R. V. Jones

Prologue

'This was a secret war, whose battles were lost or
won unknown by the public; and only with difficulty
is it comprehended, even now'

WINSTON CHURCHILL, *THEIR FINEST HOUR*

21 June 1940

Reginald Jones was late.

This was not an unfamiliar situation for the young scientist. Despite the pressures of the war, the 28-year-old Jones had pointedly maintained a more relaxed schedule. The first messages needing his attention at the Air Ministry near St James's Park rarely came in before 10 a.m., so why should he arrive earlier?

Unfortunately, however, this morning a message had for once arrived early at his office. On his desk, when he walked in at 10.10, there was a note from Daisy Mowat, his boss's secretary. It read: 'Squadron Leader Scott-Farnie has telephoned and says will you go to the Cabinet Room in 10 Downing Street.'

Jones and Mowat did not have a formal work relationship. Once, for instance, she told an important caller that Mr Jones could not come to the phone because he had jumped out of a window. He had to wrest the call from her, and – rather than deny he had climbed out of a window, which would have been an unsportsmanlike way to ruin a good joke – explain that that was just what he did for exercise. So he presumed that this message from Mowat too was a practical joke. As yet unconcerned, he went to check with her. She assured him it wasn't.

Jones rushed out and hailed a cab for the short journey to Downing Street. Then, twenty-five minutes after the meeting had been due to start, he pushed open the double doors and hurried into the Cabinet Room.

The meeting proceeded without interruption, and for Jones the sight of the dozen or so attendees must have been an intimidating one. Around the table sat Lord Beaverbrook, minister of aircraft production; Sir Archibald Sinclair, the Air Minister; Sir Cyril Newall, Chief of Air Staff; Sir Hugh Dowding, who led Fighter Command; Sir Charles Portal, who led Bomber Command; and Philip Joubert, in charge of RAF signals.

Then there were the scientific officers: the top brains in the land, who directed British research in this, the most technological war in history. There was Dick Tizard, who advised Air Staff; Robert Watson-Watt, who advised on telecommunications; and Frederick Lindemann – who was both scientific advisor and sage to Winston Churchill and, more pertinently, Jones's old professor. He was the reason Jones was here at all. Sitting in the middle of them all was Winston Churchill himself.

When Jones sat down, as quietly as he could, the conversation continued. The atmosphere was frosty, it was 'perhaps even that of a confrontation', Jones later recalled. There had indeed been a disagreement. Some of those present were unwilling to believe the claim, based on accounts from intelligence sources and half-heard conversations among downed German pilots, that the Luftwaffe had been using beams to direct their planes into Britain.

The startling theory was that the Luftwaffe could project two narrow radio beams over the country, forming a cross shape in the air. The German planes flew down the route of one of the radio beams, and when they met the other – at the point where the beams crossed – the bombers knew they had reached their target. It was an electromagnetic version of 'X marks the spot', and to many in this room it did not seem credible.

Some thought that such an idea was not merely fanciful, but impossible: a beam could not be that accurate. It could not, they pointed out, travel that far or curve around the horizon. A radiographic channel, carrying an armada of bombers to its target? It was barely worth considering. And why would any decent air force bother, in any case? British crews got by fine with stellar navigation.

Those gathered in that room were an impressive group, but as they argued Jones was not impressed. From the way they were talking, it was clear to him that many understood neither the science of the beams nor its importance.

At last Churchill turned to address a technical question to Jones. 'Would it help, sir,' the young man replied, 'if I told you the story right from the start?'

Writing after the war, Churchill described that moment as like sitting in the parlour while the great detective finally reveals the killer. 'For twenty minutes or more,' Churchill wrote, 'he spoke in quiet tones, unrolling his chain of circumstantial evidence, the like of which for its convincing fascination was never surpassed by tales of Sherlock Holmes or Monsieur Lecoq.'

