FASTENINGS ANALYSIS

HMS *PANDORA*

1983/84 SEASONS

by

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Introduction

The fastenings recovered from the stern of the wreck of HMS Pandora during the 1983/84 excavations are few and reflect the small area of actual hull remains excavated to date.

In general, the fastenings remaining and their relative location will be a product of the depth to which the hull lies buried, the angle of heel, (port/starboard), angle of dip (for/aft), water movement (tide and wave action), chemical and biological factors, e.g. galvanic couples, shipworm, oxygen supply and so on.

The effect of angle of heel and dip on the expected remains

A glance at the midships body plans of HMS Crocodile and HMS Porcupine shows that even within the 24 gun frigate type, the deadrise varies between 10-20° with obviously that range being the minimum angle of heel expected of a similar hull lying on a sand bottom.

On a flat yielding sand bottom such as that found on site, however, the angle of heel would be in excess of that expected from the midships section.

Contemporary accounts (Edwards and Hamilton 1915: 75, 145) indicate that, at most, the head of the top gallant mast and a little of the lightening conductor were exposed the day after the wreck, and at least, there was nothing visible below the top mast cross trees (Marshall, 1925: 40). The main mast length from keel to truck is expected to be around 140 feet (42 m) (Steel, 1982 reprint: 54) and in a water depth of around 110 feet (33 m). This roughly gives a maximum angle of heel of 40°.

The angle of dip is a lesser factor than angle of heel overall but has obvious ramifications for the relative state of the bow and stern today. As yet, this has not been possible to ascertain and usually requires the measurement of inclination of intact sections of the keelson or mast bases.

Obviously if the bow (for example) has buried more than the stern we will expect much more of that particular structure to remain and vice versa.

The ramifications for a study of ships hulls, fastenings and lines are obvious and can best be illustrated by pressing a model or facsimile of the 24 gun frigate hull type into a bed of damp sand. By varying the angle of heel and dip and examining the respective imprints in the sand and marks on the hull, one can visualise the vast differences even slight changes of angle can make. In the best circumstances we have the Wasa or Amsterdam cases with completely buried hulls, in the worst, no hull at all. In the mid range we have a vessel completely upright but reduced to the waterline or below by wave action or borers etc. etc. With a moderately buried hull we find that as the angle of heel increases, more and more of one side of the hull will remain till at best, one side from keel to gunwhale remains. The amount of entrance and run of the bow and stern also depends on the depth buried with the ideal case apart from the Wasa type being a hull buried completely through the line of stem and stern post.

A useful compromise is the James Matthews, Mary Rose type situation with one side of the hull almost intact from keel to gunwhale with iether the stem or stern still remaining. In the HMS Pandora instance with an expected angle of heel of 20-40° there appears then to be scope for the study of intact hull structure, lines and fastenings and also for the examination of the loose fastenings and fittings that have fallen from their disintegrating timbers.

The study of structure, lines and fastenings from the wreck then would necessarily take 3 avenues of inquiry.

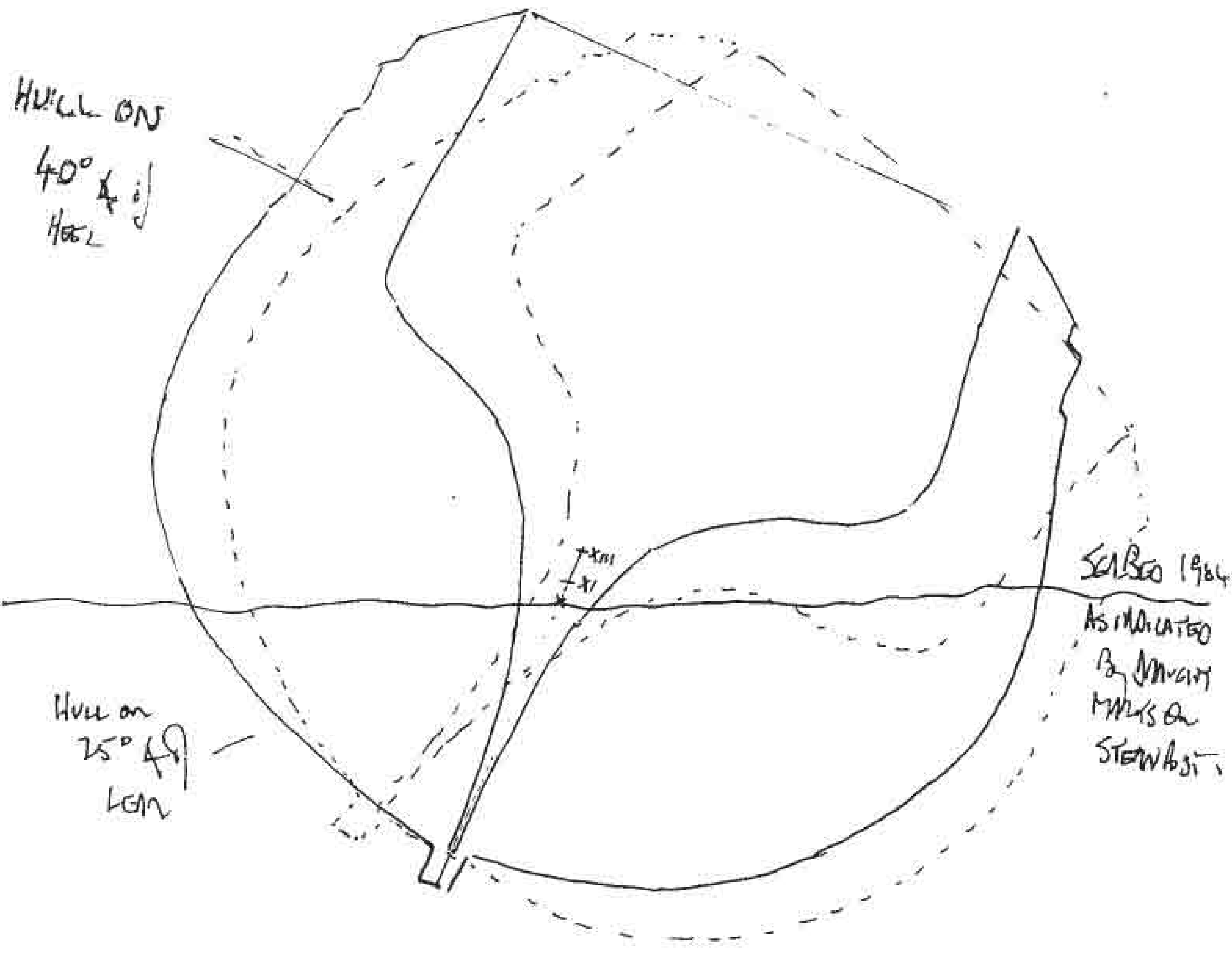
1. Archival
2. Archaeological:
   a) on intact structure
   b) on items lying loose above and around the intact structure

The location of areas excavated in relation to the vessel's hull

This obvious requirement is facilitated by the availability of lines, drawings and plans of the contemporary HMS Crocodile and HMS Porcupine and the locating of the HMS Pandora's stern post on the site itself. Marshall (1925:38) records that the rudder and part of the stern post were lost in the wrecking process. It can nevertheless be deduced from the surrounding structures that the stern remains found on the seabed lie close to their original position and are most likely still attached to some of the stern deadwood and the keel itself. As the stern post is buried to a depth of 10-12 feet as indicated by the visible draught marks and as the vessel lies on an (as yet imprecisely determined) axis of around 25° to 40° a rough but

Fig 1a (1) HMS Crocodile on 25°/40° ∠ of Lean.

(2) Seabed at 10–12 foot mark.



useful estimate of position in relation to the archaeological grids X, Y and Z axes can be made (Fig. 1). The position of grid 71 in which the first intact hull structure (ceiling, frames and outer planking) appeared can then be also roughly located in relation to the HMS Porcupine and HMS Crocodile plans when drawn to the same scale and when the hypothesised angle of lean is taken into account. Given that both the 10-12 foot draught mark and the grid 71 timbers lay within 0.5 m of the surface of a virtually flat seabed in 1984 then an approximation can be made of the depth to which the hull lies buried in the stern area. Unfortunately for the student of ships lines, hull structures and fastenings, if the analysis above is correct then at 25° angle of heel neither port nor starboard topsides will remain intact. Section 2(a) of the proposed study i.e. the examination of fastenings still located within the intact structure is thereby rendered less complete, as it requires at least one intact side of the vessel.

