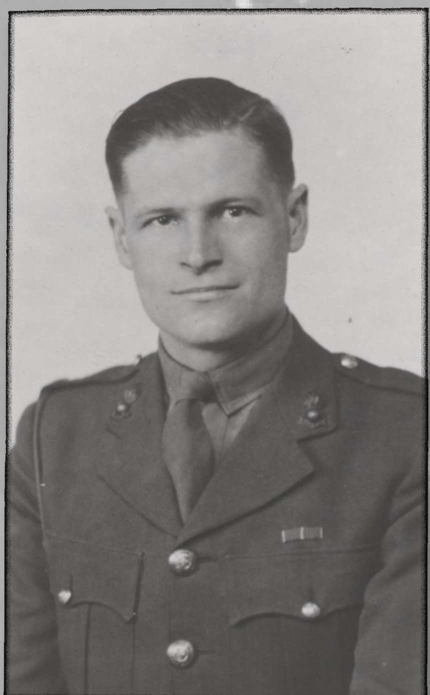
ALLAN BECKETT - RECORD OF ARMY SERVICE

INCLUDING EXPERIENCE OF DESIGN AND CONSTRUCTION OF

MULBERRY HARBOUR



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OF MULBERRY HARBOUR

October 1939 I volunteered for Military Service aged 25. I was a qualified Civil Engineer with a BSc honours degree from London University and employed as Assistant Resident Engineer at Cardonald, Scotland.

January 1940 I was called up and posted to No. 13 War Party, Napier Barracks, Shorncliffe, Kent for basic Sapper training. During the evacuation of Dunkirk I dug trenches on The Leas at Folkestone, was on watch duties at Hawkinge Airfield, and manned a searchlight at Folkestone Harbour. At that time there was considerable enemy air activity.

June 1940 I was posted to 142 Officer Cadet Training Unit at Aldershot.

January 1941 Commissioned 2nd Lt. and posted to No.2 Railway Training Establishment, Kings Newton, near Derby, where I was seconded to assist the Chief Bridging Instructor, Lt. Col. W.T. Everall RE, who was engaged in the development and practical trials of special equipment for the rapid building of Railway Bridges. In this capacity, and with the assistance of not only civilian structural engineers, Donald Ball and Bernard Ranger but also of service personnel under Max Kleinberg, I assisted in the production of designs, works drawings and descriptive manuals for bridging company use for the following equipment:-

Unit Construction Railway Bridges.
V- type steel trestling.
Everall Sectional Truss Bridging (E.S.T.B.).

The E.S.T.B. is the British equivalent of the German Roth Wagner military bridging equipment- photographs of which had already fallen into British hands. The E.S.T.B. had advantages over the German version in the speed with which it could be constructed, combined with its suitability for spans varying in length by 10 ft. increments up to 400 ft. Where necessary it was capable of cantilever erection. The connection of components was by bolts and left-in-situ drifts, in itself a highly successful Everall innovation.

Another Everall special was the "Camels Foot" - a base unit for Everall's light steel trestling. This device allowed, by screw adjustment, the levelling of braced trestles to match the irregularities of a river bed. When it was used with effective gabion protection it enabled the speedy building of railway bridges over major rivers. A typical example was the first railway bridge to be built across the river Seine after the Normandy landings, and this was constructed in less than one week.

Everall had a remarkable ability to get things done and I really enjoyed working with him. He made weekly visits to the War Office in London to report on the activities and progress of his design and development team at Kings Newton.

May 1942 Sir Winston Churchill's famous memorandum to the Chief of Combined Operations:-

"<u>Piers for use on Beaches</u>

They must float up and down with the tides. The anchor problem must be mastered. Let me have the best solution worked out. Don't argue the matter. The difficulties will argue for themselves."

Perhaps as a result of this directive Everall, on returning from one of his visits to the War Office, produced a sketch marked "Top Secret" and asked me whether, as a keen sailor, I could make sense of it.

The sketch showed a mile-long series of pontoons, each with four legs looking like four poster beds, and linked by bridges which overall covered a stretch of water shallow at one end and deep at the other. The caption was "Piers for flat beaches" - and that was all. There was no explanation, though by scaling the sketch it could be found that the spacing of the pontoons was about 80 ft.

My reaction was that the pontoons with legs were an unnecessary complication for a floating bridge, and that the same objective could be reached by a more conventional system - as long as it was designed to accept sea action without overstress and I said as much.

Everall said "If you think you know how to do better you must make it clear before next Monday when I shall be revisiting the War Office". With the help of Sgt. Major Gaunt, who was skilled with the soldering iron, I made a tin plate model of my proposed flexible floating roadway. It consisted of one torsion-free lozenge shaped bridge span and part of an adjacent span to show how the span-to-span junction could be made using spherical bearings.

