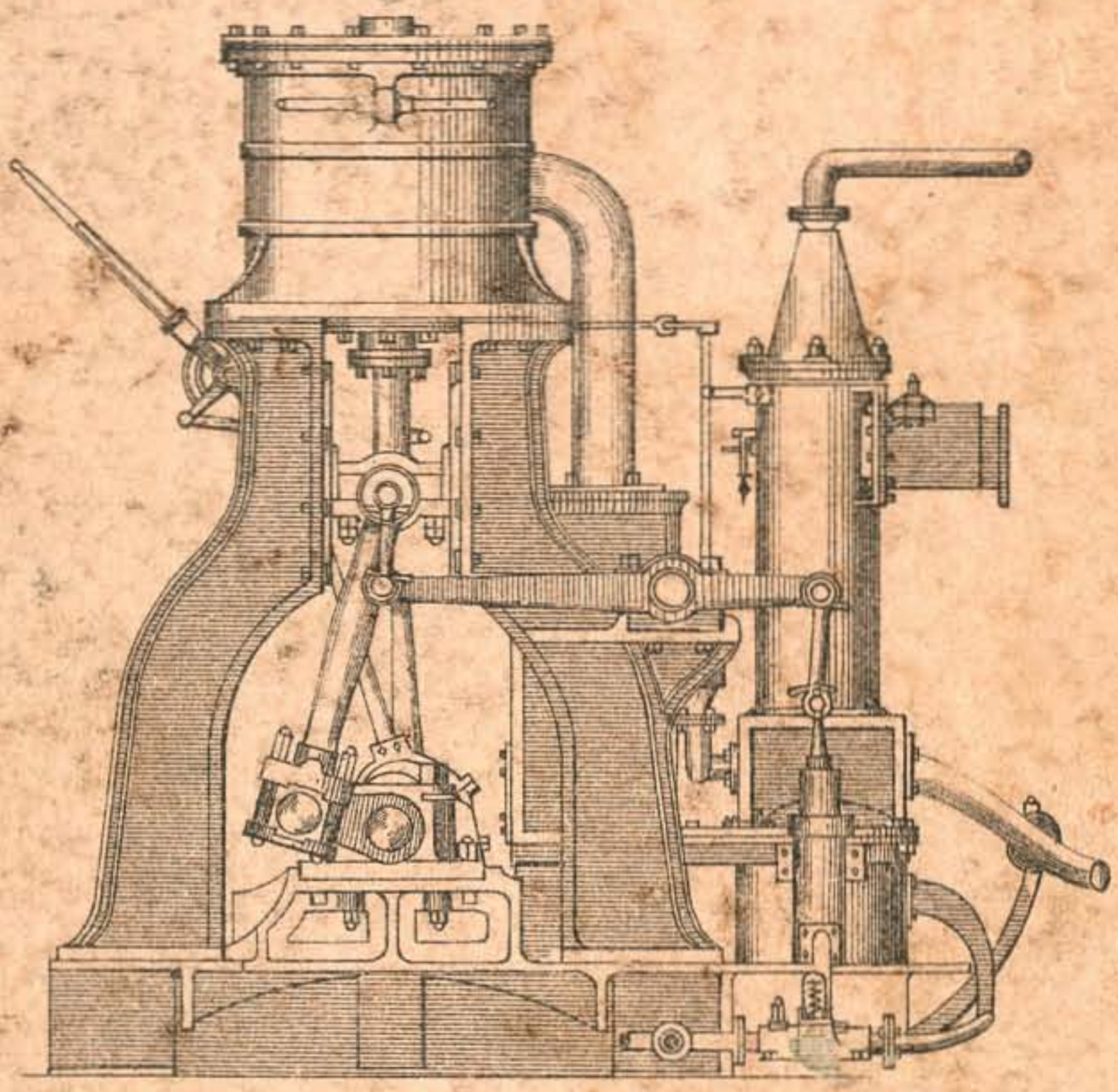
THE STEAM EXAMINATION, FOR MASTERS & MATES.



By M. ION,

PREPARER FOR THE LIVERPOOL LOCAL MARINE BOARD EXAMINATIONS.

LIVERPOOL,
PHILIP, SON AND NEPHEW,
ATLAS BUILDINGS, SOUTH CASTLE STREET.

THE

STEAM EXAMINATION

FOR

MASTERS AND MATES,

AS REQUIRED BY THE

LOCAL MARINE BOARD,

(With Illustrated Diagrams),

SHEWING ALL THE INTERNAL AND EXTERNAL ARRANGEMENT OF BOILERS, ENGINES, COMMON AND COMPOUND, ADAPTED TO THE WANTS OF THOSE WHO KNOW NOTHING ABOUT THE ENGINE.

BY M. ION,

Preparer for the Liverpool Examination.

LIVERPOOL:

PHILIP, SON AND NEPHEW,

ATLAS BUILDINGS,

49 AND 51, SOUTH CASTLE STREET.

1871.

PREFACE.