The doubters were not necessarily won over, but they were no longer relevant. Jones, at the age of not even thirty, had spoken above their heads, to make an ally of the only man who mattered.

'Being master, and not having to argue too much,' Churchill wrote of that meeting, 'once I was convinced about the principles of this queer and deadly game I gave all the necessary orders that very day in June for the existence of the beam to be assumed, and for all countermeasures to receive absolute priority. The slightest reluctance or deviation in carrying out this policy was to be reported to me.'

The Battle of the Beams had begun.

At the beginning of the Second World War, much of the RAF establishment held two firm beliefs. The first was that through British pluck and ingenuity the country had, on its own, devised a superweapon: RDF, or radio detection finding, now known as 'radar'.

All along the south coast was a chain of powerful radio transmitters. These projected an invisible arc of radio waves out towards Europe. As bombers flew into range, the radio waves would ricochet and bounce off them, returning as faint echoes to the transmitters. Through these echoes, a central command centre could see the location of the Nazi planes and direct Britain's fighters to intercept them. Then, concentrating in a massed force on the invaders, they could – at least during the day – bring them down. The Germans, ignorant of this superweapon, would never know how they did it.

The second belief held by the British establishment was that German bombers, which relied on sight, could only be accurate by day – when they were vulnerable to attack by Hurricanes and Spitfires. Their British counterparts, on the other hand, would find their targets by night as well. Britain was a maritime nation, after all. Its people were trained in the arts of celestial navigation. At 20,000 feet, there is rarely cloud cover to prevent the use of astrolabe and sextant. The RAF bombers could become a nocturnal force, flying far above the sleeping citizens of Europe, evading anti-aircraft fire and enemy fighters under cover of darkness. The stars would guide Britain to victory.

There were hints, though, that maybe these beliefs needed to be questioned. The costliest hint came as soon as the British bombing campaign began – and a vast number of RAF planes started tumbling, fluttering and smouldering down on to the fields of France. In the years to come, desperate battles were fought over occupied Europe. Four miles above the ground there were heroic deeds and terrible sacrifices that will go forever unrecorded. But these individual tales, however brave, in aggregate became simply statistics, to be analysed back at the Air Ministry. And when they were analysed, what they showed was very unsettling indeed.

For each Bomber Command sortie, out of 100 planes that left their runways, 95 returned. Fly two missions, and your odds of making it to breakfast in the mess were roughly 90 per cent. Fly three, and they were similar to a round of Russian roulette. Just under one in six failed to make it any further.

Jack Furner, a navigator who went on to become Air Vice-Marshal, later recalled his period flying with 214 Squadron. On one six-month tour, in 1943, his plane was one of just two that survived. A 95 per cent return rate always had a different meaning to him. 'The figure says it clinically: to put it in a more meaningful way – on a typical operation involving 750 bombers, it meant the loss of 260 aircrew.'

Those numbers, each representing families whose sons, fathers and husbands would never return, told a technological as well as human story. To those who knew how to analyse them they showed the Nazis had radar too, and very good radar at that. The first of the RAF's treasured assumptions was wrong.

The evidence against the second assumption, that celestial navigation worked, was harder for the RAF to come by – although the Germans knew it almost immediately. This evidence came in the unarguable form of the bombs those RAF planes dropped, at such bloody cost. Far more often than not, rather than hitting their target these bombs exploded uselessly across the fields of Germany. A top-secret report in 1941 used aerial reconnaissance to estimate that of the planes that reported attacking their target, only one in three actually got within five miles of it. Aircrew were risking their lives to put craters in fields.

When Jones met Churchill in the Cabinet Room in June 1940, all this was to come. The Blitz had not begun, the British Expeditionary Force had only just been evacuated from Dunkirk. Misconceptions about British advantages still remained uncorrected. But among the small circle of men in that room the first chink had appeared. Because whether or not British pilots really could make it to Berlin at night by following the stars, it was clear that German pilots could do the reverse journey from Berlin to London without needing to. They just had to follow the beams.

