U.S.S. *Cairo* Engine & Boilers

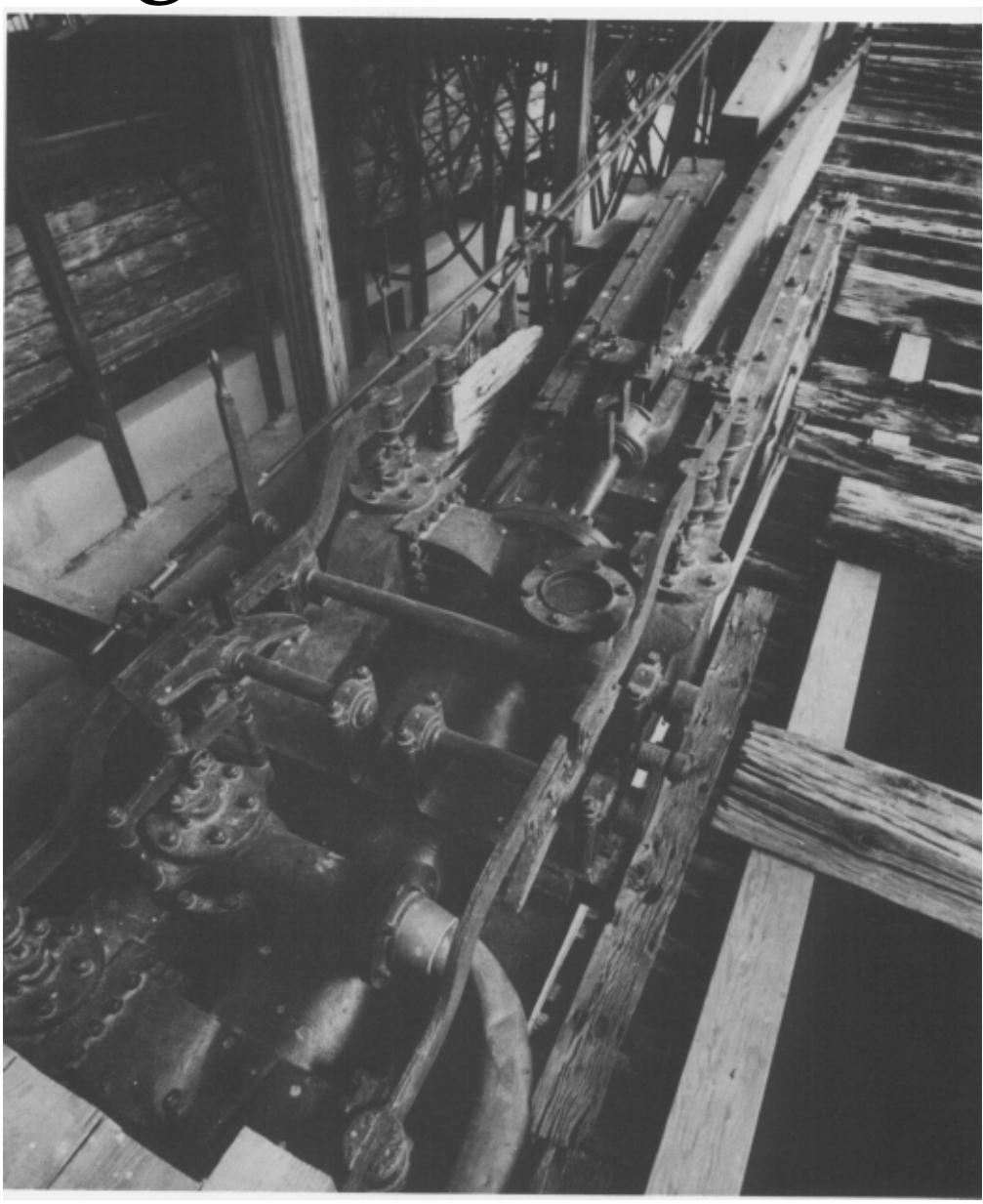


Photo by Tom Roster

A National Historic Mechanical Engineering Landmark

The U.S.S. *Cairo* and Museum, Vicksburg National Military Park

Vicksburg, Mississippi
June 15, 1990

The American Society of
® Mechanical Engineers

National Historic
Mechanical Engineering Landmark

U.S.S. *Cairo* Engine and Boilers 1862

THE *CAIRO* IS THE SOLE SURVIVOR OF THE FLEET OF RIVER GUNBOATS BUILT BY THE UNION DURING THE CIVIL WAR WITH THE OBJECT OF CONTROLLING THE LOWER MISSISSIPPI RIVER. DESIGNED BY SAMUEL POOK AND BUILT BY JAMES B. EADS, THE 175-FT. IRONCLAD VESSEL HAD 13 GUNS. THE PROPULSION SYSTEM IS THE ONLY KNOWN EARLY EXAMPLE OF THE WIDELY USED "WESTERN RIVERS" STEAMBOAT ENGINE, CHARACTERIZED BY MULTIPLE FIRE-TUBE BOILERS WITH SHARED STEAM AND MUD DRUMS, AND A TWO-CYLINDER, NON-CONDENSING ENGINE HAVING A SMALL BORE, LONG STROKE, AND POPPET VALVES. THIS WAS DESIGNED BY A. T. MERRITT. WITH A 22-IN BORE AND 6-FT STROKE, IT DEVELOPED ABOUT 600 HORSEPOWER AND DROVE A SHELTERED PADDLEWHEEL OF 22-FT DIAMETER AND 15-FT WIDTH.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS—1990

Historical Significance

The engine and boilers of the U.S.S. *Cairo,* recovered in December 1964 when the Civil War gunboat was raised from the Yazoo River in Mississippi, are of a design typical of those used for riverboats steaming the "western waters" in the mid-1800s.

