MINES AND MINESWEEPING TECHNIQUES OF WW2

This document contains a number of edited abstracts with the kind permission of R. Cordell, creator of the web site pigtrail.uark.edu (full reference below). Many other sources were consulted including information gathered during my RNR training and I have listed these on this page.

Sketches of sweeping gear are courtesy of Mike Willman and Iain Moffatt (annotated).

Formation drawings by Iain Moffatt.

It is NOT a definitive treatise on the art of minesweeping but was compiled to provide background information to ship modellers on what their model sweepers would have done in real life and to help explain the function of all the bits'n'pieces that get stuck on the back end!!

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Information sources and useful links consulted in the preparation of this :

www.pigtrail.uark.edu/people/rcordell/defense/minewar.html
www.cbrnp.com/rnp/flower/06-ms_winch/ms_winch.htm
www.tca2000.co.uk .... TON Class web site
www.geocities.com/scs028a/rnfishery.html ..... Minesweeping flotilla October 1932
www.cbrnp.com/RNP/Flower/PROFILE/Profiles-01.htm Flower Class profile drawings (colour)
www.royal-navy.mod.uk/static/pages/3137.html ..... HMS Bangor - one of my fathers old ships
www.rnps.lowestoft.org.uk/ ... home of the Royal Naval Patrol Service web site

Books consulted :

Allied Minesweeping in World War 2 by Peter Elliot
HMSO - His Majesty's Minesweepers - HMSO London 1943

Introduction :

Maritime mine warfare was an important part of the German war effort in WW2 with the obvious intention of disrupting the coastal traffic that kept much of Britain supplied and in addition, to close the entry to the main Naval ports.

Much of the minesweeping resources was drawn from the Royal Naval Patrol Service formed at the same time as the Royal Naval Reserve in August 1939 and whose base of operations was Lowestoft.
Quote from RNPS.Lowestoft.org.uk.

> "At first known as 'Pembroke X' the depot later became HMS Europa and was the administrative headquarters for more than 70,000 men and 6,000 ships which included trawlers, drifters, MFV's (Motor Fishing Vessels), ML's (Motor Launches), and later MMS (Motor Minesweepers or 'Mickey Mouses'), American produced BYMS and numerous requisitioned vessels.
>
> Because the majority were Royal Naval Reservists the RNPS became 'a Navy within a Navy' and was given a number of unofficial titles, 'Harry Tate's Navy' and 'Churchill's Pirates' being two of the more mentionable. The peacetime crews becoming Naval seamen together made for a special cameraderie which continued in the Service throughout WW2 even though by the end most RNPS members were 'hostilities only' who had probably had no connection with the sea before the war.
>
> Vessels from RNPS were on convoy duty in the Atlantic and the Arctic, in the Mediterranean and the Far East but many will first think of the keeping clear of the War Channel. Throughout the early years of the war mines were laid by the Germans by sea and air around the British Isles in an attempt to strangle the coastal convoys which were used to keep Britain supplied. It was the work of the RNPS to keep the shipping lane clear so that the convoys could continue and this meant constant minesweeping as after one area had been cleared it was a simple task for E-Boats or aircraft to mine it again."

End Quote.

The Royal Navy also had minesweeping operations and ships and, from 1939 up to 1987 ? the UK centre of operations was located at Port Edgar (HMS Lochinvar) on the Forth estuary opposite the Rosyth Naval Base (HMS Caledonia).
The ships were classed as 'General Service' ships and were commonly called Fleet Sweepers.
The oldest type were the Aldebury class of WW1 vintage named after inland towns in Great Britain. They had a displacement of 710 tons, a speed of 16 knots and were coal fired. The were known as 'Smoky Joes'!!
Next came the Halcyons (245 feet) then the Bangors (162 to 180 feet) (called after British ports), and the largest and fastest of all were the Algerines (225 feet).
The larger and faster fleet sweepers were designed to sweep ahead of the capital ships when necessary, and because of their increased offensive armament of guns and depth charges, to also undertake escort and anti-submarine duties.

By 1942 a number of other classes of sweepers (MMSs Long [295] and Short [96], BYMSs [142] and Isles Class Trawlers [135]) were coming into service, the majority of which were built in the USA and Canada.

For full reference to ship types, details and numbers and much else, there is an excellent source in 'Allied Minesweeping in World War 2 by Peter Elliott.

Type of Mines in World War 2

Contact Mines

These are the oldest types of ocean mines, consisting of a sphere with several finger-like projections (horns) sticking out of it. It was typically anchored to the ocean floor by means of a chain or wire, and was detonated when a ship struck the mine and broke one of the projections. An electricity-conduction solution was released and allowed a circuit to be completed, setting off a powerful explosion of TNT or other explosive.

The Imperial War Museum in London [URL - http://www.iwm.org.uk/] has a contact mine from World War I in its collection.
This is the description of how it worked:
Moored contact mines are designed to float just below the surface, attached to a sinker by a pre-set length of cable. When a ship hits one of the horns, the mine is detonated. *(editor note - see Sinkers on page 6)*

The mine carries the Herz horn, a German invention dating from 1868. The horn contains a glass tube with an electrolyte (Potassium bichromate solution). It is connected to a carbon plate and a zinc plate. When the horn is struck by a ship and the glass tube is broken, the solution leaks out, connecting the two plates and forming a simple battery, capable of generating enough current to ignite the mine's electric detonator."

These types of mines are still in use today, though usually not by the more advanced military powers. They are relatively cheap and easy to produce, and U.S. forces in the Gulf War swept some. *(editors note - £200 worth of mine could sink £2 million worth of ship - figures from 1932)*
See http://battle.netgate.net/etmk6.htm for an example.

Magnetic Mines

These mines were first developed in 1917, but only the Germans continued to work with them between wars. When 1939 arrived, the Germans were ready to launch a magnetic mine campaign, but the British were just beginning to reconsider them.

The Japanese also had these types of mines, though not in as great numbers as their European counterparts.

The magnetic mine of World War 2 consisted of an electrical unit that picked up the magnetic field of a ship passing over it. When the field became strong enough, the contacts on the explosives closed, and the mine detonated.

This kind of mine could be laid by aircraft as well as by ship, so they were easy to lay secretly and in large numbers.

Acoustic Mines

The first acoustic mines were detected by the British in the Tames Estuary in October of 1940. These mines operated via a microphone that was set to react to particular sound signatures — the propellers turning in the water. The mine could be set to respond to a particular frequency of sound — thus controlling whether or not the mine would detonate when a particular kind of ship passed overhead. If it was set with a "coarse" setting, it would target more kinds of ships (since they all had different sound signatures), but they would be easier to sweep that way. A "fine" setting would not explode until a larger vessel, with its louder and lower sound signature, passed overhead.

