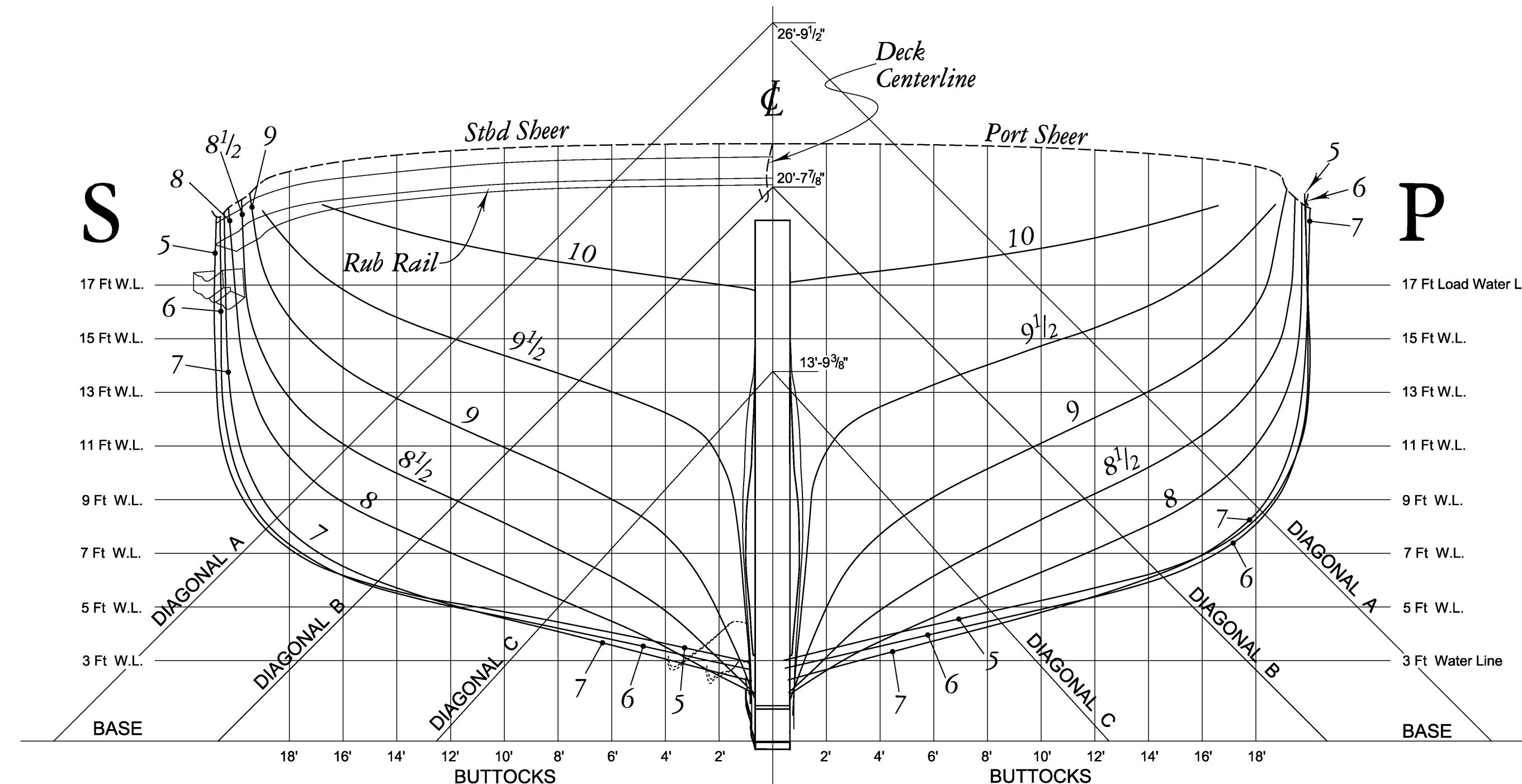


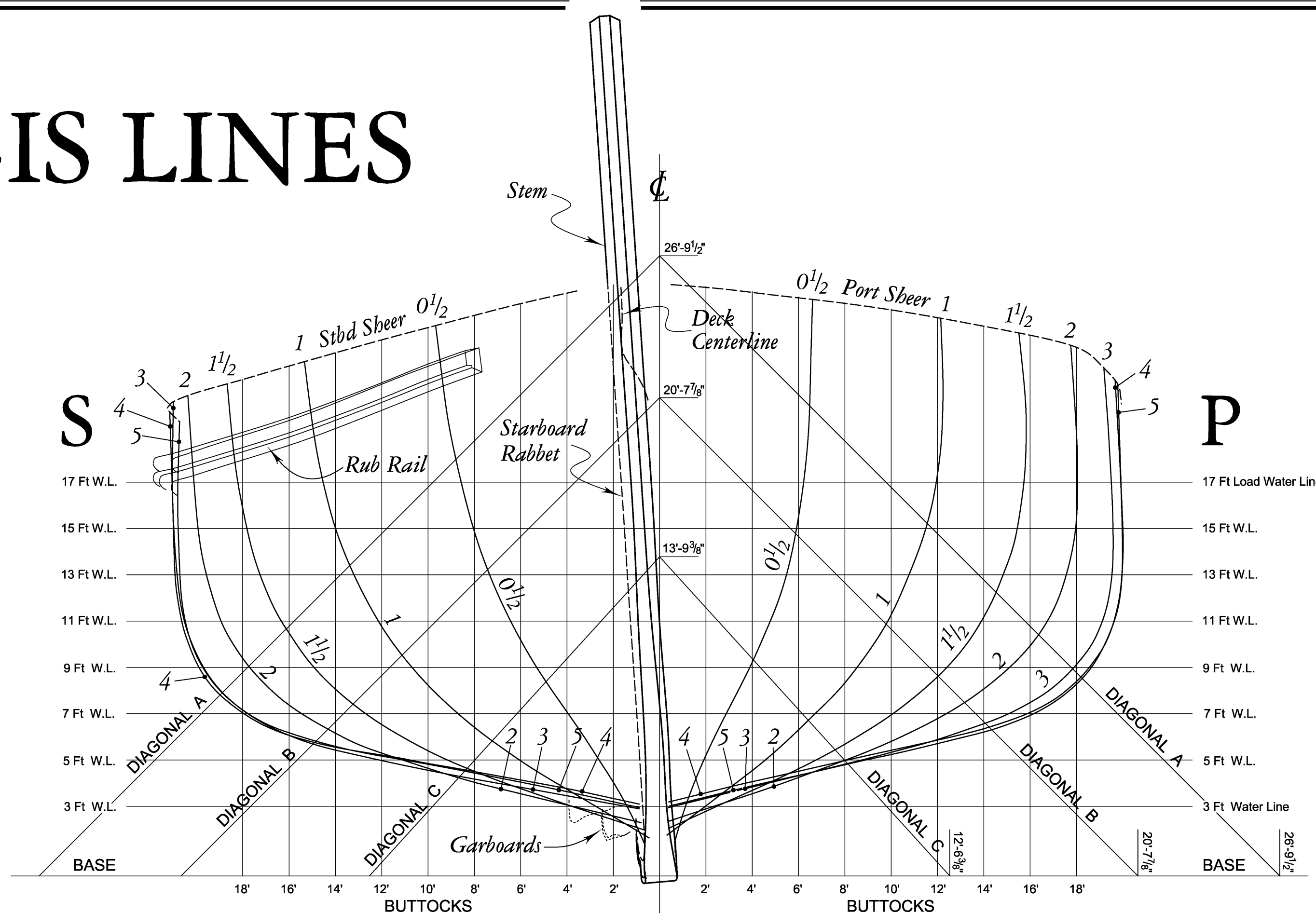
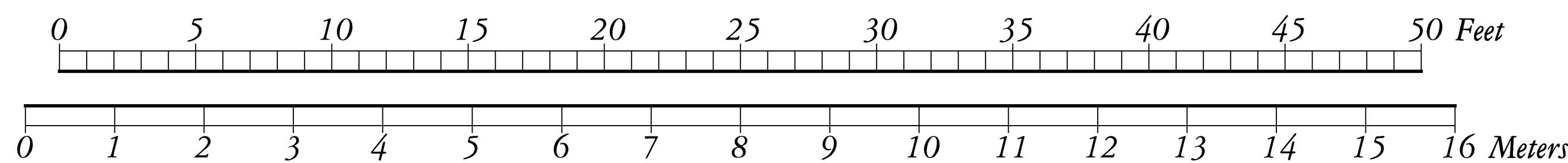
# S.S. WAPAMA: AS-IS LINES

## (2010)

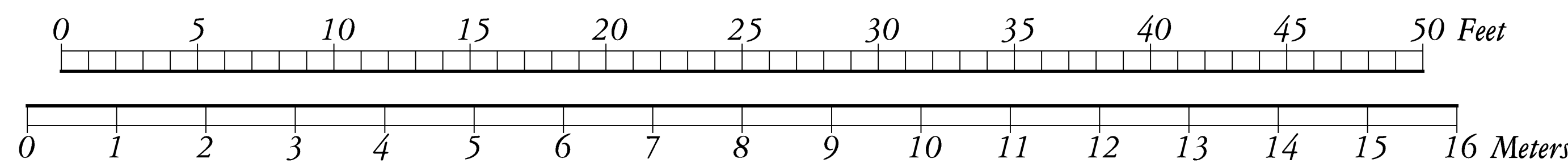
STATIONS 5 - 10  
LOOKING AFT



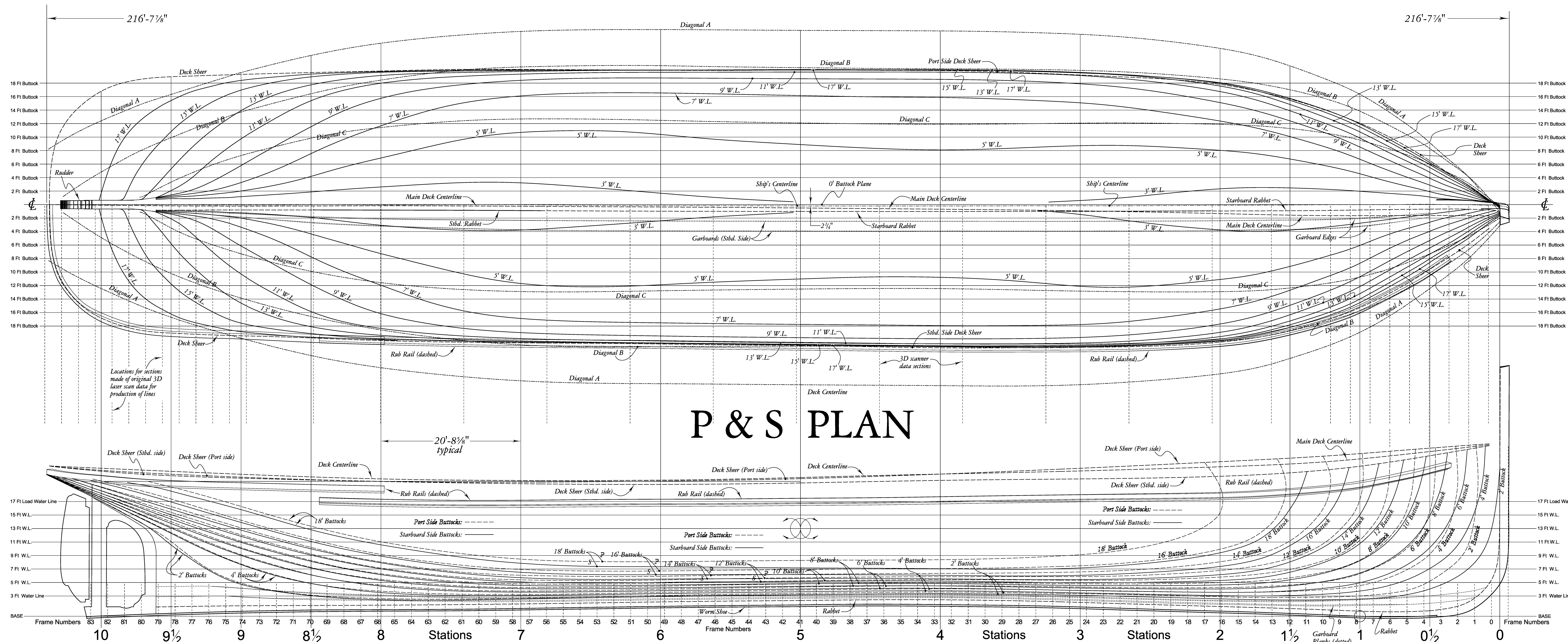
Scale: 1" = 4'-0" (1:48)



Scale: 1" = 4'-0" (1:48)



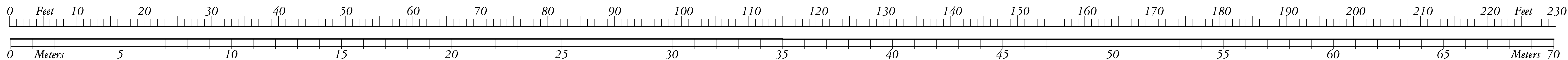
STATIONS 0 - 5  
LOOKING AFT



P & S PLAN

STARBOARD PROFILE

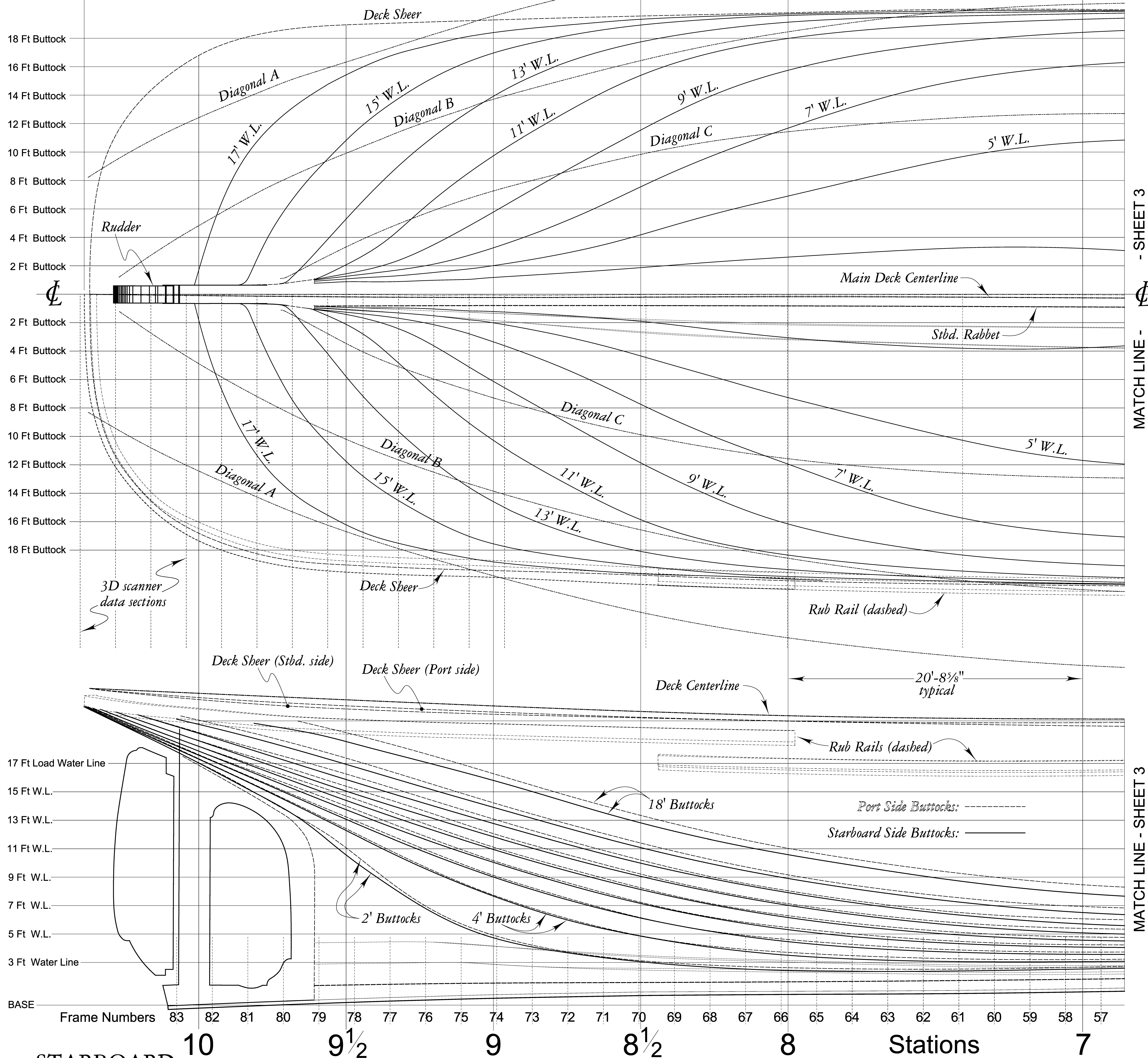
Scale: 1" = 6'-0" (1:72)





# AS-IS LINES: HALF-BREADTH PLAN

1 of 3



## STARBOARD PROFILE

1. Lines are to outside of hull planking, not to frames. Garboards were ignored.
2. In its as-is condition, the hull is twisted to starboard as seen from the sternpost forward. See Sheet 5, Body Plans, for further data.
3. In plan, the keel centerline bows  $2\frac{1}{4}$ " to starboard at midships. In profile the keel has settled irregularly on keel blocks after 30+ years on Barge 214.

Scale:  $\frac{3}{8}$ " = 1'-0" (1:32)

4. Lines were lifted by a series of 3D Laser scans performed for the HAER office, which later sectioned the point clouds at the number of field stations shown along the hull. These sections were produced in 3D CAD (Computer Aided Design software) and faired to produce a model of the hull surface on port and starboard sides.
5. At the time of scanning and documentation, Wapama was blocked up on a floating barge. The laser scans were made from instruments set up on the barge top. Due to the close-in positions

of the instruments, scans above the bottoms of the main rub rails were incomplete, insufficient to use for fairing upper surfaces. Motions of the floating barge would have introduced unknown errors into the point clouds if scans had been made from nearby piers.

6. Analysis of the CAD model revealed that its lines would be best presented if the model were rotated until the sternpost was plumb, and the hogged keel "leveled" to two points -- one the end of the skeg, the other at a point on the bow between frames 9

(Cont'd on Sheet 3)

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STEAM SCHOONER WAPAMA (1915)  
SHOAL POINT, END OF CANAL BOULEVARD  
CONTRA COSTA COUNTY

CALIFORNIA

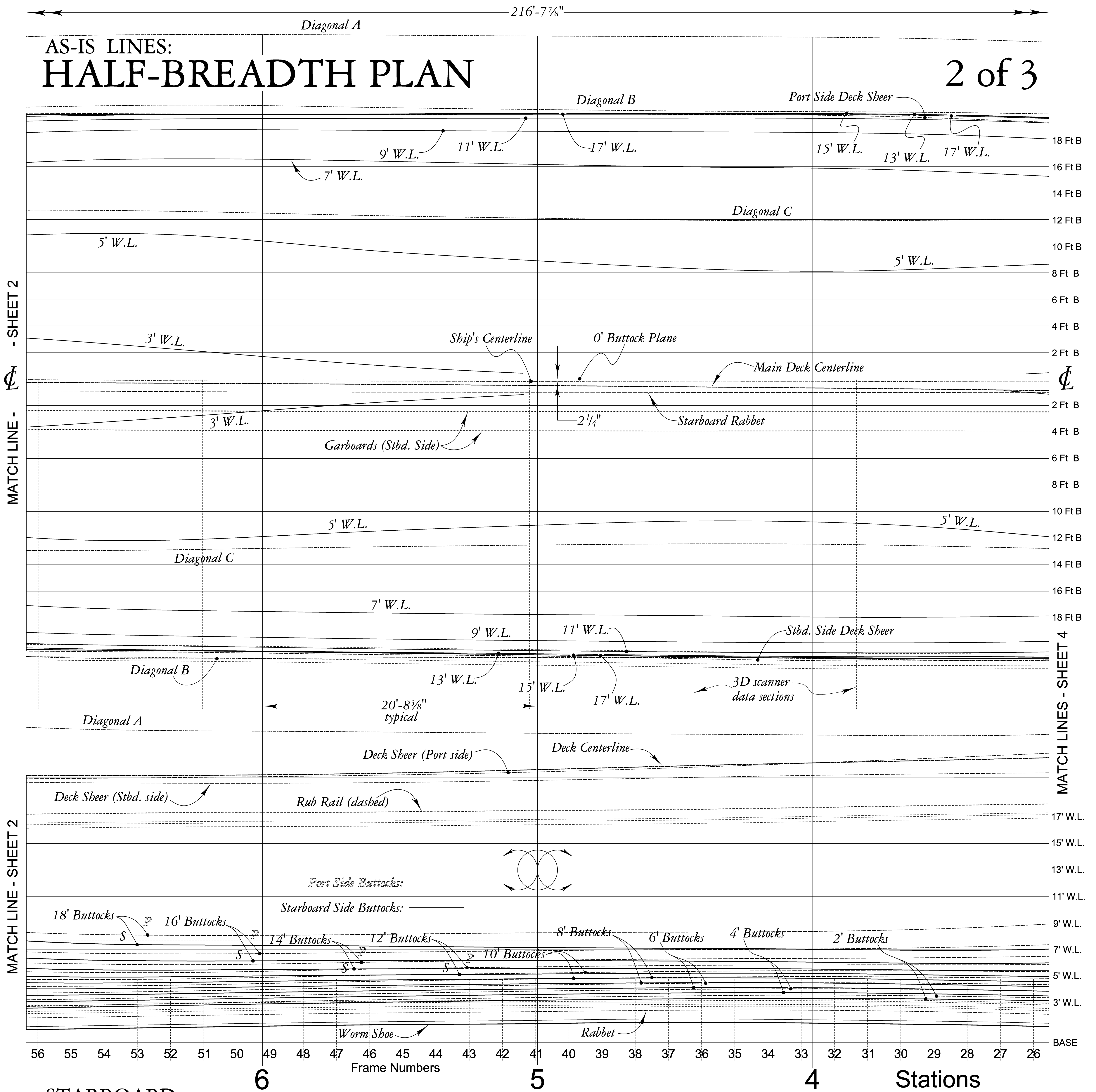
SHEET 2 OF 22

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# AS-IS LINES: HALF-BREADTH PLAN

2 of 3



## STARBOARD PROFILE

(Cont'd from Sheet 2)

and 10 where the keel seemed least deteriorated. Once in the new orientation, new sections were cut from this model at evenly spaced locations between the perpendiculars set at the intersections of stem and stern rabbets with the Load Water Line. (The original stations cut by HAER were thus rotated into skewed positions not useful for standard orthogonal drawing views.) Buttocks, water lines

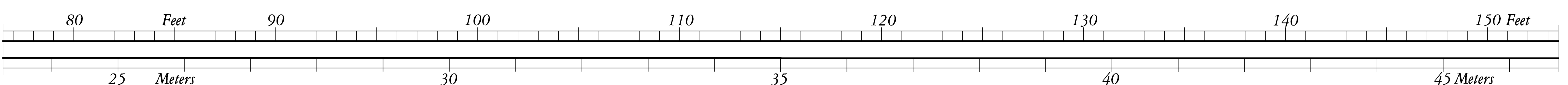
lines and diagonals were also cut from the CAD model to produce the lines shown here.