Tough, reliable, and simple to operate—though at times guilty of unexpected explosions—these mechanical wonders opened the lands to development along the Mississippi River and its major tributaries.

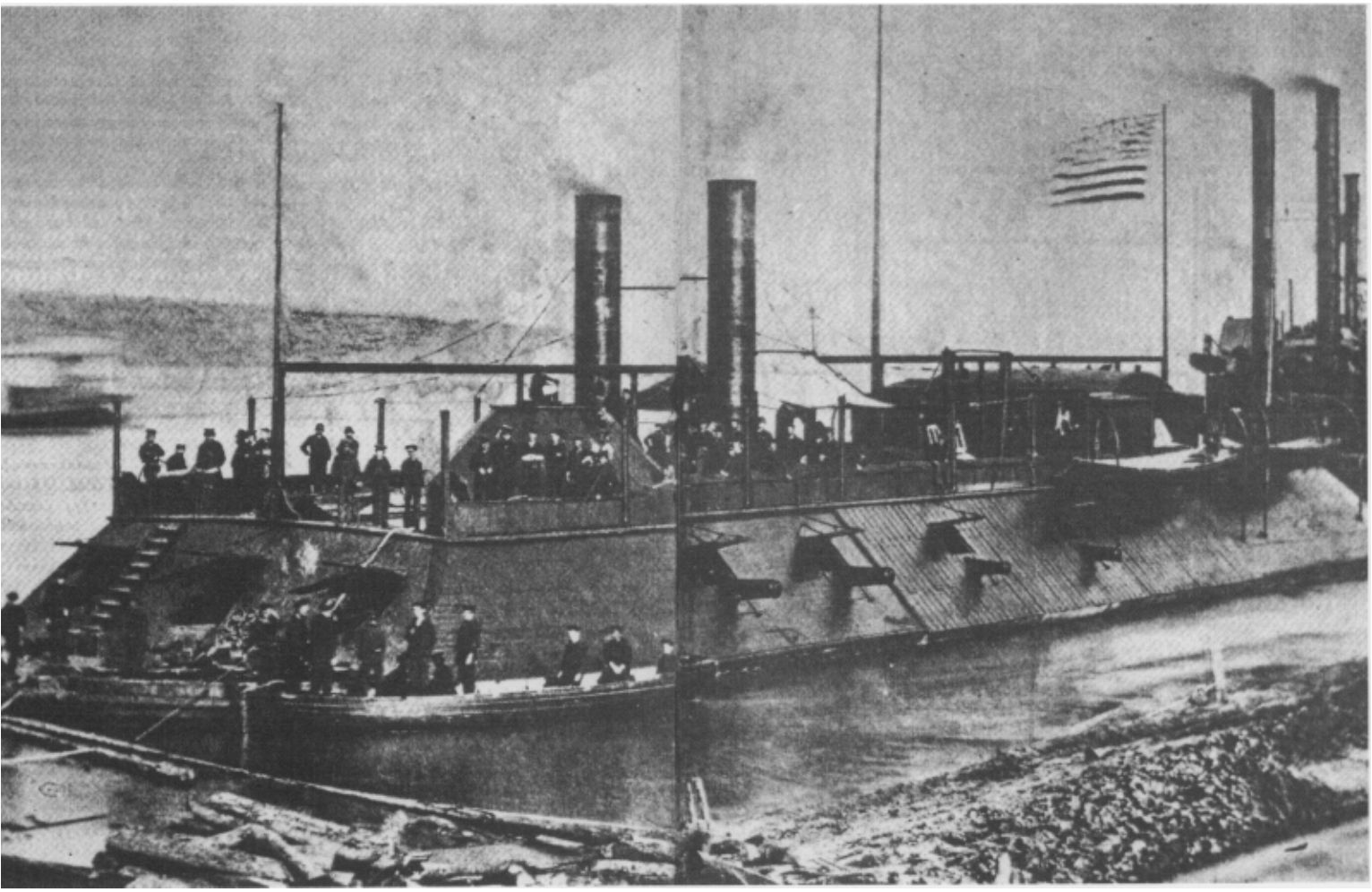
When war broke out between the North and the South in 1861, control of the Mississippi River was of critical concern to both combatants, and boats driven by this same reliable machinery helped to determine the outcome. One of these was the U.S.S. *Cairo.*

The U.S.S. *Cairo,* an ironclad gunboat, was one of seven "city class" gunboats designed by the naval constructor, Samuel M. Pook, for the Union Army in order to take control of the lower Mississippi River from the Confederates.

The engine and boilers were designed by A. Thomas Merritt, a civilian engineer from Cincinnati, Ohio, and built by the Hartupee Company of Pittsburgh, Pennsylvania. Merritt also served as superintendent of construction of the vessels.

James B. Eads, a civilian engineer from St. Louis and an experienced river boat builder, was awarded a contract August 7, 1861, by the U.S. Army to build the gunboats. The *Cairo,* named after Cairo, Illinois, was built in the Marine Railway and Ship Yard at Mound City, Illinois, and was commissioned January 15, 1862.

