

A SPECIAL THREE-PART HISTORY of the RAF's brilliant attack on the Ruhr Dams in May 1943, immortalised by the film *The Dambusters*. These articles have been written on the basis of interviews and released official British and German documents, and particularly on the private papers and diaries of Barnes Wallis -- the British scientist who invented the unique "bouncing bomb" that smashed the dams.
Picture: David Irving interviews Sir Arthur Harris in 1962

The Night the Dams Burst
by David Irving

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[In which Mr Barnes Wallis fights for acceptance of his revolutionary new weapon but then sees it fail its tests.]

THIRTY-NINE MILE an hour, I makes it," said the plain-clothes policeman. He ponderously opened his notebook and eyed the watch in his hand.

The white-haired driver of the small black Wolseley Ten saloon blinked at him absently from behind metal-rimmed spectacles.

"By Jove, was I really doing that, officer? My mind must have been miles away."

Mr Barnes Wallis looked at his own watch anxiously: it was half-past eleven, and at noon he had to be at the Vickers building in Westminster. But here he was, still in Putney Vale.

"I am on urgent business, officer -- Government business. It's top secret," he stammered.

The policeman grunted, unimpressed. "Really?" he said, licked his thumb, and turned over a new page in his notebook. Wallis groaned. He knew that he was carrying a top-secret film and that he should have an armed RAF guard with him. But this morning the instructions to report to London had come too suddenly for that.

Just two hours before, Sir Charles Craven, the Chairman and Managing Director of Vickers-Armstrong, had telephoned him at his drawing-office near Weybridge, and ordered him to come up to town at once: "The First Sea Lord wants to see your film of 'Highball'," he said. "The one you dropped at Chesil Beach."

To cap it all, just as he had been leaving the Vickers Works, the works foreman had run out and told him that a crack had been found in a Wellington bomber's spar, and it needed an urgent decision. Barnes Wallis was the famous aircraft's designer. That had delayed him for a good half hour. And now this.

"Can I see your driving licence, Sir?" Wallis fumed. He was deceptively mild-mannered, slight in build, and with innocent grey-blue eyes behind those metal frames. Keeping the Sea Lords waiting was one thing, but he dreaded the wrath of Sir Charles: Commander Sir Charles Worthington Craven was a powerful man, and Barnes Wallis had more than once fallen foul of him in his long career.

He was nearly half an hour late when he finally stumbled into the private cinema in the Vickers company's headquarters building in Westminster, clutching the precious reel of film under one arm. Four or five admirals were standing around, shifting from one foot to another in extreme impatience. Admiral Sir Dudley Pound, the First Sea Lord was talking to Craven, and Wallis could see that the glowering Vickers chairman was not in a benign mood towards aircraft engineers today.

What saved Wallis from Sir Charles now was the amazing film he had brought with him.

Onto the screen flickered a title: "Most Secret Trial Number One." Then the camera's telescopic lens focused onto the dark shape of a Wellington bomber, flying low over the waves just off shore.

"That's Chesil Beach," explained Wallis. "Now -- watch that bulge hanging beneath the plane ..."

The bulge was a large black ball, about four feet six inches in diameter. It was obviously spinning backwards at high speed. A light flashed in the cockpit, and the steel ball dropped towards the sea.

That was when the surprises began. Not only did this strange heavy ball fall much more slowly than seemed normal, but when it struck the sea it bounced -- it bounced not once but twelve or thirteen times, with Wallis jubilantly counting each bounce out aloud. It had bounded about half a mile along the sea's surface before it finally ploughed into a wave and sank.

"That's it!" announced Wallis. "That bomb answers most of the problems facing the Air Force today. Dropped at high altitude over Germany, it will float down much more slowly -- so it can be dropped from further outside the range of specially defended targets. Used as a naval weapon, it will bounce over any of the booms and torpedo nets that the enemy at present uses to protect his warships at anchor -- and his huge dams." He chuckled, like a conjurer who has just pulled off a particularly pleasing trick. "And," he said, "when it strikes a battleship's side, because of its back-spin, it will actually curve inwards beneath the ship's hull as it sinks -- so it can be exploded just where the enemy has never bothered to put any armourplate."

SINKING BATTLESHIPS alone would not win the war. Wallis believed however that there was one operation that just might do that: he had been fighting for years for one massive attack to be carried out on Germany's most vital dams -- a project he had dubbed "An Engineer's Way to Win the War."

This was typical Barnes Wallis. He was outstandingly capable of thinking up new ideas -- almost all of which met with fierce opposition from officialdom: he probably preferred it that way. When Professor Sir Thomas Merton, one of Winston Churchill's leading scientists, had first been approached by Wallis with the Dambusting bomb idea, his first feeling was, This man's absolutely cracked. But, he later told me, "after Wallis had been there for half an hour, I realised that I was talking to one of the greatest engineering geniuses of the world's history."

Much of Wallis's wartime genius had been applied to ball-shaped things. Once he had written to a newspaper that he could design a cricket-ball which would put both sides "out" twice in a day, and would be indistinguishable from a standard ball. The Cricket Club secretaries had persuaded him in anguish not to proceed with the idea. What Wallis had in mind for the four-ton ball he called "Upkeep" was not cricket.

"There are five dams in the Ruhr. gentlemen," he told the admirals.

"Without them, Germany's power -- stations can't make steam, her canals will either overflow or run dry and her most vital factories will be devastated by flooding. One dam, in particular, regulates the supply of the only sulphur-free water available to the Ruhr's steelworks. Do you know, it takes over 100 tons of water to make one ton of steel? This dam, the Moehne Dam, holds back 134,000 tons of water...

He continued enthusiastically, "I and my staff have shown -- we have tried it out on model dams -- that even with a charge as small as 6,500 pounds of RDX explosive, we can destroy the Moehne Dam, the biggest of the five, provided that the explosion occurs in actual contact with the masonry.

"My bouncing bomb will do just that. Just as the naval version will curve underneath the enemy's warship, so the dambusting weapon, over seven times as heavy, will curve in towards the dam-wall as it sinks and cling to it all the way down until the charge goes off."

The admirals had not come to listen to talk of attacking dams -- they wanted to

sink the German Navy, and in particular the Tirpitz. If Wallis's theory was right, the bomb need be no bigger than could fit snugly into the twin-engined Mosquito bomber's bomb bay. This was just what they needed. After the film show, Air Marshal John Linnell, the Controller of Research and Development at the Ministry of Aircraft Production

-- and one of Wallis's most determined opponents -- grudgingly agreed to lend him two of the precious Mosquitoes for trials of the anti -- Tirpitz

bomb. Furthermore, at ten o'clock on the following morning, the local boss of Vickers, Major Kilner, rang Wallis breathlessly from London: "The Admiralty have given us the go-ahead! Two hundred and fifty of the Highball bombs are to be put in hand -- top priority -- at once."

WALLIS WAS NOT OVERJOYED. It was good news, but still only a very low rung on a tall ladder. Sinking battleships would not win wars in the way that the sudden destruction of all Germany's most important dams might. As he put the phone down, Wallis also realised that once the weapon had been used against the Tirpitz, all hope of surprise in using it against the dams would be lost. He had to bring immediate and equal priority to the attack on the dams, and the only way to do that was to get the Prime Minister interested.

This in turn would mean winning Lord Cherwell, the physicist and politician who exploited his friendship with Mr Churchill to such devastating effect, for the cause.

Superficially, Cherwell and Barnes Wallis were similar: both shunned drink and tobacco, and both were extreme vegetarians. But there the similarity ended. The Prof., as Cherwell was known in Churchill's intimate circle, was ruthless in manner and Central European in aspect; Barnes Wallis was the typical English country parson's son -- self-effacing and slight. Above all, Cherwell was an eminent theoretical scientist, whose career had begun in the universities of Darmstadt and Berlin, while Wallis was an engineer who had started humbly as an apprentice in a shipyard at a wage of four shillings per week.

All in all, Wallis did not rate his chances of interesting Winston Churchill too highly. He had had a discouraging experience with Cherwell -- then still Professor Lindemann -- in 1940, and the last time he had called to see him he had been left waiting in an ante-room for two hours while numbers of young men wafted in and out and assured him that "their Prof." would be back from lunch any moment now. On that occasion, Cherwell had crushed him with the words, "You know, Mr Wallis, we don't think these dams are very interesting as targets."

