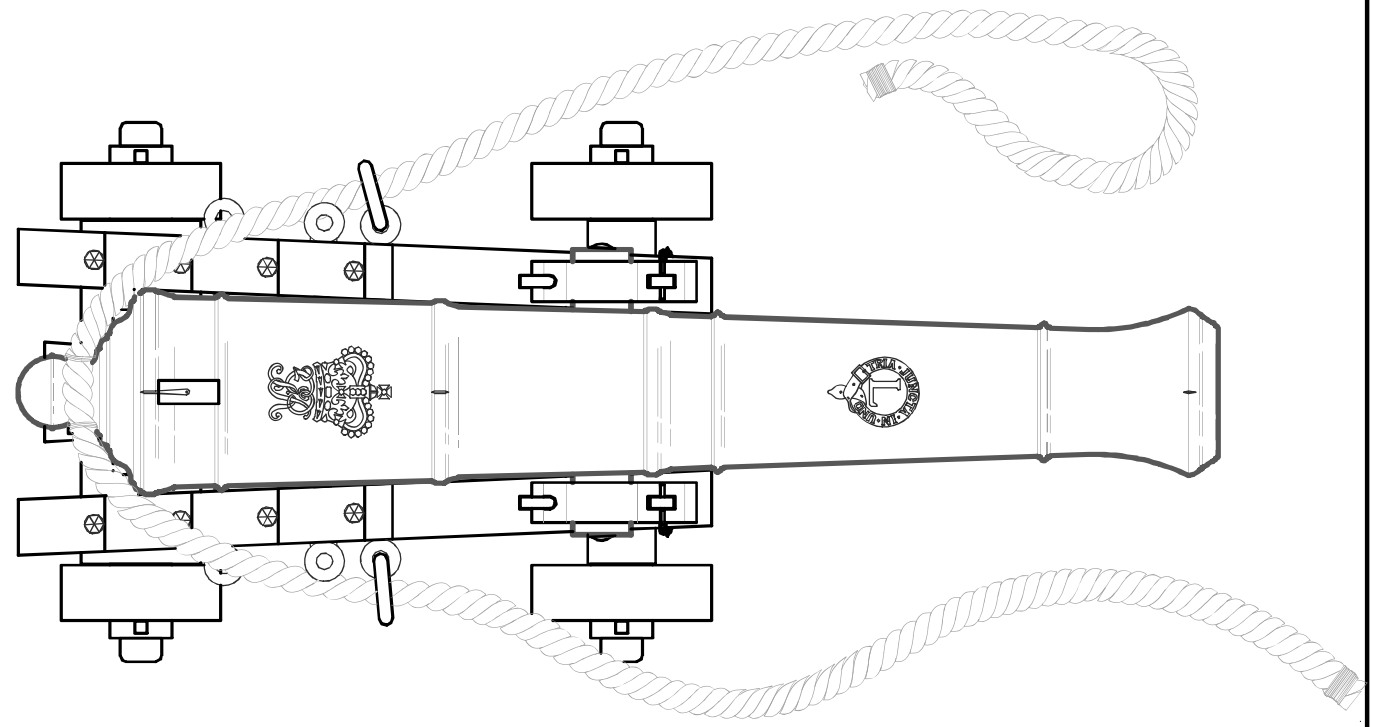
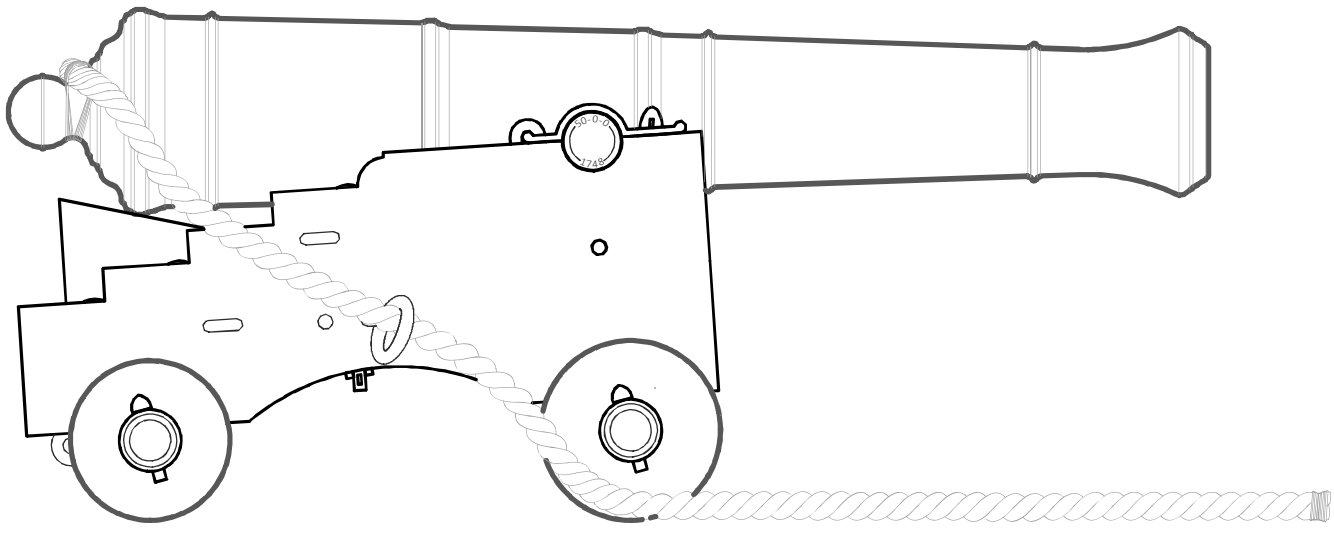
The 24 pounder Ship's Gun

Full plans to make a 24 Pounder Cannon

Plus formulae to make any Gun Carriage from 4 to 42 pounds weight of shot circa 1730 - 1860

Revision 1 February 2026





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Revision 1 February 2026.

Excavation chord radius corrected P 31

Bracket Bolt length corrected. P 39

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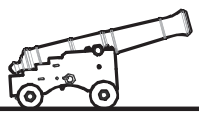


History

Cannon came into regular use in Europe from early in the 14th century. Initially deployed as siege guns because of their ability to demolish stone walls, they were soon adopted for both naval and artillery roles.

Cannon were manufactured by both government facilities and private contractors. A proliferation of styles evolved with little attempt at standardization. This began to change in the 18th Century. A more scientific approach was starting to be made to the evaluation of different cannon in the search for optimum performance. There had developed a trend towards shorter, lighter weight weapons, fired with ever smaller charges.

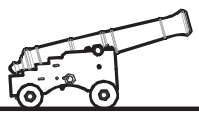
Relative to the weight of shot, the charge had reduced from 1:1 to around 1:4 or even 1:5 without loss of distance or penetration ability. This allowed the breech of the gun to be made thinner without risk of rupture, and the gun consequently lighter.

Cannon were by now made from both bronze (often referenced as Brass) and cast iron. Testing had shown that the lightest bronze guns were prone to excessive re-coil action. This made them less suitable for sea-service. In 1743 the dimensions of British naval guns were "settled" by the Board of Ordnance. Ten years later in 1753 progress towards standardization had been made, and the Board of Ordnance published tables covering the desired length and weight of guns for different applications. These were defined as:

- Ships guns were to be cast in 4, 6, 9, 12, 18, 24, 32 & 42 lb. calibers
- Garrison cannon were to be: 6, 9, 12, 18, 24, 32 & 42 lb. calibers
- Siege guns were to be in 12, 18 & 24 lb. calibers
- Field guns were to be cast in ½ , 1, 1½ , 2, 3, 6, 9, & 12 lb. calibers

All field guns were to be brass, but ships guns could be either brass or cast iron. While this may have produced more uniform weapons aboard His Majesty's ships, there were still many foundries manufacturing guns to their own pattern for the mercantile marine trade, and for static defensive positions (forts). In 1764 The Board of Ordnance tweaked the dimensions slightly towards a marginally lighter construction. The design of muzzle loading cannon changed little between the mid 18th and mid 19th centuries, when breech loading guns and shell projectiles started to make an appearance.

This doesn't mean that there was no change to carriages during this period, as experiments and detail changes were on-going, but didn't significantly change the basic design. Bear in mind that a gun carriage can't be evaluated in isolation from (a) the gun it mounted and (b) the ship it served. "Standardisation" in 1743 didn't have the same connotation it may have in 2023.

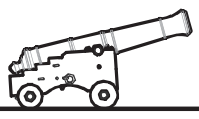


History continued

The most significant change was driven by the adoption of the Blomefield pattern gun. Sir Thomas Blomefield (1744 – 1822) designed a gun with a less ornate cascabel to provide a more uniform metal thickness behind the breech, and a cast in loop above the neck to secure the breeching rope. The first guns were cast c. 1790, and were adopted as the Naval standard from 1794, but they were not universal within the Navy until the mid 1830's. Most of the guns on and around HMS Victory are Blomefield pattern, but this doesn't mean they were present at Trafalgar.

Adoption of the Blomefield gun drove the following carriage changes:

- The breeching bolt and ring were eliminated
- The bracket loop on the upper bracket was removed, and combined to form a loop bolt replacing the hindmost hind axtree bolt. This placed the loop vertically on the hindmost bracket step. Possibly through the 1820's carriages carried loops in both places.
- Buffers, where fitted, were removed from carriages and replaced by a buffer fitted to the gun port sill on the ship. Probably from the late 1820's
- From sometime between the turn of the century and 1830 the fore axtree was narrowed to place the fore trucks closer to the bracket.
- The specification for Naval carriages called for Elm Brackets, Transom and Trucks with Oak Axtrees, however by the end of the 18th century material shortages meant many carriages were all oak.
- This lead to the adoption of two piece trucks, with two layers of wood set at right angles and secured together with a row of 6 or 8 bolts or rivets. They possibly gained an iron centre sleeve to serve as a bearing on the axtree arm, which itself sometimes carried a half-shell of copper to the underside as a wear prevention measure. Note that this change wasn't introduced till about 1840, and along with loops on top of the bracket, two ply trucks are the most often miss-represented feature on replica 18th century carriages.



Reference Sources

For those wishing to replicate an 18th century naval cannon there are no shortage of reference examples. Both brass and iron guns are displayed throughout the world in museums and in public places. There are also a number of published plans and documents recording typical dimensions. Included among these are contemporary reports that could be considered the most reliable sources.

Less accessible are details of the carriages that supported these guns. Being wooden, few have survived the test of time. This journal is as much about providing a reference for the naval gun carriage, as it is about the gun.

Dates expressed throughout this document should be considered indicative rather than absolute.

Whenever a warship returned from the conflict, and required either repair or de-commissioning, it was common practice to remove the armament and return it to store. Upon re-commissioning the ship would be re-armed, but not necessarily with the same guns. So there was a state of constant change, especially if the ship enjoyed a long service life. Take HMS Victory for example. Only a handful of the guns she currently carries were present at Trafalgar. Indeed most are fiberglass reproductions and reflect a later age. Similarly the gun carriages are replacements in the mid 19th century style.

In compiling this document I have relied on two primary sources:

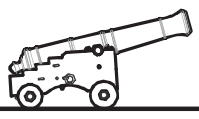
1. A Treatise of Artillery by John Muller, second edition published 1768 (1st Edition published 1757 named as A Treatise on Artillery)

John Muller 1699 – 1784
1741 – Appointed Deputy Head at the Royal Military Academy, Woolwich
1754 – Appointed First Master at the above establishment
Later – Appointed Professor of Artillery and Fortification
1766 – Retired

John Muller wrote a number of books covering the topics of mathematics, Fortification and artillery

In the Treatise Muller puts forward an argument for shorter, lighter guns that would be easier to transport on land, and allow a greater weight of shot to be fired at sea from a lighter displacement. I have found no evidence that his suggestions were adopted, at least for sea service. However in the text he gives useful data for the specification of both brass and iron guns.

Of great value though, Muller describes the construction of a contemporary naval or garrison gun carriage, and explains how to derive the carriage dimensions from the gun it has to bear.



Reference Sources continued

2. A Treatise of Mathematical Instruments by John Robertson, third edition published 1775

(1st Edition 1747;

2nd Edition 1757 added several examples of the use of the sector;

3rd Edition published 1775 added a section on perspective, and delineating cannon and mortars;

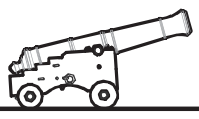
4th Edition 1778 published posthumously and was the same as the 3rd).

John Robertson 1712 – 1776
1739 – Had become a teacher of mathematics
1741 – Elected a Fellow of The Royal society
1748 – Appointed Master of the Royal Mathematical School, Christ's Hospital
1755 – Appointed (By the Admiralty) First Master of the Royal Navy Academy, Portsmouth
1761 – Asked to calibrate John Harrison's H4 chronometer prior to sea trials
1767 – Appointed Clerk of the Royal Society
1768 – Appointed librarian at the Royal Society in addition to his duties as clerk. He remained in this dual role until his unexpected death in 1776.

John Robertson wrote a number of books covering the topics of mathematics, the use of mathematical instruments, astronomy and navigation. In addition he wrote a number of papers on these subjects and their practical application.

I stumbled upon John Robertson's work after seeing reference to it in another research paper, and consider it the most authoritative document I have come across in respect of mid 18th century naval cannon. In the Treatise Robertson describes in tremendous detail the practical application of mathematics and mathematical instruments to the reproduction of architectural detail, upon which the shape of the cannon is based. I think it is worth repeating how he came upon his measurements for the 24 pounder he describes in the text:

"The author of this treatise, soon after he was appointed, by the late Lord Anson, to be the head Master of the Royal Academy at Portsmouth, obtained permission of the officers of the Gun Wharf there, to take sketches and measure of such military machines as he desired; whereby he was furnished with a competent number of dimensions of ships guns and their carriages, also of sea mortars and their beds, to enable him to come up with some papers for the instruction of his scholars in the names of the parts of those machines, and also to delineate their figures in nearly a just representation of those already in use: The dimensions which were taken with great accuracy in inches and centesimal parts, being reduced to parts of the diameter of the proper shot, it appeared that these numbers might be applied to every sized gun, without materially affecting the lengths at present established for the Navy."



Reference Sources continued

From the above we can take it that soon after 1755 Robertson measured a number of existing guns (and carriages), with a view to describing them in a formulaic manner, which could be applied across the full range of sizes while still complying with the established pattern set down in 1753. He goes on to comment on Muller's treatise, and his call for change:

"Mr. Muller, who in his treatise of artillery, proposed that the dimensions of cannon, &c. should be proportioned to the diameter of the shot, gave precepts for constructing these machines from such dimensions, founded upon a theory, which he with great ingenuity endeavored to establish, and for which, the Corps of Artillery are much obliged to him: but as the British establishment differs considerably from that proposed by this gentleman; the publication of the above mentioned papers may probably be useful to persons who wish to be acquainted with such matters."

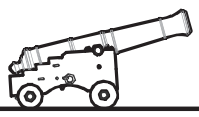
I think we can take from the above that while Muller's theories may have been embraced by the Army, they didn't influence established Naval practices.

I understand that one of the primary reasons the navy resisted the call for shorter, lighter guns, was their common practice of "double shotting" the guns in battle. This placed a significant extra load on the piece, and tests had shown the lighter weapons were prone to failure when placed under such duress.

Because Robertson copied the dimensions of an actual gun he chose as representative of the period, and Muller's book is more about proposed changes to cannon dimensions, I have chosen to replicate Robertson's work with these drawings. Also his carriage drawings are far more complete, including nearly all of the hardware and its placement.

Note on language:

When quoting from the respective texts, I have copied their punctuation, emphasis and spelling as written; Muller describes trunions with one 'n', Robertson with two. Muller refers to axle-trees, Robertson to Axtrees. I have, however, converted their use of the *f* consonant with *s* as befits our current practice.



Describing a Naval Cannon

Robertson describes the construction of a naval cannon in detail, names its' constituent parts, and describes his formula for delineating any cannon, based on a 9lb. shot measuring 4 inches in diameter. Robertson notes that both the diameter of the shot and the diameter of the bore are referred to as the caliber, the difference between the two being the 'windage' to allow the shot to pass freely in and out of the gun. He describes windage as the bore of the gun being greater than the shot by about $1/19^{th}$ to $1/20^{th}$ of the diameter of the shot. Henceforth 'caliber' refers to the diameter of the shot. Pertinent points as follows:

Notes 1 – 8 describe the various parts of the gun and the proper name for each part. These parts are all identified in this document on pages 10 and 11, and are named as:

1. The three zones that describe the length of a gun. Viz. the first reinforce, the second reinforce and the chase.
2. The Cascable.
3. The Trunnions.
4. Names the minor parts such as Button, Neck, Breech Rings, Ventfield etc.
5. Relates cannon design to architectural columns
6. Names the various sets of rings.
7. Describes the finer ornamental detail such as fillet, astragal, ovolo etc.
8. Explains Calibre of Gun, Calibre of Shot and Windage.

"9. The Bore…extends the length of the gun, all but one of its calibers; the solid mass between the bottom of the bore and the cascabel is called the Breech.

10. from the hinder part of the breech to the Mouth, or front extremity of the Bore, is reckoned as the length of the gun; exclusive of the Cascabel, which has a length generally allowed to it, of about a ninth part of that of the gun.

The Iron ships guns used by the present establishment, have neither their whole length, nor either of their chief parts, in a constant ratio to the caliber of their respective shots; some being longer, others shorter, than any one gun chosen for a standard: However a general relation between the whole length and the lengths of the three chief parts has been established in Britain; which differs but little from the practice of most of the neighboring nations.