Section 2(b) of the archaeological analysis then assumes more importance and attention. A positive side to this preliminary analysis is that the wreck forms a neat cup amidships facilitating greater extrapment of artefacts than would probably occur in the latter case.

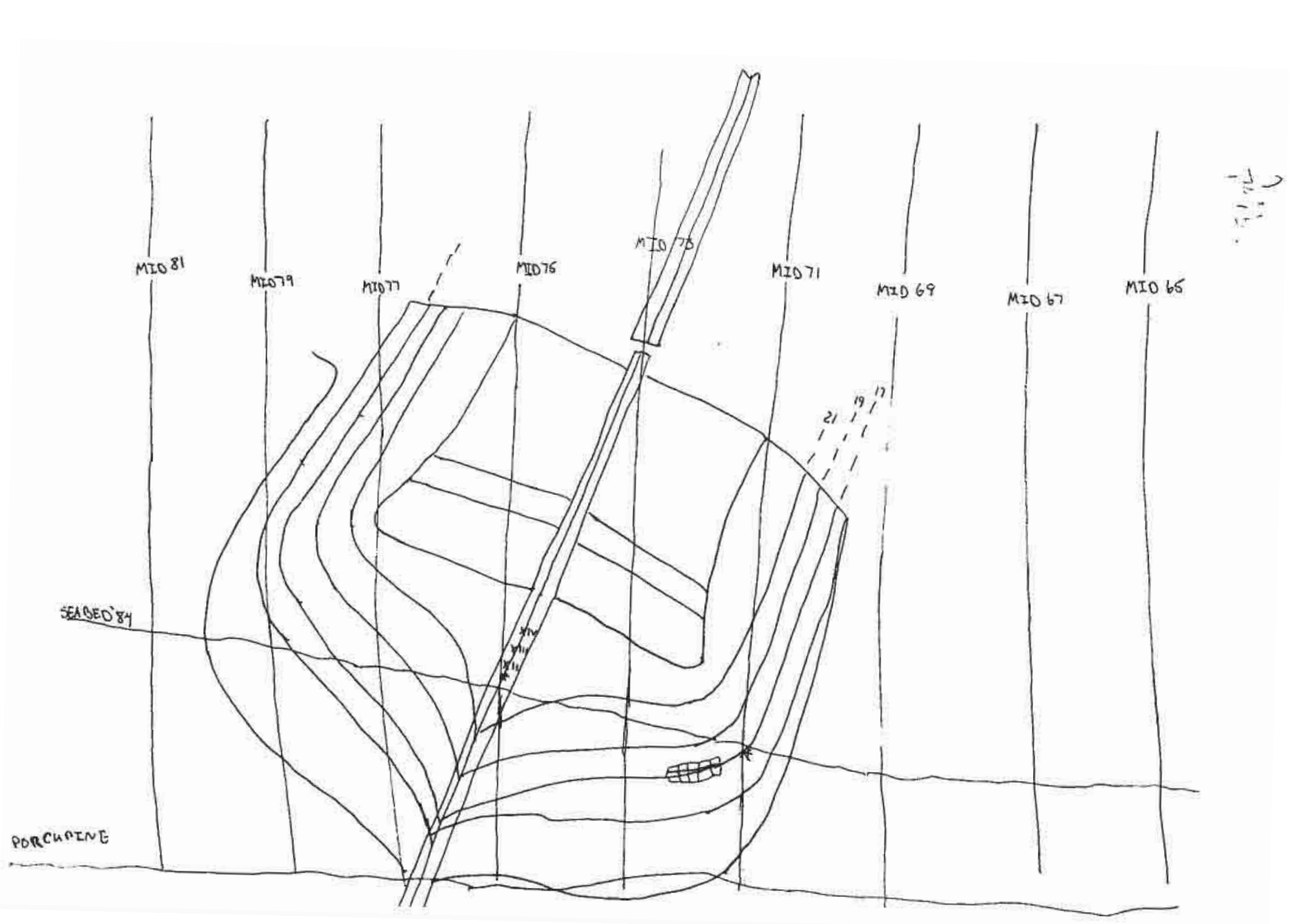
The fastenings expected from the site will be of 3 major types:

1. Copper/Copper alloy
2. Iron
3. Organic - dowels and treenails

Rudder braces, keel staples, dovetails, fishplates, will also be treated but rope and leather strapping e.g. gammoning will not be treated at this stage.

The fastenings of gun carriages and other similar units will also be treated separately.

As the vessel was built to imperial standards these will appear in all descriptions along with metric equivalents. This analysis has been hampered by the appearance of fastening sizes in metric alone and would be facilitated by the inclusion of imperial measurements in units consistent with the contract specifications for the 24 gun frigate type.


MIO 81
MIO 79
MIO 77
MIO 76
MIO 75
MIO 71
MIO 69
MIO 67
MIO 65
21
19
17
SEABED '84
PORCUPINE

Sheathing Nails: (tacks)

F 010 Copper sheathing nail (tack) 3.5 cm (1 3/8") long
Head diameter 1.65 cm (5/8") square
Shank large flat head.
Grid 1 1983 near sternpost.

F 510 Copper sheathing nail (tack) eroded point 3.3 cm (1 5/16") long
Head diameter 1.5 cm (9/16") square
Shank large flat head
Grid 34.

F 622 Copper sheathing tack. 3.0 c. (1 3/16") long
Grid 50

F 623 As above - not measured

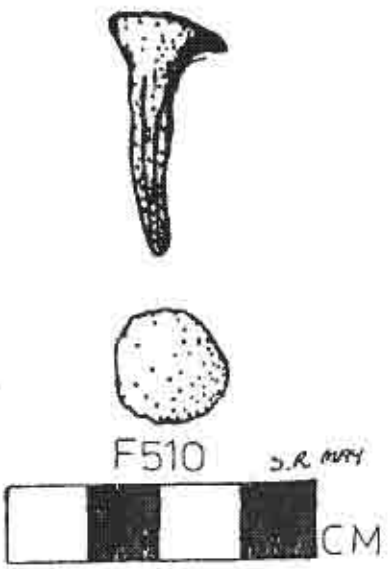
F 705 Copper sheathing nail (tack) 3.5 cm (1 3/8") long

F 716 Copper sheathing nails (tacks) 2.5 cm (1") long
From spoil heap Ex 71?

F 754 Copper sheathin nails (tacks) 3.5 cm (1 3/8") long
Grid 71

F 768 Copper sheathing nail (tack) unlike those above in shape and form
3.65 cm (1 7/16") long.
Head diameter 1.3 cm (7/16") round shank
from spoil heap (ex grid 71?)

F 768 SR May


F510
S.R MAY
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F010

Sheathing Nails:

"are used to fasten wood sheathing on the ships' bottoms" (Steel, 1822:118)

As wooden sheathing was replaced underwater by copper and copper alloy sheathing, however, its use in the sense above became obsolete though wood sheathing is seen in the splash zone above the waterline on some vessels, with copper sheathing below. Falconer,(1815:291) defines those nails used for these two purposes as both copper nails. "Copper Nails are made of mixed metal of various lengths and sizes; they have a flat round head, with a square shank about one inch and a half long and are used for fastening the copper sheathing to the bottoms of ships. Also in sheathing boards on the bottoms of ships in lining the magazines".

Though Falconer is quite specific, the use of the term 'Copper Nail' here for one of mixed metal, will obviously cause some confusion in archaeological registers and site catalogues. There is obviously also a need to differentiate between the copper nail used for nailing sheathing board and that used for the fastening of copper sheathing. Here, the term 'sheathing nail' is by definition (above) applicable to the former use while the term 'sheathing tack' has become common usage here for the latter and also appears in American literature (Arnold, 1976:129). De Kerchove (1948:527) mentions, but does not define the term, in the maritime context and in the 19th century the term was apparently more used in the context of upholstery (Mercer, 1960:235). Arnold and Weddle (1978:233) however, refers to an earlier use of the term in a maritime context though the reference to this usage is not definitive.

