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# STEAM MANUAL.

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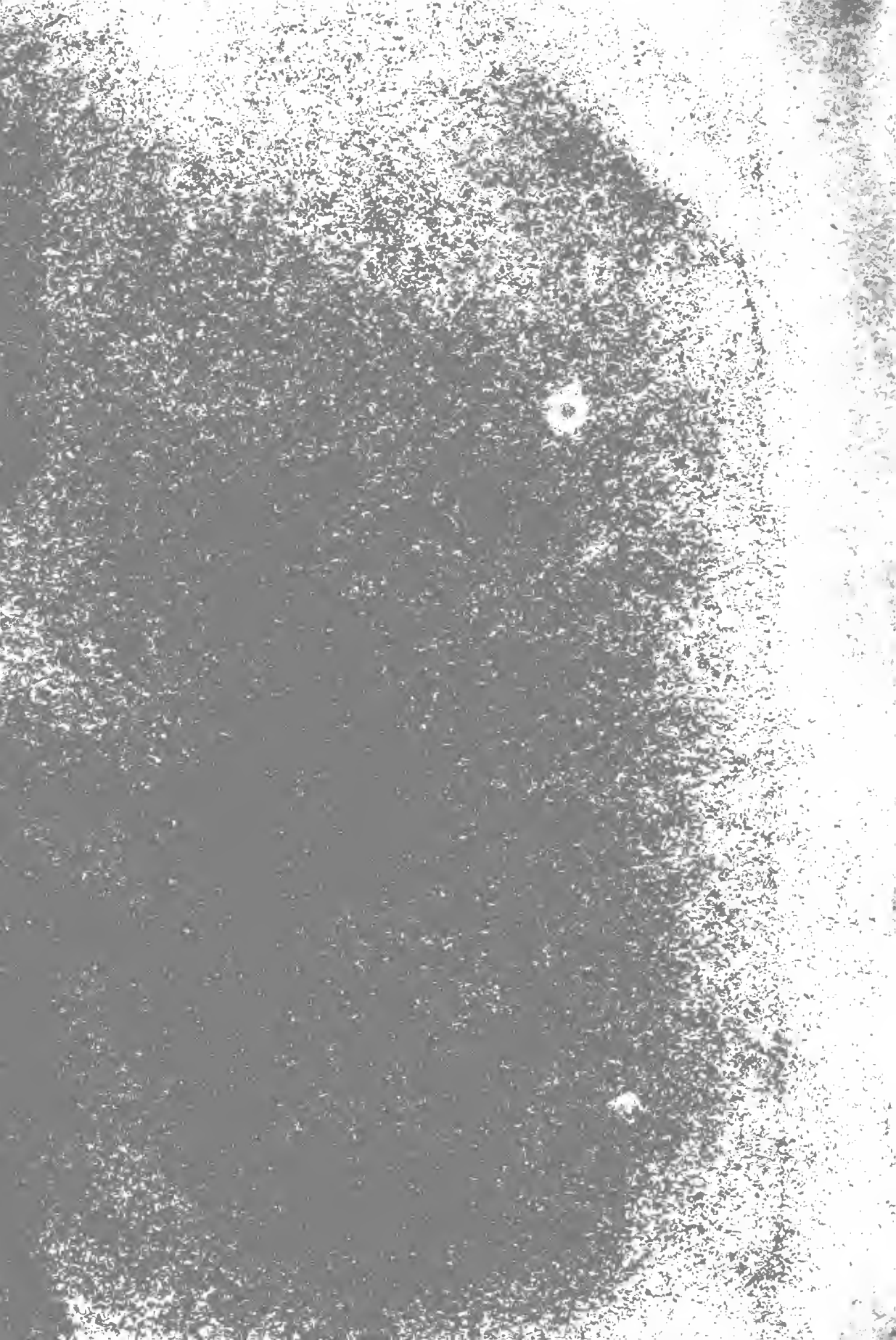
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Eng<sup>r</sup> Lieut R. M. Logan R.N



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STEAM MANUAL

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FOR

HIS MAJESTY'S FLEET

CONTAINING

REGULATIONS AND INSTRUCTIONS

RELATING TO THE

MACHINERY OF HIS MAJESTY'S SHIPS.

*(Corrected to April, 1910.)*



LONDON:

PRINTED FOR HIS MAJESTY'S STATIONERY OFFICE

By EYRE AND SPOTTISWOODE, LTD.,

PRINTERS TO THE KING'S MOST EXCELLENT MAJESTY.

1914.

C.N. 28766/10.  
Sta. 3561 A/13.

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*Note.—In the case of Portsmouth, Devonport, and Chatham Yards, the terms Captain of Dockyard, Chief Constructor, and Chief Engineer should read Captain of Dockyard and Deputy Superintendent; Manager, Constructive Department; and Manager, Engineering Department respectively.*

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# STEAM MANUAL.

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1910.

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1.

With reference to Article 923 of the King's Regulations and Admiralty Instructions quoted below, my Lords Commissioners of the Admiralty are pleased to issue the following directions respecting the "Steam Manual" therein referred to.

2.

Nothing contained in the "Steam Manual" is to be understood to supersede the King's Regulations and Admiralty Instructions, but the regulations and instructions given in the former, are to be regarded as supplementing those contained in the latter.

3.

1. Each Commanding Officer on being first appointed to command, each Engineer Officer and each Midshipman on first appointment, and each Engine Room Artificer and Mechanician on being rated as such, is to be provided with a copy of the Steam Manual. This copy is to be considered as the personal property of the Officer, Artificer or Mechanician to whom supplied, and is to be the only one supplied to him except when replaced by a revised edition or when his copy has been worn out. The supply of these Manuals to Engineer Officers, Engine Room Artificers and Mechanicians is to be made by the Engineer Rear-Admiral on the Staff of the Commander-in-Chief at the Home Ports. The books will be issued to him through the accounts of the Secretary to the Commander-in-Chief, to whom he will furnish a receipt for the total number of Manuals received. Supply in lieu of a copy worn out may be made on the approval of the Senior Naval Officer.

2. Engineer Officers are to insert in their copies on the pages provided for the purpose, such particulars of the Machinery, or other information connected with the ships to which they are attached as they may think will be of future service to themselves.

4.

1. A copy of the Steam Manual is to be provided for every Steam Vessel in His Majesty's Navy, which is to be marked with the vessel's name. In the case of new ships it is to be issued to the ship on the first appointment of the Engineer Officer.

2. It is intended that the Ship's Manual shall contain such particulars of the Engines and Boilers, &c., as to type, construction, age, makers, power, the dimensions of its more important parts, the results of trials and tests, particulars of any additions or alterations made, and its state and condition from time to time, so that, in the event of an Officer being appointed to a ship already in commission, he may be able, by its aid, to make himself acquainted with the nature of the Machinery placed in his charge. The Engineer Officer is to arrange for the insertion of such particulars on the pages provided for the purpose.

3. The Ship's Manual is to be readily accessible to all the Engineer Officers who may be attached to the ship.

Throughout the Manual, unless there is something in the context or subject-matter inconsistent therewith, the term "Engineer Officer" shall mean the Officer, or the Senior Engine Room Artificer, in charge of the Machinery, whatever his rank or rating may be.

*By Command of their Lordships,*

A handwritten signature in black ink, reading "C. J. Thomas". The signature is written in a cursive style with a large, prominent initial "C" and a flourish at the end.

To all Commanders-in-Chiefs, Captains, Commanders, and Commanding Officers of His Majesty's Ships and Vessels, the Superintendents of His Majesty's Dockyards at home and abroad, and all others concerned.

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*Extract from the King's Regulations and Admiralty Instructions.*

" Art. 923. In addition to the instructions contained herein all Officers are to be guided in the use and management of the Machinery and Boilers by the further regulations and instructions given in the 'Steam Manual,' which is furnished for their information and guidance so far as they may concern the Machinery and Boilers fitted to their ships."



## CIRCULARS.

## 9.

A copy of all Circular Letters, Admiralty Weekly Orders, Store Memoranda, &c., which may be issued, relating to the duties of Engineer Officers, or which in any way affect the Engine Room Department, is to be inserted in a Guard Book, D 475B, and all Engineer Officers are to quote in their own copies of the Steam Manual the number, date and subject on the pages provided for that purpose.

## 10.

The Commanding Officer of every ship on commissioning will be supplied from the Commander-in-Chief's Office with a set of Admiralty circular letters, Admiralty Weekly Orders, Store Memoranda, &c., to the Fleet, and with the proper addenda and errata to the King's Regulations and other books of reference and instruction in accordance with the procedure indicated in Admiralty Weekly Order No. 89 of 18 February 1910.

## 11.

1. To facilitate reference, and to prevent the Circulars, &c. from being overlooked, notes should be made in the Manual, opposite the Articles that these are intended to modify or extend, calling attention to them.

2. If the Circular should not be intended as a modification or extension of any particular Article, but as an addition to the Instructions, a note referring to the Circular should be made at the end of the Manual.

## 12.

The Engineer Officers borne for staff duties at the Ports and in the various Fleets and Flotillas will ascertain that the Steam Manuals are in the possession of each of the Engineer Officers, Engine Room Artificers, and Mechanics, and that they, as well as the Ship's Manuals, are kept duly posted up in accordance with the directions for the same.

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DUTIES AND RESPONSIBILITIES OF THE ENGINEER OFFICERS OF  
H.M. SHIPS.

## 15.

1. The Engineer Officer is to have charge, and be responsible for the maintenance in a state of efficient working order, and, as far as may be, of readiness for immediate use, all that is placed under his charge, including—

- (a) The main machinery and boilers of the ship.
- (b) The machinery and boilers of boats attached to the ship.
- (c) All auxiliary machinery and lifts, including motors, in the main machinery compartments, except as regards the electrical efficiency and repair of dynamos.
- (d) The following auxiliary machinery, however driven:—
  - Workshop engine and shafting.
  - All evaporating and distilling machinery.

All pumps, except lift pumps, and all pipes, cocks, and valves in connexion.

Hydraulic pumping engines up to the discharge valves on the pumps.  
Hydraulic tanks.

Air-compressing machinery up to the discharge valve on the separator column.

Refrigerating, ice-making, and magazine cooling machinery.

All ventilating and forced-draught fans in connexion with the main machinery compartments.

All electric motors fitted for driving any of the above if situated in the engine or boiler rooms.

(e) The following auxiliary machinery when not electrically driven :—

Electric generating machinery as far as the dynamo couplings.

Steering engines and gear as far as the rudder.

Capstan engines, shafting and spindles of capstans and windlasses.

Boat hoists and coal hoists.

Ventilating fans not in connexion with the main machinery compartments.

Any other steam, oil, or gas driven machinery and any other hydraulic machinery except that detailed in clause 3.

(f) All ventilating trunks, pipes and valves in connexion with the ventilating system.

(g) All pipes, cocks, and valves in connexion with the pumping, draining, and flooding systems.

(h) Temperley transporters, and all tools and apparatus on charge in store accounts and fixture list.

(i) All watertight doors and their gear, whether vertical or horizontal, hinged or sliding; armoured hatches with the Weston purchases or other lifting gear.

(j) Instruments and gear, not electrical, for telegraphing signals in connexion with the machinery. Stoking indicators.

(k) All double bottoms, wing spaces, coal bunkers, bilge compartments, bilges, and all spaces containing machinery which is solely or partly in his charge, as regards cleanliness and preservation. The Carpenter is, however, to be responsible as regards structural defects in these parts. (See Articles 331–353.)

(l) All steel wire rope (other than derrick purchases) forming part of or directly in connexion with any machine placed in his charge.

(m) Boilers of steam cookers.

(n) Steam heating arrangements, with the pipes, cocks, and valves in connexion.

(o) All spare gear, &c., of any of the above.

2. All dynamos, torpedoes, submerged discharge tubes, and gear in connexion with them, and all electrically driven machinery, except that mentioned in clause 1, paragraphs *a* to *d*, and clause 3, with shafts, gearing, spare gear, &c., will be in charge of the Torpedo Lieutenant.

3. The gun mountings and all machinery for loading and working the guns, for supplying ammunition, and for turning turrets, barbettes, platforms, &c., together with the pipes, cocks, valves, and spare gear in connexion with them, except when steam, oil, or gas driven, will be in charge of the Gunnery Lieutenant.

4. In ships in which only one officer of the rank of Lieutenant is borne for Gunnery or Torpedo duties; he is to be responsible for the whole of the Gunnery

and Torpedo gear referred to at Clauses 2 and 3. When no Torpedo or Gunnery Lieutenant is borne, the Engineer Officer of the ship will be in charge of the machinery referred to.

5. Any mechanical repairs to machinery in charge of the Torpedo or Gunnery Officer, and beyond the capacity of their respective staffs, are to be taken in hand by the Engineer Officer. Similarly, any repairs to motors, &c., in charge of the Engineer Officer, and beyond the capacity of his staff, are to be taken in hand by the Torpedo Lieutenant.

6. In a Torpedo Boat Destroyer, or Torpedo Boat, the Engineer Officer is, in addition to the above, to have the responsible charge of the whole of the hull equipment.

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## NEW MACHINERY AND MACHINERY OF SHIPS UNDERGOING EXTENSIVE REPAIRS.

### 18.

1. *Specification of New Machinery.*—The Engineer Officer appointed to watch the construction of new machinery of any ship will be furnished with a copy of the specification. He is to call the attention of the Chief Engineer of the Dockyard (in case of Dockyard-built ships), or the Engineer Overseer (in case of Contract-built ships), to any instance in which he may be of opinion that its terms are not being complied with.

2. A copy of the specification is also to be supplied to the Engineer Rear-Admiral on the staff of the Commander-in-Chief at the port to which the ship will be attached.

### 19.

1. *Weights of Machinery.* D. 350.—The Chief Engineer of the Dockyard or the Engineer Overseer appointed to watch the machinery of a ship in process of construction, or the placing on board of new machinery, is to record in a book provided for that purpose the weights of the different parts of the machinery, classified in accordance with the instructions contained therein, noting also, as far as practicable, the material of which each part is constructed.

2. *Record of Spare Gear.*—He is to be particular in noting in the Book of Weights where each article of spare gear is stowed, for the purpose of facilitating any calculations which may be required in reference to the distribution of the weights in the ship.

3. *Book of Weights.*—On the completion of the book, he is to forward a duplicate copy of it to the Engineer Rear-Admiral on the staff of the Commander-in-Chief at the port to which the ship is attached, for notation, who will forward it to the Engineer Officer of the ship to retain. The original is to be forwarded by the Engineer Overseer, or the Chief Engineer of the Dockyard, to the Controller of the Navy.

4. *Stationery.*—Engineer Officers employed in watching the construction or fixing the engines, or in taking weights of machinery, are, on appointment, to forward a demand to the Admiralty on Form D. 2e, for the stationery estimated to be required to the 31st March or 30th September following. Subsequent supplies are to be demanded half-yearly on the 1st February and 1st August for the six months April to September and October to March respectively.

5. Engineer Overseers other than those referred to in the following clause, will be supplied by the Naval Store Officer, R.N. Store Depôt, West India Docks, on demand, with such forms and envelopes on the Established List as may be considered necessary. Demands should be prepared on Form D. 397, in duplicate, and should be transmitted not oftener than once a quarter (1st January, 1st April, 1st July, 1st October).

6. Officers engaged at Contractors' Works in the vicinity of Portsmouth and Devonport are to draw their supplies of forms from those Yards, and demands should be transmitted to the Naval Store Officers on the dates specified in the previous clause.

## 20.

1. *Engineer Officer to be provided with tracings.*—The Engineer Officer appointed to a ship receiving new machinery will be provided by the makers of machinery with tracings showing the details of engines, boilers, auxiliary machinery, general pipe arrangements, &c. If the vessel is fitted with water-tube boilers of the small tube type, he will be supplied with sketches showing the lettering and numbering of the tubes and a guard book for the Tube History Sheets.