11. The present Rules observed in the lengths of the parts of a Cannon are the following;

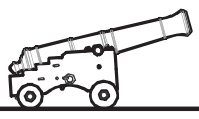
The First Reinforce is $2/7^{ths}$ of the whole length.

The second reinforce is, of the whole length, $1/7^{th}$ + 1 caliber of the shot.

The Chase is, of the whole length $4/7^{ths}$ – 1 caliber of the shot.

The center of the Trunnions is distant from the hinder part of the Breech $3/7^{ths}$ of the whole length.

But a small variation in the lengths of these parts, will not materially affect the Gun, either in strength, use, or pleasing proportion.



Describing a Naval Cannon *continued*

12. In the following table, the common notion of a 9 pound shot being 4 inches in diameter (which is very near the truth) was used, to compute the diameters of other shots, from their weights being given.

Now if w *represents the weight of any shot, whose diameter is* d.

Then $9 : w :: 4^3 : d^3 = 64/9 \times w$
And the logarithm of d = 1/3log. w + 0.84194

The length of the Gun in inches, divided by d*, gives the length in calibres of the shot."*

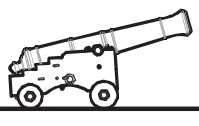
"TABLE of the British Establishment of the weights of shot; and of the lengths of Cannon and their chief parts; with their reduction to calibres of the shot:"

Weight of the Shot, in pounds	Calibre of the Shot, in inches	Length of the Gun, in inches	Length of the Gun, in calibres	Length of the 1st Reinforce in calibres	Length of the 2nd Reinforce in calibres	Length of the Chase in calibres	Length from the breech to the Ctr. Of the Trun.
4 lb.	3.0526	72 inch	23.587	6.739	4.369	12.478	10.108
6 lb.	3.4944	84 inch	24.039	6.868	4.434	12.736	10.302
9 lb.	4.0000	84 inch	21.000	6.000	4.000	11.000	9.000
12 lb.	4.4026	108 inch	24.531	7.009	4.504	13.018	10.513
18 lb.	5.0397	108 inch	21.430	6.123	4.061	11.246	9.184
24 lb.	5.5469	108 inch	19.470	5.563	3.781	10.126	8.343
32 lb.	6.1051	114 inch	18.673	5.335	3.668	9.670	8.002
42 lb.	6.6844	120 inch	17.953	5.129	3.565	9.259	7.693

Robertson was in the lucky position of being able to assess and measure a number of different guns.

" A very neat twenty-four pounder was chosen as a standard for the measures of its members."

Robertson notes that this particular gun departs from the standard formula, in that the length of the second reinforce is longer by the width of the last fillet (7.6mm), and the chase is shorter by the same amount. Unfortunately we are given no information as to who the manufacturer was, nor the weight of this particular piece. However we must assume that Robertson felt it properly representative of the time. From Muller's treatise, the target weight for a 9 foot long, cast iron, 24-pounder was 48 hundred-weight, 0 quarters and 0 pounds (48-0-0).



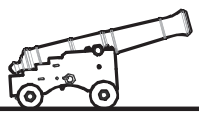
Measurements

Robertson measured this gun and recorded the results to 3 decimal parts of an inch. That equates to 1 decimal part of a millimeter (0.1mm). The metric system wasn't introduced till 1799 in France. Prior to that Britain and France both used feet and inches, but both systems had different values! I'm sure if Robertson were alive today he would embrace the metric system for its logical approach, and I have used it throughout the drawings and tables.

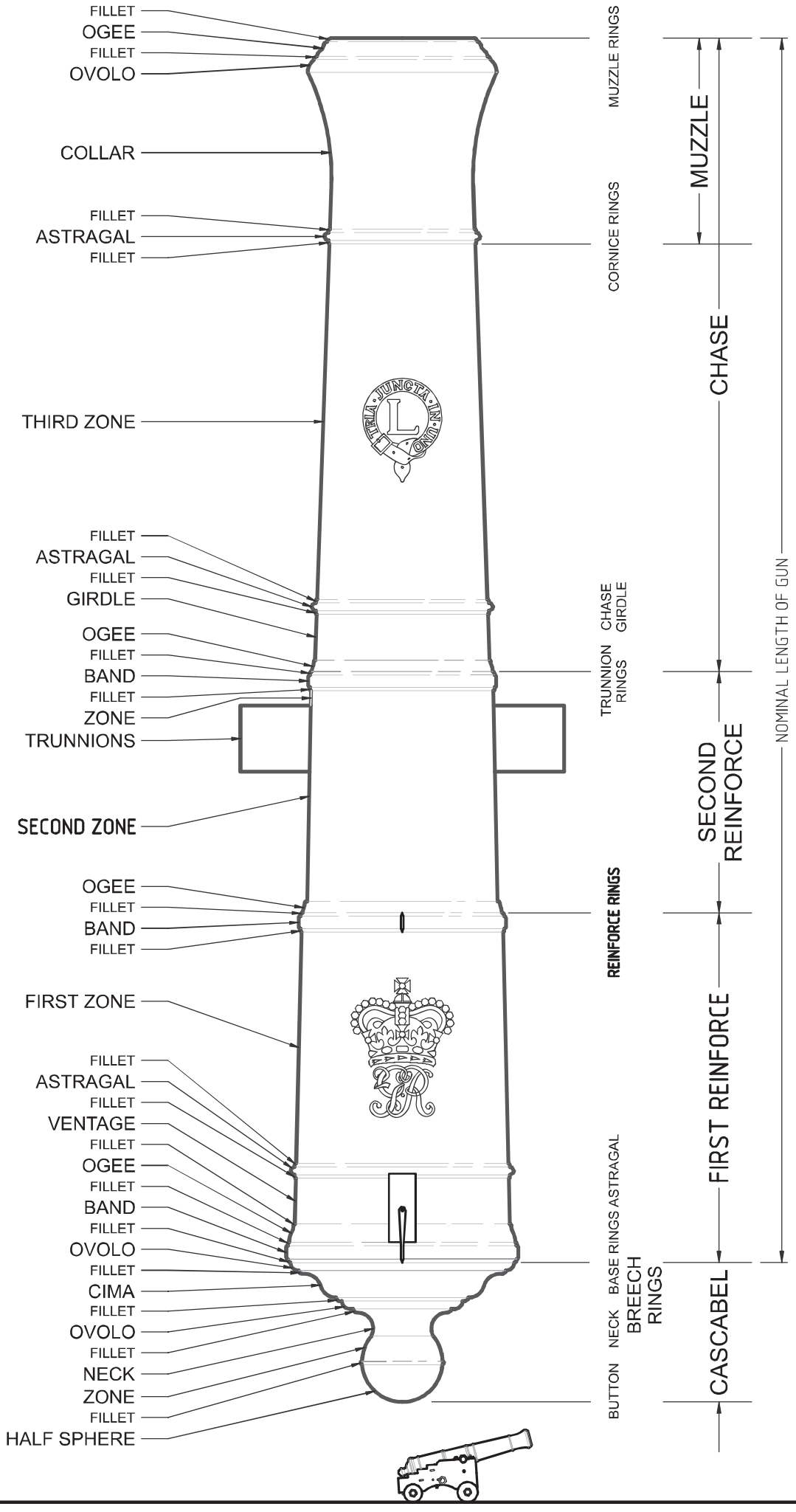
The explanation Robertson gives for the naming of all the parts and the dimensions of same is complete for a 24 pound gun. There are two anomalies which are identified on the specifications, page 11.

Robertson's description of a gun carriage is very detailed, but not quite complete. Some of the measurements are ambiguous, especially the interpretation of descriptors: length, width, depth, thickness. He hasn't consistently used these words in the way we would today. For example he gives the *length* of the head of the eye bolt as 0.415 calibres. This is what I would consider the width of the eye bolt head. It is measured along the length of the carriage, not along what is the longest axis of the component. Similarly he gives us the length and thickness of the Transom, but he is describing the height and thickness. He fails to mention that the Transom is mortised into the inner faces of the Brackets, or give us a value for the depth of mortise. To be fair to Robertson he couldn't measure these on an assembled carriage, and I suppose for the same reason he doesn't supply measurements for the dowels.

Of all the dimensions given, those for the metal hardware are the least complete. On the table of metal-ware dimensions, page 37, those figures in bold type have been given by Robertson. All the others have been extrapolated by the author following the logic suggested by the dimensions we know.



Parts of a Cannon



Dimensions of an Iron 24 pounder, whole length 9 feet (2,743.2mm) Metric Calibre: 140.8913 mm

Table 1 - Dimensions in calibres of the shot

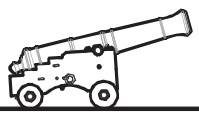
Great Part		Lesser Part	Members	Length	Diameter
Cascabel Length 2.217		Button	1/2 sphere	0.595	1.280
			Fillet	0.054	1.334
			Zone	0.406	
			Neck (1)	0.370	0.923
		Breech Rings Length 0.792	Fillet	0.054	1.568
			Ovolo	0.126	1.929
			Fillet	0.054	2.109
			Cima	0.378	
			Fillet	0.054	3.299
			Ovolo	0.126	3.569
First Reinforce Length 5.562	Large Dia. 3.425	Base Rings Length 0.612	Fillet	0.054	3.641
			Band	0.216	3.695
			Fillet	0.054	3.641
			Ogee	0.288	3.605
					3.461
			Ventage	0.847	
	Small Dia. 3.209	Astragal	Fillet	0.054	
			Atragal	0.126	
			Fillet	0.054	
			Zone (2)	3.680	
		Reinforce Rings	Fillet	0.054	3.245
			Band	0.198	3.299
			Fillet	0.054	3.245
Second Reinforce Length 3.836	Large Dia. 3.065	Part of Reinforce Rings above	Ogee	0.180	3.173
					3.101
			Zone	2.062	
			Trunnions	1.054	
			Zone	0.234	
	Small Dia. 2.902	Each Astragal projects above fillet			0.063
		Each Fillet projects above surface			0.018
		Trunnion Rings	Fillet	0.054	2.938
			Band	0.198	2.992
			Fillet	0.054	2.938
Chase Length 10.071	Large Dia. 2.776	Part of Trunnion Rings above	Ogee	0.180	2.884
					2.812
			Girdle	0.847	
		Chase Girdle	Fillet	0.054	
			Astragal	0.126	
			Fillet	0.054	
			Zone	5.656	
	Small Dia. 2.253	Cornice Rings Length 0.234	Fillet	0.054	
			Astragal	0.126	
			Fillet	0.054	
			Collar	2.380	
			Ovolo	0.198	3.010
		Muzzle Rings Length 0.540	Fillet	0.054	2.812
			Ogee	0.234	2.722
					2.397
			Fillet	0.054	2.289

Table 2 - Dimensions in millimeters

Great Part		Lesser Part	Members	Length	Diameter
Cascabel Length 312.4		Button	1/2 sphere	83.8	180.3
			Fillet	7.6	187.9
			Zone	57.2	
			Neck (1)	52.1	130.0
		Breech Rings Length 111.6	Fillet	7.6	220.9
			Ovolo	17.8	271.8
			Fillet	7.6	297.1
			Cima	53.3	
			Fillet	7.6	464.8
			Ovolo	17.8	502.8
First Reinforce Length 783.6	Large Dia. 482.6	Base Rings Length 86.2	Fillet	7.6	513.0
			Band	30.4	520.6
			Fillet	7.6	513.0
			Ogee	40.6	507.9
					487.6
			Ventage	119.3	
	Small Dia. 452.1	Astragal	Fillet	7.6	
			Atragal	17.8	
			Fillet	7.6	
			Zone (2)	518.5	
		Reinforce Rings	Fillet	7.6	457.2
			Band	27.9	464.8
			Fillet	7.6	457.2
Second Reinforce Length 540.5	Large Dia. 431.8	Part of Reinforce Rings above	Ogee	25.4	447.0
					436.9
			Zone	290.5	
			Trunnions	148.5	
			Zone	33.0	
	Small Dia. 408.9	Each Astragal projects above fillet			8.9
		Each Fillet projects above surface			2.5
		Trunnion Rings	Fillet	7.6	413.9
			Band	27.9	421.5
			Fillet	7.6	413.9
Chase Length 1418.9	Large Dia. 391.1	Part of Trunnion Rings above	Ogee	25.4	406.3
					396.2
			Girdle	119.3	
		Chase Girdle	Fillet	7.6	
			Astragal	17.8	
			Fillet	7.6	
			Zone	796.9	
	Small Dia. 317.4	Cornice Rings Length 0.234	Fillet	7.6	
			Astragal	17.8	
			Fillet	7.6	
			Collar	335.3	
			Ovolo	27.9	424.1
		Muzzle Rings Length 0.540	Fillet	7.6	396.2
			Ogee	33.0	383.5
					337.7
			Fillet	7.6	322.5

Notes: 1 Robertson lists the neck diameter at 1.1 calibres. This seems wrong relative to other guns I've seen measured, and I have used a value of 0.923

2 Robertson lists the length of the First Reinforce zone between fillets at 3.563 calibres. This must be a typographical error, otherwise the balance of his dimensions don't compute. The correct value is 3.680

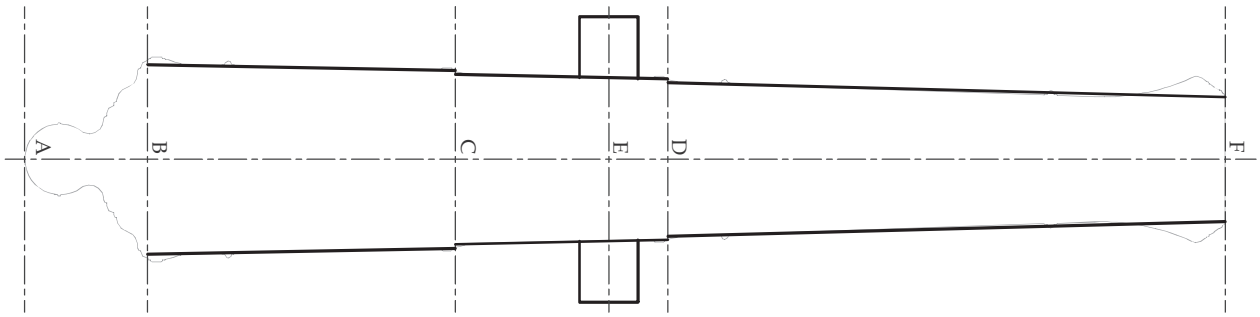


To Delineate a Naval Cannon

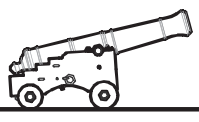
"In a line drawn AF to represent the Axis or middle of the Gun; beginning at A, apply the lengths successively in order from one to the other, as shewn in the table (reproduced on page 11) *and taken from a conveniently sized scale; as the Cascable, from A to B; of the first reinforce, from B to C; of the second reinforce, from C to D; of the Chase, from D to F; and to the centre of the trunnions, from B to E. through the points B, C, E, D, F draw lines at right angles to AF: On these normal lines, apply the respective diameters, at the end of the first and second Reinforces, and also at those of the Chase; then the respective parts being joined by straight lines, will represent the sections of the three dissimilar Conic Frustrums of which the gun is composed.*

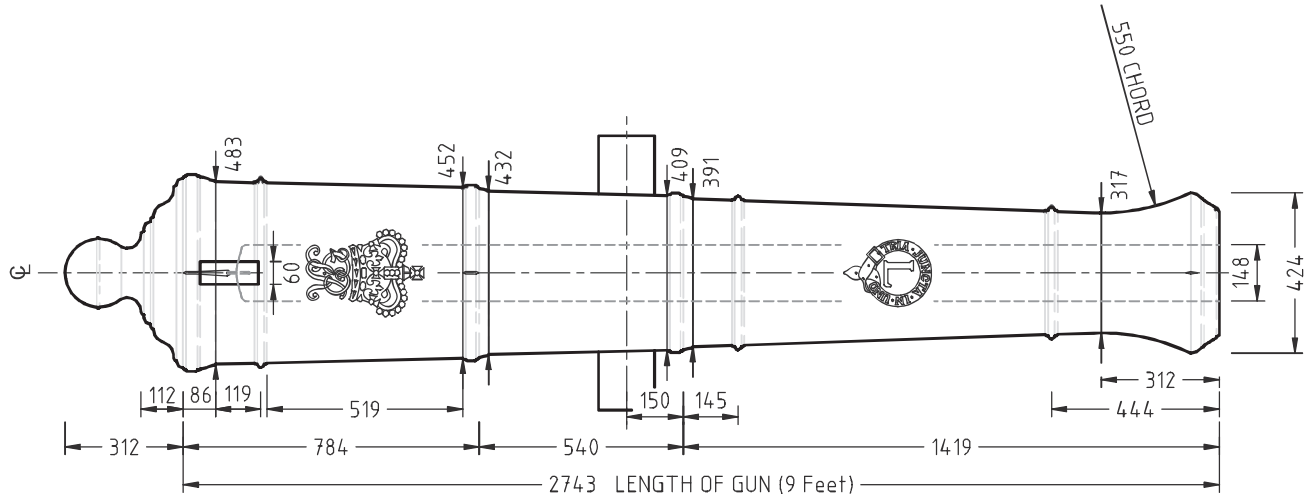
Add also, taken from the same scale, The Breech, Bore, Vent and Trunnions; also the several members of the Cascable, reinforces and Chase, are to be applied to the line AF as directed for a column…and the diameter of each member applied to the normal through the division for that member, will give the disposition of the several rings; whose extremities are to be formed according to the type of moulding to be represented: Observing that a graceful curvature is preferred in that part of the chase within about half the length of the muzzle from the front, where that curvature begins, and finally falls in with the large swelling moulding or ovolo."

