Chapter Two: Combined Operations Headquarters

In July 1940 the Prime Minister, Mr Winston Churchill, created a Combined Operations Command led by Admiral of the Fleet Sir Roger Keyes. The object of the new organisation was the study and promotion of the type of warfare in which two or more of the services were closely involved. This of course covered everything from a small commando raid to the eventual re-entry of the continent and included an intense investigation into the training and equipment necessary. Early in 1942 Rear-Admiral* Lord Louis Mountbatten succeeded Admiral Keyes as Chief of Combined Operations (short title CCO) and a number of other changes took place at the headquarters in Richmond Terrace, off Whitehall, including some increase of staff and expansion of effort.

With a wartime optimism characteristic of the British race in general and of the Prime Minister in particular, the provision of suitable craft to land troops and tanks on enemy held shores had been put in hand as early as 1940 when the likelihood of the very reverse happening seemed more than a possibility.

From the beginning the major preoccupation of CCO and his staff was the problem of landing a large number of tanks and heavy army vehicles on a hostile beach. It soon became obvious that even ships and craft specially designed for the job would almost certainly ground in ~~some~~ several feet of water. Subsequently, the dearly bought lessons of the Dieppe raid left no doubts as to the difficulties to be overcome in a major assault and particularly the re-entry to the continent.

For the initial landings vehicles could be waterproofed to allow them to wade ashore but for the great numbers involved in the follow-up and until a port was available

* Commodore 1st class at the time of his appointment. Promoted to Rear-Admiral shortly afterwards.

waterproofing was too tedious and expensive in materials and manpower. The problem became known as 'bridging the water-gap' and although a measure of success was obtained various possibilities were still being investigated as the first waves of the assault troops made their way ashore. As with a number of the problems which faced the planners, in the event this one solved itself but that is another story. ~~In fact, this happened in the case of a number of the problems which faced the planners but~~ the dangers were very real and had to be guarded against.

The next question was how to get the massive quantities of ammunition and stores ashore, again on an open beach and with the possibility of onshore gales. This of course was solved by the devising and construction of the Mulberry harbours, protected by the simple but extremely effective Gooseberry artificial breakwaters. These last consisted of a crescent of sunken blockships which stood up to the heavy weather experienced remarkably well. Another ingenious idea, the floating breakwaters or Bombardons as they were code-named, failed to weather the storm as their moorings ~~failed to~~ could not hold them. The US engineers cut them up on the beaches and made good use of the sheet steel of which they were constructed.

Without doubt the supply of fuel for the army throughout the campaign and for the air force once airfields had been established on the continent exercised the minds of the planners and the staff of COHQ to almost as great an extent as the water-gap and the artificial harbours. Indeed, providing the first two were solved successfully, the necessity for a safe and abundant fuel supply became overwhelming. Under CCO, the responsibility for trials and experiments

devolved upon Captain Thomas Hussey, his Director of Experiments and Operational Requirements, and in the summer and autumn of 1942 trials were carried out at Westward Ho! in Devon to determine the possibility of hauling out a 6 in. (150mm) steel pipeline from the shore to moorings for a tanker in deep water. The construction work was carried out by a detachment of Royal Engineers under Colonel ~~Seafarm?~~ Jennings and naval arrangements by an officer from COHQ. After a considerable amount of trial and error and hard work, including some spectacular explosive devices dear to the hearts of the sappers, a successful technique was evolved.

In due course an imposing array of brass hats arrived and witnessed a full scale demonstration which went off astonishingly successfully. However, the officers responsible for the demonstration, although absolutely convinced of the practicability of the system, had realised that owing to the perversity of inanimate objects, things are likely to go wrong at inconvenient moments, especially when brass hats are present. To counter this they arranged a by-pass system connected to a pump skilfully concealed on shore, so that if water - which was being used in place of petrol - failed to flow from the tanker when instructed to pump, the by-pass would have been brought into use and only those in the know would have been aware of the trick. Delighted with the success of the demonstration, the naval officer concerned was foolish enough to confess what they had done, with the result that the very senior army officer who headed the inspecting party went very red in the face and departed uttering dire threats - from which, fortunately there were no repercussions. It must be conceded that all demonstrations need a certain amount of stage management. Indeeed, in Russia, the magnificent Red Army Day parade

runs so smoothly that the rumour is that it is organised by the stage manager of the Bolshoi theatre.