2. *Sketch Book. Explanations to accompany Sketches.*—He will also be furnished with a book in which he is to make sketches (in ink, to scale and with dimensions) of such parts of the machinery, &c., of which tracings or prints are not supplied by the Contractors or Dockyard, especially of those parts which will be difficult of access when the machinery is complete and the ship ready for sea. The sketches should be as accurate and complete as possible, and should be accompanied by explanatory descriptions and remarks. Each sketch should be signed and dated by the officer who makes it.

3. *Measurement Book. D. 280.*—Measurement books will also be supplied to Engineer Officers to enable them to make the necessary rough sketches before drawing them to scale in the sketch-book.

## 21.

1. *Information, &c., supplied by Shipbuilders.*—Information and drawings respecting the watertight doors, the positions of the pumps and valves, the leads of the suction and delivery pipes, and the different compartments of the double bottoms will be supplied to the Engineer Officer by the Shipbuilders.

2. *Information given before Ship is Commissioned.*—The drawings of pipes, &c., will not be supplied until the work is actually completed, but in order that the Engineer Officers appointed to ships in course of construction may be as fully informed as possible, they will be allowed reasonable access to the working drawings of those parts of the structure and fittings of the ship that will come under their charge when the ship is in commission.

## 22.

1. *To point out Alterations desirable.*—The Engineer Officer of any ship building or undergoing repairs is to call the attention of the Chief Engineer of the Dockyard or Engineer Overseer (as the case may be) to any alterations or additions which he may be of opinion would be for the benefit of the Service, and to any instances in which he may consider that improper or insufficient fittings are being made in the ship.

When considered of sufficient importance, such representations are to be made in writing.

2. *Suggestions before Work is too far Advanced.*—Submissions of this nature should be made, if possible, before the work on the parts proposed to be altered has been taken in hand; but the submissions are not to be withheld even when the part proposed to be altered has been completed.

3. *Notations in Sketch Book and Ship's Manual.*—Should any changes be made in the machinery whilst a ship is undergoing repairs, explanatory sketches are to be inserted in the Sketch Book, and a notification of all such changes is to be made in the ship's Steam Manual. (See Arts. 4, 68.)

### 23.

1. *To inspect Machinery, &c., when joining Ship.*—An Engineer Officer appointed in charge of the machinery of a ship which is in charge of the Captain of the Dockyard is immediately after joining to make a careful inspection of all the machinery, boilers, parts of the ship, fittings, and stores under his care, and to report in writing to the Chief Engineer of the Dockyard and the Captain of the Dockyard the result of his examination.

2. *Responsibility.*—He will be responsible to the same extent as if the ship were in commission for the preservation in a state of efficiency of all that is placed under his charge, as laid down in Art. 15. *Vide* Art. 414.

3. *Custody of Fixtures and Sea Stores.*—He is to have the custody of, and be accountable for all fixtures, and stores on board which would be in his charge if the ship were placed in commission.

4. *Responsibility on raising Steam. To sleep on Board.*—He is responsible that on raising steam for any purpose all the precautions directed to be observed in raising steam for steam trials are strictly carried out, and on the night of the day on which the fires have been alight he is to sleep on board, provided the main engines have been worked, and sea connections opened, retaining with him a sufficient number of Engineer Officers, Engine-room artificers, and stokers to assist in case of fire or accident.

5. *Fire Regulations.*—He is to pay particular attention to the fire regulations and precautions, and is to be responsible for the prevention of danger from fire and lights in the engine-room department, and to allow no accumulation of clothes, oily wipings, or other matter liable to spontaneous ignition.

6. *To report Fire in Writing.*—He is, in any case where fire may occur, to report full particulars of the same in writing.

### 24.

1. *Responsibility when in Hands of Dockyard or Contractors.*—Should the machinery of the ship to which an Engineer Officer is appointed be in the hands of the Dockyard or of Contractors, he is to keep a strict watch over all parts which would be in his charge were the ship in commission, in order to see that all necessary steps are taken for their preservation in proper condition. If in his opinion any part is liable to deteriorate from want of proper care or other cause, he is immediately to report the circumstance to the Chief Engineer of the Dockyard or Engineer Overseer (as the case may be) who will take such steps as the particular case may require, but he is not in any way to interfere with Dockyard or Contractors' workmen.

2. *Idleness or Bad Workmanship.*—He is to take steps to keep himself informed as to, and to report any cases of idleness, bad workmanship, or irregularity of conduct on the part of these men.

3. *To watch Progress of Work.*—He is personally, or by his assistants, to watch the progress of the work (whether performed by the Dockyard or by Contractors) from its commencement in the morning to its cessation in the evening.

4. He is to keep an Engine Room Register in which a record is to be made of the progress of construction or repair of the machinery and boilers and of all examinations and tests of same.

## 25.

1. *Cocks and Valves opening to Sea or Bilge.*—During the fitting of new machinery, the Engineer Officer is to pay special attention to the position of the handles of all cocks and valves which open communication with the sea and bilge; to see that they are placed at a convenient height above the various platforms, and are readily accessible; and that all handles are so fitted that the valves will close with a right-hand motion.

2. *Fitting of Stop Valves, &c.*—Iron or steel bolts are not to be used in gunmetal flanges in situations in which they are liable to be acted on by moisture.

## 26.

1. *Lagging of Boilers, &c.*—The Engineer Officer is to see that the boilers are properly lagged throughout, and that all parts adjacent to uptakes, funnels, &c., which are liable to get overheated, are covered with a non-combustible material.

2. *Zinc Slabs.*—He is to pay particular attention to the fitting of zinc slabs, and to see that they are of the authorised number and dimensions, and of the proper description of zinc, and that they are suspended in the most suitable positions for the protection of every part of the interior of boilers or wherever else fitted.

3. *Preservation of Boilers.*—He is to see that the boilers when not undergoing examination or repair are kept completely filled with fresh water in an alkaline condition and from which air has been expelled by boiling, and weekly tests are to be made to ensure that this condition is maintained. Steps are to be taken to avoid risk of damage to boilers from frost during the winter months by keeping airing stoves alight; when necessary for boilers to be kept open for examination, repair, &c., they are to be thoroughly dried out and kept dry with airing stoves, being again completely filled with boiled fresh water in an alkaline condition as soon as possible.

4. *Internal Feed Pipes.*—Where internal feed pipes are fitted, they are to be so placed as not to allow the stream of feed water to impinge directly against any steel surfaces.

## 27.

1. *Discharge Plugs.*—He is personally to see the discharge plugs fitted in place and stowed in easily accessible positions as near to the respective orifices as they can conveniently be placed, and he is to inform the Chief Engineer of the Dockyard or the Engineer Overseer (as the case may be) when they are so fitted, in order that the Officer may cause an inspection of the same to be made.

2. *Notation in Steam Manual.*—He is to make a notification of this inspection in the ship's Steam Manual, and on every subsequent occasion of the ship being docked, the plugs are to be tried in place, and a similar notification is to be made. (See Art. 488.)

**28.**

1. *Spare Gear*.—The Engineer Officer is to satisfy himself that every article of spare gear has been properly fitted and tried in place.

2. *Stowage of Spare Gear*.—He will, when the machinery is being placed on board, at all times acquaint the Chief Engineer of the Dockyard or the Engineer Overseer (as the case may be), when the more important articles of spare gear are about to be stowed, so as to ensure their being, as far as practicable, secured in positions under protection from which they may be most readily brought into use if required, without disturbing other parts of the machinery or interfering with the structure of the ship.

3. *Notation in Steam Manual*.—Whenever it may be necessary to stow portions of the spare gear in places from which they cannot be brought into use without disturbing parts of the structure, the Engineer Officer is to make himself acquainted with the best methods of removing and replacing the same should occasion require; particulars as to where stowed and method of removing or replacing to be inserted in the ship's Steam Manual.

**29.**

*Holes through Ships' Bottoms*.—Metal label plates, with the names of the pipes which are directly below them are to be fitted in all ships in such positions as may be found most suitable, in order to give a guide to the position of the holes through the bottom and sides under water, so that, should it be necessary to examine them, a diver can descend and immediately find the orifice.

**30.**

*Position of Load Water Line*.—The position of the load water line is to be marked on the inside of all ships built or repaired, with a view to facilitate the adoption of prompt measures in stopping leaks, whether occasioned by shot or any other means. The mark is to be made by raised label plates marked L.W.L and a broken paint line two inches broad on the ship's side or bulkheads below, at such places as to admit of the line being easily seen.

**31.**

1. *Colours of Pipes*.—In order that the different pipes may be known by their colours, each pipe, or its casing, is always to be painted the colour that is shown for it on the authorised diagram.

2. The same colours will be used to show these pipes on the drawings which are supplied by the Dockyards for the information of the Officers.

3. Copies of the diagram will be supplied by the Dockyards, and are to be posted in convenient positions on board His Majesty's ships.

**32.**

*Precautions against Galvanic Action*.—Before a ship is received as complete, the Engineer Officer is to assure himself by personal inspection that all the precautions required in the fitting of bilge suction pipes, roses, &c., throughout the ship for the prevention of galvanic action, are properly carried out, and he is to report whether this has been done to the Engineer Rear-Admiral on the staff of the Commander-in-Chief at the port to which the ship will be attached.

## 33.

1. *Examination of Under-water Fittings.*—In the case of a new ship built at a Dockyard, or of a ship undergoing extensive repairs there, the Dockyard Officers are, before the ship is launched or undocked, to ascertain by careful examination that all valves, gratings, pipes passing through the bottom, and other fittings below the waterline are well and properly constructed and fitted, in efficient working order and likely to remain so, and that all orifices through the ship's bottom are clear. If the Examining Officers have any doubts as to the durability of these fittings, new ones are to be substituted.

2. The Examining Officers are to report the result of every such examination to the Principal Officer of their Department, and sign a certificate thereof, which will be kept in the office of the Chief Constructor.

3. In the case of a new ship built at Contractors' works, the above examination is to be carried out by the Hull and Engineer Overseers of the ship, in conjunction with the Contractors.

## 34.

*Closing Sea Cocks and Valves before Undocking.*—In the case of a ship building or ship undergoing thorough repair at a Dockyard, or at Contractors' works, the Dockyard Officers or Contractors respectively are responsible for ascertaining that all sea connections are shut whenever the ship is undocked, but in all other cases the Engineer Officer of the ship is responsible, except for those valves under repair by the Dockyard.

## 35.

1. *To report Docking.* M.S.—When a ship in Dockyard hands is placed in dock the Engineer Officer is to report the fact to the Chief Engineer of the Dockyard, stating whether the machinery has been affected in any way by the process of docking.

2. *To record Sea Cocks and Valves closed.* M.S.—He is also before the ship is undocked to inspect the whole of the under-water fittings, and to make a record of such examination in a book kept in the Office of the Chief Engineer of the Dockyard stating that all sea cocks and valves, excepting those in connection with the submerged torpedo tubes, are closed and correct.

## 36.

1. *Examination of New Machinery.*—As soon as the whole of the Contractor's trials in any ship, whether built by Dockyard or Contractors, are completed, and the Officers, under whose supervision and observation such trials have taken place (see Art. 385), are satisfied that the requisite indicated horse-power has been developed, and that the machinery has otherwise worked satisfactorily and is completed, so far as the trials can show, according to the terms of contract, the Contractors will at once prepare the whole of the machinery for examination, as detailed in the Machinery Specification, to enable the Examining Officers, acting on behalf of the Admiralty, to report on the state and condition of every part thereof externally and internally.

2. *Examining Officers.*—The examination is to be made by the Engineer Rear-Admiral on the staff of the Commander-in-Chief at the port to which the ship will be attached or an officer deputed by him, and the Engineer Officer of the ship, assisted by the officers and men of the nucleus crew.



3. *Arrangements for Examination.*—Should the machinery be too extensive to permit of the entire opening up at one time, the various parts are to be opened up as may be most convenient, and the Contractors will from time to time inform the Examining Officers what other portions are ready for examination, giving a day's notice in each case in order that they may be able to attend.

4. *Nature of the Examination. Specification to be read over.*—The Examining Officers are to satisfy themselves that the machinery is in every part perfectly sound and in good condition; that no fractures or flaws exist in any part whatever; that the engines and boilers, with all their connections and accessories, are properly finished in accordance with the specification and the contract; and that the machinery generally is in all respects fit and suitable for the Service. Further, prior to the acceptance of the machinery, the specification is to be read over, article by article, in the presence of the Chief Engineer of the Dockyard or his representative, or of the Engineer Overseer (as the case may be), the Contractors' Agent, the Engineer Officer of the ship, and the Engineer Rear-Admiral, or an Officer deputed by him, when all details, as to fittings, &c., are to be considered, to see whether they are in accordance with the specification.

5. *If Machinery is defective.*—If, on examination, any parts are found to be defective, or not in accordance with the contract, the Contractors are to be called upon to make all such defects good, and to leave everything complete to the satisfaction of the Examining Officers, and until this has been done the machinery is to remain in the hands of the Contractors, unless otherwise ordered.

6. *Report to be made.*—Anything found unsatisfactory is to be at once reported to the Superintendent for the information of the Controller of the Navy.

7. *Report of Examination.*—A report of the examination, signed by each of the Examining Officers, stating that the machinery and fittings are complete, fit for the Service, and in accordance with the terms of the contract is to be made to the Superintendent for transmission to the Controller of the Navy.

### 37.

*Replacing of Parts after Examination. Completion Trial.*—As soon as the examination is completed, and the whole of the parts which have been opened up have been replaced by the Contractors under the personal observation and to the satisfaction of the Engineer Officer of the ship, a trial under-way is to be satisfactorily carried out to ensure that all adjustments are correctly made, all parts properly connected and joints tight. Any defects developed on this trial are to be made good by Contractors before acceptance.

### 38.

*Examination after thorough Repair Trial.*—After a *thorough repair* trial has been satisfactorily completed, whether subsequent to repair by Contractors or by the Dockyard, the procedure as laid down in Art. 36 is to be carried out, with the exception that only such parts of the machinery are to be opened up for examination as may be considered necessary by the Examining Officers to determine the efficiency of the repairs.

### 39.

1. *Watch and Station Bill.*—Before a new ship is commissioned a Watch and Station Bill for sea and harbour routine is to be prepared by the Engineer Officer, and approved by the Engineer Rear-Admiral on the staff of the Commander-

in-Chief at the port; this preparatory Station Bill serving for the information and guidance of the Officers when the ship is put in commission.

2. *Book of Questions.* D. 554.—The Engineer Officer is to insert the necessary answers in the Book of Questions for his department, and to deliver this book, and also the Engine Room Register directed to be kept by Art. 24, cl. 4, duly signed and completed, to the Engineer Rear-Admiral at least a week before the probable date of the ship's commissioning. These books will, after examination be returned to the ship for future reference.

#### 40.

When an Engineer Officer is appointed in charge of the machinery of more than one ship he is to consider himself as in charge of each individual ship under his care, and is to act accordingly.

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### CERTIFICATES OF ACQUAINTANCE WITH THE STRUCTURE OF THE SHIP.

#### 45.

1. *Certificate of Acquaintance.* Form S. 451.—Before a ship is commissioned for service in the Home Fleet with a nucleus crew the Engineer Officer, the Second Engineer Officer, and such other of the Engineer Officers as the Admiralty may direct, are to be examined touching their acquaintance with the details of the ship by the Engineer Rear-Admiral or Engineer Captain at the port to which the ship is attached. They must obtain certificates that they are conversant with the structure of the ship under the engines and boilers, the arrangement of the various valves and cocks, the working of the watertight doors, hatches, sluices, and pumps, the system of pumping, flooding, draining, and ventilating throughout the hull, and with the general construction of the ship.

*Sketches at Examination.*—Candidates are to produce at the examination sketches and drawings made by themselves of all the more important fittings, valves, sluices, doors, &c., in the preparation of which they are to be allowed access to the specifications and drawings of Contractors, and to such drawings in the offices of the Chief Constructor and Chief Engineer of the Dockyard as may be necessary.