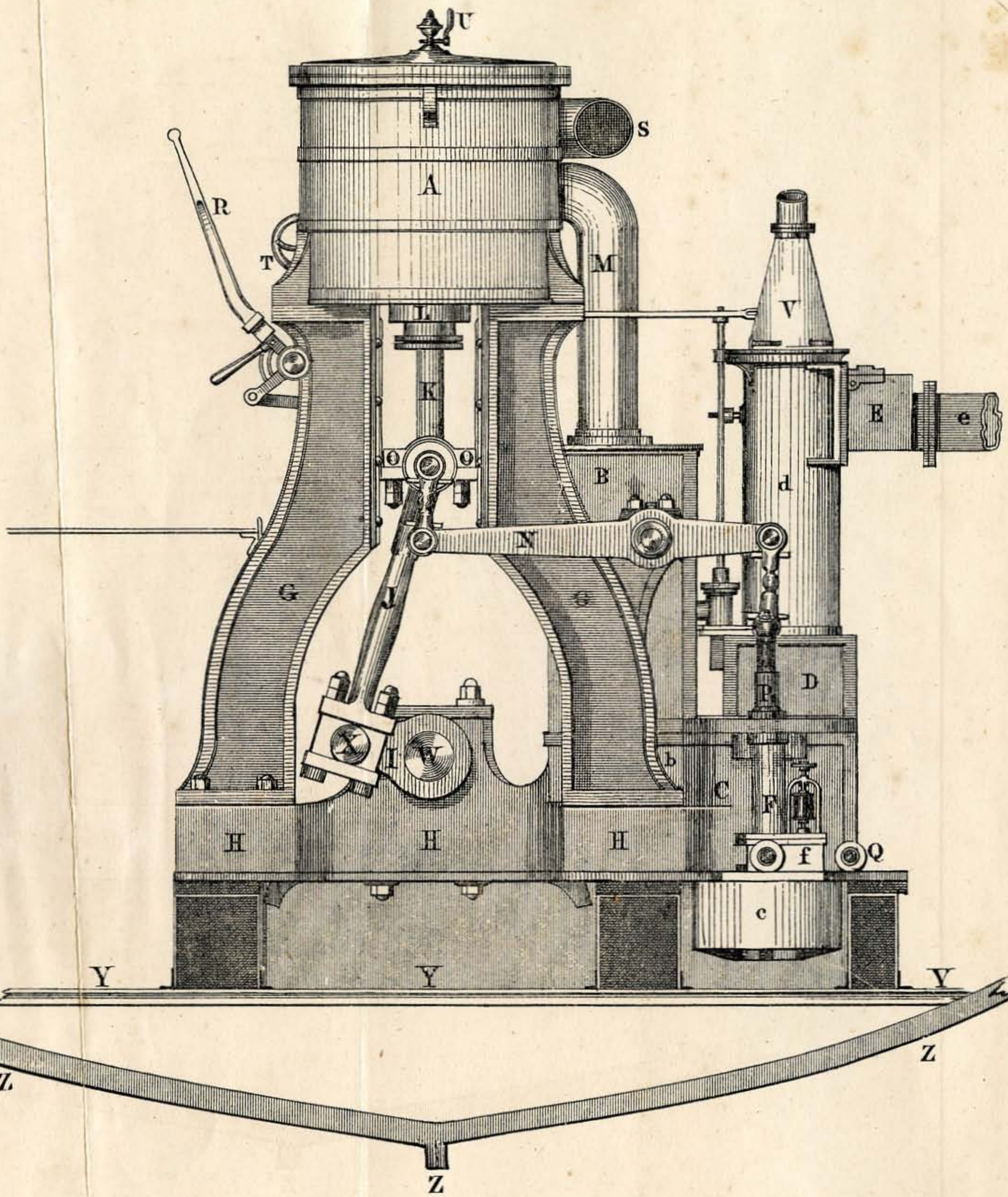
THIS work (*like all the others published by* M. ION), is for the purpose of clearly illustrating the subject in hand, free from all laborious and incomprehensible terms; and in such a way that the information needed may be acquired with ease and satisfaction by anyone of ordinary abilities.

Although the candidate is or may be wholly unaccustomed to the Engine-Room, a proper knowledge of Steam may be obtained with very little trouble; and the numerous Masters and Mates that have passed under M. ION's guidance, have been surprised that they should be able to get such confidence in themselves, as to the use and working of the machine, during a few days' study.

Having access to Engine-Rooms of various Steamers, and models kept on hand, M. ION can assure those who are anxious of obtaining a Certificate for Steam, that they may, in a week or ten days, accomplish their desire.

M. ION.

LIVERPOOL, MAY, 1871.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EXPLANATION OF PLATE (1.)

A The Cylinder.
B The Surface Condenser *Tube Case*.
b The Condenser.
C The Air Pump.
c *The bottom of Air Pump.*
D The Hot-Well.
d *The upper part of Hot-Well.*
E The Sluice Valve.
e *The Sluice Valve Pipe.*
F The Feed Pump.
f *The Feed Valve Case* and Escape Spring above.
G The Engine Frame.
H The Pedestal.
I The Crank.
J The Connecting Rod.
K The Piston Rod.
L The Stuffing Box.
M The Exhaust-Steam Pipe.
N The Air Pump Lever.
O The Cross-Head.
P The Feed Pump Plunger.
Q The Snifting Valve.
R The Starting Lever.
S The Steam Pipe.
T The Throttle Valve.
U The Cylinder Grease-Cock.
V The Air Vessel.
W The End of Shaft.
X The Crank Pin.
Y The Platform.
Z The Keel and Ship's Bottom.

STEAM EXAMINATION.

THE MARINE TUBULAR BOILER.

The Marine Boiler differs from those used on land in this particular, that the fires and tubes are within the boiler itself, and are surrounded with water in every direction, as a precaution against fire, and for the purpose of a greater amount of heating surface, essential to the saving of fuel.

The tubes must always be covered with water to the height of 6 or 8 inches above the top tier of tubes.

A large steam space above the water is desirable (*a preventive against priming*), over which the super-heater is fitted, so as the flame and gases pass around pipes or tubes through which the steam is led on its way to the engine, through the stop valve.

With regard to the construction, strength, and other particulars, it will not be necessary, for a Master's examination, to say anything, that being in the Engineer (proper) department; and we will just pass on to endeavour to understand the different items that a boiler must contain in its construction—viz., a Safety Valve, Communication-cocks, Stop-valve, Reverse-valve, Feed-valves, Blow-off-cock, Gauge-cocks, and Glass Water-gauge.

The water in the boiler should never exceed $\frac{4}{33}$ by the Salinometer, or 216° temperature when tried by the Thermometer.

Fresh water boils at 212° temperature; sea water boils at 213° temperature; and as its density increases, so does its temperature.

Therefore, when it is 216°,* it is commencing to form a scale on the tubes and boiler, which will injure them if allowed to continue.