Perhaps Wallis did not know it, but the hostility was not personally directed against him, but another product of the now famous behind-the-scenes Whitehall feud between Cherwell and Sir Henry Tizard, whose position as senior scientific advisor he had usurped. Tizard had backed the Dams Bomb project all along, and made no secret of it; he had promoted it in letters to the ministries, and to Mr Churchill himself. Above all, it was Tizard who had obtained for Wallis permission from the National Physical Laboratory at Teddington to carry out a series of spectacular model-scale experiments with two-inch steel balls catapulted down the length of the laboratory's experimental model-ship tank. This time, Wallis would not repeat his 1940 mistake. He wrote Lord Cherwell a letter. With the letter he sent a twenty-page secret report, complete with photographs and diagrams; working from facts provided by an officer of the Secret Service, he proved beyond doubt the importance of the five major Ruhr Dams, and explained the whole theory of the spinning bomb -- its aerodynamic and hydrodynamic effects.

Wallis had even found proof of the invention two centuries earlier of a gun able to fire round corners using precisely the same principle; the intrepid eighteenth-century inventor had demonstrated his weapon before an audience at the Royal Society, a body of which Lord Cherwell was now himself a prominent member.

"Unfortunately," explained Barnes Wallis in his letter to the Professor, "the possibilities of this new weapon against naval targets appear to have overshadowed the question of the destruction of the major German dams." If the consequent delay in developing the four-ton dambusting weapon known as "Upkeep" lasted any longer, he said, the whole plan would have to be shelved for a year.

"Large-scale experiments carried out against similar dams in Wales have shown that it is possible to destroy the German dams if the attack is made at a time when these are full of water." In practice that would mean May -- mid-May since the moon would also have to be full. It was now already the end of January 1943.

His present orders were to develop within the next six weeks the anti-Tirpitz bomb, "Highball", for the Mosquito. Given equal priority, he promised that he could do a similar job on the Dams Bomb for the Lancaster Bomber: "Two months," was the promise that he wrote in his letter. Two days later, on 2 February 1943, he followed the letter up with a personal visit to Lord Cherwell and showed him the film of the Wellington bomber trials two weeks before. With sinking heart, he watched Lord Cherwell's face: no spark of enthusiasm could be seen. In fact, among the papers of the late Lord Cherwell which I have reviewed, there is no indication that Churchill's scientific adviser took any action whatsoever after Wallis's visit.

FOR A WHILE the Upkeep bomb project stagnated. Wallis was moving in a jungle peopled by opponents and apathetic civil servants; frequently it was impossible to tell the one from the other. David Pye, the Director of Scientific Research at the Air Ministry and also chairman of a committee that had been set up in 1940 to study the possibilities of attacking the German dams, was one of the shrewdest of Wallis's opponents -- always seeming to help, without quite doing so. Later on the same day as Wallis's visit to Lord Cherwell, he was with Pye. Pye said: "You've got our authority to proceed with design work for the installations of the bomb and its gear in the Lancaster." Wallis, with long experience of civil service methods, demanded: "Can I have that confirmed in writing? And I shall need a full set of the Lancaster's drawings sent down to me ..." "Ah, that's a different matter," snorted Pye. "The Lancaster's one of our most secret planes, and the blueprints are not being shown to anybody."

Wallis sighed. He would have to pull still more strings -- and he was running out of them. Besides, he needed the bombers themselves, not just the blueprints. Within a few days, all that he had been given was the vague promise of the loan of a Lancaster, but on 19 February 1943 bureaucracy dealt him another blow.

Air Marshall Linnell telephoned him, and with a clear note of triumph in his voice ordered him to stop work on the Dams Bomb.

It had been decided that there was to be no further action on it. Wallis again felt himself without friends. Dr Baker, the elderly superintendent of the ship tank at Teddington laboratory, mercilessly told him, "Stop playing the fool and go and do something useful for the war ... "

That evening, Wallis had a private call from Flight Lieutenant Green, his liaison officer to the Ministry of Aircraft Production. Green confirmed his fears. In his diary, Wallis wrote: "Green says that DSR [David Pye] having ensured CRD's [Air Marshal Linnell's] refusal now pretends to back the scheme."

A few days later, injury was added to insult: a brown paper envelope arrived, and Wallis learned that he had been fined two pounds for the speeding offence in Putney Vale, despite a written plea by MIS to the Magistrate, that Wallis was working on the most urgent Government

business.

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Wallis swallowed his pride, and asked Dr Baker to let him prepare one final experiment in the lab's busy ship-testing tank. This was one experiment which would make the most hard-boiled civil servant sit up and take notice.

He built a model dam across the water tank, and catapulted the two-inch balls at it. A girl cinematographer submerged in an airtight glass tank filmed the spinning spheres as they struck the dam and sank. Wallis showed the film to the Air Staff -- there were audible gasps as the submerged camera showed the spinning balls "cling" to the model dam's face as they sank. There were louder gasps when Wallis showed them and some admirals an even more spectacular experiment in the tank at Teddington: he had moored a large model ship across the tank to represent the Tirpitz. On a signal from him, the assistant fired the first two-inch steel ball. It streaked down the tank, struck the model ship and sank, still spinning, out of sight -- to reappear suddenly on the other side of the ship, having passed right beneath the model's hull.

"I think I have made my point," said Wallis quietly. He was able to show film of this experiment to Sir Charles Portal and the First Sea Lord on 19 February. Portal was now willing for the RAF to begin planning an attack on the dams but he could imagine what Bomber Command's reaction was likely to be. In fact, he had discovered that Air Chief Marshal Sir Arthur Harris -- "Butcher" Harris -- was hostile to any idea of a dambusting operation. Harris needed every Lancaster he could get for more urgent assignments over Germany, with conventional and trusted weapons like blockbusters and incendiaries. He had run into inventors who thought they had a simple way to win the war before. As Portal watched the film with Barnes Wallis he thought of the letter he had received that morning from Harris. In it, Harris -- whose private Intelligence "grapevine" was evidently operating at high efficiency -- complained, "All sorts of enthusiasts and panacea-mongers are careering round the Ministry of Aircraft Production suggesting that about thirty Lancasters should be taken off the line and modified to carry a new and revolutionary bomb, which exists only in the imagination of those who conceived it..."

Strictly speaking, that much was true, of course. Barnes Wallis had not yet built, let alone tested, a full-size "Upkeep" rotating bomb. After seeing Wallis's amazing new film, the Chief of Air Staff wrote back to Harris. "I will not allow," Portal promised, "more than three of your precious Lancasters to be diverted." Before he got more, Wallis would have to show that his bomb worked in the full scale. To Wallis, in the meantime, Portal heartlessly offered no words of encouragement at all. Wallis, independently, decided to tackle the awesome bomber commander Harris himself. He telephoned his chief test pilot, Mutt Summers. "Mutt," he said, "we'll have to find some way of showing this film to 'Butch' Harris. You know him personally, don't you?"

"Sure, we were in the RFC together."

Summers rang up Harris's deputy, Air Vice-Marshal Sir Robert Saundby. A trip to the RAF Bomber Command headquarters outside High Wycombe was arranged.

Once more Wallis stowed his precious films into the back of his Wolseley, and this time he sat "Mutt" Summers in the front. Together they drove to High Wycombe on the afternoon of 22 February. As he was shown into Harris's office the air chief marshal glowered. "Now what the hell is it that you want?" he rasped. "I won't have you damned inventors wasting all my time!"

Barnes Wallis was unaware of Harris's unflattering remarks about him in his letter to Portal. But Harris's aversion to all inventors was understandable. As a fighter pilot at Northolt outside London, in the First World War, he had been plagued by them and any one of them might willingly have been his downfall. Several legends surrounded this. One inventor had shown him a grapnel, and proposed that Harris should sling it out at the Zeppelin airships wreaking havoc in English towns at that time. Harris had bluntly replied, "My aircraft's horsepower is 80, the Zeppelin's is 1600. Before I start hooking my plane onto a Zepp, I shall want to know who is going home with whom!"

Undeterred, that inventor had reappeared at Harris's airfield with the thing in a suitcase, which he set down on the ground. He said, "I've got it now," he said. "I've put a small explosive charge on it. All you do is press this" -- and the rest of the sentence was abbreviated by a shattering roar as the suitcase blew up of its own accord.

"I HAVE AN IDEA for a bomb," began Barnes Wallis now, blinking short-sightedly at Harris and groping for his spectacles. "A bomb which will destroy the Moehne Dam."