When Everall returned he was on top of the world. "Beckett" he said "they want six spans built right away and I have promised that you will produce the works drawings by the end of the week!"

The order for the prototype bridge spans was placed with Messrs Braithwaite of West Bromwich and a test site was established at Cairn Head near Garlieston in Scotland. For the pontoons to support the bridge spans I suggested an adaptation of Thames lighters, and this was done for the prototypes, though I was well aware that there would not be sufficient lighters available if this scheme did go ahead.

The War Office enthusiasm for the floating bridge seemed to intensify, and Everall was instructed to bring his whole design team to London. This he did and we were accommodated in County Hall and given the title of "Tn 5d" in the Department of Docks and Inland Water Transportation. I was appointed Deputy Assistant Director with Staff Major Rank.

Two other possible solutions to the problem of "piers for flat beaches" were put under trial at Cairn Head namely the "Hamilton Swiss Roll" and "Hughes Caisson Scheme". A fourth idea which was an adapted Bailey Bridge was also being tested at Westward Ho.

I made many trips to Cairn Head but the most memorable was the one I made after a few days of stormy weather when Brigadier Bruce White instructed me to go and witness the effect of storm damage on the prototypes. I spent the whole of the overnight journey wondering and worrying about what had gone wrong and quite expected to see my floating bridge a mass of broken twisted metal. Lt. Col. Sainsbury met me at Carlisle and when I asked him what had been happening his reply was "You had better see for yourself".

As we approached the coast the noise of the sea and wind was deafening and the floating bridge was writhing and twisting in a sea that had already wrecked a fishing boat. The waves were breaking over the bridge and it needed good sea legs to walk along it BUT it was intact and fully workable. The Hamilton Swiss Roll had washed away and the Hughes Caisson Scheme had failed under the movement of its piers. After several more days of rough weather it was not difficult for the Chiefs of Staff to make a choice.

They were given a demonstration of tanks and road vehicles going over the floating bridges on to a spud pontoon. Shortly after this, orders were placed for ten miles of bridging and for twelve spud pontoons.

At this stage my link with the War Office moved to Lt. Col. Steer Webster RE who, like Everall, had a special gift for getting things done. He also had the ear of Winston Churchill. Steer Webster insisted that every last detail of equipment, tools and procedure for assembly of floating Bridges and pier head pontoons on an enemy shore should be properly worked out and that the equipment be simple, easy and quick to use even in bad weather.

In order to anchor the floating bridge so that it would provide a secure roadway little lateral movement under sea conditions would be tolerated, and a stretched cable system was adopted to give the necessary measure of control. This called for a light anchor that was able to resist a 30 ton pull.

No such anchor existed so I was given a research contract with Messrs Braithwaite under which they would produce six anchors to my design, each weighing about 4 cwt, and test them by hauling with a winch over simulated sea bed conditions. To achieve the required performance it was necessary for the anchor to bury itself in the sea bed.

As a preliminary, I made several small tin plate models and experimented by dragging them through the mud at the beach near Erith Yacht Club where I kept my yacht.

The first four prototypes made by Braithwaite failed to bury themselves sufficiently to pick up any substantial load. However, we took the most promising of the anchors, modified the buoyant stock, and reshaped the point of entry, and this produced the desired effect. An anchorage resisting a 30 ton pull could be found in a wide range of sea bed materials.

Bruce White took a great interest in the solution to the anchor problem and arranged for a sea test of it from HMS Barham, a boom defence vessel stationed in Scotland. I was sent to witness the test.

The skipper of this vessel made no secret of his scepticism of my claim for the holding power of the anchor - perhaps because as it lay on the afterdeck it looked small and something of a toy. The scale of the load clock provided did not exceed 30 ton and the skipper asked me what size of wire should be attached, mentioning that the thimble on the anchor was made to suit a steel wire rope of 4~" circumference. I suggested that he chose a size that he considered appropriate. With a great show of indifference he attached a 3°" circumference steel wire rope as an anchor cable.

The vessel was steamed full ahead, the anchor was thrown over the stern and the cable was veered to an extent of 12 times the water depth, then secured through the load clock to a stout bollard. The ship was brought up all standing and the anchor cable sang like a harp string. The crew, who knew what damage a broken cable can do, vanished from the after deck in a flash.

On examination the load clock needle was bent. The skipper muttered something like "It must have caught on a rock".

We weighed the anchor quite easily and made a second test with the same result: I felt sure that the skipper had by then changed his opinion of the anchor. It was given the name "Kite" because of its burying capability under a balance of forces similar to those that cause the uplift of a kite, but of course in reverse.