Steam has the following temperatures at the different pressures, viz. :—

30-lb.	pressure,	that is,	15-lb	above	the atmosphere,	252°
40-lb.	,,	,,	25-lb.	,,	,,	269°
50-lb.	,,	,,	35-lb.	,,	,,	283°
60-lb.	,,	,,	45-lb.	,,	,,	296°

Steam less than the above pressure, viz., 30-lb., is not generally used, but the temperature of—

10-lb.	pressure,	5-lb	below	the atmosphere, is	192°
15-lb.	,,	0-lb.	,,	,,	212°
20-lb.	,,	5-lb.	above	the atmosphere, is	228°
25-lb.	,,	10-lb.	,,	,,	241°

* Fresh water boils at a temperature of 212° ; sea-water boils at a temperature of 213°. Sea-water becomes more salt by the steam which leaves it for moving the engine.

Salinometers and *Hydrometers* are constructed to shew the density of the water in the boiler, and when it stands at $\frac{3}{32}$ it shews when the brine should be blown off to prevent crust or scale forming inside the boiler.

The thermometer also will indicate the density of the water in the boiler ; for example, the boiling point of sea-water is 213°, and when its temperature reaches 216° it has become so salt that this temperature will shew when blowing off should begin, and the saturation should be tested at least once every hour.

Boiler Valves and Cocks.

Safety Valve.—Situated on the top of the boiler over the steam chest, and is so loaded that when the steam in the boiler exceeds the pressure it is loaded to, the valve will open and allow steam to escape by the waste-pipe, standing before or on the aft side of the smoke-stack.

Stop Valve.—Fitted in the steam pipe, to open or stop the passage between the boiler and engine, and to shut communication generally.

Communication Valves or Cocks are fitted so as to connect one boiler with another, so as the water can keep the same level in each boiler, when feeding by one feed only ; or to shut off one boiler from another, for cleaning, repairs, or any other purpose, while the other boiler may be working.

THROTTLE VALVE.—Regulates the quantity of steam for speed required.

REVERSE, OR VACUUM VALVE.—To admit air into the boiler when the pressure of steam is less than the pressure of the atmosphere

FEED VALVES.—Fitted in feed-pipes on front of the boilers, to open and shut, *or partially*, as required for keeping the boilers supplied with the right and proper height of water above the tubes.

BLOW-OFF COCKS.—For blowing-off the brine into the sea and changing the water, when over-saturated with salt.

KINGSTON VALVES.—Fitted to ship's sides or bottom, to admit water, or allow it to pass out; for example,—at the blow-off, it will allow the brine to get into the sea, and also to fill the boilers, when empty, as high as the water stands outside the ship; and if that should not be as high as the water should stand above the tubes, then, what more is required, will have to be pumped up by hand, or donkey, after shutting Kingston-valve.

GAUGE COCKS.—Three are fitted to each boiler, placed at different heights, the middle one being at the water surface when standing at the right height above the tubes. One above this in steam, and the other below in water. The top one when opened gives steam; the lower one water; and the middle one steam and water; and are tried frequently for testing the *glass gauge*, which shows the height of the water in the boilers, when it is working properly, and is for the same purpose as the gauge cocks.

STEAM GAUGE.—Indicates the exact pressure of the steam in the boiler, in pounds, by a hand working on the graduated face.

HAND PUMP FOR BOILERS.—* Supplies the boiler when the engines are at rest, or before the fires are lighted, and is so fitted as to work in connection with the other feed; to act as a fire engine and for washing decks; and so arranged as to draw from sea or bilge.

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* The water should stand in a tubular boiler 6 inches above the tubes; in a common boiler 6 to 9 inches above the flues. If any of the tubes are damaged and become leaky, plug them up.

ENGINE VALVES AND COCKS.

SLIDE VALVE.— Fitted to cylinder so as to admit steam to piston for the motion required, and also to keep open a communication to condenser, by which the exhaust steam can leave the cylinder and pass to the condenser.

BLOW-THROUGH VALVE is placed so that it may allow steam to pass from steam-pipe to condenser and bottom of the air-pump, to clear all the air and water that may lodge within, and supply their place with steam, in order that a vacuum may be formed with the injection condensing the steam.

EXPANSION VALVE.—For cutting off the steam at any part of the stroke, in order to economise fuel.

ESCAPE VALVES are placed at top and bottom of the cylinder, to allow any water that may have accumulated to escape, and prevent the top or bottom of the cylinder being burst out.

FOOT VALVE.—Fitted to open and shut the communication between condenser and air-pump, and stop the water from returning to condenser on the down stroke of air-pump.

DELIVERY VALVE.—Fitted to open and shut the communication between air pump and hot well, and prevent the return of the water from hot-well on the down stroke of air-pump bucket.

INJECTION VALVES AND COCKS are fitted on the condenser, for admitting water from outside to condenser, to meet the steam from cylinder and condense it, and cause a vacuum in the condenser.

FEED PUMPS are fitted at the sides of the air-pump, and work with the same cross-head as the air pump, supplying the boilers from the hot-well ; bilge or sea.

ESCAPE FEED VALVE is fitted to feed-pipe, to allow surplus feed to return to the hot-well, when the boilers do not require the quantity that the feed-pump supplies.

BILGE PUMPS are fitted same as feed-pumps, for clearing away water from leakage into any of the compartments of the ship.

SNIFTING VALVE is fitted on the opposite side of the air-pump to that the condenser is on, and opens when blowing through engine before starting; allows the water and air to escape; and when the engines are at work, closes with atmospheric pressure.

JACKET COCKS allow water to escape from the cylinder-jackets before starting.

SLUICE VALVES are fitted across the mouth of the discharge-pipe at the ship's side, and prevent water from getting from the sea to hot-well or into the vessel, if the discharge-pipe is damaged.

CONDENSER *—A large vessel for receiving steam from the cylinder after it has done its duty.

SURFACE CONDENSER is fitted with tubes, through which the steam passes while surrounded with cold water, condenses the steam, and thereby supplies the boiler with fresh-water feed. The cold water is drawn in from sea for surrounding the tubes, and forced out by the circulating pump fitted for that purpose. Therefore, surface condensation must save fuel by doing away with so much blowing-off, occasioned by salt water supplied to the boiler from the common condenser.

