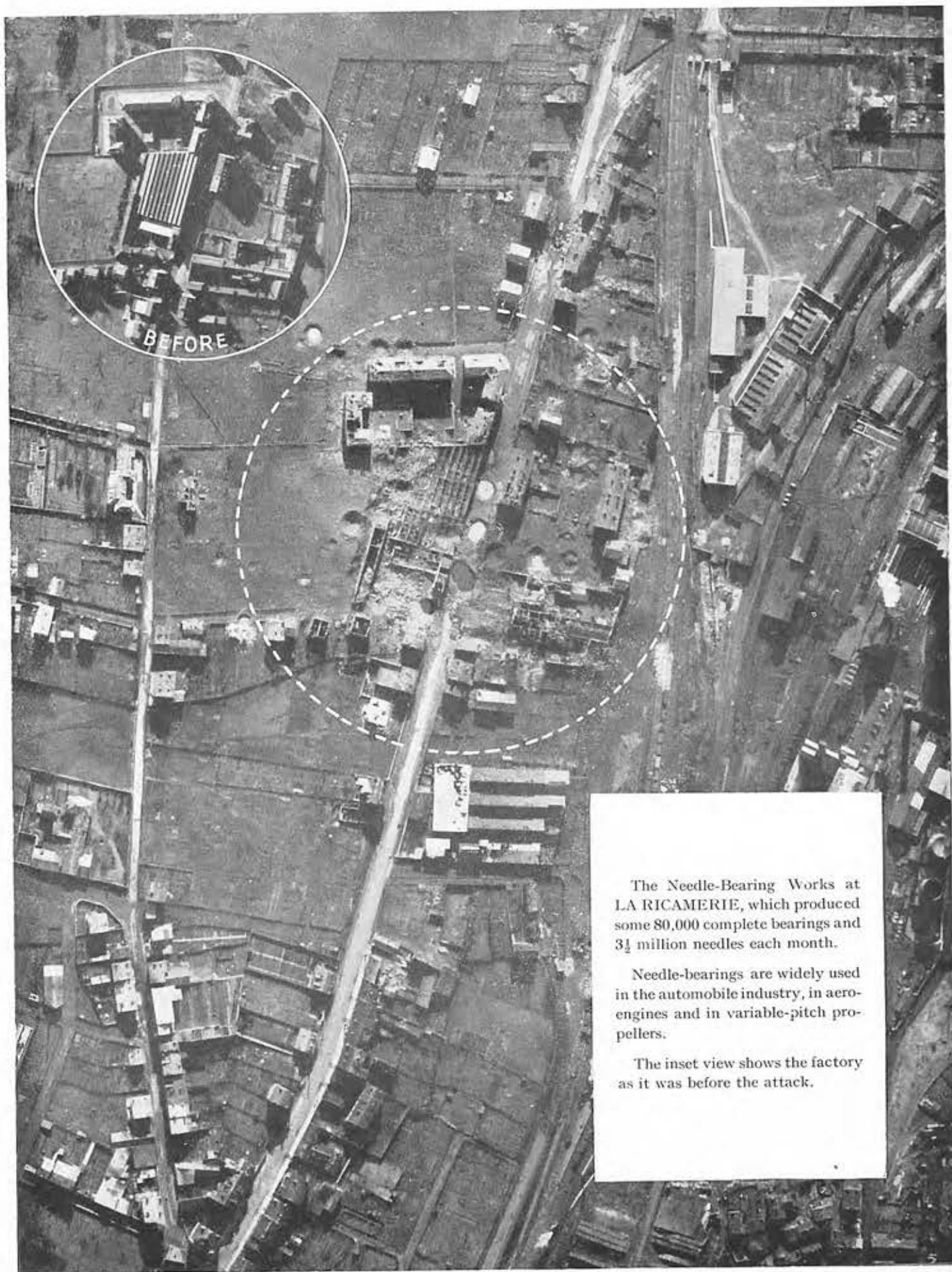
The inherent value of R/T control was emphasised in the course of the next few months when French factories were attacked by larger forces using the orthodox marking methods, and the "Master Bomber" was of great value in helping the main force to plaster the Peenemünde Radar Station last August. Meanwhile, No. 5 Group continued to practise and improve their technique, using very small forces of Lancasters with varying success against such difficult objectives as switching and transformer stations in Northern Italy, railway viaducts on the Riviera, and the military objectives across the Channel. By 8th February of this year they were ready to start in earnest.