I have been asked as to whether the kite anchor did in fact bury itself in the rocky outcrops of the beach at Arromanches. Where these rocks were exposed at low tide we took no chances, and with a bulldozer scraped a hole into which the anchor was pushed. However, for the most part the anchors were totally or partially buried by the pull of the cable. When Mulberry was ultimately dismantled very few anchors were recovered because the cables broke in the attempt to disengage them from the sea bed.

The next step was to develop a rapid anchor laying system. I thought the best idea was to have mooring shuttles each carrying two anchors, supported on trap doors and with a mooring cable wound on a drum. With such equipment the shuttle could be towed to an upstream transit and the cable end connected to one anchor which, by releasing its supporting trap door, would be lowered to the sea bed. By towing the shuttle under the floating bridge girders, but over the lowered racking springs to a position where the cable on the drum reached its end, the second anchor could be attached and lowered by releasing its supporting trap door. The system proved fast and simple but did of course need a bridge party to tension and secure the cable to stoppers on the bridge pontoons.

The axle for the cable drum was so positioned that its rim projected below the bottom of the twin hulls of the shuttles and allowed the whole unit to be pushed along the deck of the floating bridge like a wheel barrow. Each six-span bridge tow should have carried to sea six shuttles and a small ramp whereby they could be launched quite easily. Regrettably not all tows arrived with their full complement of shuttles after their journey to Normandy.

With regard to the flotation of the bridge spans, other more pressing uses were found for Thames lighters. Many were converted to a form of landing craft called a Power Boat Ramp. I was therefore asked to design the ideal float for the bridge. The steel beetle was the outcome. It had a shape designed to minimise pitching yet had plenty of strength for pounding on a hard beach in surf conditions. The beetle pontoon was compartmented and had independent sections that were bolted together and thus permitted different pontoon lengths. Each section was air pressure tested at the works to ensure water tightness. There was produced a reinforced concrete alternative but I was not happy with it as it seemed to me to be less suitable for the rough and tumble of military use at sea.

Much of my time was devoted to the means by which the floating bridge (by this time code named "WHALE") could be assembled and positioned on the enemy coast. There were of course the problems of towage across a hundred miles of open sea with a long fetch from the Atlantic Ocean, and the limitation on the number of tugs available to make and repeat the round trip, and transport of not only floating bridge units, but pier head spud pontoons, various types of intermediate pontoons, concrete breakwaters, floating steel breakwater units and blockships.

The first scheme devised for the coupling of the floating bridges involved a system of tows in each of which one bridge span linked two pontoons and carried a second span on top. Thus a two-span length of bridge comprised a single tow. This system was tested at Cairn Head by Major Tonks and his 970 Floating Equipment company. Assembly at site was by no means simple, easy or quick and the idea was discarded. A naval officer watching the operation with me suggested that I might think about using a Camel - a pontoon in which buoyancy can be changed. I had not considered it but from that moment on could think of little else as a solution to this assembly problem. Eventually an erection tank or form of Camel was evolved and with it the trumpet-shaped locators that allowed one six span tow to be coupled up to another in just twenty minutes, given any sort of reasonable weather. This meant that a mile-long pier could be positioned and moored up in about four hours as long as we had sufficient tugs to bring the tows across Channel. My "Notes of Floating Bridge Equipment" published in January 1944 describes the assembly of tows.

The manufacture of so much bridging in so short a time put great strain on the British steel fabricators, yet the objective was achieved very much through the skill of Col. P.K. Benner in the Ministry of Supply. The bridge components were made in small pieces by firms all over the country, some of them developing expertise in precision fabrication by welding that had previously not been thought possible. Assembly of these components into fully fitted operational tows by army units took place at Richborough under Lt. Col. Holmwood RE and at Marchwood under Lt. Col. Stork RE. Because Richborough had limited depth of water, only tows using steel pontoons could be assembled there.

It was by now proving impossible to produce sufficient steel plate to meet both the demand for steel beetles and the Navy's floating breakwater "Bombardon" and my objection to concrete was therefore overruled and a form of concrete beetle, having thin walls 1≈" thick but still very heavy, was introduced. It was to be positioned only where depth of water ensured it would not ground on the sea bed. All the concrete beetles were made at Marchwood and formed the floats for the flexible spans assembled in that depot. The tows, when fully assembled, were to be towed to and moored in assembly areas more or less in the shelter of the Isle of Wight. This required a substantial coastwise journey for the units assembled at Richborough though not of course for those assembled at Marchwood.

However there must have been some problems with the Marchwood tows because although they left Marchwood they failed to arrive at the Selsey assembly area and several of them had disappeared completely enroute.

I was sent to find out what had happened and joined one of the newly finished tows at Marchwood with another that left just before us and we departed together for the assembly area. I asked our tugmaster what he thought of his tow. His reply was that he hoped he would not be asked to tow anything like this across the Channel!