And therein lies a problem. While we can establish the lengths of each part of a gun from 4 to 42 pounds, we aren't given the diameters other than those for a 24 pounder. The diameters can be calculated, but with an understanding of Palladian architecture which is beyond the scope of this document. For those desiring to draw guns of other sizes, I would recommend scaling the data for the 24 pounder based on the relative calibres (the diameters being relative to the bore).

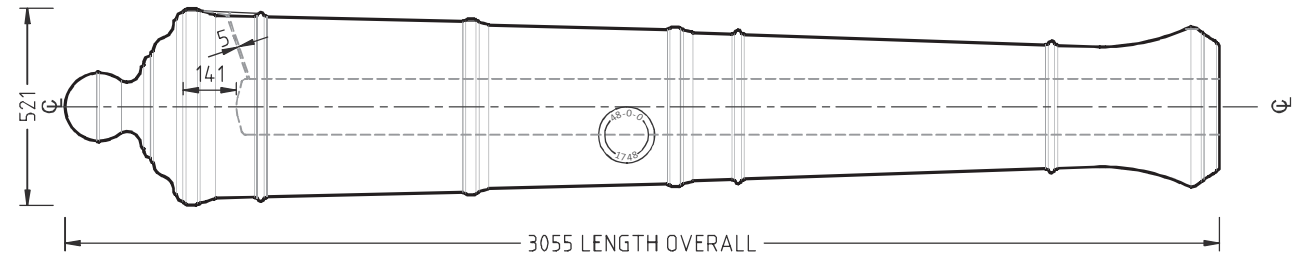


To Draw a Naval Cannon

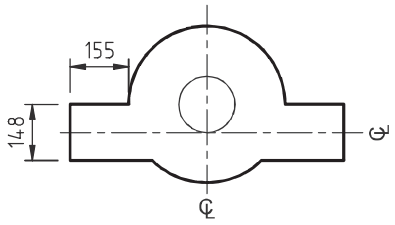




GUN - PLAN



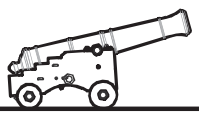
GUN - ELEVATION

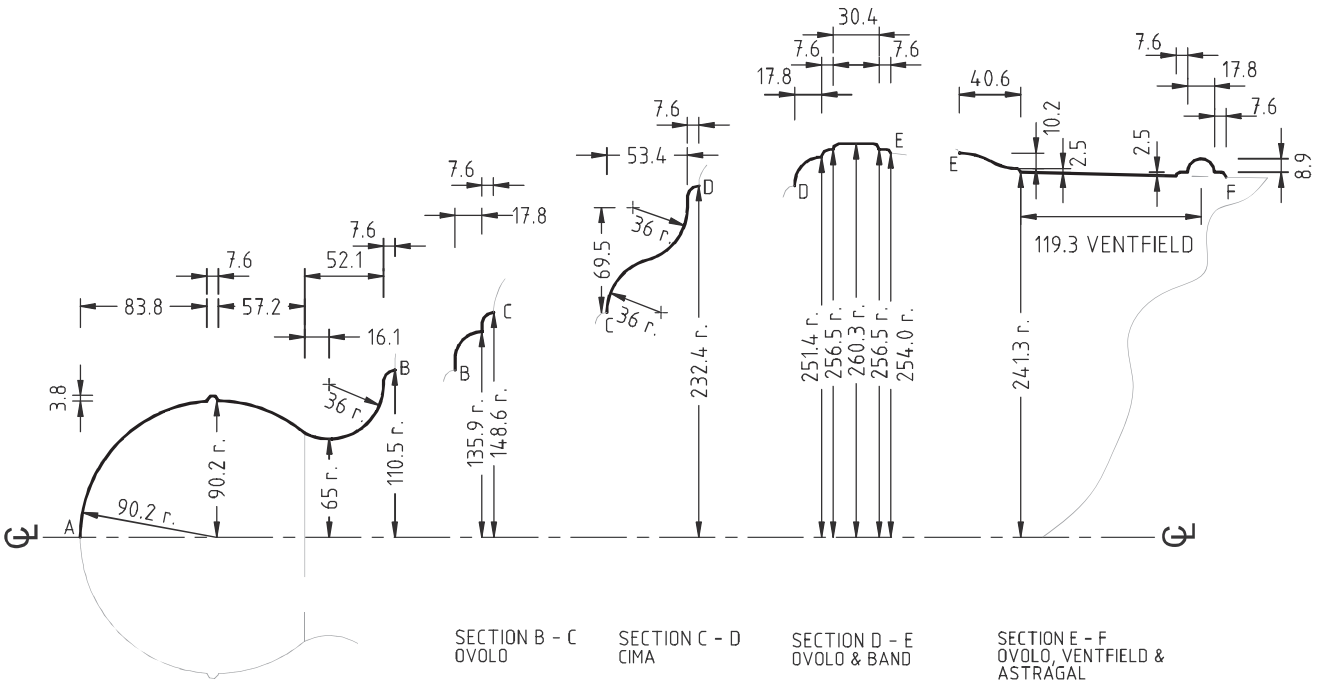


TRUNNIONS
SECTION

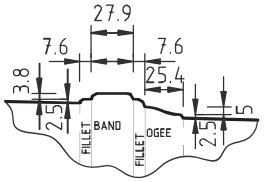
The dimensions on this sheet have been rounded to the nearest millimeter for clarity. Refer to page 11 for the source data.

24 Pounder Naval Gun

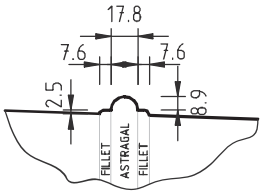




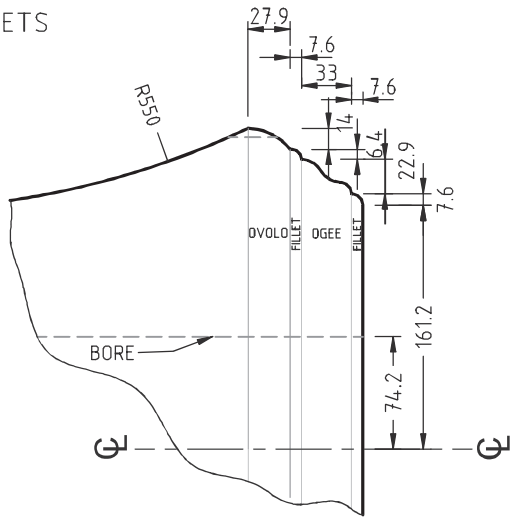
CASCABLE
SECTION A - B
HALF SPHERE, ZONE & NECK



BAND & FILLETS
SECTION

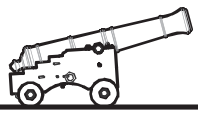


ASTRAGAL & FILLETS
SECTION



MUZZLE
SECTION

24 Pounder Gun Detail



Describing a Naval Gun Carriage

Both Muller and Robertson describe a naval gun carriage in their books, although both take a different perspective. Muller starts with a plan view and Robertson with an elevation. To complicate matters, un-necessarily in my view, Robertson describes his carriage sitting on its wheels, so it is raked up nearly 4 degrees at the front.

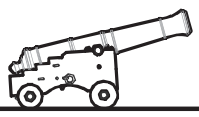
We know that gun carriages were made to suit the requirements of individual ships. The parameters determining their size and shape were:

- The dimensions of the gun, Viz. The diameter of the breech rings, the diameter of the second reinforce rings and the distance from the breech to the trunnions.
- The height of the gun-port above the deck.
- The height and width of the gun port.
- The deck camber.

It is far easier to draw the carriage parallel to the ground and then add the wheels, and this is the approach I have taken.

While Robertson describes selecting "*a very neat 24 pounder,"* he gives no indication of the source of his gun carriage, other than to say that he was "*furnished with a competent number of dimensions of ship guns and their carriages".* One imagines that Robertson intended the gun and carriage whose dimensions he describes, to fit together. I have made both, and they do. However with reference to the first of the above parameters, the carriage should be 5mm wider each side of centre (i.e. 10mm overall). I have drawn it exactly as Robertson describes it, however the modeler may wish to bear the above changes in mind.

Robertson and Muller both take a different approach to laying out a gun carriage. As a result, their carriages are slightly different. The Muller carriage is 25mm longer. All of this additional length is forward of the trunnions, and the front axle sits forward by 25mm as well. I have chosen to reproduce the Robertson carriage, firstly so that it matches up with the Robertson gun, and secondly because his description is so much more complete than Muller's. However the Muller design has a simple logic behind it and I have explained both constructions in the text.

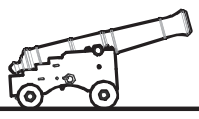


Gun Carriage Parts NOT Described

Bearing in mind that gun carriages were custom built to suit each application, there are a number of points that are left un-said by both Muller and Robertson:

1. Neither makes any mention of the carriage sides tapering towards the gun in the vertical plane. Yet there is evidence that carriages were sometimes made this way. It certainly complicates construction to do so.
2. The top of the side pieces (Brackets) are cut into four steps. Neither mention if these steps are angled perpendicular to the brackets (which themselves are angled – narrower at the front), or perpendicular to the centre line of the gun, which is a bit more challenging to construct. Indeed Robertson has drawn the plan view of his carriage with one bracket each way! Perhaps he is trying to show that either is acceptable practice.
3. Prior to 1760, cannon trunnions were supposedly tapered away from the barrel. Robertson and Muller both describe them as parallel prior to that date. The main point being that both shows the Cap Square, which retains the gun in the carriage being parallel to the bracket. I speculate that this may have been the case when trunnions were tapered.

   Robertson shows the Cap Square on his drawing somewhat larger in proportion to the bracket thickness, than is expressed in the table of dimensions. It is quite possible to set the cap square (made to his dimensions) parallel to the axis of the gun, and this greatly simplifies manufacture. Indeed Robertson's gun won't fit his carriage unless the Cap Square is either set parallel to the gun, or made somewhat oversize, or made of quite a complex shape with the half round section formed at an angle to the flats. Robertson gives the same dimension for the diameter of the half round and the diameter of the trunnion holes, so I have drawn it set parallel to the gun, mainly for ease of manufacture. The maker must decide for himself which is right.
4. Neither makes any reference to a bumper, and we know these were fitted on a ship-by-ship basis as needed.
5. The drawings imply the head of the joint bolt is square in section, and Robertson notes the vertical section at 0.207 calibres, for a bolt of nominal 0.216 calibres. This perhaps reflects the bolt being worked into a U shape to form the hinge. There is no mention if the body of the joint and eye bolts are round or square in section. Round holes are much easier to form through the depth of the brackets and that has been my approach.
6. Robertson describes the front axle stays as 'S' shaped, but these were sometimes 'Z' shaped.
7. Robertson doesn't explain (but Muller does) that the ends of the transom are mortised into the inner faces of the brackets.
8. Robertson doesn't detail the stool-bed bolt dimensions, and doesn't mention the stool-bed bolt riveting plates other than including them in his collective list of 12 ''plates''. Muller lists both but with no dimensions. Because Robertson appears to have drawn the bolts to a smaller diameter, and Muller lists the plates separately to all the other riveting plates, I imagine they are to a smaller size. I have shown these at 0.75 scale of the bracket bolts.



Of The Parts Of A Ship Gun Carriage – By Robertson

A ships gun carriage is essentially a kit set of wooden parts held together by wrought iron hardware, with additional metal hardware to facilitate operational requirements. The carriages had to be easily made and repaired in service. Each carriage requires 15 separate wooden components, but some 82 individual metal parts.

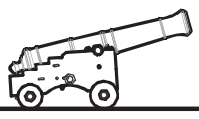
Robertson lists the wooden and metal parts, then describes each piece and gives a table of dimensions. Unfortunately there are some omissions from each reference, which are identified below:

"The parts of Wood, are the two Sides, Cheeks or Brackets, The two Axtrees (Axles), *The four Trucks* (wheels), *The Transom, the Stool-bed and the Coins"* (Quoin).

British Ordnance specifications at this time (mid 18th century) called for Brackets, Transom and Trucks to be made from dry elm, and Axtrees to be made from oak. In practice carriages were made from available material, often all oak. The brackets, stool bed and coins are each made from two components

"The parts of iron are the two Cap-Squares, the 16 bolts with four Burrs; the six Loops; the 12 Plates: the 4 Axtree hoops, and two Stays; the 4 Lynch, and 4 Dowel pins; Rings and Keys 10; with two Staples, Chains and Keys."

The 12 plates initially caused me some head scratching because they are not fully covered in Robertson's descriptive text. However reading Muller's description, the twelve plates are: 4 x recessed loop plates, 2 x surface mount loop plates, 2 x recessed bracket bolt plates, 2 x recessed stool bed bolt plates and 2 x traversing plates.



Wooden Parts Of A Ship Gun Carriage

*"**BRACKETS**, are the two side planks of the carriage; of a thickness equal to the caliber of the shot; the hinder half length and breadth is fashioned into four equal graduations called **STEPS**, so as to make the breadth behind only half the breadth before; and to diminish their weight, without lessening their strength, the bottom of the bracket is usually hollowed away, a quantity about a third of the length and sixth of the breadth, and bounded by a circular curve."*

*"In 12 pounders, and all above, the bracket consists of two planks fastened edge to edge by two **Dowel Pins."***

*"**Axtrees**, are the two timbers crossing the brackets before and behind, which support them, and on which run the four wheels, called **TRUCKS."***

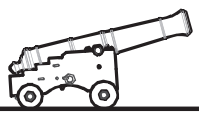
*"**TRANSOM** is that piece of wood joining the brackets over the fore Axtree, or that next the mouth of the Gun, and is of the same thickness as the bracket;, and serves to preserve the brackets in their proper vertical position."*

*"**STOOL-BED** is a board, having a cross piece or Bolster at one end, which rests on the hind Axtree; and with the **COINS**, or wedge-like pieces of wood, serve to raise or lower the breech of the Gun."*

"In the Stool-bed is another excavation, called the hind notch; its use is also to receive the Bed bolt, when the Stool-bed is pushed so much forward as to let the bolster drop of the hind axtree; for then the breech of the gun descends between the brackets."

With the benefit of CAD modeling we can see that this makes very little difference to the elevation of the gun unless the Stool-bed is removed completely and the breech rests on the Axtree.

*"**TRUNNION-HOLES**, are those semicircular cavities sunk in the upper sides of the brackets over the fore Axtrees, which receive the trunnions of the gun."*



Metal Parts Of A Ship Gun Carriage

*"**CAP-SQUARE** is a thick iron plate, bent circularly in the middle to go over the trunnions and retain them in their places; with a flat part on each side of the circular part; one end of the hinder part moves in a joint, and in the fore flat is a hole to receive the Eye bolt, by which the cap-square is held down with a key fastened to a chain hanging to a staple fixed on the side of the bracket."*

*"The **EYE BOLT** passes quite through the plane of the bracket and the middle of the fore Axtree, its upper end going through the hole in the fore flat of the Cap-square."*

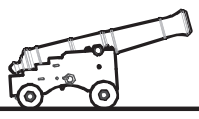
*"The **JOINT BOLT** passes also through the plane of the bracket, a little behind the trunnion hole and the fore Axtree; in the upper end of this bolt is a circular hole to receive one end of the Cap-square, which moves in that hole like the joint of a hinge: The lower ends of these two bolts are connected by the **AXTREE STAY**, which is an iron plate bent like an **'S'**, with holes in its extremeties to receive the ends of the bolts."*

*"**HIND AXTREE BOLTS** and **BRACKET BOLT**, all pass through the plane of the bracket; the former two, through the two lower steps and the hind Axtree; and the latter through the upper step, and terminates in the circular hollow in the lower part of the bracket. In the lower end of each of the above-mentioned bolts, are holes, called **Eyes**, over which slips a circular iron plate, called a **Ring**, and a flat piece, called a **Key**, passes through the eye, which being somewhat twisted prevents their being jolted out of the eyes".* I have seen a drawing dated 1792, which shows screw threads and nuts instead of keys. As the first screw cutting lathe wasn't invented till 1770, this must be a rare configuration, but nonetheless appealing to today's manufacturer. Horizontal fastenings were always riveted over burrs: see below.

*"**TRANSOM BOLT** and **BED BOLT**, both pass across the carriage and through both brackets; each end of these bolts are riveted with a round head, on circular plates, called **Burrs**. The transom bolt passes through the transom, under the Trunnion hole, about the middle of the breadth of the bracket; and the bed bolt lie below the middle of the upper step, about two thirds of the breadth of the bracket in this part."*

*"**BREECHING BOLTS** are two, placed one in each bracket about the middle of the length, a little before the bed-bolt; the inner end lies flush with the inner side of the bracket; the outer end is finished with a circular eye, which holds the **Breeching ring**, by which the carriage is lashed to the ships side."* Note the breeching bolts are identical to the loops, but are fitted with the breeching rings. They are sometimes described as loops and sometimes as bolts.

*"**LOOPS** are bolts, like the breeching bolt, having a large round eye at one end; two are placed in each bracket, one over the bed bolt, about mid height of the third step; another over the fore part of the hind truck, about mid height of the bracket in this part: the inner ends of these four loops, and the two breeching bolts, are riveted flat, on square plates, which lie flush with the inner side of the brackets. The loops serve also to stay the carriage in place.*
There are two other loops, one in the middle of the front of the Transom, and the other in the middle of the rear of the hind Axtree; serving to haul the carriage forwards or backwards."