Harris groaned silently. "I've heard about it," he said. "It's far-fetched."

Wallis mentally noted that Harris had obviously been "very much misinformed re job" (as he wrote in his diary).

He launched into a long technical explanation of the principle of the spectacular weapon and concluded: "...you see, if the bomb has a backspin on it, it will be forced against the dam face all the time it is sinking,

and it will explode in contact, just as we require."

Harris was taking more notice now. There was something about this quiet-spoken engineer that separated him from the rest. In any case, the man who had designed the sturdy Wellesley and Wellington bombers could not be ignored. Nodding at the projectionist threading the film into the machine, Harris grunted to Wallis: "If this thing's as good as you say, the fewer people who know about it the better." He turned to his deputy. "Saundby, you work the projector."

In the headquarters cinema, with nobody watching except the two air marshals, Wallis and his test pilot, the top secret films of the underwater antics of the rotating bomb "Upkeep" and the airborne trials of "Highball" off Chesil beach were shown again. No sound was heard except the whirring of the projector. When the lights came on again, Harris's pink-complexioned, puffy face was expressionless. He tossed a letter to Wallis, and said, "You'd better read this."

It was the letter from Sir Portal, requiring Harris to lend three Lancasters to Wallis for the full-scale "Upkeep" trials.

Wallis had no idea of how well he had scored personally with Harris. He could not penetrate the mask of the air marshal's face. As they left, he took Summers's arm and said in relief, "Well, that wasn't too bad after all, was it! "

In fact his troubles were not over. Harris -- impressed though he was -- still refused to withdraw a Lancaster squadron from the front line to train for the dams attack. And at this moment, another force intervened with Wallis -- almost certainly guided by the hand of the shortsighted Air Marshal Linnell who had blocked Upkeep at every stage.

At 10 a.m. on the morning after his face-to-face meeting with Harris, he and "Mutt" Summers were ordered to report to Major Kilner's office at the Vickers works. Kilner unhappily told them that Sir Charles Craven, Vickers's chief executive, had ordered them both to London at once.

At Vickers House, the air was frigid was hostility. "I have been asked to tell you," Craven snapped at Wallis, "that you are to stop your nonsense about destroying dams. I have been officially advised that Mr Wallis of Vickers is making a damn' nuisance of himself. You are wasting the Government's and the firm's time and money -- you are to start working on something useful for once. You are forbidden to work any longer on this absurd bouncing-bomb project."

As a final grotesque outburst, he shouted hysterically at Wallis. "And what happened on the Golf Links at Ulverston?"

To Wallis, the whole row was beyond comprehension, let alone Craven's final cryptic challenge. The slight white-haired engineer looked the powerfully built former naval commander in the eye and said, "Well, Sir, if I'm not serving the best interests of the company and the country, I had better offer you my resignation."

It was coolly said; it was meant; and it was too much.

Sir Charles Craven stood up, and crashed his fist down onto the desk, bellowing, "Mutiny, mutiny, mutiny!"

Barnes Wallis stalked sorrowfully out. In his diary he wrote: "Private interview afterwards with [Major] Kilner, and told him again [am] anxious to go ..."

He lunched at the RAF Club in Piccadilly with the Secret Service officer who had given him such support before, and both recognised that their only hope now was Mr Churchill.

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The way through Lord Cherwell was evidently barred. But Mr Churchill was also known to rely extensively on a scientific committee set up earlier in the war by Mr Oliver Lyttelton, and it was to two of this committee's three members, Sir Sydney Barratt and Professor Merton, that Wallis went, in Richmond Terrace, that afternoon, still shaken by the mauling meted out to him by Craven.

The two scientists could see that something out of the ordinary had happened. Wallis answered their questioning looks: "I'm done for," he murmured. "I've resigned from Vickers. The dams plan is off." Barratt, who would later become chairman of the mighty Albright & Wilson chemicals concern, questioned Wallis for ninety minutes on the scientific basis of

the case, and then Wallis left for home.

This meeting proved to be the turning point, Mr Churchill called for the papers on "Upkeep" and then, his imagination fired, gave the order for the dams raid to be prepared on top priority. At three o'clock on the afternoon of 26 February, Barnes Wallis's hour of sweet revenge arrived, when he and Craven were summoned to the room of his old enemy, Air Marshal Linnell; Linnell, evidently controlling himself with some difficulty, informed Wallis that the War Cabinet had directed that the development and testing of the dambusting bomb and the modified Lancaster bombers that were to carry it were to proceed at once. Choking with rage, Linnell told Wallis: "The Air Staff have ordered me that you are to be given everything you want." A few days later, Linnell announced his intention of resigning.

MANY YEARS AFTERWARDS Wallis would explain: "Half the joy in life really consists in the fight, not in the subsequent success."

Now his fight against bureaucracy was suddenly and unexpectedly over -- but the result of the long delays was that he had now only just eight weeks left to do the job. As he left Linnell's room, he felt physically sick and lonelier than ever before in his life. They've called my bluff, he thought. And out loud he said, "If only I had somebody to lean on..." The Director of Technical Development, Norbert Rowe, must have overheard him, for next morning there was a letter in the post at Wallis's drawing office: "Dear Barnes Wallis," it read. "I was so distressed to hear your involuntary exclamation after the meeting yesterday. We Catholics always pray to St Joseph when we are in special difficulty." He enclosed the wording of the prayer, and Wallis was not ashamed to say the prayer every morning for the next two months.

Even now Wallis was not given everything he needed. He had to have two hundred tons of steel billets to make the dies for the manufacture of the perfectly spherical bomb casings. This was refused him, and he had to content himself with designing the "Upkeep" version of the bombs as boilers, and padding them out to the spherical shape with wooden casing, held tightly in place by thick steel bands.

One spectre haunted him -- the spectre of failure. Conference followed conference.

The Avro company's Roy Chadwick, the famous designer of the Lancaster, came to discuss the bomber's modification; Group Captain Sidney Bufton arrived to work out the special bomber tactics to be used; armament experts came, to advise on the design of a pressure detonator (a hydrostatic pistol) robust enough to withstand the bomb's first 300 m.p.h. impact with the water, yet delicate enough to go off when the bomb had sunk precisely thirty feet. Avro's promised to let Wallis have the first of the three experimental Lancasters by the first day of April 1943. Wallis moved in distraction between his secret country-house drawing office in the former Golf Club house at Burhill, the arsenal at Woolwich where the test tombs were being filled, and the experimental dropping grounds. Soon he was working ninety hours a week.

He himself designed and built the powerful calliper arms which were to grip each side of the rotating bomb as it was suspended in the Lancaster's bomb bay. He put to leading Government scientists like Professor Patrick Blackett complex questions like how much time would have to elapse before the waves on the Moehne lake's surface subsided after each bomb's detonation, should one bomb not be enough to breach the dam. On a test rig at Weybridge the four-foot bombs were spun at slowly increasing speeds then suddenly dropped into a specially-prepared pit of grease and sandbags to test the equipment's release action. All seemed to be going well. On 24 March 1943 "Mutt" Summers drove down to Burhill, bringing a passenger with him in his little Fiat -- a babyfaced Cornishman with smiling eyes and the uniform of an RAF Wing Commander. Summers introduced him:

"This is Gibson -- Guy Gibson."

"Gibson," wrote Wallis in his diary, "is doing the big job." Gibson had already survived doing 173 other "jobs" for Bomber Command, which made him a very rare bird indeed.

Of this first meeting with the bomb's inventor, Gibson himself later wrote:

"He looked around carefully before saying anything, then said abruptly but benignly over his thick spectacles:

"'I'm glad you've come; I don't suppose you know what for.'

"'No, I'm afraid. SASO [Senior Air Staff Officer, Saundby] said you would tell me nearly everything, whatever that means."

"He raised his eyebrows. 'Do you mean to say you don't know the target?' he asked.

"'Not the faintest idea.'

"'That makes it very awkward, very awkward... Only a very few people know, and no one can be told unless his name is on this list.'"

Wallis waved a list of names in front of Gibson. Gibson's name was not on it. The upshot was that the young wing commander returned to his special squadron fully informed about the new bomb, and about the low-level tactics his bombers would have to employ, but with no idea as to what kind of target they would be attacking.