It was 'a painful shock', wrote Churchill. 'The Germans were preparing a device by means of which they would be able to bomb by day or night whatever the weather . . . like an invisible searchlight [it would] guide the bombers with considerable precision to their target.'

With France about to fall, the first serious raids from the Luftwaffe were expected any day – to soften up Britain for invasion. As Jones sat down in that room, there was an obvious conclusion to be drawn. They needed to find the beams, and find them fast.

We know about Bletchley Park and the Manhattan Project. They have entered mythology. Just as conventional militaries understood that victory came from concentrating their army's firepower on a single target, these were places where a nation concentrated its brain power. Brought together into a fizzing critical mass of intellectual energy, these boffins – as the popular newspapers of the time called such men and (just occasionally) women – solved problems that seemed insoluble, and in doing so shortened the war.

There was another scientific war, no less important than code-breaking or atomic weaponry: the battle to outwit the enemy not merely in the air but on the airwaves. The full scale of this technological war has often been overlooked, or if it has been recounted we have concentrated on just one aspect of it – the development of defensive radar. But the wider electromagnetic war was crucial first to survival and then to victory. The tools developed by its combatants allowed Britain – in its darkest hour – to see.

This war was fought with the tools to hand. The effort to beat the beams required jury-rigged countermeasures, designed on the fly and, on more than one occasion, commandeered in desperation. Somehow, though, this scientific war has never quite gained the same status.

Bletchley and Los Alamos were nurseries for the world's top scientists. Bletchley was where the finest Cambridge mathematicians applied their once arcane knowledge to codebreaking. The Manhattan Project was where the Allies' greatest physicists came together to solve the greatest practical problem in science. Their names would become famous, and sometimes infamous: Oppenheimer, Fermi, Bohr, Feynman, Fuchs.

Radio research was a similar process. After the war, released from their military duties, many of radio's leading figures would go on to populate the top universities. Some would stay in radar, developing the systems that could track Soviet ballistic missiles. Still others would move into parallel fields – building Britain's first nuclear power station or, in the case of Sir Bernard Lovell at Jodrell Bank, and Martin Ryle, the Nobel Laureate, adapting radar work to radio astronomy.

In the First World War the British army swept in on cavalry but soon saw their dreams of a decisive charge scythed down by the pitiless machine-guns of the Western Front. Likewise the notion of navigational exceptionalism did not survive contact with the enemy. Neither, though, in part thanks to Jones and his intervention at Downing Street, did the Nazi belief in their own mastery of radio waves.

Together these scientists, and the German adversaries they sought to outwit, created a new kind of war. At the start of the war the sky was a lonely place. A British bomber aimed by sight, and navigated using techniques that would have been recognized by participants at the Battle of Trafalgar.

By the end, there were navigation systems that had changed those lamentable bombing odds. They could direct a lone bomber to a single factory in the Ruhr – and leave it in rubble. There were radars that could spot the outline of Berlin from 20,000 feet through thick cloud. Meanwhile there were German anti-aircraft guns that could spot the bomber through thick cloud and shoot back. And there were also nightfighters that could spot all of these radio waves bouncing around and lock on to the bomber that sent them.

This is not the book to tell the history of all of these advances, or of all the people involved. Like Turing and Flowers at Bletchley or Oppenheimer and Bohr at Los Alamos, though, in the tale of this electronic one-upmanship there are names that stand out. One of these is Reginald or, to use the initials he preferred, R. V. Jones.

Jones is far from unknown. In the 1960s and 70s he emerged from the shadows of intelligence and briefly gained minor celebrity status – a status he rather enjoyed – with a TV show and an autobiography. Although that book retains cult status in the scientific community, outside it Jones has been almost forgotten. If the length of a Wikipedia page is a measure of a man's worth, his at the time of writing is 1,200 words. Turing has 10,000. Smoky, a Yorkshire Terrier adopted as a mascot by the US 5th Air Force, has 1,600.