In the space of seven weeks, up to the end of March, twelve small but important French targets were bombed and only one of these—a viaduct—escaped damage. Four of the factories were so thoroughly wrecked that it is unlikely the Germans will attempt to rebuild them. All the others suffered extensive damage. These creditable results were obtained for a total effort of less than 350 sorties, and a single missing aircraft.

The first attack was undertaken in bright moonlight by 12 Lancasters of a 5 Group squadron. Their objective was the aero-engine factory at Limoges in Western France which was producing for the Germans something in the region of 50 engines a month. Thick cloud with tops at 5,000–6,000 ft. was experienced on route, but cleared just short of the target. There visibility and illumination were as good as could be wished for and no opposition was encountered. The leader dived to 200 ft. to release a load of 30 lb. incendiaries on the centre of the factory—as shown in the remarkable photograph here reproduced as Fig. 16. The deputy-leader followed up at 7,000 ft., dropping two "Red Spot Fires" among the incendiaries and the rest of the force were ordered to bomb this unmistakable aiming-point. They did so, from about 9,000–10,000 ft. The first H.E. to go down was a 12,000-pounder, which was seen to score a direct hit on the factory. Four more 12,000-pounders were dropped during the attack and all but one fell on the factory. Smoke and debris rose thousands of feet, though the biggest fire was later damped down by a heavy bomb landing in the middle of it. As a result the leader was able to observe the last

* On page 9 of *B.C. Quarterly Review*, No. 6, will be found a narrative of this operation as told by the Flak liaison officer who accompanied the Leader.

NIGHT ATTACK ON A SMALL FACTORY



The Needle-Bearing Works at LA RICAMERIE, which produced some 80,000 complete bearings and $3\frac{1}{2}$ million needles each month.

Needle-bearings are widely used in the automobile industry, in aero-engines and in variable-pitch propellers.

The inset view shows the factory as it was before the attack.

FIG. 15.—One of the outstanding achievements of accurate night bombing was the work of sixteen Lancasters on 10/11 March, 1944. Although cloud made it almost impossible to see the target except from directly overhead, the Needle-Bearing Works was almost entirely destroyed. The multi-bay building was obliterated, and only one of the smaller buildings was undamaged. The factory covered an area of about 170 yards by 90 yards.



The GNOME & RHONE WORKS, LIMOGES

This modern aero-engine plant was the target for a very successful night attack by twelve Lancasters, on 8/9 February.

FIG. 16 (*above*).—Low level view, from a cine-film taken by the Leader's aircraft, showing 30-lb. incendiaries bursting on the works.

FIG. 17.—Columns of smoke rose from the target as the attack developed—a vertical night photograph.

FIG. 18.—A ground photo of the ruins after the attack. This shows the modern reinforced-concrete type of construction.

(See Figs. 19 and 20.)