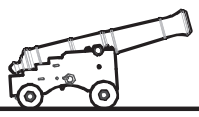


Metal Parts Of A Ship Gun Carriage *continued*

*"**TRAVERSING PLATES**, one in the bottom of each bracket, between the tail and the hind trucks. These plates lapping from under the brackets a small way up the sides, preserve the wood from being fretted by the **handspikes** in frequent traversing of the carriage".*

*"**AXTREE HOOPS**, one on the end of each **arm** to keep them from splitting: Between these hoops and the trucks, are cut square holes, one through each arm, to receive the **Linch-pins**."*

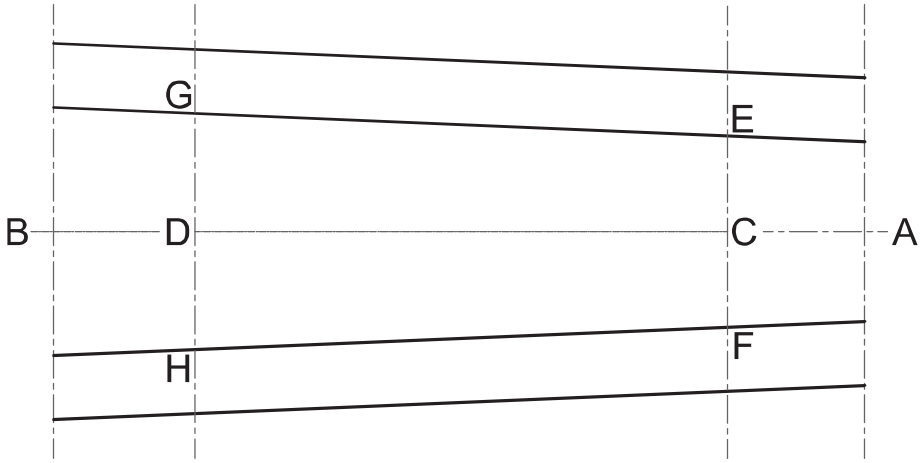
*"**STOOL-BED BOLTS**, are two, fixing the plank of the **Stool-bed** to its cross piece or **Bolster**."*



John Muller's Gun Carriage - Plan

This is how Muller describes the steps in setting out of a ship gun carriage:

- Draw the centerline of the carriage A – B
- Mark two points on that line, C & D. The distance between C & D, is the distance between the centre of the trunions and the extremity of the breech. That is equal to three sevenths of the guns nominal length.
- Draw two lines C-E and C-F, perpendicular to A-B. Each line is equal in length to half the diameter of the second reinforce ring.
- Repeat with D-G and D-H, each line equal to half the diameter of the base ring.
- The quadrilateral F-E-G-H represents the internal dimensions of the carriage.
- Add a line parallel to E-G, but spaced one caliber distance outboard. Repeat for F-H. These two sets of line represent the brackets.
- Establish the distance D-B. This is the length of the cascabel.
- Establish the distance C-A. This is half the diameter of the trunions plus half the diameter of the fore trucks. Now A-B will be the length of the carriage. The line E-F marks the centre of the trunions and the line G-H marks the centre of the hind axletree.

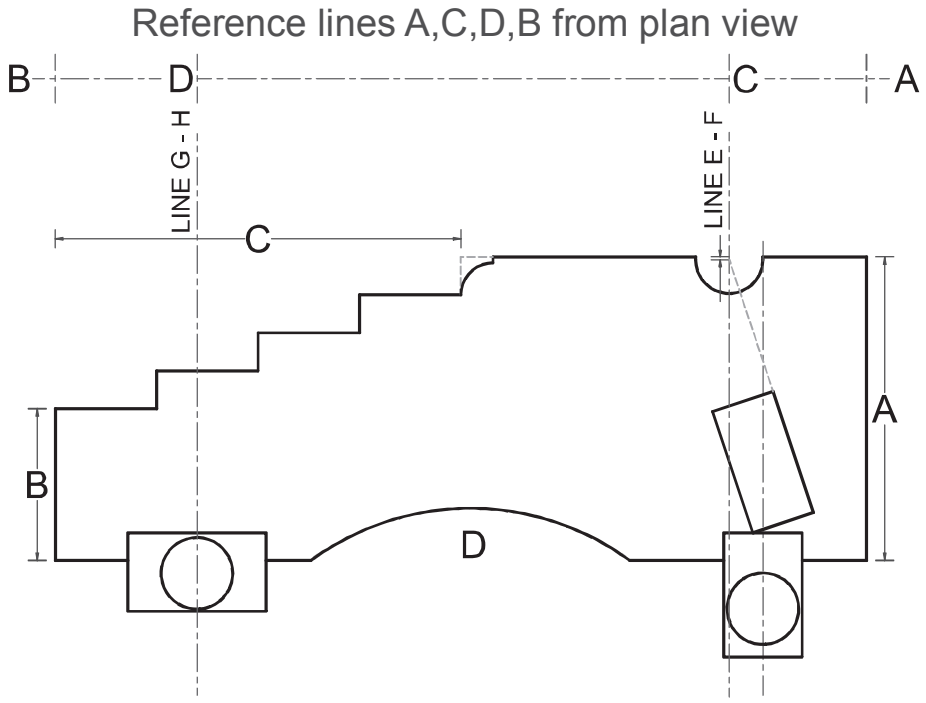


JOHN MULLER CARRIAGE SET-OUT

PLAN VIEW

John Muller's Gun Carriage - Elevation

- Drop a perpendicular line from points A, C, D, B on the plan view, marking the ends of the carriage (A & B), and the positions of the hind axletree (D), and trunions (C).
- On the elevation, the height of the side pieces, A, is equal to $4^{3}/_{4}$ the diameter of the shot.
- At the hind, the height B, is half the height at the front A.
- Half the length of the side, C, is divided into four steps, equal in length and height. The quarter round is taken from the fore part.
- The dropped line from the plan E-F passes through the centre of the trunion holes, which are a caliber, and the centre is ¼ inch (6.35mm) below the upper surface of the side pieces.
- The dropped line G-H represents the centre of the hind axletree. Allow 6 inches (152.5mm) ahead and behind this for the width of the hind axletree which is always 12 inches (305mm) wide irrespective of the size of gun.
- The bottom of the side pieces is hollowed out as shown at D.
- Both axletrees are let into the side pieces as shown.
- The transom is placed directly over the fore axletree. It is a diameter of the shot broad and two high. It is placed exactly in the middle of the height of the side pieces; though it is customary to place the fore-part in a line, passing through the centre of the trunion holes, and so as to project the axletree by an inch (25.4mm), and the lower edge to touch the axletree.



John Muller's Table of Gun Carriage Dimensions

After giving us his description of 'how to draw a gun carriage', Muller offers the following table of carriage dimensions. Unfortunately he provides no advice as to the source of this data. One can only speculate that the Board of Ordnance, or similar body published an accepted standard as guide to gun carriage manufacturers. Muller writes:

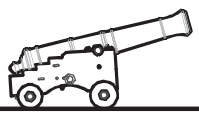
"These dimensions are expressed in inches and decimals; and as the arms of the hind axle-tree have the same dimensions as the fore ones, they have been omitted, as well as the height behind the side pieces."

"It may be observed, that these dimensions were used in 1748; but if the guns are made different from those at that time, the length and width of the carriages will likewise differ. The height of the side pieces and the diameter of the trucks depend on the height of the port-holes in ships from the deck. Those of the lower tiers ought to be such, that when the breech of a gun lies upon the hind axle-tree, the muzzle of the gun should touch above the port-hole, in order that it may not push the shutter open when the ship rolls in stormy weather."

Note the reference to removing the stool bed and resting the gun breech directly on the rear axle-tree to gain maximum elevation. Refer page 18.

Nature of the gun	*42*	*32*	*24*	*18*	*12*	*9*	*6*	*3*
Width inclosed before	*18*	*18*	*16.5*	*15.5*	*14*	*13*	*11.5*	*9*
Behind	*23.5*	*23.5*	*22.5*	*21.5*	*19.5*	*18.5*	*16.8*	*12.5*
Fore Axletree length	*57*	*57*	*54.5*	*51.5*	*45.5*	*42.5*	*38.8*	*32.5*
Body length	*35.4*	*36.6*	*34.9*	*33.1*	*29.5*	*27.5*	*24.8*	*19.5*
Height	*10.8*	*10.8*	*10*	*10*	*10*	*9.5*	*9*	*8.5*
Breadth	*6.8*	*6.8*	*6.8*	*6*	*5.5*	*5.2*	*5*	*4*
Arms length	*10.8*	*10.2*	*9.8*	*9.2*	*8*	*7.5*	*7*	*6.5*
Diameter	*6.2*	*6.2*	*6.2*	*5.8*	*5.2*	*5*	*4.5*	*3.5*
Hind Axletree length	*57*	*57*	*54.5*	*51.5*	*45.5*	*42.5*	*38.8*	*32.5*
Body length	*35.4*	*36.6*	*34.9*	*33.1*	*29.5*	*27.5*	*24.8*	*19.5*
Height	*6.8*	*6.8*	*6.8*	*6*	*5.5*	*5.2*	*5*	*4*
Breadth	*12*	*12*	*12*	*12*	*12*	*12*	*12*	*12*
Fore Trucks diameter	*19*	*19*	*18*	*18*	*16*	*16*	*14*	*14*
Breadth	*6.5*	*6*	*5.5*	*5*	*4.5*	*4*	*3.5*	*3*
Hind Trucks diameter	*16*	*16*	*16*	*15*	*14*	*14*	*12*	*10*
Breadth	*6.5*	*6*	*5.5*	*5*	*4.5*	*4*	*3.5*	*3*
Side Pieces height before	*26.8*	*26.2*	*26*	*23.6*	*20*	*18.8*	*16*	*13.6*
Length	*78*	*78*	*72*	*69*	*66*	*63*	*60*	*37.5*
Breadth	*6.5*	*6*	*5.5*	*5*	*4.5*	*4*	*3.5*	*3*
Trunions from the head	*8*	*8*	*8*	*8*	*6.8*	*6.6*	*6.6*	*6*

If nothing else, this provides today's modeler with an alternative set of dimensions which may be more appropriate for the early 18th century period.



John Robertson's Gun Carriage - Elevation

Just as with his description of the gun, Robertson sizes his carriage based on the caliber of the shot. He explains his workings carefully, and his design is far more detailed than Muller's.

"To construct the elevation and Plan of a Ship Gun-Carriage

For the Elevation."

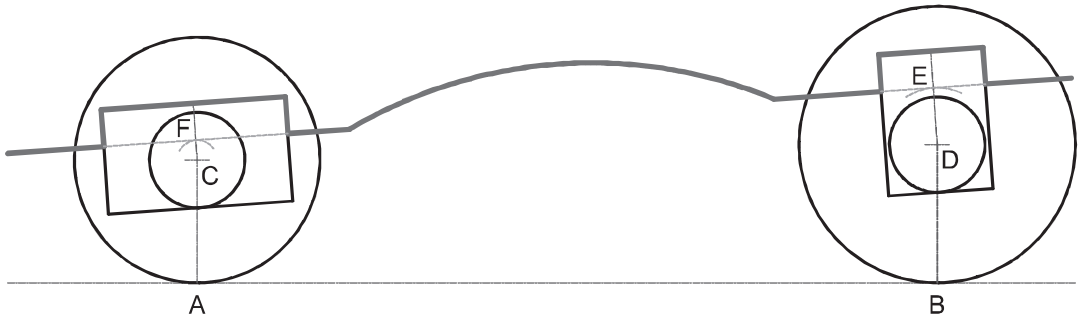
*"In the ground line AB, take the distance of the points A, B, equal to 8.693 *[1] calibers of the shot; and in perpendiculars through those points, take BD, AC for the radius's of the fore and hind trucks; and describe the Trucks, and the Arms of the Axtrees."*

*[1] Note that in the table Robertson uses 8.684 calibers. The difference is just over 1mm, and in the interests of accuracy, to comply with his figure for the length of the sides, the correct figure is 8.689 calibers!

Robertson offers the following for the algebra buffs:
$(AB)^2 = (CD)^2 - (BD\text{-}AC)^2 = (FE)^2 + (DF\text{-}CE)^2 - (BD\text{-}AC)^2$

*"From the centers D, C, describe arcs with the radius's of the heights of the brackets above the centers of the arms *[2]; then a tangent drawn to these Arcs will represent the bottom line of the bracket; to which, Normals from the centers D,C, give E,F, for the middle of the Axtrees."*

*[2] The sum of the depth in the bracket (61mm) and the radius of the Arm (79mm), taken from the depth of the Axtree (Hind 173, Fore 234), leaves the height of the bracket above the center of the arm (Hind 33mm, Fore 94mm).



JOHN ROBERTSON CARRIAGE SET-OUT

ELEVATION VIEW - AXTREE PLACEMENT

John Robertson's Gun Carriage - Elevation

"In the line EF, take the distances EG, FH, of the bracket ends from the middle of the Axtrees; complete the parallelogram of the brackets, with the steps and the ovolo; put in the trunnion hole, and mark its lowest point I."

"To represent the Sections of the Axtrees and Transom"

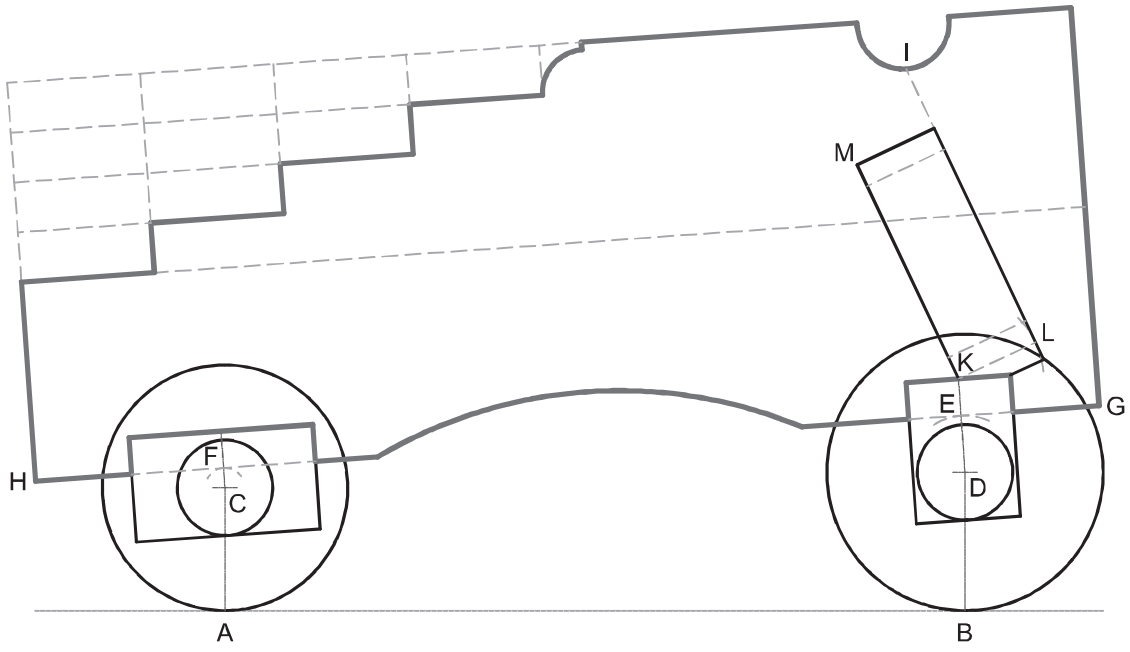
"By the depths, breadths, and parts let into the brackets, the sections of the Axtrees may be expressed.

From K, the middle of the upper part of the fore Axtree, describe an arc L, at the distance of the thickness of the transom; draw a tangent I to L, and complete the section of the transom LM."

Robertson doesn't explain the dotted lines across the transom, about 40mm in from each end. These maybe the top and bottom of the tongue, mortised into the inner face of the bracket.

"Let the length of the excavation at the bottom of the bracket be the base of an equilateral Triangle, whose vertex is the centre of the curve."

Isn't that a more elegant way to describe a gun-carriage? I can't help but feel though, that Robertson could have simplified the process greatly by stating that the Axtree Arms were flush with the under-side of the Axtrees, and drawn the brackets parallel to the ground.