Pressure Mines

The Germans also produced mines that lay on the seabed and operated on the pressure waves of a ship passing overhead. The Japanese also used these kinds of mines.

Protective Measures and Minesweeping Techniques

Magnetic mines posed a very significant threat, not the least because they could be set to explode only when the magnetic signature of the passing ship was large enough. They could therefore ignore small vessels.

Protection against such mines was not easy to achieve given the physical size of ships.
The technique adopted to neutralise a ships magnetic signature is called Degaussing and although described here in the context of minesweepers, it was also applied extensively to American built Liberty ships and T2/T3 tankers which had degausing coils installed around the ship at main deck level, together with all the necessary electrical connections and switching gear. This simply required connection to a suitable powerful electrical power source.

Degaussing

This technique was used to allow metal hulled minesweepers (like the DEFENSE) to pass over magnetic mines without detonating them. The equipment, engines, wiring, and other devices aboard a ship gave it a strong magnetic quality, and minesweepers found that if they wrapped a large electric cable around the hull and hooked it up to a generator, they could neutralize much of the magnetism of the ship and safely pass over magnetic mines. The cable could also be used to intensify the magnetic field of the ship so that the mines exploded too far away to do any damage. The British began degaussing in early 1940, and the US ordered all naval ships fitted with the devices in June.

Degaussing coils were useless until the magnetic field under a ship could be accurately measured. Drawing on British experience, the US Navy began setting up channels with a row of search coils laid along the bottom and connected to meters that measured the magnetic field of passing ships. These meter readings were used to fine tune the electrical charge in the degaussing "girdle" around the ship.

"De-perming" was another technique used to remove the "permanent longitudinal magnetism" of a ship. A metal ship would acquire a distinct magnetic signature based on the location of the shipyard that built it. Removing this residual magnetism took an elaborate procedure, consisting of ten to twenty turns of a solenoid coil around a ship and connected in series to a direct current source. Starting with several thousand amperes, a series of current "shots" would be applied in ever-decreasing strength and alternating in direction. This would neutralize the fore and aft permanent magnetism of a ship for up to a year, and made degaussing more effective and easier.

"Flashing" and "wiping" were designed to give some protection without the use of degaussing coils. Both techniques are similar to de-perming, except that vertical, rather than horizontal, magnetic fields were applied to the ship. In "wiping", a current was passed through several turns of cable around a ship at the waterline, then was dragged (while energized) up to deck level, thereby "wiping" the ship with a magnetic field. "Flashing" consisted of a large loop of cable near to, but not touching, the hull. Strong flashes of current were applied to the cable to help neutralize the magnetic field of the ship. Ships classified as YDG were "mobile" degaussing/de-perming ranges.

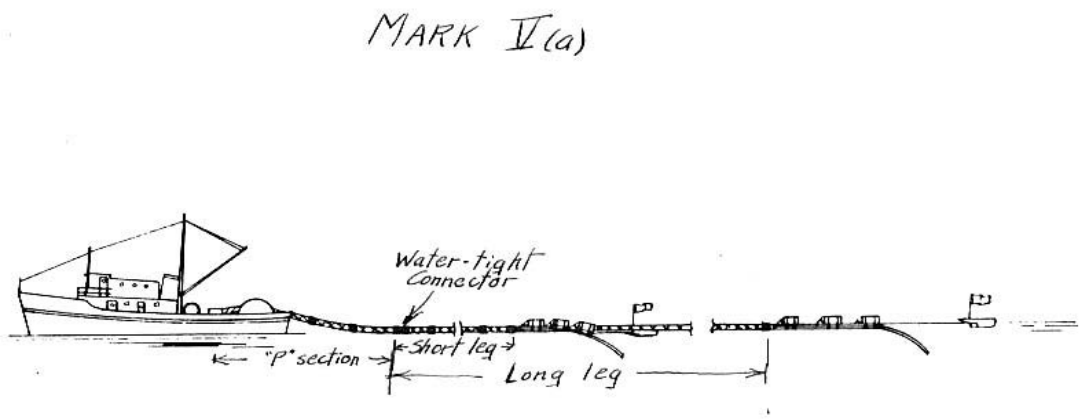
Magnetic Minesweeping

Several attempts were made to develop a technique for sweeping magnetic mines, including an "A" type sweep wire (between two ships) that carried a number of magnetic bars intended to create a strong enough field to detonate magnetic mines. It was called the "bosun's nightmare" because it was so difficult to handle when it was recovered from the water.

Another attempt was an electric cable (powered by a generator on one of the ships) towed the same way — but it was so easily damaged that it was abandoned as well. The RAF even mounted giant magnetic coils in the bomb bays of Wellington bombers (along with an auxiliary engine and generator in the fuselage) and buzzed magnetic minefields at 25 feet. It actually worked, though the flight crews could tell when they triggered a mine by the bits and pieces of their aircraft that would fly off. The bombers moved too fast and would fly into the explosion Magnetic Sled— a little too much excitement for most pilots.

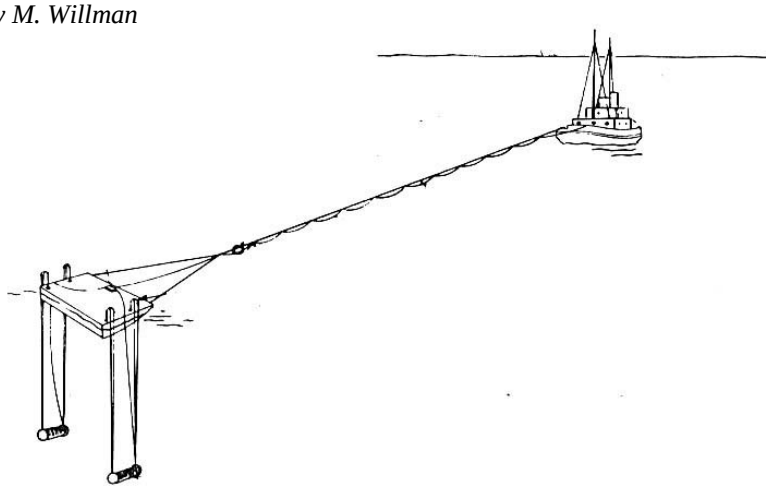
One successful magnetic sweep was the electric skid, consisting of an electromagnetic coil on a barge towed behind a ship. This technique was used extensively at the Normandy beaches prior to the D-Day landings.