LIMOGES AERO-ENGINE WORKS WRECKED BY TWELVE BOMBERS AT NIGHT

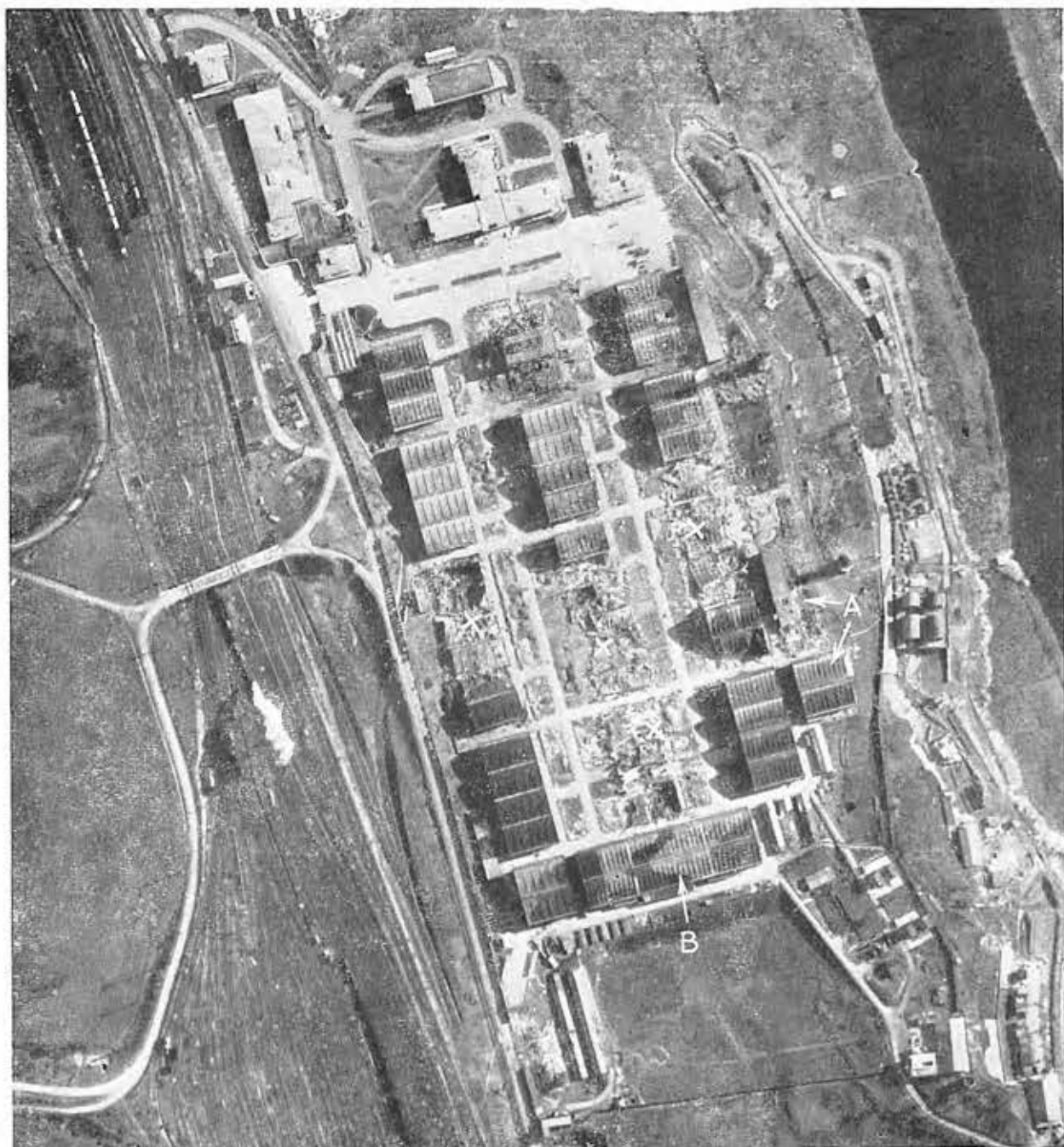


FIG. 19.—Vertical reconnaissance showed that four out of the five 12,000-lb. bombs dropped by the Lancasters had scored direct hits (X) on the works, each on a separate building. Only seven of the 48 bays comprising the factory escaped damage. The Assembly and Experimental Shop (B), for instance, was considerably affected by blast. The area marked A is seen obliquely in Fig. 20 below.



FIG. 20.—This oblique photograph, taken by a Mosquito on low-altitude reconnaissance, provides an interesting comparison with the vertical view above, and the ground photograph opposite. The buildings on the left are those marked A in Fig. 19.

MICHELIN TYRE PLANT, CLERMONT-FERRAND



FIG. 21.—On 16/17 March 21 Lancasters attacked the Cataroux section of the MICHELIN TYRE PLANT, the second largest rubber factory in Europe. At least five direct hits (X) were scored by 12,000-lb. bombs on the two largest buildings.

The Power Station (A) was put out of action. The units for truck- and car-tyre production (B), and the inner-tube plant (C) were wrecked beyond repair. Note distortion of roof girders. Many other buildings, including the Compounding Workshop (D), were also damaged.