Appledore, situated at the mouths of the rivers Taw and Torridge, was the headquarters of the Naval Officer in Charge of the area, Rear-Admiral Franklin, a retired officer who had served gallantly as Commodore of convoys and who ruled his present command as a benevolent autocrat. His organisation was affectionately referred to as 'Frankie's private navy' and as nearly all concerned were Devon men there was probably a strain of piracy somewhere. The area became the centre for a great deal of Combined Operations trials and experiments with the eventual establishment of COXE - Combined Operations Experimental Establishment, under Colonel Courtney. Later the US Navy had an establishment with headquarters in what must have been a Mississippi river steamer, moored in the river Torridge.

Originally, a select committee of three officers from COHQ were deputed to examine the Appledore area and check its suitability for trials and experiments and of course permission to do so was sought from the NOIC. On arriving by car somewhere in the vicinity the officers decided to alight and continue on foot, in order to survey as much of the terrain as possible. They had not proceeded very far when they were politely arrested by a posse of men dressed as seamen and in due course appeared before the Admiral. From him they received a sharp reprimand for not reporting to his headquarters before making free of his domain, together with the assertion that they might have been Hitler, Goering and Goebbels for all he knew. He was of course quite right in pointing out the lapse of protocol and from then on he became most helpful and friendly in every way.

The doubts about the availability of small tankers for the invasion has been mentioned and although the success of the ship to shore pipeline trials had proved that bulk supply over the beaches was possible, the dangers of this method were obvious. A tanker moored just off a beach and attached to a pipeline would be a sitting target and a highly explosive one at that. Neither CCO nor the planners were happy at the thought of a critical phase of the assault relying on Tombola, which was the code name given to the ship to shore pipelines. Even when a port was captured and in workable condition, enemy activity might still make a reversion to Tombola necessary.

The estimated requirements of petrol, oil and lubricants (short title POL) of both the British and US forces were such that it was essential to provide bulk supplies as soon as possible after the initial landings. Until secure beach-heads had been established fuel would be landed in jerricans, of which some millions were being provided but it was realised that it would be impossible to maintain sufficient supplies in this way and that refilling the jerricans from bulk must be arranged. It was anticipated that the invading forces would need 2,000 tons of fuel a day in the early stages mounting to 7,000 tons a day as the armies advanced.

Some modifications to the Tombola system were proposed and one was given an exhaustive trial. This consisted of a ten inch (250mm) diameter steel pipeline, the pipes welded together to the required length and constructed to float just awash when empty but to sink to the bottom when full of fuel. A 1,000 ft (305m) length was welded up on the beach at Ferryside, Carmarthen, and then towed round to the Solent. Bad weather was experienced on the trip and the long

pipe writhed through the waves like a giant snake but in spite of this rough treatment it arrived at its destination still airtight, the ends of course being sealed. After intensive trials this method of connecting a tanker to the shore was adopted as an alternative to the hauling out along the sea bed of a 6 inch (150mm) steel pipe for Tombola, and code named Amathea, but it was not used. One reason was said to be the dangers of towing a long and barely visible pipeline through the huge concentration of vessels in the vicinity of the beaches.

The flash of inspiration for an entirely novel method of conveying bulk supplies of fuel to the other side of the channel emanated from COHQ and the credit for immediate recognition of the possibilities must go to Admiral Mountbatten in his capacity as CCO. Captain Hussey ~~has~~ claimed that the original idea was his and a number of people have insisted that the idea could not have been put into practice without their contribution. This may well be true and no doubt many skilful artisans should be included in that category. In fact, at this distance it would be less than wise to make positive assertions and certainly no reputations will suffer if it is suggested that Admiral Mountbatten and Captain Hussey were the true originators of the idea of a pipeline under the channel. To this must be added the intimation that as far as is known they made no proposals as to how this should be achieved and the credit for the brilliant solutions lies elsewhere as will be shown.

The origin of Pluto usually quoted is that Admiral Mountbatten, in his capacity as CCO, was attending trials of flame-throwers staged by the Petroleum Warfare Department. Mr Geoffrey Lloyd, Secretary for Petroleum, asked

Admiral Mountbatten whether there was anything else that his department could do to assist COHQ. Lord Louis is said to have replied, 'Yes, you can lay an oil pipeline across the channel.'

Mount/ Captain Hussey recalls that he and Admiral Mountbatten were at a demonstration at Inverary (a Combined Operations training centre) of the landing of important stores subsequent to an assault. The petrol was in tins, which were easily damaged and prone to leak, with the inevitable fire risk. They agreed that this was a dangerous way to handle follow-up supplies and in addition it was unlikely that enough suitable vessels to carry fuel so packed could be provided.