In the Pandora (1791) case and all others I recommend the continual use of the word 'sheathing nail' in descriptive catalogues with the word (tack) appearing in brackets (as above) to differentiate the two types. The two are quite distinctive in appearance with the sheathing nail designed for boards being 10-12 cm ($2\frac{1}{2}$-3") in length with that for metallic sheathing obviously smaller.

Bolts:

Clinch Bolts (through bolts)

All of the following are seen to fall into the category of through bolts and clinch bolts.

The presence of a single clinch ring in all cases but F 767 confirms the latter general analysis while the former is indicated by evidence of working at both ends of the bolt. From the drawings, Fo 19, F 616, F 628, F 635, F 680 and F 681 each

may however have suffered damage and have broken in two or in the case of F 019 not show evidence of working. In these instances the category 'through bolt' is not necessarily applicable and a re examination of each is necessary to establish the validity of this classification.

Bolts: (please check all lengths and diameters as I am unable to get accuracy from the drawings and notes)

Clinch Bolts (through bolts and butt bolts)

F 019 Copper with clinch ring 650 mm x 16 mm diameter
(21¼" x 9/16" diameter) from the illustration it appears either broken off or only lightly burred if at all.
If not burred it may not be a through bolts

F 612 Copper with clinch ring (61 cm x 3.5? x 1 3/16") inscribed Roe and Co.
Grid 52.

F 616 Copper with clinch ring (67 cm x 4 cm)??"
Possibly broken - please advise
Grid 50

F 620 Copper with clinch ring, (76 cm x 3 cm)??"
Possibly fastened through a cant frame
Grid 50

F 621 Copper with clinch ring and timber traces (73 cm x 3.5 cm)??" again possibly fastened through a cant frame. Ceiling timber thickness indicated
Grid 50

F 625 Copper bolt 70 x 3.5 cm inscribed Roe & Co.
Information on Roe & Co should be available from archival sources.

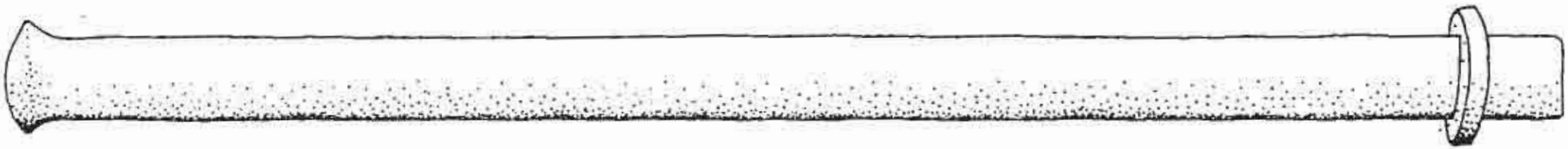
F 627 bolts with wood 97 x 4 cm
Grid 52

F 635 Copper bolt 52 x 4 cm
Grid 52

F 636 Copper bolt 64 x 4 cm
Grid 52

F 637 Copper bolt 51 x 4 cm
Grid 52

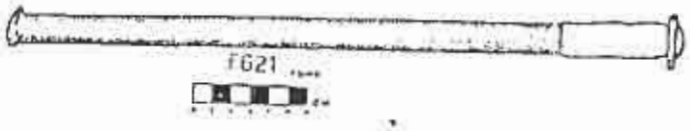
F 639 Copper bolt 55 x 4 cm
Grid 50



FC 19

C 1/


FG20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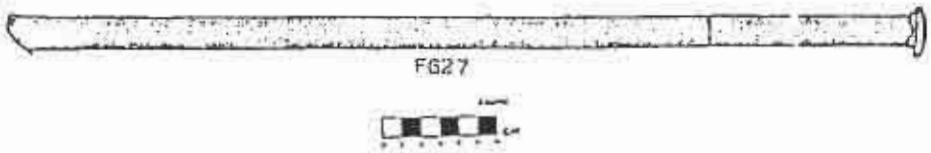
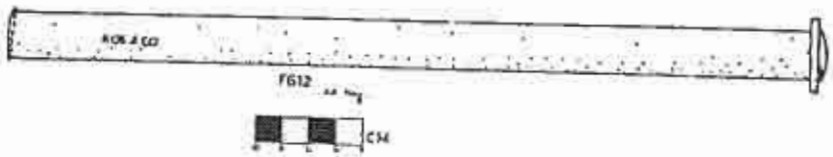

FG27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FG10
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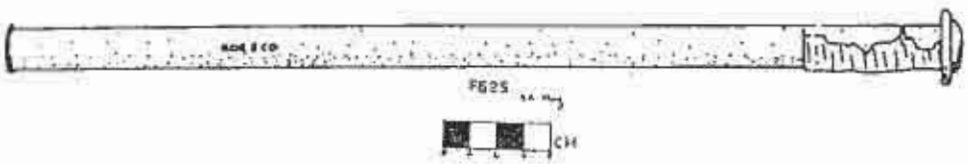
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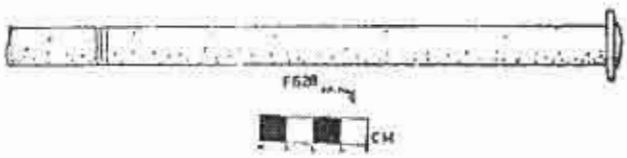
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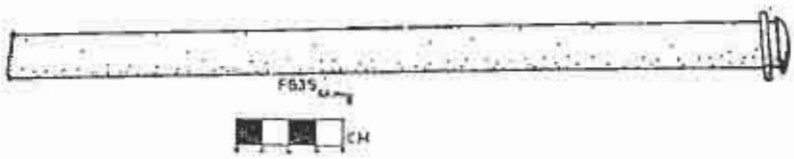
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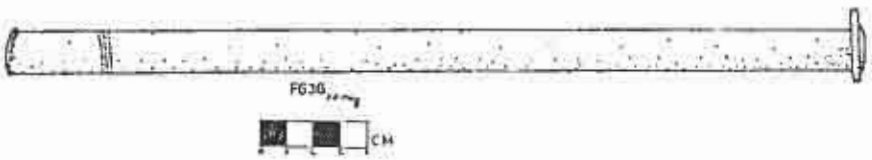
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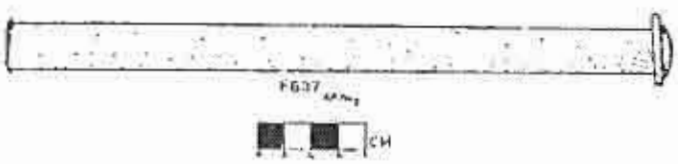
FG37
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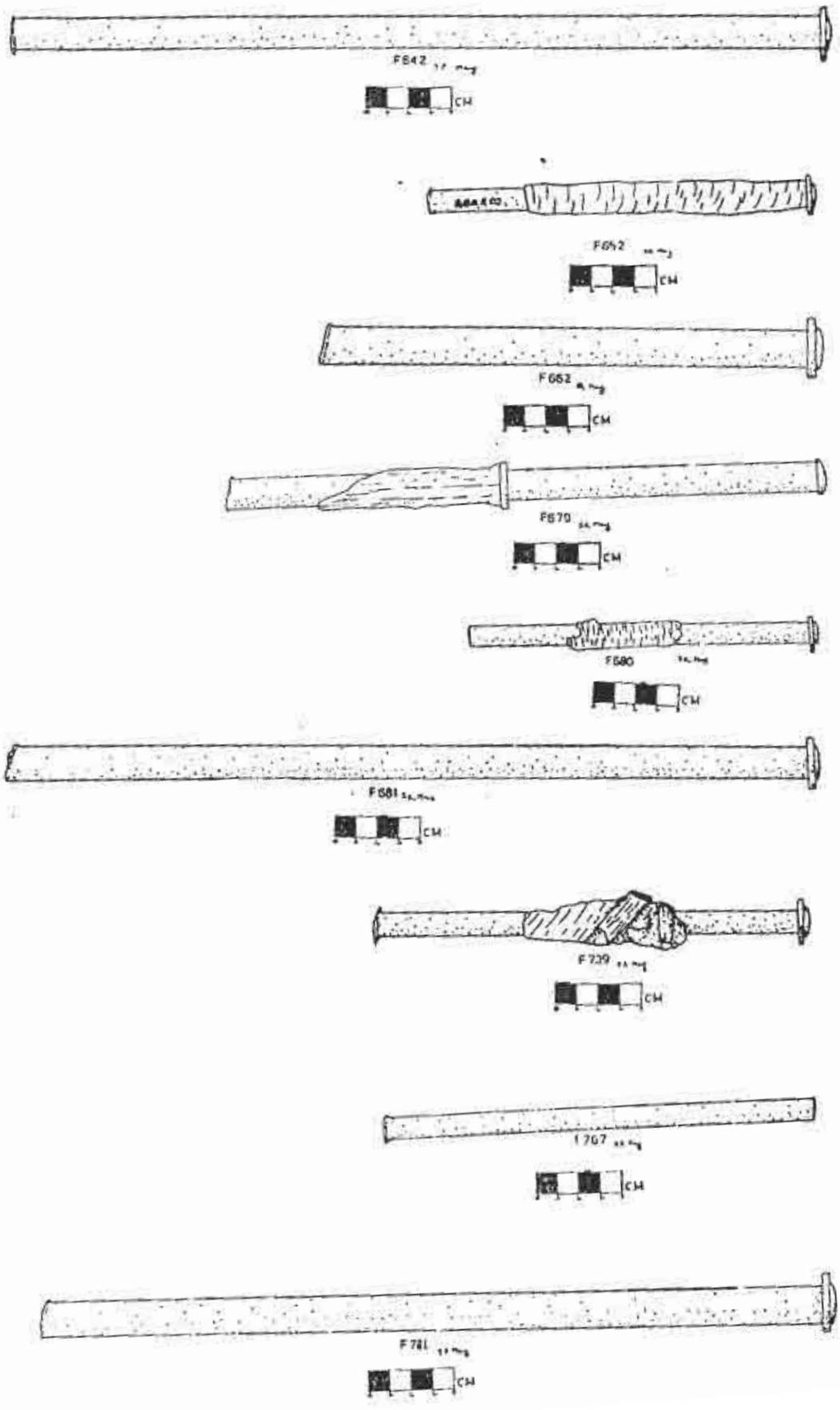
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F 642 Copper bolt 77 x 3.5 cm
Grid 52