6. The deck surface centerline shown was derived from scantlings and dimensions provided by a series of 13 drawings made in 1985 by Don Birkholz, Sr. for a Historic Structures Report of Wapama written by Tri-Coastal Marine, Inc. Internal inspection of Wapama's hull in 2010 revealed that keelsons, hold stanchions, deck beams and decking were largely intact, so the sum of vertical dimensions for these components could be

added to the external keel configuration to arrive at a deck centerline curve within an error estimated to be no greater than +/- 1".

7. Deck sheer port and starboard are defined in these lines as the intersection of the top surface of the main deck with the outer hull surface. These intersections were derived from a series of assumptions and from dimensions in the Birkholz drawings, not external measurements or new field measurements. There is no clear physical demarcation for the deck sheers at the hull sides sufficient for 3D

(Cont'd on Sheet 4)



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STEAM SCHOONER WAPAMA (1915)  
SHOAL POINT, END OF CANAL BOULEVARD  
CONTRA COSTA COUNTY

CALIFORNIA

SHEET 3 OF 22

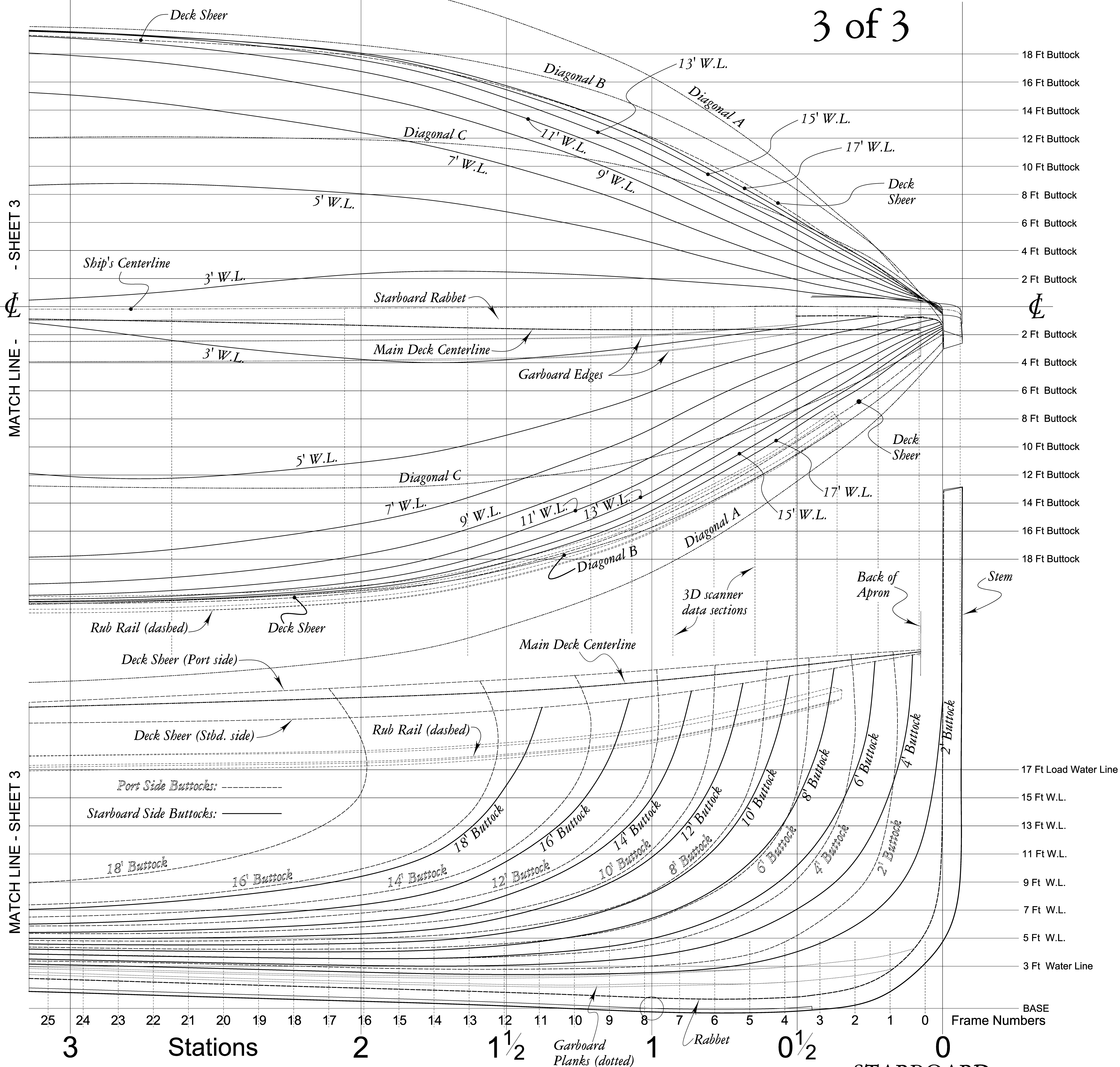
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216'-7<sup>7</sup>/<sub>8</sub>"

# AS-IS LINES: HALF-BREADTH PLAN 3 of 3



(Cont'd from Sheet 3)

scanners to record. To generate the sheer lines, a "vertical" centerline was erected at each hull section which split the distance between the sides of the hull as recorded at the rub rail and the centerline of the keel. A deck camber of 550'-4" radius (derived from the Birkholz midship section) was applied tangent to the deck centerline with its radial point along the newly erected section vertical centerline. Symmetry of the deck camber was assumed. A surface was faired through the deck

Scale:  $\frac{3}{8}" = 1'-0"$  (1:32)

profiles at each station, then the intersection between this deck surface and the hull sides was created to generate the sheer lines shown.

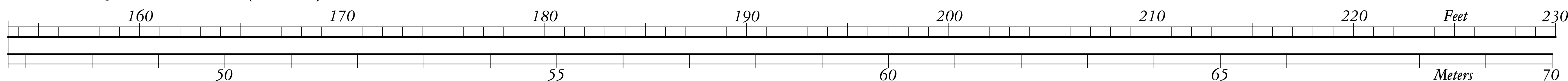
8. Bulwarks were extended and faired enough to reach the deck sheer P&S, but scanner data above the rub rail was insufficient to permit construction of bulwarks based on scanner data alone.
9. The propeller aperture was traced from large format HAER photograph No. CA-67-6, scaled to approximately fit Birkholz drawings.

10. The rudder profile was traced from large format HAER photograph No. CA-67-6, without pintles and gudgeons.

Length Over All: 216'-7<sup>7</sup>/<sub>8</sub>"

Length Between Stations 0 and 10: 207'-2<sup>1</sup>/<sub>4</sub>"

## STARBOARD PROFILE



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SHEET OF SHEETS  
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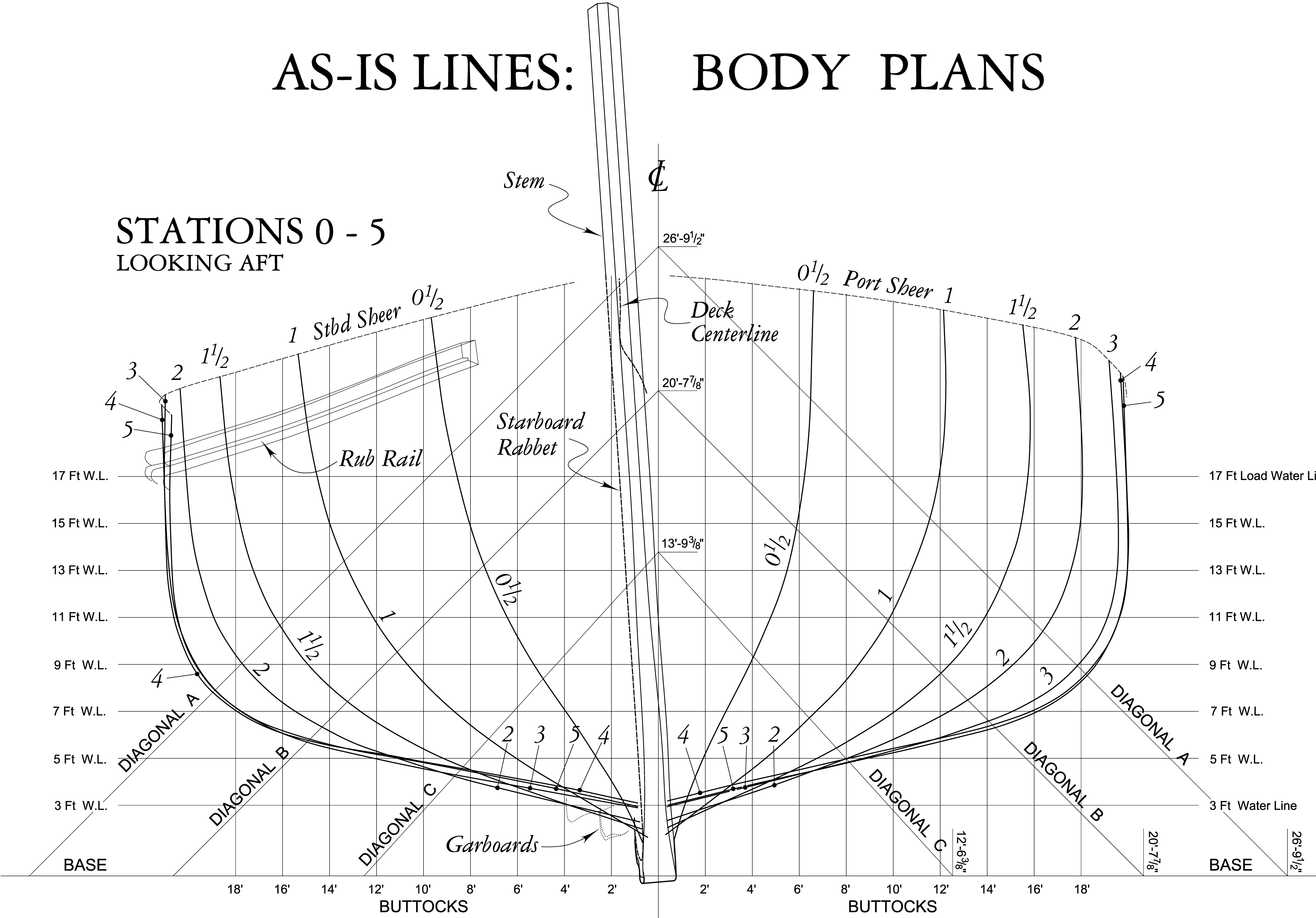
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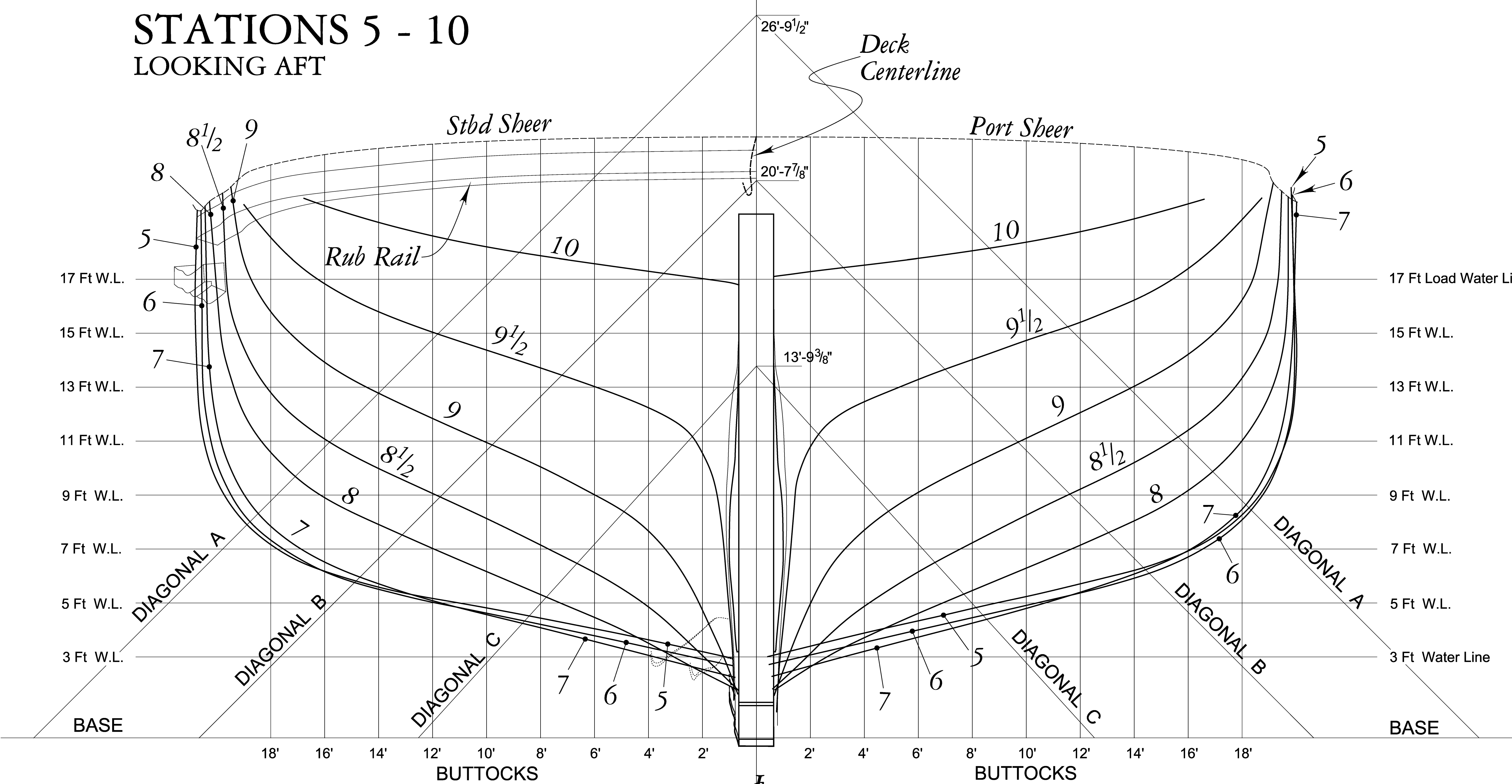


AS-IS LINES: BODY PLANS

STATIONS 0 - 5  
LOOKING AFT



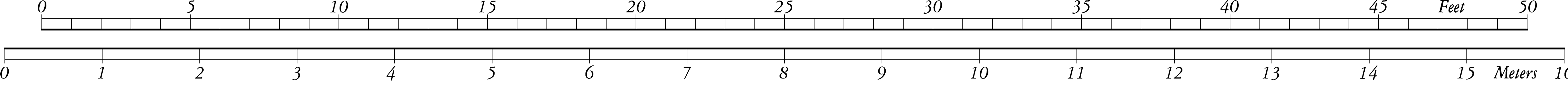
STATIONS 5 - 10  
LOOKING AFT



Port and starboard sides of hull are shown due to distortion;  
see Sheet 10 for a corrected table of offsets.

See Sheets 2-4 for annotations regarding field conditions  
and data processing for production of the above drawings.

Scale: 1/2" = 1'-0" (1:24)





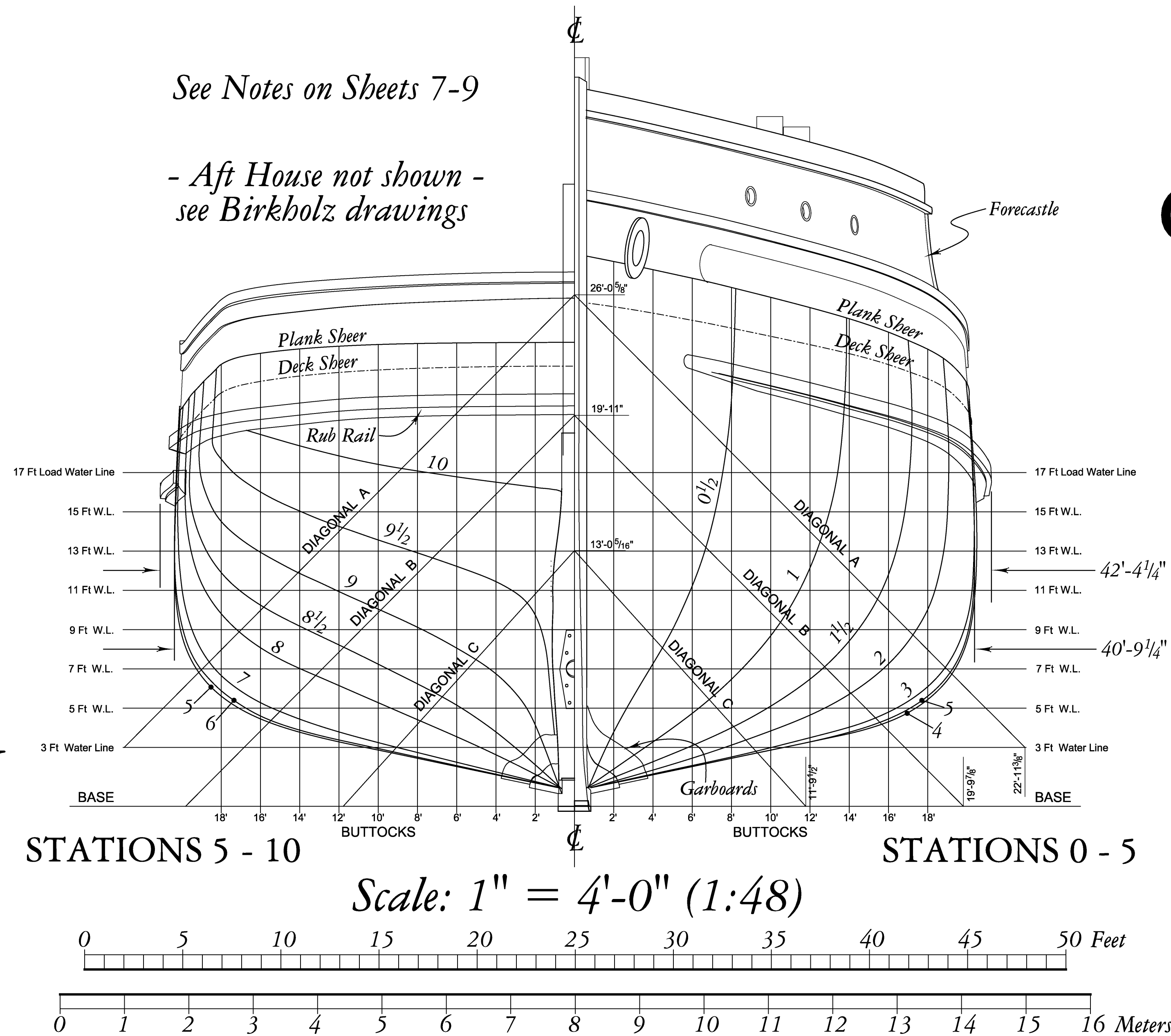
# S.S. WAPAMA:

See Notes on Sheets 7-9

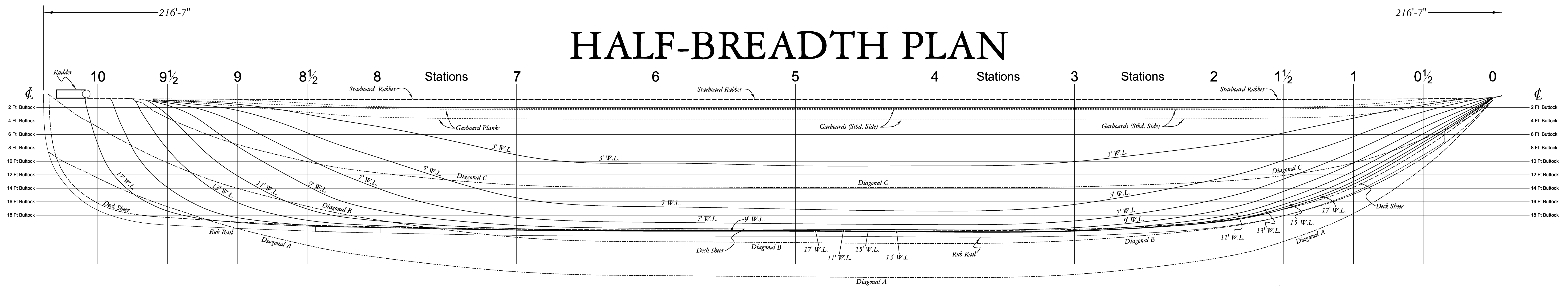
- Aft House not shown -  
see Birkholz drawings

# CORRECTED LINES

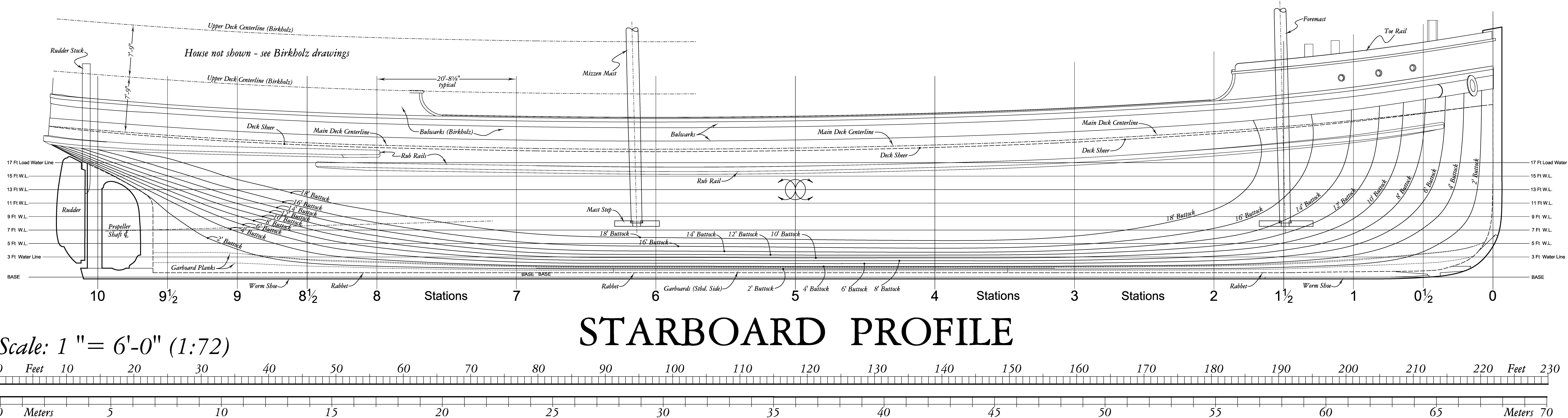
## BODY PLAN



## HALF-BREADTH PLAN



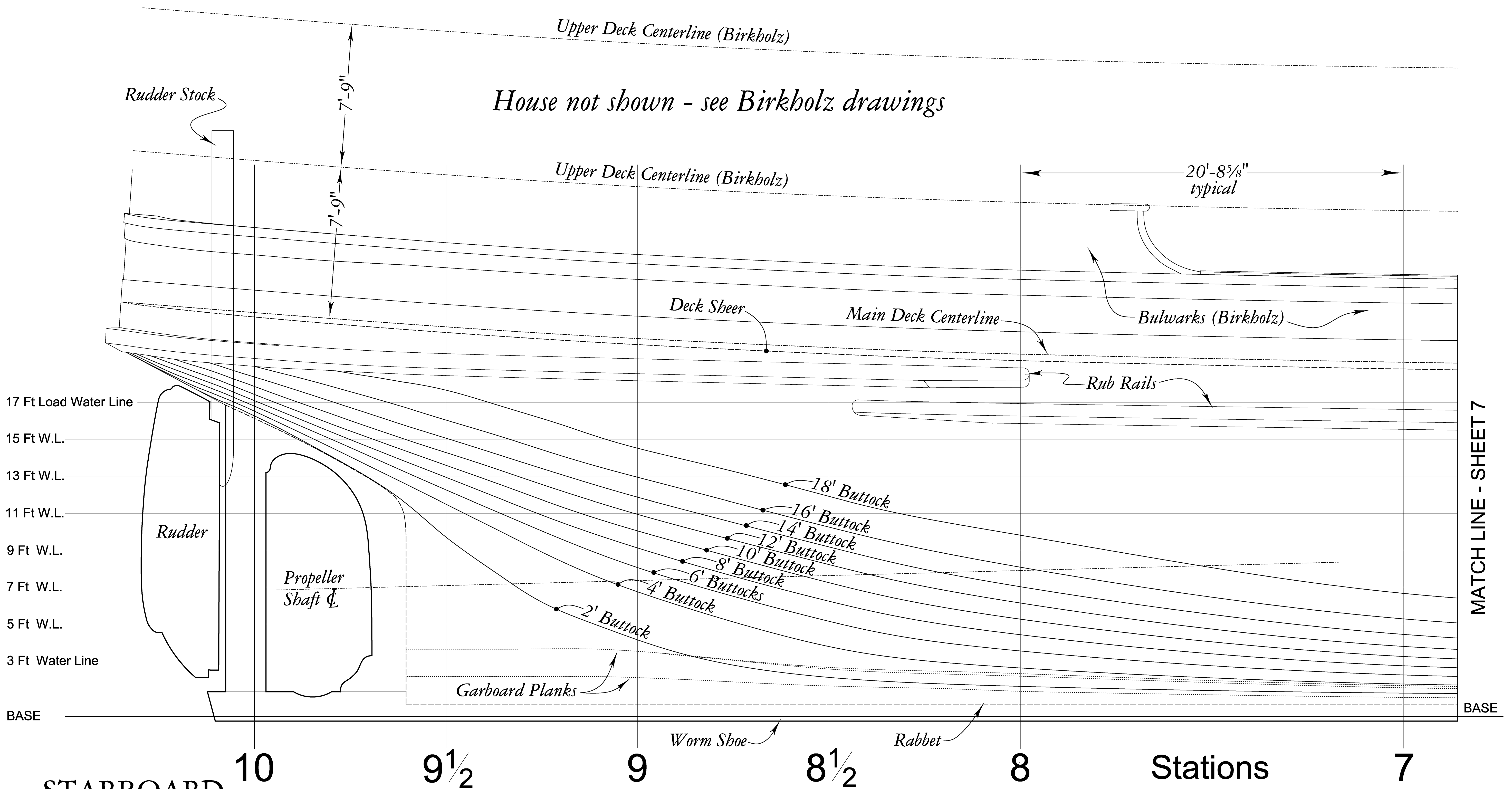
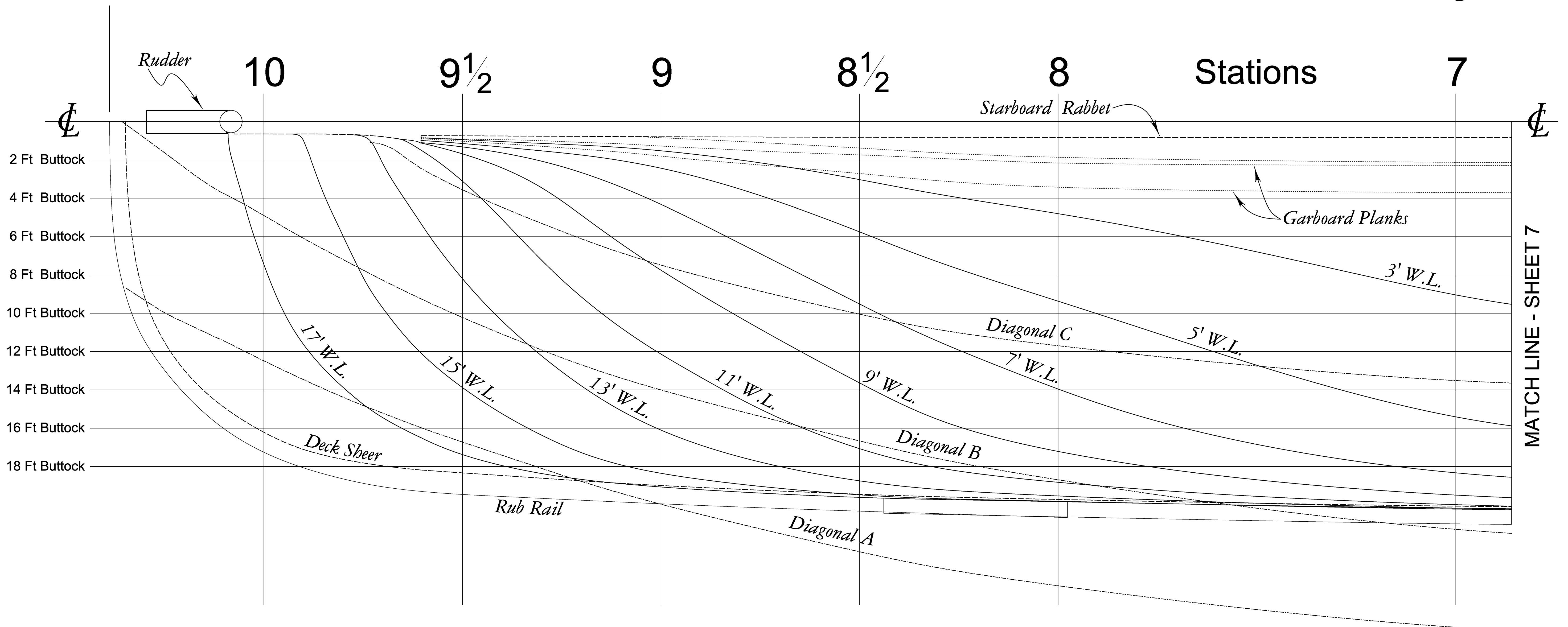
## STARBOARD PROFILE





# CORRECTED LINES: HALF-BREADTH PLAN

1 of 3



## STARBOARD PROFILE

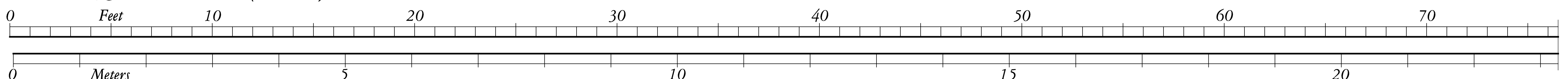
1. Lines are to the outside surfaces of hull planking, not to frames. Garboards are shown, but their surfaces were ignored in body sections. These lines treat the planking as if it faired smoothly to the keel.
2. Deck sheer is defined as the intersection of the outer planking surface with the upper surface of the main deck.

3. Plank sheer is defined as top of the 4 1/2" thick hull planking, at the base of bulwarks planking. Plank sheer is above the deck sheer.
4. Hull shape and sections for corrected lines were derived principally from 3-dimensional laser scanning data of a hogged and slightly twisted hull, supplemented by scantlings in measured drawings by Don Birkholz, Sr. Twist was corrected in

computer-aided design (CAD) software by tilting Sections 0-8 from "As-is" lines to port until their respective centerlines became vertical. The sections were set in a common centerline plane to remove the horizontal sweep in the keel before they were adjusted vertically to remove hog. From this point, hull symmetry was assumed and only the starboard side received further processing.

(Cont'd on Sheet 7)

Scale: 3/8" = 1'-0" (1:32)



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STEAM SCHOONER WAPAMA (1915)  
SHOAL POINT, END OF CANAL BOULEVARD  
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(Cont'd from Sheet 6)

*from a series of deck camber curves of 550'-4" radius set along the deck centerline, stem to stern.*

7. *The bulwarks and bulwark rail were built up from scantlings and profiles provided by the Birkholz drawings. Laser scanning data for the bulwarks was not complete enough to use for erecting drawings of this portion of the hull.*

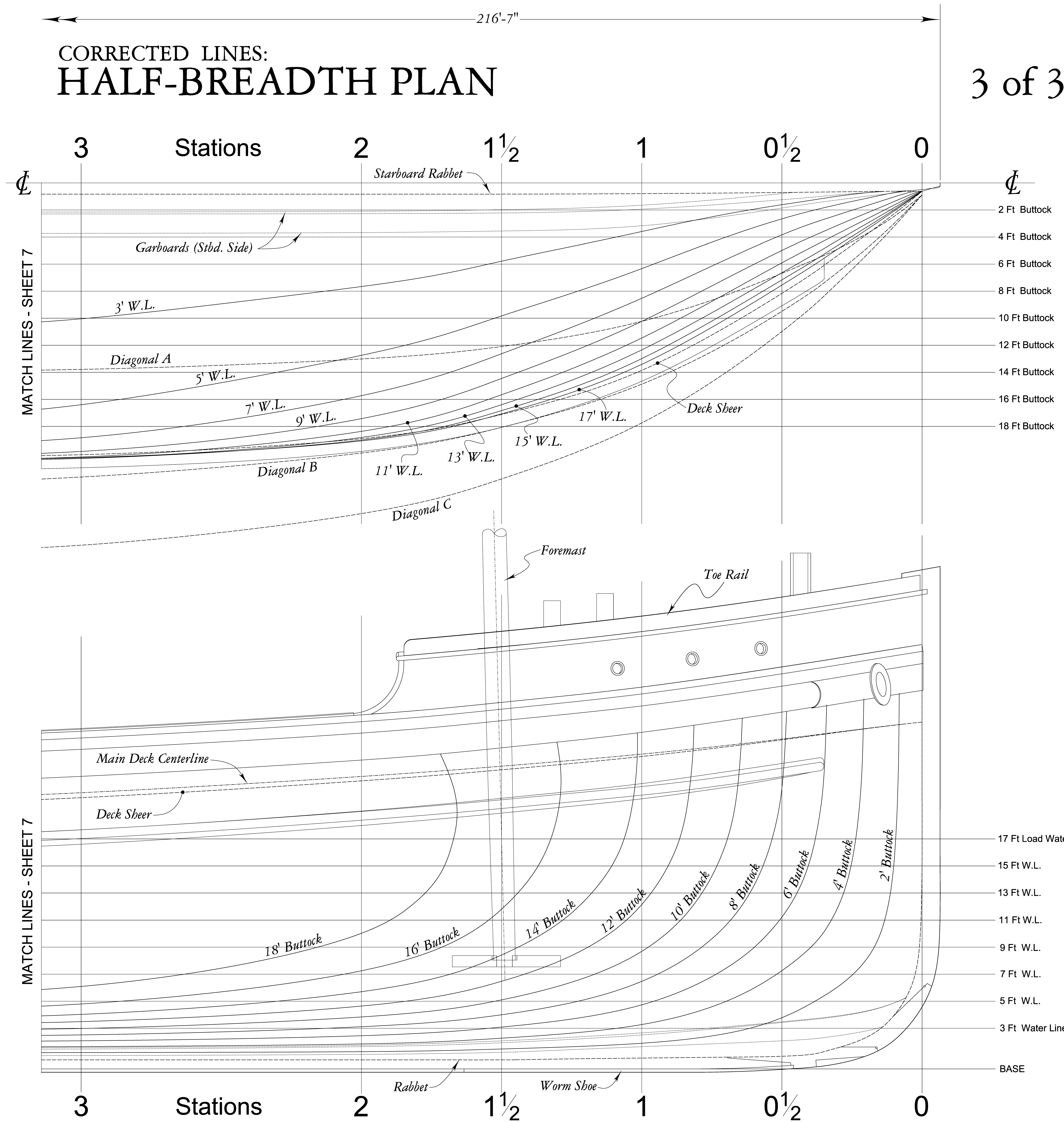
(Cont'd on Sheet 9)

A horizontal ruler with two scales. The top scale is labeled 'Feet' and ranges from 0 to 150, with major tick marks every 10 units and minor tick marks every 1 unit. The bottom scale is labeled 'Meters' and ranges from 0 to 45, with major tick marks every 5 units and minor tick marks every 1 unit. The two scales are aligned such that 0 feet corresponds to 0 meters, 100 feet corresponds to 30.48 meters, and 150 feet corresponds to 45.72 meters.



# CORRECTED LINES: HALF-BREADTH PLAN

3 of 3



## STARBOARD PROFILE

(Cont'd from Sheet 7)

8. The forecastle shown above was drawn entirely in 3-dimensional CAD from data in the Birkholz drawings, faired into the hull surface derived from scanner data.

9. The rub rails shown are based to a large degree on Birkholz drawings and scantlings. The present rub rails have a variety of cross sections, since they have been patched in numerous places. Field data

from scanners were incomplete for drawing these components in strict as-is condition.

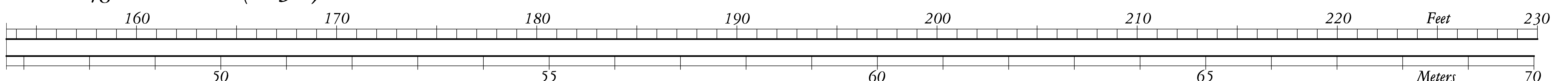
10. See measured drawings by Don Birkholz, Sr. for scantlings, particularly the midship section.