Captain Hussey then approached the Admiralty who confirmed that it would not be possible to allocate the large number of vessels that would be necessary to supply all the fuel requirements of the army if it were packed in tins. He also discussed the question with the War Office department responsible for the supply of petrol and pressed for a decision to provide follow-up supplies in bulk. The head of the department concerned was Brigadier 'Tiny' Bond, a very able and experienced officer, who said that he could not agree that tins were unsuitable and pointed out that they had been used exclusively in the North African campaign and had proved satisfactory. This can only have been true at that time as later captured jerricans were used in the desert and a pipeline laid to provide bulk supplies.

The ship to shore pipeline trials at Westward Ho! having proved successful, Captain Hussey suggested that this was half-way towards solving the problem of bulk supplies and CCO agreed wholeheartedly. But with Tombola and even in a port when one was captured, supply by tanker was likely to be extremely hazardous and by no means assured.

As a result, Mr Geoffrey Lloyd (now Lord Geoffrey-Lloyd) accepted that a fuel pipeline from Britain to the continent was an operational requirement and proceeded to deal with it as such.

It was originally considered that the cross-channel pipeline should have an internal diameter of 6 inches (150mm) and on posing the question of how it was to be achieved Mr Lloyd was met with considerable doubt and discouragement from the experts on his staff and others. But he was not the sort of man to be put off easily and he refused to give up at the first hurdle. In this he was supported by A.C.Hartley, Chief Engineer of the Anglo-Iranian Oil Company ~~and~~ who was one of his advisers. Clifford Hartley had had extensive experience of laying pipelines over all sorts of terrain and was convinced that this was a problem that could be solved.

The other experts had assumed that a pipeline across the channel would have to be made up of jointed lengths and rightly decided that this would entail using a large number of craft with heavy moorings. This would make the work extremely hazardous owing to the weather and tidal conditions of the channel, to say nothing of the dangers of enemy attack. Hartley agreed and suggested that the only possible way of laying a pipeline across the channel would be in one continuous length, without stopping and at a speed sufficient to overcome the strong currents encountered.

In a remarkably short space of time he came up with a soloution. It was clear that a pipe of the type suggested would have to be of small diameter owing to considerations of bulk and weight but if it could be laid quickly it should

be possible to lay a number of lines to make up the necessary throughput. He remembered that a difficult pumping problem through the hills of Iran had been solved by using pipes of only 3 inches (75mm) internal diameter. Working at the very high pressure of 1,500 lbs ~~per sq in~~ P.S.I more than 100,000 gallons (454,600 litres) or about 350 tons a day were delivered by pumping stations 40 miles apart. At this point Hartley's mind turned to the method of laying submarine cables and immediately conceived the idea of a large cable with a hollow core through which the fuel could be pumped.

Sir William Fraser, Chairman of Anglo-Iranian and honorary petroleum adviser to the War Office, offered his full support and Hartley then consulted Dr H.R.Wright, managing director of Siemens Bros. & Co. Ltd. of Woolwich, a firm with great experience of the manufacture and handling of submarine cables. Dr Wright agreed that the proposal was feasible and at once arranged to make a trial length of cable. This was to consist of an internal lead pipe, bound with steel tapes to withstand the pressure and reinforced longitudinally by steel wires. It was at this point that the vital importance of secrecy led to the adoption of the word HAIS (Hartley-Anglo-Iranian-Siemens) for the cable to avoid the use of the word pipe or pipeline.

Siemens produced the experimental 200 yard (219m) length of cable in a week and it withstood test pressures of up to 7001b per sq in before failing at the plumbed ends. It had an internal diameter of 2 inches (50mm) and was designed for a working pressure of 5001b ~~per sq in~~ P.S.I. It was calculated that this combination would only deliver about 30,000 gallons (136,380 litres) a day over the shortest distance across the channel, 20 miles, but it was an encouraging start.

Further tests consisted of handling the cable in and out of a Post Office cable ship and when these proved satisfactory samples of the Hais cable were shown to the Prime Minister and service chiefs by Geoffrey Lloyd. This led to instructions to proceed with further development with all speed.*

Foot-note (* Only such technical details of the manufacture and handling of Hais cable as are necessary to make clear the part played by COHQ are given in this chapter. Full details are given in chapter four.)