F 652 Copper bolt 36 x 1.8 cm
Inscribed Roe & Co with wood
Grid 52

F 661 Copper bolt 48 cm long
Grid 52 not sighted

F 662 Copper bolt 48 x 4 cm
Grid 52

F 679 Copper bolt 55 x 3 cm
Grid 52

F 680 Copper bolt with wood 32x2 cm

F 681 Copper bolt 76 x 3 cm diameter
Grid 52

F 739 Copper bolt with wood and treenail attached 40.5 x 2 cm
Treenail fragmented 2.0 cm diameter
Grid 71

F 767 Copper bolt 39.5, 2.2 cm diameter (7/8")
position unknown. Most likely from the group removed from 71

F 781 Copper alloy bolt 750 x 24 cm

An examination of the above (including I suspect F 019 which is listed here shows that in all but the cases noted each fastening went 'through' the timbers joined. This is shown by evidence of 'working' on each end. In all cases that receiving most working being the end with the clinch ring. The other is in most cases less heavily burred. In some cases indications are of the bolt going through a cant frame (F 739) with ceiling planking thickness evident through 'necking' on the bolt itself F 627.

In all cases bar F 767 the clinch ring is still attached. Three definitions therefore here apply "buttbolt", "through bolt" and "clinch bolt". As the latter is contemporarily with the building of HMS Pandora and the clinch rings are in evidence that definition is more appropriate. The term butt bolt may apply to the smaller fastenings but unless found in that configuration on existing hull it cannot be safely used.

Through bolt:

A fastening that passes completley through two pieces of timber, de Kerchove, (1948:833). Also called 'in and out' bolts de Kerchove, (1948:390).

Clinch bolt:

Defined in Roding (1793:345) and in de Kerchove (1948:152) who state a clinch bolt is "a long through fastening..... having its end rivetted over a washer or clinch ring..... used for fastening scarphed joints, stems, deadwoods, keelsons, stringers, clamps and knees".

Butt bolt:

"A through bolt in the timbers nearest butt timber..... to fasten butts, through bolts, treenails and short welts are used. Butts are usually cut upon the middle of a timber, and are fastened with one treenail and one short bolt through the butt of each plank into (the) butt timber (timber butt is cut on) and one through bolt colled a butt bolt in timbers nearest to butt timber". Desmond (1919:60).

Clinch ring:

"a kind of round washer ..... with a hole in the centre over which the head of a bolt is clinched. Also called clench ring". Clenching is the "operation of fastening the point of a bolt or nail on a ring or rove of iron by hammering it so as to make it spread" Falconer (1815:90). Bugler (1966:13) uses the term rove, while Roding (1793:345) uses the term plate to describe the diamond shaped or square washer used with iron fastenings.

Dumps: (Short bolts)

Given that F 014 and F 006 are at or around their original length and are not an eroded fragment of a larger bolt they fit the category of short bolt or dump. The term "dump" is used by Steel (1805) and is therefore contemporary with HMS Pandora. The term is used here in the belief that each is largely intact.

F 014:

A copper 'dump' or 'short bolt' 280 mm x 20 cm dia at head and 17 mm near point (i.e. 11" x 13/16-11/16" dia) with broad arrow inscription.

F 006:

A copper dump or short bolt 225 mm x 20 mm dia 8 3/4" x 13/16" Eroded with broad arrow. Grid 1.

F 007?:

Dimensions as above, Grid 1. (not sighted)

F006

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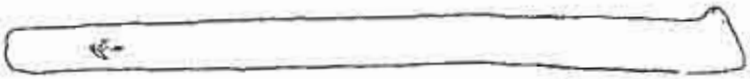

F014

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F019

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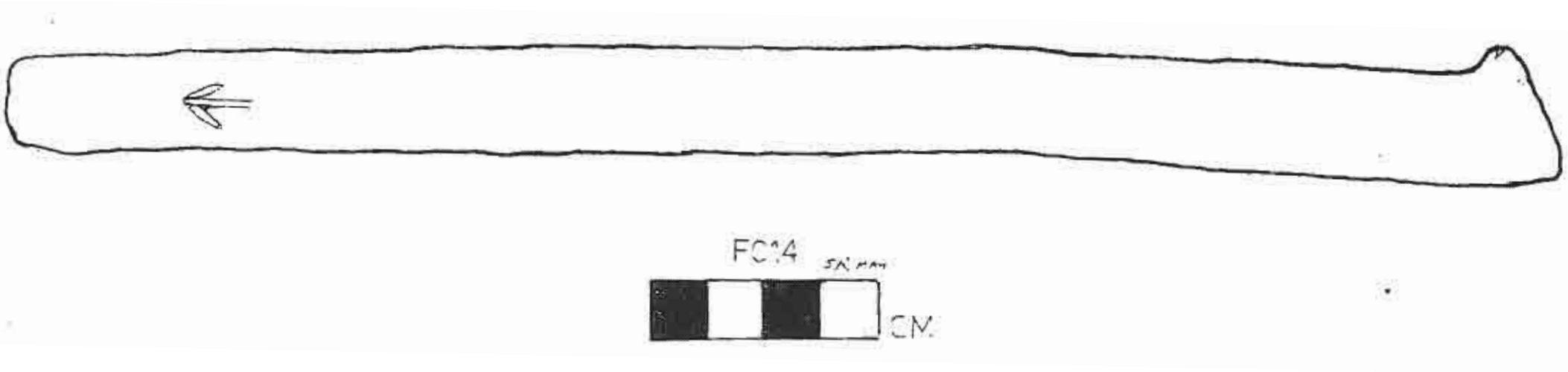
FC14
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F003
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Dumps:

Steel (1805) (F) refers to the term dump in the context of false keel fastenings but it also appears in Australian Lloyds Rules and Regulations (1864) as a form of plank fastening. Thearle (1874:230) refers to dumps as "nails of mixed metal" and varying in length from 7 inches long in 2¼ inch plank to 12 inches long in 5 inches plank and so on, increasing 1 inch in length for every half inch increase in the thickness of the plank. The term also occurs in Bugler (1966:129) with reference to HMS Victory.