INTENSIVE TRAINING began, and soon complaints about low-level flying were cascading into the Bomber Group's headquarters. One angry local mayor said that he had seen motorists actually duck as the black-painted four-engined Lancasters thundered past only 150 feet up. Legend has it that Group HQ wrote back: "Our pilots have now been instructed to show due regard for other road-users..."

Late on 6 April 1943, the first special Lancaster was delivered to Farnborough; its mid-upper gun-turret had been removed, and special modifications had been made to the bomb bay. Now the first "Upkeep" bomb was clamped into position between the callipers, and the hydraulic motor coupled up to test the bomb's spin. That evening Wallis telephoned the RAF's new Controller of Research and Development, and told him that everything was "Okay".

All was ready for the Lancaster to begin the first dropping trials. "We'll try the first drop at about 270 m.p.h.," Wallis told the pilot, Sam Browne, "giving the bomb a backspin of about three hundred revs. Let it go when you are level, at 150 feet."

In confident mood, Barnes Wallis waited behind the little ruined church on the shore at Reculver on the north Kent coast, watching for the Lancaster. Wing Commander Gibson drove up shortly and joined him, both of them shivering in the cold morning wind.

Soon they heard the familiar full-throated roar of Lancaster engines in fine pitch. Dead on time the big bomber appeared out of the low early-morning sun, followed by another Lancaster, slightly higher, carrying a cine-camera to record its progress. The first Lancaster had the bulky Dams Bomb suspended beneath it -- the first that had ever been tested. As the Lancasters neared the white marker-buoys a hundred yards off shore, Wallis began to shout, hopelessly, into the roar of engines, "Sam, Sam, you're too high. You're too high!"

Gibson trained a pair of binoculars onto the bomb itself, chequered black and white and already spinning backwards at great speed. He had never seen anything like it. He wondered what on earth could be the target for such a remarkable device. He saw the bomb slowly detach itself from the Lancaster. "It seemed to hang in the air for a long time before it hit the water with a terrific splash," he wrote.

A plume of water sprang up out of the sea, missing the Lancaster by inches. But instead of bouncing, the bomb lurched briefly out of the boiling cauldron of spray, then sank without trace.

After lunch, a second bomb was dropped, with the bomber much lower than before; this time, the bomb suddenly disintegrated in a shower of wooden staves, steel bands and bolts, the heavy steel cylinder bursting out with such violence that one wooden segment smashed into the Lancaster's tail just above it, and nearly brought the aircraft down.

Sunk deep in thought, Wallis trudged with Gibson back through the shingle to where their cars were parked.

[Chapter Two: In which Mr Barnes Wallis gets the special bomb to work, and the raid begins]

BRITISH INVENTOR extraordinary Barnes Wallis shivered as the sea slowly rose to his neck. I'm getting beyond this sort of thing, he thought. He and a handful of middle-aged men dressed only in underpants, were slowly edging their way out from the beach. Had anybody else been strolling down that deserted shore in Kent that chilly April evening, it would have been a strange sight that met his eyes.

But there were no onlookers. It was wartime. This was 17 April 1943, and all access roads to this secluded spot had been cordoned off by sentries all day.

Wallis was one of the foremost aeronautical engineers in Britain. The other bathers were leading scientists and civil servants.

"It's no use," sighed Wallis after a while. "We've been looking for hours. The fragments must all be buried far too deep. Let's go back to the Miramar for dinner -- I'm getting cold."

They were looking for the remains of a ball that they had lost -- a four-ton spherical bomb. A low-flying Lancaster bomber had dropped it in the sea, but instead of bouncing along on the surface of the sea, it had exploded and sunk before their eyes.

The bouncing bomb was Wallis's invention -- an invention with which he hoped to destroy the Germans' heavily-guarded power and water supply dams, vital to the Ruhr where most of Germany's heavy industry was concentrated.

"An Engineer's Way of Winning the War" was how he had described it.

"I just don't understand it," he said to mathematician Professor Taylor, as he recovered his thick, horn-rimmed spectacles from his pile of clothes and replaced them on his nose. "We gave the bomb the right amount of backspin. We dropped it from the right height, and at the right speed. And yet -- crunch -- it falls to pieces."

He shivered in the cold spring air, as he dried himself on the only thing available, a large pocket handkerchief. He was in no doubt as to the bleak future. The whole operation -- crews, aircraft and bombs -- had to be perfect by 10 May 1943, which was less than four weeks from now. Only then would the moon be full -- and the reservoirs.

For three years he had campaigned for the recognition of his project, and now at last people had listened to him. He had blown-up scale models of dams and shown that his shockwave theory of destroying them held, but only so long as the bombs could be exploded in contact with the dam wall. He had developed small-scale bombs that would bounce over the defences, and cling to the dam wall as they sunk. Colossal sums of money were being invested in the operation now -- not just the 400 his tiny model-dam experiments at the Road Research Laboratory had cost.

Against military and civil-service opposition, Mr Churchill had intervened and ordered the establishment of a special Lancaster bomber squadron, and that unit, No.617 Squadron, was even now training for the one task of destroying the five major Ruhr dams. Twenty-one Lancaster bombers had been taken off the production line at Avro's and drastically modified to carry the special spherical bomb that he, Wallis, had promised would do the trick.

So now there was only one snag: the full-scale bomb was a failure. The first time they had dropped it, a monster steel cylinder padded out to the shape of a sphere with wooden packing, it had burst as soon as it struck the sea. That was no good at all.

ON THE DAY after their fruitless bathing party, Wallis and the other experts watched three more full -- scale bombs dropped in the English Channel off Reculver by the same Lancaster. Two had been given a special varnish coating, and the third was finished in plain wood. On the first run, the sphere stayed intact but sank immediately, without bouncing. The second bomb burst into fragments, just like the one they had dropped some

days before.

Wallis groaned, and steeled himself for the failure of the third. As the Lancaster roared past this time, something unexpected happened. The bomb hit the sea, and the wooden casing completely disintegrated just as before. But the bare steel cylinder was left, still madly spinning, and this burst out of the tower of spray and hopped quite clearly several times across the sea, covering finally a distance of seven hundred yards. "The sphere broke up," exclaimed Walls, speaking more to himself than to the others. "But the cylinder ran just as it should have done! It ran!" He gave orders for full-size bombs to be manufactured keeping the steel cylinder shape, bare of any kind of wooden casing. Early on 22 April, the Lancaster test-dropped one of them off the same deserted beach from a height of 185 feet. This test too was a failure, but Wallis was sure he knew a way of licking the problem. His staff saw him reach for his sliderule and a pad of paper.

Two days later, he met with Wing Commander Guy Gibson, 617 Squadron's commander, and put it to him. "I know this is asking an awful lot," Wallis said hesitantly. "You must tell me at once if it can't be done. Can you bring your planes down to a level sixty feet, instead of 150, and make exactly 232 miles an hour, before you release your bomb?"

Gibson flinched. He thought, If 150 feet is low, then sixty feet is very low. At that height you've only got to hiccup to land in the drink. But he loyally replied, "We'll have a crack tonight."

When the morning chosen for the final crucial trials dawned, it was pouring with rain and there was a freezing wind. Walls and the Air Ministry experts again crowded the foreshore at Reculver beach.

Just sixty feet up, the black Lancaster bomber roared past them. As the bare steel cylinder dropped from its bomb bay, spinning backwards, and slowly fell towards the sea, Wallis silently prayed.

It struck the sea with a crash -- and emerged from the plume of spray making a gigantic bounce. The bomb bounced, bounced, and bounced again -- each time striding hundreds of yards forward and throwing up huge spouts of water as though an invisible giant was stamping across the sea. Then it settled, and sank from sight.

Wallis had done it!

In his mind's eye, at the moment that his "bouncing bomb" disappeared from view, Barnes Wallis could see a huge masonry wall looming across the horizon, towering up out of the waves -- a wall suddenly rent by blast and collapsing under the weight of millions of tons of water: the Moehne Dam. Then the others were crowding round him, clapping him on the back and congratulating him. Wallis allowed himself a cautious smile, as he returned to his car.

ONE TRIAL ALONE was not enough, of course. Other tests followed, to get the speed of the aircraft and the amount of backspin imparted to the bomb just right.

A means had to be found for aircraft to fly at precisely sixty feet over smooth water by night -- an apparently suicidal task. Then someone remembered that a similar problem had been solved by an inventor in the First World War, who had proposed mounting two spotlights underneath a plane, angled so that their beams would only intersect at a certain height. In a surprisingly short space of time the actual apparatus was found gathering dust in a store at Farnborough, and the contraption was adapted for Guy Gibson's squadron.