On the journey I inspected each of the six pontoons and found them perfectly watertight. I was thoroughly mystified about the disappearing tows until we approached the gate through the submarine defence, whereupon a concrete beetle at the first tow seemed to get entangled with it. After extrication this leading tow went ahead but was slowly sinking and, like its predecessors, sank before it reached its destination. In the case of my own tow greater care was taken in negotiating the gate and we were the first of the tows to arrive at Selsey from Marchwood without damage. I remained convinced that for military equipment, subject to rough handing in maritime conditions, something more robust than thin walled concrete was required. My report to War Office was not well received. It was known that I disliked the concrete beetles and it was considered too late to make a change in plan. The chosen answer was to increase the number of spare concrete beetle pontoons. This seemed to me to be treating the floating bridge as well as its concrete pontoons supports as lavishly expendable. The American Construction Battalion (See Bee's) took a different view and put in hand the replacement of their concrete beetles by an adaptation of their steel N.L. pontoon equipment. Such modified Floating Bridge tows found their way into Mulberry A and later on into Mulberry B after the storm of D + 13.

The assembly of tows with steel pontoons at Richborough also had problems. Due to the limited slack water period at high tide it became difficult to load all six shuttles on board each of the six span tows, and dispensation from War Office was obtained to send off the tows with only one mooring shuttle aboard.

When I told Steer Webster of my concern about the resulting shortage of anchors on the enemy coast he arranged, with the help of Sainsbury, for the deficiency to be made good by transferring some of the balance of loaded anchor shuttles on to the deck of pier head spud pontoons. Unfortunately only Mulberry B had its full complement of anchors and it is my opinion that the shortage of anchors at Mulberry A contributed to its failure in the storm of D + 13.

Regarding the positioning of tows for coupling together on the enemy shore, I had, before D day, a part to play. To handle the tows into position it was originally intended to use TID tugs. They were a British war time expedient but for their size and weight were unhandy. When the American Construction Battalion under Lt. Freeburn practised with the floating bridge equipment at Cairn Head they quickly saw an advantage in the use of the American M.T.L.(Motor towing launch). This was a wooden towing launch powered by a Chrysler petrol engine with large capacity fuel tanks and highly manoeuvrable. I was convinced that we should have them for Mulberry B and we persuaded Steer Webster to indent for six such launches complete with American crews.

2nd June 1944 I received an order from Major General Sir D. McMullen RE to go to the Isle of Wight and attach myself to 21 Army Group as technical adviser in the field. On arrival I was met by the crews of six MTLs looking for someone to tell them what to do. As no one seemed interested I took them under my control and arranged for all of the launches to be towed to Arromanches - one each behind the first six of the Whale tows.

I left for Arromanches (the site for Mulberry B) late afternoon on D+1 on the MTL hitched behind the first whale tow. The voyage, which lasted a night and a day, was not without incident, as apart from all the general activity in the Channel our Royal Navy escort was under attack from German E boats. Every now and then during the hours of darkness the night sky was illuminated by mortar incendiaries ("flaming onions") which, when they hit their target, started small fires. In a matter of seconds these small fires turned the target into a blazing inferno from stem to stern and lit up a wide area.

We were in a wooden boat which carried scores of gallons of petrol and we felt extremely vulnerable. I was very conscious of the fear and apprehension amongst the crew and to give them something positive to do I suggested that we might prepare a long rope to trail behind the boat made up into a series of loops one behind the other about 6 ft. apart. If we were hit and our boat caught fire we could jump into these loops and find towage. I had the feeling that American troops held British Officers in high regard, even though I was unable to give them complete reassurance on their safety if they had to use the rope!

It seemed to take a very long time for the crossing, and when we did get to the enemy coast we cruised up and down amongst gun fire and a massive smoke screen from our Navy until high tide, when we beached the shore ramp float and set up the anchors.

At Arromanches I arranged a three shift system (8 hours on and 8 hours off) for the working of the MTLs. This seemed to work well, not only for the assembly of the Whale components, but also for the removal of drifting craft that could, by collision, damage Whale equipment. The crews soon learnt to handle their vessels skilfully no matter how bad the sea conditions, and by contrast with Mulberry A all six MTLs remained in first class working order throughout the bad weather of D+13 and after.

As to the construction of the floating roadways, all went well and a whole day's supply of tows could be positioned and moored up in an hour or so, but we had the frustration of long delays between the arrival of each batch of tows.

I had the feeling that the establishment of the Whale facilities was being given low priority especially when we could see almost continuous activity in the towing and positioning of the floating breakwater Bombardon. However by D + 5, I was told that at Mulberry A they had a Whale Pier in operation. I lost no time in getting there and sure enough tanks were coming ashore in quick succession over a Whale pier made up of part L.S.T. equipment designed for 40T tanks and part stores pier designed for 25T road vehicles. They had to keep the 40T tanks moving fast because the pontoons sank down to deck level underneath their weight.