12,000-pounder fall right through the roof of one of the remaining factory buildings and burst inside it. Subsequent reconnaissance (Fig. 19) confirmed that four out of five of the very heavy bombs scored direct hits, each on a separate building. These were all of recent reinforced concrete construction. Of 48 bays comprising the factory, nearly half were destroyed and only seven escaped damage.

As reference has been made to the damage caused to other factories associated with aircraft production and munitions in subsequent attacks (see Part I, *Review of Operations*) it will suffice to mention three operations which were equally successful, despite initial difficulties in marking the aiming point.

When the Michelin plant at Clermont-Ferrand was attacked by 21 Lancasters (16/17 March) the incendiaries released by the leader from 140 ft. fell to the east of the target, and he instructed his deputy to assess their position for the information of the rest of the force. The deputy-leader did so and, from a height of about 100 ft., released incendiaries accurately across the factory, placing his "Red Spot" fires amongst them. The leader ordered the remaining aircraft to bomb these markers and to ignore those to the east. Daylight photographs showed at least five direct hits by 12,000-pound bombs on the two largest buildings of the works.

On another occasion, when 15 Lancasters were ordered to bomb the factory at Albert (2/3 March) the leader was unable to mark the target because his bombsight was unserviceable. Accordingly the marking was carried out by the deputy and severe damage was caused to the target.

Perhaps the most impressive testimony to this bombing technique was the execution of the attack on the Needle-Bearing Works at St. Etienne/La Ricamerie. This time weather was described as "greatly hampering the attack" so that the planned procedure had to be modified. The leader reported that "cloud made it impossible to see the target except from directly overhead. Flares could not be used since their setting would have caused them to burn above the clouds"—which were at 6,000–8,000 ft. He therefore marked with 30 lb. incendiaries the west and eastern edges of the target and ordered the other 15 Lancasters to bomb the incendiaries through cloud. In the circumstances it would not have surprised anyone acquainted with the difficulties of night bombing if a factory which only covered an area of about 170 yards by 90 yards had escaped serious injury. However, reconnaissance (Fig. 15) shows it almost entirely destroyed, and the ruins form the centre of a compact group of bomb-craters.

It is therefore evident that, although these operations depend upon visual pin-pointing and the accurate placing of a single marker assessed by the leader, the technique has a flexibility which offers a good chance of success in all but the least favourable circumstances. There are limitations, of course, but some initial difficulties have been overcome and marking is now being undertaken from a considerably higher level. Since the end of the quarter further small attacks have achieved notable results and, on a more ambitious scale, the marking technique has been employed deep inside Germany itself. As it is too soon to assess fully the results of these latest operations they will be discussed in the next issue of the *Review*.

(b) Some Medical Factors which Affect Bomber Operations

In the selection of flying personnel, the R.A.F. pre-war standards applied to the physical aspects have stood the test of time and experience. All aircrew personnel now undergo, however, X-ray examination of chest and special equipment has been developed for ensuring the reliability of the physical tests, more particularly in respect of the examination of the functions of the eyes and ears, which play a part in operations of paramount importance.

The psychological aspect in selection, although it was not neglected in peace time, had not then the same significance it has in war, where strain and fatigue have emphasised the effect on the attainment of success in operations particularly of family and individual predispositions.

The physical tests now employed together with those which deal with the psychological side of the make up of an individual and which include tests similar to those used to determine suitability for trades have produced very considerable economies in training by sorting out at a preliminary stage individuals likely to be best fitted for particular duties.

As the many ailments, illnesses and disabilities to which flesh is heir can only be kept under

limited control, and bearing in mind that the suspicion of any illness in a crew member automatically renders him a doubtful starter, a substantial rate of non-effectiveness due to sickness, having a weighty effect on operational effort, might be expected to arise.

An analysis of this non-effectiveness over a period of 12 months of strenuous operational effort has shown that for every 1,000 aircrew an average of 1.6 becomes non-effective sick daily. If the average duration of each case is taken as a fortnight this means that out of 7,000 personnel required to man 1,000 heavy bombers, approximately 150 persons will be constantly non-effective sick.