2. If subsequently appointed, these Officers are to be examined by the Engineer Captain attached to the Fleet to which the ship belongs, or in fleets where no Engineer Captain is borne, by the Engineer Officer of the Flagship, and in the case of the 1st and 2nd Destroyer Flotillas of the Home Fleet, by the Engineer Commander of the Flotilla Depot ship. In these cases the examination should be applied for within three months of the Officer joining the ship.

3. *Duplicate Certificate.*—The Certificates are in all cases to be in duplicate, one copy being for the candidate and the other being retained by the Commander-in-Chief for local record.

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### MACHINERY OF SHIPS IN COMMISSION.

#### 51.

1. *Engineer Officer on Appointment to examine Machinery.*—When the Engineer Officer in charge of the machinery is relieved, his successor is, in conjunction with a competent Engineer Officer detailed for the purpose by the

Commander-in-Chief or Senior Officer present, to examine the machinery, &c., specified in Art. 15, for the preservation and efficiency of which he is responsible either solely or partly with other officers.

2. *Engineer Officer to assist with Examination.*—Unless the exigencies of the Service will not permit, the Engineer Officer (Staff) is to survey the machinery in conjunction with the new Engineer Officer.

Should the exigencies of the service be such as to prevent the Engineer Officer (Staff), or where no such Officer is borne, the Engineer Officer of the Senior Officer's ship, from carrying out this duty, reasons for such departure are to be stated on the report (Form S. 354).

3. *Accuracy of Report.*—This examination is to be carried out in such a manner that the results recorded on Form S. 354 can be accepted as an accurate statement of the actual conditions of the parts examined. All facilities consistent with the service on which the ship is employed should be afforded the Surveying Officers to ensure this.

4. *Report of Examination. Form S. 354.*—After the examination the Surveying Officers are to make a joint report on the Established Form (S. 354) to the Captain of the ship in triplicate, who will cause the triplicate to be attached to the Engine Room Register for the current quarter. The original and duplicate to be sent to the Commander-in-Chief for inspection, after which the original is to be forwarded to the Admiralty and the duplicate inserted in the Ship's Book.

5. *Interim Report.*—If the examination is not completed when the first Quarter's Engine Room Register is forwarded after the new Engineer Officer has taken charge of the machinery, and interim report, S. 354, is to be attached to that Register. In this report the parts which have been examined, with their state and condition, should be clearly indicated, together with a statement as to the probable date of the completion of the survey.

6. *Examination deferred.*—Should it be impracticable to make this examination when the Engineer Officer first joins his ship, the fact is to be reported by the Captain to the Admiralty, and the examination is to be carried out as soon afterwards as the exigencies of the Service will admit.

## 52.

1. *Acquaintance with History of Machinery, &c.*—The whole of the Engineer Officers are to use all possible diligence in making themselves thoroughly acquainted with the construction and condition of the machinery and boilers, with the nature and extent of the repairs (if any) that they have undergone, and the date of the more recent, and with such other facts as may be necessary to afford thorough knowledge of their history and capabilities.

2. *Acquaintance with Watertight Doors, Valves, &c.*—They must also make themselves thoroughly acquainted with the positions of and methods of working the watertight doors, and also with the positions and uses of all pumps, valves, and pipes, in connection with the bilges, and with the different compartments of the double bottoms when the ship is so constructed, so that in case of necessity there shall be nothing to prevent their immediate use.

3. *Drawings to be Accessible.*—All official drawings, as well as those contained in the sketch book, are always to be accessible to the Engineer Officers of the ship (Art. 20).

## 53.

*Engineer Officer to furnish Reports.*—The Engineer Officer is, through his Captain, to furnish the Engineer Rear-Admiral, Engineer Captain, or the Chief

Engineer of the Dockyard with such written reports or returns as they may require relative to the state of the machinery and boilers in his charge; and whenever these Officers visit the ship he is to afford them every facility, and all the information in his power, to enable them to carry out the duties entrusted to them.

#### 54.

1. *Quarterly Inspection of Machinery.*—The Engineer Captain or Engineer Commander borne for staff duties in each Fleet Squadron or Flotilla is to inspect the machinery and boilers of the ships of such Fleet or Squadron quarterly, or oftener if necessary, and is to inform the Commander-in-Chief of the result. On these inspections he is to examine the Engine-room Registers, Ship's Steam Manual, and Engineer's Store Accounts, and to report any neglect he may discover in properly recording all the information required to be inserted in the Register and Steam Manual, and any undue or excessive expenditure of stores. The date of his inspection is to be noted on the first page of the register, and signed by him.

2. *Machinery of Harbour Ships in Commission.*—The machinery of all ships in commission belonging to the home ports and not attached to a fleet is to be inspected once in each year by the Engineer Rear-Admiral or Engineer Captain on the staff of the Commander-in-Chief of the port. The reports are to be made on the Established Form, and forwarded as directed in Art. 51, cl. 4.

#### 55.

1. *Orders tending to Injure Machinery. E.R. Register.*—Whenever any order is received which, if executed, would in the opinion of the Engineer Officer tend to injure the machinery or boilers, or cause a useless expenditure of power, he is to make a representation to this effect to the Captain, but, unless the order is countermanded after his representation, he is to execute it. Whenever this occurs, the Captain will cause the orders received and the representation made to be noted in the Engine-room Register.

2. *Representations of Engineer Officer. E.R. Register.*—Whenever the Engineer Officer may, in the course of his duty, make any representations or suggestions to the Captain with reference to the repairs or preservation of the machinery or boilers which the Captain either thinks unnecessary, or, if necessary, which the exigencies of the Service do not admit of being carried out immediately or at an early date, he will direct the Engineer Officer to note the particulars in the Engine-room Register.

#### 56.

1. *Natural Draught Power. Forced Draught Power.*—The Natural Draught Power given for ships in the Official Navy List, or where no Natural Draught Power is given, the Forced Draught Power, is to be taken as the Authorised Full Power of the ship which is not to be exceeded except in circumstances of emergency during actual war service when the maintenance of the highest possible speed may be of great advantage. Under these latter circumstances in the endeavour to obtain the highest possible speed by forcing the boilers, the previous performances of the ship or similar ships, the existing condition of the machinery, the state of the boilers with regard to cleanliness and freedom from defects and any other known circumstances affecting the question, must be weighed against the possible risk of accident and loss of future fighting efficiency.

In vessels where indicator or other measurements of the power developed are not obtainable; the receiver pressures and revolutions per minute recorded during the Contractors' full power trials of the ship are not to be exceeded except under

the circumstances and subject to the considerations referred to in the preceding paragraph.

2. *Maximum Air Pressure.*—The air pressures employed in obtaining the specified powers are different with different boilers, and no definite pressure can be laid down for general observance. Unless special instructions have been issued from the Admiralty, as to the limits of air pressures to be observed, the pressures originally required, at the respective powers, during the Contractors' trials of the ship are not to be exceeded.

3. *Air Pressures generally.*—The air pressures generally employed should be kept as low as practicable, in order to avoid straining of furnaces and combustion chambers, to reduce wear and tear of casings and tubes, and to ensure that the closest possible attention is given to obtain efficient stoking. The Engineer Officer is at all times to satisfy himself with regard to the amount of air pressure in use, that it is necessary for efficient combustion of the fuel, that due attention is being given to maintaining a suitable thickness of fire, to the regulation of the ash-pit doors, the removal of soot and clinker, the prevention of air leaks in casings and of excessive air supply, whether through or over the fire-grate, and that the whole of the fire-grate area in use is being efficiently utilised without undue forcing at those portions where the fires are in the best condition. When burning oil fuel the air pressure is to be adjusted as may be found necessary for obtaining complete combustion.

4. With boilers in which the passage of matter causing deposits is known to have occurred or which have been under steam for prolonged periods since being cleaned internally, the maximum amount of air pressure used must be reduced sufficiently to meet the existing condition of the boilers and the probable effects of forcing at any part of the fires, in order to avoid injury to the heating surfaces and thereby rendering the boilers unsafe.

5. *Air Pressure Gauges. E.R. Register.*—The Air pressure gauges should be frequently tested. Their indications are to be recorded in the Engine-room Register every hour.

6. In boilers fitted with closed ash-pits the air pressures recorded should be those obtained in the ash-pits.

## 57.

1. *Reduced Powers. Half Boiler-Power.*—When steaming with a portion of the boilers only, the steam supply necessary for developing the indicated horse power of the main engines, together with that required for the auxiliary engines in use, should be obtained without forcing any boiler to a rate of evaporation beyond that required under authorised full power conditions.

2. With boilers corresponding to half the boiler power, if the boilers in use are all of the water-tube type not more than 50 per cent. of the authorised full power is to be developed in the main engines; should cylindrical boilers be included in the boilers in use the power developed in the main engines is not to exceed 45 per cent of the authorised full power. In either case the air pressure laid down in clause 2. Art. 56, is not to be exceeded.

## 58.

1. With cylindrical and locomotive boilers the fans are not to be used for the purpose of rapidly urging the fires and raising steam quickly, and all instructions as to the necessity of avoiding rapid changes in the pressure of steam and the temperature of the boilers are to be strictly followed. (*See Art. 192.*)

## 59.

1. *Classification of Powers.*—The following classification of the powers to be used on various occasions is to be adopted:—

(a) The authorised full power	-	-	The unit.
(b) " With all despatch "	-	-	$\frac{4}{5}$ the unit.
(c) " With despatch "	-	-	$\frac{3}{5}$ the unit.
(d) " With moderate speed "	-	-	$\frac{2}{5}$ the unit.
(e) " Ordinary speed "	-	-	$\frac{1}{5}$ the unit.
(f) " Most economical speed "	-	-	As determined by trial and in accordance with the varying conditions of wind and weather.

2. *Authorised Full Power.*—The authorised Full Power is to be used only in an emergency or as directed in the regulations relating to passage trials and except in an emergency is not to be maintained for periods exceeding eight hours.

3. *Four-fifths Power.*—Four-fifths power (b) is only to be used in cases of great urgency or as directed in the regulations relating to passage trials, and is not to be maintained for periods exceeding thirty hours.

4. *Three-fifths Power.*—Three-fifths power (c) should not be materially exceeded when the period of steaming exceeds thirty hours, and ample boiler power should be employed.

## 60.

1. *Stokehold Staff.*—In vessels other than Torpedo Boat Destroyers, the stokehold staff is based upon the development of the following proportions of the authorised full power, the staff being in three watches and assistance given from the deck when the coal is worked back:—

Vessels fitted with tank boilers or water-tube boilers of the small tube type	-	-	-	-	-	-	$\frac{3}{5}$ ths.
Vessels fitted with water-tube boilers of the large tube type	-	-	-	-	-	-	$\frac{1}{2}$ .

2. *Stokers.*—The stokers are not to be worked in two watches except under urgent circumstances, and when necessarily so employed, it is only in cases of real urgency that they should be so worked for more than 24 hours.

3. *Assistance from Deck.*—Assistance is to be given from the deck whenever the coal is worked back, to bring the coal into more accessible positions if the work cannot properly be done without it; also in those cases where the power developed exceeds that on which the stokehold staff is based, assistance from the deck should be given in proportion to the increase of power.

## 61.

*Coal Consumption for Auxiliary Purposes.*—With a view to effecting economy in coal consumption for auxiliary purposes, the following directions should be carried out:—

- When electric light is in use all unnecessary lights should be switched off.
- The issue of fresh water should be under strict supervision, and in localities where supplies of suitable shore water are available, distilled water should not be used for drinking and culinary purposes.
- When additional steam power may be required or occasional extra services in harbour due notice should be given to avoid forcing the fires or keeping an uneconomical number of boilers alight. Steam should be

carefully shut off from all steam and exhaust pipes not in use and from engines not required.

- (d) The use of capstan engines, boat hoists, and coal hoists should be limited as far as possible to their legitimate functions, and the number of auxiliary engines and the extent of steam piping in use at any time should be reduced as far as practicable.
- (e) Careful attention should be given—
- (1) To the frequent cleaning of all heating surfaces; internally and externally of the boilers.
  - (2) To the economical working of the fires, covering with ashes, &c., any excess of grate area not immediately required; and all small or partially burnt coal is separated from the ash and clinker and burnt completely.
  - (3) To prevent the admission of excess of air through or over the fire-grate, and all air leaks in casings or casing doors.
  - (4) To reduce the steam pressure maintained in the auxiliary boiler to the actual requirements of the engines in use.
  - (5) To maintain the steam-tight condition of all pistons, slides, differential valves, &c., so as to prevent wasteful leakage of steam from pressure to exhaust.
  - (6) To maintaining the watertightness of plungers, pistons, and valves of all pumps.
  - (7) To the instructions contained in Art. 116 concerning the cleanliness of condenser tubes.
  - (8) To the complete and efficient lagging of auxiliary engines and steam-pipes in order to reduce loss by radiation.
  - (9) To reduce the amount of make-up feed required by keeping joints, valves, blow-down and other cocks, glands, &c., in efficient condition. Leaks should be dealt with without delay and gland packings not allowed to become hard.
  - (10) To the use of the closed exhaust system, either for evaporating, or in the main engines, whenever possible, in accordance with Art. 121, and at as low a pressure as will meet the requirements.
  - (11) To the instructions contained in Art. 121 as to the condition of the vacuum control valves and the economy obtainable by working the evaporator upon a steady vacuum.

## 62.

*Time available for making good Defects.*—On each occasion of completing a voyage the Commander Officer should ascertain from the Commander-in-Chief or Senior or Naval Officer, the time available for examining and making good defects of machinery, and acquaint the Engineer Officer so that the latter may make the necessary arrangements for completing the work, if possible, by the time the ship is next required, or for proceeding with it in such a manner as to enable him to undertake that which is the most urgent and important, whilst keeping the vessel ready for service within a given number of days' notice.

## 63.

*Weekly Return of Work.* S. 163.—In all ships, except Torpedo Boat Destroyers and Torpedo Boats, weekly returns on printed forms are to be rendered to the Captain by the Engineer Officer, showing:—

- (a) The number of Artificers and Mechanics borne.
- (b) The number of hours they have worked during the week at their respective trades.

- (c) A summary of the work on which they have been engaged.
- (d) Defects completed and new defects developed.

## 64.

*Quarterly Return of Work. S. 353. E.R. Register.*—In all ships, except Torpedo Boat Destroyers and Torpedo Boats, a quarterly return is to be prepared showing—

- (a) The number of ordinary routine working hours for Engine-room Artificers and Mechanics, whilst the ship was in harbour.
- (b) The number of ordinary routine working hours and the number of men-hours actually utilised for examination and repair of machinery, boilers, &c.
- (c) The number of days on which steam was on the main engines.
- (d) The number of hours, outside ordinary working hours, and the number of men-hours, which have been utilised for examination and repair of machinery, boilers, &c.
- (e) The occasions on which permission has been given to lay up the main machinery, for a period of three or more consecutive days, for the purpose of examination, repair, &c.

This return is to be rendered on the back of the form "Extract from Engine-room Register, S. 353."

## 65.

*When necessary to put into Port on account of Defects.*—When the Engineer Officer considers it absolutely necessary to put into port on account of defects in the machinery or boilers, he is to make a written report to that effect to his Captain, stating the reasons that render such a step necessary, instead of making the requisite repairs at sea; this report will be appended to the list of defects for the information of the Senior Officer of the port at which the ships arrives, who will transmit these documents, with any remarks he may have to offer thereon, to the Commander-in-Chief, or Senior Officer of the Station or Squadron, by whom, in special cases, they will be forwarded to the Secretary of the Admiralty.

## 66.

1. *Defects of machinery.*—When making out a list of defects, any which can be undertaken by the ship's artificers are not to be included. It is to be carefully discriminated between the items of repairs absolutely required for "seagoing and fighting efficiency" which are to be forwarded on Form S. 340, D. 275, and those desirable for other reasons which are to be forwarded on Form S. 340 B., D. 275 B. In order to avoid duplication of labour in dealing with lists of defects in H.M. ships, the Pink Lists (Form S. 340) should contain all items of work which, in the opinion of the respective Commanding Officers, cannot be deferred without loss of efficiency.