The most successful technique was the "LL" sweep. This was a pair of electric cables towed behind the sweeper and powered by a 200+ kilowatt generator aboard the ship. The two cables were of different lengths in order to allow the current to pass through the water and detonate the mines. The development of buoyant cables allowed better sweeping, though they had to be handled carefully to avoid damaging them.



Designated "LL" sweep

Sketches by M. Willman



Acoustic Minesweeping

In mid-1940, the British began experimenting with a pneumatic road drill banging against a ship's bulkhead to set off acoustic mines from a distance. The "Kango" brand hammer was used, and the device became known as the "Kango sweep" — much to the delight of the manufacturer.

The next step was to mount the hammers inside an external box that was lowered into the water when in use — after a few sweepers had been sunk by acoustic mines while using internally mounted Kango hammers. The external hammers were usually hung over the side of the ship with a winch, though sometimes they were used over the bow of the ship.
The Mark IV (a spring hammer towed in a steel box) was the standard acoustic mine sweeping device on minesweepers from 1942 until the end of the war. The Mark V was basically the same as the Mark IV, but with the addition of "rabbit ears" to divert the box away from the ship.

The British also had a variety of other experimental and standard techniques, including dropping hand grenades down a tube extended from the deck of a ship into the water, an air raid siren inside a torpedo-shaped container towed behind a ship, a flywheel set to run out of balance, and pipes fitted into a loose framework that allowed them to rattle around as they were pulled through the water.

Editors Note - SINKERS

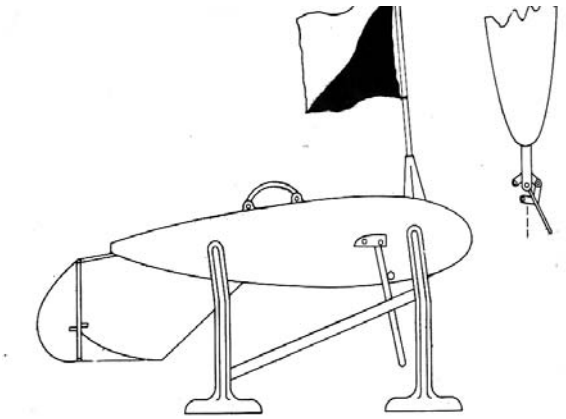
Mine Sinkers incorporated a cable reel that could be pre-set to release a specific length of cable thus controlling the depth at which a mine would float.
In addition, the sinker contained a cable release timing device that could delay the 'rise' of the mine for any period up to several weeks.

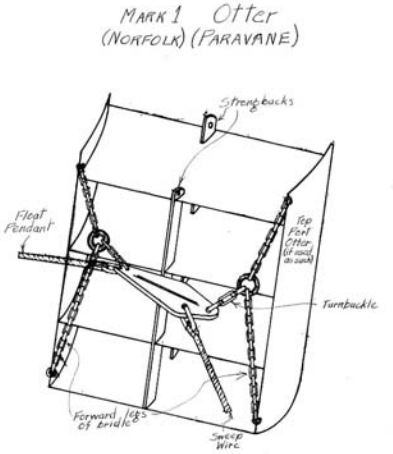
Mine fields were frequently laid with a mixture of timer settings. In this way, a field could never be said to have been completely swept since (a) not all mines in the field would be 'floaters' at the same time and (b) the conventional Oropesa sweep could not clear bottom anchored mines that had not released. Nasty eh!!

Furthermore acoustic, magnetic and pressure mines were filled with internal timing devices that could delay the 'arming' of the explosive charge.

Oropesa Sweep

This is the "O" gear referred to in all of the deck logs of the USS DEFENSE.
It consisted of a single wire with a torpedo-shaped float (a paravane) attached to the end.

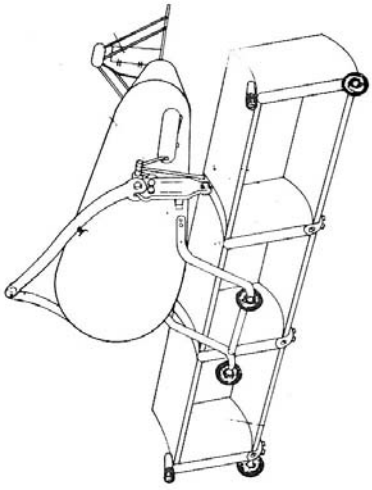


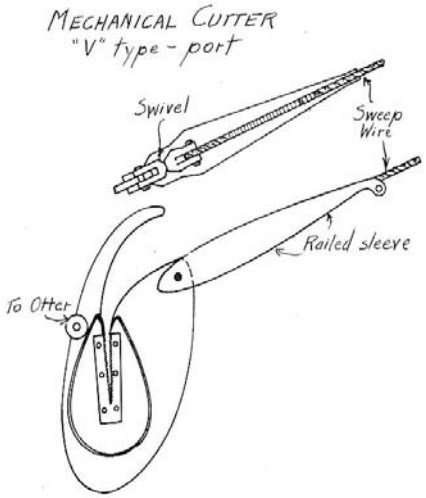


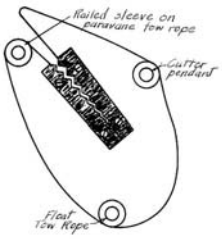
Sketches by M. Willman

Out near the paravane was a device called an "otter" — consisting of an array of angled fins that pulled down on the end of the sweep and kept it at the proper depth.
The length of wire between the paravane and the otter was called the "pendant."

There was also a "depressor" up near the ship, suspended on a length of "depressor wire."
This was used to pull the end of the sweep wire nearest the ship down to the desired depth.
There were v-type cutters spaced along the sweep wire that would sever the chains holding the mines, allowing them to float to the surface and be shot and exploded by the mine disposal ships.







Sketches by M. Willman

So, when you read the deck logs, where it says "All "O" type gear streamed to 300 fathoms of sweep wire, 60 foot float pendant, 35 fathoms of depressor wire," it means that the depressor (holding the sweep wire under water) at the back of the ship was down at a depth of 210 feet, then 1800 feet of sweep wire with cutters out to one or both sides of the ship, then 60 feet of wire running from the "otter" up to the paravane float.

The name "Oropesa" comes from the trawler that invented the technique in 1917

Minesweeping Formations

The British had a wide variety of sweeping formations, but the DEFENSE seemed to usually work with her sister sweepers in echelon formation with "O" gear streamed to both sides. The logs refer to other sweep formations — one called "sweep formation #4", another called "sweep formation #5," one called "starboard quarter echelon," and "port echelon."

The type of formation also depended on whether the sweepers were doing an "exploratory" sweep or a "clearance" sweep. Exploratory sweeps were used to determine the extent of the minefield to be swept — or whether a minefield existed at all.