Length Over All: 216'-7" +/-1"

Distance between Stations 0 and 10: 207'-2 1/4"

Accuracy of corrected lines estimated to be +/- 1" except for lean intersections which may be +/- 3" or more

Scale: 3/8" = 1'-0" (1:32)



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SHOAL POINT, END OF CANAL BOULEVARD  
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CALIFORNIA

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9 22

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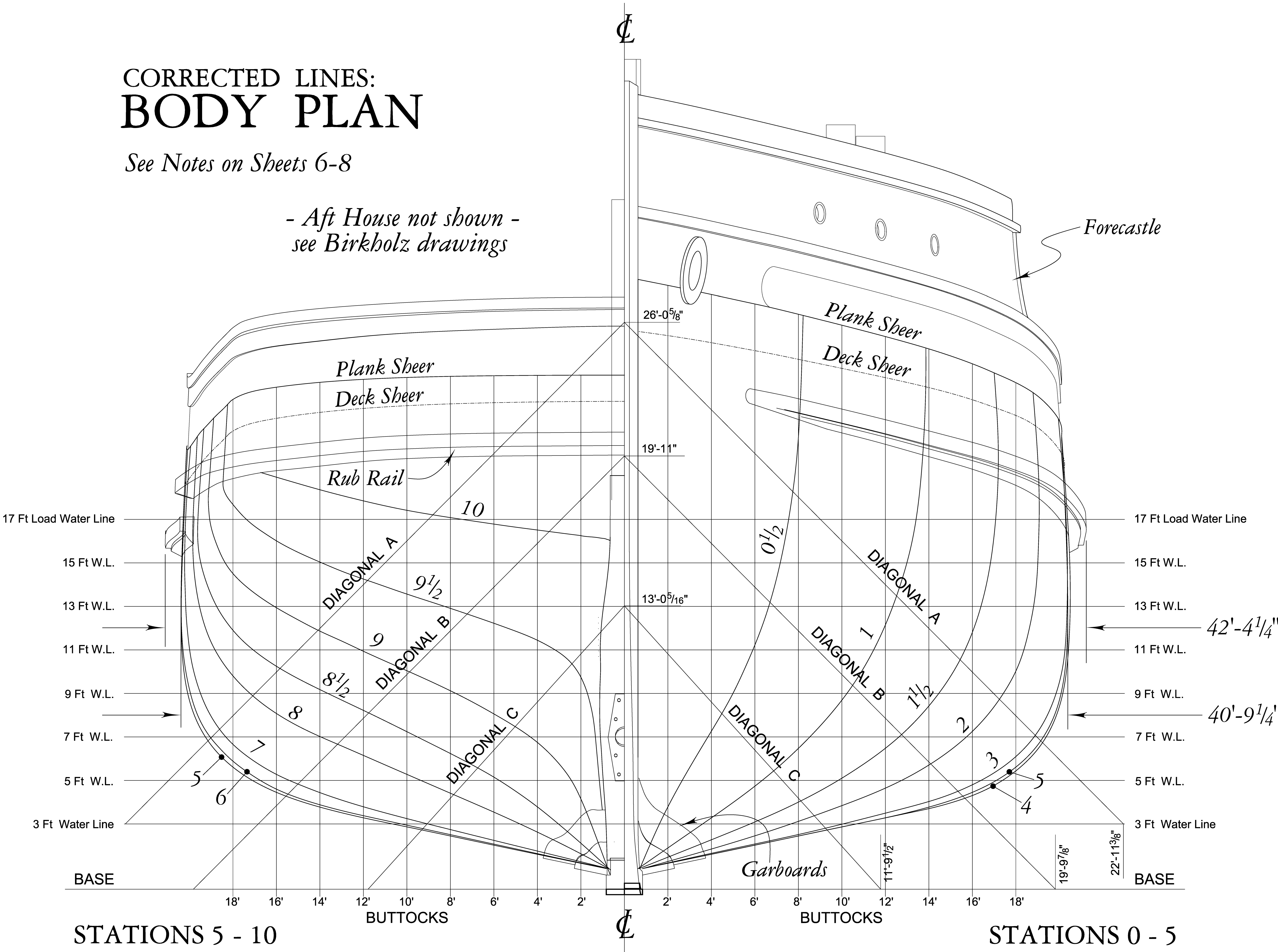
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CORRECTED LINES:  
BODY PLAN

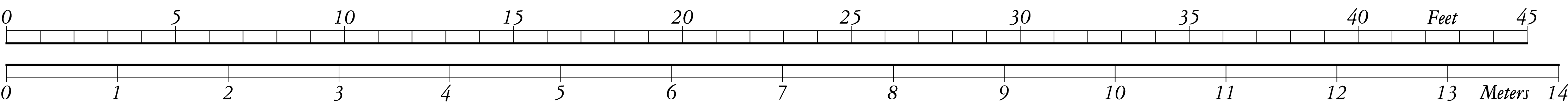
See Notes on Sheets 6-8

- Aft House not shown -  
see Birkholz drawings



		S T A T I O N S															
		10	9 1/2	9	8 1/2	8	7	6	5	4	3	2	1 1/2	1	1/2	0	
HEIGHTS above Base	Plank Sheer	23-0-6	22-3-4	21-7-7	21-2-0	20-9-6	20-4-4	20-2-4	20-4-4	20-10-1	21-7-4	22-10-0	23-8-7	24-10-4	26-4-4	28-0-4	
	Deck Sheer	21-7-2	20-9-2	20-1-3	19-7-3	19-3-0	18-9-4	18-7-4	18-9-4	19-3-1	20-0-4	21-3-4	22-1-3	23-1-1	24-3-7	25-7-5	
	18' Buttock		17-7-6	14-6-1	11-10-7	9-9-6	6-8-0	5-10-5	5-7-3	5-5-2	6-1-1	10-0-2					
	16' Buttock	18-11-2	16-0-3	12-11-2	10-3-0	8-1-0	5-3-3	4-7-2	4-5-3	4-3-5	4-9-5	7-3-0	11-9-5				
	14' Buttock	18-4-3	15-0-5	11-10-3	9-2-1	7-0-2	4-5-2	3-10-5	3-9-2	3-8-4	4-0-3	5-8-4	8-5-1				
	12' Buttock	17-10-2	14-3-2	10-11-2	8-2-5	6-1-5	3-9-4	3-4-4	3-3-3	3-3-3	3-6-0	4-7-6	6-5-6	12-1-6			
	10' Buttock	17-5-0	13-7-0	10-0-4	7-2-7	5-3-1	3-3-0	2-11-3	2-10-3	2-10-3	2-11-7	3-10-1	5-1-2	8-8-2			
	8' Buttock	17-1-0	12-11-2	9-1-4	6-2-7	4-5-0	2-8-7	2-6-1	2-5-3	2-5-3	2-6-1	3-1-3	4-0-0	6-5-5	20-9-0		
	6' Buttock	16-9-3	12-3-1	8-0-5	5-1-7	3-6-4	2-3-0	2-0-7	2-0-2	2-0-2	2-1-0	2-5-3	3-1-1	4-8-7	11-2-6		
	4' Buttock	16-6-1	11-5-7	6-9-0	3-9-3	2-7-5	1-9-0	1-7-5	1-7-2	1-7-2	1-7-6	1-10-2	2-3-2	3-3-3	7-3-1		
HALF-BREADTHS	2' Buttock	16-3-0	9-8-4	4-1-6	2-1-3	1-7-4	1-3-1	1-2-4	1-2-2	1-2-2	1-2-4	1-3-2	1-5-5	1-10-6	3-9-4		
	Rabbit	16-1-4	0-8-0											0-8-0	0-11-2	15-0-0	
	Plank Sheer	16-1-3	18-2-6	18-10-5	19-4-0	19-7-5	19-11-3	20-1-0	20-1-4	20-1-2	19-11-4	18-9-4	17-0-0	13-10-3	8-2-5	0-7-7	
	Deck Sheer	16-2-4	18-4-0	18-11-7	19-5-3	19-8-5	20-0-6	20-2-0	20-2-4	20-2-5	20-1-1	18-10-7	17-1-3	13-10-2	8-2-0	0-7-4	
	17' W.L.	7-5-4	17-4-4	19-0-7	19-7-3	19-10-0	20-2-1	20-3-0	20-3-3	20-4-4	20-3-6	19-0-7	17-0-7	13-5-0	7-6-5	0-7-4	
	15' W.L.		13-10-4	18-4-2	19-5-6	19-9-6	20-2-5	20-4-0	20-4-2	20-5-6	20-4-3	19-0-1	16-10-0	12-11-7	7-2-0		
	13' W.L.		8-2-3	16-1-2	18-9-0	19-6-3	20-2-0	20-4-4	20-4-5	20-6-0	20-4-2	18-9-6	16-4-6	12-4-1	6-7-5		
	11' W.L.		3-1-3	12-1-5	17-0-6	18-9-7	19-11-7	20-3-4	20-4-1	20-5-0	20-3-1	18-4-3	15-7-7	11-5-4	5-10-7		
	9' W.L.		1-8-2	7-9-0	13-7-5	17-2-4	19-5-7	19-11-3	20-0-1	20-1-7	19-10-2	17-5-1	14-5-4	10-2-6	4-11-7		
	7' W.L.		1-3-7	4-3-7	9-6-0	13-11-4	18-3-7	19-0-5	19-3-2	19-4-6	18-10-0	15-8-6	12-7-4	8-6-3	3-10-0		
Diagonals	5' W.L.		1-1-6	2-5-2	5-9-0	9-4-4	15-4-7	16-8-7	17-1-2	17-4-5	16-4-6	12-8-6	9-10-0	6-4-0	2-7-7		
	3' W.L.		0-11-3	1-6-3	3-0-3	4-9-5	9-0-4	10-3-1	10-8-0	10-8-0	10-0-4	7-7-7	5-9-3	3-7-1	1-7-3		
	Half-siding	0-7-7	0-9-0	0-9-4	0-9-7	0-10-0							0-10-0	0-9-4	0-8-4	0-7-4	
	A	12-5-6	16-8-5	19-11-5	22-5-3	24-2-5	26-4-5	26-11-4	27-1-5	27-3-1	26-9-3	24-5-3	21-10-5	17-8-7	10-11-6	0-10-5	
Diagonals	B	4-10-6	10-2-5	14-0-0	16-8-0	18-8-3	21-3-3	21-11-1	22-0-6	22-2-3	21-8-7	19-11-5	18-0-7	14-10-4	9-5-7	0-10-5	
	C		3-6-6	7-5-7	10-0-5	11-8-3	13-6-1	13-9-6	13-10-6	13-10-6	13-9-3	13-0-1	12-1-1	10-2-6	6-7-5		

Scale: 1/2" = 1'-0" (1:24)





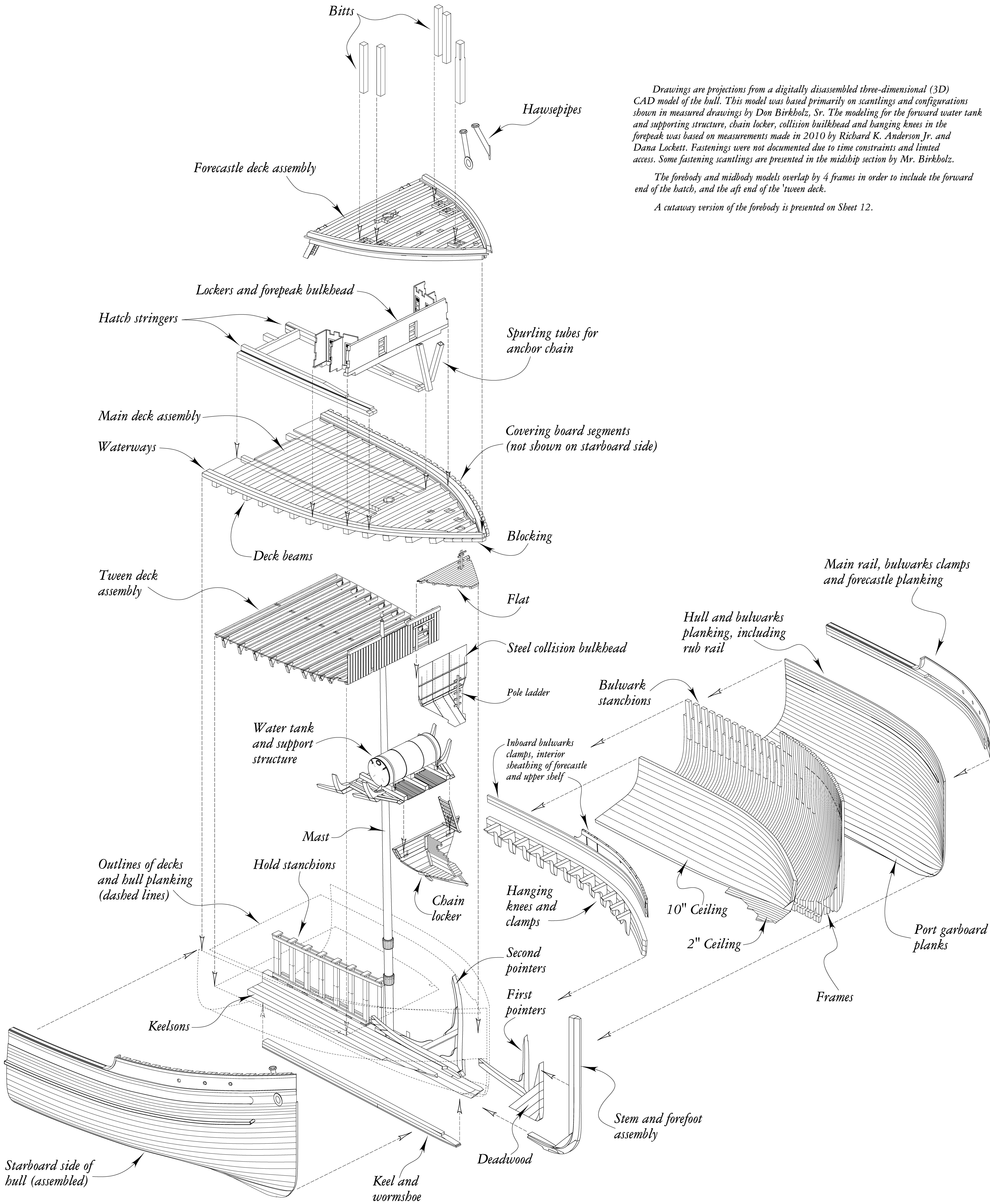
# FOREBODY CONSTRUCTION

## FRAMES 0 - 29

Drawings are projections from a digitally disassembled three-dimensional (3D) CAD model of the hull. This model was based primarily on scantlings and configurations shown in measured drawings by Don Birkholz, Sr. The modeling for the forward water tank and supporting structure, chain locker, collision bulkhead and hanging knees in the forepeak was based on measurements made in 2010 by Richard K. Anderson Jr. and Dana Lockett. Fastenings were not documented due to time constraints and limited access. Some fastening scantlings are presented in the midship section by Mr. Birkholz.

The forebody and midbody models overlap by 4 frames in order to include the forward end of the hatch, and the aft end of the 'tween deck.

A cutaway version of the forebody is presented on Sheet 12.



Richard K. Anderson, Jr., 2011.

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STEAM SCHOONER WAPAMA (1915)  
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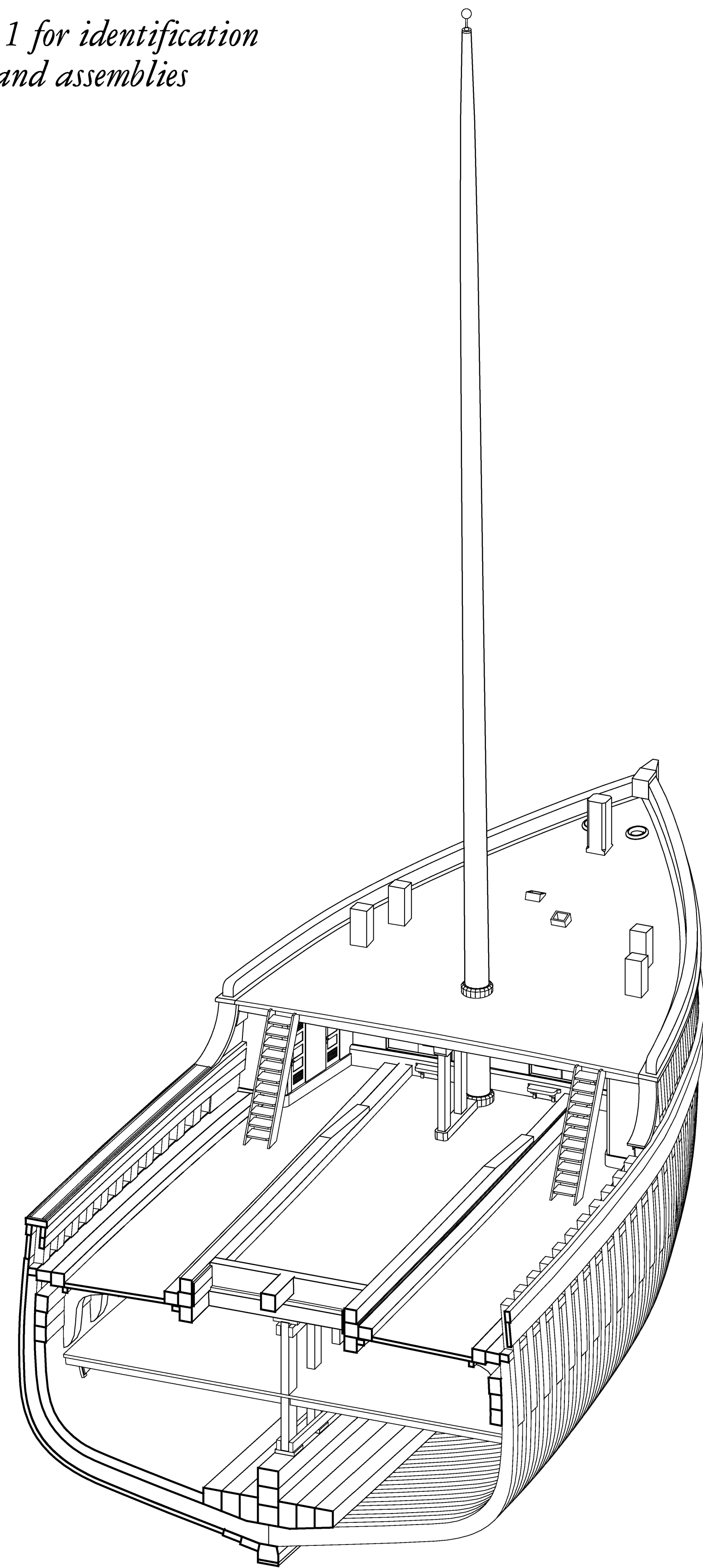
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# FOREBODY CONSTRUCTION