I have been asked what I did at Arromanches as I was obviously a supernumerary from the War Office without any specific job. My first interest was of course the Whale project as I had had a good deal of responsibility for its design. It was with great relief that I witnessed the ease and speed with which it could be set up once the tows arrived. Of course I made sure that the roadways were properly moored and enjoyed the greatest possible co-operation from Sainsbury in this respect.

I had plenty of time also to observe the behaviour of the spud pontoons, Phoenix caisson breakwaters and Bombardons. The failure of all the Bombardons came as no surprise because, prior to D day, I had been asked by Bruce White to assess the suitability of their moorings and I had reported them to be far too weak under the assumptions for wave pressure I used for the floating bridge. Eventually I assisted Sainsbury in sinking, by Piat mortar, one of the Bombardons that had broken adrift, collided with and breached the Phoenix breakwater, then entered the harbour creating the risk of even greater damage.

The power of the sea in a storm was evident even within the breakwaters of Mulberry B. I witnessed the driving ashore on to rocks of a Rhino pontoon fully loaded with company transport and other equipment. The whole of the pontoon and its cargo was beaten into a shapeless mass of twisted steel and sheet metal. The only easily recognisable part of the deck cargo that remained was the rubber tyred wheels which had become detached because their axles broke. The whole of this destruction took place in little more than 3 hours.

Whilst Mulberry B survived the storm on D + 13 with only minor damage, the destruction by sea action at Mulberry A was total. The beach was littered with wrecked vessels piled one on top of another. It seemed to me that had these vessels put out to sea instead of relying on protection from the breakwater they would not have been lost. Basically, the Phoenix breakwaters failed due to overtopping whereupon all except one of the spud pontoon pier-head units became damaged beyond repair. The floating bridge behaved like a great net collecting all forms of miscellaneous craft which sawed through such moorings as had been laid. However the floating bridge itself was not too badly damaged and I was asked to act as liaison officer for its repair and transfer to Mulberry B to make good the losses sustained in cross Channel towing during the storm. This was done and in the end we had in Mulberry B more floating bridge equipment than we could use. (see aerial photos). I was interested to find that the one spud pontoon that had survived the storm at Mulberry A did so because the operator, despite instructions to the contrary and red light warnings of rope overload, had raised the pontoon well clear of the sea surface.

On reporting back to War Office on the performance of Mulberry B during the storm of D+13, I was asked by Bruce White how the Phoenix breakwater units behaved in Mulberry B. These I had watched during the storm and I described how some failures resulted from overtopping by long period waves. In such cases the seaward concrete walls fell outwards, as if driven by hydraulic internal pressure far in excess of that which might be attributed to wave height.

As to the behaviour of the spud moored pierhead pontoons I reported that where pontoons were immediately downwind of the open harbour entrance the spud controlling cable had failed. In other words where the pierhead pontoons were protected by the breakwater they sustained no serious damage. Also there was at least one instance where a spud was broken clean off below water level. The pontoon was removed to a less exposed position and a tug holed itself on the below-water broken spud then quickly sank out of sight. At low tide I looked for eddies that might indicate the location of the wreck but eventually found it by hitting it with the bottom of my MTL!. I laid a buoy, then reported the matter to the Naval Officer in charge who encircled my buoy with three green wreck markers at a suitable distance. My MTL was making unhappy engine noises so we beached her and found a bent propeller shaft. Fortunately we carried a spare shaft and after replacement the vessel was as good as new.

I have been asked to give my impression on the success or otherwise of the Mulberry harbours as a military undertaking, not only in the role of the designer of some of the equipment but as an observer of its use in warfare.

Firstly, one must accept that the sea conditions under a strong on-shore wind can cause far more damage than enemy action so that the value of breakwaters has to be a prime consideration.

In this respect the blockships were an unqualified success. They are quick and easy to get to site and, when expertly handled, little trouble to sink in position. The cost is of course high and the substitute in the form of Phoenix concrete caissons was effective in enlarging the area under protection from wave action. There is difficulty in compromising the necessary weight for stability with buoyancy for flotation and structural strength to resist wave pressure. In the open topped version of the Phoenix they failed when long period waves spilled over the caisson wall. However with some patching up they served their purpose in Mulberry B. This cannot be said for Mulberry A.

The floating breakwaters (code named Bombardon) were a complete failure due to insufficient strength in their design and inadequate moorings at site. Even worse, their manufacture had jeopardised supply of thin steel plate which was indispensable for the making of small landing craft and pontoons. The spud pontoon pier heads worked well but their instructed mode of operation required that only part of the weight of the pontoon be applied to the spuds, because the weight of deck cargo and concrete gravity fenders when added to that of the pontoon exceeded the capacity of the spud control cables. This meant that the protection of the breakwater was vital to the success of the pier head. Where the breakwaters were less than fully efficient the spud pontoons failed. This happened totally in Mulberry A except in one case where the pontoon deck was empty and the whole pontoon was jacked up above sea level. On Mulberry B the few failures were limited to an area behind the main entrance through the breakwater.