At this point the Admiralty, COHQ, the War Office, Post Office and Anglo-Iranian were all brought together to arrange a complete trials programme and the manufacture of further lengths of cable which this would necessitate. Clifford Hartley and Dr Wright of Siemens were of course key figures and consulted at all stages. In fact, Siemens went ahead with the production of a further length of cable without waiting for an official order - possibly with some encouragement from Hartley - and on 10 May a length was laid in a loop in the river Medway off Chatham by the Post Office cable ship Alert. A pumping test was then carried out using pumps borrowed from the Manchester Ship canal. These had been kept for emergency use in case of damage to locks by enemy action.

After two days of pumping a failure was evident and the cable was recovered and examined by Post Office experts, Siemens and also by Henleys, another large firm of cable makers which had been brought in at Siemens' suggestion to provide further manufacturing facilities.

The failure proved to be due to the extrusion of the inner lead pipe through a gap in the containing steel tapes

caused by one tape riding over another. This was due to a kink in the cable, probably done during the laying.

The National Physical Laboratory was now brought into the discussions and with the Post Office engineers, Siemens and Henleys, helped to prepare a modification to the cable using four steel tapes in place of the original two. The tapes and the reinforcing wires were given opposite lays, right and left hand, to balance one another and prevent the cable twisting under pressure. Further lengths of the 2in. id. cable to the new specification were ordered from both Siemens and Henleys for working pressures up to 750lbs p.s.i. ~~sq in.~~

The construction of the internal lead pipe, the importance of which could not be over-stressed, now came under consideration. Siemens had used their vertical presses which had proved satisfactory for producing the sheathing for normal deep sea cables but this had a longitudinal seam which might have disadvantages. Another cable maker, Pirelli, used a continuous extrusion machine and it was decided to use this method but before work could be put in hand the premises were bombed and the presses put out of action. However, Henleys lead pipe, produced on Judge straight-through presses proved satisfactory and continued to be used until the very large quantities required necessitated other cable companies being asked to join in the manufacture. Considerable quantities of the lead pipe were made at the Erith works of Callenders Cable company.

The next tests were made in the Clyde when the Post Office cable ship Iris laid two lengths of Hais cable, one manufactured by Siemens and one by Henleys. The Siemens length was laid first, the lead pipe only containing air at atmospheric

pressure. It was laid over the bow sheaves as an ordinary deep sea cable would be laid and subsequently recovered from a depth of 200 feet (61 m) where it had been subjected to a pressure of 90lb/sq in.

On being tested it was thought that the Siemens cable was leaking but further examination showed that this was due to a kink in the lead pipe caused by the external water pressure. The kink forced water through the external casing when the pressure test made it resume its normal shape.

The Henley cable was also laid over the bow sheaves but with the ship going astern and with the lead pipe full of water at 100lb sq in. internal pressure. After recovery the tests were entirely successful and as the Siemens cable ~~it~~ withstood such rough handling without major damage it was decided to go ahead with the manufacture of six operational lengths of 2 inch Hais cable, each thirty miles in length.

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It now became necessary to carry out a full scale trial in conditions as near as possible to those likely to be encounter/in crossing the English channel. Throughout all this preliminary work the executive responsibility on the military side rested with CCO and his staff and of course Captain Hussey and his department were actively engaged in all matters on the naval side. Up to now, Post Office cable ships with their experienced crews had undertaken the trials at sea but for the thirty mile length of the large and heavy Hais cable it was necessary to equip a ship specially for the job.

A 1,500 ton coaster, the ss London was fitted with Johnson and Phillips cable gear which was lent by the Post

Office. The work was done under the direction of the Director of Naval Construction at the Admiralty and on completion the vessel was re-named HMS Holdfast. Mr (later Sir) Archibald Gill, Assistant Engineer in Chief of the Post Office was responsible for the provision of Cable-laying gear and also advised on many aspects of the operation

Other problems were now occupying the experts; some purely technical and some concerned with the technique of handling the cable. The 2 inch Hais was very much heavier than normal deep sea cables and in addition had to be kept filled with water under pressure. Failures had occurred at the fittings used to seal the cable ends in order to retain the pressure and although this problem was soon solved it emphasised the importance of efficient couplings for joining the main lengths of cable to the shore ends and for making joints should it be necessary to carry out repairs. Eventually an extremely efficient and easily fitted coupling was evolved, the details of which are described later.

It was also appreciated that the cable-layer would not be able to approach the shore closely owing to her draft so there was also the problem of how to get the cable end on shore. Experiments and trials of methods of doing this were carried out by COXE at Appledore, using an LST (Landing Ship Tank) as these craft would be available on the beaches.