The *Cairo's* first captain was Lieutenant Nathaniel C. Bryant. The boat took part in missions on the Ohio, Cumberland and Tennessee rivers before going down the Mississippi River and engaging in its first contest May 10 off Plum Point above Fort Pillow, Tennessee, a Confederate stronghold guarding the river approaches to Memphis. During the summer of 1862, the *Cairo* patrolled the waters north and south of conquered Fort Pillow, engaging in little activity.



The only known photograph of the U.S.S. Cairo, *taken early in 1862 while she was being outfitted at Cairo, Illinois.*

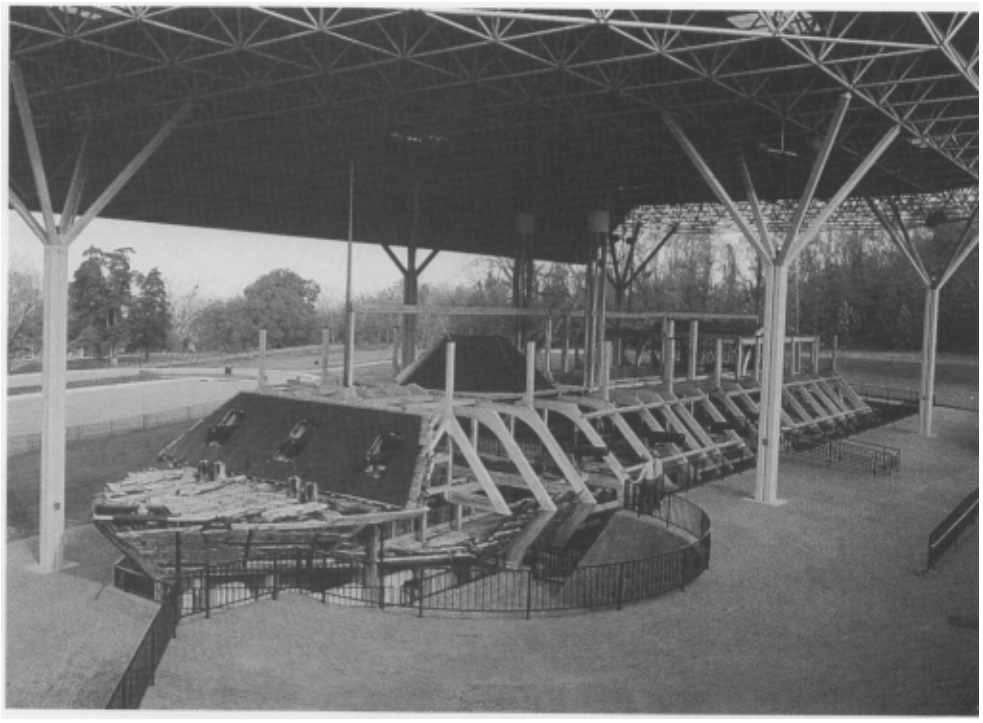
Due to Lieutenant Bryant's failing health, he turned his command of the gunboat over to Lieutenant Commander Thomas O. Selfridge Jr. on September 12. In late 1862, the *Cairo* was ordered to participate in another attempt by the Union to capture Vicksburg. One of her assignments was to help clear the Yazoo River up to Greenwood, Mississippi.

On the morning of December 12, accompanied by the tinclads *Marmora* and *Signal,* the ram *Queen of the West*, and the ironclad *Pittsburg,* the *Cairo* made its way up the Yazoo River with the *Marmora* leading the way. Sixteen miles up the Yazoo River, Commander Selfridge, hearing small arms fire, believed his flotilla was under attack and ordered the *Cairo* ahead into unreconnoitered waters. Within minutes, two Confederate torpedoes (mines) exploded under the *Cairo,* sinking it within twelve minutes. The mines were connected to a battery cell on the shore, which detonated the mine. This was the first craft ever sunk by an electrically detonated mine.

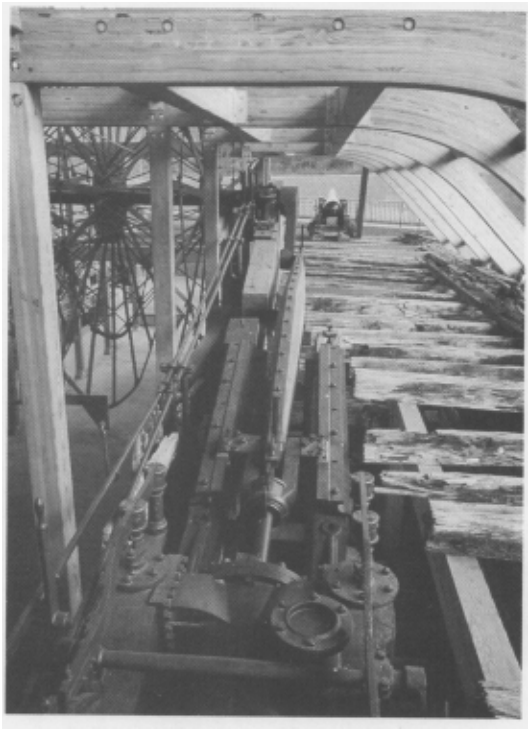
After laying on the bottom of the muddy Yazoo River for more than 100 years, the *Cairo* was raised in December 1964. Her major contribution to history lies in her preservation of firsthand information on the type of gunboats and their propulsion systems used for river operations in the Civil War, and of the details of boat life lived by the crewmen on board.