Another aspect of operational non-effectiveness is the last-minute cancellation of a sortie due to sudden illness, injury or other medical disability. During the year 1943, only three out of every 1,000 sorties which had been detailed, were cancelled from this cause. This small average of 0.3 per cent. cancellations due to sickness at the last moment suggests, apart from its medical insignificance, a high degree of morale and individual keenness not to let the crew down.

A further aspect which is a corollary to the above is the number of sorties abandoned after take-off for such conditions as air sickness, syncopal attacks, oxygen lack and temperature effects. In 1943, abandonments through these causes totalled only 0.7 per cent. of the total sorties.

It is worth enlarging a little on the subject of lack of oxygen which has been for a long time a matter of prime consideration.

Training of aircrew in the decompression chamber of which there are 13 in the Command, has proved invaluable, but once the proper use of the equipment and the effects of anoxia (oxygen lack) have been demonstrated in this way, it has been essential, by continued training, to instil a crew procedure or drill which will reduce the possibility of anoxia occurring, and which will ensure immediate warning should any member of a crew show signs of it.

The nature of the onset of symptoms through oxygen lack is well understood and can be countered by good procedure and warning, but at altitudes of 20,000 ft. and above, progressive anoxia invariably ends in unconsciousness, manifested in one of the following ways:—

- (i) Simple loss of consciousness characterised by no previous symptoms to allow a warning to be given.
- (ii) A feeling of weakness and dizziness which permits time to call aid, but the individual is likely to be unconscious when aid arrives.
- (iii) A sudden lapse into unconsciousness with marked convulsions.
- (iv) A sudden respiratory arrest and failure.

Unconsciousness occurring at a crew station which is exposed to extremely low temperature may result in death at altitudes in the neighbourhood of 25,000 ft., but sudden lapse into unconsciousness and sudden respiratory arrest are, fortunately, of rare occurrence.

Before these stages are reached, however, investigations have shown that lack of oxygen, as ascent is made, can be responsible for varying degrees of failure in operational efficiency, and it is towards the prevention of these that so much attention to the development of reliable equipment for use by the individual and insistence *ad nauseam* on its correct fitting and maintenance, have been made. In addition, it has been necessary to lay down regulations as to the rate of flow of oxygen at varying heights in relation to the rate of climb, effort to be sustained, duration of sortie, and temperature encountered, at the same time having regard to economy in oxygen.

With the oxygen flow provided and with the correct fitting of the oxygen mask, its correct assembly and its perfect union with the main supply, when combined with correct procedure for use, there have been no oxygen failures. Failures have occurred due to a combination of personal and equipment error—mostly personal error. The "G" type mask has proved efficient at all heights, except that in very low temperatures there has been a tendency to ice formation. Crew members have been instructed how to deal with such freezing. There has, however, been evidence of oxygen failures from this cause and its

remedy has been one of the main problems on the heavy bomber operations, in an endeavour to relieve the individual of having himself to de-ice by manipulation. The problem, however, has been localised to personnel manning exposed crew stations such as turrets, or to personnel who have to perform duties in the prone position such as bomb aimers or other crew members engaged in downward search. In these latter the tendency for moisture, on expiration, to gravitate along the corrugated tube and thereafter cause ice formation, is considerable.

A microphone heater and a modification round the expiratory valve of the "G" mask have been developed and in operational use have almost eliminated icing problems.

The flight engineer and others whose duties involve moving about in the aircraft during which the use of the portable oxygen supply is necessary, present an additional problem owing to the small content of the oxygen in the portable bottle and to the difficulty experienced of transfer from main to portable supply at 20,000 ft. or over, and consideration is now being given to providing additional tubing to ensure the crew member being connected to a main oxygen point while permitting a range of movement.

Psychological Aspects in Operations

Psychological factors have had to be kept continually in mind, and to these, R.A.F. consultants and specialists in neuro-psychiatry have devoted much time in personal contact with crew personnel at O.T.U.s and operational units.