BAROMETER, OR VACUUM GAUGE.—Fitted to the condenser to shew the state of vacuum.

†THE AIR PUMP draws the water and air from condenser to the hot-well, and creates a vacuum in the condenser, and is in shape like a cylinder, but of less dimensions.

THE HOT-WELL is the receptacle for the water lifted by the air-pump, and to which pipes are fitted for carrying the water through the feed-pumps to the boiler.

FEED-PUMP draws the water from the hot-well and forces it into the boiler, and if the full force of the feed gives the boiler more than is needed, close the feed valve on the side of the boiler, and the overplus will escape back again to the hot-well by escape-valve and branch pipe fitted for that purpose.

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* CONDENSER.—It will have been seen from the foregoing that the Condenser is a vessel between the cylinder and air-pump, for receiving the steam after it has done its duty, and where it is condensed to water.

† The air-pump also, when working, creates a vacuum in the condenser, which draws the exhaust steam from cylinder, and not only relieves the piston but assists in moving it by suction, and is kept in motion by both steam force on one side and the vacuum pulling on the other side, to the extent of its state and strength.

ENGINE GEARING.

THE PISTON is a hollow iron plug fitted into the cylinder, on which the steam and vacuum acts for moving the engine.

PISTON ROD is fitted in the centre of the piston, and projects out of the cylinder cover or bottom through stuffing-box, working steam tight.

STUFFING-BOX AND GLANDS.—Forms a guide for the piston-rod to work in, made steam-tight by packing.

CONNECTING-ROD.—One end is attached to the piston-rod, and the other to the crank, and each stroke of the piston gives the crank its revolution.

CROSS-HEAD keeps the piston-rod working parallel. Each end sliding in guides fitted to the engine-frame.

CRANK is fitted on to the screw-shaft, and gives the shaft its rotary motion.

ECCENTRICS are fitted on the screw-shaft, to which rods are attached, called eccentric rods, leading one to each end of the link. One rod gives forward and the other stern motion, at the option of the engineer who has the engine under command, with a wheel or lever, the movement of which puts that eccentric to work which he requires, or the sliding block in the middle of the link stops the engine.

LINK MOTION is an arrangement for moving the slide-valve, having an eccentric at each end of the link, for head and stern way. In the slot of the link, a solid sliding-block is fitted, to which the sliding-valve rod is attached by a wheel or lever; by which the eccentric for ahead or astern motion is given instanter.

THRUST PLUMMER-BLOCK is a bearing for the screw-shaft, in which are recesses for the collars on the shaft to work in, and so equalise the thrust toward the engine produced by the propeller.

GREASE COCKS.—For admitting tallow into cylinders for the purpose of lubricating the pistons, or when attached to bearings, for the same purpose, viz., lubricating.

PRIMING-GREASE COCK admits tallow to the Boilers when the water is boiling so furiously as to be liable to get into the Steam-pipe and through Stop-valve to the Cylinder, and cause a break-down by knocking the cover or bottom out of the cylinder. The cause of boiler priming is dirty water, or sudden change of water from sea to a river. In some cases a syringe is used to inject tallow or oil to the boiler, which assists in smoothing the surface.

COMPOUND ENGINES are constructed with High and Low-pressure Cylinders connected with each other. The high-pressure, or smaller cylinder (*only*) receives the steam direct from the boiler, which is cut off, usually, at less or about half-stroke; expands the remaining portion of the stroke; and passes to the large, or low-pressure cylinder, where it does another duty at a diminished pressure, leaving by the exhaust to the surface-condenser in the usual way, as already explained in the ordinary engine.

The High-pressure Cylinder is placed in different positions: one maker has the high-pressure on the top of the low-pressure; another the high-pressure inside the low-pressure; a third has the small cylinder at the back of the large one; a fourth the high-pressure in front of the low-pressure;—each and all on the same principle of producing a complete expansion to the end of the stroke in the large cylinder.

The power and violence of the high-pressed steam (60 *to* 65-*lbs. pressure*), requires to enter a small cylinder first, to curb its force, which would do damage by its sudden concussion if allowed to enter a large cylinder direct.

Expansion, in all engines, economises fuel, and the compound engine, being expansion complete, of course saves fuel to a greater extent than by expansion in the ordinary engine.

The steam being dried, and increased in temperature by the super-heater, has the advantage of saving fuel and being better adapted for the compound engine than common steam, and on reference to plate (2), you will find an arrangement above the boiler for admitting either common, super-heated, or *mixed* steam to the engine. Mixing the common with the superheated steam softens and assists in lubricating the piston, the packing of which works with increased friction; as superheated steam being dry, the cylinder requires a vast amount of oil and tallow.

READY FOR SEA.

Explain all that will have to be done for putting the engine into motion.

The boilers filled to the proper height above tubes; fires lit and steam got up to the pressure required; see all clear of the moving parts of the engine; blow through; open escape valves on cylinder, and let water out of jackets; open sea-cocks, stop-valve, &c. All being ready, give the commander that notice, and if the reply is "turn a-head slow," I will open partially the throttle-valve injection, and turn the starting-wheel for giving forward motion on the link, and stand by for the word—faster, full-speed, or stop-her—as required.

Fuel running short and find that there is only sufficient for twelve days, and the distance to run will occupy fifteen days. To make it last out the whole distance the engines must be worked with less steam, *expansively*, cutting off at any portion of the stroke required, and using the aid of canvass when an opportunity serves. Also, avoid driving against a head wind and sea, which consumes more fuel than necessary, and don't give the proportion of speed that it would under more favorable circumstances.

When the water in the boilers is dangerously low, opening the safety-valves will allow the steam to escape, and give less resistance to the feed, reducing the danger of accident. Also, open fire and flue doors, feeding the boiler up to the height required as fast as possible, and look out sharper that the water don't get so low again.

Besides regulating the quantity of water in the boilers, the engineer's attention must be directed to the quality of the feed water in the hot-well, as regards its temperature and density.