JOHN ROBERTSON CARRIAGE SET-OUT

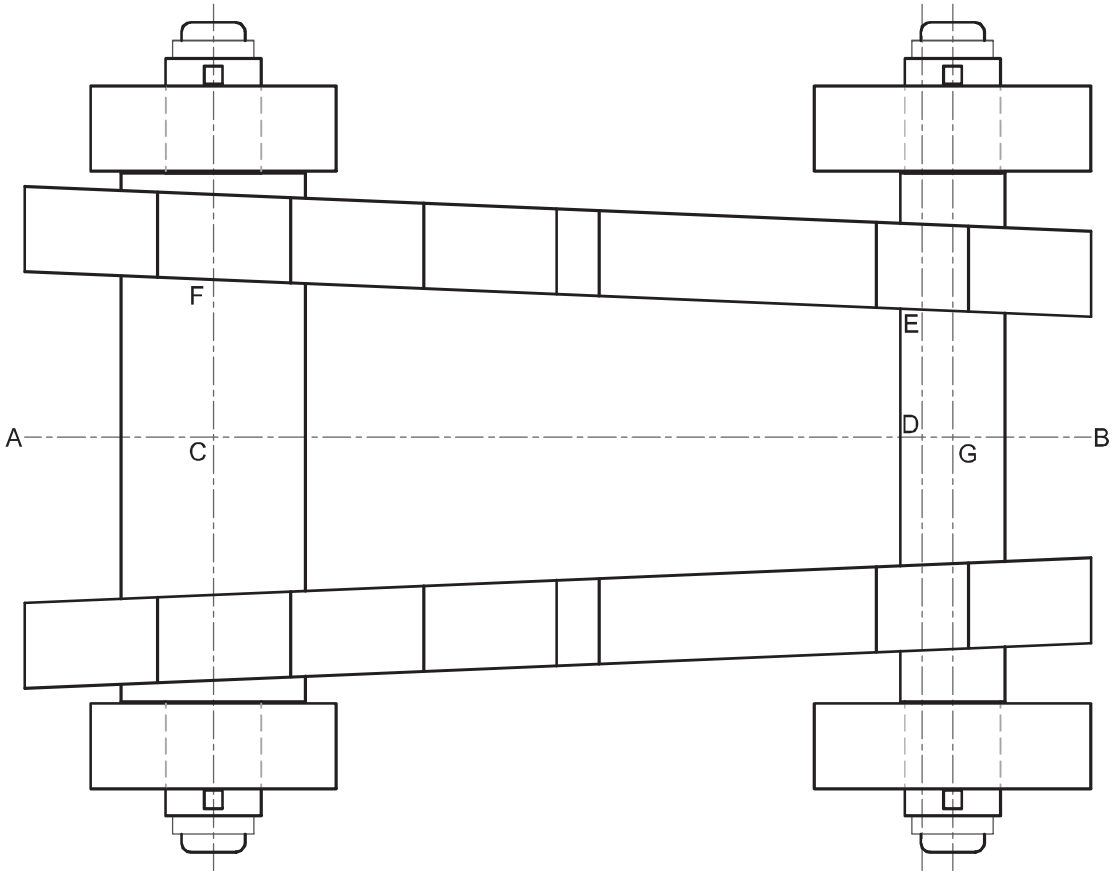
ELEVATION VIEW - BRACKETS

John Robertson's Gun Carriage - Plan

"Let the line AB represent the middle line and length of the carriage. Take BG, AC, the distance from the bracket ends of the middles of the fore and hind Axtrees, and BD the distance of the center of the trunnion holes from the front; through G,C,D,B,A, draw normals to AB."

"Make DE, CF the half distance of the Brackets, at the middle of the trunnion holes and hind Axtree; a line through E,F, shews the inner line of the bracket, and parallel; to it, at the distance of the thickness, shews the outside line of the bracket, terminating in the normals through A,B, and on these mark the steps, quarter round and trunnion hole."

"In the normals through G,C, take the lengths of the Axtree, and of the Arms; to the Arms apply the thickness of the trucks, and their diameters; also apply the breadths of the fore and hind Axtrees, as well between the brackets as without them, and also the diameters of the Arms; and compleat the plan of the Axtrees and Trucks."



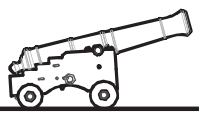
JOHN ROBERTSON CARRIAGE SET-OUT

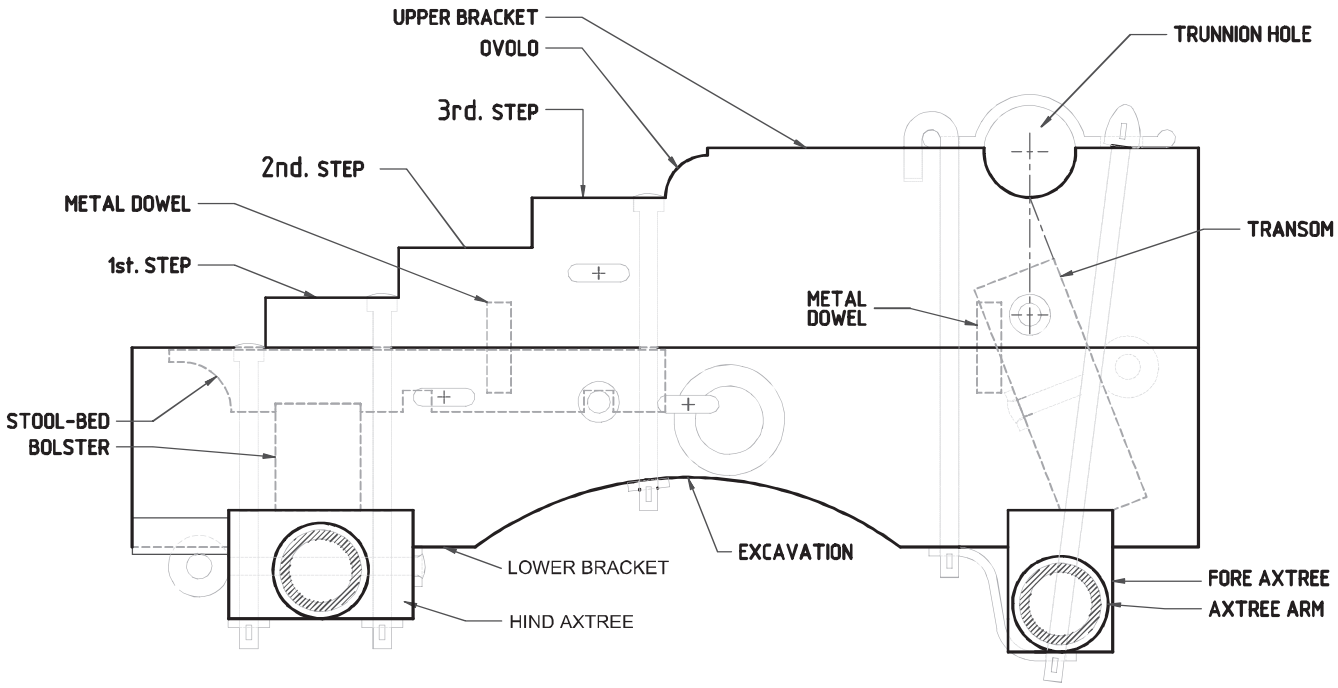
PLAN VIEW

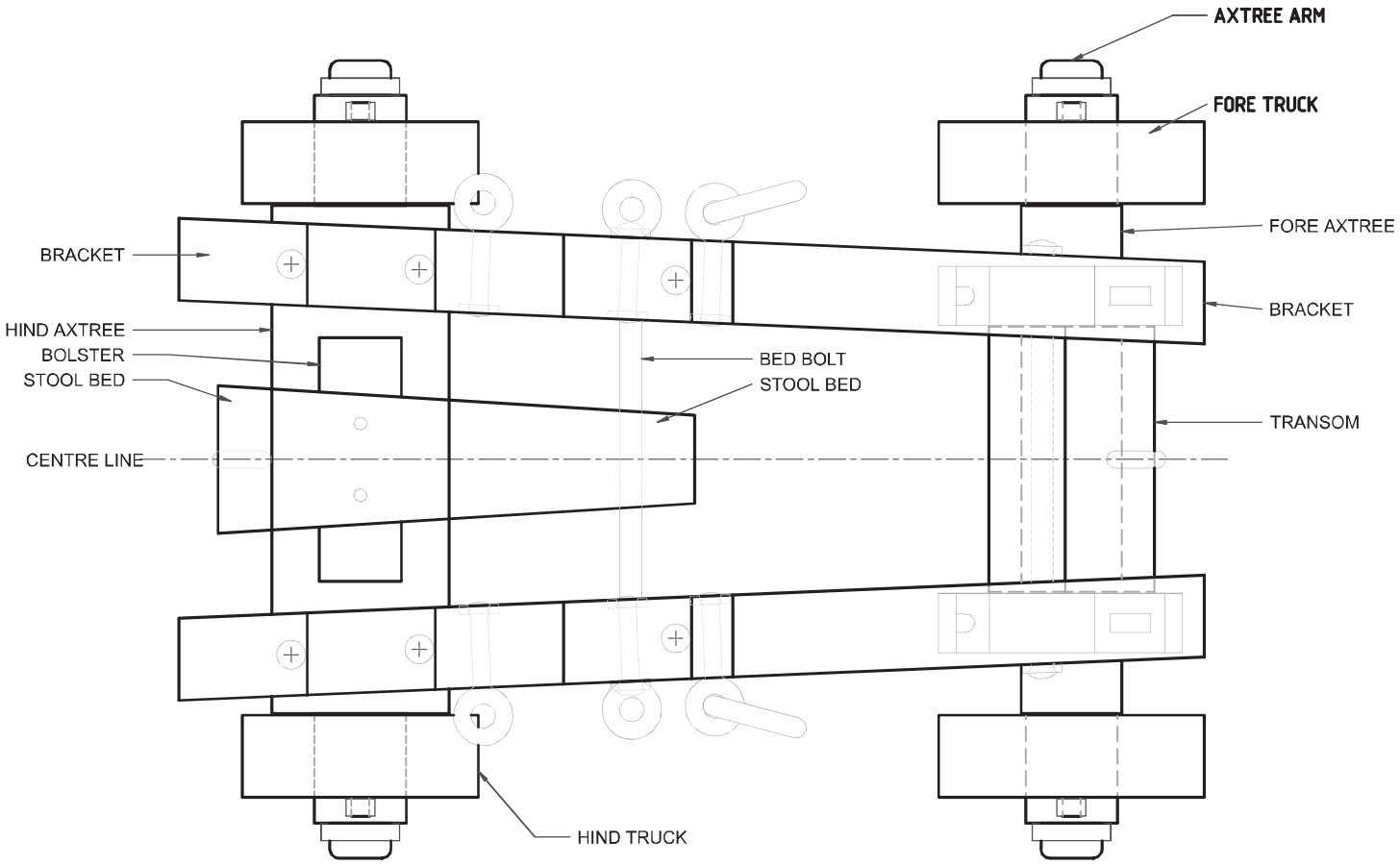
John Robertson v John Muller

Now to the differences: If we compare Muller's and Robertson's carriages to the table given by Muller, and we must bear in mind that Robertson's writing was done at least seven years after Muller, and after ordnance dimensions were 'settled' again in 1753, then the key differences are slight.

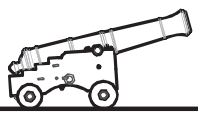
- Muller's bracket length is 50mm shorter than the table, Robertson's is 65mm shorter, but this is slightly miss-leading, as the bracket length is expressed on the center line of the carriage. Robertson's true length is 1771.5mm.
- Robertson and Muller have identical inside fore-widths, both 3mm more than the table.
- Both have identical inside hind-widths, but both are 52mm narrower than the table.
- Muller's brackets are 9mm taller than Robertson and the table.
- Muller's trunion holes are 100mm further back than the table, and Robertson's are 76mm further back.
- Muller's transom is two shot diameters high, Robertson's is three.
- Note that only Robertson has a clearance dimension for his trunnion holes.
- Muller gives no dimensions for small parts, but in all instances, Robertson's comply with the table.
- At this time 24 pounders were made in both 9' and 9'6" lengths. The table and Muller don't specify the length of gun described, but Robertson tells us his is a 9' model. This may explain the small differences around the bracket dimensions.

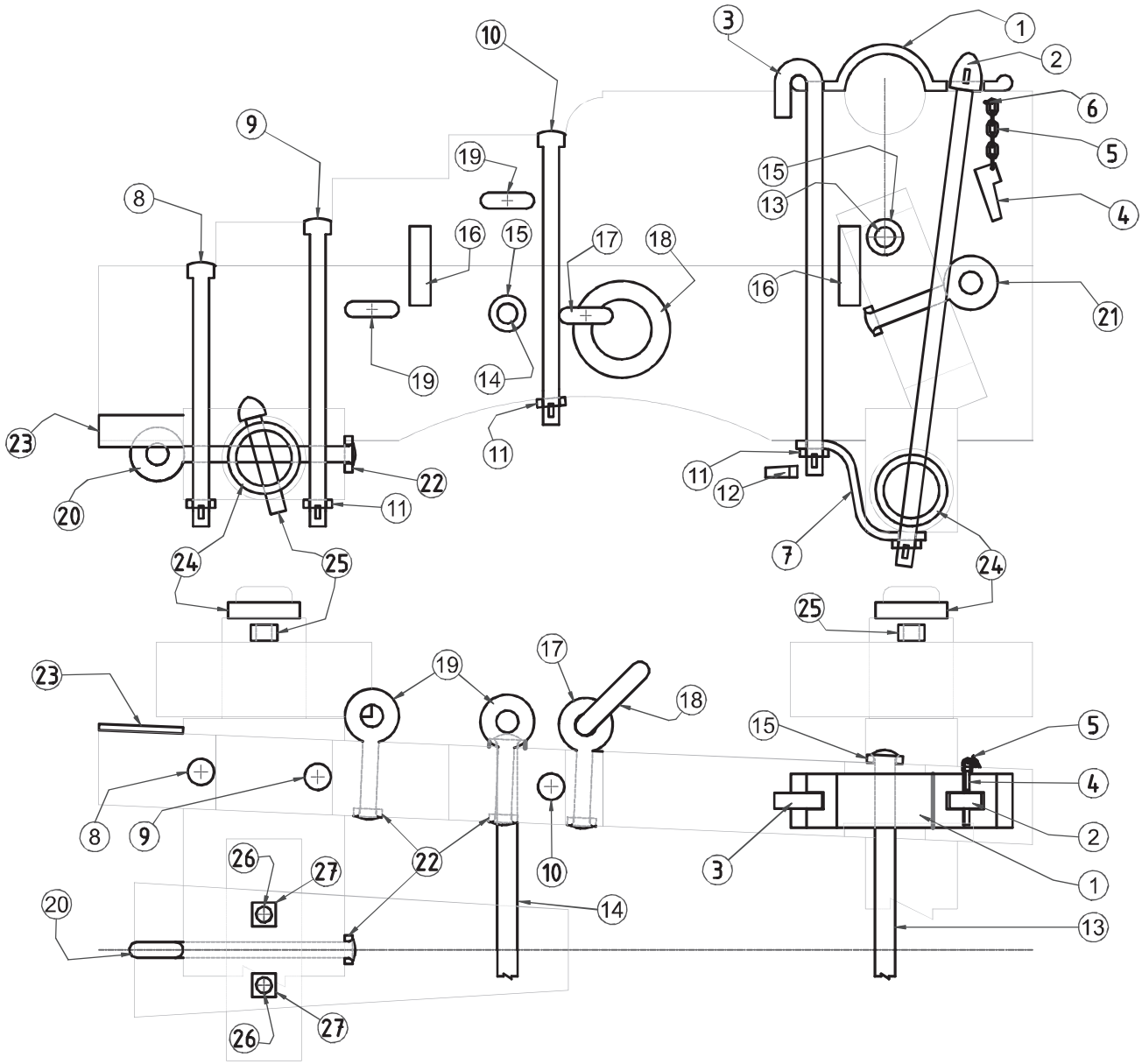






Wooden Parts of a Ships Gun Carriage





No.	Description		No.	Description		No.	Description
1	Cap Square		10	Bracket Bolt		19	Bracket Loop
2	Eye Bolt		11	Bolt Ring		20	Hind Axtree Loop
3	Joint Bolt		12	Bolt Key		21	Transom Loop
4	Cap Square Key		13	Transom Bolt		22	Loop Plate
5	Chain		14	Bed Bolt		23	Traversing Plate
6	Staple		15	Burr Ring		24	Axtree Hoop
7	Axtree Stay		16	Dowel		25	Linch-Pin
8	Hind Axtree Bolt		17	Breeching Bolt		26	Stool-Bed Bolt
9	Hind Axtree Bolt		18	Breeching Ring		27	Stool-Bed Plate

Metal Parts of a Ships Gun Carriage

Gun Carriage Specification

Table of General dimensions of the parts of a ship gun carriage in calibers of the shot

24 lb. Shot Diameter	5.5469 Inches 140.9 Millimetres

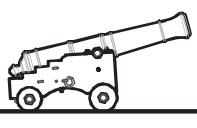
Wooden Parts	Calibers		Millimetres
THE BRACKETS			
Length	12.522		1764
Thickness	1.000		141
Breadth Before	4.686		660
Breadth Behind	2.343		330
Distance at the trunnions	2.992		422
Distance at the middle of the hind axle trees	3.695		521
Distance, centre of trunnion from front	1.983		279
Diameter of trunnion hole	1.082		152
Centre sunk in side	0.045		6
Radius of the Ovalo next the upper step	0.500		70
Excavation in bottom - length of chord	5.000		704
In bottom - distance from front	3.500		493
THE AXLETREES			
Whole Length	9.735		1372
The arms - length	1.767		249
The arms - diameter	1.118		158
Breadth between the brackets at the fore	1.226		173
Breadth between the brackets at the hind	2.163		305
Breadth between brackets and arms	1.226		173
Depth in the middle of fore	1.659		234
Depth in the middle of the hind	1.226		173
Distance between middle of the axletrees	8.684		1223
Distance of the mid from the bracket ends - Fore	1.622		229
- Hind	2.215		312
Depth of axletrees let into brackets	0.432		61
THE TRUCKS			
Their Thickness	1.000		141
Their Diameter - Fore	3.245		457
Their Diameter - Hind	2.884		406
STOOL BED, BOLSTER & TRANSOM			
Whole Length	5.822		820
Thickness	0.721		102
Breadth - before	1.082		152
Breadth - behind	1.803		254
Bolster - length	2.974		419
Bolster - breadth	1.000		141
Depth	1.250		176
Let in	0.090		13
Fore notch - Breadth	0.342		48
Fore notch - Depth	0.234		33
Fore notch - Distance from front	0.613		86
The transom - length (height)	3.000		423
The transom - thickness	1.000		141