De Kerchove (1948:249), defines the dump fastening as "....a metal fastening which does not go quite through both pieces of timber, so that only one end is visible. It is usually made of a small round bolt with a solid head and of the same thickness throughout, also called dump". He gives French and German equivalents for these and blunt bolts below as "chevillage a bout perdue; a stump fverbolzung". De Kerchove (1948:71) refers also to a 'blunt bolt' as being "a bolt driven into a plank and timber as a partial or extra security. It is not driven right through the timber and is therefore often referred to as a short driven bolt, also called dump bolt". Desmond (1919:60) refers to dump, welts and short bolts in the same context.

Boudriot (1977:141) refers to "Cheveille a pointe perdue" as round or square pins with a lost point and Roding (1793:347) refers to "scharf-bolzen or bolts with a sharp point or pointed bolts" and bolts without a sharp point are called 'stuvbolzen' (see above). Paasch (1890:8) defines dump quite simply as "one of short length not extending through the material". 'Dump fastening' is also a particular method of fastening like single, double fastening as explained by Thearle (1874:230) and as illustrated in Desmond (1919:10) and refers to the use of one dump to every four bolts in plank fastenings.

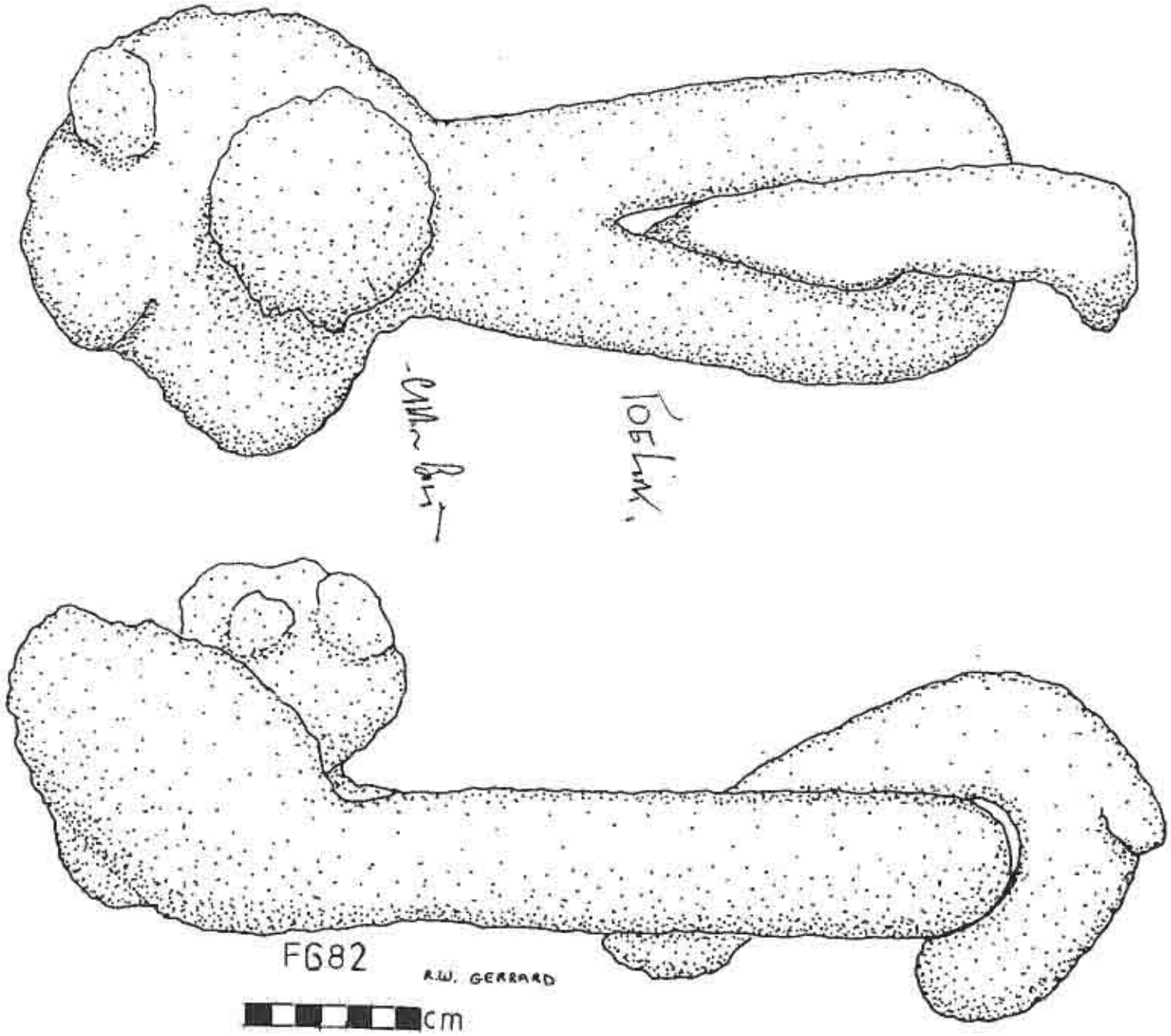
Miscellaneous:

F 682 Possibly the Toe link from a set of chains with a section of the chain bolt and part of the middle link. Grid 52, Length 48 cm.

Chain bolts:

A large bolt to secure the chains of the deadeyes for the purpose of securing the mast by the shrouds, Steel (1822:94) ".... Those bolts which are driven through the upper end of the preventer plates and the toe link of the chains".

Note: The word chain plate as used in the registers and indicates a form of securing shrouds with plate, square or round bar, where chains are in evidence as in Pandora. The term chains is more appropriate and the contract is headed chain plates but goes on thus " to have chains or chain plates as shall be directed..... the iron of the links or plates.


FG82
R.W. GERRARD
cm

Bolt:

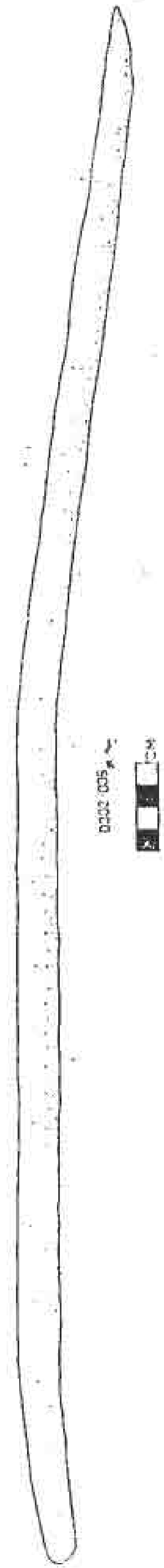
F 002/005

Copper alloy possibly bronze 710 mm x 20 mm (? x 3/4") could be an eroded through or clinch bolt but also may have emanated from the vessels deadwood, keel or keelsons. Without the site location data this theory cannot be strengthened.
This type of 'specific purpose bolt'alluded to above, can also be categorised as 'through or clinch bolts, rivets etc' dependent on their configuration Paasch (1890) for example refers to deadwood bolts, keelson bolts, transom bolts etc.
The bolts also may originally have been what American sources commonly call a drift bolt though this description occurs only in a more modern context being a particular type of clinch bolt. The use of the term is now common American practice. "Has a washer on a clench ring and upset head on the exposed end and is slightly pointed on the other. Also called a drift. Drift bolts are always driven obliquely (canted) to the seam, they fasten and are used on keels, deadwood, rudders..... and similar places where there is ample wood and clinch bolts cannot be used or are unnecessary" der Kerchove (1948:243).

The term drift however is contemporary and signifies the difference between the size of a bolt and the hole into which it is to be driven. For instance if a bolt be one eighth of an inch larger than the hole, the bolt is said to have one eighth drift Falconer (1815:127).

Chapelle (1966:173) expands thus: Drift Bolt....." the point is tapered .....it is not necessary to make a long taper usually less than half inch being sufficient. This gives a rounded, blunt point. Through Fastening Drifts, 1966:175: "the drift is usually driven from the outside to the inside of the hull wherever practical". The term drift bolt then refers to a specific type of clinch bolt and probably due to corrosion and site damage has not been positively identified as such on Australian sites. Unless seen as described above by de Kerchove (1948) and Chapelle (1966) the term is best not used. Further, Desmond (1919:102) uses drift in the context of edge bolts and Roding (1793:345) states that bolts generally are thinner at one end to facilitate driving, i.e. like a drift.