Although considerably damaged during the lifting operation, the boat was substantially restored and made available to the public for viewing. The *Cairo* was restored by the National Park Service and can be seen at the Vicksburg National Military Park. Artifacts for the *Cairo* are on exhibit at the adjacent U.S.S. *Cairo* Museum. The engine and boilers are restored within the *Cairo.*

Illustrations courtesy of the National Park Service.



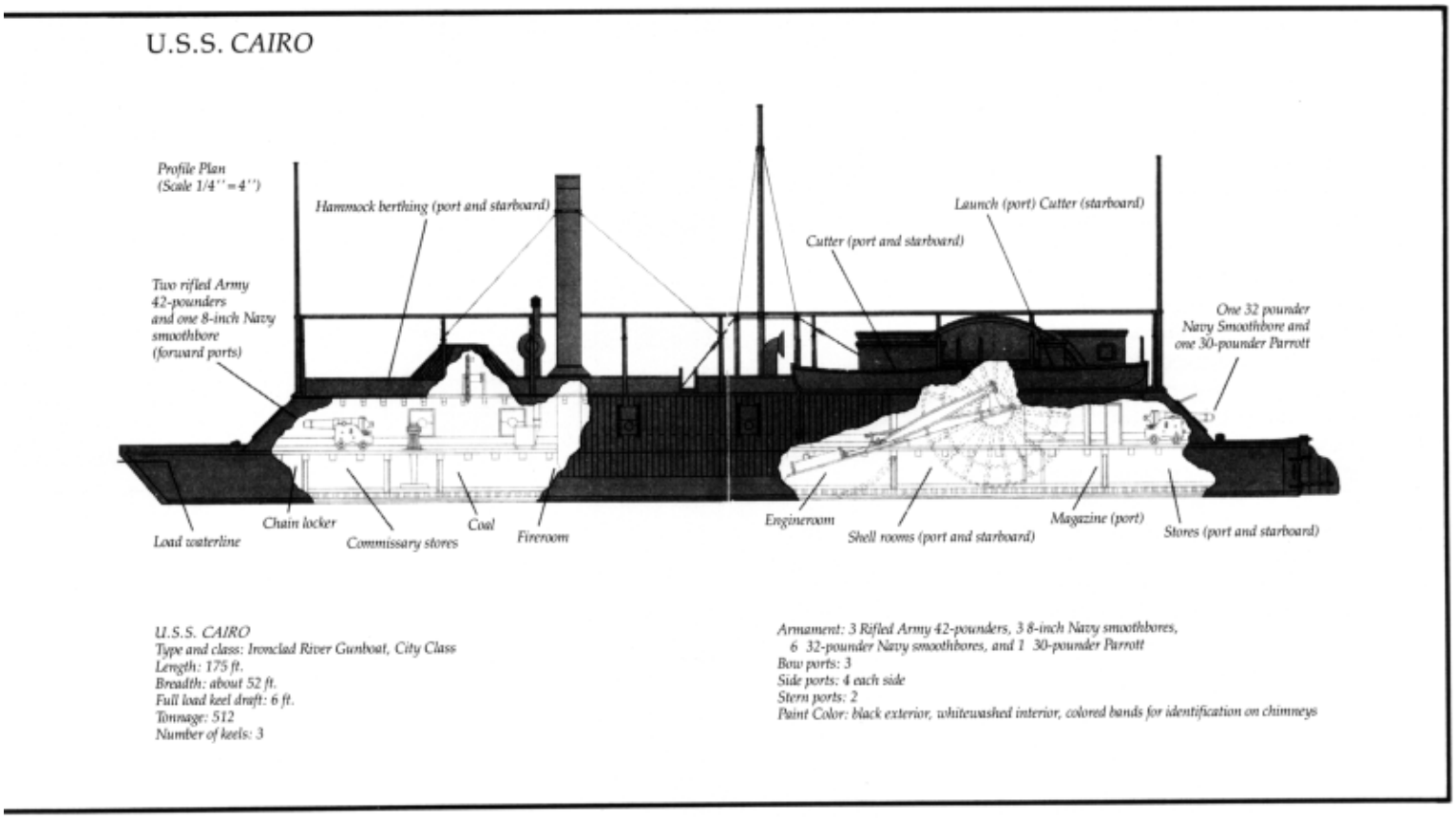
U.S.S. Cairo, *restored – Vicksburg National Military Park*



Wood and iron pitman arms on each side of the Cairo *served as connecting rods between steamdriven engines and paddle shaft cranks.*

Technical Background

The U.S.S. *Cairo* is the only surviving example of a class of warships specifically designed for use on the Mississippi River during the Civil War. The *Cairo's* engine and boilers are among the oldest and best surviving examples of typical engines designed for boats plying the "western rivers."



Sectional view of the U.S.S. Cairo

The reciprocating steam engine was the universal prime mover in self-propelled craft during that era. All of these engines were simple, single-expansion, and either condensing or non-condensing. The different types of engines were labelled according to the position of the cylinders—vertical, horizontal, or inclined. The engine position matched the type of paddle wheel used to propel the boat. Vertical or inclined engines were used to drive the side wheel types. A stern wheel would be driven by a horizontal or an inclined engine, with the latter being more desirable for a gunboat, since the engine would be under the water line.