Metal Parts	Calibers		Millimetres
CAP SQUARE			
Whole Length	2.974		419
Breadth	0.721		102
Thickness	0.125		18
Bend	1.082		152
Fore Flat	1.171		165
Hind Flat	0.721		102
Head of joint bolt - Length	0.663		93
Head of joint bolt - Breadth	0.216		30
Head of Eyebolt - Length	0.415		58
Head of Eyebolt - Breadth	0.216		30
Rounding at ends of cap square	0.216		30
Joint bolt projects out of cap square	0.207		29
Thickness of the key	0.054		8
BOLTS			
Their diameter	0.270		38
Diameter of burrs & heads	0.360		51
Diameter of burr ring (washer)	0.486		68
LOOPS			
Inner Diameter	0.300		42
Outer Diameter	0.721		102
BREECHING RING			
Inner Diameter	0.800		312
Outer Diameter	1.300		61

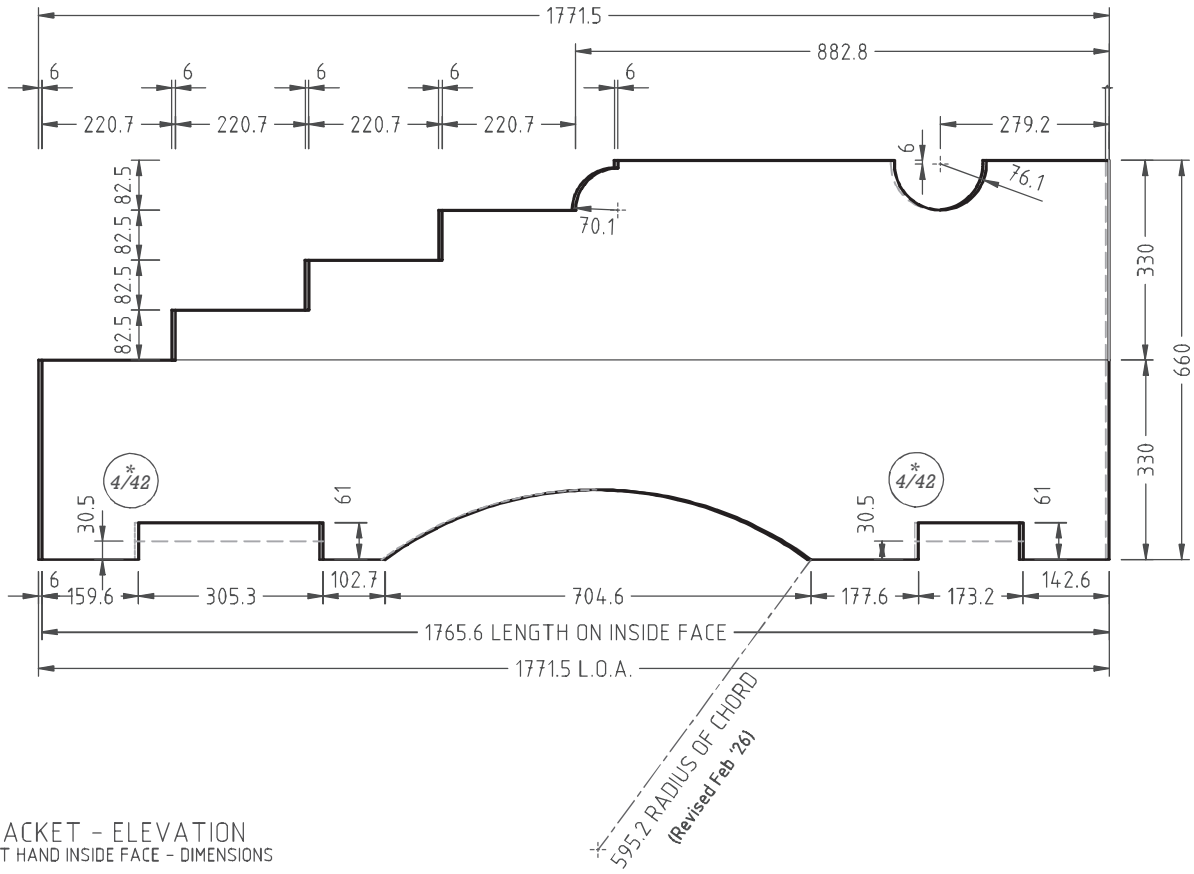
These are the dimensions quoted by Robertson in his treatise.

They are listed here in the interests of completeness, and makers should refer to the plans for detailed dimensions.

Note that where Robertson quotes the 'length and breadth' of the head of eye bolt, for example, he is quoting the width and thickness. The length along the longest axis is not given here.

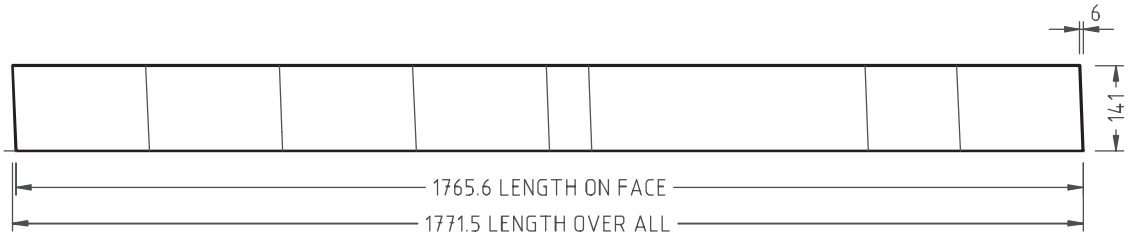


(*1/42) References manufacturing notes.
First No. is note reference,
Second No. is page reference



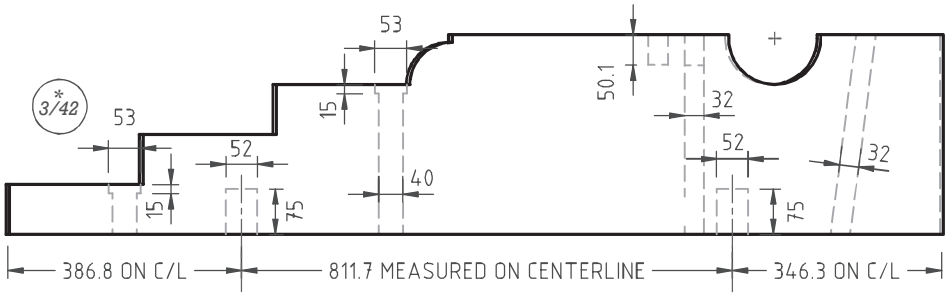
BRACKET - ELEVATION
LEFT HAND INSIDE FACE - DIMENSIONS

NOTE: BRACKETS DRAWN WITH ENDS PERPENDICULAR TO CENTRELINE OF CARRIAGE

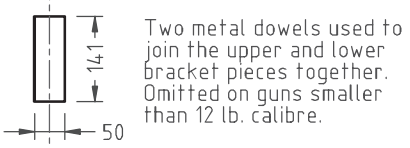


BRACKET - PLAN

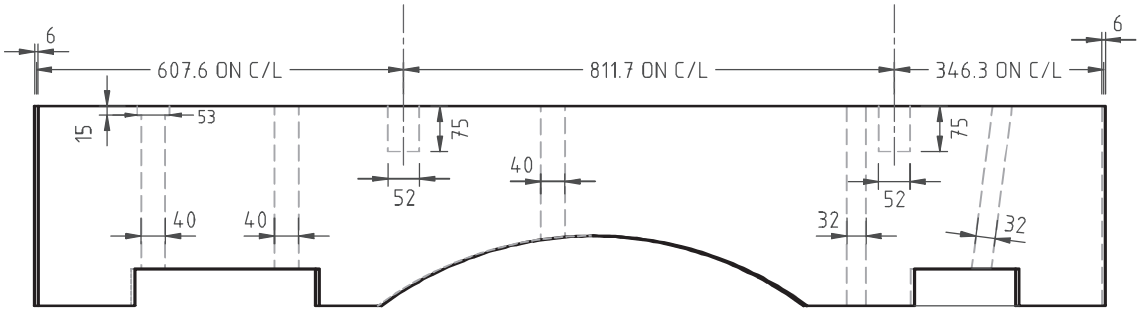
24 Pounder Bracket Dimensions



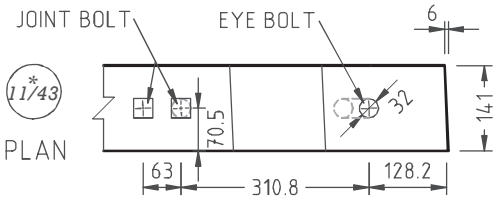
UPPER BRACKET - ELEVATION



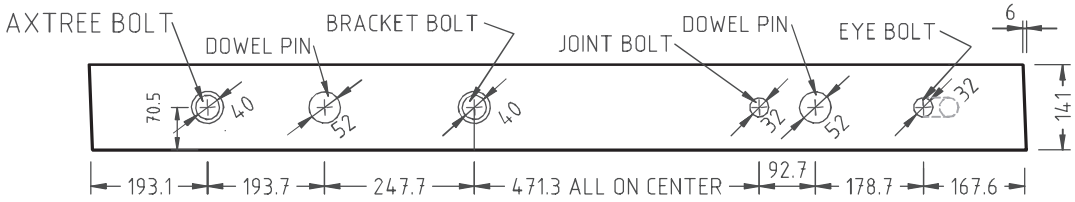
Two metal dowels used to join the upper and lower bracket pieces together. Omitted on guns smaller than 12 lb. calibre.



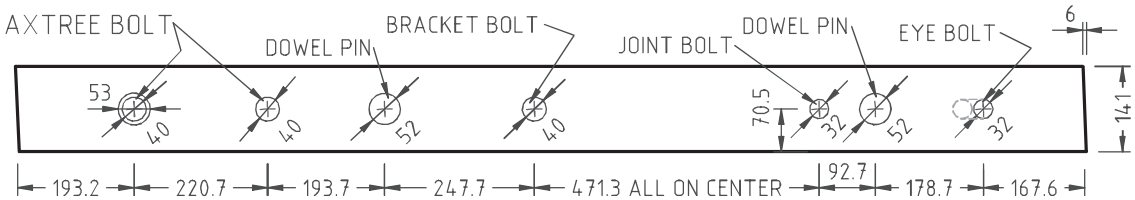
LOWER BRACKET - ELEVATION



UPPER BRACKET - PLAN
TOP FACE - DRILLINGS



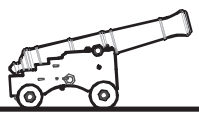
UPPER BRACKET - PLAN
BOTTOM FACE - DRILLINGS

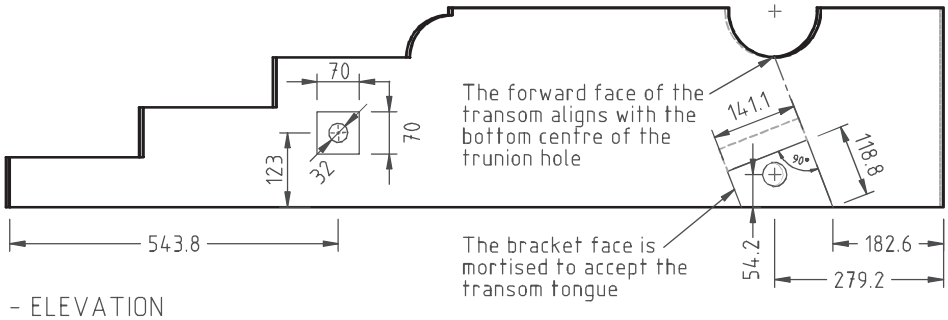


LOWER BRACKET - PLAN
BOTTOM FACE - DRILLINGS

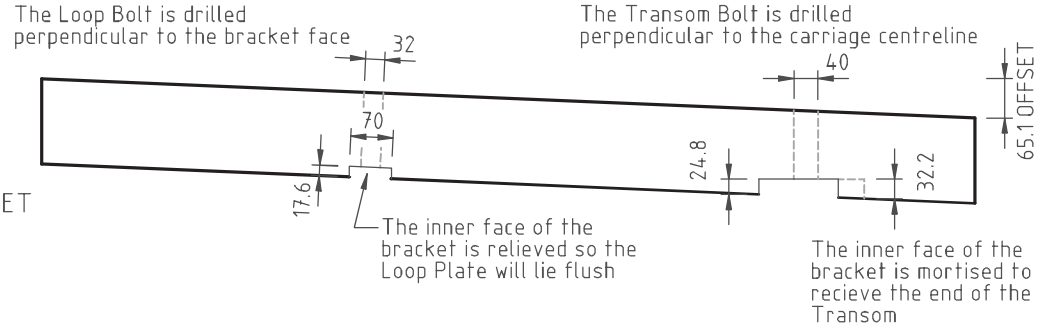
24 Pounder Bracket

VERTICAL DRILLINGS

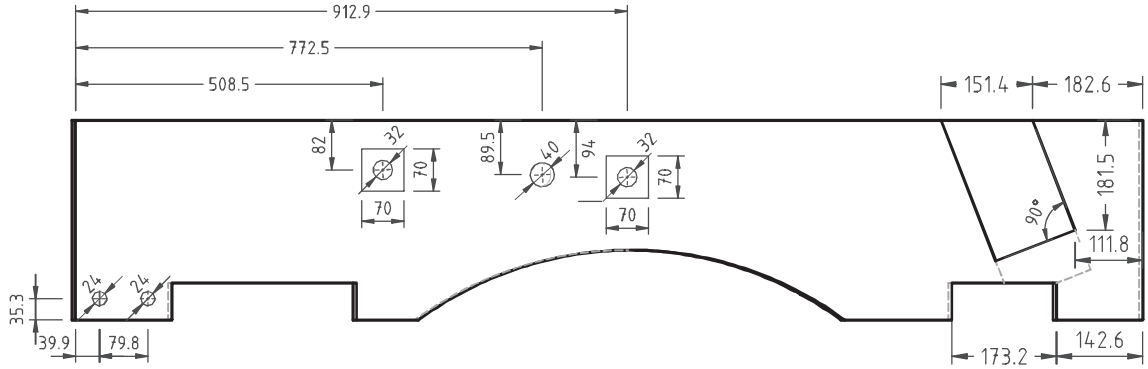




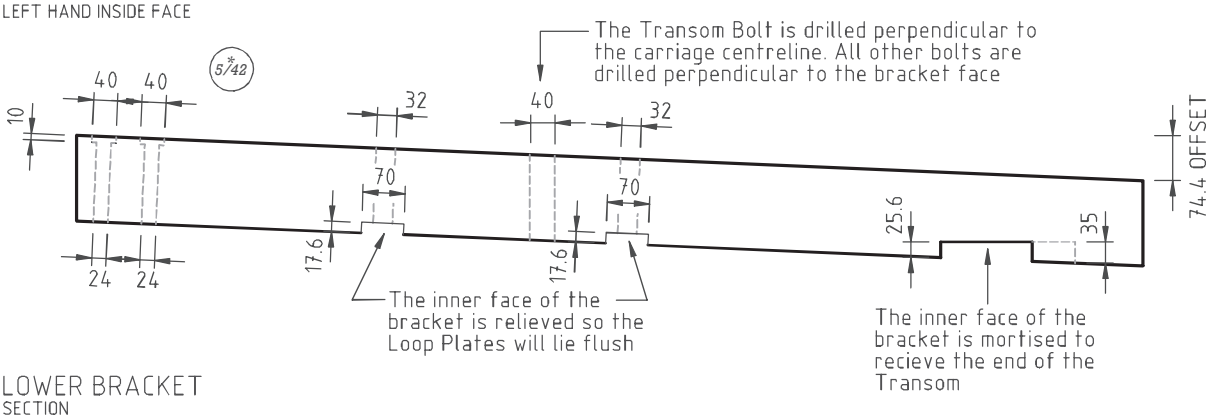
UPPER BRACKET - ELEVATION
LEFT HAND INSIDE FACE



UPPER BRACKET
SECTION



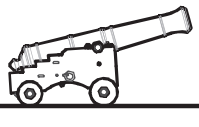
LOWER BRACKET - ELEVATION
LEFT HAND INSIDE FACE