A high degree of morale amongst bomber aircrew has been evident throughout and is proof that innate fearlessness, which is the possession of a few only, is not so important an asset in operations as is courage, which is a state of mind in which fear is present but is controlled and mastered for the sake of attaining an object. It is to the stimulation of courage that effort and treatment have been applied, and in this the role which the creation of confidence plays has been a most important one. Sound training, reliability of aircraft and equipment, good leadership and objective planning have supplied the ingredients which have restored after a short period of rehabilitation, many of those whose confidence had been shaken.

The limitations to tours of operational duties and to the number of successive sorties which an individual is required to make, have been carefully planned in relation to the power of the average aircrew member to perform his duty, and the limits have had to be governed by the necessity of ensuring that the experiences gained by him will be used to produce the maximum operational effort which total war demands. The success of the planning in this respect is borne out by the increased operational effort which the Command has been able to sustain.

Visual Problems Affecting Operations

Apart from the visual standards required in respect of acuity, colour perception, refraction, accommodation and ocular muscle balance which have been determined in relation to the duties to be performed, only the problems of night visual

capacity and visual fatigue need particular reference in a Bomber Command Operational Review.

A night visual capacity (N.V.C.) of some degree, as a pre-requisite to night bomber aircrew, is in the view of Bomber Command Air Staff and its Medical Staff a *sine qua non* and the problem of measurement of this eye sense has been to the R.A.F. Consultant in Ophthalmology, who holds a similar view, a matter of profound research.

The whole theory and practical aspects of night vision have been fully and simply explained in an A.M. Pamphlet No. 158, *Hints on Night Vision*, available to every crew member.

Clearly for crew members in their duties of "air to air" and "air to ground" search and scanning, for sighting and air firing and for other offensive and defensive tactics a high degree of N.V.C. is desirable, even should the development of special equipment reduce its essential need.

On the pre-requisite of a night visual capacity score has followed the formation of night visual training schools in the Command, at which crew members are taught how to see and to make the best use of their night visual sense. This training has been directed to development of correct procedure in the use of the eyes by night, to ensure full employment of the peripheral or rod vision, to development of form sense and to training in search under conditions of low light contrasts. The development of these schools during the last 12 months, starting from a central night vision school, has been a notable feature of training in which medical participation and stimulation have been considerable.

The effects of anoxia on night vision have been clearly determined and researches have shown quite definitely that oxygen is even more important to night vision than to day vision.

In considering night vision the problems of dark adaptation has had to be kept in mind. This adaptation can be destroyed in seconds and takes many minutes to return, therefore, the means of lighting in aircraft—panels, navigation map and

charts, etc., and of protection from searchlights, reflection from perspex, etc., have had to be considered from the medical angle.

Fatigue arising from prolonged use is normal to all eyes, but when used under conditions applicable to night bomber operations, particular attention has had to be given to the problem and as under present conditions a visual contact is still required for the purpose of sighting and firing, it is necessary in order to reduce eye fatigue, to ensure efficient controllable internal lighting in aircraft, clean perspex or open panels, use of oxygen at heights over 4,000 ft. and moderation in alcohol and smoking.

Aids for Prevention of Casualties while Airborne

Some considerable investigation has been made as to the value of protective armour for crew personnel. These have indicated that a protective armour, such as a heavy flak jacket, would not be of any considerable value for crews of the heavy night bomber type. The incidence of injuries to the parts of the body to which protection would be given is relatively small as compared with the enormous disadvantages which the wearing of the jacket causes in the performance of the duties required. The investigation carried out took into consideration the number of crew who were known to have received injuries by flak and gun fire, the types of aircraft in which the injuries occurred, the various crew stations involved and the frequency of the injuries to the various parts of the body.

The provision of first aid equipment in aircraft has proved its value many times. The scale of provision made is on the basis of the one outfit for one/three crew aircraft, two for four/six crew aircraft and three for over six crew aircraft. Special care has been taken to confine the lectures given to aircrew to the essentials of first aid in the air. The points required to be remembered are:

- Rest—therefore place in a comfortable position.
- Warmth—hence the value of full flying kit.
- Freedom from pain—hence morphia.
- Fluids—except in abdominal injuries.
- Reassurance.