This is an injustice. Jones was one of those rare scientists who had the ability to sit in a room and, with pencil and paper, see into the mind of his enemy. He worked out, often with just fragmentary information, what the Nazis were planning – and what the devices they built to achieve it would look like. Then he and others were able to devise ways to defeat them.

Unlike the caricature of the boffin, as exemplified by Turing, Jones was not someone who would avoid human contact. This young man, the son of a postman, was a practical joker who could look you in the eye, who would go to the pub with his most junior colleagues – but was unperturbed about contradicting the most powerful men in the land. He was a showman who would tell a good anecdote – even if after the war his contemporaries occasionally complained the stories were a little too good.

He was the most unlikely of leaders, but war is a great leveller. In a crisis, talent can rise. When the war began he was assigned to the Air Ministry as a scientific advisor. Because he needed a title, and it was far from clear what this job even was, he was made Assistant Director of Intelligence (Science). What he directed, and indeed who he assisted, was not clear. At the start, he was the only person in his team. Because he was very good at his job – a job he largely created – by his thirtieth birthday he was part of the small circle that knew the great secrets of the state.

Jones received Enigma decrypts direct from Bletchley; he had the ear of Churchill. At his request, pilots were sent on perilous photographic reconnaissance missions to German radar stations, and commandos on daring raids into enemy territory. He gained this power – or perhaps respect is a better word – not through his rank, but through his results, through an uncanny ability to predict what the Germans were about to do.

He was not working alone. There were others, many others, involved in radar and radio intelligence. There was the network of spies and resistance fighters in Belgium and France. There were the decoded messages and ingenious work of POW interrogations. There was the new science of photographic interpretation. And there was a team of some of Britain's most able scientists.

Then there were those who turned insight into activity. To be worth anything at all, what he and his colleagues discovered needed to be acted on: by the engineers and physicists who built the countermeasures, and by 80 Air Wing, the RAF unit who applied them. But, still, it was of Jones that Churchill would later say his 'magnificent prescience and comprehension . . . did far more to save us from disaster than many who are glittering with trinkets'.

During the four years after the retreat from Dunkirk the only Western Front that existed lay in the air. It was here that the Axis and Allied powers parried and probed. For every advance, there was a counter-advance. One side developed onboard radar on bombers to see attacking planes, the other put receivers on attacking planes to see the radar signals from the bombers they were stalking. Ground-based radar could spot individual bombers from distances well over 100 kilometres, but at the same distance individual bombers could also drop reflectors that deceived those on the ground into thinking they were a vast armada.

This was a game of shadows and feints in the skies above France. On any one night, flying over occupied Europe, there were new radar systems, old radio systems, and systems that existed solely to be jammed – decoys there so that the real advance they were hiding was ignored a little longer. Major technological improvements, that in peacetime would give an air force superiority for years, were introduced knowing that, at best, they had a useful lifespan of three months.