The floating bridge roadway, if properly moored and supported on steel pontoons, appeared to be indestructible by wave action but suffered from collision by craft out of control. With regard to the floating bridge supported on concrete pontoons little of this survived the Channel crossing. One theory for the loss is that the excessive weight and draft of the concrete pontoons, when subjected to wave action, caused motion of the pontoon incompatible with the six span tow as a whole - resulting in separation of pontoons from bridge spans.

With regard to establishing the equipment on the enemy coast there can be no doubt that once the tows arrived they were handled into position quickly, so much so that it became tedious when the interval between arrival of tows became extended.

With hindsight, the planning could be improved by adopting an "early use" concept and dispatching the tows accordingly. Under such a plan blockships would be accompanied by enough tows in the first stage to build a complete roadway with pierhead unit using the most robust equipment i.e. all steel floats for the floating bridge and spud pontoons that could safely be lifted clear of wave action. The second tows would be sufficient to construct the LST pier complete and enlarge the stores pier. The follow-on process would likewise be aimed at maximising the cargo discharge facilities having regard to the number of tugs available. There would be no need to wait for breakwater completion because the floating bridge and the pierhead units can ride the sea. The discharge of ships alongside the pier head might be difficult and interrupted in bad weather but modern large fenders could minimise this difficulty pending completion of the extension of the breakwater.

There could be a case for developing a special purpose self-propelled recoverable blockship of composite steel and concrete construction to reduce dependency on tugs.

The unloading of stores calls for comment. The cargoes coming ashore over the stores pier were all of such size and weight that can be shifted by hand - principally jerry cans, compo boxes and ammunition. In other words they were ideal for conveyer or roller runway. They were in fact discharged by ships gear and cargo nets at a rate that seemed pathetically slow. It would have been perfectly possible to install in the hold of each cargo vessel a ship's-power operated elevator on to which the cargo could be rapidly fed by hand and which would discharge over roller runways straight into waiting lorries.

Summarising Were the Mulberry harbours a success?

Mulberry A failed after only one week in service due to overtopping and failure of the Phoenix breakwaters in bad weather. Mulberry B provided the facilities required for the length of time required and was in my view a success.

Following the completion of Mulberry B, I was sent to Halle near Brussels where a stock of German bridging equipment had been found. It was novel and in sufficient quantity to be put to use. With the aid of a sergeant, six men and a crane we made trial assemblies, found how it was intended to be used, and produced an instruction brochure-cum-stores list for Command H.Q.

Following our entry into Antwerp I was sent to find out if the port was as intact as the War Office had been advised. I found it was, although the Germans still occupied half the port. No doubt they expected to retake it all for they still operated the power station from which we were happy to use the electricity. Of course the British were not able to use Antwerp port until Walcheren Island, which commands the entrance to the river Scheldt, was cleared of its German fortresses. This was done with the aid of the RAF who breached the dykes by bombing, thus flooding the island, which brought the movement of ammunition and other supplies by the enemy to a standstill.

Meantime, because the war was still far from over, the design team of Tn5d was very busy. They designed and supervised the conversion of cross channel ferry vessels "Twickenham", "Hampton" and "Shepperton" so that they were each able to carry and position a bridge span to establish a rail connection with the shore and thus land locomotives and rolling stock. Likewise the ferry vessels "Iris" and "Daffodil", which had already been modified for wartime duties as mother ships for landing craft, were fitted out with specially long ramps to enable breakdown cranes as well as normal rolling stock to be landed in France.

A further responsibility entrusted to TN5d was the design of emergency lock gates suitable for any reasonable width of opening. The equipment (code name SHARK) consisted of steel tanks that could be towed flat and then up-ended by partial flooding before coupling one to another to correspond in width to a lock opening.

With the military advance through Europe the equipment designed by Everall came into wide use and inevitably the problems that were met in the field raised questions for the design team to answer. One such occasion was the construction of a large Everall Sectional Truss Bridge at Deventer in Holland and I was sent to help. The bridge was complete and a train waiting ready to cross. It was apparent that the dimensions of train and bridge were such that the knee bracing to the top chords would foul the locomotive and rolling stock so I, after checking the strength, instructed the removal of this bracing and the train proceeded on its way. I reported back to Everall but he was not too pleased. He had designed this bridge for the Berne gauge which was an agreed European standard. The train I had allowed to cross was clearly out of gauge and in his view should never have been allowed to pass. I was told to take more care of his bridges in future!