The basic, and safest, formation for sweeping was called a "protective echelon."
This formation allowed each ship to sweep just inside of the paravane of the ship ahead of it, and the lead ship was only in danger during the first pass though an area.

A "wedge" formation had sweepers out to both port and starboard of the lead ship, but it was more dangerous because the lead ship was always in unswept waters, even when they turned to make another pass.
The fastest sweeping method, and the most dangerous, was the "open echelon" formation in which all ships are always in unswept waters.

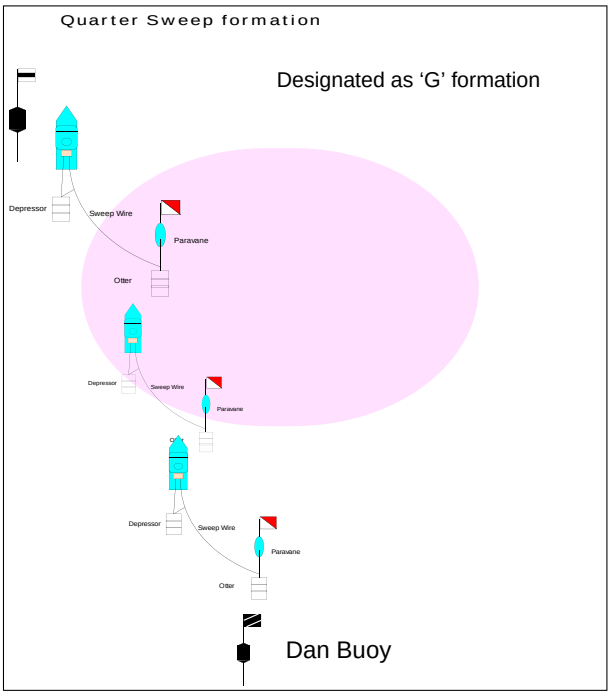
"A" Sweep

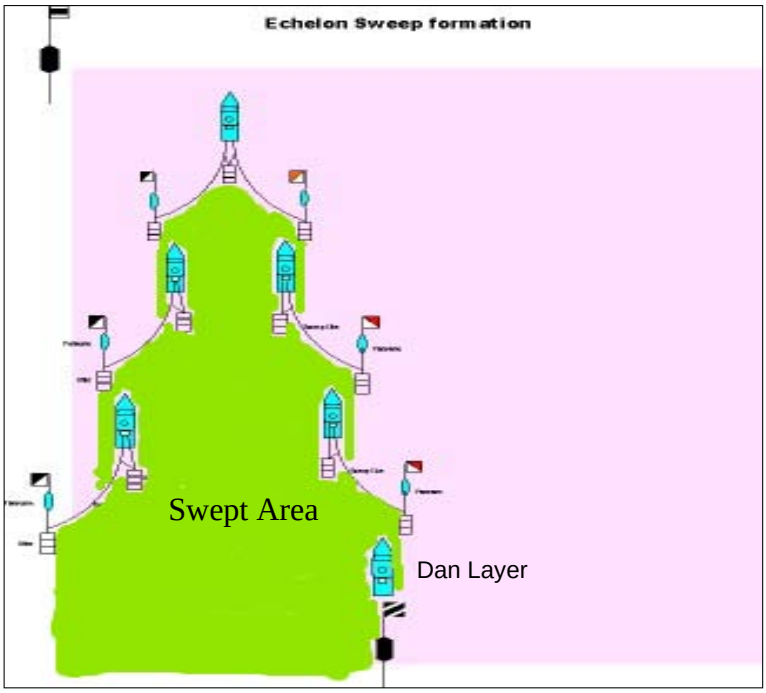
The "A" sweep was used extensively in World War 1, and consisted of a sweep wire strung between two or more ships. It was rarely used in World War 2 because it limited the sweepers' freedom of movement — and with air power playing such a large role in the sea battles of the day, being tied to another ship in the middle of an air attack could prove fatal.