2. *Parts to be included.*—This list to include all such defects in any of the parts specified in Art. 15.

3. *Defects and Supplementary Defect Lists. When to be forwarded.*—The list of defects is to be prepared in a complete and intelligible manner, so that the requirements of the ship may be clearly understood, and a speedy decision given as to proceeding with the work.

The defect list is to be forwarded to the Dockyard to which the ship is assigned for the purposes of repair, so as to arrive there one month before the date fixed for the arrival of the ship.



In the case of any fittings requiring special preparation, all necessary details are to be sent with the defect list, and accurate and fully dimensioned sketches with templates, gauges or patterns of any parts requiring renewal should accompany the lists.

When forwarding lists of defects for which Dockyard assistance is required, a manuscript list is to be attached to the original, and duplicate copies of the lists of defects, stating in detail what further items of repairs, examinations, and other work not included on Forms S. 340 and S. 340b, are proposed to be carried out by the ship's staff during the time the vessel will be in Dockyard hands. These lists are to accompany Forms S. 340 and S. 340b, for the information of the Dockyard Officers and of the Admiralty.

Should any defects develop which cannot be undertaken by the ship's staff subsequent to the transmission of the main lists, a supplementary list is to be sent immediately after the arrival of the ship at her port.

4. When ships in commission come into the Dockyard hands to have defects made good, only such defects as have been represented by the Officers of the ship, or have been apparent to the Examining Officers, or become apparent during the opening up necessary to make good known defects, and which may be approved to be taken in hand, will be made good. No special examination will be made in search of further defects.

5. The following items of work should generally be dealt with by ship's Artificers:—

*Work to be done by Ships' Artificers.*—Adjustments of main and auxiliary engines. Examination of machinery and boilers. Re-seating small and medium size valves. Re-making ordinary steam and water-pipe joints. Packing glands and repairs to pipe lagging. Cleaning boilers. Renewals of protective slabs in boilers, condensers, &c. Minor repairs to furnace brickwork. Renewals of boilers. Examination and refit of underwater fittings, boiler mountings, cylinder fittings, &c. Tests of boilers, condensers, and pipes, by water pressure. Small renewals of condenser tubes, tightening ferrules, &c. Overhaul and ordinary repairs of steam-boats' machinery and the smaller auxiliary engines.

6. *Form S. 134 D.*—Any materials required for making good defects by the ship's artificers, which cannot be met out of the ship's stores, will be supplied from the Dockyards, a demand being made on Form S. 134 D., and a brief statement as to the nature of the defect to be made good given in the space at the foot of the Form. Such defects are not to be included in the lists forwarded on Forms S. 340, D. 275, and S. 340 B., D. 275 B.

7. In those fleets, squadrons, and flotillas of which the ordinary means of effecting repairs are supplemented by a repair ship; as soon as defects are discovered the assistance of the repair ship is to be fully utilised in reduction of those defects which cannot be made good entirely by the ship's artificers, and for which some Dockyard assistance would otherwise be required. As much of such defects as can be conveniently done by the ship's staff are not to be undertaken by the repair ship.

## 67.

1. *Engineer Officer to watch Progress of Work.*—Whenever the ship comes into the hands of the Dockyard to have defects made good in the Engine-room department, the Engineer Officer is personally, or by his assistants, to watch the progress of such repairs, and he will be held responsible for all risks of fire arising from the presence of Dockyard workmen in his department. He is not, however, to interfere with such workmen, but he is to report to his Captain if he observes any idleness or bad workmanship on their part, or any other irregularity.

2. *E.R. Register.*—Full information respecting the nature of the defects and repairs should be given in the Engine-room Register with references in the Quarterly Abstract at the end of the Register.

3. Whenever the machinery and boilers of any of H.M. ships are under repair by a Dockyard or by Contractors, the Engineer Officer of the ship is to watch carefully the progress of the work in hand, and give all the assistance in his power.

4. He is to consider it a part of his duty to bring to the notice of the Engineer Rear-Admiral, or Engineer Captain, anything that has been done, or omitted to be done, which would in his opinion impair the efficiency of the machinery or boilers.

5. If during the progress of the repair the Dockyard Officers or Contractors do not consider it desirable to carry out any proposal the Engineer Officer may put forward, he is to bring the circumstances of the case to the notice of the Captain of the ship, as, on the completion of the repair, he (the Engineer Officer) will be held responsible for having satisfied himself that the machinery and boilers are in all respects in good working order.

## 68.

1. *Alterations and Additions.*—Any alterations and additions in ships which experience suggests as being desirable are, in the case of a new ship, to be reported by letter through the respective Commanders-in-Chief to the Admiralty six months after the date of first commissioning. In all other ships any proposed alterations and additions are to be submitted annually, and at the same time as the lists of defects. (*See Art. 66.*)

2. Care is to be taken in ships that have completed one or more commissions that the lists of such proposed alterations and additions are confined to items necessary for sea-going and fighting efficiency.

3. In forwarding proposals for alterations and additions it should be stated whether it is proposed that the work involved shall be carried out by the ship's Artificers, and in such cases a demand on Form S. 134 D. for such materials as are required should be prepared and forwarded to the Dockyard, a note being placed on such demands that the materials are for effecting an alteration or addition submitted to the Admiralty, and will be required immediately Admiralty approval has been given for carrying out the work.

It is to be distinctly understood that no alteration or addition is to be taken in hand without Admiralty approval.

4. Lists of any outstanding alterations and additions which have been approved, but not yet carried out, are to be forwarded to the Dockyard at the same time as the defect list, so as to arrive there one month before the date fixed for the arrival of the ship.

5. Should any change be made in the machinery while the ship is in commission or undergoing repairs, explanatory sketches are to be inserted in the sketch book, and a notification of such changes is to be made in the ship's manual. (*See Arts. 4, 20, 22.*)

## 69.

1. *Underwater Fittings.*—Before a ship is undocked the Engineer Officer is to satisfy himself that the valves, gratings and other underwater fittings, excepting those in connection with the submerged torpedo tubes, are in efficient working

order, and likely to remain so, and that all the orifices through the ship's bottom are clear. If there is any doubt of the durability of these fittings, new ones about which there is no doubt are to be substituted.

2. *Defects.*—Any defects in underwater fittings which cannot be remedied by the Engine-room Staff of the ship should be inserted in the list of defects to be made good by the Dockyard.

3. *Periodical Examination.*—For ships in commission which are ordered to be docked every six months, the underwater fittings need only be thoroughly overhauled once a year, unless the Officers know or have reason to suspect that any of them are defective.

4. *E.R. Registers.*—The particulars of every such examination are to be inserted in the Engine-room Register, and a certificate that the examination has been satisfactorily completed is to be forwarded to the office of the Chief Constructor.

5. The Engineer Officer is responsible, whenever a ship is undocked, that all sea-connections, except those valves under repair by Dockyard and those in connection with the submerged torpedo tubes, are closed.

## 70.

*Special Service Vessels.*—In Special Service Vessels with reduced nucleus crews every working day the main engines are to be moved, by means of the turning gear, sufficiently to complete not less than one revolution of the main engines per week. Steam is to be raised at half yearly periods for steaming the main and all auxiliary engines. All steam pipes are then to be tested by steam to the working pressure and the main engines and all steam and hydraulic machinery are to be worked and oiled. One of these half-yearly occasions of raising steam may be preparatory to the annual steam trial at sea required under Art. 443.

## 71.

1. The Engineer Officer is responsible at all times for the good order and cleanliness of the Engine-room department.

2. *Station Bill.*—He is to prepare a Station Bill showing clearly the stations and duties of each Officer and man under his control, which, after being approved by the Captain, is to be hung up in some conspicuous position in the Engine-room. (See Art. 39.)

In the disposal of the officers and men, he is to consider what are the best arrangements possible for meeting the requirements of the ship, both before and during an action, as far as they can be anticipated. *Vide Arts. 89; 134; 512, cl. 5; 517 and 519.*

3. *Allotment of Work.*—He should allot the work of his department in such a manner as will best ensure its being efficiently performed by the Officers and others composing his staff, and so that each may know definitely for what he is personally responsible.

4. *Watch-keeping in Engine-room.*—All Engineer Officers in commissioned ships with the exception of the Engineer Officer in charge of the machinery are to be employed in watch-keeping in the Engine-room when steaming under way, except under exceptional circumstances. Officers employed on particular duties, as in the case of the Second Engineer Officer, and those employed in assisting the Engineer Officer with his clerical work, should keep at least four hours' watch per day, to ensure the watches being placed to as great an extent as possible in charge of Officers.

## 72.

1. *Engineer Officer to visit Department.*—The Engineer Officer is to visit the Engine-room department repeatedly during the day, and at any time, either by day or night, when his presence may be rendered necessary by any accident or other cause. He is always to be in the Engine-room when going into or out of harbour, or through any intricate channel, or when performing any evolution when more than ordinary care is requisite in executing with promptitude the orders given from the deck.

2. *Department to be Inspected.*—When not under steam the whole of the Engine-room department is to be inspected every evening by one of the Engineer Officers, who must satisfy himself that all the cocks and valves are shut or otherwise as ordered; that there are no signs of fire, nor anything lying about that may ignite by spontaneous combustion, and there is no probability of an accident occurring in any part of the Engine-room department during the night. (See also Art. 541 *et seq.*)

A watch is to be kept in any stokehold in which fires have been alight, for 12 hours after the fires have been drawn or have burnt out.

## 73.

1. *Training of Midshipmen.*—The Engineer Officer will be responsible that the necessary arrangements are made for the training of the Midshipmen attached to the Engine-room Department.

2. It is primarily intended that their instruction should be effected by actual experience of the work carried on, and that they should in this manner become acquainted with the methods and practice adopted in harbour for the care and maintenance of the machinery, and acquire the necessary knowledge and experience under way to enable them, by the time they go up for examination for Sub-Lieutenant, to perform the duties of Engineer Officer of the Watch.

They should see such repair work as is going on in any part of the Department and take part in examinations of hull and machinery, advantage being taken of any opportunities that present themselves of seeing engineering operations in the Dockyards.

3. They should make themselves sufficiently acquainted with the accounts kept of the receipt and expenditure of stores, and with the Engine-room Register and Defect List, to obtain an insight into the business management of the Department.

4. Each Midshipman is to keep an Engineering Note Book in which he is to insert descriptions and detailed sketches of parts of the main and auxiliary machinery, and particulars of important repairs, with the reasons necessitating them. This book is to be periodically signed and dated by the Engineer Officer, and is to be examined and valued at the preliminary examination in Engine-room duties.

## 74.

1. *Staff conversant with their Duties.*—The Engineer Officer is to take such steps as may be necessary to ensure that the Engineer Officers and all Engine-room ratings belonging to the ship are fully acquainted with their several duties, and he will at all times encourage them to perform those duties with promptitude and to the best of their abilities. He is responsible that the machinery and boilers are taken due care of, and that all examinations are conducted carefully at the specified times, and as necessary.

Engineer Sub-Lieutenants with little experience should, as far as practicable, be trained for a time in the duties of watchkeeping under Senior Officers.

2. *Inexperienced Officers.*—Should there be in the Engine-room Staff an Officer who is inexperienced, or who cannot be considered thoroughly competent, such Officer is not to be entrusted with the examination or repair of any important part of the machinery, or with the performance of any of the important duties of the department, except under the supervision of the Engineer Officer himself, or of an experienced Officer on whom the Engineer Officer can rely, and the Engineer Officer is to take every opportunity to instruct any such Officers in their several duties, and to use his best endeavours to make them competent.

## 75.

*Engineer Officer to instruct Artificers.*—The Engineer Officer is to instruct the Junior Engine-room Artificers in their duties, and to make such arrangements as may be necessary to enable them to become qualified, as soon as possible, to keep watch in the Engine-room or Boiler-room.

## 76.

1. *Training of Stokers.*—The Engineer Officer is to give particular attention to the training of the stokers, especially as regards the management of the fires, and to cause the Officers under him to take advantage of every opportunity for instructing the stokers how to burn the coal in the most economical manner.

2. In water-tube boilers of the small tube type, they should be cautioned against throwing coal over the brickwork at the lower end of the tubes, where it might cause overheating of tubes and choking of air passages between tubes.

## 77.

*Working Boilers at Full Power.*—In order that good results may be obtained when the development of the highest speed is a matter of great importance, opportunities should be taken of training stokers to work the boilers at their full output during ordinary passages.

With this object in view, and to insure that the boilers in use are being worked at approximately their full output, when more careful stoking will be necessary than is required under the easier conditions of steaming in company, it is important that no more boilers are in use than are required for the speed ordered, except when sudden demands for an increase in speed are anticipated.

## 78.

1. *Employment of Stokers out of Engine-room.*—The stokers are not to be called out of the Engine-room department when the ship is under steam, except in cases of actual necessity. In all cases the order is to be given through the Engineer Officer of the watch, so that he may take such precautions as may be necessary.

2. *E.R. Register.*—When any of the engine-room Staff are employed on duties unconnected with their own department, the following particulars are to be noted in the Engine-room Register:—

The number of men absent.

The number of hours they were absent.

The nature of the duty on which they were employed.

## 79.

1. *Spare Gear.*—The Engineer Officer is to satisfy himself that the spare gear belonging to his department is in good condition.

2. *Preservation of Spare Gear.*—Such bright parts of the spare gear as are not readily accessible or are liable to get rubbed or knocked, are to be protected by being painted, or, if necessary, covered with tallowed spunyarn or other suitable material; other parts may be bright and oiled or tallowed.

3. *Examination of Spare Gear.* *E.R. Register.*—Bright parts of the spare gear which have been painted or otherwise protected are to be cleaned for examination at least once a year. After examination they are to be made bright and again protected as before, and notes are to be made at the end of the Engine-room Register to show what parts of the spare gear have been examined, in what condition they were found, and the way in which they have been again protected from injury.

4. *Spare Gear left on Shore.*—Should any article of spare gear be left behind when the ship goes to sea, the Engineer Officer is to report the same to the Captain, in order that it may be reported to the Admiralty for the information of the Controller of the Navy. A notation of the circumstances is to be made on the fixture list.

5. *Articles removed from the Ship.* *E.R. Register.*—If any articles of spare gear are removed from or deposited out of the ship, the authority for the removal, the place of deposit, and the officer in whose care they remain, are to be stated in the Engine-room Register on the day of the removal, and also at the end of each Engine-room Register, until they are brought back again to the ship. On change of Home Port or Station any articles of spare gear so deposited are to be dealt with as provided by Arts. 1061 and 1788 of the King's Regulations and Admiralty Instructions.

6. *Transfer of Vessel.*—Whenever a vessel is transferred from one port to another or in the case of torpedo-boat destroyers, torpedo-boats, or steamboats from one ship to another, the whole of the spare gear is to accompany the vessel, with a proper list for verification.

7. *List of Spare Gear.*—Each vessel will be furnished by the Dockyard Officers with a complete list of spare gear belonging to it in store at the Dockyard, a separate list of machinery, &c., appropriated to classes of vessels being furnished to each vessel for which suitable. In the case of vessels attached to a flotilla, copies of such lists will also be furnished to the Base Ship.

## 80.

1. *Care of Tools.*—The Engineer Officer is to exercise constant supervision to see that the machines, tools, and other fittings supplied for the Engineers' workshop are kept in good order and thoroughly efficient.

2. *Expenditure of Stores.*—He is to have charge of all Engineers' stores. He is to keep the accounts of receipt, expenditure, and remains, to be responsible for the due care of them, and that they are only used for purposes for which they were issued, and to render the accounts at the stated times. (*See Arts. 566 et seq.*)

3. *Yeomen of Stores.*—A Yeoman of Stores, who will assist in the issue of the Engineers' stores and tools, will be allowed in all ships of 3500 I.H.P. N.D. and above, except Torpedo Boat Destroyers.