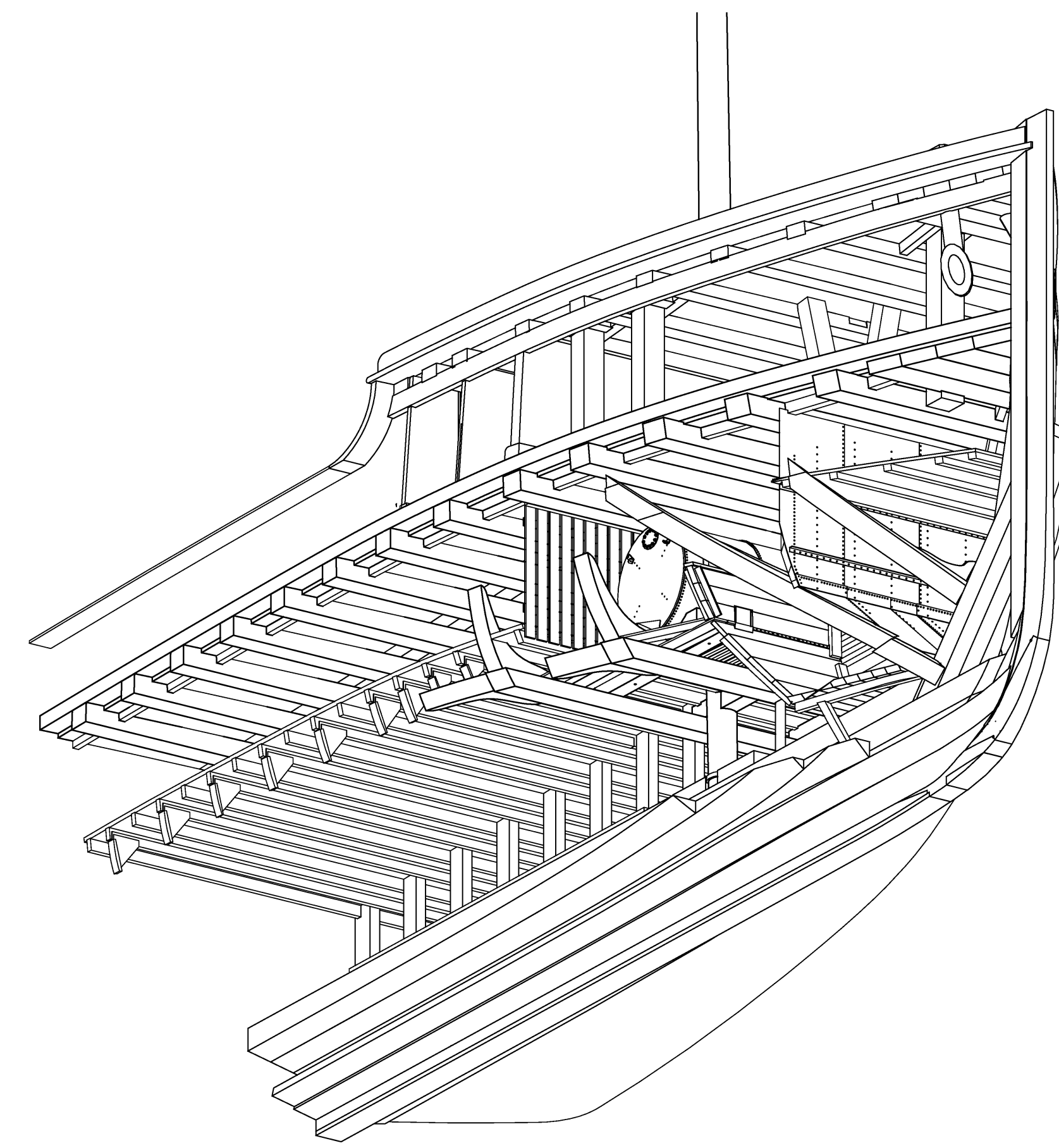
FRAMES 0 - 29

*See Sheet 11 for identification  
of timbers and assemblies*

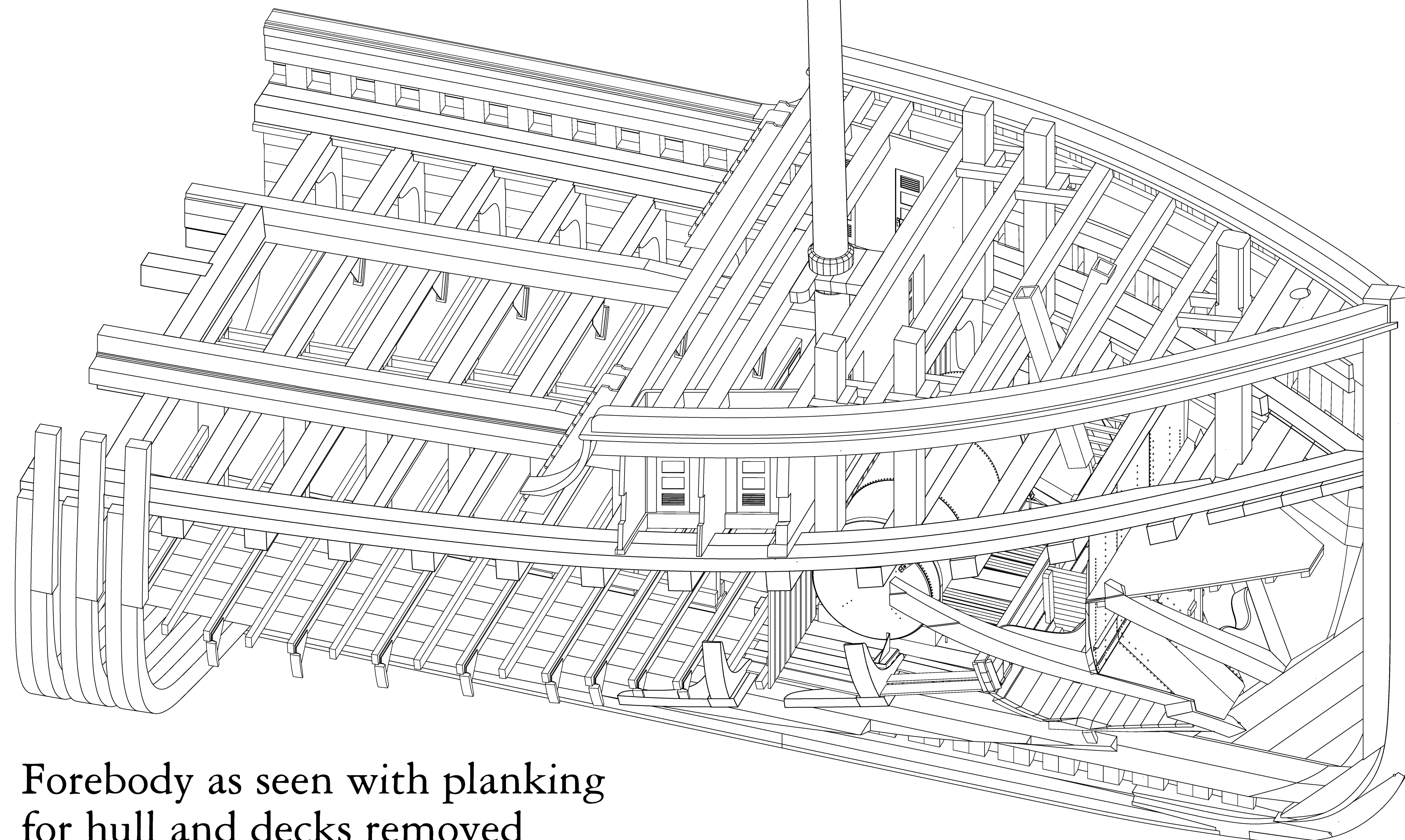


Forebody as seen from  
astern, starboard hull  
planking removed  
to show frames

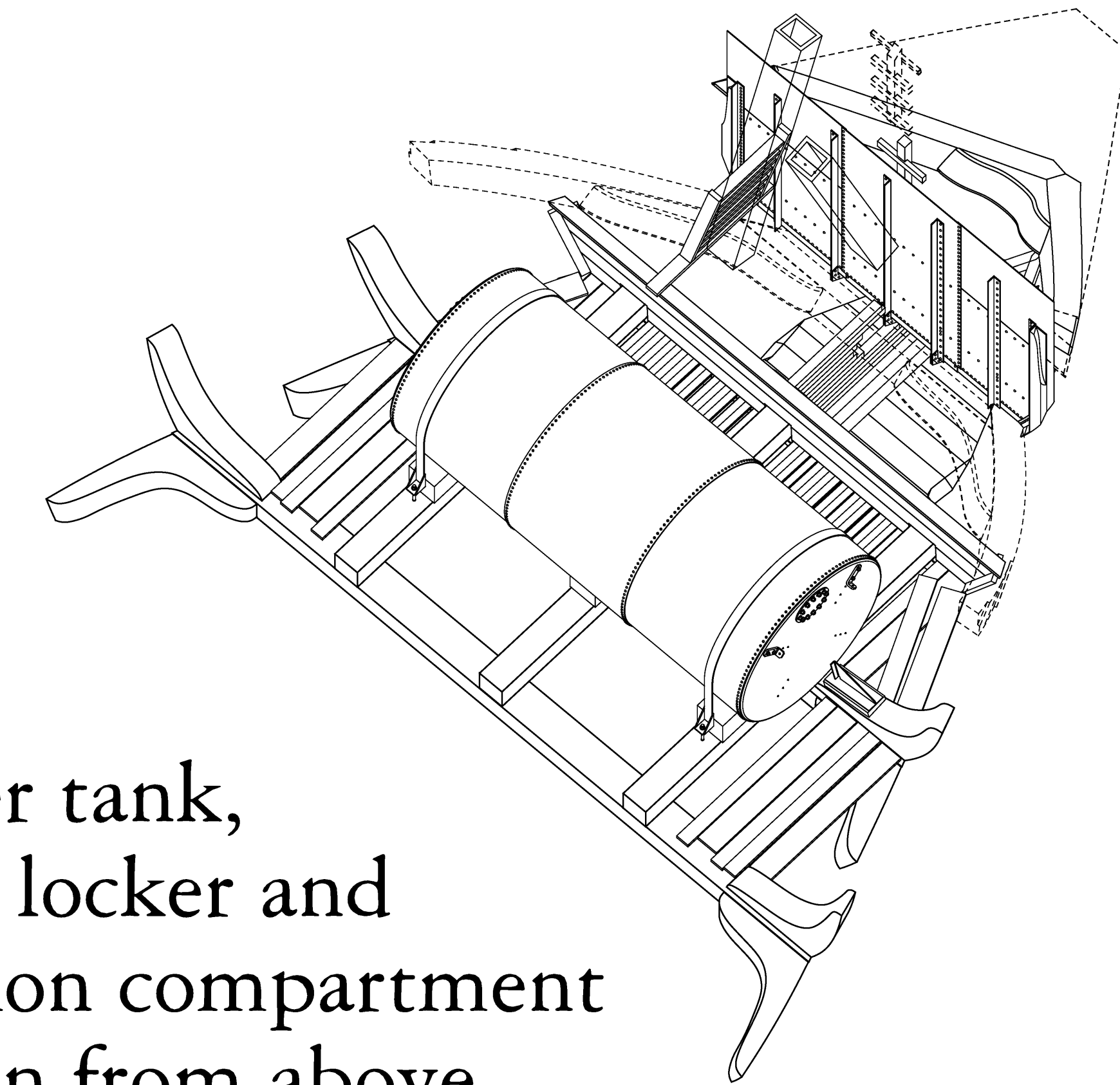
*Deck and ceiling plank joints were  
omitted for clarity in this view*



Forebody as seen from  
below, starboard side  
removed



Forebody as seen with planking  
for hull and decks removed



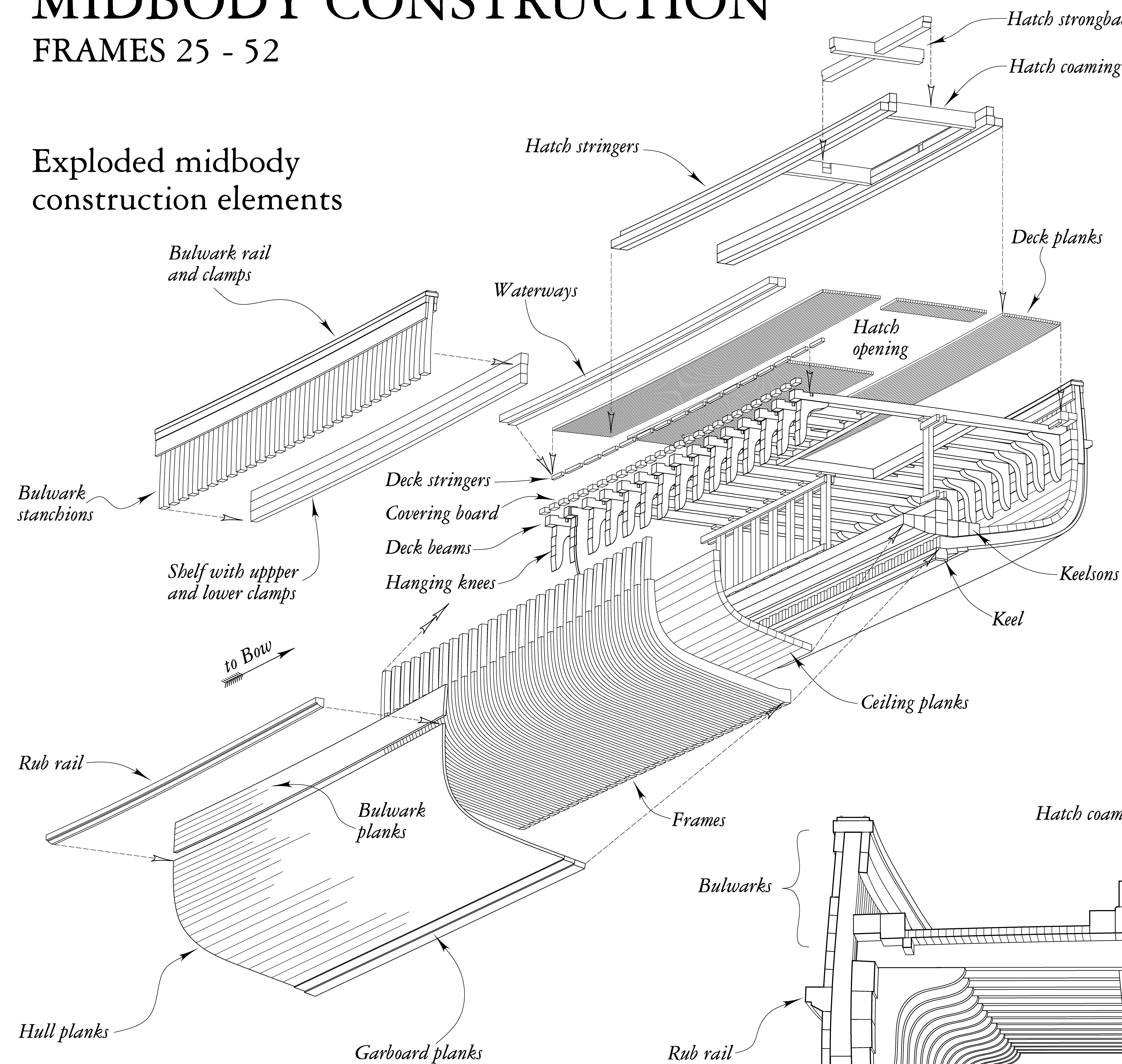
Water tank,  
chain locker and  
collision compartment  
as seen from above  
without surrounding hull



# MIDBODY CONSTRUCTION

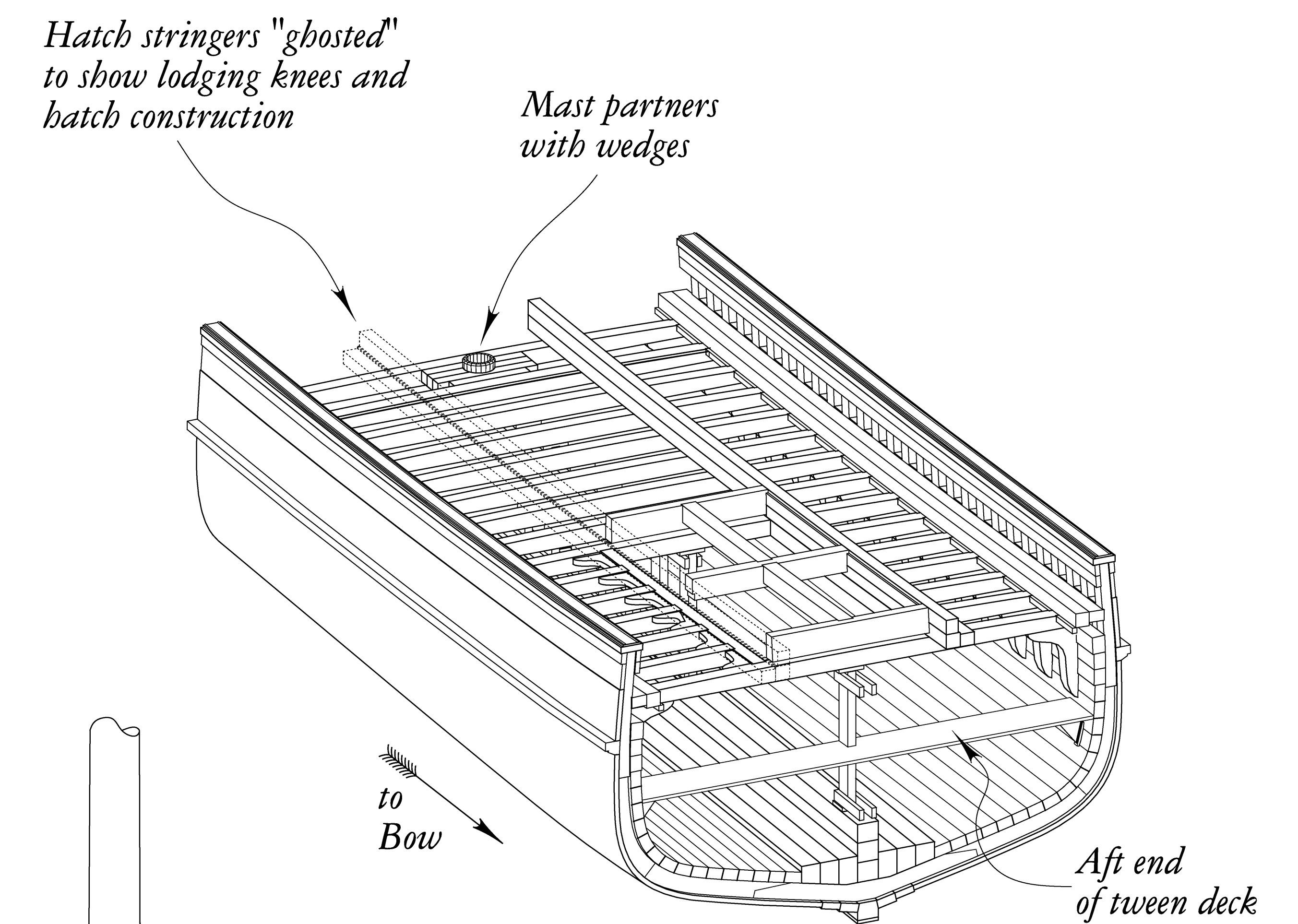
## FRAMES 25 - 52

### Exploded midbody construction elements

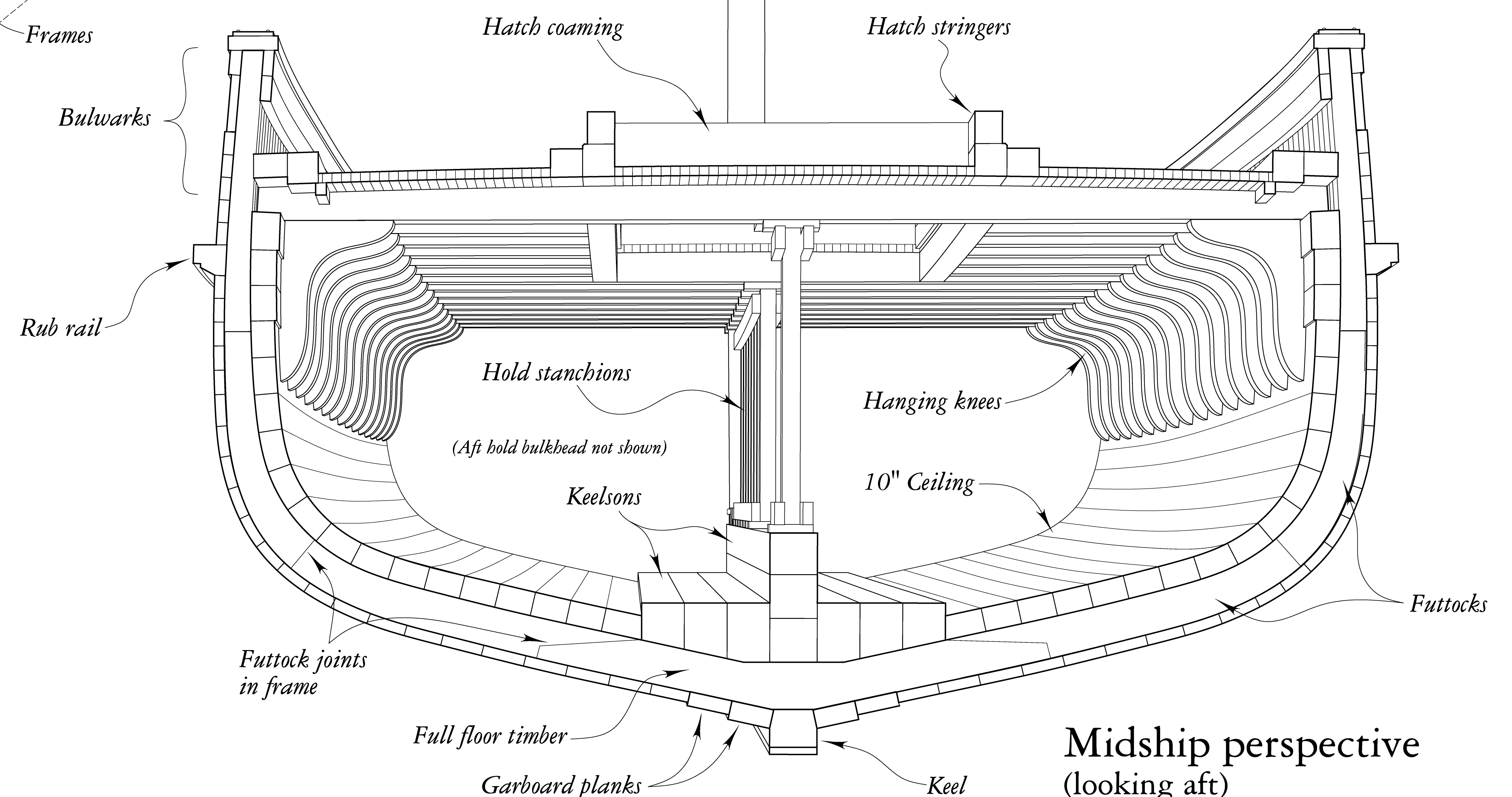


Drawings here are projections from a three-dimensional (3D) CAD model of the hull, digitally disassembled for some views. This model was based primarily on scantlings and configurations shown in measured drawings by Don Birkholz, Sr. Fastenings were not documented in 2010 due to time constraints and limited access. Some fastening scantlings are presented in Birkholz's midship section. (At the time of her construction, fastening types and spacing, along with spacing of butt joints in planks in Wapama's hull were specified by insurance company regulations.)

The end of the 'tween deck and the bulkhead between the hold and aft machinery spaces were omitted for clarity in the midship perspective. The aft house was omitted in all views to better show hull construction. The full floor in the layer of each frame was not modeled in 3D because the varying dimensions for the floors and futtocks along the hull were not verifiable. The exploded view treats both frame layers and covers as if they butted at the ship's centerline. See Sheet 14 for an exploded view of a typical midship frame which more accurately portrays frame construction.