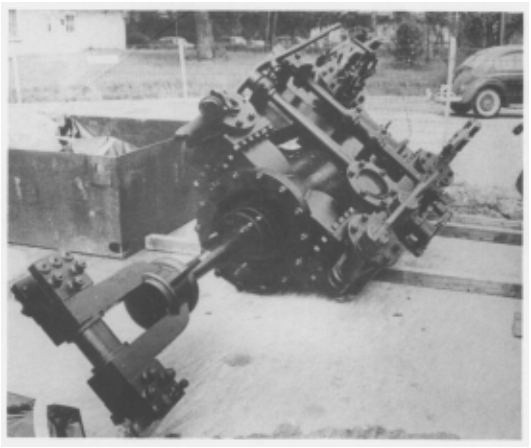
Similar to the stern wheel, the *Cairo's* recessed paddle wheel was located within the protected raceway, between the casemates to protect it from enemy fire. The iron shaft of the paddle wheel was driven at either end by cranks mounted 90 degrees to each other. The two rudders were located aft on each side of the raceway to steer the gunboat.

The ironclad was equipped with five fire-tube boilers, each 36 inches in diameter and 25-feet long, with five 7 1/2-inch flues inside each boiler. The sides of the boilers are 5/16-inch thick, with heads 12/16-inch thick. The boilers operated at 140 pounds per square inch steam pressure. Instrumentation installed on each set of boilers was a steam gauge and a water gauge. The cast-iron fire fronts fit to the front of the boiler with a five-foot-long firebox. It consumed 18 to 20 bushels—approximately 1,980 pounds—of coal per hour. The bed of the firebox was lined with fire brick and enclosed in good sheet iron. Located under the forward section of each boiler, it supplied hot gasses to the boilers by routing the gas aft and under the boilers and into the aft flue mouths of the boilers. The flue gas was drawn forward through the flues and drawn up the tall stack by natural draft. Placed on the front end of the boilers were two smoke stacks, 44 inches in diameter and 28 feet in height.

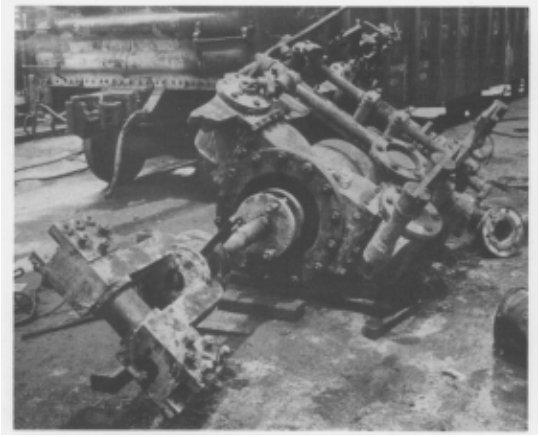
Two mud drums, which supported the boilers and collected sediment of the pumped feed water, were connected to the bottom of the boilers. One was located close to the after end of the boilers with stop valves for supplying the boilers with water. The other mud drum was located immediately aft of the firebox, but without water supply connections. At one end of this drum was a blow-off valve to drain the boilers.

Steam was carried from the boiler to the steam drum. Located in the rear of the boilers, it served as a collector and manifold. Each connection pipe to the drum had a stop valve to cut off steam flow to the drum and, more importantly, to the engine. Connected to the after side of the center of the steam drum, was a steam pipe carrying steam to the main steam engine, steam-driven capstan and auxiliary engine.