The early work on Pluto was carried out apparently on the assumption that a 30 mile length of cable would be adequate for the crossing but it was not long before it became known that the assault would be made in Normandy and that a distance of over 60 miles must be provided for. This meant that Holdfast could not take part in the initial lays and that much bigger vessels would have to be converted for cable-laying.

Siemens own cable ship, Faraday, was destroyed by an enemy aircraft in March, 1941, and her master, Commander Treby Heale RNR was serving in the naval control service at Milford Haven. He was an obvious choice for command of Holdfast and in September 1942 was given a temporary appointment to Combined Operations command for duty in the cable ship. He later pointed out that that temporary duty lasted for something over three years.

His new command had been completely refitted throughout with two cable tanks, roller stern baulks and cable bow sheaves. Also installed was Johnson and Phillips cable gear with 9ft 6in (2.9m) drums and special heavy type cable leads and dynamometers.

The trial was to be held in the Bristol channel and the Hais cable laid from Swansea to Watermouth near Ilfracombe. The National Oil Refineries Llandarcy depot supplied the petrol and a pumping station was erected on the sea wall at the Queen's dock. Tanks, pumps and loading racks were provided at Watermouth. The shore installations were constructed and manned by Royal Engineers.

During October 1942 Holdfast arrived at Siemens works at Woolwich to load the 30 mile length of 2 inch Hais cable, which commenced as soon as the armouring was completed. The ship left for Swansea in December and towards the end of the month a meeting was held at Swansea with one of Captain Hussey's officers in the chair to co-ordinate the arrangements for the lay. Inview of the importance of the project and the amount of effort and equipment necessary to mount the trial, it was essential that no details should be overlooked in order to achieve success.

On 28 December the shore end, to connect the main cable

to the pumps, was laid out into deep water by the Royal Engineers from an LCT and the end buoyed. The following morning Holdfast anchored and veered down onto the buoy which was picked up and the shore end brought on board where it was joined to the main cable with the mechanical coupling.

Immediately the join had been made, Holdfast went ahead paying out the heavy Hais cable over the stern rollers smoothly and remarkably rapidly. The weather was fine at the start but deteriorated steadily and the wind had reached moderate gale force by the time half the distance to Watermouth had been covered. In spite of this the lay proceeded satisfactorily and an average speed of 4.6 knots was maintained.

To allow for some increase in distance due to divergence from the course, an additional two miles of cable was carried but in fact a straight course was made and the spare cable was expended by running a mile along the coast and back before slipping the end of the pipeline off Watermouth. The wind had now increased to gale force from the north-west and it was pitch dark so that there was no question of the trial having been carried out under easy conditions. It was also clear that Treby Heale was master of his craft in more ways than one.

Even for such an experienced captain as Treby Heale, the situation off Watermouth, with the ship off a lee shore in a gale and firmly fast to a long and heavy cable, must have been distinctly harrowing. According to the original plan, Holdfast should have made fast to a buoy provided so that the end of the main cable could be passed down into the craft which was to couple up to the shore end. In the weather prevailing this was impossible and it became necessary to slip

and buoy the cable end. This was by no means easy as the coupling on the end of the cable was too big to pass under the drum round which it was wound before passing over the stern sheaves. So the turns had to be taken off the drum one at a time by hand. Under ideal conditions the heavy cable would have made this a difficult if not dangerous task. On a pitch dark night, in a gale off a lee shore it might well have produced broken limbs, as well as grey hairs. One can imagine the relief when the end went over the side and the ship was removed from her unpleasant situation. Holdfast then returned to Swansea.

So far all had gone remarkably well and there was an understandable amount of restrained optimism at COHQ. But making the final join at the Watermouth end proved to be the most difficult and frustrating part of the whole operation and indeed this problem of the connexion on the far shore continued to pose problems over the whole period of Pluto operations. However, the first full scale laying operation with the 2 inch Hais cable must be considered to have been highly successful. Not only had the possibility of laying the cable over a long distance in a comparatively short space of time been demonstrated convincingly but two essential lessons had been learned.

One was that a new coupling must be designed in order that it could pass round the drum of the cable ship and the other was that an LCT was unsuitable for making the shore end connexion and that methods used in commercial cable work must be adopted. This consisted of coiling the cable horizontally into the hold of a self-propelled barge fitted with stern sheaves and compression brakes. In the LCT the cable had been coiled on a drum mounted vertically and

paid out over the ramp with the vessel going astern. It seems hardly surprising that this made it virtually impossible to manoeuvre the LCT and Major Harper of the Royal Engineers who was in charge of this part of the operation spent many weeks of hard work and frustration before the connexion to the tanks erected on shore was finally made. Although Pluto was short of trained personnel there was plenty of expert advice available and it seems extraordinary that the problem of joining up the shore end had not been solved by using the commercial method long before it eventually was. No doubt the fact that the Pluto cable was in a number of respects very different from the commercial variety contributed to the delay in finding a solution and also the fact that the actual operation would take place on a beach with the enemy possibly not far away.