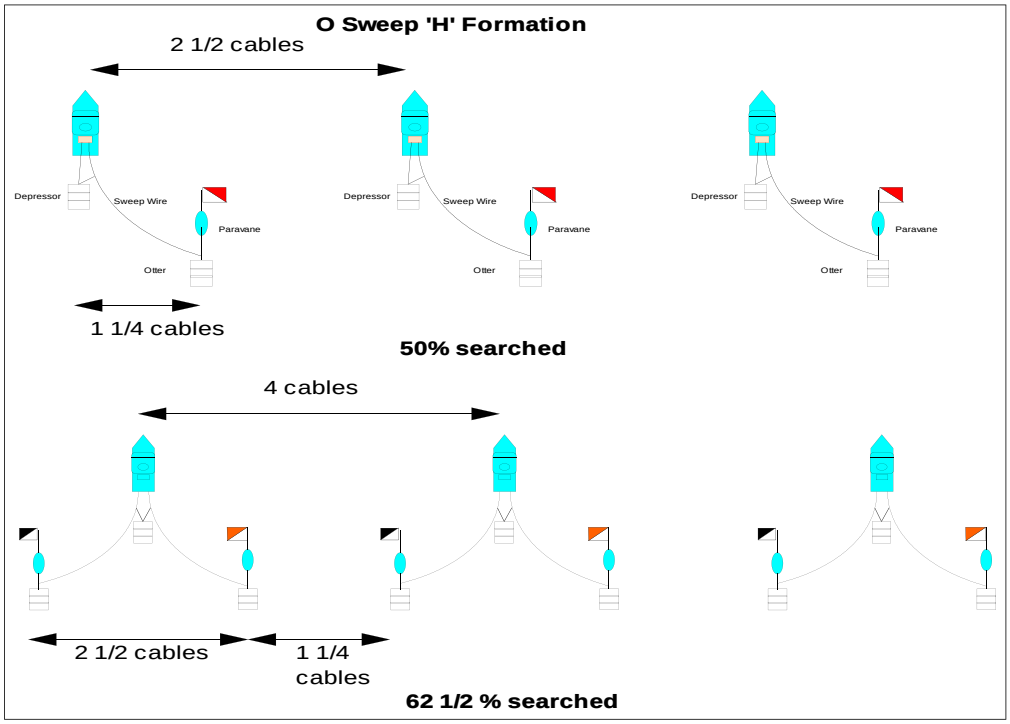
Support Groups

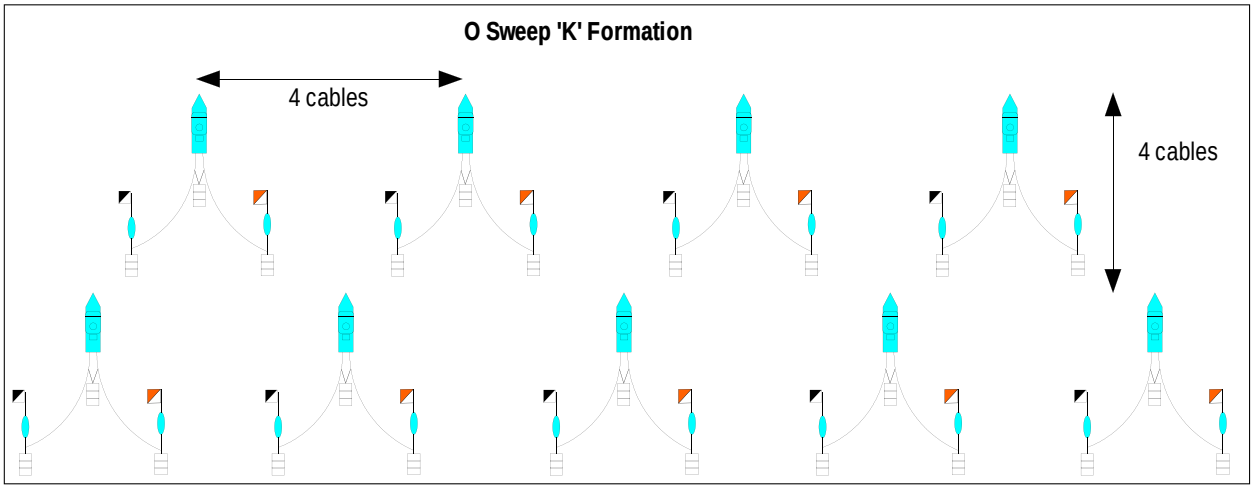
Other ships also operated with the sweepers — some ships marked the areas that had been cleared with dan buoys (and were called "Dan layers"), while others disposed of the floating contact mines that had been cut loose by the sweepers. These ships could be any of a number of types — destroyers, minelayers, auxiliary vessels, pretty much anything with a gun on it.
Since they were supposed to stay at least 100 yards away from the mines they were disposing of, they usually had to have a 20 or 40mm gun, but most anything would do in a pinch. Mine experts warned them to stay 200 yards away from most Japanese mines.