It must be quite clear and evident that the greater the heat of the feed water, the sooner it will produce steam; also the fresher the water, less blowing-off will be needed, and the natural consequences, less consumption of fuel, also less injury to the boilers. The stoke-hole should also command some claim on the engineer's attention, so that the owner's interest don't go up the chimney any faster than it ought, as pitching in coals is not always judicious firing; but opening the fire doors only at the proper time, and placing the proper quantity of fuel in its proper position in the furnace, secures the economical generating of steam.

STEAM EXAMINATION.

Q. What is the Safety-Valve, and its use?

A. It is a valve fitted on the top of the boiler to allow the steam to escape up the waste steam-pipe, when it exceeds the required pressure.

Q. Explain the use of the Throttle-Valve?

A. The Throttle-Valve is fitted in the steam-pipe, and regulates the quantity of steam that the engineer requires for the engine.

Q. Of what use is the Stop-Valve, or Cocks?

A. To shut off and admit steam from the boiler to the engines, or to open and shut off any communication, as between one boiler and another, when required.

Q. What are the Blow-off Cocks?

A. They are fitted on the bottom of the boilers for blowing off the brine when changing the water in the boiler. They are used for filling the boilers, when empty, as high as the water is outside the ship.

Q. What are the Blow-through Cocks?

A. Cocks fitted to admit steam to the condenser, for blowing through foot-passages and clearing them from any lodgement of water which passes out of the snifting-valve, and filling the *cold* condenser with steam; when condensed forms a partial vacuum to start with.

Q. Is the Snifting-Valve of any other use?

A. It is only used when blowing through.

Q. Could the Snifting-Valve be made of any other use?

A. Yes; it will assist in pumping out a leaky ship, by allowing the water to come into the air-pump, if the water reaches the snifting-valve.

Q. What is the use of the Injection-Pipe and Cock?

A. For admitting cold water to the condenser from the sea; to condense the steam as it comes from the cylinder.

Q. What is the Foot-Valve and its use?

A. It is fitted between the condenser and air-pump, and opens on the up-stroke of air-pump, and closes on the down-stroke, and thereby prevents the water returning to the condenser.

Q. Describe the Delivery-Valve?
A. It is fitted in the passage at the top of air-pump, to hot-well, and allows the water lifted to pass into the hot-well, and prevents its return.
Q. How are Sluice-Valves fitted?
A. They are placed at the ship's side for allowing water to pass from the hot-well to the sea, and prevents any returning. It acts the same in any other communication with the inside and outside of the vessel.
Q. What are the Slide-Valves and their use?
A. They are fitted to travel over the ports on the cylinder for admitting steam to the top and bottom of the cylinder for moving the piston, and allowing the steam to escape.
Q. What is the Eduction-Pipe?
A. The passage by which the steam leaves the cylinder and finds its way to the condenser.
Q. What is the Eduction-Port?
A. The port between the top and lower port of the cylinder, and receives the steam after it has done its duty.
Q. What is the Expansion-Valve and Gear?
A. The Expansion-valve is fitted to the slide-valve case to admit only that quantity of steam that is needed, cutting off at one-fourth, one-third, or one-half stroke, as wanted.
Q. What is a Reverse-Valve, or, as it is sometimes called, Atmospheric-Valve?
A. It is placed on the upper part of the Boiler, to admit air into it when a vacuum has been formed in the boiler which might cause a collapse.
Q. What are the Stuffing-Boxes?
A. They are metallic boxes through which the piston and air-pump rods slide through the cylinder and air-pump covers, and fitted with packing and rings to keep them steam and air-tight.
Q. What is the Steam-Gauge?
A. To indicate the pressure of steam in the boiler.
Q. What are the Glass Gauge and Cocks?
A. To indicate the height of water in the boiler.

Q. What is the Vacuum-Gauge?
A. To indicate the state of vacuum in the condenser.

Q. What are Escape-Valves?
A. They allow water to escape from the top and bottom of the cylinder; also allow surplus feed to return to the hot-well.

Q. What is the use of the Air-Pump.
A. To clear the condenser of the water and air, and create a vacuum in it.

Q. What is a Kingston-Valve?
A. It is placed at the side or bottom of the vessel, to close when any alterations or repairs are required to the pipes inside the ship, which lead to the sea through the Kingston-valve.

Q. What are the Air-Pump Bucket-Valves?
A. They are fitted on the top of the bucket, to allow the water to pass through the bucket and not to return, and exactly the same as the clapper on the upper box of the ship's-pump.

Q. What is the Steam-Chest?
A. The space at the top of the boiler above the water.

Q. What is the Super-Heater?
A. A contrivance fitted above the boiler, and in the lower part of the smoke-stack, in which are tubes through which the steam passes before going to the engine. The waste flame and gases pass round these tubes before leaving by way of smoke-stack.

Q. How are the Boilers kept supplied with water?
A. By the feed-pumps, fitted so as to take the water from the hot-well and force it into the boilers.

Q. At what temperature does Fresh and Salt-Water boil?
A. Fresh-water at 212°; salt-water at 213°.

Q. How is the saltness or density of the water known?
A. By the salinometer, hydrometer, or its temperature.

Q. Explain how you use a Salinometer?
A. Draw off a bucket of water from the boiler, and when it has cooled to the temperature the Salinometer is intended for, then see how it floats when it stands; between $\frac{3}{32}$ and $\frac{4}{32}$ indicates when it has got to the limit of saltness, which it should not exceed, or it will form crust on the water-space inside of the boiler and tubes, when they will burn, and bag down.