One day early in May, a Lancaster dropped the first special bomb to be fully charged with its explosive: a huge pillar of water shot up, towering over a thousand feet into the sky. Barnes Wallis's work on the weapon was complete; everything was now up to Gibson and his crews.

*

At three o'clock on the afternoon of Saturday 15 May, Wallis climbed into a white Wellington aircraft with his Chief Test Pilot "Mutt" Summers and Major Kilner, Vickers' managing director. There was a big Red Cross on the aircraft's sides -- it was the only plane available.

In brooding silence, the little party flew from Vickers' aerodrome at Weybridge up to the operational bomber station at Scamp -- ton. No.617

squadron's nineteen specially modified black Lancaster bombers were already waiting at their dispersal areas.

Guy Gibson met Wallis as he climbed down the Wellington's ladder.

"The AOC's just told me we're doing the job tomorrow night, if the weather holds," he said.

Wallis nodded absently, unable to believe that after three years of increasingly frustrating battle against bureaucracy, the day had come when 133 hand-picked RAF officers and men were to stake their lives on the accuracy of his calculations. How could he express his feelings to these men? He was nearly sixty -- they were almost without exception under twenty -- three, carefree -- looking and eager.

Young though they were, their faces wore the battle -- hardened expressions of veterans. All had completed two tours of bomber operations, so there were no greenhorns among them: all had been decorated, and all were experts in their crafts.

At six o'clock, the inventor faced the nineteen captains of aircraft for the first time: chalk in hand, standing on a platform in the almost empty Briefing Hall, he went through the now-familiar explanation of the crucial importance of the Ruhr Dams to Hitler's war industry. As he spoke, Wallis recalled how many times he had appealed for this attack before. What if there were some unconsidered factor even now, which would prove his theories wrong? The effects of gravity in such an enormous structure as the Moehne Dam, for example. It did not bear thinking of.

Wallis finished his lecture. He slowly surveyed the curious faces through his spectacles, and said: "You see, you gentlemen are really carrying out the third of three great experiments: we have tried this out on model dams, and we have tried it out on a dam one-fifth the size of the Moehne. I can't guarantee that it will come off. But I hope it will..."

Giant eight-wheeled trucks were rolling across the airfield as he left the Briefing Hall. Each was laden with the huge cylindrical bombs, covered with tarpaulins and each was still warm from the four tons of special high-explosive cast inside it at Woolwich Arsenal.

In Guy Gibson's crowded office, the final plans were hatched. Code-words had to be arranged, last-minute alterations to the bomber routes worked out. He and Wallis stayed there until well after midnight. This time tomorrow Gibson would already be over the Moehne Dam, and Wallis would know whether his calculations had been correct.

*

It was far into Sunday morning before Barnes Wallis woke up. It was a balmy, sunny day such as seldom comes in May. He breakfasted late, and spent the afternoon fussing round the special Lancasters. Each crew wanted him to see if their bomb was spinning properly. At mid-day, the last of the special Lancasters arrived, brand -- new from Avro's. Nineteen aircraft and crews were now ready.

At three o'clock, the clattering fingers of the teleprinters at Scampton slammed into the paper roll, repeating a signal from No.5 Bomber Group Headquarters:

CODE NAME FOR FIVE GROUP OPERATION ORDER B.976 IS "CHASTISE".

And ten minutes later the die was finally cast for that night:

EXECUTIVE, OPERATION "CHASTISE", 16 MAY 1943, ZERO HOUR 11.48.

Three hours later, behind locked doors, Wallis again briefed the bomber crews. They looked tired and strained, and small wonder: in two months of intensive training for "Chastise" they had completed nearly two thousand hours of nerve-racking low-level cross-country flight, most of it in darkness.

As they trooped out of the Briefing Hall, Wallis turned to Gibson, his voice choking. "I hope that all come back," he said.

"It won't be your fault if they don't," came the reply.

GIBSON'S SECOND-IN-COMMAND, twenty-three year old "Hoppy" Hopgood, shouted:

"Hey, Gibby. If you don't come back, can I have your egg tomorrow?"

It was the oldest of the RAF's aircrew gags. It veiled Hopgood's own anxiety: as his crew climbed aboard their Lancaster, he said, "The first aircraft to attack the dam will probably catch the flak gunners with their

pants down. But the second to attack won't be so lucky -- and that's us, fellers."

Wallis stood on the airfield and watched as the heavy bomber³, pregnant with his bouncing bombs, lumbered down the runway and lifted into the air. None but the crews knew that this was the real thing. There was not even the usual farewell party of WAAFs and ground crew to wave them off. Soon the last aircraft had lifted into the moonlight air. Lincolnshire mist rolled across the almost-empty airfield.

Barnes Wallis wandered into the Officers Mess, but his appetite for dinner was almost gone. He wondered how many of these young men would return. By the time he had finished his meal, seven had already died -- obliterated in a sheet of flame as Lancaster K for Kite, flown by Sergeant G.W. Byers, struck the Waddensee lake in Holland, hit by a flak battery based on one of the offshore Dutch islands. He had been flying at three hundred feet instead of the sixty feet ordered, and that probably proved his undoing. At two minutes past eleven, the first two waves of 617 squadron's bombers swept in across the enemy coast at points widely separated, so as to divide the Luftwaffe fighter forces. As Guy Gibson's own little formation of three Lancasters reached the lakes near Haltern, they ran into an unexpected nest of flak guns. Within seconds, all three aircraft were trapped in a dazzling cone of searchlight beams.

Gibson threw his aircraft to one side and got out unscathed.

Flight Lieutenant Hoppood's M-Mother suddenly shuddered as cannon shell tore into the port wing. Shells exploded in the cockpit, and over the intercom the rest of the crew hears "Hoppy's" flight engineer gasp "Bloody Hell...!"

"Hoppy" had been hit in the face, and blood was streaming out of a wound. He shouted to his engineer grimly, "Don't worry. Hold your handkerchief against it."

He switched on his VHF radio, and called up Gibson: "We've been hit, Sir. But we're carrying on. See you on target."

He checked on his crew one by one: there was no reply from the front gunner.

Gregory must have bought it, he thought.

The aircraft were now flying so low that accidents were bound to happen. One dropped so low over the Zuyder Zee that the bomb suspended beneath its bomb bay was torn off by a wave. Still the remaining aircraft swept on. The noise on the ground must have been deafening.

Flight Lieutenant Hoppood suddenly saw through a cloud of pain that he was heading straight for a line of pylons. He was only sixty feet up, and took a split -- second decision. He pushed his column forwards, and swooped beneath the cables; as the tail of the bomber went up, rear gunner Pilot Officer Tony Burcher thought they had had it. He saw the shadows of the cables whip across the top of his turret, and then the danger was past. The leader of the second wave, Flight Lieutenant Bill Astell, lost his way soon after midnight: it was only for a fraction of a second, but that was long enough to kill him. After crossing a canal he had to turn south briefly to try to find a landmark, and he was shot down almost at once by machine-gunners on Gilze-Rijen airfield. Out of control, his B-Baker crashed into a block of barracks on the airfield's edge and blew up in a slow red glare that momentarily swelled to light up the whole sky. The other Lancaster crews saw the clouds of smoke, but these faded into the distance until they were out of sight of the rest of the formation.

In G-George, Wing Commander Guy Gibson threw a glance at his watch. Quarter past midnight. "Well, boys, I suppose we had better start the ball rolling!"

He meant it literally. The flight engineer flicked a switch, and with gathering momentum the special bomb suspended between powerful calliper jaws in the bomb bay began to revolve. A few minutes later, the flight engineer reported: "Five hundred revs, Sir."

Gibson switched on his transmitter: "All aircraft switch over to radio -- telephone control."

Ahead of him he could see the Ruhr hills coming towards them. He lifted the Lancaster up and cleared them with feet to spare. There was a shout from his bomb-aimer.

"We're there!"

There ahead of them was the Moehne lake, and at its far end, silhouetted against the moonlight, was the Dam, 2,100 feet long. The lake was so full that its parapet barely showed above the water's mirrorlike surface.

"Good God -- can we break that?" gasped Gibson.