A mistake has occured in the register details found in May (1984) artefact register in that the term Muntz appears. As used it refers to a specific patented alloy of copper and zinc not in common use before 1830. Unless analysed as this specific 60:40 alloyed ratio and bearing the Muntz stamp the term is best not used and can lead to identification and analysis problems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Bolt:

002/003 Broken head of copper alloy bolt 80 mm x 30 mm diameter (1 3/16").
Actual type of bolt indeterminable though the diameter is of significance.

Miscellaneous:

Keel Staple?

003-002 Eroded copper strap 165 mm x 20 x 7 mm
The strap appears too thin for a false keel staple and the gentle curve shown in the illustration also casts doubt on that analysis - with staples having more of a sharp angle to them and though this is dependent on the shape of the false keel itself.

Staple:

Crooked fastening: keel staples are generally made of copper from 6 - 12 inches long with a jagged book at each end. They are driven into the sides of the main and fasle keels to fasten them. Steel (1822:135).

False Keels

(otherwise apart from India ships) are fastened to the main keel with dumps underneath and keel staples along the sides about 3 feet apart observing to shift both dumps and keel staples.
False keel 5" thick.

Treenails:

F 739 Copper through or clinch bolt with treenail.bolt 40.5 x 2 cm
Treenail fragmented 5 cm remaining diameter 2 cm (3/4")

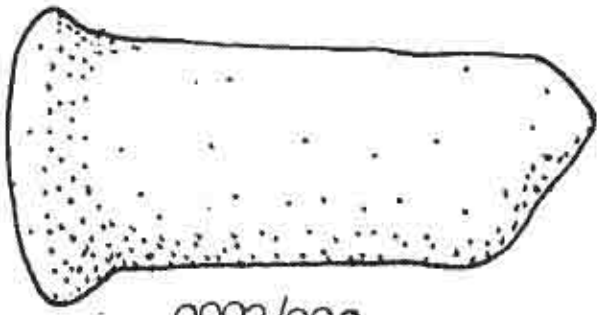
Iron Fastenings:

Experience has shown that on sites such as HMS Pandora these rarely appear in anything but iron based concretions or as imprints in other material such as wood.

Bolts? Iron

F 633 Wood, concretion with iron bolt impression length 17, diameter 2.2
Grid 52

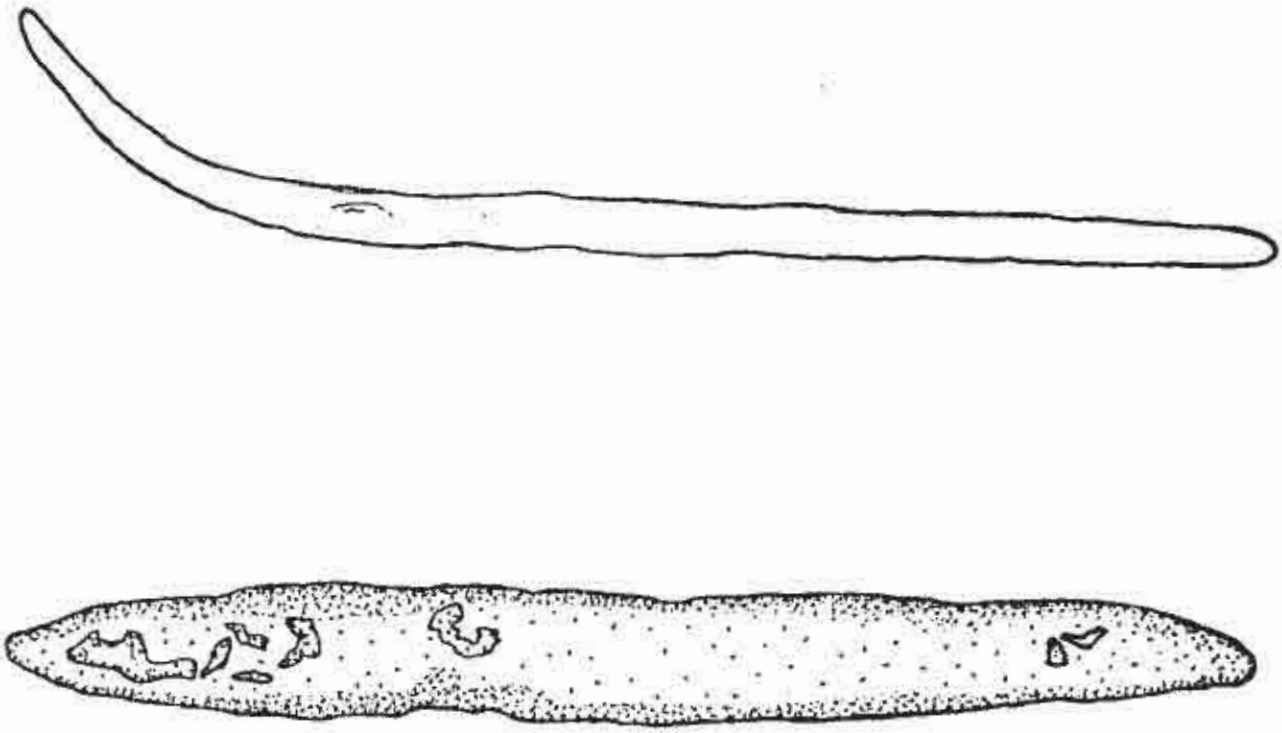
F 653 Iron bolt concretion 34 cm x 2.5 cm dia
Grid 52



0002/003

S.R. May

CM



0003/002 P. GEISLER

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F 663 Iron bolt concretion - 38 cm length
Grid 52

F 664 Iron bolt concretion 32 cm
Grid 52

F 517 Iron bolt concretion inside diameter 1.8 cm
Grid 31

F 506/2 A. Iron concretion fastening bolt
B. Iron concretion coupling fastening

F 777 Large iron concretion with wood attached
Length 98 cm bolt hole ID 2.5
Grid 34

Ring Bolt:

F 549 Fe bar with ring bolt Length 33 ID 5.5, dia 1.2?
Grid 32

F 578/2 Fe ring bolt
Length 15, , ID
Grid 48

F 528 Fe concretion containing ring bolt impression
Length 11.5 ID 2.6

F 775 Fe concretion/ring
Length 68, width 17
Not conclusive

F 135 Eyebolt concretion
Grid 3
Not sighted

F 682

Ring and Eye Bolts:

"for securing guns and have the part that enters into the wood cylindrical, those for ring bolts have the rings turned into an eye made at the head of the bolt. The rings are sometimes made angular to receive many turns of lashing. Such are the eye bolts for lashing the booms and spar anchors. Eye bolts have only an eye made at the head of the bolt to which the tackles etc., may be hooked. Some eye bolts have a shoulder..... as the fish tackle eye bolt which has a plate or long strap made under the eye to prevent its burying into the plank" Steel, (1822:89 (with illustrations)). The descriptions of ring and eye bolts appearing in the 1782 contract for building a 24 gun ship fit those definitions above.

Nails/Spikes:

F 533 Wood fragment with planking
Nail impression length 8.5 ID 0.9

F 532 Concretion Fe with nails
Length 25

F 525/3 Concretion wood from fitting with square shank nail holes
8.9 ID 0.4
Grid 32

F 728 Wood with nail impression
Length 4.4 Width 3
ID 1.8 x 1.8
Spoil heap

F 729/8 Assorted concretion with nail holes ID of nail holes
1.4 (1.7)
1 (1.1)
.8 (1.0)
1 (1.2)
Spoil heap

F 719 Wood concretion with nail impression
Length 7.5 Width 6.5
ID 0.9 x 1.2
Grid 49

F 062 Fe concretion round section spike Length 9.0 diam 19.
Cannon hole. not sighted.

F 071 Iron conretion of spike on wood. 400 mm long
Cannon hole

Spikes:

The term spike refers to "a large cut or wrought nail of square section therefore also called boat spike, spike nail, deck nail.....used by boat builders for fastening thick planking (de Kerchove 1948:753).

The definition of Roding (1793:95), Falconer (1815:291) and Steel (1822:118,48) fit this nodern description and it is apparent the term nail and spike were used synonomously. Agreement on length and form however has not been reached.