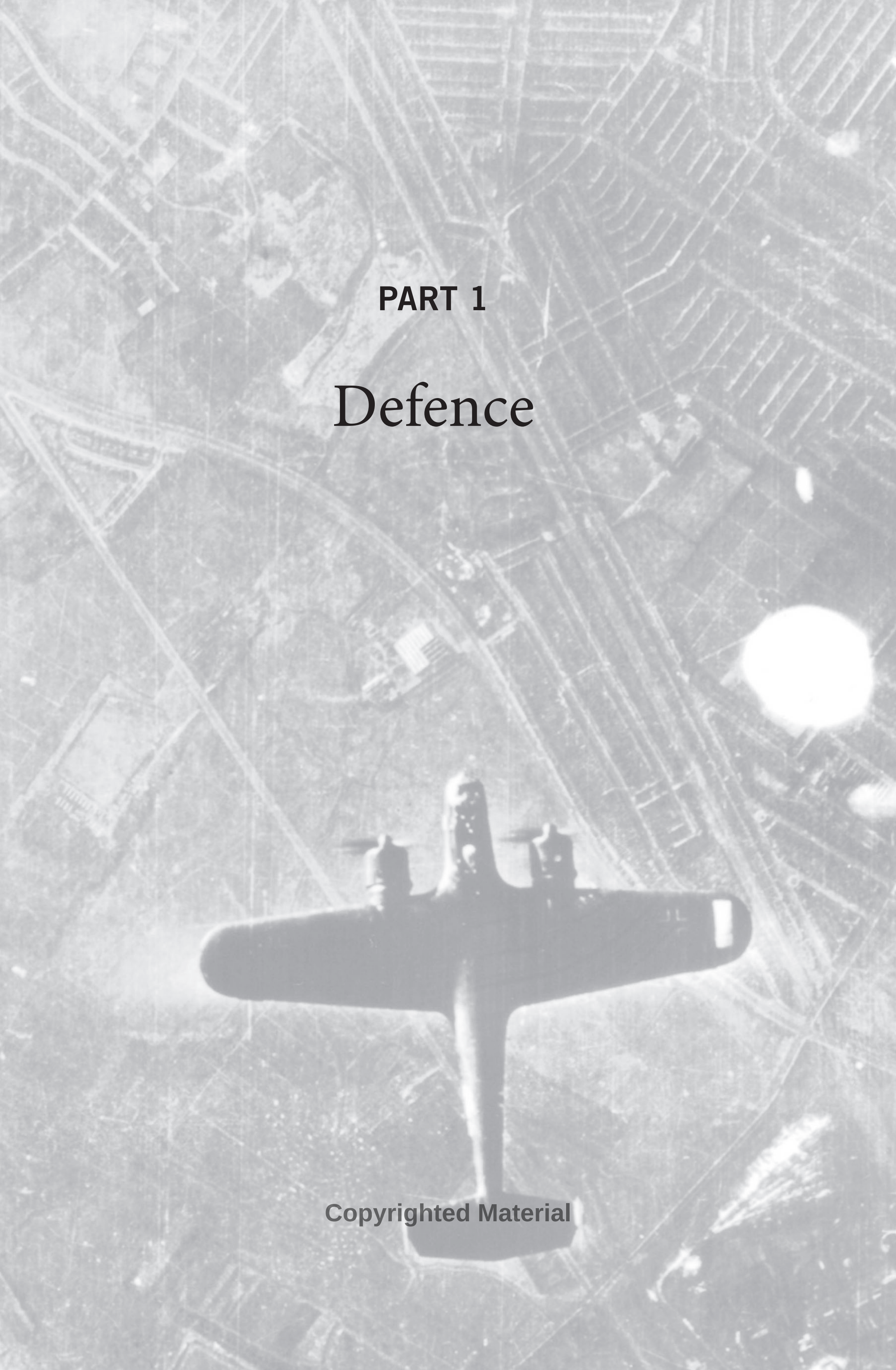
It would be decades before most of the public came to realize that during the Second World War air superiority – that term that became one of the defining strategic goals of the war – had also meant airwave superiority.

And somehow at the centre of it was one man, a man half the age of most of those who he spoke over that day in Downing Street.

To understand how the young Jones had ended up here addressing the cabinet, to appreciate the chain of evidence that led him, like Lecoq, to his inevitable, inescapable conclusion, you need to go back. You need to go to a hotel room in Oslo in late 1939, where a travelling German businessman sat down to write a report.

PART 1

Defence



CHAPTER 1

The Killing of a Sheep at a Hundred Yards

'A beast like Hitler should not win the war'

HANS FERDINAND MAYER

Eight months before Jones's meeting with Churchill

One evening in early November 1939, a German businessman made a request of the head porter at the Hotel Bristol in Oslo. Would it be possible, he asked, to borrow a typewriter?