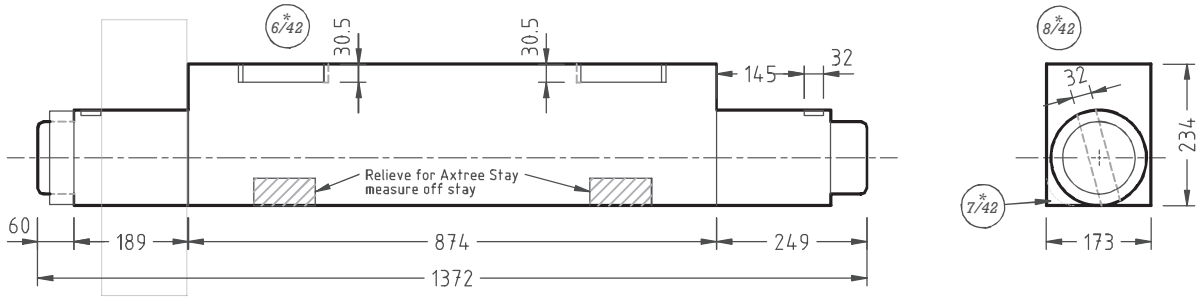


LOWER BRACKET
SECTION

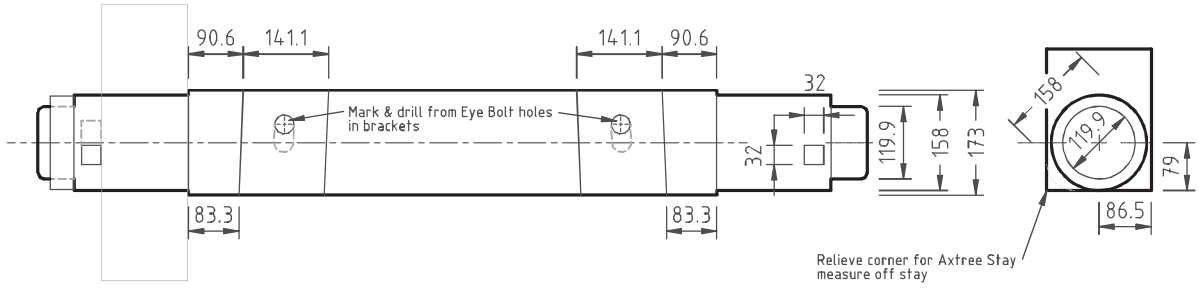
24 Pounder Bracket

HORIZONTAL DRILLING & MORTISES

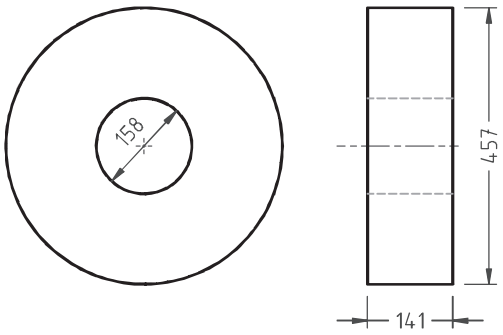




FORE AXTREE - ELEVATION

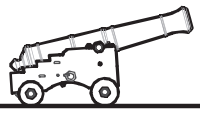


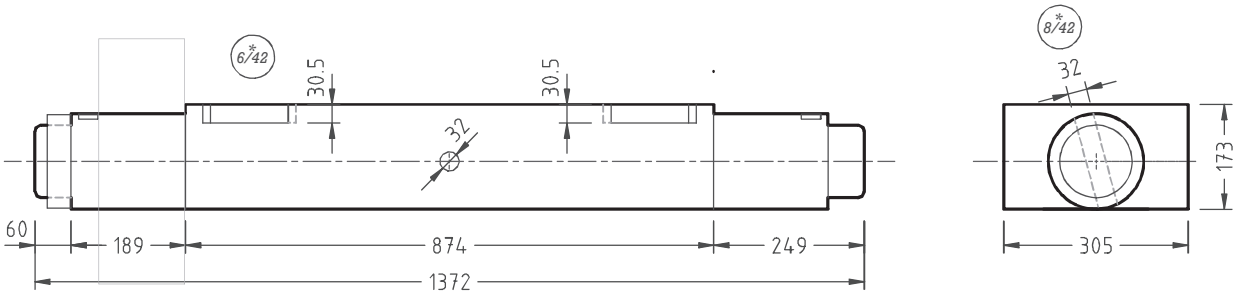
FORE AXTREE - PLAN



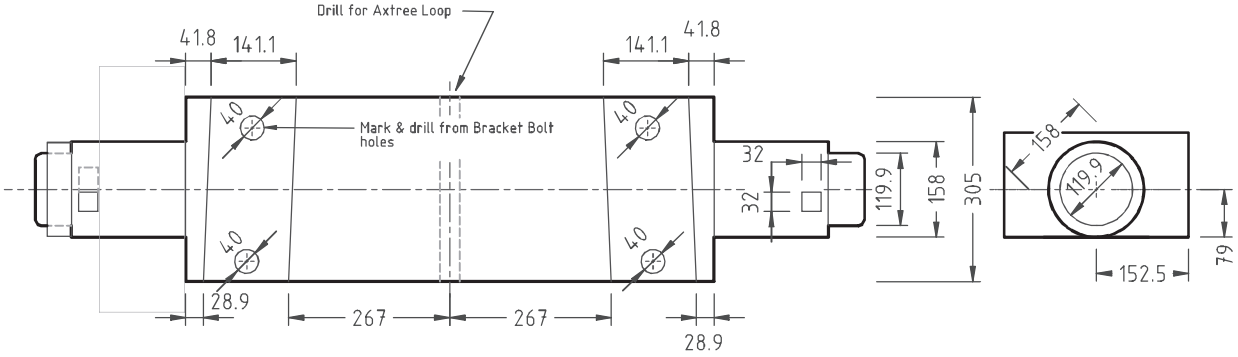
FORE TRUCK
ELEVATION & PLAN

24 Pounder Axtree and Truck Dimensions

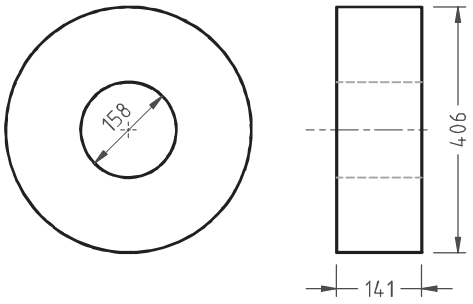




HIND AXTREE - ELEVATION

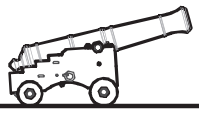


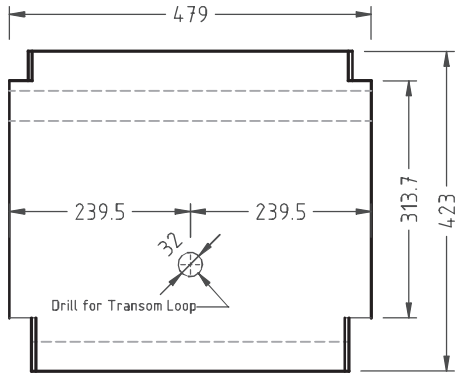
HIND AXTREE - PLAN



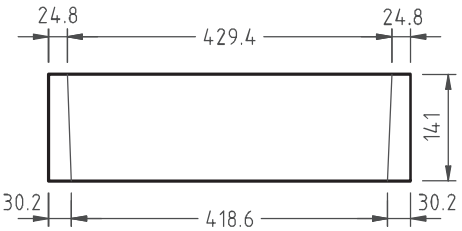
HIND TRUCK
ELEVATION & PLAN

24 Pounder Axtree and Truck Dimensions

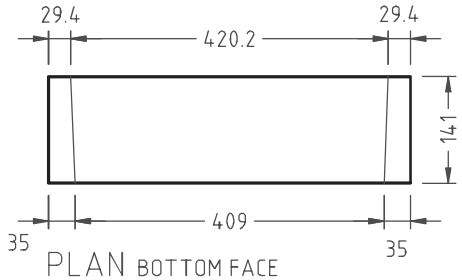




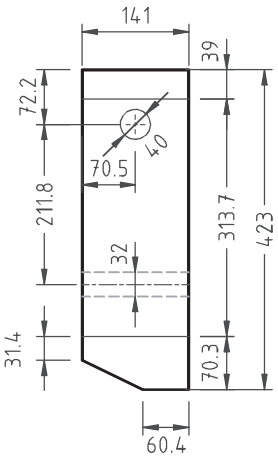
TRANSOM - ELEVATION
FRONT FACE



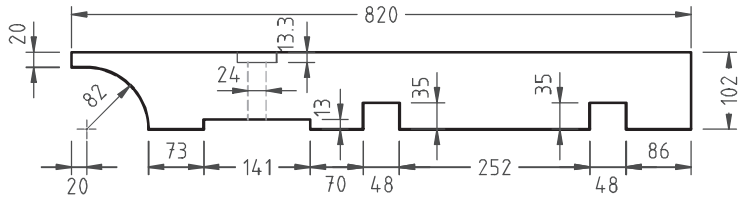
PLAN TOP FACE



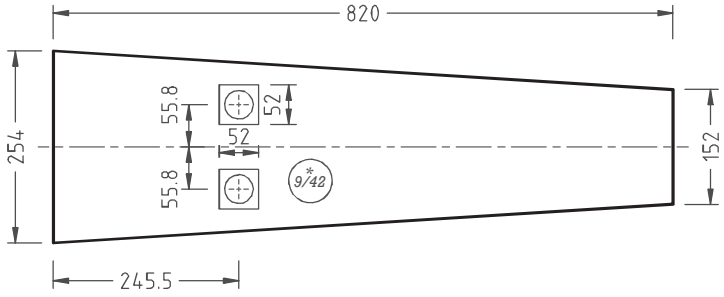
PLAN BOTTOM FACE



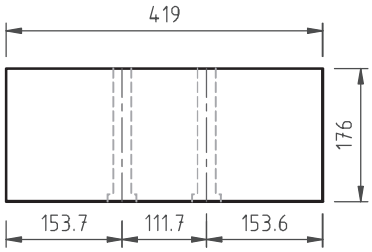
VERTICAL SECTION

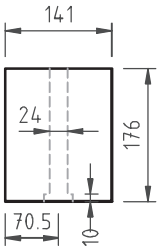


STOOL-BED - ELEVATION
RIGHT HAND FACE



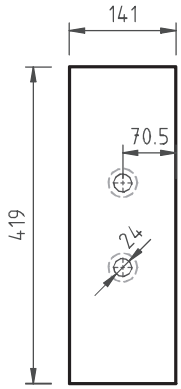
STOOL-BED - PLAN
TOP HAND FACE





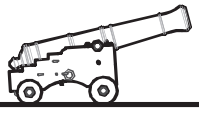
VERTICAL SECTION

BOLSTER - ELEVATION
FRONT FACE



PLAN
TOP FACE

24 Pounder Transom, Stool-Bed & Bolster



Dimensions of the metal hardware in calibres of the shot & mm.

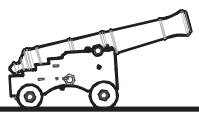
(one calibre equals 141 mm. For a 24 pounder)

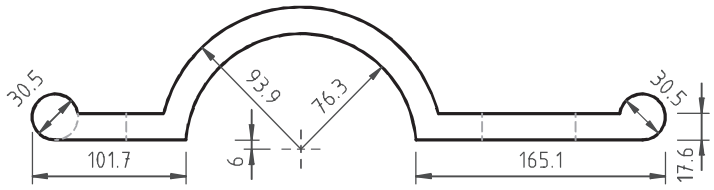
Item	Description	No. Req	Thickness	Length OA	Width	Bend Diameter	Fore flat	Hind flat	Rounding at ends
1	Cap-Square	2	**0.125**	**2.974**	**0.721**	**1.082**	**1.171**	**0.721**	**0.216**
Dimensions in mm.			17.6	419.3	101.7	152.6	165.1	101.7	30.5

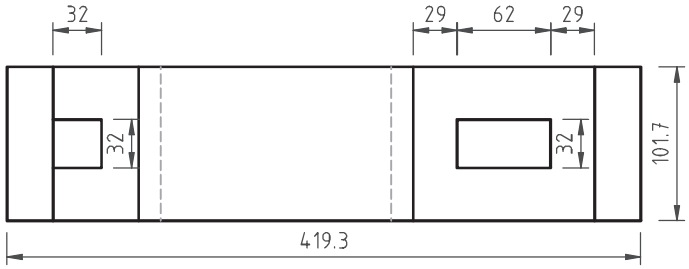
			Measurements in Calibres of the shot				Measurements in millimeters			
Item	Description	No. Req	Thickness or Diameter	Width	Length of Head	Length OA	Thickness or diameter in mm.	Width in mm.	Length of Head in mm.	Length Overall in mm.
2	Eye Bolt	2	**0.216**	**0.415**	0.498	6.817	30.5	58.5	70.2	961.2
3	Joint Bolt	2	**0.216**	**0.631**	0.663	5.468	30.5	89.0	93.5	771.0
4	Cap-Square Key	2	**0.054**	0.284	0.234	0.721	7.6	40.0	33.0	101.7
5	Chain	2	0.043	0.157		0.228	6.1	22.1		32.1
6	Staple	2	0.043	0.157		0.456	6.1	22.1		64.3
7	Axtree Stay	2	0.125	0.721		2.674	17.6	101.7		377.0
8	Hind Axtree Bolt	2	**0.270**	**0.360**		3.582	38.1	50.8		505.1
9	Hind Axtree Bolt	2	**0.270**	**0.360**		4.167	38.1	50.8		587.5
10	Bracket Bolt	2	**0.270**	**0.360**		3.715	38.1	50.8		523.8
11	Bolt Ring	10	0.125	**0.486**			17.6	68.5		
12	Bolt Key	10	0.054	0.142		0.486	7.6	20.0		68.5
13	Transom Bolt	1	**0.270**	**0.360**		5.390	38.1	50.8		760.0
14	Bed Bolt	1	**0.270**	**0.360**		5.816	38.1	50.8		820.0
15	Burr Ring	4	0.125	**0.486**			17.6	68.5		
16	Dowel	4	0.355			1.000	50.1			141.0
17	Breeching Bolt	2	**0.210**	**0.721**	**0.721**	1.750	29.6	101.7	101.7	246.8
18	Breeching Ring	2	**0.250**	**0.800**	**1.300**	1.300	35.3	112.8	183.3	183.3
19	Bracket Loop	4	**0.210**	**0.721**	**0.721**	1.750	29.6	101.7	101.7	246.8
20	Hind Axtree Loop	1	**0.210**	**0.721**		3.012	29.6	101.7		424.7
21	Transom Loop	1	**0.210**	**0.721**		1.850	29.6	101.7		260.9
22	Loop Plate	8	0.125	0.486	0.486		17.6	68.5	68.5	
23	Traversing Plate	2	0.094	0.594	0.594	1.132	13.3	83.8	83.8	159.6
24	Axtree Hoop	4	0.125			0.284	17.6			40.0
25	Linch-Pin	4	0.216	0.360	0.284	1.841	30.5	50.8	40.0	259.6
26	Stool-Bed Bolt	2	0.162	0.270		1.920	22.8	38.1		270.7
27	Stool-bed Plate	2	0.094	0.360	0.360		13.3	50.8	50.8	

Item	Description	No. Req	Thickness	Inside Diameter	Outside Diameter	Thickness or diameter in mm.	Inside Diameter	Outside Diameter
11	Bolt Ring	10	0.125	0.270	**0.486**	17.6	38.1	68.5
15	Burr Ring	4	0.125	0.270	**0.486**	17.6	38.1	68.5
17	Breeching Bolt	2	**0.210**	**0.300**	**0.721**	29.6	42.3	101.7
18	Breeching Ring	2	**0.250**	**0.800**	**1.300**	35.3	112.8	183.3
19	Bracket Loop	4	**0.210**	**0.300**	**0.721**	29.6	42.3	101.7
20, 21	Fore & Aft Loop	2	**0.210**	**0.300**	**0.721**	29.6	42.3	101.7
24	Axtree Hoop	4	0.125	0.850	1.100	17.6	119.9	155.1

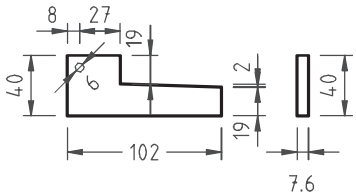
Note: Dimensions in bold type are as given by Robertson. All other dimensions are extrapolated by the author, following the logic expressed by Robertson in the text.