Steel (1822:118) defines a nail as a small spike made of either iron, copper on mixed metal. It is important to differentiate and the author proposes that in registers the term spike, can safely refer to square section nails over 3 inches long, the term nail to small square or round sectioned fastenings falling between the category tack and spike and the term dump to round section nails or short bolts in excess of 3".

Rudder Nails:

F 173 Rudder pintle (bronze) 6 fastening holes in each side.
Length 840 Width 340.

These holes indicate the use of rudder nails rather than rivets or through bolts as in the discussions below. A discussion on the pintle itself has been previously published by Henderson.

Rudder Nails:

".....are about 5 inches in length with a full head and used for fastening pintles to the rudder" Falconer (1815:291). ".....used chiefly for fastening the pintles and braces" (Steel, 1822:118). They also fit the category of short bolts and Paasch (1890:9) refers to rudder pintles and rudder brace bolts.

There is also a case for calling those bolts passing through both straps of braces (gudgeons) and pintles or through gripe irons (horse shoes), fishplates, dove tails, fishtails and stirrups as through bolts (Fig. 16), (Chapelle, 1916:161). If, however, they are clenched at both ends the term 'rivet' (Falconer, 1815:408) is applicable. A variety of different methods of fastening brace and pintle straps have been found, with through bolts, rivets, lag bolts, ragged rudder nails and rudder nails being evident in various configurations on different vessels. Common however, to many though not all mid 19th century vessels encountered, is the practice specified in Australian Lloyds (1864:22) of through bolting nearest the crowns of the pintles and braces. "the two bolts, the nearest to the crowns of the pintles and braces of the rudder are also to be through and clenched, those through the braces

to be in the main piece of the stern post".

In this case and in all the late 18th early 19th century examples seen by the author the brace and pintle straps are fastened with rudder nails alone.

Treenails:

F 739 Copper through or clinch bolt with treenail: bolt 40.5 x 2 cm
Treenail fragmented 5 cm. remaining diameter 2 cm (3/4")

Treenails: "are long cylindrical pins of cleft oak from an inch to an inch and a half in diameter and from one foot to three feet six inches in length used for fastening the inside and outside plank of a ship to the upright timbers" (Falconer, 1825:579).
There is general agreement on this point in the early references though Desmond (1919:97) prefers locust and refers to the common practice of end wedging across the grain with hardwood wedges. These wedges are inserted after the treenail is cut flush with the planking and have been seen in a variety of configurations.

Gunport hinges:

F 504 Gunport hinges therefore possibly from vessels aft quarter.
1 through bolt with clinch ring for attachment to ships timbers appears on the hinge. The port lids themselves are secured by port nails, see the ringbolt shown appears to be used for securing the port lid open.

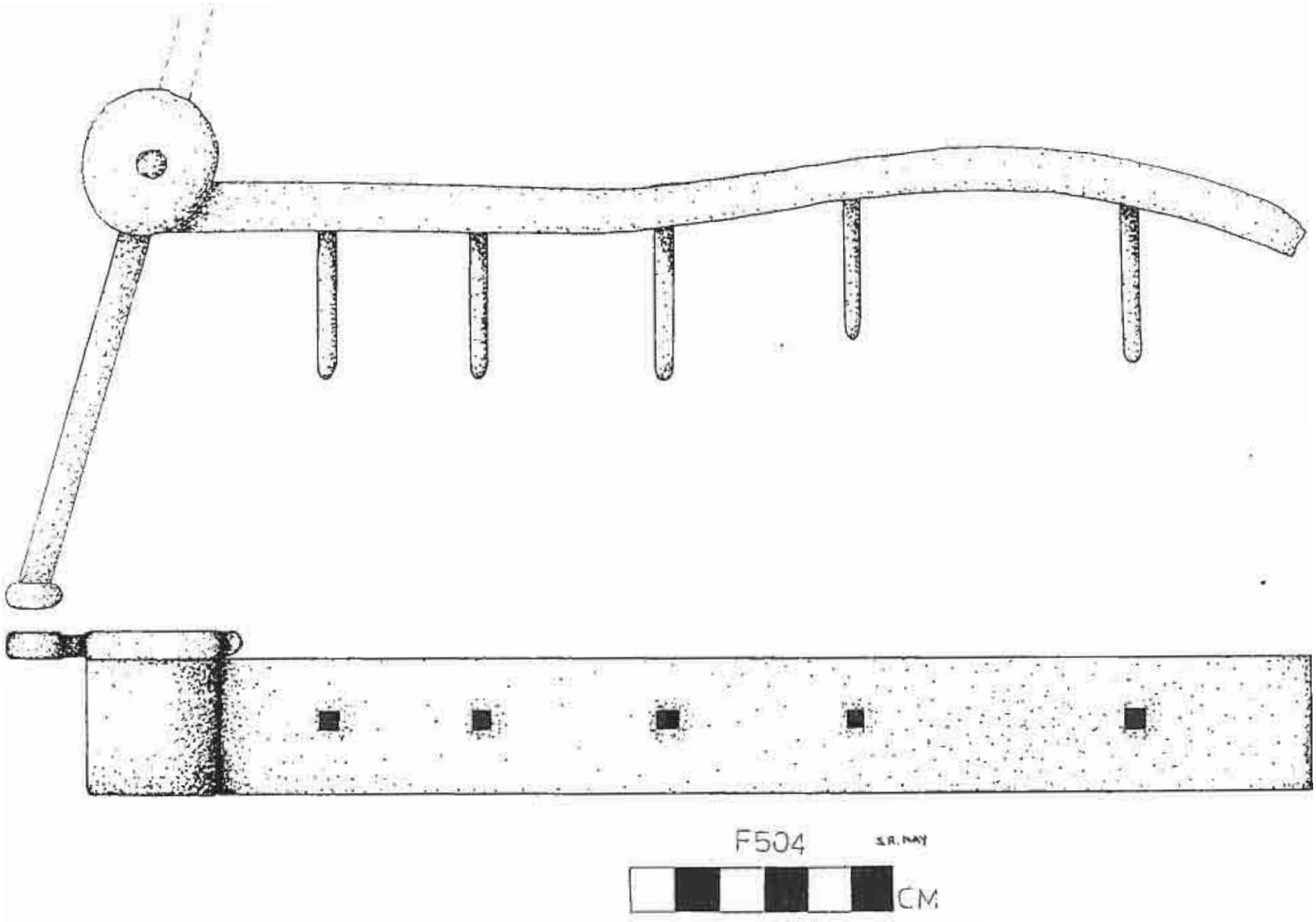
Port Nails:

"Are used in fastening hinges to the port lids, as also for fastening plates to the bill boards. (Falconer 1825:291)

General Notes

The 1782 contract for the building of a 24 gun ship has obvious relevance even at this early stage in the analysis of HMS Pandora fastenings.