*Report as to Fitness.*—On the Engineer Officer of the ship being superseded, or on a man holding the rating of Yeoman of Stores leaving a ship, a report is to be attached to the man's certificate as to his fitness or otherwise to be employed again in that capacity. Similarly, a report is to be attached to his certificate if it is found necessary to remove him from the duty for any reason.

4. In the case of a ship recommissioning at a Home Port the Yeoman of Stores of the previous commission may be retained for a period not exceeding 14 days in order that his relief may become acquainted with the stores transferred. When a ship commissions abroad and the Yeoman is due for relief, he is to be retained so long as practicable within the limit of 14 days but is to return with the paid-off crew.

### 81.

*Absence from Ship.*—During the absence from the ship of the Engineer Officer, the Senior Engineer Officer or Senior Engine-room Artificer remaining on board is to observe and follow the instructions for that Officer, and to be responsible for the care and proper working of the machinery, and all parts connected therewith.

### 82.

1. *Control of Engine-room Ratings.*—When the ship is under steam the Officer of the Watch in the Engine-room department, whether an Engineer Officer or a Chief Petty Officer, is to have the immediate control of the Engine-room ratings on watch, and is to exercise a general superintendence over the machinery, shafting and boilers. He will be held responsible for the efficient management and working of the whole of the machinery and boilers in use during the period of his watch.

2. *Absence from Department during Watch.*—He is not to be absent from the Engine-rooms or Stokholds at any time during his watch, unless properly relieved; he should quit the Engine-room platform as little as possible, so as to be at hand to execute the orders he may receive from the upper deck or to stop the engines in case of necessity.

When leaving the Engine-room platform to inspect other parts of the department, he should leave a subordinate on the platform who is competent in these respects.

3. The Officer about to take charge of the watch is to satisfy himself—

- (a) That all bearings are working well, and are in a proper state of lubrication;
- (b) That the feed pumps are working correctly, and that the water in the boilers is at the proper working height, and of a satisfactory density;
- (c) That the auxiliary engines and the evaporating and distilling plant in use are working satisfactorily;
- (d) As to what cocks and valves are open;
- (e) What depth of water there is in the bilge;
- (f) What Bunker doors and other W.T. doors in the Machinery Compartments are open.

4. Until this inspection has been made the Officer going off duty is to continue in charge of the watch, and if the on-coming Officer of the watch is not satisfied with the condition of the machinery he is to acquaint the Engineer Officer of the ship with the fact before taking charge of the watch.

### 83.

*Engineer Officer of the Watch. Duties of.*—The Officer of the watch in the Engine-room department is to attend very particularly to the expenditure of coal, oil, and other stores, and to see that they are not wasted; to record in the Engine-room Register, at the specified intervals, all the information required therein relative to the working of the engines, &c.; and he is, during the period of his watch, to be responsible for the good order of the Engine-room department and for all the duties connected therewith.

## 84.

1. *Duties on Watch.*—Should an accident of any kind occur to the machinery of a ship when under steam, or should the Officer of the watch in the Engine-room department observe, or be informed there is anything going wrong with the engines or boilers, he is immediately to make the Engineer Officer acquainted with it, and, at the same time, take such steps as he may consider necessary for the safety of the machinery.

2. *Communications with Officer of the Watch.*—All communications with the Officer of the watch on deck, or with the Engineer Officer, are to be made, if possible, through the voice pipes or telephones fitted; if, however circumstances prevent this, an Engine-room Artificer, Leading Stoker, or some other trustworthy person is to be sent with the message.

3. When important auxiliary engines such as steam boat-hoists, capstan and hydraulic engines are required; the method of communication between the officer in charge on deck and the Engineer Officer on duty, also the organisation of the Engine-room staff in reference to these details, are to be of such a character as to preclude the possibility of danger to men employed on the funnels. Attention is called to Art. 121, clause 4 (a) in reference to the piston relief valves between the auxiliary exhaust pipe and the condenser.

## 85.

*Water in Bilge. Rough E.R. Register.*—Constant attention is to be paid by the Officer on watch in the Engine-room department to ensure that the bilge pumps are acting properly. The height of the water in the bilges is to be measured at least once each hour when under steam, and the maximum height of water during each watch is to be noted in the rough Engine-room Register.

## 86.

*Signatures in Register.*—The Engineer Officers of the watches are to certify by their initials the correctness of the particulars inserted in the Register for the time they were on watch, and each day's proceedings are to be verified by the signature of the Engineer Officer.

Instructions relative to the entries to be made in, and the method of keeping the Engine-room Register are given in the first three pages of the Register.

## 87.

1. *Charge in W.T. Compartment.*—The Officer, Chief Petty Officer, or Petty Officer in charge of the machinery in each watertight compartment is directly responsible for the efficient working and proper management of the whole of the machinery and boilers in that compartment when no Senior Officer or Petty Officer is present. Should an accident of any kind occur, or should he observe anything which he thinks is likely to cause injury to the machinery or boilers, he is immediately to acquaint the Engineer Officer of the watch, and his responsibility only ceases with the presence of a Senior Officer.

2. *Not to leave the Compartment.*—He is on no account to leave the compartment in which he is in charge unless properly relieved, and all communications with the Engineer Officer of the watch should be made by the voice pipes or telephones fitted; if, however, circumstances prevent this, a trustworthy person is to be sent with the message.



## 88.

1. *Stokers' Dress.*—When under steam it is essential to the health and comfort of the men that they should be suitably clothed, and the dress either for closed or open stokeholds, is to consist of fearnought or wollen trousers, flannel vest, cloth cap, and boots.

2. *Stokers to be Mustered.*—At the end of each watch the stokers, as soon as they are relieved, are to wash themselves and put on dry and clean cloths before returning to their messes or “turning in” to their hammocks. The Engineer Officer is to satisfy himself that this instruction—on the due observance of which the health and comfort of the men so much depend—has been as fully attended to as the circumstances of the moment will admit of. The Senior Chief Stoker of the watch to be responsible for the mustering and inspection.

## 89.

1. *Preparation for Action.*—Before going into action, as much steam and exhaust piping as is not required to be in use should be shut off, in order to reduce, as far as practicable, the extent of piping from which steam would escape in the event of injury. Steam and exhaust pipes which pass through protective decks or outside armour protection are, from their exposed positions, the most liable to injury. The pipes to all auxiliary engines not in use should be shut off as near to the boilers as possible.

2. The possible emergencies of an action and the best means of meeting them should be made the subject of close attention by the Engineer Officer and his subordinates. As many as possible of the Engine-room staff should be familiar with the arrangements of the several compartments of the ship, the positions of the various water-tight doors, valves and pipes in connection with the ventilation, flooding, draining, and pumping systems and the means of working them, the voice pipes and other means of communication, and the arrangements for connecting up the different sections of shafting, &c., for engine-room telegraphs and steering engine control.

A considerable number of the engine-room ratings detailed for each part of the ship should be trained to a ready acquaintance with the various arrangements and appliances appertaining to their part, so as to avoid the necessity of relying upon the special knowledge of a few officers and men for dealing with the casualties of an action.

3. The following are among the emergencies and requirements liable to arise in action. The most suitable measures for meeting them are to be considered and, as far as may be practicable, provided for by the officers in each ship, in connection with the arrangements actually fitted:—

- i. Damage to bulkheads, water-tight doors, sluice and drain valves, ventilation and magazine cooling trunks and their valves or to the various spindles and gearing connected with them.
- ii. The readiest means of disconnecting and working the undamaged parts under armoured protection and the provision in each compartment of the necessary tools for the purpose.
- iii. Damage to steam pipes and parts of machinery under steam pressure.
- iv. The use of fans and fire hoses in relieving compartments of steam.
- v. Extemporised repairs by means of shores, wedges, iron plates, asbestos and india-rubber sheet, bales of waste, coal sacks and such other of the ship's stores and gear as could be utilised in temporarily dealing with a serious escape of steam.

- vi. Damage to boilers and their steam and feed pipes.
- vii. The readiest means of isolating boilers and groups of boilers, with their steam pipes, in the event of the sectional and other stop valves being rendered inaccessible by the escape of steam ; also the best disposition of the men for meeting the emergency.
- viii. The full uses of the fire main and its connections fitted throughout the ship, when sections are damaged ; and the ready isolation and repair of damaged portions.
- ix. Damage to hull compartments causing flooding of bunkers, store-rooms, and machinery spaces. The best means of localising the effect of flooding and of relieving the compartments of water as soon as the inflow is sufficiently stopped.
- x. The best use of the compartments of the double bottom, wings, trimming-tanks and other spaces with their pumping and flooding appliances in correcting any loss of trim, in the event of such steps being ordered by the Commanding Officer.
- xi. Extemporised means of communication and conveying orders in the event of telegraphs and other ordinary means of controlling the working of the main engines or of the steering engine, being disabled.
- xii. Damage to funnels, funnel casings and armour gratings and their temporary repair with such stores as may be available.
- xiii. First aid to injured men in the engine and boiler rooms and their disposal during an action, and the controlled supply of food and drinking water to men, if under armoured hatches for prolonged periods.

When at general quarters the engine-room staff should be exercised in meeting various supposed emergencies such as may arise in action, and such exercises are to be regarded as an important part of the general preparation for war.

The foregoing instructions are not to be understood as referring to all the emergencies which may arise or as being more than of a general and suggestive character.

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## ENGINES.

### 91.

1. *Economical Working at Reduced Speeds. Comparison of Results.*—To ensure the economical working of modern machinery, especially at reduced speeds, Engineer Officers are enjoined to study the matter in relation to the particular engines in their charge, and to compare recorded results of their performances at different powers, noting especially the rate of consumption per I.H.P. over sufficiently extended periods to ensure fairly reliable results.

2. The subject of economical steaming at all powers is to be considered as of the greatest importance ; and every means that are supplied for this purpose are to be used to attain this end.

3. Officers are to be guided in the care and management of turbine machinery by the Memorandum of Instructions for Turbine Machinery.

### 92.

1. *Rate of Expansion.*—The engines fitted in H.M. vessels are designed to carry out the principle of expansion to its utmost practical limits, and the valve gear of reciprocating engines should be set so as to give the degree of expansion

found to produce the most economical results for the speed required. If the engines are in proper condition the use of a high rate of expansion should not affect their smooth working. The limiting rate of expansion will generally be found to have been reached when loops have been formed by the compression curve in the indicator diagram.

2. *Adjustable Links*.—The adjustable links fitted are intended for the regulation of the ratio of the work done in the several cylinders. The practice of obtaining equal powers in the cylinders is to be considered of only secondary importance, and the adjustable links should be set to give the most economical results for the speed required as found by trial, provided the differences in the powers developed are not excessive and do not interfere with the smooth working of the engines.

3. *Cut off. E.R. Register*.—If at any time circumstances arise which render it necessary to adopt a low rate of expansion—say, a cut off later than half stroke in the high-pressure cylinder at about three-fifths the authorised natural draught power, or later than four-tenths stroke at one-fifth that power—explanations are to be given in the special column for remarks in the Engine-room Register, and also on any report of trial.

4. *Jackets*.—The jacket drains and the steam pressures in the jackets are to be carefully adjusted; these will require special attention at high rates of expansion in order to avoid undue liquefaction or dryness.

5. *Economy*.—Although it is of great importance to obtain the maximum economy, it should always be borne in mind that the proper preservation of the machinery is of the first importance.

### 93.

1. *Rates of Expansion for different Speeds*.—As early as possible in each commission, trials should be made to determine the most economical rates of expansion and the most suitable pressures of steam in the jackets for different speeds. When steaming at a given speed, the rates of expansion in the cylinders and the steam pressures in the jackets should be varied, and indicator diagrams taken under the varying conditions so that the power developed and steam used under each condition may be compared.

2. *Receiver Pressures*.—Care must be taken in making these experiments not to work at such a high rate of expansion in the intermediate or low-pressure cylinders as to cause the pressure in the receivers to rise too high. The receiver safety valves will indicate when the limits of safety are liable to be exceeded, but the experiments should be commenced using the lowest rate and gradually increasing up to the highest rate of expansion admissible.

3. *Boiler Pressure*.—The steam pressure in the boilers should be maintained as nearly as possible equal to the initial pressure required in the H.P. cylinders, provided this pressure is sufficient to ensure the prompt reversing of the main engines, and the correct working of the auxiliary machinery including the steering engine.

4. *Indicator Diagrams. E.R. Register*—Sets of indicator diagrams, taken under the varying conditions for each speed, are to be attached to the Engine-room Register.

5. When the above particulars are determined for the different speeds they are to be registered so that whenever the speed of the engines is varied there may be no delay in setting the valves and links for the altered power.

### 94.

1. *Warming Engines*.—Every care is to be taken in the admission of steam to the engines before they have been thoroughly warmed, as there is great danger of

serious injury from unequal expansion. This is more especially the case with large cylinders and turbines, and Engineer Officers are to use every precaution when getting under way to warm the engines very gradually (except in cases of extreme urgency). The fires should be lighted in the boilers some time before the engines are required and the communication valves opened so that the hot air and steam may pass into the engines and jackets and gradually raise them to the working temperature.

2. *Drainage*.—It should be borne in mind that the process of warming the engines by the admission of rising steam will cause a large amount of condensation. Care should be taken that all stop valve boxes, steam pipes, separators, turbine casings, slide casings, &c., are clear of water before attempting to move the engines; similar precautions should always be taken whenever the engines have been stopped even for only a short time.

### 95.

1. *Opening of Steam Stop Valves*.—Steam stop valves are to be opened only to an extent sufficient to give the maximum speed required, without causing excessive pressure on the boiler-side of the valve.

2. *Starting Valves*.—When the steam for the starting valves is drawn from the main steam pipe, care is to be taken that the slide valves are not blown off their faces by the admission of steam through the starting valves to such an extent as to overcome the pressure on the back of the slides.

### 96.

1. *Water on Bearings*.—Every endeavour is to be made to keep the machinery in such alignment, adjustment, and condition of the bearings and other working surfaces, that, with good lubrication, the use of water service at all powers may be avoided as far as possible. The Engineer Officer of the watch is to exercise the utmost vigilance for ensuring the prompt detection of any warming of bearings, &c., and is to see that they are not allowed to become too warm before resorting to the use of water. Great caution is always to be exercised in first applying water in order to avoid injury to the heated parts from sudden and unequal cooling. Whenever water is used care is to be taken at the end of a passage, before the engines are stopped, that its use is discontinued in time to admit of the surfaces of the journals being thoroughly covered with oil. Neglect of this precaution is likely to entail serious injury to any bearings on which water has been used.

2. When using mineral oil only for external lubrication, water should be used as a last resort in the case of hot bearings, and if found necessary to do this, a vegetable oil should be used for the bearings at the same time.

### 97.

*Caps and Bolts of Bearings*.—When water has been used on the bearings the caps and brasses should be removed at the earliest opportunity for examination, and the bolts of the connecting rods and main bearings drawn back, cleaned, and coated with mineral oil to which a little blacklead has been added, before being replaced. The same precaution should also be taken whenever bearings or couplings are examined, in order to prevent the bolts from setting fast.

### 98.

*Towing, Thrust Blocks, &c.*—When vessels are used for towing purposes, special attention is to be paid to the thrust block fittings and care taken that the lubricating arrangements are efficient.

## 99.

1. *Turbine Machinery, Shafts, Thrust Blocks, Towing, &c.*—In order to preserve the correct alignment of each turbine shaft it should be revolved in sections as rarely as possible, and whenever vessels fitted with turbine propelling machinery are being towed, the propeller shafting is not to be uncoupled, except when damage to the turbines themselves or other exceptional circumstances render such a course necessary. The turbines are to be kept thoroughly drained and the forced lubrication maintained. Particular attention to the instruction contained in the preceding article is to be given.

2. *Air Pumps.*—If the air pumps can be used it will be advantageous to maintain a vacuum in the turbine casings, steam being kept on the turbine glands.