Following the re-capture of Walcheren island and the liberation of Holland, the Dutch Rijkswaterstaat engineers sought assistance from the War Office to enable the four gaps in the dykes made by the RAF to be closed. Brigadier Rolfe of Tn5 suggested the use of large concrete elements that had been held in reserve for the Mulberry harbours. He also offered my services to show how the equipment might be used.

As the equipment had not been designed for this purpose there was plenty of scope for imagination. I was required to report to Brigadier Reed and found myself in Middelburg with an amphibious vehicle for transport.

The first gap to be closed was Nolle, near Flushing, because it is exposed to the South West prevailing wind and being devoid of shelter was expected to become enlarged and uncloseable if not sealed off before winter.

It was interesting to discover the techniques used by the Dutch engineers for closing gaps in their dykes, and to discover that all their huge areas of reclamation were founded on the process of enlarging areas naturally protected by sand dunes. They had no record of ever closing a gap in a location of a lee shore facing a long fetch. This is the situation at Nolle and to a similar extent, at the gap at WestKapelle.

The "large elements" sent from U.K. turned out to be concrete beetles and concrete intermediate pontoons. I asked for and was sent many kite anchors and cables.

The Dutch engineers principally Prof. Thysse and Verhay asked me how the "large element" technique was to be applied and I suggested that after laying mattresses across the diverted floor of the gap using the standard Dutch method, we should then position and sink the concrete beetles side by side and afterwards fill the space between them with boulder clay. At high water and low tide the sea rushed through the gap at 6 to 8 knots and as it was obvious that the beetles would need to be anchored I suggested this be done by means of the kite anchor. The Dutch engineers were full of misgiving - the anchor looked too small for the job - but I was able to demonstrate that it could resist the breaking load of a 2°" circumference steel wire rope. Using a D8 tractor fitted with a Hyster winch we hauled the anchor until it buried itself in the sandy beach. We then increased the pulling force until we broke the rope. Professor Thysse was convinced. The first concrete beetle was anchored in the Nolle gap and all the senior Dutch engineers enjoyed sinking it by punching holes through the bottom of the concrete beetle with steel rods. They were so pleased with themselves once this had been done - an innovation in dyke building - that it was followed by Schnapps all round!

Three or four more beetles were anchored and sunk in this way but, because the slack water period in the gap was short, it was finally closed by positioning and lashing beetles one to another rather than anchoring them individually.

Thus the Nolle gap was closed and sealed using clay and sand after which the contractors plant was moved to WestKapelle to repeat the exercise.

Unfortunately the crest of the new dam at Nolle was not raised to sufficient height to avoid overtopping in storm conditions and on the night of 23 September 1945 the new dam was breached and many of the unanchored beetles washed away inland. Worst of all the brushwood mattress foundation was destroyed and the depth of water in the gap increased to an extent greater than ever before. This no doubt was due to the resistance given to gap widening by the concrete beetles.

The Dutch engineers were sure that they would have to re-route and rebuild the dam in the shallow water further inland of the breach and that the undertaking could not be completed before winter, with the possible loss of the whole island.

There was a general air of depression and I was asked if I had any experience of dealing with such trouble - I had none but when looking round Flushing harbour had noticed huge piles of torpedo netting and a large concrete intermediate pier head pontoon. I suggested to Professor Thysse that if we were quick before the gap widened much further we could lay and sink the pontoon like a patch across the opening. "All very well" he said, "but the bottom protection is gone and the hole under the pontoon will just deepen".

I suggested that we dropped torpedo netting into the hole beneath the pontoon. After long discussion the Dutch engineers decided to give my idea a trial - not because they thought it could possibly succeed but because if they did not I would report back to War Office and aid from U.K. would dry up!

The Dutch engineers worked with a will and made the idea work. Thus the dam was repaired and raised to a height that could not be overtopped.

The story is told by the official Dutch reporter C. Spoelstra in his book "Roll back the Sea".

Postscript

When the war was over, and whilst waiting for discharge from the Army, I made a model of what might be developed as a more versatile form of floating bridge and one not beset with the problem of tugs. The bridge itself was carried on cylindrical pontoons of light gauge steel filled with expanded foam. Support for the bridge was provided by stub axles projecting centrally at each end of the pontoon. In its stowed position the bridge spans were to be coupled, one end only, to the pontoons and inclined so that the pontoons lay close together. This inclination permitted the whole assembly to be stowed on the deck of a large self-propelled spud pontoon with an adjustable ramp. The link between bridge spans was to be by slides so that the floating bridge could be extended like a concertina. The essence of the idea was that the pier head unit should find its way to an enemy beach without tugs, beach the shore end of the floating bridge then proceed seaward at the same time allowing pontoons with bridge spans to roll off the stern ramp. When fully discharged of pontoons linked by bridge spans the pierhead unit would lower its spuds and thus secure its position.