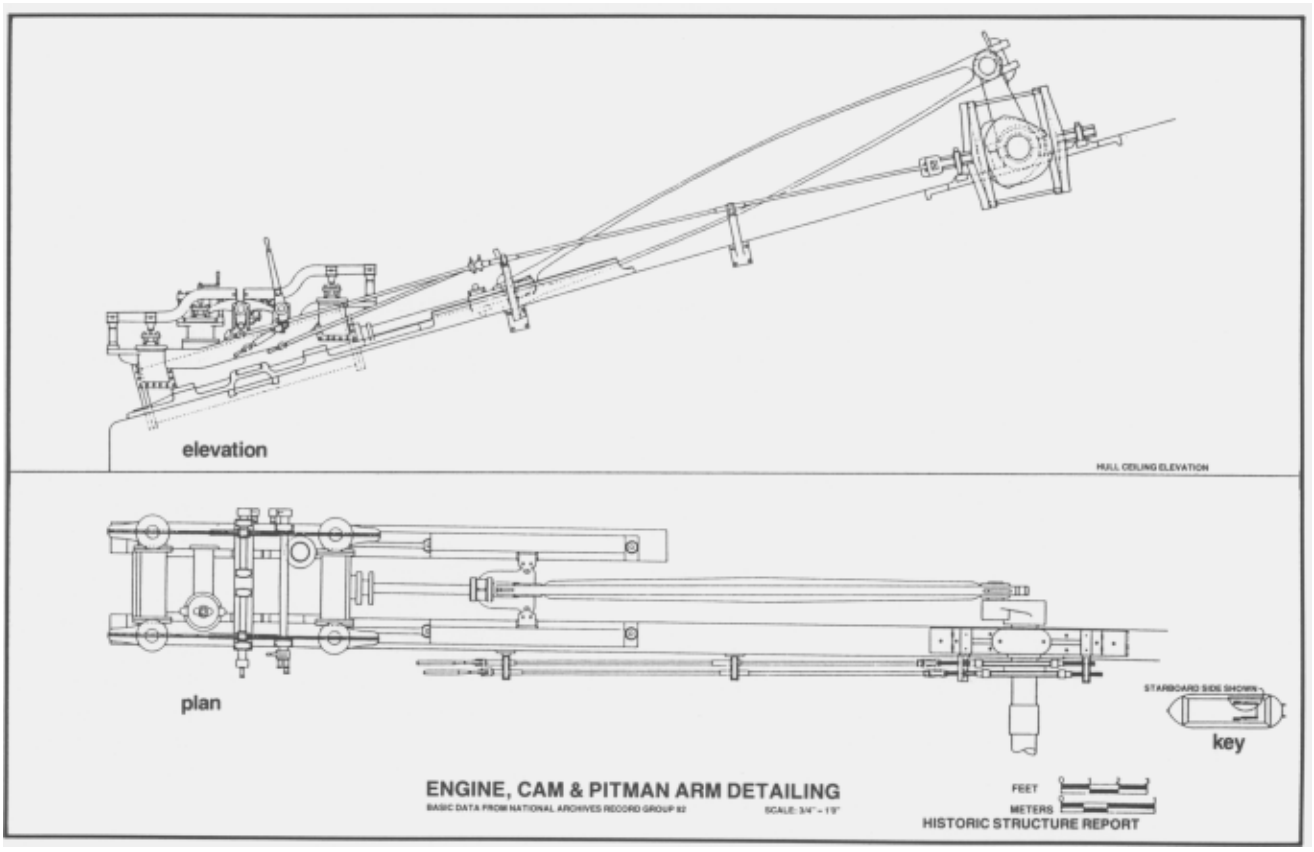
The *Cairo* was equipped with a two-cylinder non-condensing, reciprocating main steam engine. The cylinders, mounted at a 15-degree angle, were made of cast-iron with a 22-inch bore and were of a length to accommodate a 72-inch stroke. On one side of the cylinder at each end was a supply nozzle with an opening of 9 inches by 4 inches, with a flange 15-inches square by 1 1/4-inches thick, for receiving steam. On the