### Assembled midbody (main deck removed)

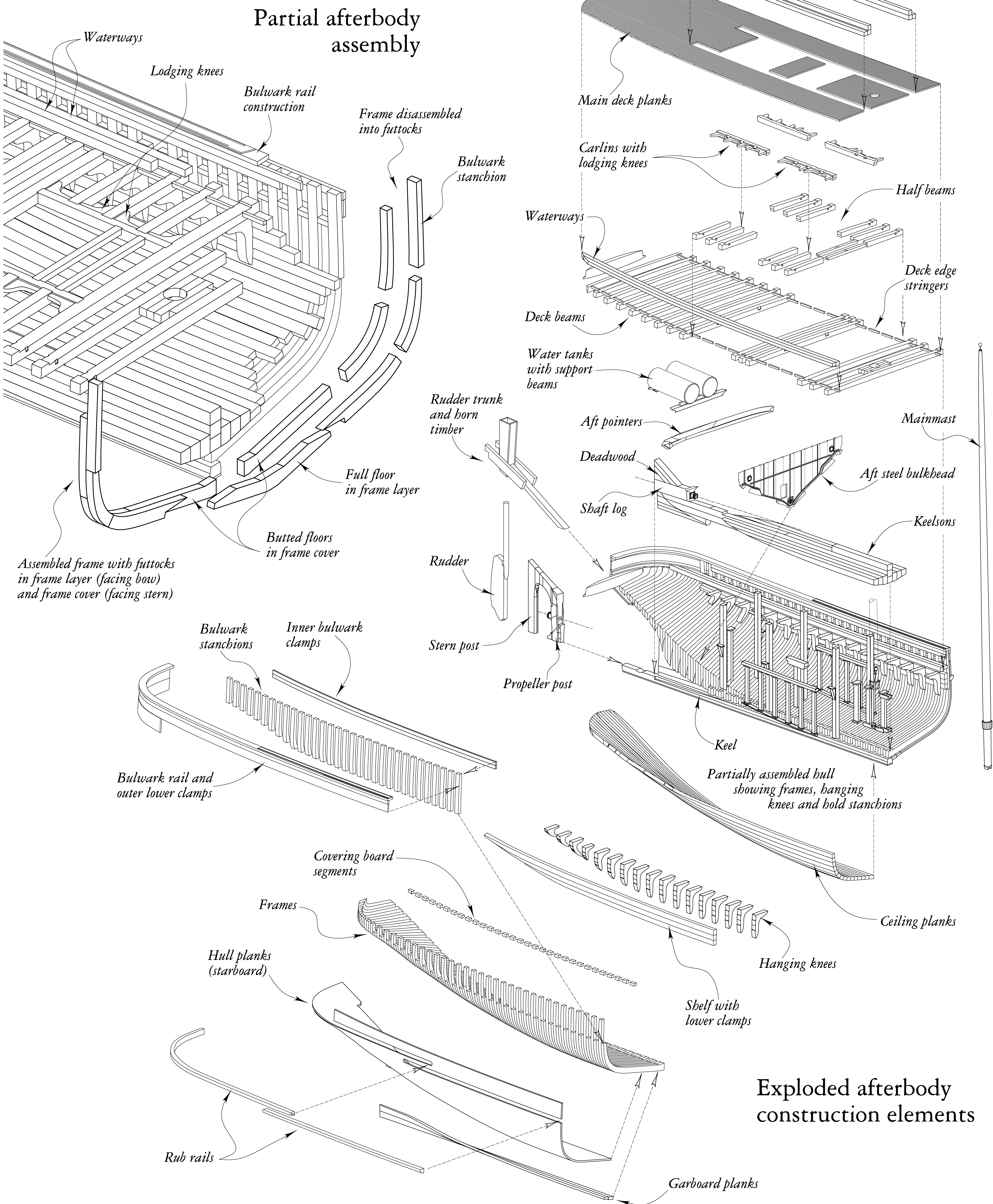


### Midship perspective (looking aft)



# AFTERBODY CONSTRUCTION

FRAMES 49 - 84





# AFTERBODY CONSTRUCTION

## FRAMES 49 - 84: Machinery Spaces

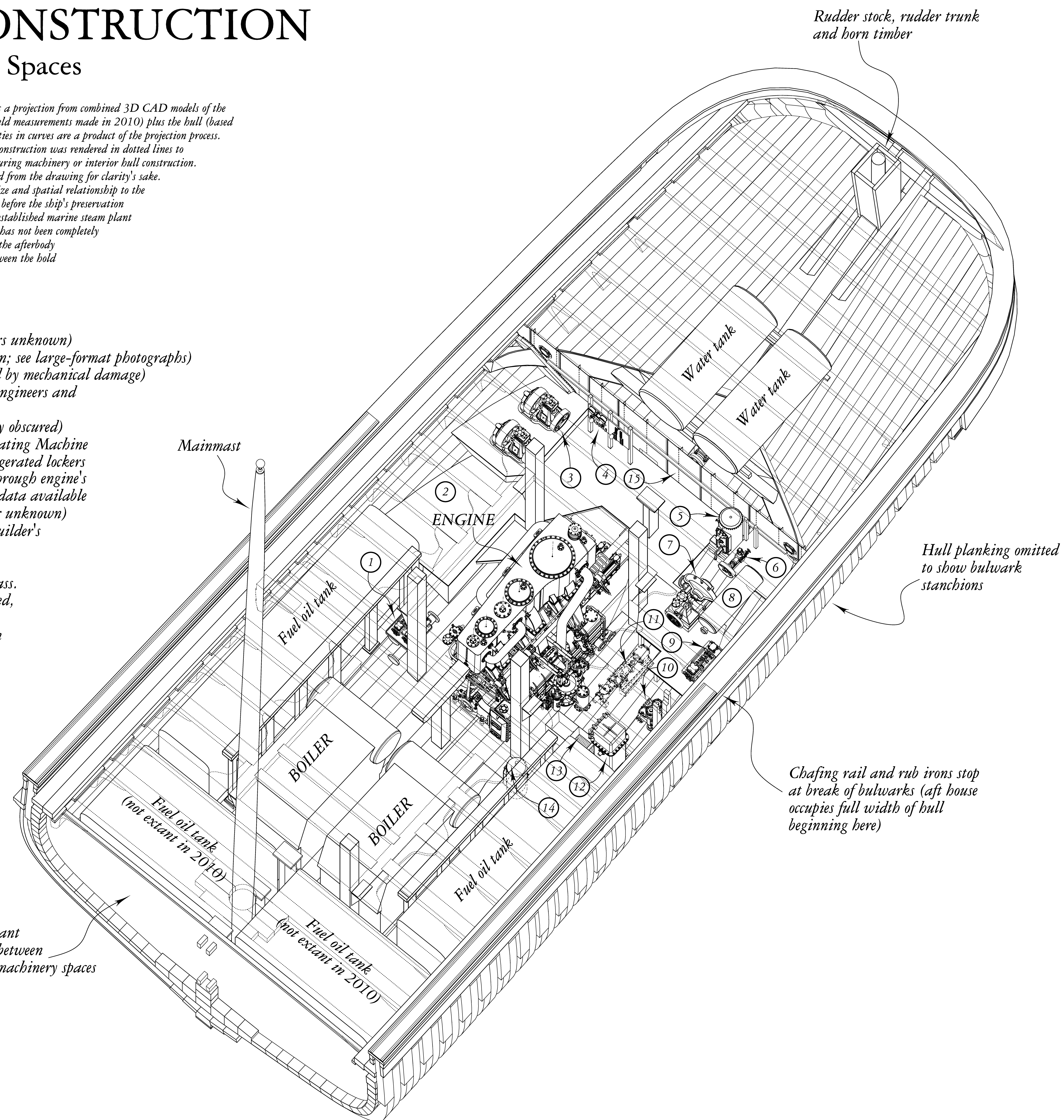
*This drawing of WAPAMA's afterbody and main machinery spaces is a projection from combined 3D CAD models of the ship's triple-expansion steam engine and its auxiliary machinery (based on field measurements made in 2010) plus the hull (based on previous drawings made in 1985 by Don Birkholz, Sr.). Any irregularities in curves are a product of the projection process. No portions of the engine or hull were disassembled for documentation. Deck construction was rendered in dotted lines to show relationships between deck structure, boilers and the engine without obscuring machinery or interior hull construction. Maintenance galleries around the engine (visible in photographs) were omitted from the drawing for clarity's sake. Auxiliaries such as pumps, dynamos and tanks were included to show their size and spatial relationship to the engine. However, piping of all sizes has been omitted; much of it was removed before the ship's preservation as a museum property, and its layout can only be inferred from general, well-established marine steam plant engineering principles. Construction of deck and bulwark timbers at the stern has not been completely documented; speculative reconstructions were not attempted. The 3D model of the afterbody overlaps that of the midbody by 3 frames in order to include the bulkhead between the hold and the machinery spaces.*

### Numbered Parts:

- 1) Fuel heaters and reciprocating pumps (manufacturers unknown)
- 2) Platform for tools and parts storage (racks not shown; see large-format photographs)
- 3) Sturtevant dynamos (builder's plates partly obscured by mechanical damage)
- 4) Switchboard (built by Herzog & Bahl, Electrical Engineers and Contractors, San Francisco, California)
- 5) Grissom-Russell evaporator (builder's plate partially obscured)
- 6) Ammonia compressor (built by T.P. Jarvis Refrigerating Machine Works, San Francisco, California) for galley's refrigerated lockers
- 7) Centrifugal circulating pump for forcing seawater through engine's condenser (built into engine bed); no builder's plate data available
- 8) Steam-heated potable hot water tank (manufacturer unknown)
- 9) Worthington two-cylinder reciprocating pump; no builder's plate data available
- 10) Blake & Knowles 7 $\frac{1}{2}$ " x 5" x 6" two-cylinder reciprocating pump; serial no. 213982, Boston, Mass.
- 11) Electric fire pump (installed in 1960s; shown dashed, no builder's data recorded)
- 12) Pacific Feed Water Filter & Heater (built by Main Street Iron Works, San Francisco, California)
- 13) Hotwell (no builder's plate discernible)
- 14) Evaporator (disconnected, no builder's plate discernible)
- 15) Aft steel watertight bulkhead

*Blake & Knowles 10" x 6" x 10" two-cylinder reciprocating pump in upper engine room is not shown*

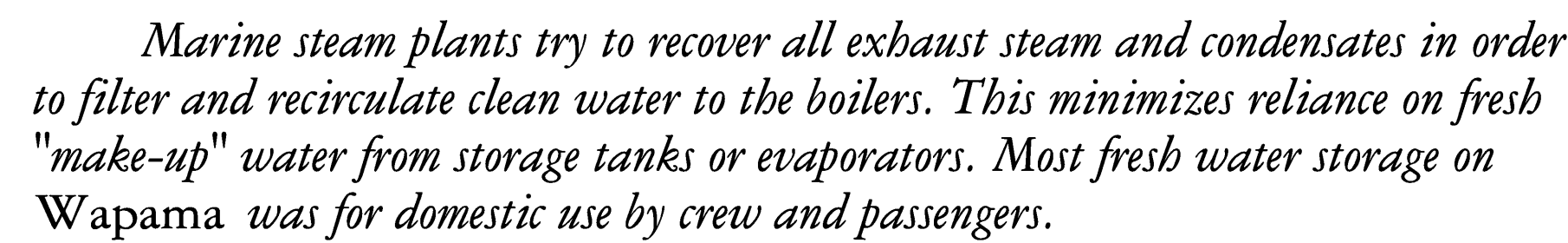
*Fire-resistant bulkhead between hold and machinery spaces*





*This piping diagram is based on general features of marine steam propulsion plants (c. 1915) and an extensive field survey of surviving piping aboard Wapama. Much original piping was removed prior to 2010, and no piping diagrams specific to this vessel are known to survive.*

*The engine room contains several major subsystems, principally fuel oil for the boilers, supply steam to the engine and auxiliaries, exhaust steam and condensate returns to the condenser, potable (and boiler feedwater) supply from onboard tanks, make-up water from evaporators, and seawater supply and disposal (for condenser, bilge draining and fire systems).*



*A marine plant is designed with many redundant systems so that a ship can continue sailing when equipment malfunctions or cannot be repaired until the ship reaches port. Most on-board pumps are extensively cross-connected to the engine, potable water supply, boiler feedwater supply, fire system and bilge drains. If one or more pumps should break down, others can take up their duties through opening and closing appropriate valves in cross-connecting manifolds. Except for the fuel oil system, the manifolds and their connections aboard Wapama are missing; consequently it isn't possible to produce a diagram showing anything more than general connections.*

The connections shown in this drawing are schematic and do not necessarily represent any physical piping connections among auxiliaries. Some auxiliaries have been rotated 90 or 180 degrees in plan from their true position aboard 'Wapama' so that significant features and piping connections are more easily displayed. The ammonia compressor for on-board refrigeration was omitted because it is electrically driven; the modern electrically-driven fire pump (installed after the vessel became a museum property) was also omitted.

*Richard K. Anderson, Jr., 2012.*

**STEAM SCHOONER WAPAMA RECORDING PROJECT**  
NATIONAL PARK SERVICE  
UNITED STATES DEPARTMENT OF THE INTERIOR

**RICHMOND**

**STEAM SCHOONER WAPAMA (1915)**  
SHOAL POINT, END OF CANAL BOULEVARD  
CONTRA COSTA COUNTY

## CALIFORNIA

SHEET OF SHEET  
16 22

HISTORIC AMERICAN  
ENGINEERING RECORD  
CA-67

IF REPRODUCED, PLEASE CREDIT HISTORIC AMERICAN ENGINEERING RECORD, NATIONAL PARK SERVICE, NAME OF DELINEATOR, DATE OF THE DRAWING.



# STARBOARD SIDE

Wapama's 800 horsepower triple-expansion steam engine was built by Main Street Iron Works of San Francisco, California. The diameters of its cylinders are 13" (high pressure), 23" (intermediate pressure) and 40" (low pressure) with a 30" stroke for all pistons. Its eccentrics have a 6" throw; valve travel varies with valve gear settings.

Drawings are projections from a 3D CAD model of the engine based on field measurements; any irregularities in curves are a product of the projection process. No portions of the engine were disassembled for documentation.

Engine cranks are 120° apart. For illustration purposes the intermediate crank has been modeled at 90° with other cranks positioned accordingly. All other rotating and reciprocating parts were modeled in proper locations relative to the crank positions.

During modeling, it appeared that the two low pressure eccentrics had been moved about 2" aft of their proper positions on the crankshaft. Nothing else could account for the misalignment between the eccentrics' fore/aft centerlines and the centerline for the low pressure valve stem and expansion link. Engine has been modeled and drawn with eccentrics in corrected positions.

Eccentric phase angles relative to the cranks were not analyzed for correct position. They were modeled as-found. The forwardmost eccentric is keyed to the crankshaft, but it could not be determined if any or all other eccentrics were similarly keyed.

The engine is mounted on a 1.5° degree incline inside the hull. It is shown level in these orthogonal views.

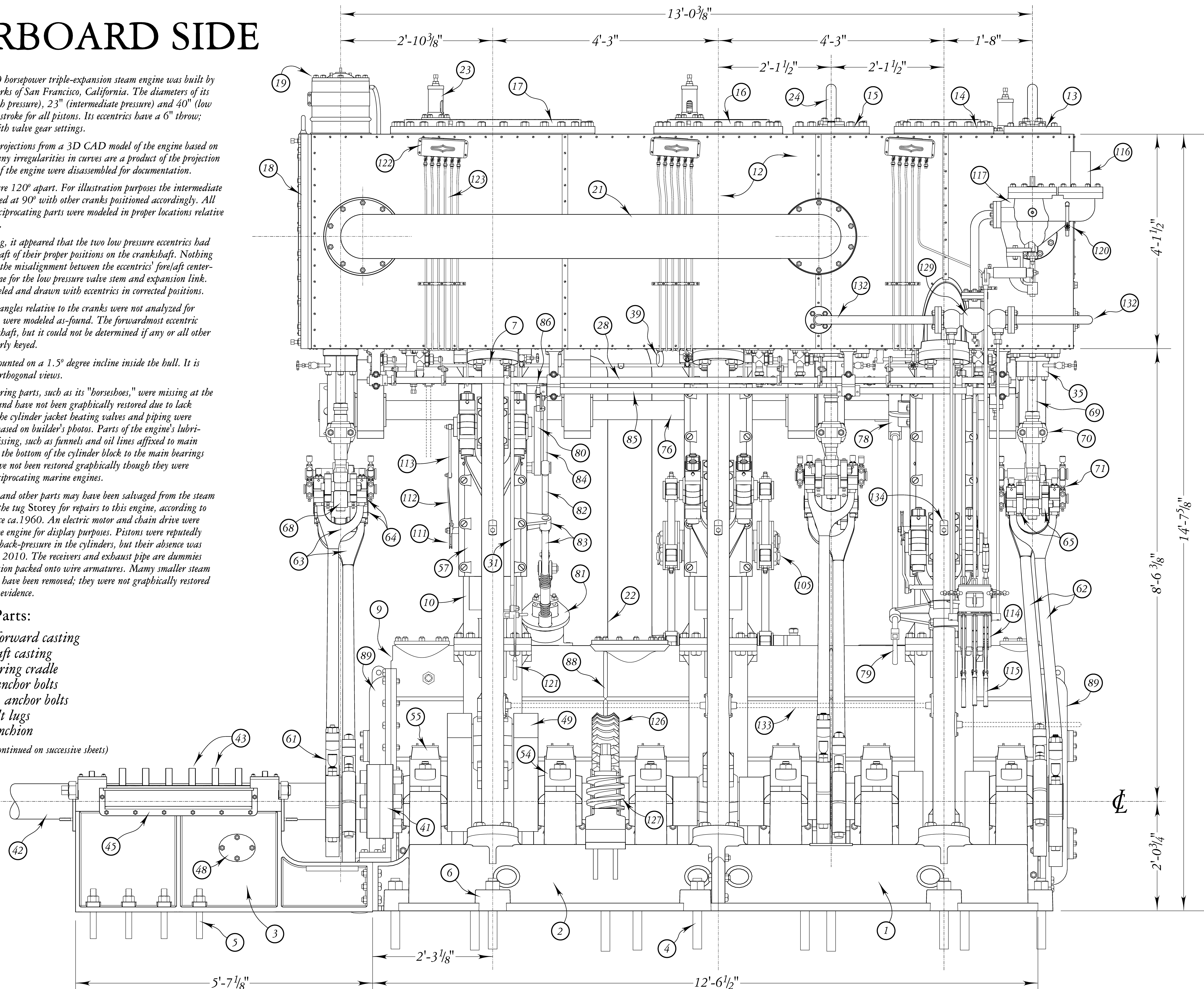
Many thrust bearing parts, such as its "horseshoes," were missing at the time of documentation and have not been graphically restored due to lack of specific evidence. The cylinder jacket heating valves and piping were graphically restored based on builder's photos. Parts of the engine's lubrication system were missing, such as funnels and oil lines affixed to main rods to carry oil from the bottom of the cylinder block to the main bearings in the rods. These have not been restored graphically though they were typical features on reciprocating marine engines.

Bearing brasses and other parts may have been salvaged from the steam schooner Celilo and the tug Storey for repairs to this engine, according to museum correspondence ca.1960. An electric motor and chain drive were installed to revolve the engine for display purposes. Pistons were reputedly removed to eliminate back-pressure in the cylinders, but their absence was not verified on site in 2010. The receivers and exhaust pipe are dummies made up from insulation packed onto wire armatures. Many smaller steam pipes and drain lines have been removed; they were not graphically restored due to lack of specific evidence.