Minesweeping Formations - Contact Mines



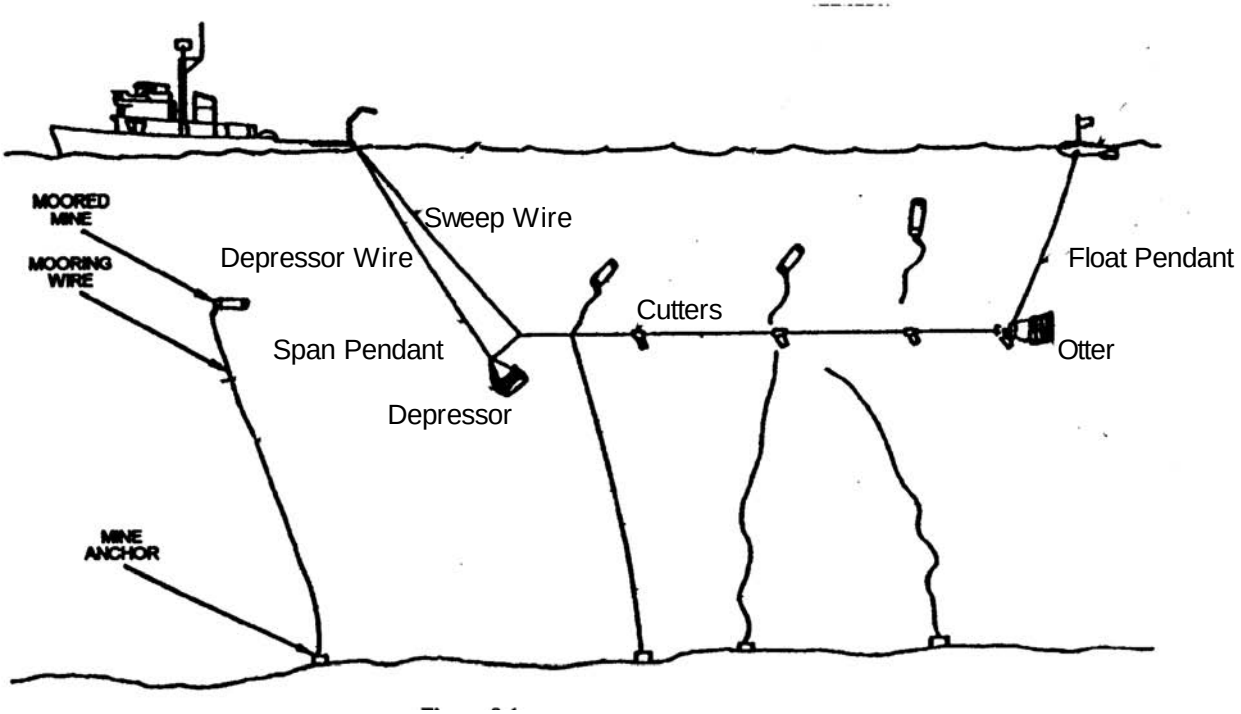




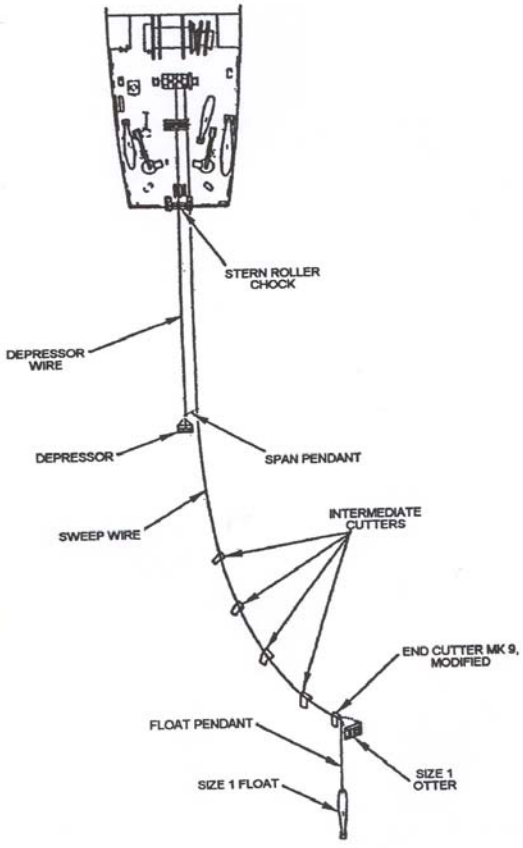


Drawings by Iain Moffatt

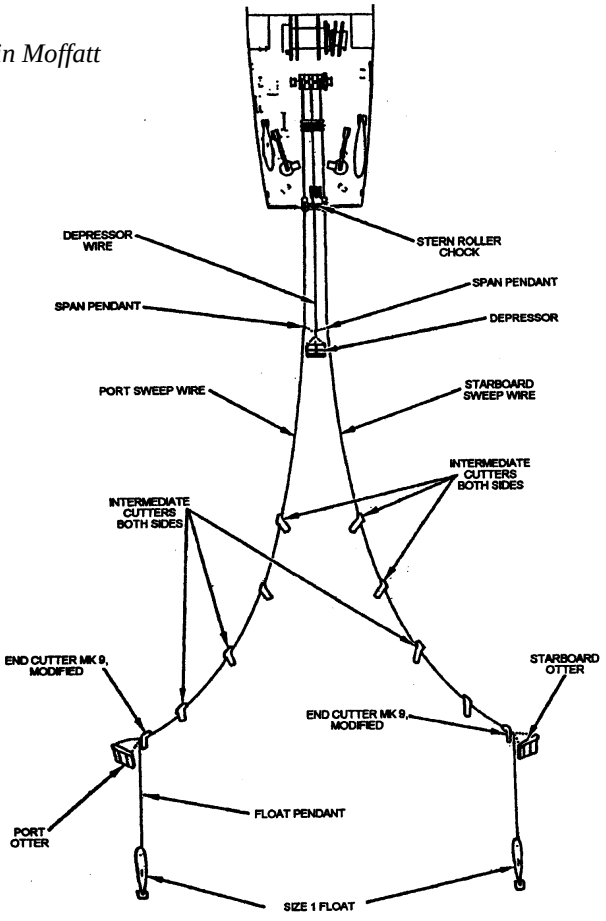
NOTE : Cutters were ‘once only’ devices. Mechanical cutters had a shielded jaw that, once the cutter had been activated, closed thus preventing further mine wires entering the cutter.
Explosive cutters were operated by a cartridge charge that was set off by the mine wire hitting a contact. When the charge went off it firstly cut the mine wire and secondly it severed the shear pin securing the cutter to the sweep wire thus allowing it to fall off.
The next mine wire then ran down the sweep wire until it came into contact with the next cutter.