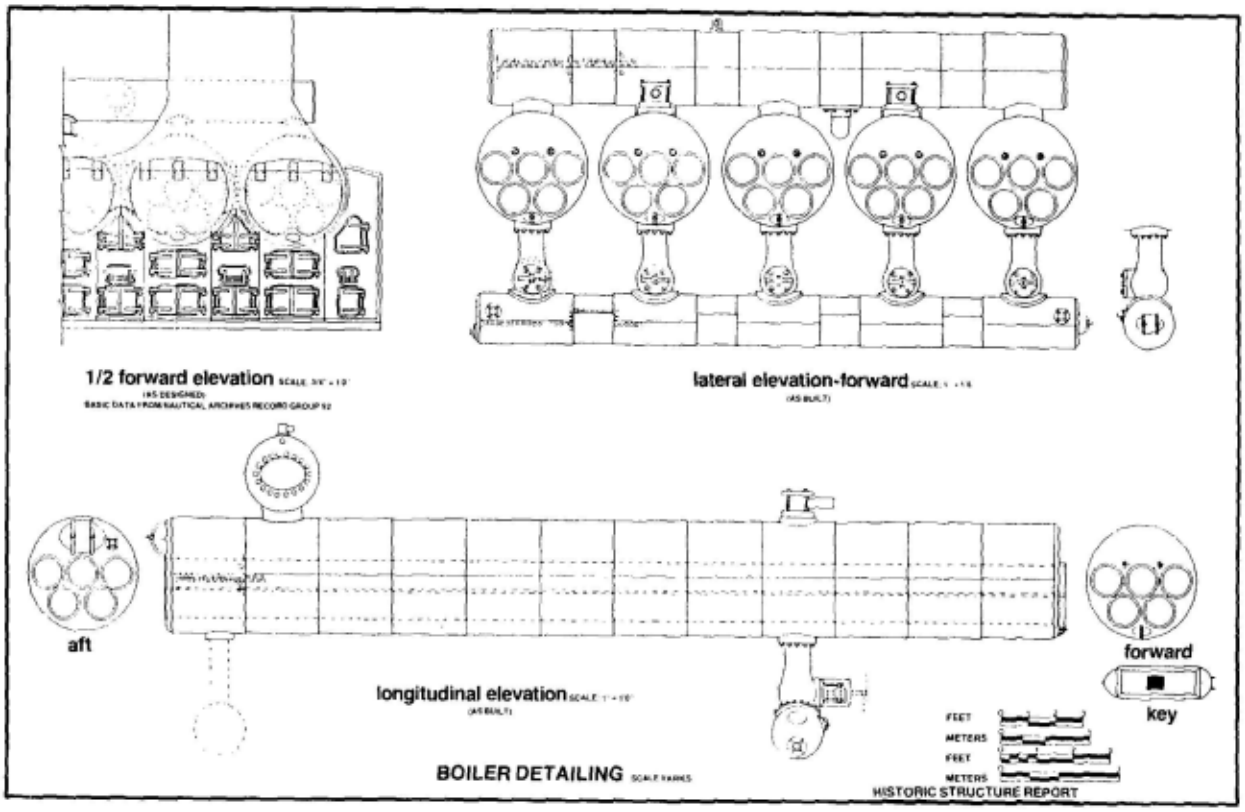


U.S.S. Cairo *engine before restoration*



U.S.S. Cairo *engine after restoration*




1/2 forward elevation
(AS DESIGNED)
BASIC DATA FROM NAUTICAL ARCHIVES RECORD GROUP 52
lateral elevation-forward
(AS BUILT)
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FEET
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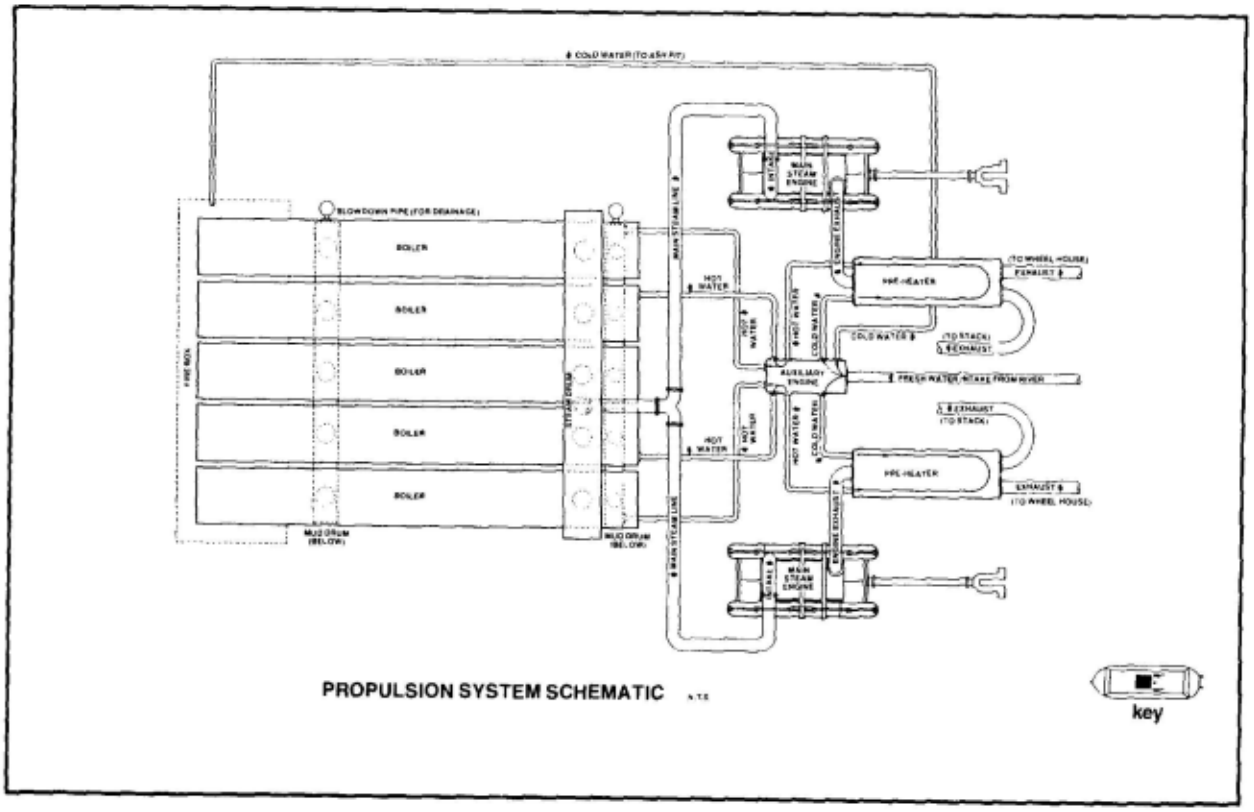
BOILER DETAILING
HISTORIC STRUCTURE REPORT


COLD WATER (TO ASH PIT)
BLOW DOWN PIPE (FOR DRAINAGE)
BOILER
BOILER
BOILER
BOILER
BOILER
MUD DRUM (BELOW)
MUD DRUM (BELOW)
MAIN STEAM LINE
MAIN STEAM LINE
MAIN STEAM ENGINE
MAIN STEAM ENGINE
PRE-HEATER
PRE-HEATER
AUXILIARY ENGINE
HOT WATER
COLD WATER
EXHAUST
(TO STACK)
(TO WHEEL HOUSE)
FRESH WATER MAKE FROM RIVER
key
PROPULSION SYSTEM SCHEMATIC

other side of the cylinder were two similar nozzles for steam exhaust from the cylinder. The cast-iron piston, with a 4-inch space for packing, was attached to a wrought iron piston rod which was 4 inches in diameter and 110-inches long. The engine exhaust steam heated water in the preheater, and then exhausted to the stack.

A one-cylinder auxiliary engine, also called "the doctor" because it cured the ills of the steam boat, was used to drive two cold-water pumps and two main force pumps to supply the boiler with water, drawing it from the river. The cylinder was made of cast-iron with a diameter of 8 inches and a length to accommodate a 21-inch stroke. The cast-iron piston, which was 5-inches deep and fitted with metallic packing rings, was attached to a piston rod which was 1 3/4-inches in diameter and 3-feet long. Steam ports were one-half inch by 2 inches and the exhaust port was 1-inch by 2-inches. The steam chest was one-half-inch thick. The *Cairo* doctor was lost during the salvage, but was traditionally located aft of the boilers between the cylinders of the main engine.