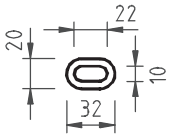




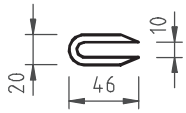
CAP SQUARE
ELEVATION & PLAN



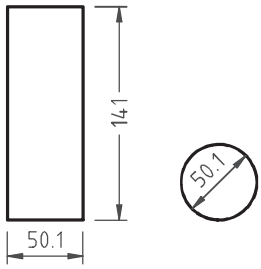
CAP SQUARE KEY
ELEVATION & PLAN



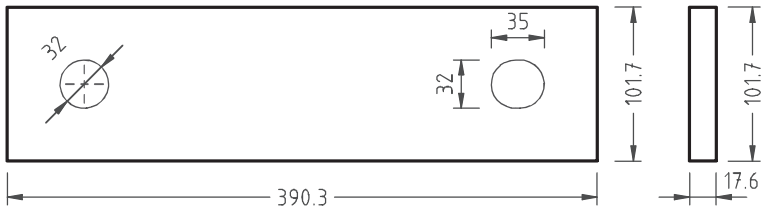
CAP SQUARE
CHAIN RING



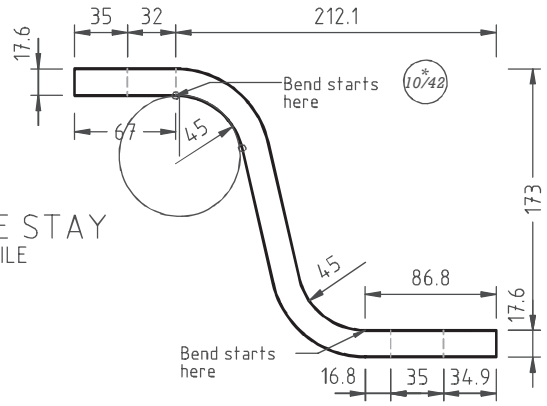
CAP SQUARE
STAPLE



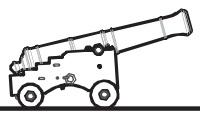
DOWEL PIN
PLAN & SECTION

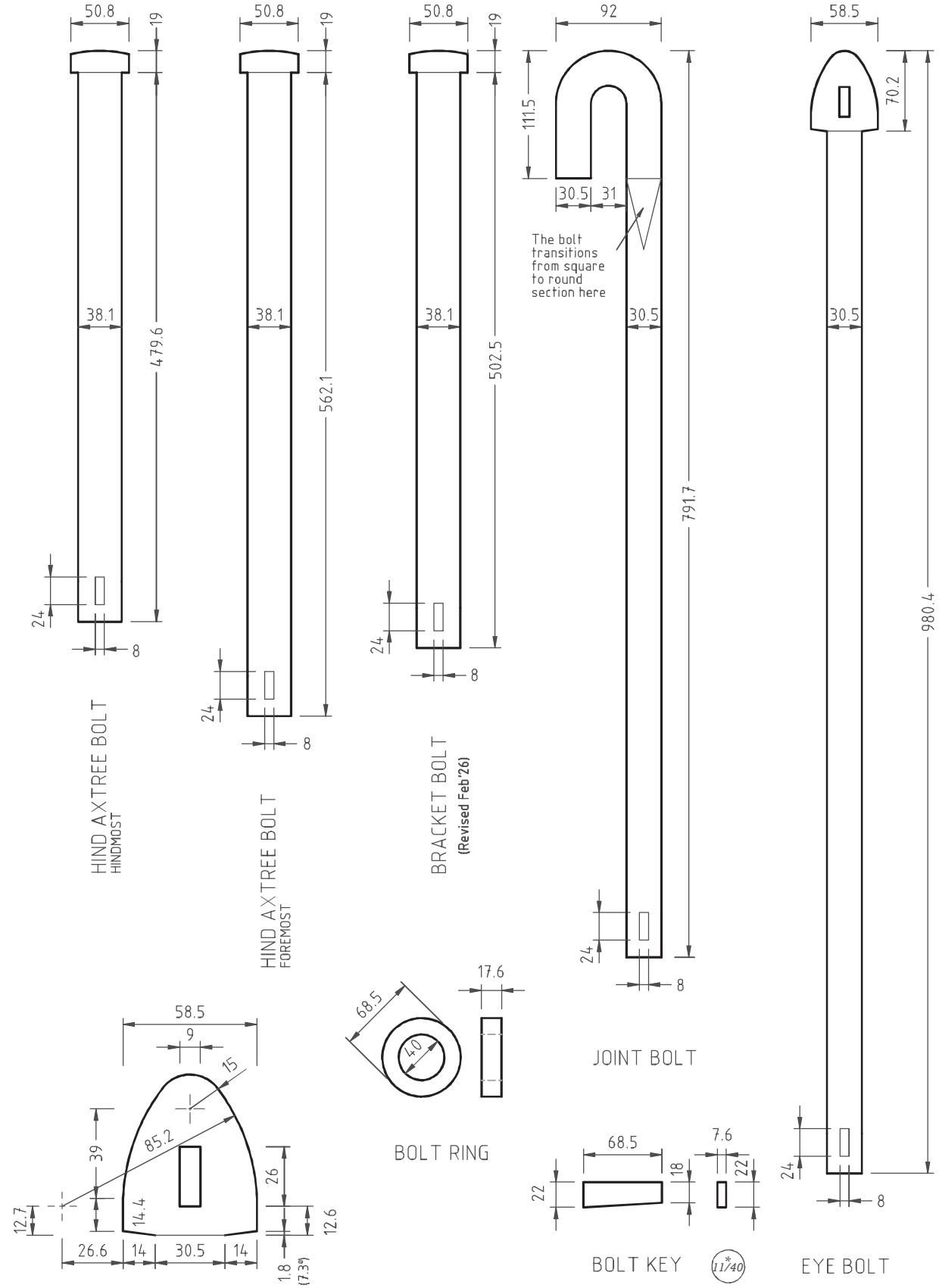


AXTREE STAY
PLAN & SECTION BEFORE
BENDING

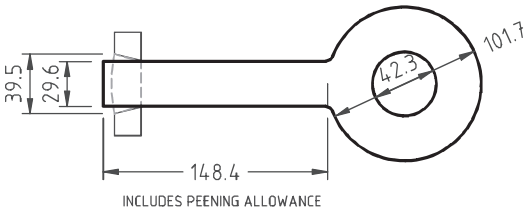


AXTREE STAY
BEND PROFILE

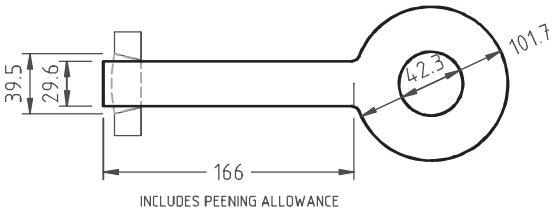




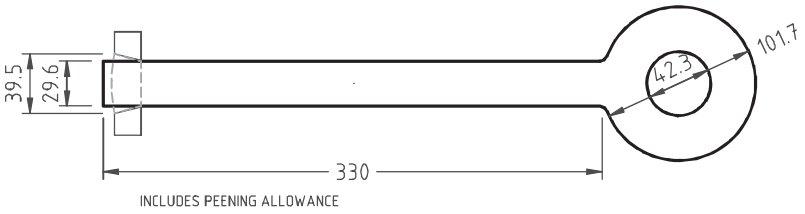
24 Pounder Bolts 10*/40



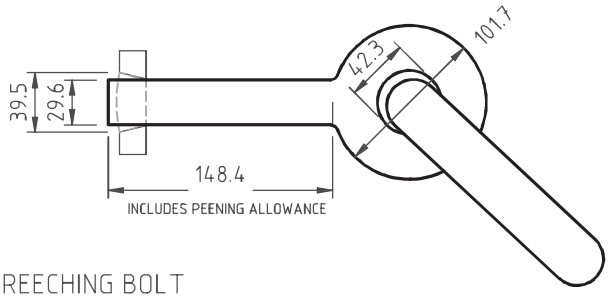
BRACKET LOOP



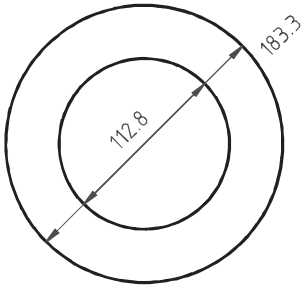
TRANSOM LOOP



HIND AXTREE LOOP



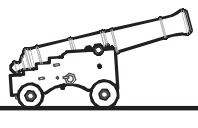
BREECHING BOLT
& BREECHING RING

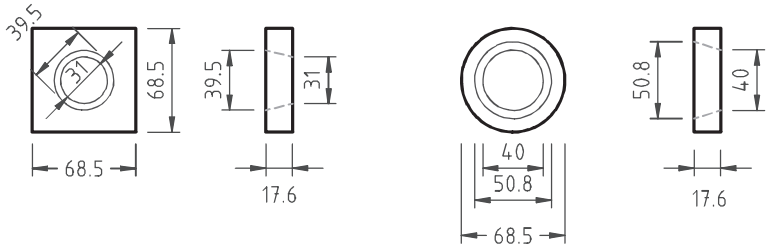


TRANSOM BOLT

BED BOLT

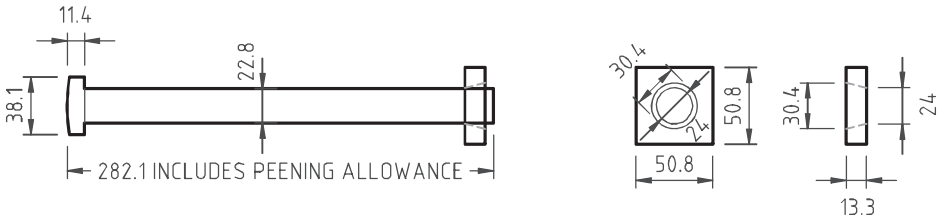
24 Pounder Loops & Bed Bolts (14/43)





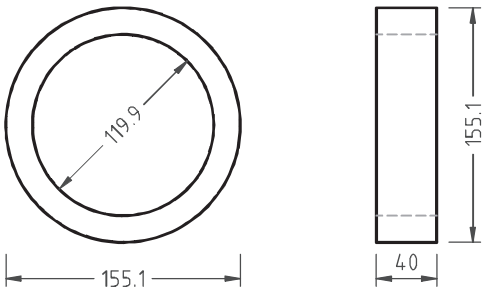
LOOP PLATE

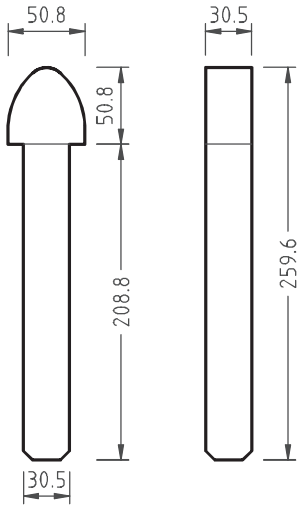
BURR RING



STOOL-BED BOLT

STOOL-BED PLATE

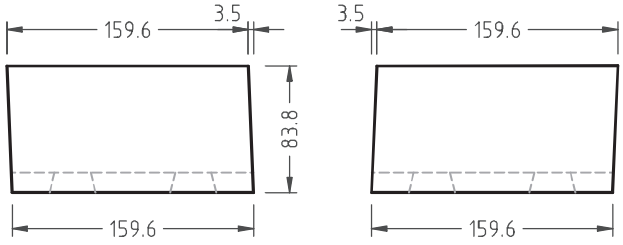




LINCH PIN

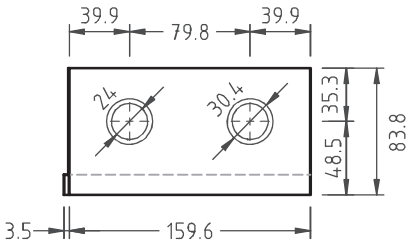
(15/43)

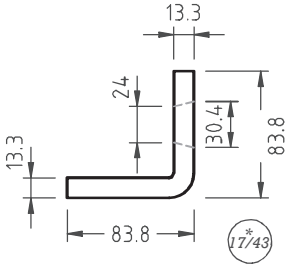
AXTREE HOOP



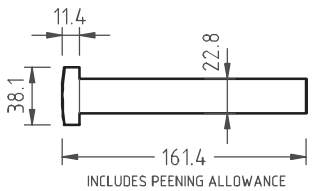
TRAVERSING PLATE
PLAN
RIGHT HAND FROM ABOVE

TRAVERSING PLATE
PLAN
LEFT HAND FROM ABOVE





(17/43)



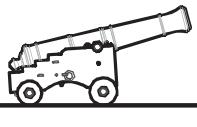
TRAVERSING PLATE
ELEVATION
RIGHT HAND SIDE SHOWN

(16/43)

SECTION

TRAVERSING PLATE BOLT

24 Pounder Plates, Burrs, Hoops, Pins



Manufacturing Notes

1 Before constructing a Naval Gun Carriage, the builder needed the following data: the length of the gun; the Diameter of the Base Ring; the Diameter of the Second Reinforce Ring; the Camber of the Deck; the open height of the gun port and the height of the gun port sill above the deck. Robertson proposed substituting his shot-calibre based formula (see page 24)

2 Robertson's descriptions are incomplete. He has measured and drawn those features that are readily viewed on an assembled carriage. Other features are hinted at in his drawings, or mentioned in text only. While the wooden parts are generally well described, the metalwork is less so. Where a dimension in the tables is in bold type, it has been given by Robertson. All others are the authors suggestion.

3 Robertson gives no description of the bolt heads, but has drawn them as a flange or shoulder bolt type, recessed into the top of the brackets. I have drawn them accordingly.

4 I assume Robertson never saw a carriage diss-assembled, which is probably why he hasn't given dimensions for features he couldn't see and measure for himself. He has given us a dimension for the axtrees let into the brackets of 61mm. Muller states that sometimes the brackets were let into the axtrees instead. I chose to use a half lap joint for my own model, which provides a very rigid structure. If following this method the 61mm needs to be split between bracket and axtree.

5 Note the traversing plate bolts are drilled perpendicular to the bracket, so the set out is different on each face. See also note 14 on page 43.

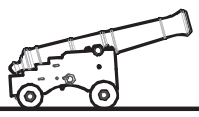
6 The above half lap (note 4) is drawn on the axtrees. If setting all the dimension into the brackets ignore this dado.

7 The trailing edge of the fore axtree needs to be relieved to accommodate the stay. Both Robertson and Muller describe stays as being either 'S' or 'Z' shaped. If making them 'Z' shape the relief is not required.

8 Robertson doesn't mention the set of the Linch Pins, but in contemporary illustrations they are often shown tilted back at the top. I've used 15° for this.

9 Robertson includes stool-bed bolts and plates in his parts list, but gives no dimensions, description or fitting instructions. He shows them a smaller diameter to other bolts on his drawings. To not hinder the Quoin, they need to be let flush into the top of the stool-bed. Both Robertson and Muller refer to stool-bed plates, not bolster plates, so I take it from that the plates are let into the stool-bed.

10 Because the top bend starts at the edge of the holes, its best to form the bend before drilling the hole. Robertson lists bolt rings for these bolts, which seem unnecessary. The rings need to be drilled with a smaller (32mm dia) clearance hole, and the ring on the joint bolt requires a chamfer on its forward face to clear the sharp turn on the stay.



Manufacturing Notes

11 The bolts were wrought iron, handmade by blacksmiths. I don't know what the raw material supply was, or if the bolts were round or square in section. Robertson has drawn all bolts except the joint and eye bolts with round heads. On the basis it's easier to make a round hole, I have assumed all bolts are round with the following exceptions: The top of the joint bolt forming the cap square hinge is square section. The top the eye bolt is rectangular in section, and I chose to fabricate these two bolts from a separate head and shank. The linch pins are square section and go through square holes in the axtree arms to prevent them turning.

12 The vertical bolts through the brackets are secured with a bolt ring and key. The key passes through a keyway in the bolt and is held in place by having the ends bent or distorted to prevent removal. These keyways are challenging to reproduce at scale, so I threaded the bottom of my bolts and fabricated nuts to resemble the bolt ring and key.

13 No dimensions are given for the shape of the Eye Bolt, but it must be functional and of pleasing proportion. The shape given achieves the objective and allows the cap square to open without fouling the bolt head

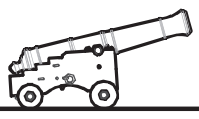
14 The loops and transverse bolts are riveted into place over a plate or ring with a counter sunk hole. Bolt and loop shank lengths are given as a guide to allow for this, but the constructor might want to complete a sample before finally cutting to length. Plates on the inside face of the brackets are let in flush, but the ones on the transom and hind axtree are not.

15 The Linch pins are definitely square in section and pass through square holes. The heads share proportions with the eye bolts.

16 Traversing plates are a problem. Robertson doesn't show them on his drawings and I have never seen a replica or archeological carriage with them fitted. Robertson and Muller both list them with their metal-ware. This is what Robertson says of them "*Traversing Plates, one in the bottom of each bracket, between the tail and the hind trucks. These plates lapping from under the brackets a small way up the sides, preserve the wood from being fretted by the handspikes in frequent traversing of the carriage.*" A key question is how they were attached. Certainly not from underneath with a couple of self tapping screws. Every other transverse fitting on the carriage is riveted into place, and I have adopted the same method, borrowing the smaller diameter bolts from the stool-bed. There seems no need for additional plates or rings, and I have shown the bolts riveted directly into the traversing plate. Similarly I have recessed the bolt heads because this appears to be standard practice.

But…There are no fixings listed in the metalware schedule of Robertson or Muller. Given that they both list the staple securing the cap-square key chain this seems something of an oversight. I doubt that the plates were nailed on, as they would be a heavily loaded component in service. This is an area that needs further research.

17 A gentle radius on the external corner of the traversing plate would greatly facilitate its function.

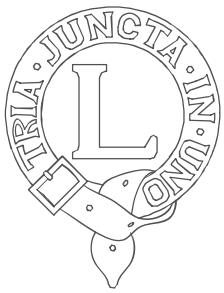


Markings

1 THE REGENT'S CYPHER

On Naval cannon the Regent's Cypher featured top centre on the first reinforce. On both bronze and iron guns this was typically cast, but was sometimes engraved.

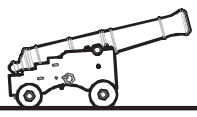
For the period of the style of gun featured – say 1720 : 1830 – choices are: George 1st. 1714 – 1727; George 2nd. 1727 – 1760; George 3rd. 1760 – 1820; George 4th. 1820 – 1830. There would be some overlap of dates because of manufacturing work in progress carried over from the previous reign.



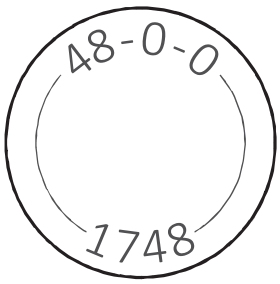
2 CYPHER OF THE MASTER GENERAL OFF THE ORDINANCE

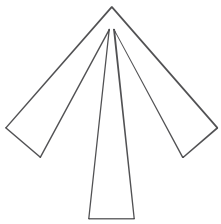
The cipher of the Master General of the Ordinance was typically carried on the top of the chase, about midway between the Chase Girdle and the Cornice Rings.

There are more than 20 candidates covering our time period, and my recommendation would be to pick a candidate whose cipher isn't too hard to reproduce. I chose John, 1st. Viscount Ligonier 1759 – 1763. Before you so rightly point out that my drawings reflect a 1748 gun which pre-dates his appointment, from 1748 till 1755 the office of Master General was vacant. At this time Ligonier was Lieutenant General and in effective command. He was not yet a Viscount, so his cipher doesn't yet carry a coronet. He became Master General in 1759 and his cipher changed to reflect his status.



Markings





OTHER MARKINGS

While the ciphers were normally cast as part of the gun, manufacturing related marks weren't normally added until the piece had been machined, and were normally engraved. These could include all of the following, but certainly the first 4.

- Weight expressed as Hundred-weight – Quarters – Pounds.
- Makers Name
- Serial Number
- Manufacturing date
- The Broad Arrow mark for government owned weapons
- The size of gun in Pounds of shot
- Sometimes the weight of proof and service charges

The first four marks were often placed on the trunnion ends, but not exclusively. They could alternatively be just about anywhere on the top of the gun, but especially around the first reinforce.

24 Pounder Markings