(c) Maintenance of 1,000 Aircraft

The work of the ground crews, though unspectacular, is one of the most arduous and important tasks of all, and upon their efficiency depends the ability of the aircrews to carry out successfully the missions imposed upon them. Every job they do has to be done with a full sense of responsibility for they well know that the lives of their comrades may be forfeit if their work is not of the very best. This knowledge is undoubtedly responsible, in no small measure, for the very high standard of workmanship that has been reached with the result that the aircrews have the greatest confidence in the aircraft in which they fly.

The substitution of the four-engined for the two-engined bomber in the last two years and the very great increase in the numbers and complications of the equipment carried, has more than doubled the work of maintenance as a whole. If a

moment's thought is given even by those unversed in the mysteries of aircraft and aero-engine construction, it is not difficult to visualise to some extent the care and skill that must be exercised in maintaining an aircraft at the high pitch required for the dangerous tasks that have to be performed.

The task, moreover, involves exceptionally hard work often carried out in the most unpleasant and uncomfortable conditions. It is done, however, with a will and cheerfulness almost beyond comprehension except perhaps to those who know the satisfaction which a skilled tradesman feels after a long day's work when he sees the aircraft take-off without a hitch and, better still, return to base having successfully accomplished a good night's work.

It may be thought that there is little work for ground crews during times when operations are

less frequent due to weather conditions or during the hours when the aircraft are actually out on a raid. This is not so, for, save on exceptional occasions, a unit will always have some aircraft unserviceable at any given time, and when the aircraft are out on an operation, the mass of ground equipment required to keep the aircraft serviceable has itself to be serviced and everything prepared for the returning bomber so that it can immediately be serviced and made available for operations the following night.

Not only are the technical staffs planning routine inspections and endeavouring to find quicker and better methods of doing certain work, but they have to be ready at all times to meet emergencies. Their aim is to make as many aircraft serviceable for an operation as possible and frequently more than one aircraft will return to a unit requiring an engine change, which is no light task in itself. However, so adept have the servicing personnel become that normally a Rolls Royce power plant can now be changed within four hours and some units have even accomplished it in 2½ hours. However, careful planning is required to change the engines and carry out various forms of repair work and to re-fuel and re-arm the aircraft and make them available for the following night's operations, especially in the winter when the hours of daylight are short, for all the work is carried out in the open.

The work of the engineer officer is long and arduous. He likes to be present at briefing and take-off. When the aircraft have been despatched he is looking after the welfare of the men and seeing that everything is in order for the return of the aircraft. He is present at the interrogation of crews and receives the reports on the condition of the aircraft. Many and varied are the details of damage that have to be examined, much of it due to enemy action, and he has to plan the work that is necessary, laying down the various priorities, and it is his responsibility to supervise and see that the work is carried out properly. Sometimes an aircraft will crash land on the airfield while the work is being carried out and he then, without delay, must set about clearing the airfield. There is very little "let up" for the servicing staff.

A few figures may help to illustrate the size of the task involved in preparation for an operation by a thousand bombers.

Over 2,000,000 gallons of petrol, 70,000 gallons of oil, and 5,000 gallons of coolant are put into the aircraft. Over 4,500 tons of bombs may be required and 10,000,000 rounds of ammunition for the guns. Thirty thousand bicycles, 3,500 bomb trolleys and 6,000 other vehicles are employed. Fifteen million litres of oxygen are required. Eight thousand pints of coffee and 6,000 lbs. of food are placed in the aircraft.

(c) Maintenance of 1,000 Aircraft

The work of the engineer officer is long and arduous. He likes to be present at briefing and take-off. When the aircraft have been despatched he is looking after the welfare of the men and seeing that everything is in order for the return of the aircraft. He is present at the interrogation of crews and receives the reports on the condition of the aircraft. Many and varied are the details of damage that have to be examined, much of it due to enemy action, and he has to plan the work that is necessary, laying down the various priorities, and it is his responsibility to supervise and see that the work is carried out properly. Sometimes an aircraft will crash land on the airfield while the work is being carried out and he then, without delay, must set about clearing the airfield. There is very little "let up" for the servicing staff.

A few figures may help to illustrate the size of the task involved in preparation for an operation by a thousand bombers.