Q. If you have no Salinometer or Hydrometer, how do you find its saltness?

A. By the temperature, which should not exceed 216°, which indicates when to blow-off. (*The water becoming more salt gets a higher boiling-point.*)

Q. How do you change the water in the boiler?

A. By blowing-off, and feeding-up from hot-well.

Q. What is the Hot-well?

A. The tank that receives the water from the air-pump, and when it is full is forced by the air-pump outside.

Q. What is the use of the Starting-Lever.

A. It moves the slide-valve, to admit steam to the top or bottom of the piston as required.

Q. How is a vacuum formed?

A. In the cylinder, by the exit of steam for condensation.
In the condenser, by the air pump.

Q. What use are the Tubes in the Boiler?

A. To afford more heating-surface to the water by which they are surrounded, and thereby create steam more quickly by the flame and gases passing through them from the fires before going up the smoke-stack.

Q. How do you start an Engine?

A. Open the Throttle-valve Injection, and move the wheel or hand-gear, *as it may be fitted.*

Q. What is Link-Motion?

A. Gearing attached to the slide-valve, which gives forward and reverse motion, without disconnecting the eccentrics, both of which are attached to the link, one for a-head, the other for stern way, and the slide-valve placed in the middle of the link, stops the engine, as neither eccentric can then do duty.

Q. How high should the water stand above the tubes in the Boiler?

A. About six inches.

Q. In a Flue-Boiler, how high should the water stand above the Flues?

A. About six to eight inches.

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Q. What is a Vacuum and its use?

A. A vacuum is an empty space, and sucks the steam from the exhaust side of the cylinder.

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Q. In a Flue-Boiler, how high should the water stand above the Flues?

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Q. When the Boilers are thin, what would you do to prevent them blowing-up.

A. Work them with a reduced pressure.

Q. How do you know they are thin?

A. By tapping them gently with a mallet or small hammer.

Q. What advantage has a Screw over the Paddle?

A. It being always immersed, except when pitching hard, exerts the same power, which a wheel cannot do when burdened to leeward, or working in the air on the weather side.

Q. If the Blow-off Cocks are set fast, how will you change the water in the Boilers?

A. Blow off with any other cock that has communication with the sea, or through the feed-escape. (*Some knock out a rivet.*)

Q. How feed the Boilers when the Engine is not working?

A. By hand or donkey feed-pumps.

Q. If the Safety-Valve is set fast, how will you relieve the pressure of steam?

A. Let it escape through the safety-valve of the other boiler, and blowing through engines by way of snifting-valve and bilge-injection, &c., and open fire and flue-doors.

Q. When any of the tubes in the Boiler are damaged, and cannot take them out, what will you do?

A. Plug them up with wood, or a bolt and washer through them.

Q. What is meant by the Boiler Priming?

A. The water bubbling up by being dirty, and the ebullition may sometimes be so much as to get into the steam-pipe, and thence to the cylinder, which would cause a break-down.

Q. How prevent Priming?

A. By introducing oil or melted tallow into the boiler with a syringe, or mixed with feed-water; and keep the steam-pressure low,

Q. How is the steam condensed in a Surface-Condenser?

A. The condenser is fitted with tubes for the steam to pass through, while they are surrounded with cold water by the circulating pump, and the cold water applied to the tubes condenses the steam, leaving it entirely fresh water for feed, the cold salt water not mixing with the steam as in a common condenser.

Q. How is the Engine worked slow?
A. By partially closing the throttle-valve.

Q. What is meant by using Bilge-Injection?
A. It is allowing the injection to come from the bilge, instead of outside, having pipes fitted for that purpose, which is also keeping the ship free from water when leaky.

Q. What is meant by a Compound-Engine?
A. A compound-engine is so constructed that the steam of a very high pressure, and *super-heated*, passes first into a small high-pressure cylinder, does its work, and then leaves into a large low-pressure cylinder, and does the stroke out by expansion, which saves fuel, and is otherwise more economical than the ordinary engine.

Q. What effect has Super-heated Steam on the Piston, Packing, &c.?
A. Super-heated Steam, being so dry, requires more lubrication than common steam, to ease the increased friction on the cylinder and piston.

Q. If short of oil and tallow, how will you assist in lubricating the Piston?
A. By admitting a portion of common steam mixed with the super-heated steam, which has a beneficial effect.

Q. How is the Piston lubricated?
A. By admitting melted tallow to the cylinder by the grease-cock, opened on the exhaust or vacuum-side of the piston.

Q. How do you disconnect an engine if there is no coupling-gear fitted?
A. By taking out the crank-pin.

Q. Having fifteen days' run, and only twelve days' coal, how make it last the whole distance?
A. By working the engines expansively, cutting off the steam at an earlier part of the stroke, and let the remainder of it be done by the expansion of the steam given.

Q. If the Feed-pump working apparently all right, and the water don't rise in the boiler, what may be the cause?
A. If the Feed-pipe is hot, the feed-water is not going to the boiler, on account of some of the valves in pump not

working; or the water may be returning by the escape, which is not sufficiently weighted; or the pump may draw air.

Q. What is the pressure of the atmosphere?

A. 15 lbs. to the square inch.

Q. What quantity of steam will be obtained from a cubic inch of water?

A. One cubic foot.

Q. How is a Salinometer graduated?

A. It is first put into fresh water at a temperature of 200°, and marked at the floating line, 0. It is then immersed in salt-water at the temperature of 200°, and marked where it floats $\frac{1}{32}$. The distance between 0 and $\frac{1}{32}$, taken in the dividers, and placed below $\frac{1}{32}$, gives $\frac{2}{32}$. The same distance below $\frac{2}{32}$ is marked $\frac{3}{32}$, and again $\frac{4}{32}$ in the same way; *and bear in mind when the Salinometer floats any lighter than* $\frac{4}{32}$, *deposit of salt or scale is forming in the boiler and on the tube.*

Q. Is there any other mode of graduating the Salinometer or Hydrometer?

A. Yes; put the instrument into salt-water at a temperature of 200°, and mark it $\frac{1}{32}$. Boil the water down to one-half the quantity, viz., by letting the steam escape until the water has only half its former bulk, and immerse the instrument again at the temperature of 200°, and mark this $\frac{2}{32}$, and with the dividers mark the distance from $\frac{1}{32}$ to $\frac{2}{32}$, below for $\frac{3}{32}$, and $\frac{4}{32}$ as before. *In this manner Salinometers have been made with any long tube-shaped bottle weighted at the bottom.*

Q. What is meant by Cushioning?

A. Cushioning is the resistance to piston from the exhaust steam left in the cylinder on the vacuum side, being prevented escaping to condenser through a wrong lead or lap of the slide valve, or a bad vacuum.