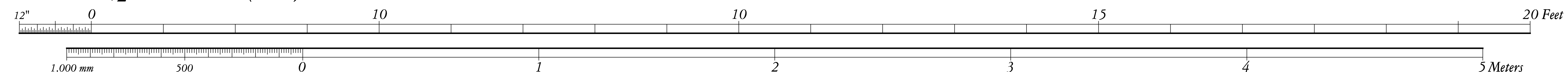
## Numbered Parts:

1. Bedplate, forward casting
2. Bedplate, aft casting
3. Thrust bearing cradle
4. 2" diam. anchor bolts
5. 13/8" diam. anchor bolts
6. Anchor bolt lugs
7. Engine stanchion

(Number key continued on successive sheets)



Scale: 1 1/2" = 1'-0" (1:8)





# TOP VIEW of ENGINE

Numbered Parts: (continued from Sheet 17)

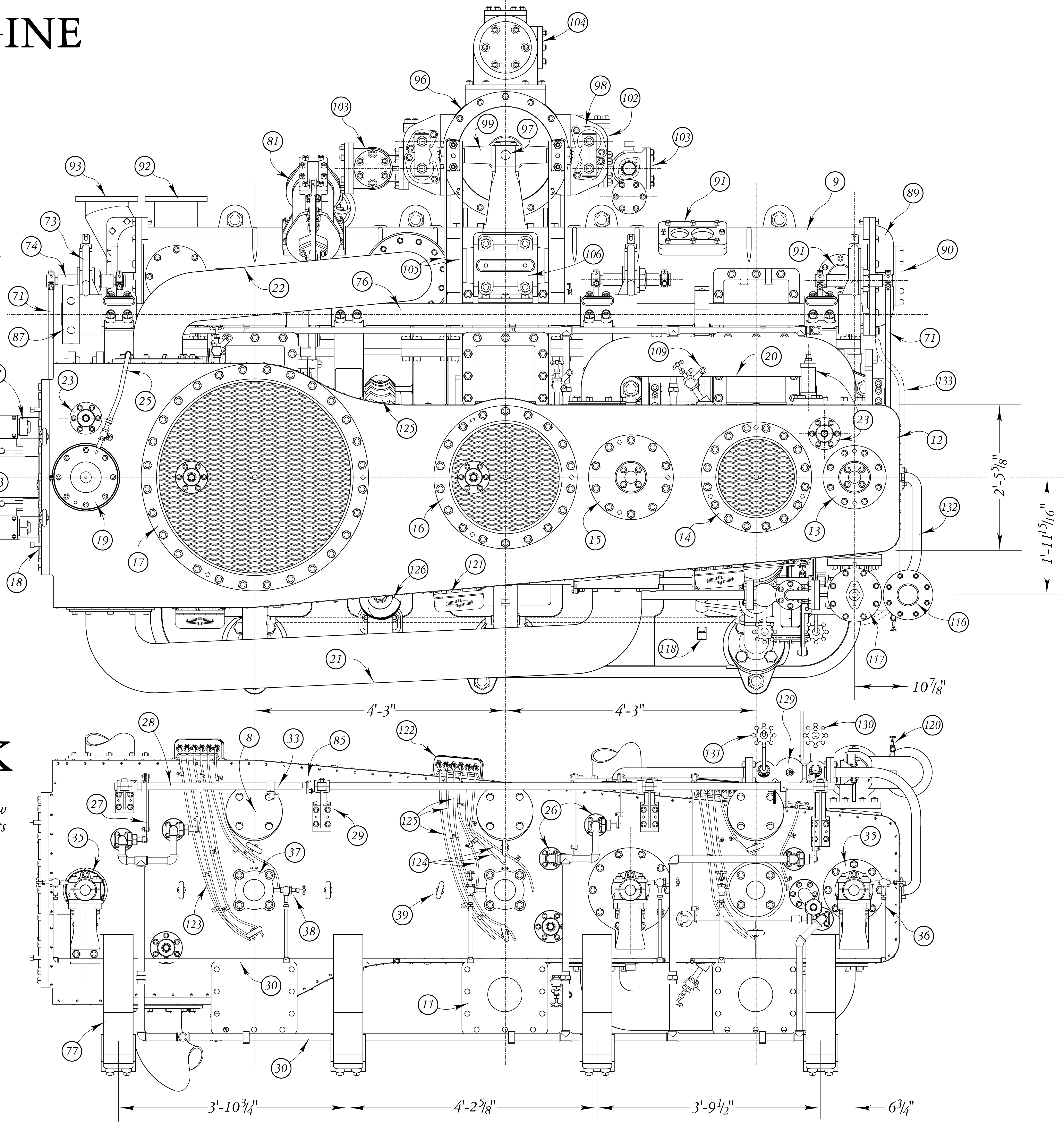
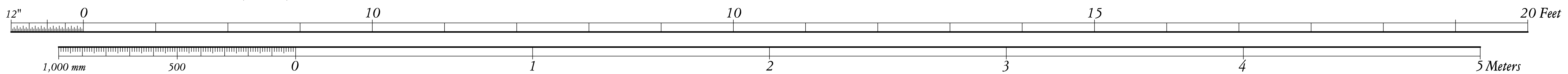
- |                                      |   |
|--------------------------------------|---|
| 8. Stanchion seat                    | 34. Fore actuating lever for drain cock shaft                                       |
| 9. Surface condenser                 | 35. Valve stem packing gland and guide bearing                                      |
| 10. Housing                          | 36. Valve stem packing gland drain line and valve                                   |
| 11. Housing seat                     | 37. Piston rod packing gland  |
| 12. Cylinder block                   | 38. Piston rod packing gland drain line and valve                                   |
| 13. High pressure (HP) valve         | 39. Lifting eye (for chain falls to remove or install parts beneath cylinder block) |
| 14. 13" HP cylinder                  | 40. Crankshaft  |
| 15. Intermediate pressure (IP) valve | 41. Shaft coupling  |
| 16. 23" IP cylinder                  |   |
| 17. 40" Low pressure (LP) cylinder   |   |
| 18. LP valve                         |   |
| 19. LP valve balance cylinder        |   |
| 20. HP to IP receiver                |   |

- |  |                          |
|--|--------------------------|
| 21. IP to LP receiver                        | 42. Propeller shaft      |
| 22. Exhaust line to condenser                | 43. Thrust bearing disks |
| 23. Water (condensate) relief valve, typical | 44. Oil bath             |
| 24. Valve rod tail guide                     | 45. Side oil pan         |

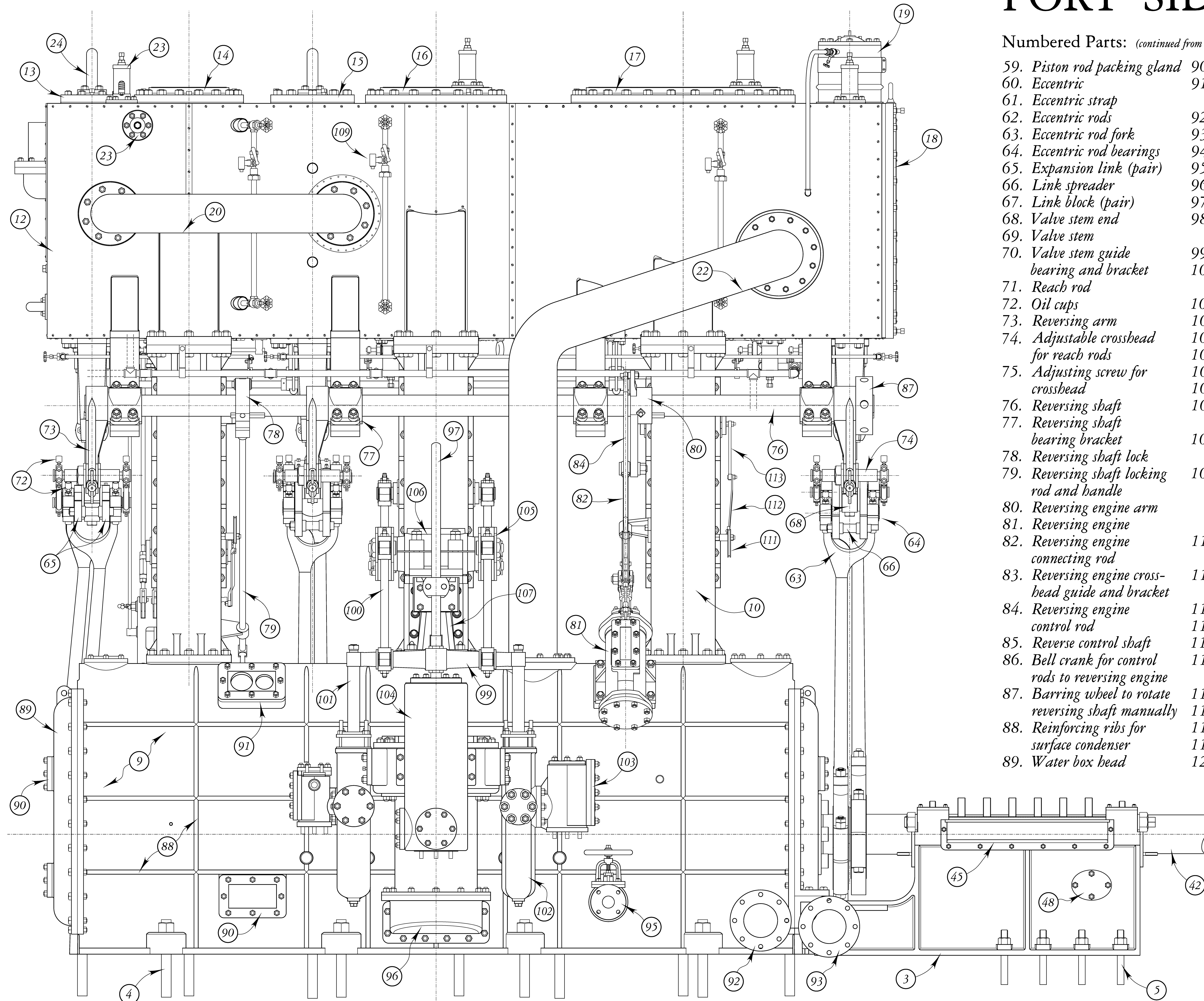
# BOTTOM of CYLINDER BLOCK

- |  |  |
|--|--|
| 25. Balance cylinder drain line              | 46. Horseshoe adjustment screw   |
| 26. Cylinder or valve chamber drain cock     | 47. Adjustment screw lock nuts   |
| 27. Drain cock operating lever and link      | 48. Oil pan clean-out port   |
| 28. Drain cock operating shaft               | 49. Crank, 30" stroke  |
| 29. Drain cock operating shaft bracket       | 50. Connecting rod   |
| 30. Brass drain line (to condenser)          | 51. Connecting rod lower bearing   |
| 31. Drain cock rod                           | 52. Oil hole   |
| 32. Aft drain control lever                  | 53. Holes for missing bracket, oil line and funnel once affixed to each main rod |
| 33. Aft actuating lever for drain cock shaft | 54. Crankshaft bearing cap   |
|  | 55. Oil cellar   |
|  | 56. Crosshead  |
|  | 57. Crosshead guides   |
|  | 58. Piston rod   |

Scale:  $1\frac{1}{2}" = 1'-0"$  (1:8)

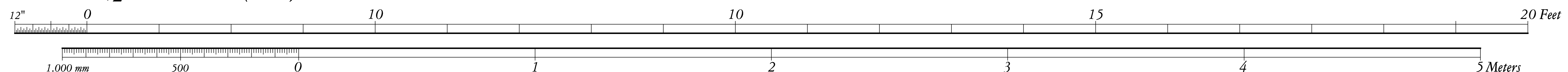






All piping to/from feed pumps and surge chamber was removed before 1960;  
cover plates were installed over all openings.

Scale:  $1\frac{1}{2}" = 1'-0"$  (1:8)



# PORT SIDE

Numbered Parts: (continued from Sheet 18)

- |  |  |
|--|--|
| 59. Piston rod packing gland                         | 90. Inspection port  |
| 60. Eccentric  | 91. Auxiliary exhaust steam inlet  |
| 61. Eccentric strap                                  | 92. Cooling water outlet   |
| 62. Eccentric rods                                   | 93. Cooling water inlet  |
| 63. Eccentric rod fork                               | 94. Exhaust/condensate inlet   |
| 64. Eccentric rod bearings                           | 95. Valve (unidentified)   |
| 65. Expansion link (pair)                            | 96. Air pump   |
| 66. Link spreader                                    | 97. Air pump rod   |
| 67. Link block (pair)                                | 98. Packing gland and nuts (not extant)  |
| 68. Valve stem end                                   | 99. Crosshead  |
| 69. Valve stem                                       | 100. Driving rods from walking beams   |
| 70. Valve stem guide bearing and bracket             | 101. Feed pump rams  |
| 71. Reach rod  | 102. Feed pump bodies  |
| 72. Oil cups   | 103. Valve box   |
| 73. Reversing arm                                    | 104. Surge chamber   |
| 74. Adjustable crosshead for reach rods              | 105. Walking beams   |
| 75. Adjusting screw for crosshead                    | 106. Walking beam bearing  |
| 76. Reversing shaft                                  | 107. Bracket for walking beam bearing  |
| 77. Reversing shaft bearing bracket                  | 108. Brumbo pulley for IP indicator  |
| 78. Reversing shaft lock                             | 109. Indicator fitting (indicator device not installed unless valve timing needs adjustment) |
| 79. Reversing shaft locking rod and handle           | 110. Indicator piping and shut-off valves  |
| 80. Reversing engine arm                             | 111. Brumbo pulley (drives an indicator via string or chain)                                 |
| 81. Reversing engine                                 | 112. Pulley arm  |
| 82. Reversing engine connecting rod                  | 113. Pulley link   |
| 83. Reversing engine cross-head guide and bracket    | 114. Controller quadrant   |
| 84. Reversing engine control rod                     | 115. Levers for control of drains, reverse, and throttle                                     |
| 85. Reverse control shaft                            | 116. Steam inlet from boilers  |
| 86. Bell crank for control rods to reversing engine  | 117. Throttle valve chamber  |
| 87. Barring wheel to rotate reversing shaft manually | 118. Throttle lever  |
| 88. Reinforcing ribs for surface condenser           | 119. Throttle rod  |
| 89. Water box head                                   | 120. Throttle valve drain line   |

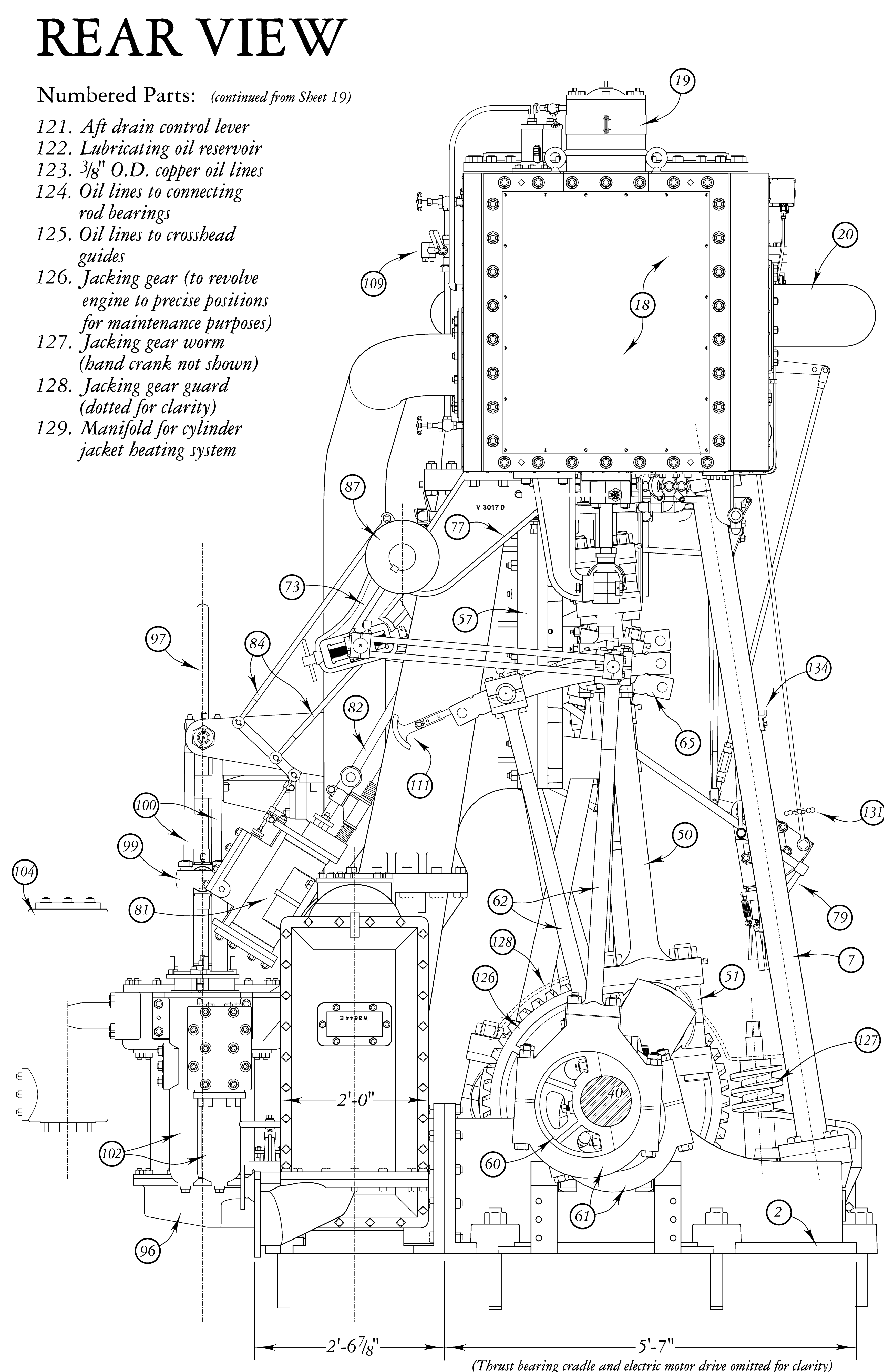
(continued on Sheet 20)



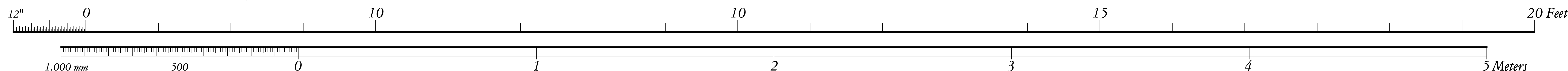
# REAR VIEW

Numbered Parts: (continued from Sheet 19)

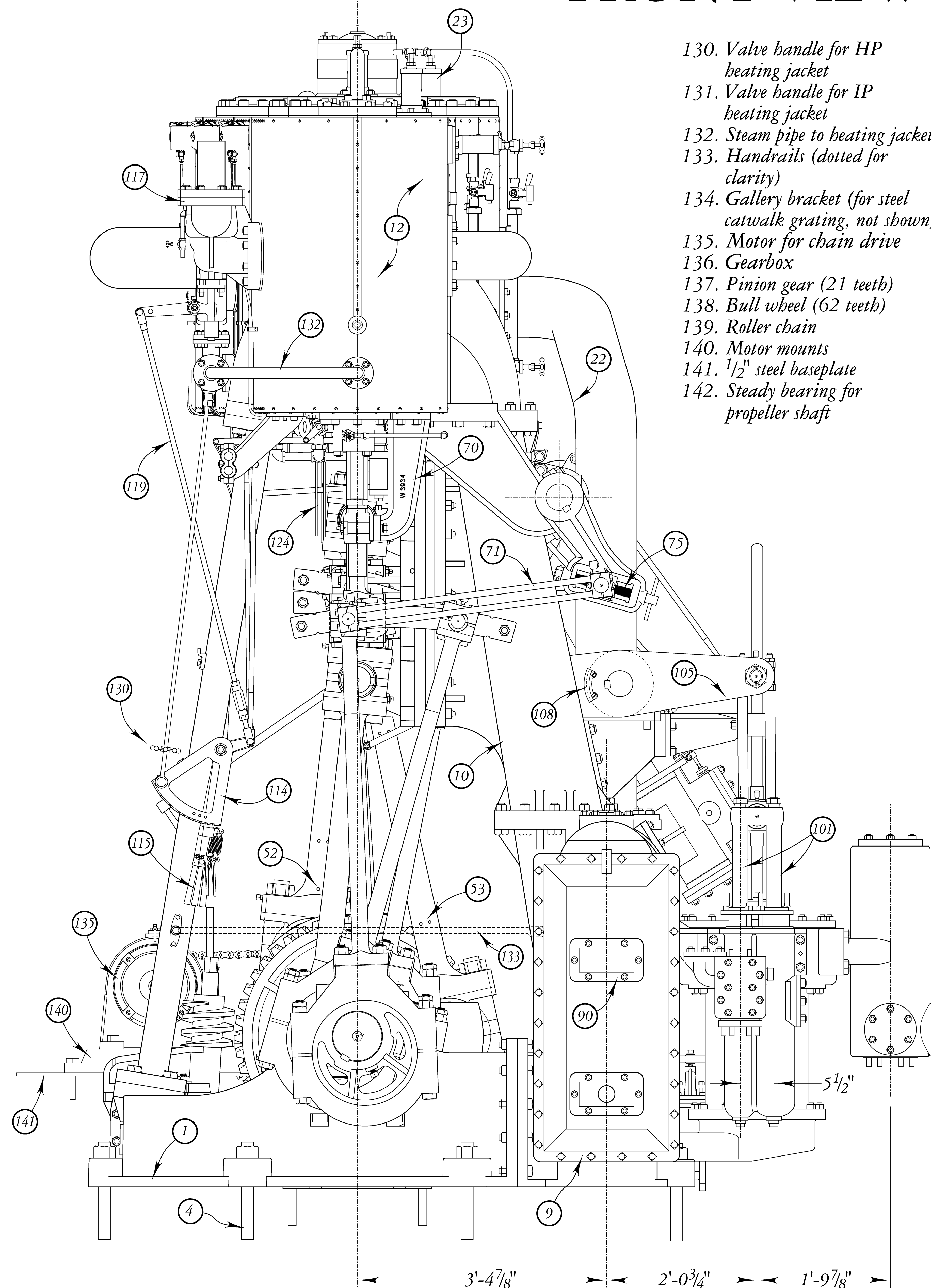
- 121. Aft drain control lever
- 122. Lubricating oil reservoir
- 123. 3/8" O.D. copper oil lines
- 124. Oil lines to connecting rod bearings
- 125. Oil lines to crosshead guides
- 126. Jacking gear (to revolve engine to precise positions for maintenance purposes)
- 127. Jacking gear worm (hand crank not shown)
- 128. Jacking gear guard (dotted for clarity)
- 129. Manifold for cylinder jacket heating system