Those specifications of immediate relevance are listed below and relate to those items identified beyond doubt.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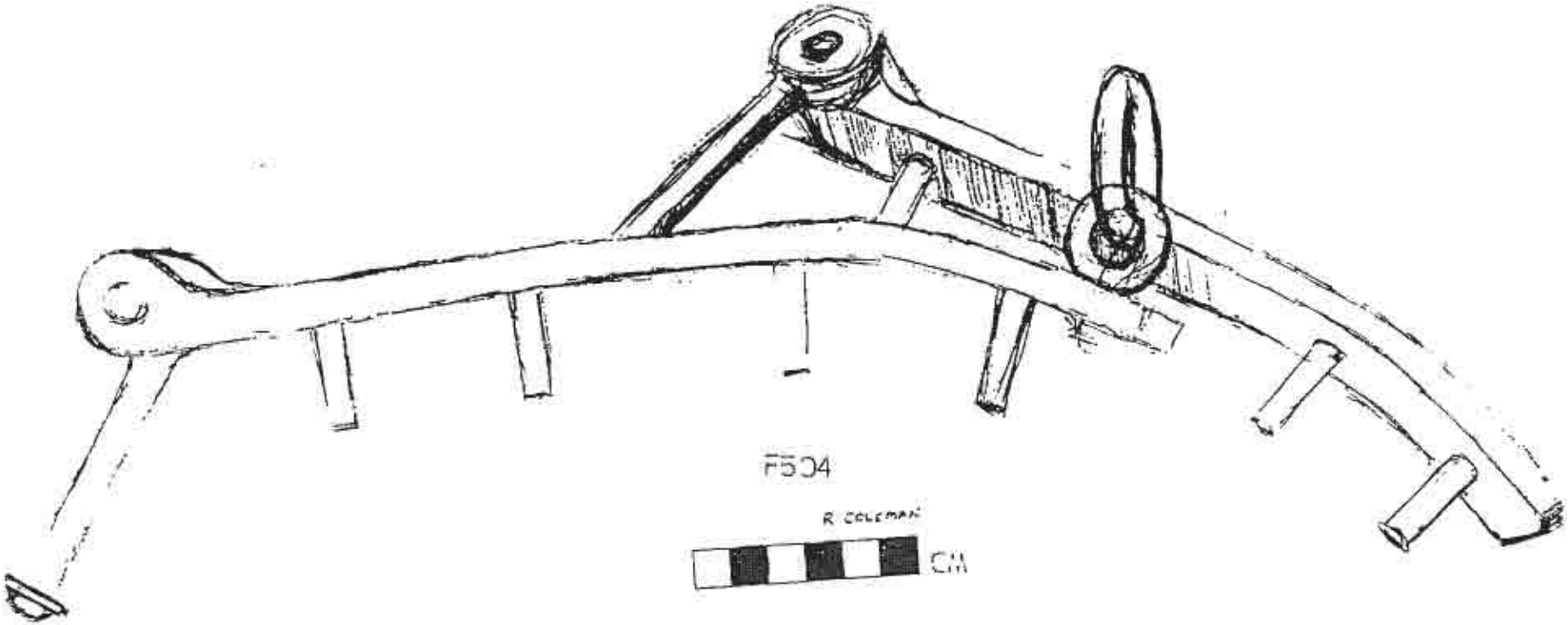
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Copper bolts:

The Horseshoe and Dovetail Plate, with the Keel Staples, with all the Braces and Pintles, to be of a mixed metal, and copper bolts below the load draught of water, if required, and to be found by His Majesty, and whatever the weight of them may be, the value of the same weight in wrought iron, after the rate of ..... per Cwt. is to be abated out of the Contractors Bill. All the copper bolts to be one sixteenth of an inch more than what has been before observed.

Treenails:

All the treenails to be dry, seasoned, clear of sap, and converted from timber of the growth of Sussex, or equal in goodness thereto; to be well mooted, not over haled with an axe in driving, and all to be caulked or wedged at both ends.

Iron Work:

All the iron work shall be wrought out of the best sort of Orgrounds Iron, not burnt, or hurt in working; all the bolts to be clenched or belayed, as shall be directed; those to the iron knees and standards to be drove through them into the transoms, beams or timbers, and all clenched on rings let into the wood.

Chain Plates:

To have chains, or chain plates, as shall be directed, or sufficient strength, and long enough for the chain bolts to come through the upper deck spirketting as low down as can with ease be drove out, and the preventer bolt to come below the upper deck. The iron of the links or plates to be of a proper size, as shall be directed, and made out of the best sort of orgrounds iron, wrought with all imaginable care. The chain bolts 1/8 inches diameter, and the preventer bolts 1 3/8 inches diameter.

Butt End Bolts:

To have butt end bolts under water in the next timber to the butt of each piece where necessary of 3/4 inches diameter, to be clenched within board on the footwaling, and also bolts of 3.4 inches diameter in the timbers next the butt timber of the lower and upper deck spirketting, and to be well clenched.

Fastenings Location:

Any attempt to locate the loose fastenings above in relation to original hull structure is premature. As indicated previously, if the wreck is canted c 40° to starboard then enough of that side will remain to render such an analysis unnecessary (Fig. 1(a) dotted outline) and the fastenings can be relocated with reference to their position on the remaining hull section. If the hull lies on an angle of around 25° (Fig. 1) then such a theoretical analysis will be a required undertaking as there will be little of the topsides remaining on either side of the hull to allow the fastenings to be located beyond doubt. Then the student will have to make recourse to the contract for building the 24 gun type.

In that contract reference is made to fastenings found in 47 separate timbers or locations in the area abaft the mizzen. The questions posed however, are greater than the answers and these references range from specific sizes and locations, e.g. butting bolts, chain plates, transoms, rudder (Rother), crutches, tiller and so on to general comments.

As indicated the location of the fastenings at this stage is a premature exercise dependent upon the as yet incomplete task of fixing the hull in relation to the excavation.

Grid 71, one of the last excavated in 1984, gives some clue. The cant frames expected in that area are shown from the contemporary plans to be at around 5-10° angle to the keel.

Producing the cant frames located in Grid 71 on down to an angle of 5-10° towards the keel produces a surprisingly neat fit with the angle of the stern post as visible today.

That leads to the conclusion that the logical axis of the hull (i.e. keel alignment) lies at a substantial angle away from that of the archaeological grid fixed over the remains.

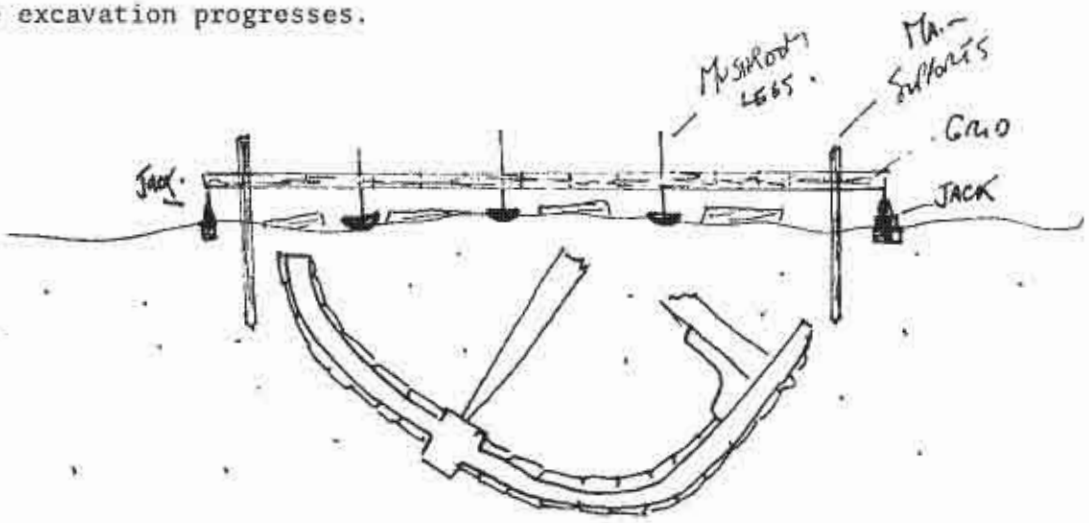
Though not of paramount importance to the locating of moveable items within the existing hull this discrepancy will be of some irritation to students of hull structure, fastenings and ships lines.

For the purposes of those interrelated studies now and more importantly in the future, I make the following recommendations:

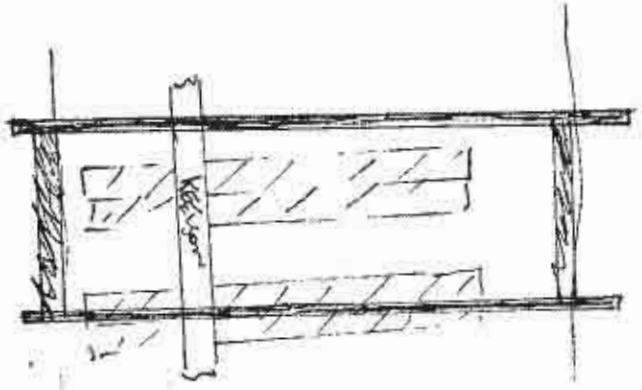
1. the realignment of the grid system to use the keel when found as the axis on site.

2. the on-site measurement of all fastenings and structures in metric and imperial units and the appearance of same in the registers.

3. the use of 2 m wide collapsible site grids extending right across the hull structure on the proven 1984 design but with mushroom pods for grid supports within the hull itself.
These can be constructed from plough shares and can be removed or lifted as the excavation progresses.



These large grids will then allow for uninterupted rapid analysis of ships lines and structure from Port to Starboard. They need to be set up only once and as a by product do not require the risky hammering in of supports into the hull area itself.



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