The Moehne Dam looked like an enormous, angry and impregnable battleship, with its low freeboard and two stone towers. The battleship was firing a broadside at them from twelve or fifteen guns, and there were more guns on the lake's north shore. The deadly onionstrings of tracer fire streamed across the lake, aimlessly as yet because the aircraft were hard to see and echoes were reverberating from every hill.

Gibson called up each of his force's Lancasters in turn. All but Bill Astell reported in. Astell had been dead twenty-five minutes by now.

"Hullo all Cooler aircraft. I'm going in to attack. Stand by to come in to attack in your order when I tell you..."

It was precisely twenty-eight minutes past midnight. Gibson brought his Lancaster round, and dived over the woods fringing the lake. His bomb aimer "Spam" Spafford shouted, "You're going to hit those trees."

"That's all right, Spam -- I'm just getting my height."

His navigator Terry Taerum switched on the two spotlights. This was when things could get really dangerous. He watched the two short lines projected onto the lake just in front of the plane. They were still some way apart.

"Down ... down ... down..." he directed.

Gibson shifted in his seat nervously, as water came up toward the thundering plane. "That's it!" came Terry's voice. "Steady now."

They were just sixty feet up. Spam clicked the bomb's fusing switches into the "On" position.

A mile ahead of them, one of the German gunners shouted, "They've switched on their landing lights! They must be mad!"

A hail of fire swept out from the crest of the dam, converging on the advancing aircraft. Crouched behind his controls, Gibson thought In another twenty seconds we shall all be dead.

Spafford cried out, "Bomb gone!"

The black cylinder slipped out of its clamps. The bomber lurched upwards as its load fell away. The bomb struck the lake, bounced once ... twice ... three times, covering hundreds of yards with each enormous bound. The weapon slammed into the dam's parapet, right between the valve towers -- a magnificent shot. The bomb ricocheted backwards, and sank into the lake. The seconds began to tick away.

Gibson's wireless operator had fired a red Verey cartridge as they crossed the dam. As the flare soared up into the sky, there was a colossal explosion and a column of water and spray mushroomed up into the sky, towering a thousand feet above the dam. It was the most fantastic spectacle they had ever seen -- this silver column of water, lit a lurid red on one side by the red signal flare.

But the dam was still holding.

Gibson ordered his wireless operator to signal back to England using the prearranged code that they had released the special bomb; that it had exploded only five yards from the dam; and that the dam had not been broken.

*

Shortly before midnight, a large black saloon car swept up to the guardroom at No.5 Group's headquarters at Grantham. The driver flashed special recognition lamps at the sentries, and they stood back and allowed the car to pass at once.

This was Air Chief Marshal Sir Arthur Harris, Commander in Chief of Bomber Command -- otherwise known as "Butcher" Harris.

He strode into the Headquarters Operations Room. Barnes Wallis was already there. He had been driven over from the Scampton airfield an hour before.

"Any news yet?" barked Harris.

"Apart from an early flak warning from Gibson there's nothing at all," answered Air Vice-Marshal Cochrane, the Group commander. "But they should be attacking at any moment."

One of the room's long walls was dominated by a blackboard listing the

bombers taking part. On a dais running along the opposite wall sat the operations officers, in telephone contact with the wireless room. Barnes Wallis had long ceased pacing up and down, and was now sitting in a dejected heap on the little staircase leading up to the dais. Harris joined the Group commander at the other end of the room, underneath the map of Europe.

Suddenly there was a shout.

"There's a signal just coming through, Sir." The Chief Signals Officer had a telephone to his ear. "It's from Wing Commander Gibson:

GONER-bomb exploded five yards from dam, no apparent breach."

He waited. Then he added: "That's all."

So Gibson's bomb had been correctly placed, but the dam was still standing. An icy chill gripped Wallis: all those lives, he thought. He buried his head in his hands; out of the corner of his eye he could see the two air marshals at the far end of the room, and there was a clearly perceptible look of vexation invading "Butcher" Harris's puffy features.

ALONE IN THE 6,000-kilowatt powerhouse below the Moehne Dam, there was a look of fear on 52-year-old foreman Clemens Koehler's face. Now there was no doubt at all! The British were attacking his dam.

A look-out on the Bismarck Tower had raised the alarm at twenty minutes past midnight, just as the first Lancaster had begun circling the lake. At first the small but wiry foreman had not been afraid -- air-raid warnings were not uncommon in the Ruhr by 1943.

But suddenly something clicked in his mind: tonight there was a full moon, and the RAF did not normally venture over the Ruhr on moonlight nights. And tonight the lake's level was higher than it had ever been before. Soon his fears were confirmed. The British bombers were not droning past high overhead -- they were swarming like stray bees around the distant end of his lake, and one was coming nearer.

Koehler's hand reached for the telephone. With trembling fingers he dialled the number of the United Electricity Company of Westphalia offices in Nierderense and Neheim -- the little towns just down the valley. The noise of aircraft engines was very loud now. Hoarse with fear, he shouted: "This time they are attacking the dam!" The voice at the other end was sleepy at first, and downright disbelieving. Koehler slammed the phone down, and ran for the door.

As he tore the door open, he caught the sound of the guns on both towers firing wildly and then Guy Gibson's Lancaster thundered over him, barely a hundred feet up, the whole valley vibrating to the roar of its four Rolls-Royce Merlin engines. A huge explosion tore at Koehler's lungs, and water cascaded over the top of the dam.

Drenched to the skin, Koehler began to run -- he ran as he had never run before until he had reached the side of the valley, hundreds of yards away; and then flopped down underneath a larch-tree half-way up the slopes. He turned round, and gazed as though hypnotised at the enormous dam wall's moonlit face. It was still not cracked.

GIBSON WAS RADIOING the second of his aircraft to go into the attack.

"Hello, M-Mother. Make your attack now. Good luck!"

"Hoppy" Hopgood, his face numb from loss of blood, grunted: "Okay, attacking."

Over his aircraft intercom he ordered: "Stand by, rear gunner. They're putting up a terrific barrage ahead."

Facing rearwards, Pilot Officer Tony Burcher, M-Mother's rear gunner, couldn't see much. He moistened his lips and watched the lake surface coming up towards his turret. Streams of tracer and cannon-shell flashed past his turret on either side as the Lancaster raced in towards the dam. He swung his turret round onto the beam, ready to open fire on the dam's gunners as soon as they came into his field of fire. The front gunner is not firing, Burcher noticed. He must be dead already.

He could hear the navigator's voice telling the pilot to take her down lower -- and then lower still.

Suddenly there was a Whummph, and sparks and flames streamed past Burcher's turret.

"Christ! We're on fire!" shouted the flight engineer. "Feather Number Two" ordered Hopgood. The startled bomb-aimer released the special bomb about a fifth of a second too late -- bounding across the lake, it smashed into the parapet of the dam and blew up in a vivid yellow flash. "Prepare to abandon aircraft!" That was Hoppy's voice. Burcher desperately tried to swing his turret round to the fore-and-aft position, but the hydraulics were powered by a pick-up on the port-inner engine, and that engine was a mass of flames. The turret wouldn't budge. I'm trapped. His parachute pack was hanging inside the fuselage, and he could not get at it until the turret was fore-and-aft. Parachute! What use was a parachute at zero feet? Like a man possessed he began to crank the Dead Man's Handle, slowly inching the turret round by hand. Mopping the blood away from his eyes, the Lancaster's commander "Hoppy" Hopgood clung grimly to his controls with his free hand. But the plane was losing power and he could not gain much height. He knew he would never get out alive himself. But there was a last service he could perform for his crew, and he did it: he banked the Lancaster round to the right, away from the valley which was doomed to be drowned.

GIBSON'S OTHER CREWS had seen the red Verey cartridge fired by Hopgood's radio operator Sergeant Minchin as the bomb went. Now they were transfixed by the horrifying sight of the Lancaster flown by Flight Lieutenant Hopgood, the gentle English boy they had all come to like so well, plunging on into the night, streaming a growing plume of flame. Burcher was inside the fuselage by now, struggling to strap on his parachute. The rear hatch flew open, and he saw that Minchin had opened it. The radio operator had dragged himself along the fuselage, his right leg shot away. Burcher could have jumped out now, but he grabbed Minchin's own chute and fastened it properly onto the white-faced, dying man. Then he hurled him out of the plane. He held on to Minchin's D-ring, but he did not see any chute opening. Still in the plane, Burcher pulled his own ripcord and bundled as much of the silk parachute under his arm as he could. Then, in one final mechanical act -- the act of an officer exceptionally well drilled -- he plugged his intercom into the socket by the rear hatch and gasped, "Rear gunner, abandoning ship now!" He heard Hoppy scream, "For Christ's sake, get out of here!" They were the last words Hopgood ever -spoke. M-Mother erupted in a sheet of flame as the flames reached back to the main-wing fuel tanks. Burcher was blasted up into the air, his back broken by the bomber's tail-fin. Less than two hundred feet below, the ground rushed up to meet him, and a painful darkness enveloped his consciousness.