Scale: 1 1/2" = 1'-0" (1:8)



# FRONT VIEW



- 130. Valve handle for HP heating jacket
- 131. Valve handle for IP heating jacket
- 132. Steam pipe to heating jacket
- 133. Handrails (dotted for clarity)
- 134. Gallery bracket (for steel catwalk grating, not shown)
- 135. Motor for chain drive
- 136. Gearbox
- 137. Pinion gear (21 teeth)
- 138. Bull wheel (62 teeth)
- 139. Roller chain
- 140. Motor mounts
- 141. 1/2" steel baseplate
- 142. Steady bearing for propeller shaft



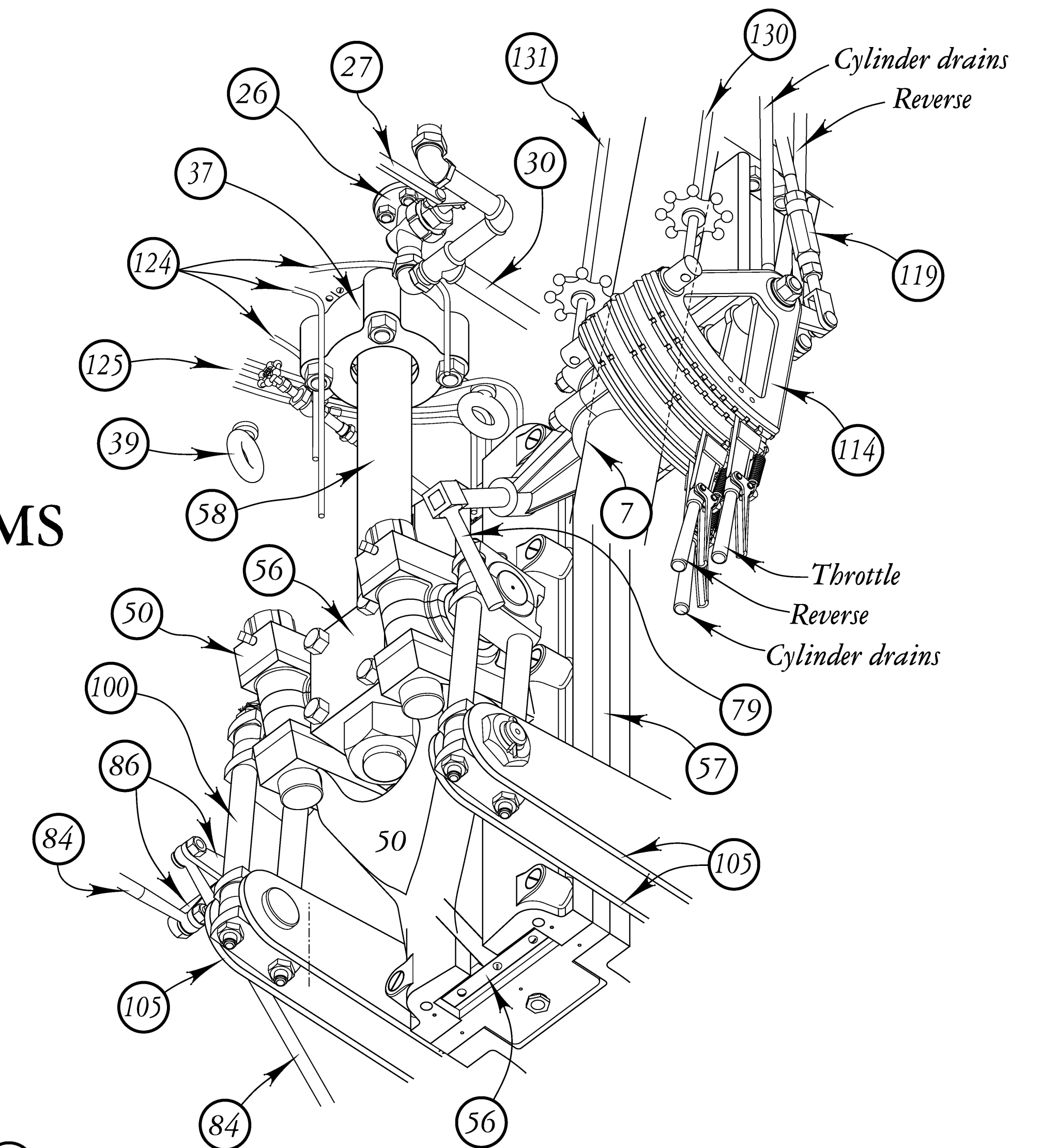
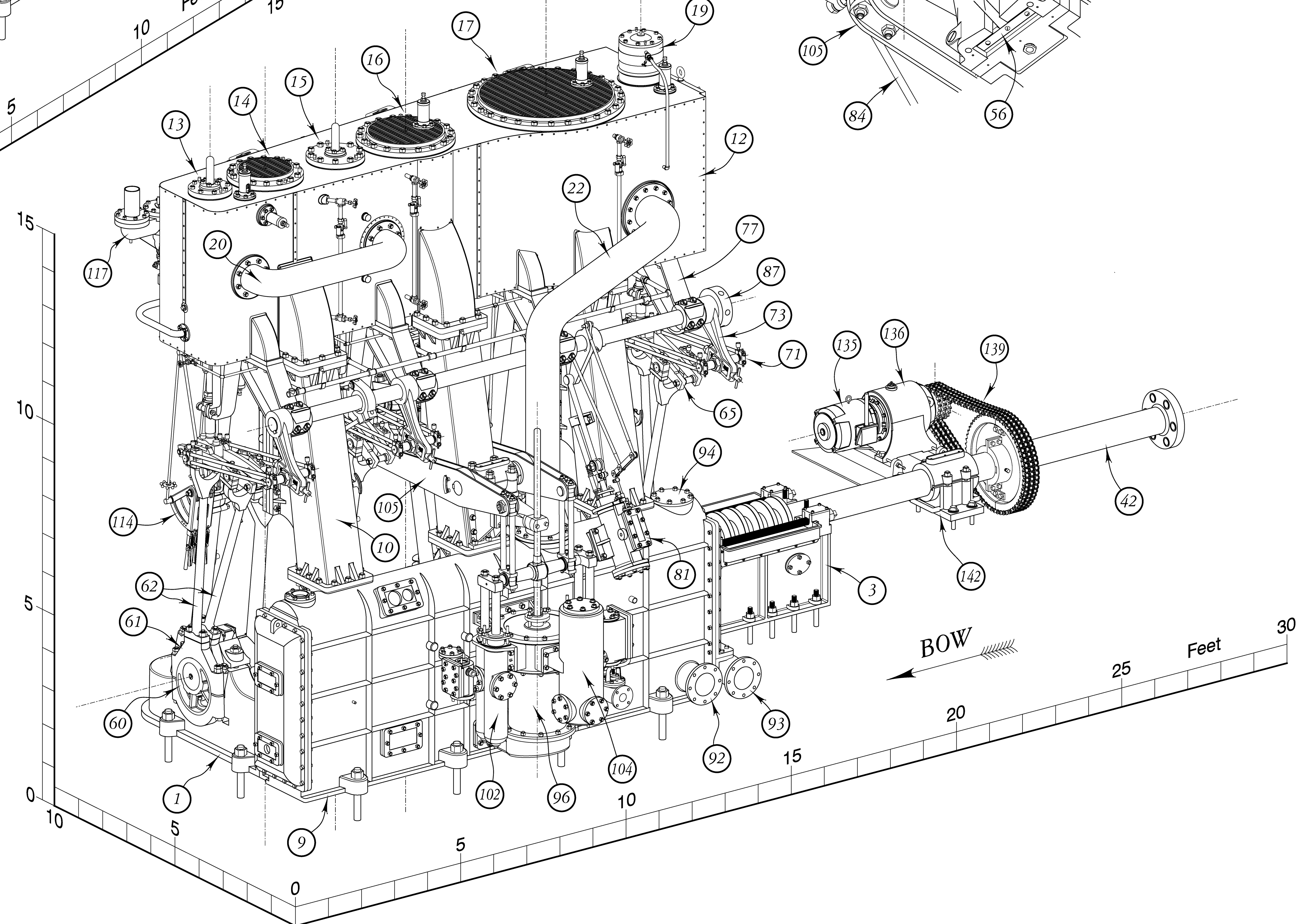
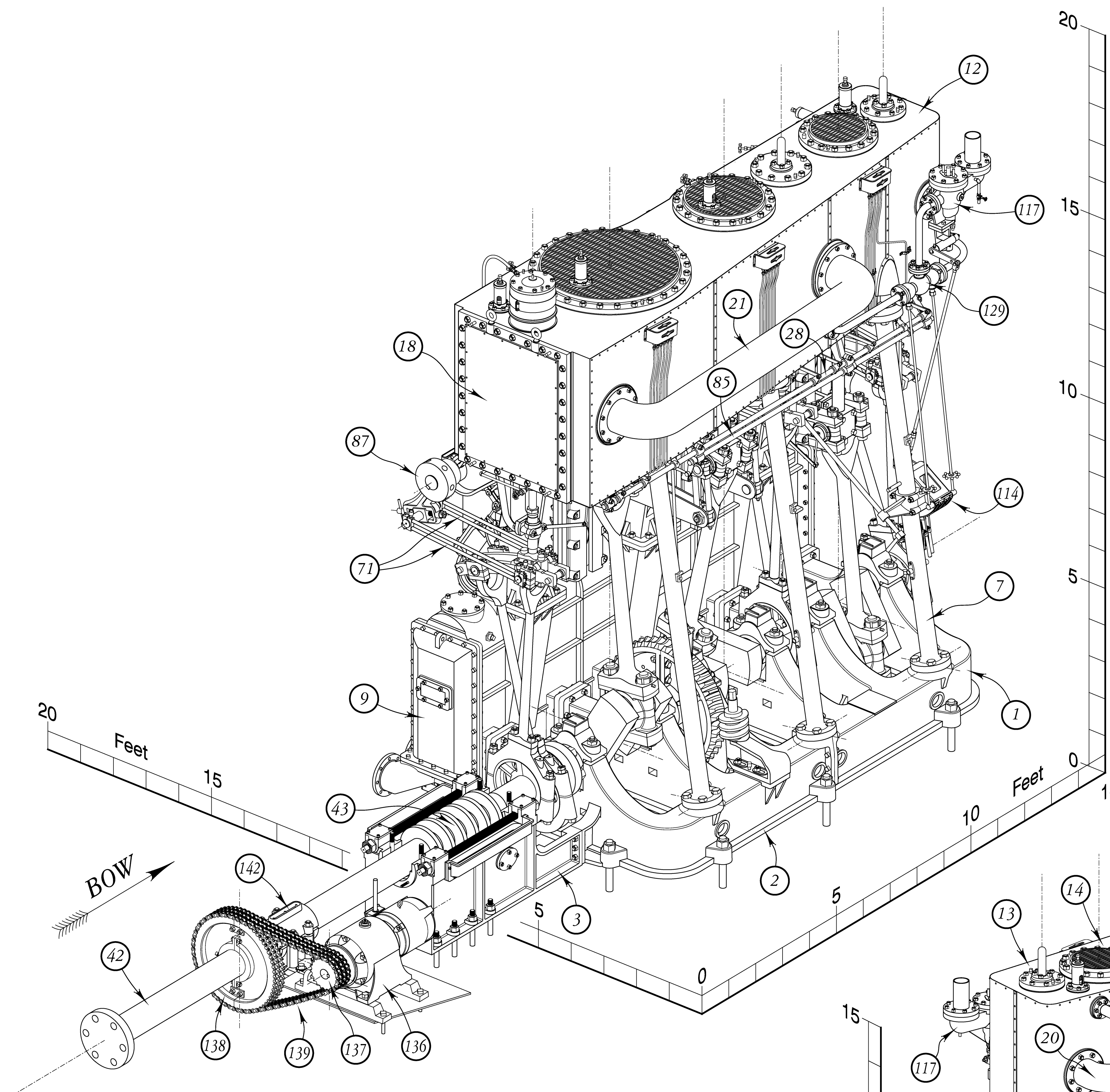
# AXONOMETRIC VIEWS

Scale is provided by the axonometric bar scales. See Sheets 17-20 for index to numbered keys.

No engineering drawings from Main Street Iron Works are known to survive for this engine. Orthographic and axonometric drawings presented here are projections from a 3D CAD model of the engine based on field measurements; any irregularities in curves are a product of the CAD program's projection process.

The 1.5° incline astern of this engine in the ship's hull is not shown in these projections for ease of scaling.

## DETAILS OF PISTON ROD, CROSSHEAD, WALKING BEAMS AND ENGINE CONTROLLER





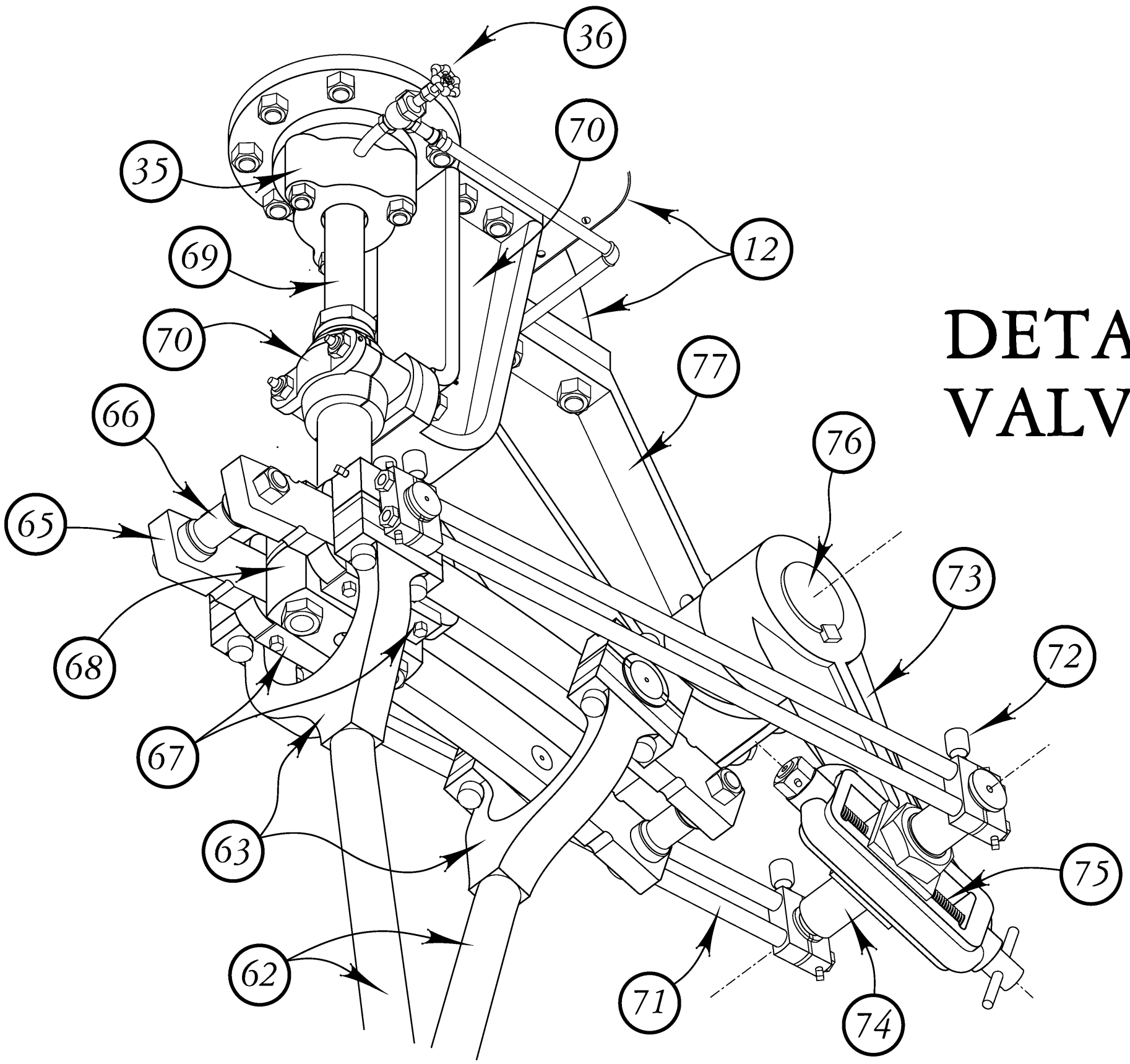
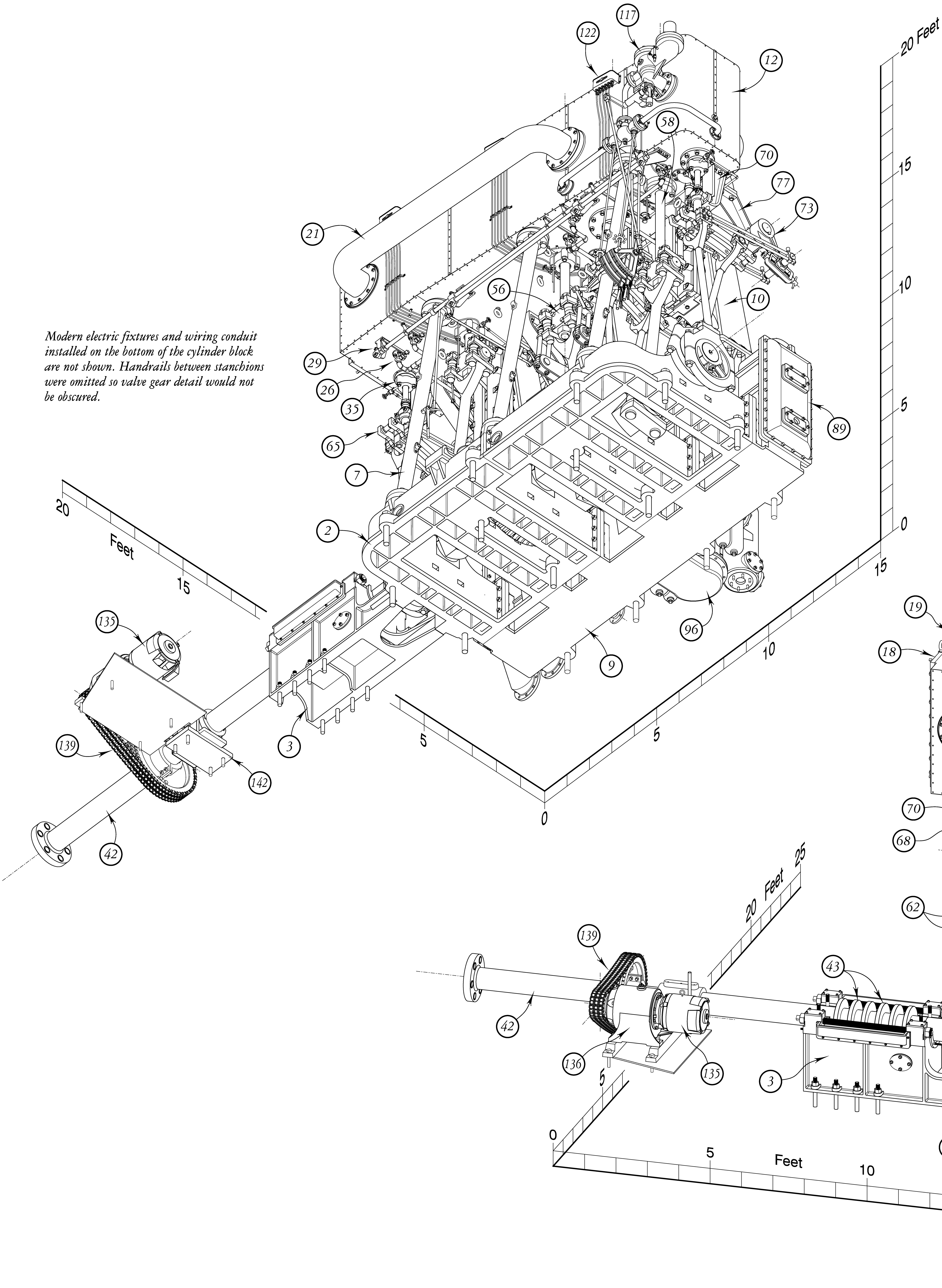
# AXONOMETRIC VIEWS

Scale is provided by the axonometric bar scales. See Sheets 17-20 for index to numbered keys.

Drawings are projections from a 3D CAD model of the engine based on field measurements; any irregularities in curves are a product of the CAD program's projection process.

The 1.5° incline astern of this engine in the ship's hull is not shown in these projections for ease of scaling.

The webbing and hollows shown in the bottom view of the bedplate castings at left were not documented directly. They were inferred from typical features shown in Sterling's Marine Engineer's Manual (1920) pp. 853-854. No similar information for the bottom of the surface condenser was discovered in the various sources consulted.



DETAIL OF  
VALVE GEAR