The cold-water pumps sent water into the preheater where the water was heated by exhaust steam from the main engine. The main force pumps sent the heated water into the aft mud drum and to the boilers.

Robert M. Shepard III
ASME Mississippi Section
Landmark Ceremony Committee

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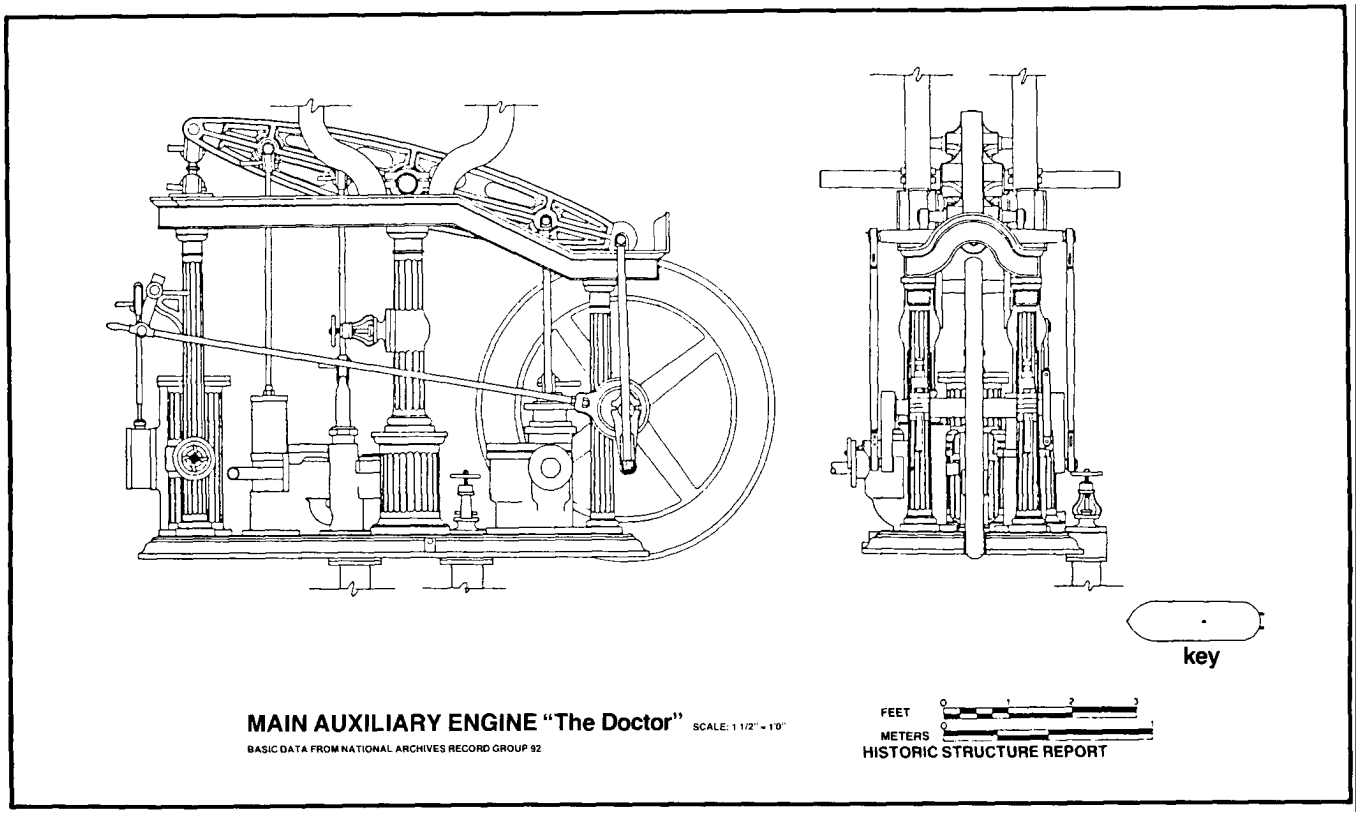

The History and Heritage Program of ASME

The ASME History and Heritage Recognition Program began in September 1971. To implement and achieve its goals, ASME formed a History and Heritage Committee, initially composed of mechanical engineers, historians of technology, and the curator of mechanical engineering at the Smithsonian Institution. The committee provides a public service by examining, noting, recording, and acknowledging mechanical engineering achievements of particular significance. The History and Heritage Committee is part of the ASME Council on Public Affairs and Board on Public Information.

The U.S.S. *Cairo* engine and boilers are the 96th National Historic Mechanical Engineering Landmark to be designated. Since the ASME Historic Mechanical Engineering Program began, 136 Historic Mechanical Engineering Landmarks, five Mechanical Engineering Heritage Sites, and one Mechanical Engineering Heritage Collection have been recognized. Each reflects its influence on society, either in its immediate locale, nationwide, or throughout the world.

An ASME landmark represents a progressive step in the evolution of mechanical engineering. Site designations note events or developments of clear historical importance to mechanical engineers. Collections mark the contributions of a number of objects with special significance to the historical development of mechanical engineering.

The ASME Historic Mechanical Engineering Recognition Program illuminates our technological heritage and serves to encourage the preservation of the physical remains of historically important works. It provides an annotated roster for engineers, students, educators, historians and travelers, and helps establish persistent reminders of where we have been and where we are going along the divergent paths of discovery. For more information, please contact the Public Information Department, American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017, (212) 705-7740.