PILOT OFFICER ANTHONY BURCHER, Royal Australian Air Force and twenty-one years old, lay in a crumpled heap in the middle of what felt like a plowed field. He opened his eyes, and saw the moon and stars. "Good God," he thought. "I'm still alive!" Echoing round the valley he could hear the familiar sound of Lancaster bomber engines. He wondered what had happened to his own aircraft, M-Mother; not so many minutes ago, he had been crouching in its rear gun-turret, watching the sheet of water flash past sixty feet beneath him and the streams of tracer shells streak by on either side. He felt hungry. Instinctively, he thrust his hand inside his blue polo neck sweater and felt for the bottle of Horlicks tablets. His mother, back in Goulburn, Australia, had heard that everybody in England was starving, and every month she sent her boy Tony a supply of the tablets to keep him going until he could return to the outback. His locker back at Scampton was full of them. Hell, he was glad of the impulse that had made him pick up a box of them on his way over to the briefing hall. The briefing hall . . . in a rush it all came back to him. His Lancaster had been one of nineteen sent out by 617 Squadron with the task of

destroying five vital barrage dams that supplied the Ruhr arms factories with all their water. M-Mother had been the second to attack the first target, the biggest dam of them all -- the Moehne dam. But they had been hit by flak and blown up, right over the dam, only about a hundred and fifty feet up. How had he survived?

With a dull sense of inevitable disaster, Tony Burcher realised that somewhere up the valley from where he lay, there was the dam, which even now his comrades-in-arms were trying to breach. In a few minutes he was going to get very wet indeed, unless he could run. But his back felt as if it were broken.

Man's instinct, if he has to die, is to die unseen. With enormous difficulty Burcher dragged his broken body across the field and hid in a culvert, where he lapsed back into unconsciousness. And just a mile away from him the 23,000 souls in the little valley town of Neheim-Huesten waited in their basements and air-raid shelters -- waited for sirens to sound the All Clear, unaware that tonight the RAF was attacking the dams above them.

THE BOMB DROPPED by M-Mother just before she blew up had bounded right over the dam's parapet and crashed onto the roof of the powerhouse below it. Smoke from the burning building mingled with the spray thrown up by the earlier detonations on the lake side of the dam, and obscured the whole target area. It was some minutes before Wing Commander Guy Gibson felt it proper to continue the attack.

A few minutes after half-past midnight, he ordered Flight Lieutenant Mick Martin to attack in P-Popsy, as Martin unofficially dubbed his aircraft. The night air was still heavy with spray, and this clung to the aircraft's windscreens; at first Martin's bomb-aimer could not see the target properly at all -- just the distant blurred glow of M-Mother's wreckage burning in the hills about two miles beyond the dam.

Even as the range closed to just over a mile, he could see only one of the dam's two distinctive valve-towers through the dense cloud of dust and smoke. He need to see both to get the range right.

Wing Commander Gibson realised that Martin's only hope of success was for the enemy gunners' attention to be distracted. He switched on all his own aircraft's lights and flew alongside P-Popsy, blazing away at the defences with the dazzling 100-per-cent night-tracer in his guns.

Martin's bomb-aimer got a sight on both valve-towers only at the very last moment. He pressed the bomb release, and the special bomb skipped across the lake towards the dam. The smoke did not seem to hamper the gunners at all, and Martin felt his aircraft shudder as a row of 20-millimetre cannon shells tore into his starboard outer fuel tank and ailerons. A streak of fast vaporizing petrol shot out behind the plane, but miraculously it didn't catch fire.

A huge waterspout shot up eight hundred feet into the air as Martin's bomb exploded, but the range must have been slightly midjudged as the base of the spout was not quite centred on the dam. The giant blast wave hurled two of the German gunners from their towers, and they lay senseless on the crown of the dam.

Martin radioed Guy Gibson, "Okay -- attack completed."

WHEN THE NEWS of this third unsuccessful attack reached the Bomber Group's headquarters at Grantham, a clammy air of extreme depression gripped the operations room. Barnes Wallis, the special bomb's inventor, buried his head still deeper in his hands so as to avoid the black looks of the two air-marshals pacing up and down.

But the foreman of the Moehne powerhouse, Meister Clement Koehler, could see something that none of the British airmen could yet see. Koehler had got out of the power-house just in time and was now sheltering beneath a larch-tree halfway up the valley. And what he could see was this -- fine cracks were forming, branching and spreading along the dam's parapet, and silver jets of water were issuing from them, glinting in the moonlight. He thought of his six nephews and cousins asleep in their house by the

sawmill down the valley -- they never paid any attention to air-raid warnings; he thought of the gamekeeper, old Wildening, and the thirty old-age pensioners that he boarded; he thought of the villages of Himmelpforten -- "The Gates of Heaven" and Niederense and the town of Neheim-Huesten. Nothing could save them now.

BARELY TWO MINUTES after Flight Lieutenant Martin's bombing run, Gibson sent in "Dinghy" Young. "Be careful of the flak," Gibson warned him. "It's pretty hot."

Again Gibson deliberately drew the enemy gunners' fire; he flew his Lancaster up and down the valley on the dry side of the dam with his landing lights blazing, taunting the gunners and firing his guns at them. Young got in his bomb run unhampered while the gunners' backs were turned. Gibson thought that the bomb must have been accurately placed, because the column of water was far taller than after Mick Martin's attack.

Hundreds of tons of water slopped over the crest of the dam, and Young shouted exuberantly, "I think I've done it, I've broken it!" But as the spray cleared, Gibson saw that the enormous wall of masonry was still intact -- but was his imagination playing tricks, or had it bulged slightly since the last two attacks?

With fresh confidence, he called up the fifth aircraft on the radiotelephone, Flight Lieutenant Dave Maltby, and ordered him in to attack.

Maltby's aircraft closed in fast. His bomb-aimer saw the dam very early, and got good sightings on both valve-towers when still two thousand feet away. In the centre of the dam, there seemed to be something happening already -- Maltby swung his aircraft to port a little. At the precise moment that the towers lined up on the bomb-aimers's two sighting wires he released the bomb.

It bounced three times, smacked into the dam's parapet and settled, still spinning furiously, down the dam's submerged face. At a depth of thirty feet, the charge went off -- four tons of the most powerful explosive the British had yet devised.

It looked perfect.

The dam was out of Gibson's sight for some minutes as he careered his Lancaster round the valley; his windscreen was still partly obscured by spray. But time was running out. Certain that the fifth attack too had failed, he called up the sixth, Dave Shannon, and told him to go in.

IN THE MEANTIME, between 12:50 and 12:55 a.m., the Lancasters had radioed to England the coded results of these last three attacks. "Dinghy" Young reported that his weapon had exploded in contact with the dam, Martin radioed that his had exploded fifty yards short, and Flight Lieutenant Maltby believed that his bomb had also failed to breach the Moehne Dam.

ONE MINUTE LATER, Guy Gibson's aircraft thundered over the dam again, and an awful, spinechilling sight met his eyes. The centre of the dam had vanished -- it had rolled over, and a tidal wave had pushed aside the thousands of tons of masonry and was pounding down the valley. One German gunner on the rest of the dam, but only one, was still firing. Gibson swiftly called up Shannon and told him not to attack.

The Moehne dam had ceased to exist. From the side of the valley Clemens Koehler had watched, paralysed, as the masonry wall had solemnly bulged and then burst with terrible ferocity between the two valve-towers. A mighty wave of water had spilled out of the breach and plunged to the valley floor, striking the ground with a colossal crash -- a sight without parallel in most men's lives. The remains of the power-house vanished in a fraction of a second, and then the tidal wave settled down, the angry vortices and whirlpools vanished, and a wall of water began tearing down the moonlit valley at twenty feet a second, ripping everything with it. Shortly afterwards, a cloud of spray and water-vapour rose, and mercifully

obliterated the rest of this infernal spectacle from Koehler's sight. At four minutes to one a.m., the 'phone rang for the signals officer at Grantham. He listened briefly, then shouted: "Gibson has signalled NIGGER, Sir -- they've done it."