3. *Disconnecting Turbine Shafts.*—If the forced lubrication pumps cannot be worked, the turbines are not to be allowed to revolve but are to be disconnected from the propeller shafts. In this case special attention is to be paid to the lubrication of the special thrust collar fitted for this purpose.

4. *Turbine Turning Gear.*—The turning gear is not to be used for locking shafts when the vessel is being towed.

## 100.

*Turbine Clearances*—It is essential for the safe working of turbine engines that the clearances at the dummy turbines should not be reduced below, and for economical working that they should not be increased above, the designed amounts. These clearances and the wear on the turbine bearings are to be frequently checked.

## 101.

*Turbine Expansion Couplings.*—Frequent examinations are to be made of the expansion couplings fitted in the shafting connecting the main and cruising turbines in order to ensure that the parts are well lubricated, and that an efficient sliding coupling is maintained.

## 102.

1. *Turbines, Drainage of.*—When under way care is to be taken that all turbine engines not in use and steam pipes connected with them are thoroughly drained.

2. *Turbine Machinery; Working and Management of.*—Further detailed instructions for guidance in the care, management, and working of turbine machinery of the Parson's Marine type are contained in enclosure to A.L., C.N. 35341-1909, of 6th December 1909.

## 103.

*Injury to Machinery.*—Every precaution is to be taken to prevent injury to the machinery, particularly when in motion, from anything falling on it.

## 104.

*Lubrication.*—Mineral oil only is to be used for the lubrication of all parts of the main and auxiliary engines which come in contact with steam or feed water, and, with steam pressures of 155 lbs. and over, heavy filtered mineral oil is to be used exclusively for this purpose.

## 105.

1. *Passage of Oil to Boilers.*—The defects which may result from the presence of oil in the boilers render it imperative that every available means should be resorted to in order to reduce as much as possible its passage into the boilers with the feed water.

The oil used on the piston, slide, or air pump rods should be reduced as far as may be found practicable.

Where practicable these rods should be lubricated sparingly by means of brushes rather than the oil fittings usually fitted. The oil used should be a pure mineral. Lubricators on cylinder and slide chest covers of auxiliary engines should be removed where possible, and in any case should not be used except in case of necessity. Recesses forming receptacles for oil in continuity with these rods should be modified so as to keep the oil off the rods. The falling or splashing of oil from adjacent parts should be guarded against, especially if any vegetable oil is in use.

2. Under ordinary conditions the water of liquefaction forms sufficient lubricant in the cylinders of the main engines when at work; but on occasions of large reduction in the speed of engines, or at any time when working slowly with high-pressure steam in the boilers, a small quantity of water should be occasionally introduced into the high-pressure slide casings.

3. When not under steam, mineral oil for preserving the machinery is to be used sparingly; syringing oil through sight holes on to the working surfaces, or supplying oil by oil cups, is only to be resorted to when time does not allow of the removal of manhole covers. As a general rule the manhole covers of the machinery are to be removed and the internal working surfaces carefully cleaned as soon as possible after the engines are done with.

4. Before closing up the machinery for raising steam, any mineral oil that has collected in the internal parts should as far as possible be removed, and the working surfaces cleaned.

5. When raising steam the cylinder and slide drains of main engines are to be kept in communication with the bilge, and are not to be connected to condensers or feed tanks until the Engineer Officer is satisfied that there is no oil or grease contained in the drainage.

6. Except in cases where ships are fitted with Belleville (Economiser type) or cylindrical boilers, the feed tanks should be cleaned from grease on the first opportunity after each 14 days' ordinary steaming of main engines. (See Art. 115.)

7. The filtering material of the grease filters should be frequently examined, and it should be cleaned after not more than three days' ordinary steaming with main engines and renewed as necessary.

Filter grids should be stiffened at the rims and longitudinally, and the whole of the grids should be adjusted to ensure a watertight joint.

Where practicable, two thicknesses of towelling should be fitted to as many grids as will not interfere with the flow of the water.

8. The drainage of the steam and exhaust pipes of auxiliary engines is to be led to the drain tanks, and that of the auxiliary engines themselves should be led into the bilges to prevent the admission of oil to the feed water.

9. Whenever the closed exhaust system is in use, all engines fitted with forced lubrication are always to be run on the closed system, and the direct exhaust lead to the auxiliary condenser, where fitted, is not to be used.

## 106.

1. *Use of Oil. E.R. Register.*—The Engineer Officer is to personally ascertain that all the Engine Room watch keepers are fully instructed as to the means of lubrication provided for each part of the Machinery, and as to the kind and amount of oil to be used at each part according to the different speeds of the engines. Reciprocating main engines not fitted with forced lubrication :—Olive oil is only to be used for external lubrication at and above four-fifths authorised full power, and endeavour is to be made, as far as possible, to minimise its expenditure by mixing it with the greatest proportion of mineral oil that experience has shown to be practicable.

At powers immediately below four-fifths authorised full power, special mineral oil (*i.e.*, of a higher grade than the ordinary service mineral oil) should be used alone, and ordinary service mineral oil should be used at the lower powers.

If it should be considered necessary to use olive oil alone or mixed with other oils at powers below four-fifths authorised full power, a notation is to be made in the Engine-room Register, stating the reason.

2. In reciprocating and turbine main engines fitted with forced lubrication :—Special service mineral oil only is to be used in main engine forced lubrication systems. Such oil should be pure and free from any admixture of fatty or vegetable oils.

A proportion of heavy filtered mineral oil may be mixed with the special mineral oil for the lubrication of the cross-head bearings if considered necessary.

3. *Auxiliary machinery* :—Ordinary service mineral oil alone is to be used for the external lubrication of auxiliary machinery generally, but a small proportion of heavy filtered mineral oil may be added, if considered desirable, in the case of auxiliary engines fitted with forced lubrication.

4. *Oil Drums, &c.*—All tanks and drums intended for the reception of oil should be thoroughly cleaned before filling, in order to avoid the ill effects of mixing different oils.

5. *Colour of Mineral Oil Drums.*—The general appearance and smell of the “Ordinary” and “Special” mineral lubricating oils for external lubrication are very similar, and it is therefore necessary that in dealing with deliveries of these oils great care should be exercised at all times with a view to preventing one being mistaken for the other. “Special” and “Ordinary” mineral lubricating oils will be supplied in drums painted green and yellow respectively. Rapeseed oil is no longer to be used for lubricating purposes. This oil and “mineral sperm” will be supplied in drums, painted brown.

## 107.

1. *Forced Lubrication Examination of Circulation.*—In the case of turbine and other engines fitted with independent oil circulating pumps, before admitting any steam to the engines, these pumps should be started and the lubricating system examined to ensure that oil is flowing freely through all bearings fitted with forced lubrication.

2. *Corrosion of Journals.*—In order to prevent corrosion of the journals when the engines are not in use, oil which has been ascertained to be free from water should be circulated through the bearings and the engines turned by the turning gear, after the engines are finished with, sufficiently to ensure the bearings being filled with oil free from water.

3. *Attention to Lubricating System.*—When under way constant attention should be paid to the lubricating system, and the temperature of the oil as it drains from the bearings should be frequently examined.

4. *Examination of Oil in System.*—When oil has settled in the drain tanks, settling tanks, or crank chambers, a quantity should be drawn from the bottom for examination and any oil which has become deteriorated should be removed and filtered and used for open auxiliary engines, &c. The strainers should be frequently examined and cleaned. The oil wells beneath the bearings also act as settling tanks and should be cleaned out periodically.

5. *Nitrate of Silver Test.*—Water settling out from the oil should be tested with nitrate of silver, and if sea water is present, all possible means of its access to the system should be examined and any defect at once made good.

6. *Naked Lights.*—When opening out the crank chambers of forced lubricating engines, no naked light is to be taken near the engine till the oil chamber has been thoroughly ventilated. In any cases where serious overheating is suspected, the engine should be at once eased, and naked lights, if present, removed from the vicinity of the crank chamber.

7. *Admission of Oil to Cylinders.*—Constant attention must be given to the means fitted for preventing the oil being carried into the cylinders and slide casings by the piston and slide rods.

8. *Thermometers, &c.*—Mercurial instruments, such as thermometers, barometers, &c., are not to be used in connection with condensers or oil coolers.

Receptacles for thermometers (in thermometer box connections) are not to contain mercury, except those fitted in connection with steam or oil-fuel heating fittings. These receptacles are to be of steel, unless they are in connection with sea water, when gunmetal is to be used.

### 108.

*Silent Blow-off Valves.*—When necessary to use the silent blow-off valves, they should be opened with great caution. The steam-tightness of these valves should be frequently attended to.

### 109.

*Precautions after Steaming.*—When the main engines are stopped after being under steam, men are not to be sent to work about them until it has been definitely ascertained that there is no steam present, that the vacuum is destroyed, and that the turning gear is shipped.

### 110.

*Engines Turned. E.R. Register.*—In harbour the main engines are to be turned partly round every day, and a notation to the effect that this has been done is to be made in the Engine-room Register daily. The slide valves are to be moved by the hand reversing-gear.

### 111.

*Chocks and Ties. E.R. Register.*—All chocks and ties fitted to cylinders, boilers, and other parts of machinery, to prevent them from shifting from the effects of collision, are at all times to be kept in efficient condition; they are to be examined once in each quarter, and their condition noted in the Engine-room Register. (See Art. 219.)

### 112.

*Clearances and Leads.*—The greatest care is to be taken when adjusting the various bearings of the main and auxiliary engines; washers should be fitted



whenever the split pins are not hard up on the check nuts in bearings so fitted, and the Engineer Officer should satisfy himself by personal examination at frequent intervals that the fastenings of all fittings which are liable to become loose through the working of the engines are properly secured. When setting up the brasses of the connecting rods, the amount of clearance left at each end of the cylinder is to be accurately measured to see if it coincides with the original clearance and noted for future guidance. The leads of the slide-valve are to be carefully measured to determine the necessary re-adjustment through wearing down. Care is especially necessary in the case of fast-running engines.

### 113.

*Examination of Machinery.*—After a vessel has steamed about 20,000 miles, the following examinations, adjustments, &c., of the machinery should be carried out in a thorough manner:—

**Cylinders.**—Ascertain the condition of the walls and gauge the diameter, both in the athwartship and fore and aft directions at the middle and ends of each cylinder; the tightness of the cylinder jackets should also be tested if it is considered necessary, and the liner bolts examined.

**Pistons.**—Gauge wear on metallic rings, and see that all the springs are efficient; adjust the restraining edges of restrained rings as necessary to keep them efficient; also note the clearances at the ends of the stroke.

**Piston rods.**—Test the rods for straightness and parallelism, see that the nuts are tight, that the metallic packing is in good condition, ascertain that the crosshead pins are parallel with the crank shaft, and adjust the guides as necessary.

**Slide valves.**—Gauge wear of liners and spring rings of all piston valves, and see that they are efficient; adjust restrained rings if fitted; examine the faces of the flat valves, and adjust the relief arrangements; care should be taken not to screw up the packing, if so fitted, more than necessary to keep the rings at the back steam-tight, and to keep the valves in position; particular care is necessary when india-rubber packing is used, owing to its liability to swell under the action of mineral oil. Check the positions of all the valves, and compare with the original settings.

**Slide valve rods.**—Examine nuts and check nuts by which the valves are secured to the rods; see that the rods are parallel and the metallic packing is efficient; and adjust the guides as necessary.

**Connecting rods.**—See that these rods are in line with the piston rods; adjust brasses as necessary, keeping in view the clearance of the pistons. Particular care is required with vertical engines to prevent the crank-pin brasses from becoming slack, as any "hammering" on the centres will tend to split the pistons.

**Crank and propelling shafting. Thrust Bearings.**—Remove all bearing caps and examine journals; test the conditions of alignment, making such gauges or templates as will enable this to be done with facility; rectify any tendency to imperfect alignment which the machinery may develop in working, as imperfect alignment is a frequent cause of heated bearings; the alignment of the crank shafts should be tested both when the engines are cold and also when under the temperature of working condition; examine condition of thrust bearings, and see that the crank shafts are not forced forward; see that all coupling bolts are in good condition.

The outboard portions of the propeller shafting to be examined as provided for in Arts. 242 *et seq.*

Eccentrics, straps, and rods.—See that the eccentrics remain an accurate fit on the shafts, and that the keys are in good condition; gauge their diameters to ascertain if they are worn oval, and rectify any inaccuracy; adjust the straps and rods, keeping in view the setting of the slide valves.

Link motions.—All the pins, bushes, brasses, &c., to be examined and adjusted as necessary.

Air-pumps.—All the valves and guards to be carefully examined and renewed where necessary; see also that the plunger packing is efficient. The clearances at the end of the stroke are also to be ascertained and corrected as necessary.

Condensers.—The condition of the tubes, and ferrules, and the tightness of the tube ends in the tube plates to be ascertained and defects remedied. (*See Art. 116 et seq.*)

Holding-down bolts and other fastenings, &c., to be examined to ascertain whether they are secure and efficient,

Auxiliary engines, &c.—Such auxiliary engines as could not be overhauled while the vessel was under way, and all other parts of the machinery, are to be well examined and all defects made good, so that as far as possible the engines shall be in a state of thorough efficiency.

2. *Occasional Examinations.*—In the cases in which vessels do not make lengthened runs, the examinations above mentioned are to be carried out as opportunities offer, but the whole of the parts enumerated should be thoroughly examined during a period of 12 months. The Engineer Officer must determine for himself, knowing the general condition of the machinery, the order in which such examination should be made, and also whether it may be necessary to examine any portion more frequently.

3. *Pistons of Horizontal Engines.*—The wearing down of the pistons in horizontal engines is to be carefully watched, and they are to be lined up to the central position when required; the packing rings are also to be turned some distance round as they become worn.

4. *E.R. Register.*—Each of these examinations, with full information concerning the state of the parts examined, and the adjustment or repair carried out, is to be noted in the Engine-room Register.

5. While machinery is opened out for examination or repair and when closing up, every necessary precaution is to be taken to prevent anything lodging, falling into, or remaining inside or upon any part of the main and auxiliary machinery; which would be likely to lead to obstruction or injury when the machinery is in motion. A responsible officer is on all occasions to satisfy himself that the machinery is entirely free from tools, starting screws, loose bolts and nuts, dirt, or any other obstruction before the several parts of the machinery are closed up.

#### 114.

*Preservation of India-rubber Valves. E.R. Register.*—India-rubber valves become defective when exposed to the action of oil and grease, which softens them and destroys their tenacity and elasticity. They should be washed occasionally in a soda solution to remove any greasy matter which may have adhered to them. To prevent overlapping they should be cut if necessary. These valves should be examined periodically, and their condition at each examination noted in the Engine-room Register.

#### 115.

*Feed-water Tanks. E.R. Register.*—The feed-water tanks should have slabs of zinc suspended in them, in order to prevent corrosion of the steel, care being

taken to fit them as directed in Art. 164 respecting the zinc slabs suspended in the boilers.

These tanks and zinc slabs should be examined and cleaned at least once a quarter and their condition noted in the Engine-room Register. (See Arts 105 and 347.)

### 116.

1. *Tubes of Surface Condensers.*—The tubes of the surface condensers are to be thoroughly examined from time to time, and if they require cleaning, they are to be drawn for that purpose should time permit, unless the construction of the condensers will admit of its being done while they are in place; in either case they are to be kept perfectly clean.

2. *Cleaning Condensers.*—When the tubes are coated with grease internally, they may be cleaned by sponging them out with brushes dipped in a strong solution of soda; and it may sometimes be advisable to cleanse the condensers of grease by filling them with such a solution, and allowing it to remain in them for some time.

### 117.

1. *Condensers to be kept Dry.*—The covers and doors of the foot and delivery valve chambers are to be taken off when the engines are not likely to be used for some time, and all the condensed water drained out of the condenser and hot-well, which are then to be kept dry. The covers and doors are not to be replaced until the engines are required to be in readiness for steaming.