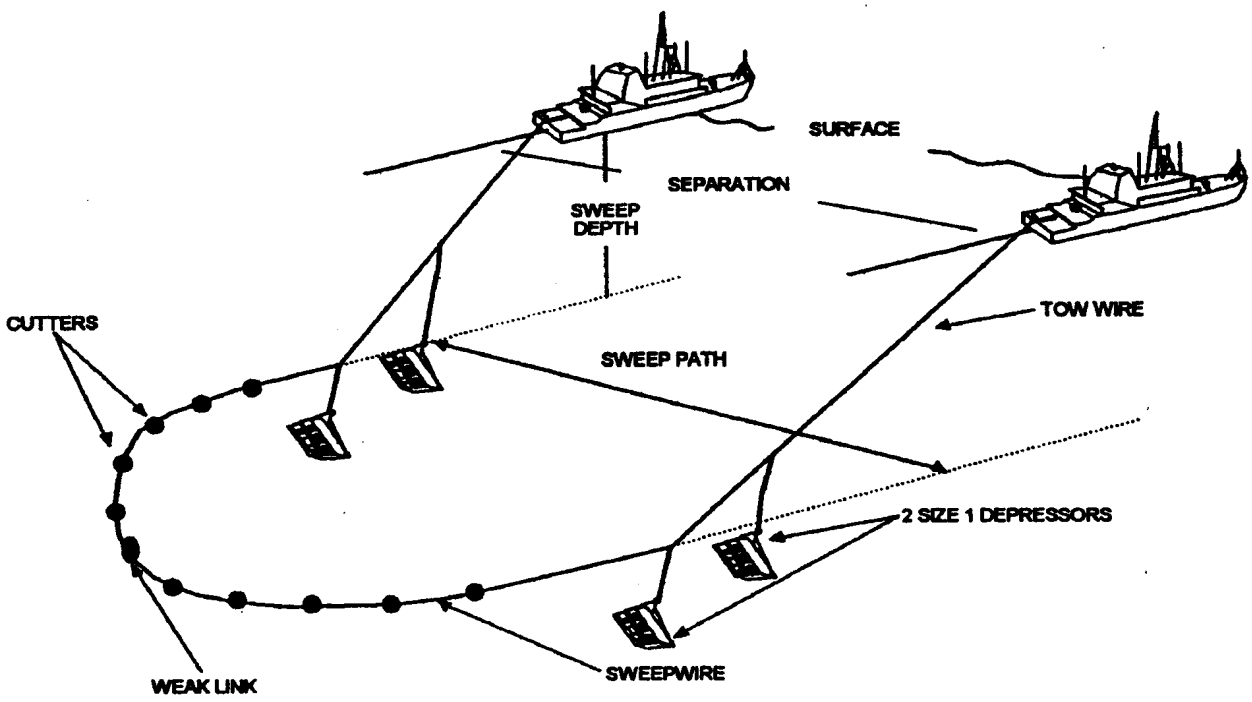
Drawings prepared by Iain Moffatt



Quarter Oropesa Sweep

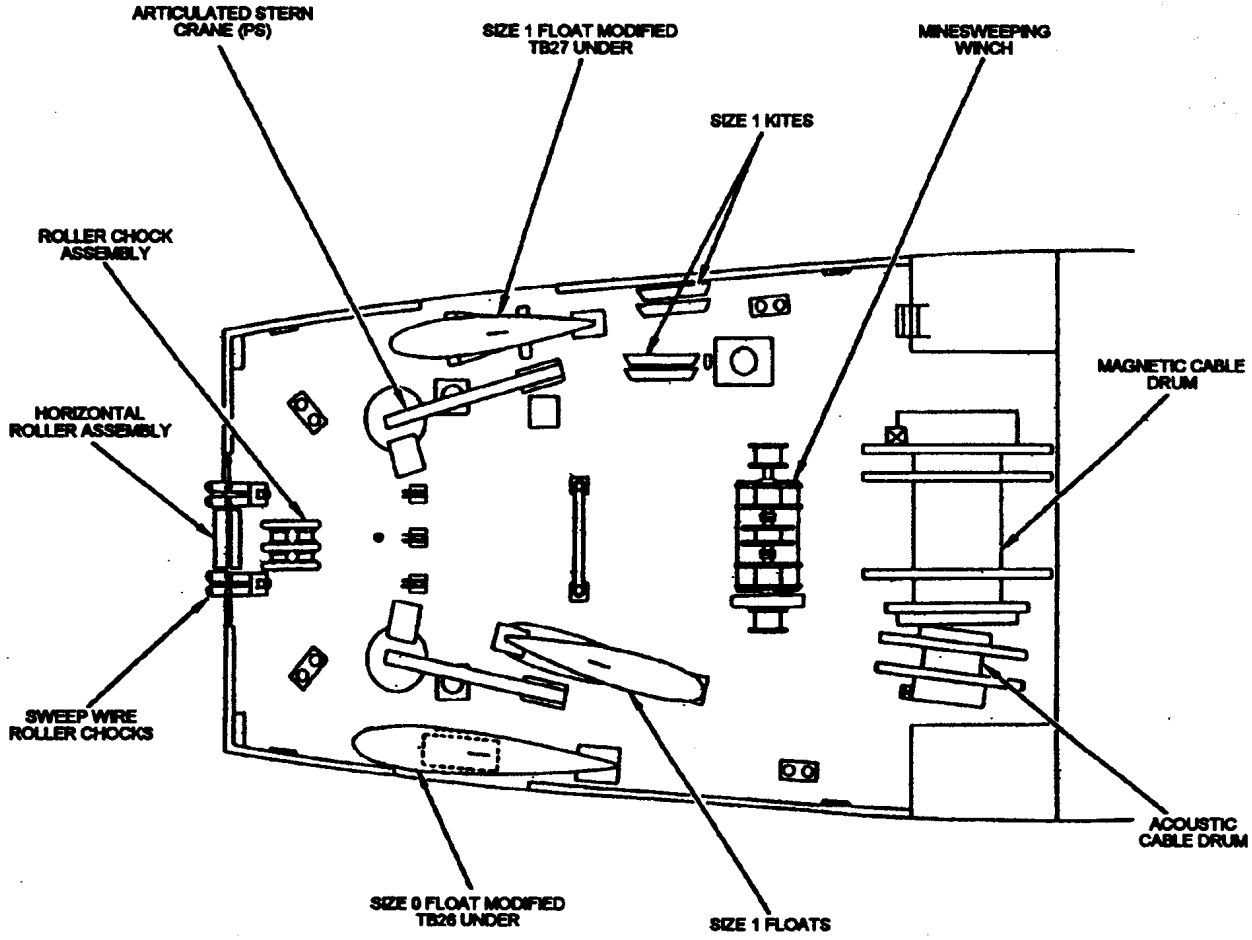


Double Oropesa Sweep

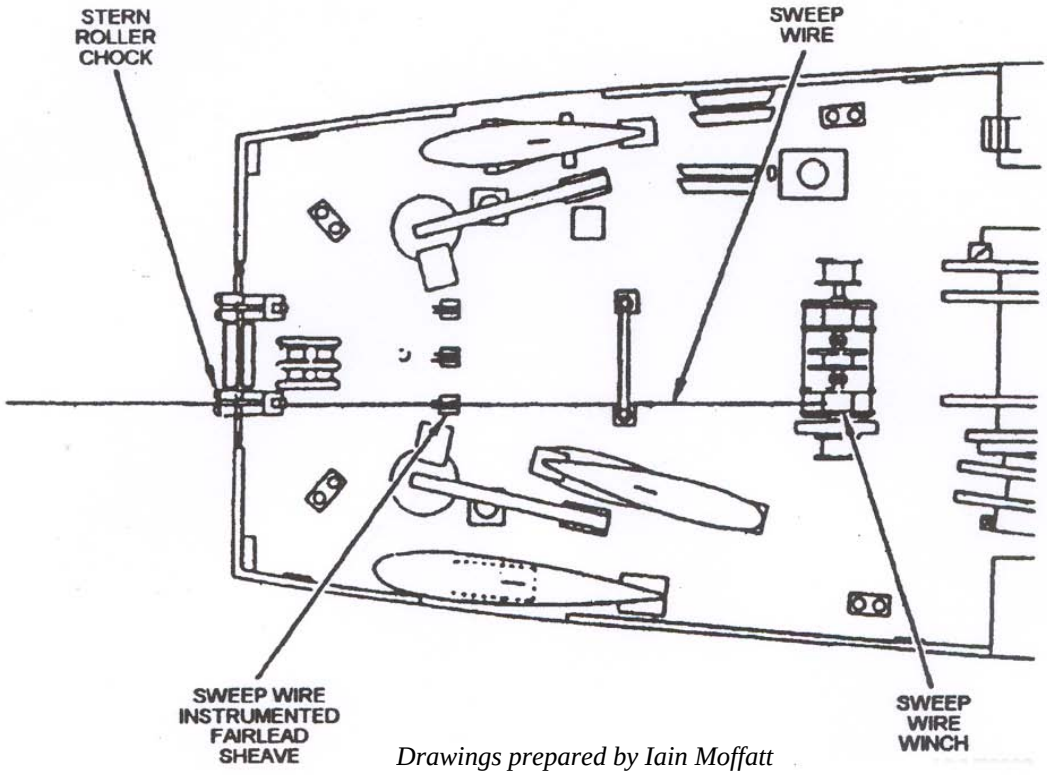


"A" Sweep

Drawings prepared by Iain Moffatt



The Sweep Wire

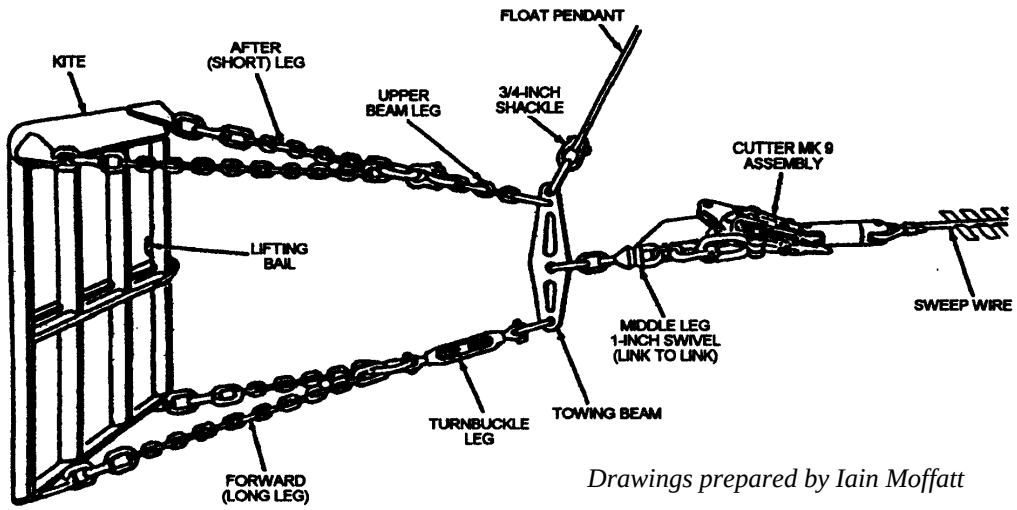


Drawings prepared by Iain Moffatt

Above is the arrangement of the main sweep wire and below is the Otter fitted at the outer end of the sweep wire. The otter is connected to the Float by a float pendant.
Sweep wires were usually 4000 feet of non-magnetic, 5/8th diameter wire either left hand or right hand lay (depending on which side they were to be streamed) with a breaking load of around 32000 pounds.
They were fitted with 'cutters' at intervals along their length. Some sweep wires had 'counter laid' cutting strands that also helped to sever a mine wire as it was dragged along the sweep.