Q. How is the Glass Water Gauge proved to be working right?

A. By trying the gauge cocks. The top one gives steam; the middle one steam and water; the lower one water only.

Q. What is the cause of bearings heating?

A. By working new engines at too high a velocity.

Q. How do you cool the bearings when they become heated?

A. Slacken the nuts of the cover, work the engines slow, and

use tepid water and oil mixed for some time, and when it is cooled gradually down, keep cool water playing upon it from a pipe leading from outside to the bearing.

Q. In running free or pitching, with a heavy sea and a jump on the engines, how would you prevent any accident occurring?

A. By attending the throttle valve and working the engine slow, and constantly attending the throttle valve.

Q. If the condenser refuse the injection, what is the matter?

A. The condenser is too hot, and no vacuum, by neglecting the injection cock, which should have supplied more cold water, and so preventing the condenser from getting too hot. The engines must work slow until it is cooled down by pouring on cold water outside, and letting the steam escape from inside. *In a surface condenser this cannot happen.*

Q. How do you stop an engine?

A. Shut the throttle valve, and place the slide valve rod in the middle of the link.

Q. The engine is stopped, and while standing, what will need attending to?

A. If waiting to start again, I would keep up the feed in boiler by hand-pump or donkey. If not going to start again, draw fires and allow steam to escape up waste-pipe through safety-valve.

Q. What height can water be lifted or forced by any kind of pump?

A. 30 feet is the limit, and if needed higher a second pump must be used to take the water from the first pump.

Q. How do you ascertain that the tubes in the condenser are cracked and leaky?

A. By such an increase of feed in hot-well that could not possibly be produced from the amount of steam to condense.

Q. How do you know there is such an increase of feed water?

A. By its discharge through the overflow, and its temperature.

Q. What will the effects be of having leaky tubes in the condenser?

A. The feed water being salt will require the water in the boiler to be changed more frequently than it would by the feed water not being so salt; the feed water will also be much cooler.

Q. What is meant by surplus feed?

A. The additional water required from some other source to keep the water at the right height above the tubes.

Q. If you could get sufficient feed from the hot-well what would be the matter?

A. The overplus of feed water shews that the cold water surrounding the tubes in the condenser finds its way to the feed water through leaky tubes.

Q. What would you do if your tubes in condenser are all damaged, and none to replace them?

A. I would work the surface as a common condenser, and it should be so fitted as to work both ways when required.

Q. State your rule for finding the quantity of coal a Bunker will hold, or, in other words, its capacity.

A. Multiply the length by the (*mean*) breadth and depth, and divide by the cubic feet per ton: this gives the number of tons the Bunker will hold.

EXAMPLE.

The length of a Bunker is 18 ft. 3 in.; breadth (*mean*), 9 ft. 6 in.; and depth, 10 ft. 9 in.: 40 cubic feet to the ton, required the Bunker's capacity?

18.3 — 18.25

9.6 — 9.5

10.9 — 10.75

18.25
9.5

9125
16425

173.375
10.75

866875
1213625
1733750
---
40 { 5)1863.78125
---
8)372.75625

Tons....46.59453
20

Cwts....11.89060
4

Qrs.....3.56240
28

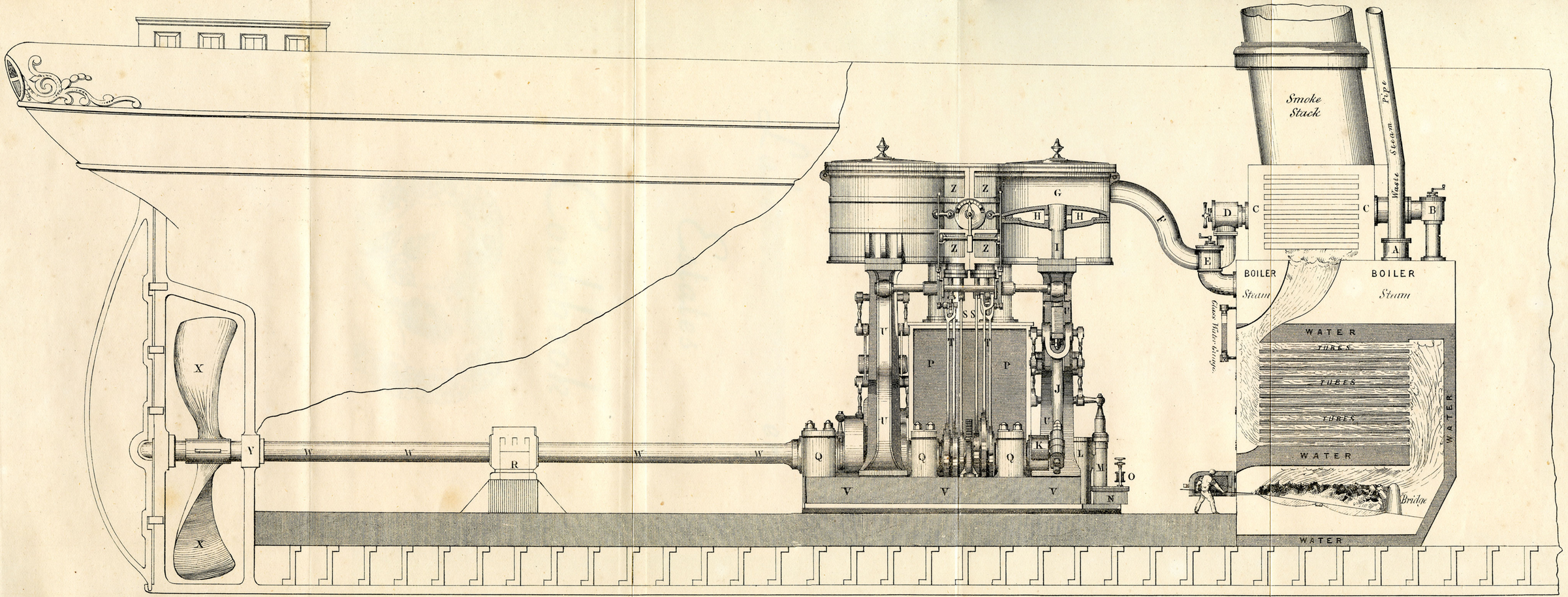
449920
112480

Lbs.....15.74720

	Tons.	Cwt.	Qrs	Lbs.
Answer....	46	11	3	15

EXPLANATION OF PLATE 2.