2. If the condenser casings are of iron, zinc plates or bars should be used to protect them; if of gun-metal, brass, or copper, steel plates or bars are to be used for this purpose.

3. *Protective Slabs for Condensers, &c. E.R. Register.*—The protective slabs, discs, or bars fitted to surface condensers, double distillers, or evaporators, are to be regularly inspected, cleaned, and renewed, care being taken, when securing the connections, that good contact is made. The results of the inspection are to be noted in the E.R. Register.

### 118.

1. *Decay of Condenser Tubes.*—When gun-metal, brass, or copper is adopted for condenser cases, a more rapid decay of the tubes than in the case of iron condensers may be expected; the general effects being marked evidence of corrosion through all its stages up to extensive perforation.

2. Although this condition is not wholly absent in tubes where the condenser shells are of iron, it manifests itself in its severest form where the condenser shell is of metal with the circulating water flowing round the tubes, and in a less degree where the circulating water flows through them.

3. In every case the corrosive action originates on the condensing waterside of the tubes affected.

4. *Interior of Shell.*—To arrest this action in cases where the circulating water flows through the tubes, it is necessary to insulate as far as possible by the application of a stiff wash of cement, the interiors of the condenser covers, the tube plates and the interior of the ends of the tubes and ferrules.

In cases where the circulating water flows round the tubes, the condenser shell should be similarly treated as opportunities occur. This operation would generally involve the withdrawal of the tubes, and it is not considered expedient to undertake so much work for the purpose of effecting this object alone; but

whenever the removal of the tubes is taken in hand for any other purpose, the Engineer Officer is to take the necessary steps to provide for the complete work described being carried out at the same time.

5. *Cement Wash*.—Care should be taken when applying the cement wash to the tube plates, &c., to coat the inner surface of the ferrules and the internal portion of the tube ends as far inwards as possible by using a small brush, so as to leave a slight protective coating of cement in the tubes without restricting the inlet area to any serious extent.

6. *Steel Bars*.—If corrosion is taking place in any condenser, the number of protective slabs should be increased and the positions chosen for these should be as close as possible to the affected parts. In the case of condensers where the circulating water flows round the tubes, where slabs cannot be fitted, steel bars are to be used and screwed into solid metal capnuts made to fit the stuffing boxes in tube plates, tubes being drawn in the proportion of 1 in 300 to admit of the insertion of these bars in tube plates (both ends) and equally distributed over the whole area.

### 119.

1. *Measure to arrest Decay*.—Engineer Officers, are to use their best endeavours to keep themselves acquainted with the general state of soundness of the tubes, and will adopt not only the measures indicated, but such others as may suggest themselves as being applicable to each particular case.

2. *Defective Tubes, Report*.—All instances of condenser tubes becoming defective by perforation, splitting, local corrosion, or in any other manner, are to be reported by letter, giving a description of the defect, the position of the defect in the tube, and the tube in the condenser; the positions relatively to the defect of the sea inlets, exhaust or drain pipes and their baffles, and protectors (with condition of these); the character and quality of the material of the tube; the name of the maker of the tube, or such information as will assist in tracing him; the opinion of the ship's Officers as to the cause of the defect, and proposals for the avoidance of the recurrence of such defects. Outline sketches showing the relative positions of the defect and the fittings mentioned should accompany the report.

### 120.

1. *Indicators*.—The Engineer Officer is to see that the Indicators are kept in an efficient state, so that, in addition to being able to ascertain the power the engines are developing, he may at any time, by means of an Indicator diagram, be able to form an opinion of the working of the internal parts of the engines.

2. *Indicator Diagrams, E.R. Register*.—When under steam, Indicator diagrams are to be taken at least daily, or oftener if any material variation in the power occurs, except in Scouts and Torpedo Boat Destroyers. At the same time, the force of the wind and its direction relative to the ship, and the state of the sea are to be registered, so that correct average results may be ascertained. In Scouts and Torpedo Boat Destroyers, diagrams are to be taken occasionally to enable an opinion to be formed as to the working of the internal parts of the engines. When not so taken the reason for the omission is to be stated in the Engine-room Register.

3. *Data on Diagrams*.—The following particulars are to be given on all indicator diagrams:—

Date. Steam Pressure. Cut off. Scale. Time. Vacuum, Receiver Pressure, Mean Pressure. Cylinder. Revolutions. Jacket Pressure. I.H.P. Closed Exhaust Pressure. Diagrams to be marked top and bottom to show from which end of the cylinder they are taken.

## 121.

1. *Closed Auxiliary Exhaust System.*—In vessels fitted with closed auxiliary exhaust system, the system is to be used in harbour and at sea when water is required to be made by the evaporators. When proceeding independently, the system should always be in use, any steam not required for making water being admitted to the L.P. receivers or turbines.

2. When engaged in evolutions in company with the squadron or under any other circumstances in which the main engines are likely to be subject to great changes in speed or to sudden stoppage or reversal the connections to the L.P. receivers or turbines should be kept closed.

3. *E.R. Register.*—When the system is in use a note to that effect is to be inserted in the Engine-room Register, and the pressures in the auxiliary exhaust pipe and vacuum in the auxiliary condenser are to be recorded every four hours. The water made by the evaporators is to be entered in the proper column.

4. In order to assist the Officers in charge of machinery and the Engine-room Staff generally in the management of the system, the following information is added:—

- (a) The object of the piston relief valve leading from the auxiliary exhaust pipe to the condenser is to provide a ready escape for any surplus of exhaust steam not required in the evaporators, L.P. receivers or turbines, and particularly for any sudden surplus consequent on the use of the steering engine, hydraulic engine, boat hoist, or other intermittent working engines, and also to maintain generally a steady pressure in the exhaust pipe of the amount desired. It is important that the piston relief valve should be maintained in an efficient working order. As the piston valve, if kept properly free, cannot be relied upon to be quite steam-tight, a locked valve is provided on the pipe leading from the valve to the condenser to enable the condenser to be isolated for repair. This valve is locked open and should only be closed when the condenser is not in use, a suitable instruction plate to this effect being attached to the valve opening gear or other prominent position.
- (b) The piston relief valve to the low-pressure receiver will prevent the pressure in the exhaust pipe from being interfered with by fluctuations of pressure in the receiver; also, this piston relief valve should be set to lift a few pounds below that at which the piston relief valve to the condenser is adjusted, as by this means the passage is ensured to the L.P. receiver or turbine of the surplus exhaust steam not required in the evaporator coils.
- (c) These piston valves are provided with lifting gear so that they can be readily moved by hand, and they should be kept free and moved frequently when steam is up. The valves should also be taken out occasionally and cleaned.
- (d) The pressure to be maintained in the auxiliary exhaust pipe will depend on the quantity of water required from the evaporators and also, when at sea on the pressure in the L.P. receiver or turbines.

When in harbour and also when steaming at low speed, it will generally be practicable to obtain all the water required from the evaporators with exhaust or coil pressures considerably below the 25 lbs. which is the limit to which the system can be worked.

These pressures should always be kept as low as possible consistent with making the water required and with ensuring the flow of the surplus steam to the main engines.

- (e) Owing to the auxiliary exhaust service being in this system shut off from the condenser, the production of a considerable vacuum in the condenser is made readily possible.

Advantage should be taken of the vacuum in the condenser to increase the production of the evaporators and so allow the lower exhaust pressures to be used. The formation of scale on the evaporator coils is much reduced by emptying the evaporators to the bilge or sea every six or eight hours.

When working on a vacuum care should be taken that no cocks are opened or allowed to leak which will admit air into the water space of the evaporator.

- (f) In order to limit the amount of vacuum which can be produced in the evaporator shell, vacuum control valves are fitted to the vapour outlet pipes. These are set so as to close with a vacuum of 10 inches in the evaporator shell or less as may be desired; they should be very frequently moved and examined and kept smooth and free to ensure their continuous and sensitive action. As a sudden opening of these valves when they are acting to limit the vacuum might cause priming, the gear for moving them by hand is arranged so that it can only be used to forcibly close the valve, the opening being effected by the action of the spring only.
- (g) When changing from open to closed auxiliary exhaust the speed of the circulating and other auxiliary engines liable to be affected should be first increased and again adjusted to the requirements after the change has been satisfactorily made.

### 122.

*Auxiliary Machinery. E.R. Register.*—The auxiliary machinery is to be examined frequently, and all examinations and repairs are to be noted in the Engine-room Register, and auxiliary engines not in use are to be turned by hand daily.

### 123.

*Telegraphs. E.R. Register.*—The condition of the instruments fitted on board for telegraphing signals in connection with the machinery is to be noted at the end of every week in the Engine-room Register.

### 124.

1. *Steering Engines, Telegraphs, &c. Examination. E.R. Register.*—The Steam Steering Engine, and its controlling gear, and all telegraphs and their shafting, including the Helm Signal Gear from the rudder head to the drum or wheel which receives the wire halyards, are to be examined personally once a week by the Engineer Officer, or competent subordinate detailed by him, and the result of this examination is to be recorded in the Engine-room Register. On all occasions before getting under way a further examination is to be made, and the Engineer Officer is to satisfy himself by personal inspection, and by actually working the steering gear and telegraphs, that these fittings are free from obstruction and in good working order, care being taken that the instructions issued with telemotor controlling gear are strictly observed. A report to this effect is to be made by the Engineer Officer to the Commanding Officer at the same time that the main engines are reported ready.

2. *Inspection of Rudder.*—Whenever the rudder is required to be worked by steam, the Engineer Officer is to satisfy himself, by personal inspection, or by the

report of a competent subordinate detailed by him to make the inspection, that the rudder is unlocked, and the locking bolts stowed in the place provided for them when not in use, before the controlling gear of the Steering Engine is connected and steam is admitted to the engine.

3. *Care when Steering Gear has been Disconnected.*—Whenever the Steering Gear has been disconnected from the Steering Engine, special care is to be taken before vessels get under way, during the examination and working referred to in clause 1, to ensure that the gear and engines are properly connected, so that when the helm is placed hard over both ways the gear is well clear of the stops. For this purpose the rudder, after connection to the engine, is first to be worked by the engine before the deck gear is connected, and should be put over *gradually* both ways to intermediate angles, and the angles of the rudder compared in each case with the angles recorded on the indicator at the engine, to ensure that the readings agree. When the deck control gear is connected a similar procedure is to be followed.

### 125.

1. *Evaporating and Distilling Apparatus.*—The attention of the Engineer Officer is directed to the necessity of maintaining the evaporators in a condition of through efficiency, and as their continual and successful working depends largely upon the conditions of steam pressure, density, height of water, and state of heating surfaces under which they are worked, it is expected that he apply himself to the determination of the best working condition for the particular class of apparatus in his charge so as to obtain from it the maximum production at the minimum of cost in coal. He should also occasionally test the water distilled to see that it is in a pure state and free from salt, and he should see that the pumping arrangements, whether hand or steam, for filling the receiving tanks are kept clean and in good order. The density in the evaporator should never exceed 30° by hydrometer.

2. *Testing.*—After cleaning the coils, and on completion of repairs to an evaporator, the portion which is subjected to the pressure of the primary steam, should, if practicable, be tested by steam or water.

### 126.

1. *Air Compressors.*—After using the air-compressing machinery, great care is to be taken to see that the engines, pumps, separators, charging columns, and reservoirs are blown out and well drained of water. The valves on the pressure gauges of the separators should be left open, so that any pressure left in the pump or separator may be indicated to avoid accidents in disconnecting the pumps, &c.

2. *Spare Leathers.*—A set of spare leathers should always be kept in the presses supplied, as it is found that to ensure the leathers being more efficient, the act of pressing them should be divided into several operations extending over two or three days.

3. *Testing.*—The Torpedo air-compressing machinery, reservoirs, columns and air pipes are to be tested to the full pressures once a year, and the whole of this plant should be tested at the same period. The Engineer Officer is to be responsible for testing as much of this machinery as is placed under his charge by clauses 1 and 4 of Art. 15. All H.P. air bottles ashore or afloat, besides being water-tested periodically in place are to be unsweated, cleaned, and proof-tested for expansion by the Dockyards at the first opportunity which occurs after the bottles have been four years in actual use, and every four years afterwards. Instructions as to the testing of the various parts by water pressure are supplied with each set.

4. *E.R. Register*.—A notation of this annual test is to be made in the Quarterly Report at the end of each Engine-room Register.

5. *Oil for Lubrication*.—The oil for lubricating the internal parts of the pump should be neatsfoot, or, if not supplied, an animal oil

6. *Water for Lubricating*.—The water used for lubricating the internal parts of the pumps should be free from lime and other impurities, and should be distilled if possible.

7. *Clearance*.—Owing to the very small clearances allowed in the air-compressing pump, great care is required in the adjustment of the bearings.

### 127.

1. *Lubrication of Air Compressors*.—Air compressors are never to be run without the continuous injection of water and a small quantity of light oil, about one drop per second for each compressor. The level of the crank chamber oil in electrically-driven compressors should be kept as low as possible to prevent the splashing on to the cylinder walls and the passing over of crank chamber oil into the air system.

2. *Precaution when Levelling Air System*.—The operation of levelling up different parts of the air system, where one part is only of small volume, is not to be done too quickly, owing to the risk of explosion of any oil which may have collected, if too sudden a generation of heat occurs.

### 128.

1. *Refrigerating and Ice-making Machines: Cold Air Type*.—The wooden air trunks and ice boxes fitted to refrigerating and ice-making machines of the cold air type, are to be carefully smoke-tested whenever the machines show a falling-off in performance, and any leakage detected should be made good.

2. The internal lubricants used for the compression and expansion cylinders should be limited to the lowest possible quantity.

### 129.

1. *Refrigerating, Ice-making, and Magazine Cooling Machines: Ammonia (NH<sub>3</sub>) and Carbonic Anhydride (CO<sub>2</sub>) Types*.—The instructions supplied with ammonia and carbonic anhydride machines furnish reliable information as to the best method of starting, charging, and working the plant; also as to the best method of packing the compressor gland, and as to testing the circuit.

The speed of the machine is in no case to exceed the revolutions per minute stated on the drawings and instructions supplied.

2. Owing to the small clearances in the compressors, great care is required in the adjustment of the bearings.

3. *Oil for Compressor Gland*.—Mineral oil only is to be used for sealing the compressor gland. If the machine is not expected to be required for a time, the packing should be withdrawn from this gland.

4. *Air and Gas Cocks*.—Cocks are provided at the top of condenser and of refrigerator to prevent accumulation of gas. These cocks are to be opened at least once in each watch for a short period when the machine is at work, and kept open when the machine is not in use.

5. As hydrogen gas is liable to be generated in the condensers and refrigerators of these installations, naked lights are not to be brought near the ends of the escape pipes from the condenser or refrigerator.



6. *Brine Solution.*—Calcium chloride solution only is to be used for the brine ; a sea water or a common salt mixture will have a quicker deteriorating effect on the refrigerator coils.

7. *Tests of Circuits. E.R. Register.*—The compression cylinder and coils are to be water-tested annually ; in the case of ammonia compression machines to 1,500 lbs. per sq. in., and in the case of CO<sub>2</sub> machines to 2,000 lbs. per sq. in. The results of these tests are to be noted in the Engine-room Register. The coils are to be first examined externally for any signs of corrosion, and internally for any deposits, and are to be blown through by air or steam for this purpose till clear and clean.

8. Should these machines show falling-off in efficiency, the coils are to be blown through, and the compressor pistons and valves examined for tightness.

9. The circuit is to be tested for tightness both under conditions of pressure and vacuum before re-charging.

10. *Magazine Cooling Machinery ; Trials every three months : E.R. Register.*—In order to ensure the machinery being kept efficient and to give the Engine-room staff experience in its working ; the whole of the magazine cooling machinery is to be worked continuously for thirty hours at intervals of not more than three months, whether the temperatures of the magazines exceed 70° or whether they do not. During six hours of this period the machinery is to be worked continuously at full output. The results of this trial are to be noted in the Engine-room Register on the day of trial.