Gibson had already diverted his remaining aircraft to the second main target, the Eder dam. This contained even more water than the Moehne, 202 million tons, making it the biggest artificial reservoir in Europe. This dam was 139 feet high, 1,310 feet long and built of masonry like the Moehne dam. As Gibson's aircraft reached it, small rivers of water were running out of the dam's overflow channels, so it could not have been fuller. The only anti-aircraft guns on this dam had been removed after the defeat at Stalingrad five months before. It was virtually undefended. Only sentries with rifles patrolled the road running along the dam's crest. At 1:32 a.m., the telephone rang in the local Air Raid Defence controller's office. An officer in SS uniform answered: "Lieutenant Saahr speaking."

"This is the Warnzentrale! There are several enemy aircraft circling the Eder dam!"

An hour earlier, the local authorities in the valley below the Moehne Dam had refused to believe the similar warning telephoned to them by Clemens Koehler. But this SS officer did not hesitate. He shouted to the Warnzentrale to clear the line, and at once telephoned the SS unit closest to the Eder Dam, the third Company of 603 Regional Defence Battalion at Hemfurth. The duty corporal there confirmed that there were three enemy aircraft circling overhead.

"I'll call you back in a couple of minutes," said Saahr. "If an attack starts before then, sound the alarm!"

Then Saahr telephoned through to SS Colonel Burk, the commanding officer of the SS Flak Training Regiment nearby, and warned him that a flood disaster was imminent. Within minutes, Colonel Burk had told one hundred men and lorries to stand by.

Almost at once, Lieutenant Saahr telephoned him again, and the news was even more alarming: "The local battalion says the planes are releasing flares -- and they have switched on searchlights!"

The roar of lorry engines and motorcycles on the grobund mingled with the noise of aircraft engines in the air, as the Germans prepared for the biggest flood-disaster operation of the war.

IT HAD TAKEN Guy Gibson some time to find the Eder lake: there was mist in the valleys, and this made each of them look not unlike a reservoir from the air. When he found the right valley he flicked on his microphone switch and called up the other aircraft: "Can you see the target?" Dave Shannon's voice came faintly into his earphones: "I can't see anything -- I can't find the dam."

Gibson fired a red Verrey light over the dam, and Shannon's voice came immediately:

"Okay, I'm coming up."

Shannon was a perfectionist. At 1:39 a.m., he attempted his first bombing approach but his bomb-aimer was not satisfied and they circled back to the other end of the lake. He tried again, but again the bomb run was not quite right. On the third run-up, the bomb-aimer released the special bomb: it bounced twice, and scored a direct hit on the dam's narrow parapet. Sixty seconds ticked past as the bomb sank, then a mighty explosion rent the air and a pillar of water shot up hundreds of feet into the air, followed by a blinding blue flash as the blast-waves shortcircuited the 60,000-volt power-lines leading across the valley from the generator house.

But the dam was still standing.

The generator-house foreman, Meister Karl Albrecht, later described: "At first we had assumed that the bombers were only using the lake as an assembly point, as they had done so often before. The first bomb fell at about half-past one, but it did not damage the wall much, though it did cause damage to the Power House No.1. I went to the No.2 Power House, on the right-hand side of the valley by the dam. There were two brilliant

flares burning on the little island between the two plants, presumably as an aiming guide for the bombers.

"The aircraft continued to circle ..."

Gibson called up the second of the three Lancasters: "Hello Z-Zebra -- you can go in now."

It was 1:50 a.m.. Squadron-Leader Henry Maudslay dived his Lancaster steeply down over the castle which marked the beginning of the bombing run at the far end of the lake, and closed in towards the dam.

During their bombing trials a few days before, this quiet, athletic English officer had totalled one of these irreplaceable Lancasters when he had dropped the special bomb from so low that the water had damaged the fuselage. There appeared to be no defences on the Eder dam at all, but luck seemed to be against him: as Z-Zebra thundered across the moonlit lake, Gibson and his other pilots could see that besides the dambusting bomb, there was some other large object dangling from beneath the plane -- it must have been damaged by the enemy defences on the flight out.

Something else must have been wrong, because Maudslay's Lancaster released the spinning bomb far too late from the callipers. The bomb volleyed into the Eder Dam's parapet at 250 miles an hour and blew up instantaneously, right beneath the bomber that had just dropped it.

A few of the dam's huge masonry slabs were blown off the parapet like confetti, and a yellow glare lit the whole valley as bright as day for several seconds. Out of the darkness, somebody's voice on the radiotelephone said quietly what everybody was thinking, "He blew himself up."

Guy Gibson called up the aircraft. There was no reply. He tried again:

"Z-Zebra, Z-Zebra, are you okay?"

This time, there was a faint, tired reply. "I think so," it said. "Stand by."

But the voice was very weak. Maudslay was doomed. His radio operator performed one more duty. At three minutes before two a.m. he sent back to England a coded wireless signal signifying: "Special weapon released, overshot dam, no apparent breach..." But that was the last that was ever heard of this aircraft or its crew.

THIS LEFT ONLY one aircraft ready to attack. A third wave of 617 Squadron's aircraft was now invading German territory, as an airborne reserve to fill in the gaps. But by 2 a.m. there were more gaps than aircraft in this reserve: seven minutes earlier, S-Sugar had exploded in mid-air over Tilburg in Holland -- the other aircraft could not see why, but German records suggest that it was flying so low that it fouled electric power lines. Its captain, Canadian Pilot Officer L.J. Burpee had just got married to an English girl, and they had been hunting for a house near Scampton. Now she was already a widow.

In any case, there was already a glow in the East where the dawn was coming up. The last aircraft in Gibson's immediate force, piloted by an Australian, Les Knight, swept in towards the dam, made one dummy run, and then attacked, using the flares that had been dropped beyond the dam as a rough guide. Guy Gibson, flying alongside Knight and just above him, saw the bomb bounce three times, roll up to the dam wall, sink and detonate perfectly, throwing up an eight-hundred-foot water-spout.

A huge hole suddenly appeared about thirty feet below the dam's parapet, as though a giant fist had punched through the masonry. Barnes Wallis's special four-ton bomb had started a collapse that would push aside twenty-four thousand tons of masonry.

Five minutes later, the telephone rang in SS-Colonel Burk's office, waking him out of a fitful sleep. "This is Lieutenant Saahr again, Herr Colonel! Arolson Post Office has just phoned through a report from the 603 Regional Defence Battalion. The dam has been destroyed. I have tried to contact them myself, but all the lines are dead."

The villagers closest to the stricken dam needed no telephone to know what had happened. A motorcyclist rode through the main street of Affoldern, screaming at the top of his voice, "The dam's been hit -- the water's coming. Everybody out of the cellars!" Within seconds, the streets were

full of scores of people, clutching children and suitcases and scrambling for the higher ground. There was a noise like a hundred express trains coming from up the valley -- 8,500 tons of water a second were cascading out of the dam, and the breach was getting wider every moment. As the people reached the higher ground, they turned round and looked at Affoldern -- within minutes it had vanished into the flood. The steel suspension bridge at Hemfurth collapsed with an enormous rumble into the torrent.

The villagers could hear the bellowing of cattle chained and trapped in their stalls, and the screams of those people who had not been able to escape in time.

Colonel Burk did not underestimate the size of the catastrophe. Within minutes, he had telephoned emergency flood warnings to the major city of Kassel, forty miles away, and to the Luftwaffe's big airfield at Fritzlar. By 2:30 a.m., the Army Command at Kassel had alerted an engineer battalion, and within half-an-hour troops were being rushed by the lorry load to the disaster area.

At 4:15 a.m., a Major Emergency was proclaimed. The Royal Air Force had succeeded in doing what the Germans had believed to be impossible, and now the Germans were paying the price.

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It was at about this time, four in the morning, that "Bomber" Harris, listening to the final signals filtering in to No.5 Bomber Group headquarters at Grantham, finally said: "Well, that's all we can do here. Let's go over to Scampton and meet them as they come back."

His expression as he turned to the bomb's inventor was softer than it had been earlier that night. "Can I give you a lift, Mr Wallis?" he asked. Wallis accepted gratefully, because Harris's black limousine was one of the very few yet fitted with a heater -- and the early hours were chilly.