A Safety Valve.
B Valve for Admitting Steam from Boiler to the Super-heater.
C C Super-heater.
D Valve for Exit of Steam from the Super-heater to Engine *(Stop Valve)*.
E Valve for Admitting Common Steam to the Engine *(Stop Valve)*.
F Steam-pipe between Boiler and Engine.
G Cylinder.
H H Piston.
I Piston Rod.
J Connecting Rod.
K Crank.
L Air Pump *(Part of)*.
M Feed Pump.
N Feed Pump Valve Box.
O Escape for Surplus Feed.
P P Condenser.
Q Q Q Shaft Bearings.
R Thrust Bearing.
S S Eccentrics for working Expansion Valves.
T T Eccentrics for working the Link Motion.
U U U U The Engine Framing.
V V V Base-plate for Engine.
W W W Screw Shaft.
X X Propeller.
Y Bearing and Stuffing Box.
Z Z Z Z Slide-valve Case.


Smoke Stack
Waste Steam Pipe
BOILER
Steam
BOILER
Steam
WATER
TUBES
TUBES
TUBES
WATER
WATER
WATER
Bridge
Glass Water Gauge
A
B
C
C
D
E
F
G
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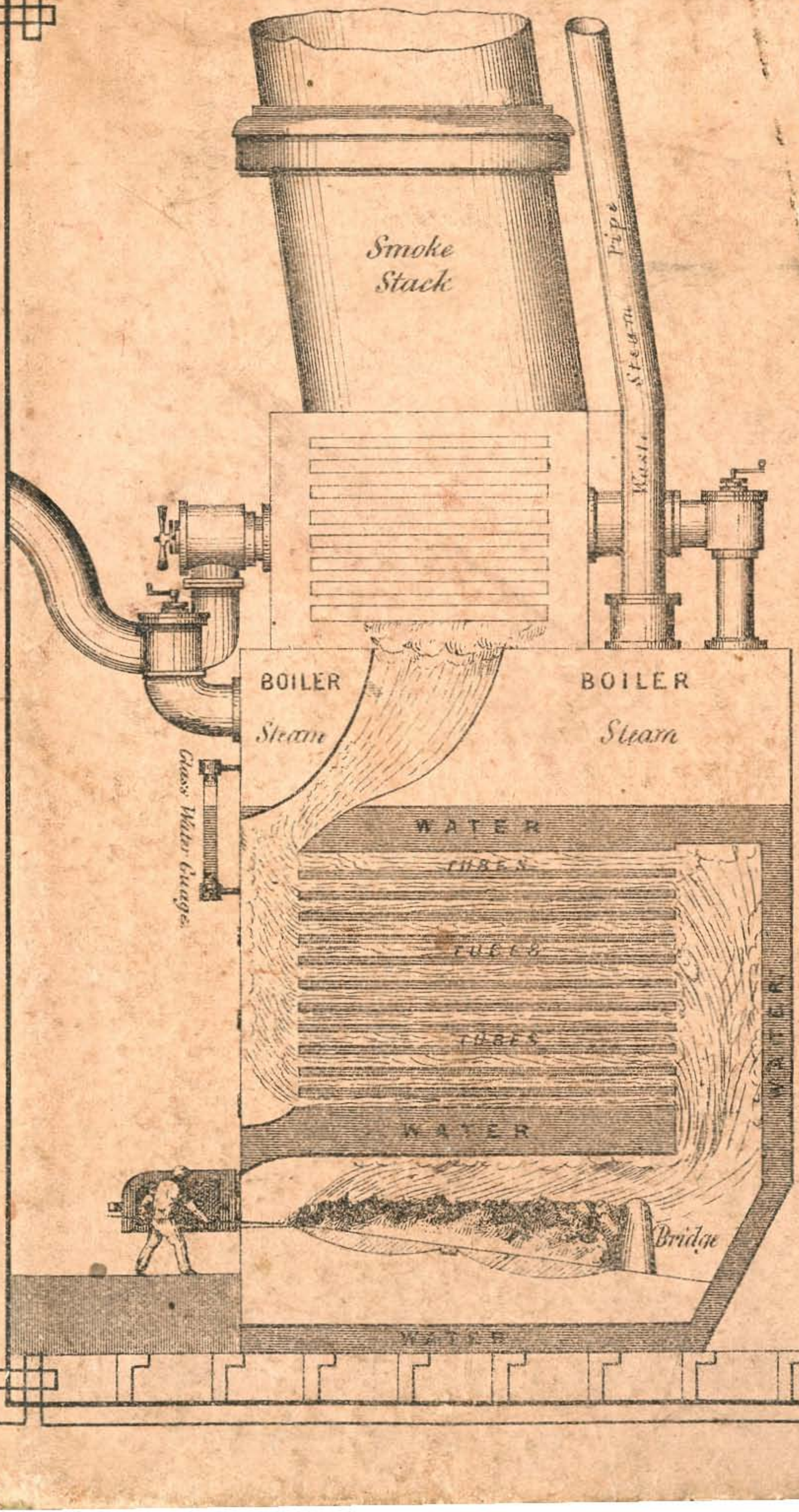
Smoke
Stack
Pipe
Steam
Waste
BOILER
BOILER
Steam
Steam
Glass Water Gauge
WATER
TUBES
TUBES
TUBES
WATER
WATER
Bridge