As soon as the connexion was made at the Watermouth end, water was pumped through the line from Swansea to check that it was still intact. Petrol followed, the first supply reaching Watermouth on 4 April 1943. Mr Geoffrey Lloyd visited the installation and saw the petrol flowing into the tanks with obvious satisfaction. He obtained a sample of the petrol which had made this historic journey and took it to the Prime Minister. Pluto had at least made an encouraging start.

As many difficulties were overcome and pumping petrol through some thirty miles of hollow deep-sea cable tended to become commonplace it became necessary to dispose of the precious fluid on the Devon side. Some 56,000 gallons a day were being pumped across the Bristol channel and were being distributed by tanker to normal outlets. Right up to the time when pumping from Llandarcy was abandoned it is doubtful whether any of the users in Devon and Cornwall

had any idea of the source of their petrol.

Pumping through the 2 inch line had started at 750 ~~lbs sq in~~ P.S.I. but was later increased to 1,500 ~~lbs sq in~~ P.S.I. which was found to be quite satisfactory. Other valuable information was obtained quite gratuitously. During a gale a ship in the Mumbles anchorage dragged right across the Hais cable and fractured it, which involved the loss of a considerable quantity of petrol. But the pipeline was recovered by Holdfast* and repaired without any major difficulties. Also, a bomb dropped by an enemy aircraft within about 100 feet of the cable proved that it was virtually immune from the effects of enemy action while on the bed of the sea. In fact apart from the delay in finding a solution to the problem of linking up the shore end at the conclusion of a lay the whole trial had gone off in most impressive fashion. This fact no doubt contributed to the decision to proceed with the manufacture of many miles of Hais cable and the provision of the sizeable fleet of ships and craft necessary to carry out the major operation necessary for the invasion.

Meanwhile the training of troops from the Royal Engineers and the RASC continued at the installations on both sides of the Bristol channel, assisted by experienced personnel from the National Oil Refinery at Llandarcy and other experts.

Much of the research and planning for the operation was initiated by committees which met at COHQ, one of which included Professor J.D.Bernal and Professor Solly Zuckerman whose cyclopaedic knowledge of such unlikely subjects as the composition of the sea bed in the English channel frequently astonished their fellow members.

* Now under the command of Cmdr. Bickes-Caarten

Although Pluto was undoubtedly one of the major projects developed by Combined Operations Headquarters, possibly ranking with the Mulberry harbours in the estimation of many of the staff, there were a host of other devices designed to solve some of the many problems of the great assault. Anyone not conversant with the day to day transactions of Captain Hussey's Experimental and Operational Requirements department might be forgiven for thinking that many of the devices under consideration must have emanated from a madhouse. He might have seen some highly coloured and beautifully drawn proposals for craft of all sorts and capabilities, submitted by the Higgins Company of America, renowned for its ability to build ships in days rather than weeks. A suggestion that troops could be landed on a hostile shore by providing them with parachutes and propelling them by an enormous catapault, ~~which~~ was a dear old lady's contribution. On a larger scale, the floating aerodrome constructed of a mixture of ice and sawdust. The Panjandrum, featured by the TV programme, 'Dad's Army', ~~which~~ did in fact run amok scattering brass hats everywhere, the huge catherine wheel propelled by rockets and literally breathing fire and brimstone. Perhaps there was some reason for the fact that to admit being on the staff of COHQ was to invite curious and perhaps apprehensive glances.

was the brain child of Professor Ryke. (Spelling)

Approved by Lord Mountbatten.

As the probable date of the great invasion began to get nearer the problems of supply and demand became more acute. It was clear that if Pluto was to be able to convey anything like the quantity of fuel across the channel that the planners considered necessary, a considerable number of lines would have to be laid. With materials like lead in short supply and with many other requirements for ships and men, th

it is not surprising that there were some sceptics in various high places as to the necessity for Pluto and indeed its practicability. But stemming from the doubt about the provision of sufficient Hais cable from the available resources came an even more astonishing and ingenious proposal for a different sort of underwater pipeline altogether and this was already being considered as a way of providing the additional capacity.