Hans Ferdinand Mayer was a middle-aged man with neat swept-back hair and the sort of boringly technical job that rarely invited further questions. As he took the machine up to his room on that cold Norwegian night, it seems unlikely anyone would have looked up from their drinks to watch a man in a generic suit heading upstairs. The chances are, in fact, that no one who saw him that day ever learnt that they had been witness to one of the greatest intelligence leaks in history.

Mayer was a brilliant scientist, who had become part of the German corporate machinery. He had studied under a Nobel laureate, published papers and patents, then risen through the ranks to head up the Siemens research laboratory in Berlin. Here, during the 1930s, his job had changed, subtly at first. Increasingly his role was not civil but military and, especially, he wrote, he found himself working on 'new and secret weapons which required communications and electronics techniques'. He understood all too well the significance. 'This meant – sooner or later – war!'

This worried him greatly. Mayer did not like the Nazis. He loathed them, in fact. He could not understand why his colleagues joined the Nazi party. '[Hitler] had proclaimed the Germans to be the "Master Race", superior to all other nations, which should work for them as slaves,' he said. 'He had also deprived the Jews of their citizenship, confining them to the status of "subjects".' It was not merely that this was, to him, abhorrent. Perhaps he could forgive his Nazi colleagues if they were merely evil. To his rational scientific mind, it was something else too, something far less understandable. It was, he said, 'such nonsense'. He wanted nothing to do with it. Later in the war, when he was awarded a medal for his work at Siemens, he took it home and pinned it to the pyjamas of his four-year-old son.

Even by 1939 he had already taken considerable risks in working against Hitler. A year earlier, he had learnt of a Jewish woman, married to an Aryan, who had been expelled. Because their daughter was half-Aryan, she could not leave with her mother. Because she was half-Jewish, her father did not want her. Mayer helped arrange for a passport for the girl under the name of an English friend called Cobden Turner, who effectively pretended to be her father.

Turner, who worked in the General Electric Company, had in turn pushed for Mayer to do more to oppose the Nazis. He had tried to get Mayer to pass secrets over to Britain. Mayer refused. He would only do that, he said, if the two countries went to war. Saying goodbye at their last meeting, in mid-1939, he had pressed a small and very powerful magnet into Turner's palm, part of an experimental device known as a proximity fuse.

Now, war had indeed broken out and the only way Mayer could save the soul of Germany was through helping the British win. But with the outbreak of hostilities his ability to contact Turner was gone. There was, however, another way. As the Siemens laboratory's director, Mayer was tasked with going abroad to represent the company in technical negotiations. This meant he was able to arrange his own travel – and he arranged it with care. On this particular occasion he was ostensibly in Norway because he needed to meet with a representative from the Norwegian Post shipping company. He was also there because, with four months to go until the German invasion, it was still a neutral country containing foreign embassies.

Closing the door of his hotel room and carefully putting on a pair of gloves to avoid his fingerprints being traced, Mayer began to type a report.

Being a senior scientist at one of the Reich's leading engineering firms meant that he was privy to information, or sometimes just gossip, from across German military research. It gave him a privileged position, in which he had an overview of the country's most secret projects. 'We worked together with the Army, Navy and Air Force, and there was hardly any secret weapon, conceived at that time, which was not known to me,' he later said. 'Some of these deadly weapons were already field-tested, and large-scale manufacturing had started.'

The report, written on two consecutive nights, reflected all that knowledge – and also its fragmentary nature. He started with a description of the bomber programme. Before the start of April, he said, 25,000 of the feared Junkers 88 aircraft were to be produced. He moved on to relaying Germany's plans for remote-control gliders and missiles. These would be particularly effective against ships, he suggested.