Should the distance from the beach be insufficient a second such spud pontoon similarly loaded with bridge spans and cylindrical pontoons would couple up and take up a position further from the shore.

I would like to know if any interest has been generated by this idea.

For my work at Arromanches I was awarded M.B.E. (military).

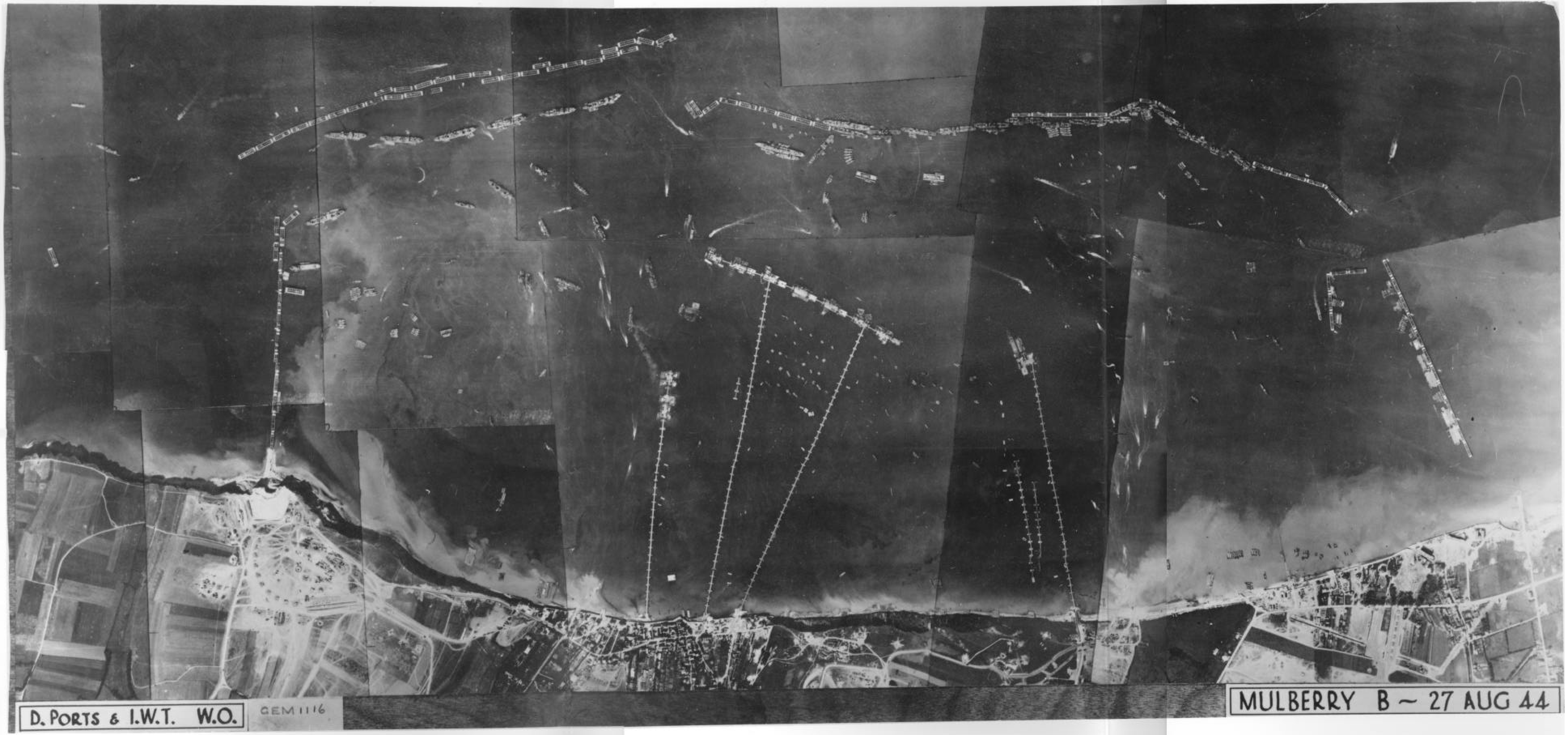
I received a special award for inventors for the development of the Kite anchor.

I received a special award for inventors for the design of the floating bridge.

After demobilisation in 1946, I initially set up as a freelance Civil Engineer, then joined Brigadier Bruce White, (who had by now been Knighted) in his family firm of Consulting Engineers, Sir Bruce White, Wolfe Barry & Partners.

In June 1947 I gave a paper to the Institute of Civil Engineers entitled "Some aspects of the design of flexible bridging, including 'WHALE' floating roadways". This paper appears in the series entitled "The Engineer at War" and a copy is enclosed.

Enclosed also a copy of Notes on Floating Bridge Equipment January 1944 and aerial photo of completed Mulberry B.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