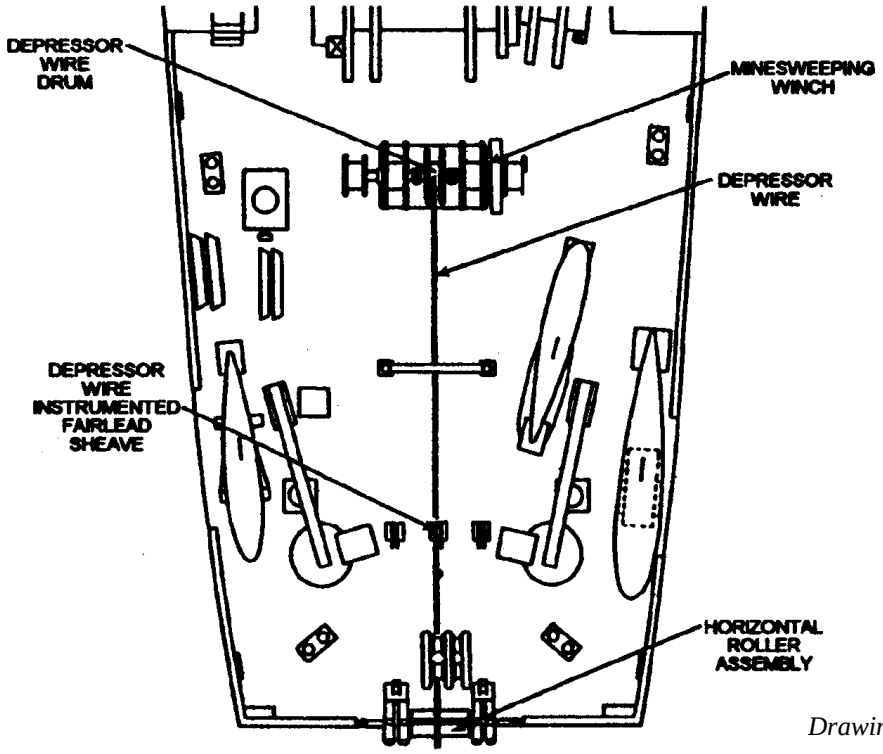
The depth of the sweep wire was regulated at the outer end, by the length of the float pennant.
To maintain approximately the same depth along the sweep wire, it was attached to a 'depressor' also fitted with a pennant connecting it to the sweep wire, streamed at the end of its own 'depressor wire' (see next page)

Sweep wires are always fitted with an 'emergency cutter' that could be actuated by a lanyard from the sweep deck. Depressor wires are similarly fitted. This meant that, in an emergency the complete sweep could be rapidly disconnected from the ship.



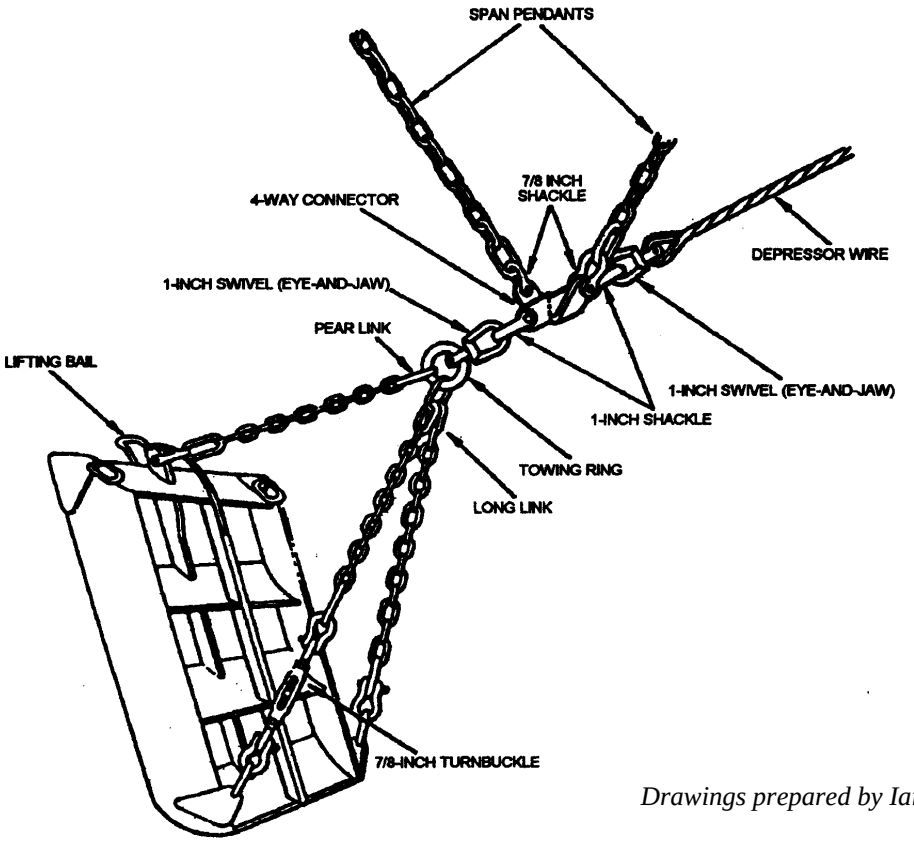
Drawings prepared by Iain Moffatt

The Depressor



Drawings prepared by Iain Moffatt

The depressor (shown below) was attached to the end of a 5/8 inch, 1800 foot long depressor wire and regulated the depth of the sweep wire.
The sketch below shows two 'span pendants' as would be used is the depressor was fitted to a double-O sweep. The span pendant is attached to the main sweep wire and acts to pull the wire down to the required depth (controlled by how much depressor wire is payed out).



Drawings prepared by Iain Moffatt