He had pieces of information, but not always the full jigsaw. Some of the sections of the report were way off, and obviously so to those who specialized in the subjects. Some were little more than a few sketchy sentences – one was about the name of a newly launched aircraft carrier, and the name he wrote down was wrong. Others were remarkably detailed. He revealed, for instance, that the Germans had an extraordinary kind of radio device. It was a prototype early warning system, he explained, that would bounce shortwave pulses off aircraft. Then – through dark or through cloud – it could display the reflections on a cathode ray tube. It had already spotted RAF planes from 120 kilometres away.

Another paragraph spoke of navigation, describing in detail a radio system that could tell a bomber how far it had travelled towards its target – providing precise information that could be used for pinpoint bombing. It suggested that German expertise in controlling radio waves was far further advanced than Britain had thought. It also suggested that, with a few extra tweaks – a narrow beam, say – they could guide bombers directly to their targets.

To one of the documents he pinned an actual proximity fuse, to be united with the magnet previously pressed into Turner's palm. Proximity fuses were small and unglamorous devices attached to anti-aircraft shells that would prove to be among the most important advances of the war. At the time, anti-aircraft fire was astonishingly inaccurate. Gunners not only had to aim quite literally miles ahead of their target to have a hope of hitting it, they also had to determine the correct altitude for shells to explode. Get either wrong, and the gun was useless. Proximity fuses were designed to make their job considerably easier. The idea was that they removed the guesswork – detonating in the presence of nearby metal objects.

At the start of the war, there were many different experimental approaches taken, by both sides, to achieve this. Some used miniature radar, with the shell bouncing a signal off nearby planes. Others contained light sensors that detected the shadow of bombers. The one gifted by Mayer was a German prototype, which was triggered by the tiny fluctuations in electric charge caused by the passing of large metal objects.

The two packages arrived separately at the British Embassy in Oslo on 2 and 3 November, landing on the desk of Captain Hector Boyes, the naval attaché. This was not in itself of note. The problem for Britain's embassy in Norway was too much espionage rather than too little. 'At that point,' confessed Boyes, 'one was inundated with various anonymous correspondence which it was necessary to sift.' This one seemed, he said, to have 'matters of interest'. He forwarded it on, and thought little more of it.

Mayer, doubtless, thought of little else. He was now a traitor, and had no idea if it had even been worth it. In the gloom of the northern European winter, he waited. At the bottom of the second report, he had placed a request. If it had been received, would the BBC be so kind as to change the greeting at the start of its World Service broadcast to 'Hello, hello, this is London calling'?

Later in the war, his habit of listening to the BBC would result in his arrest and imprisonment. Now, though, on the evening of 20 November 1939, at the start of the eight o'clock news, it brought instead validation. From across the North Sea came a crackly voice, the voice that in the grim years to come would remind him another Germany was possible. 'Hello,' it said, 'hello, this is London calling.'

Radio waves are just light you cannot see. Less than a century before Hitler invaded Poland, a scientist called James Clerk Maxwell realized that what we thought of as the spectrum was so much wider than the red through to violet we see in a rainbow. This, which we now call visible light, accounts for just the tiniest sliver of the smallest segment of what Maxwell called electromagnetic radiation. In the years since his death, we have learnt just how useful the rest of it can be.

Light is a wave, a form of energy that wiggles through space. When the wavelengths – the distance between a crest and trough – get shorter than 400 nanometres, you stop being able to see them and end up with X-rays. In 1896 Wilhelm Röntgen, the discoverer of X-rays, realized they could pass through some solid objects – even his wife's hand. When she saw the result she was shocked to see her bone structure clearly visible amid the fainter outline of flesh. She said, 'I have seen my death.'

When the wavelengths get longer, different properties emerge. After red comes infrared, which is visible to some insects (and special forces soldiers with the right equipment) and gets emitted by hot objects.

After infrared come microwaves, with wavelengths in distances that we can finally envisage on a human scale. Definitions differ, but typically the wavelengths of microwaves are anything from a millimetre to 30 centimetres. These too have proved useful. One day during the Second World War, an American called Percy Spencer was working on microwave emitters and he noticed the candy bar in