In ships of the 4th Division of the Home Fleet the magazine cooling machinery is to be worked for a period of thirty hours when all boilers are alight for annual trials, and a half-yearly trial is to be carried out with only such boilers alight as may be necessary at the time.

The condensers and coolers should be kept empty and dry when not in use.

### 130.

1. *Ammonia Machines. Drenching Arrangement.*—The water service fitted to enable the ammonia connections to be quickly drenched in the event of a sudden leakage of ammonia is to be tested on every occasion of starting the machine.

2. *Leakage of Ammonia.*—Generally, a slight leak of ammonia can be dealt with and the machine approached if a piece of wet waste or similar material be held over the mouth and nostrils, but in the event of a bad leakage of ammonia, or should the shut-off valves be found defective when re-packing the compressor gland, the whole charge is to be blown out of the machine. The emptying pipe is always to be kept in position and a bucket of water placed near the machine, so as to be readily available for this purpose.

3. *Water for filling Ice Moulds.*—Care is to be taken that only water of a temperature not greater than that of the atmosphere is used for filling or replenishing the ice moulds. The use of hot water for this purpose is dangerous, and is strictly prohibited.

4. *Pressure Gauges.*—Special steel pressure gauges are supplied for use in the ammonia circuit. The ordinary service pattern pressure gauges should not be used except in case of absolute necessity, and then only for a short period, as the ammonia acts on the metal of which these are constructed, and very quickly causes deterioration.

### 131.

1. *CO<sub>2</sub> Machines. Ventilation and Precautions.*—The ventilation of the compartment in which CO<sub>2</sub> machines are placed is to be kept as efficient as possible,

and whenever machines of this type are in use, a lighted *candle* is always to be placed on the deck near the machine, as a precautionary measure, to indicate the presence of any serious leakage of CO<sub>2</sub> gas.

2. In the case of a large leak in a CO<sub>2</sub> machine, such as due to the safety disc bursting, it will usually be impossible to close the valve to the condenser sufficiently quickly to save any portion of the charge, and where the machine is situated in a small compartment, no attempt should be made to do so, but the compartment should be temporarily left.

### 132.

1. *Ammonia and CO<sub>2</sub> Flasks. Tests and Examination.*—Each flask containing ammonia or CO<sub>2</sub> is to be examined before receipt into store, to ascertain that it has passed the prescribed tests, and is to bear the following marks :—

A manufacturer's mark, a rotation number, an Admiralty Overseer's mark with date, and a water pressure test mark with amount and date. The weight of the flask empty with valve but without cap, and the greatest permissible amount it may contain is also to be stamped on the flask. The marks are to be made on the hemispherical end and are to be permanent and easily visible.

A plate is to be affixed to each flask showing the nature of its contents, and containing directions that the flask is to be kept cool and not be exposed to the heat of the sun or any artificial heat.

2. *Water Test.*—Each flask is to be water-tested, before delivery, to 2,000 lbs. pressure per square inch in the case of ammonia flasks, and 3,500 lbs. per square inch in the case of CO<sub>2</sub> flasks, without any permanent alteration of form, and must not show the slightest leakage.

The valve box is to be in place during the water test, and, wherever practicable, the valve box is to be tested with valve open and with valve shut.

3. *Valve Fittings.*—The valve fittings on flasks are always to be protected by a steel cap, and in cases where ammonia flasks are immersed, provision is to be made to preserve the steel valve box and fittings.

4. Care is to be taken when handling or transporting the filled flasks; they are to be enclosed in wooden cases, and must not be dropped nor be subjected to rough usage.

5. When a flask is emptied a distinguishing mark to that effect is to be painted on it.

6. *Tests to be Repeated and Flasks Re-annealed.*—The water pressure test is to be repeated at least every two years, and the flasks are to be close annealed every four years, and are to be water-tested immediately after the re-annealing. The dates of each water-test and of each re-annealing to be stamped on the flasks with the Inspecting Officer's marks.

7. The number of flasks kept in store is to be arranged so that this order as regards water-testing and re-annealing can be complied with, each Yard making the necessary arrangements so that these instructions can be carried out for all flasks in store and for those supplied to vessels attached to that port.

8. *Record of Tests.*—A record is to be kept of all tests and re-annealing, and copies are to be sent to the Admiralty.

9. *Flasks Failing on Testing.*—Flasks which fail in testing are to be destroyed or rendered useless; and a report of such failure is to be forwarded to Admiralty for record purposes.

10. *Flasks to be Painted.*—Each flask is to be painted externally, care being taken that the record of tests, &c., stamped upon it are left legible. The paint to be removed during the water test.

### 133.

*Precautions when Refilling Flasks.*—The following precautions are to be taken when flasks require refilling:—

1. Each flask is to be completely empty and to be thoroughly dry before being refilled. The contents of each flask must not exceed the following quantity:—  

Ammonia flasks—	Half a pound per lb. of its water capacity.
CO <sub>2</sub> „	Two thirds of a pound per lb. of its water capacity.
2. Every flask is to be carefully weighed before and after filling, and in order to ensure the correct amount being inserted, the weights are to be independently checked by the Firm and by the Inspecting Officer attending the filling.
3. Each flask is to be packed in a suitable wooden case for protection during transit. When the flask is filled the nature of the contents is to be plainly marked on the case, and directions painted on it that it is to be kept cool and is not to be exposed to the heat of the sun or any artificial heat and must not be dropped nor be subjected to rough usage.

### 134.

1. *Ammonia Flasks: Storage of.*—Flasks containing ammonia or CO<sub>2</sub> are to be stowed in a cool place, under projection from the sun or other source of heat, and, if more convenient, they may be submerged in fresh water in open tanks. They are to be stowed at some distance from sleeping quarters, and provision is always to be made for readily drenching ammonia flasks in case of an escape of gas.

2. *Precaution before going into Action.*—In the event of a ship going into action the gas is to be blown out of the machine, and the charged flasks are to be landed or emptied if arrangements cannot be made to stow them in such a position as to avoid any possibility of their being struck by missiles or débris.

### 135.

1. *Internal Combustion Engines, Naked Lights, Precautions with Motor Boats.*—The instructions issued by the makers of the various types of internal combustion engines are to be generally followed in their care and management.

2. When opening out the internal combustion engines, electric lamps, the connections of which are in good order and not liable to sparking, should be used if possible. No naked light is to be brought in the vicinity of the vaporisers or crank chambers until all inflammable gas has been expelled.

3. The inflammable vapour which may be formed, being heavier than air, its dispersion from tanks and closed spaces by ordinary means of ventilation is very difficult. The use of bellows or windsails will assist in expelling the vapour. In motor boats especial care is necessary.

4. The ignition circuit throughout must be carefully insulated and the electric leads properly supported. External sparking is, as far as possible, to be guarded against.

5. *Fuel Tanks*.—Fuel tanks and all fuel pipes and connections are to be regularly examined, and their freedom from leaks ascertained.

6. *Matches*.—Matches or lamps are on no account to be brought in the vicinity of the fuel tanks, or lockers.

7. Cans for containing inflammable oil, whether empty or not, must be securely closed and stowed in the locker provided. When not required to be open, the locker is to be properly closed, and is not to be used for any other purpose.

8. If fire extinguishers are supplied for motor boats they are always to be carried in the boat, and the crew instructed in their use.

9. *Motor Boats, hoisting in*.—The supply of oil fuel to the motor is to be shut off before the boat is hoisted in board.

### 136.

1. *Vaporisers*.—The vaporisers should be cleaned at regular intervals, the frequency of which will depend upon the quality of the oil and the number of hours at work.

2. *Crank Chambers*.—The crank chambers should be cleaned out at regular intervals and filled with clean oil.

### 137.

1. *Lubrication*.—Special arrangements for lubricating the cylinders of internal combustion engines have generally been found unnecessary. Where necessary, special mineral oil is to be used, but if unprocurable, ordinary service mineral may be used, in which case the pistons and cylinders are to be more frequently examined for deposits of carbon.

2. *Oil Level*.—The level of the oil in the crank chamber is to be kept as low as is found just sufficient for the lubrication of the bearings. Any excess of lubricating oil is found to pass the pistons into the combustion space, where it burns, fouling the cylinders and increasing the expenditure of oil for combustion.

### 138.

1. *Cylinder Temperatures overheating*.—The temperatures of the lubricating oil and the circulating water discharge should be frequently taken during the running of the engines. The rise of temperature of the circulating water discharge should not exceed that obtained during the trials of the engines.

2. *Cylinder Jackets and Covers*.—The cylinder jackets and covers are to be examined regularly, and any deposits from the circulating water removed from the surfaces.

3. In the event of the cylinders overheating internally or the circulating water having an unusual temperature, the jacketed surfaces in contact with the cooling water should be cleaned at the earliest opportunity.

### 139.

1. *Clutch*.—The clutch of internal combustion engines so fitted, is to be frequently examined, the surfaces transmitting the power lined up or refaced as necessary, and the amount of wear carefully noted.

2. *Starting Reservoirs ; Motor Baats*.—Where motor boats or other engines are provided with compressed air starting arrangements, care is to be taken to recharge

the air reservoirs after starting, and to keep them charged and ready for use whenever required.

3. *Air Reservoirs, test of; E.R. Register.*—The periodical test of air reservoirs of internal combustion engines so fitted, are to be carried out as laid down in Art. 126. A notation of the test is to be made in the Quarterly Report at the end of each Engine-room Register.

4. *Motor Boats when turning.*—It will generally be found with motor boats that a minimum speed of revolution exists below which the engines are liable to stop under a sudden use of the helm. This speed should be noted and inserted among the details in the ship's steam manual.

#### 140.

1. *Pistons and Valves.*—The pistons and valves of internal combustion engines are to be kept clean and in good condition, in order that the work of the engines, may not be impaired by leakage during compression.

2. *Diagrams; Diesel Engines.*—Indicator diagrams are to be occasionally taken from internal combustion engines to ensure that they are working correctly.

3. In ships fitted with Diesel engines, the blast pressure should be maintained as low as possible consistent with obtaining the necessary power from the engine.

4. The firing in the cylinders of internal combustion engines should be observed regularly to ascertain that the oil fuel injected is correctly burnt and does not accumulate. This is particularly important in engines of the Diesel type, and can be tested by opening the indicator cocks.

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### BOILERS.

#### 151.

*Acquaintance with Construction, &c., of Boilers.*—The Engineer Officer is to make himself thoroughly acquainted with the construction and staying of the boilers, and with any arrangement or fitting that may require special care or mode of working; and he is to see that the other Engineer Officers are well acquainted with these particulars.

#### 152.

1. *Drawing of Boilers.*—When any ship is fitted with new boilers, or the boilers are thoroughly repaired in a Dockyard at home or abroad, the Dockyard Officers will furnish the Engineer Officer of such ship with a drawing showing the construction of the boilers, the nature of the material, and the original and present thicknesses of the plates and stays; and with a copy of the report of examination and drill or other tests made to ascertain the wear and waste at such time of repair, and with any other information which may be of value in connection with the boilers.

2. A copy of the report by the Dockyard Officers giving the results of their examination of the boilers, with drill or other tests, if any have been made, is to be placed in the Captain's ship's book, to which the Engineer Officer should be at liberty to refer.

#### 153.

S. 353B. S. 467A. *History Sheet.*—In the case of water-tube boilers, the history of the boiler-tubes should be kept recorded in Forms S. 353B or S. 467A, in accordance with the instructions printed thereon.

## 154.

1. *Responsibility.*—The Engineer Officer is responsible for the safety and condition of the boilers under all circumstances, and he should keep himself thoroughly acquainted with their state, and see that every effort is made to keep them efficient and fit for use, special care being necessary when they are becoming worn.

2. *Durability. E.R. Register.*—He is to exercise care and judgment in estimating the probable period of the durability of the boilers for insertion in the Engine-room Register. He is not to consider that this responsibility is in any way lessened by his having reported the state and durability of the boilers in the Engine-room Register, or by a report having been made by the Dockyard Officers that the boilers would be fit for work for any specified time.

## 155.

1. *Load on Safety-Valves. E.R. Register.*—The Engineer Officer is to report to the Captain, should he at any time consider it necessary to reduce the load on the safety-valves, and a survey is to be held by two Engineer Officers, if available, for the purpose of reporting as to the necessity for the reduction of pressure. Subject to the reports and with the approval of the Captain and the sanction of the Senior Officer present, the load is to be reduced as necessary. The amount of the reduction, and the reasons for making it, are to be stated in the Engine-room Register, and reported to the Commander-in-Chief, for the information of the Admiralty. (*See also Arts. 220 and 376.*)

2. *Proposal to Reduce Pressure.*—Whenever a proposal is made by Dockyard Officers to the Admiralty to reduce the pressure of the boilers in any ship in commission, the Captain or Officer in command, and the Engineer Officer of the ship, will be informed that such proposal has been submitted for the consideration of the Admiralty, and that the result will be communicated to them.

## 156.

1. *Condition of Interior of Boilers.*—The Engineer Officer should be at all times cognisant of the general condition of the interiors of the boilers, and be fully satisfied, by personal inspection, that no material deposit, either scale or grease, is present on the heating surfaces which may produce overheating; and that no undue corrosion is taking place.

2. *Measures to be taken if doubt exists.*—Should he at any time have reason to believe that any deposit is present, he will not be justified in working the boilers at powers necessitating the use of air pressure, excepting in cases of extreme emergency, under the direct orders of the Captain, who should be made fully acquainted in writing with the risk involved.

3. *Deposition of Scale. Cause of overheating.*—If the deposition of scale cannot be wholly prevented, it must be very carefully watched, and every available opportunity taken of thoroughly cleaning the surfaces exposed to heat. It must be borne in mind that for the efficient working of boilers of modern type with the high temperatures consequent upon the use of fan draught and high-pressure steam, scale, however thin, or whatever its character, cannot be disregarded, and which, if allowed to accumulate, will certainly tend to overheating and consequent injury.

## 157.

1. *Danger of Oil in Boilers.*—Experience shows that the presence of mineral oil in the boilers, even when worked with fresh water, aids in the formation of a

deposit which attaches itself to all vertical surfaces and to the under sides of horizontal ones. (See Arts. 104, 105.)

2. *Blow-out Arrangements.*—Where surface and bottom blow-out arrangements are fitted, the water in all boilers should be scummed and blown down at frequent intervals to get rid of the grease and deposits which experience shows collects. Marks should be placed on or adjacent to the water gauges showing the proper height of water in the boilers with regard to the scum pans. All boilers under steam should be scummed and blown down at least twice daily and on fires being allowed to die out. In Babcock and Wilcox boilers, where greasy deposits are observed to be greater under the main feed inlet, the corresponding side of the boiler should be blown down more frequently than the other. Boilers of this type should be blown down at least twice each watch, and should, unless free from scum, be scummed at least once each watch.

3. *Oil in Boilers.*—No oil of any kind is to be put into the boilers for any purpose whatever.

### 158.

1. *Deposit Round the Tube Ends. Drawing Tubes.*—In boilers in which water surrounds the tubes, rings of deposit usually form around the tube ends at their junction with the tube plate, and when such accumulations unavoidably occur, and prove to be difficult of complete removal, a sufficient number of tubes should be drawn whenever opportunity offers for this purpose. The presence of such deposits is liable to cause leaks between the tube ends and the tube plates.

2. *Tube Ends annealed before Replacing.*—Whenever tubes are withdrawn, care should be taken to anneal the ends before replacing them, and when appreciably thinned in the process of rolling, new tubes should be fitted.

3. *Deposit on Surfaces and Bulges.*—Other parts necessarily requiring close attention with respect to the presence of deposit are the furnaces and the sides, tops, and backs of combustion chambers, as, wherever great heat prevails, bulges will be produced if the surfaces are not clean on the water side, even when there is no shortness of water.

4. In some cases the parts most liable to be affected may be protected by the application of a brick lining, or by local protection by fireclay and covering plate in combustion chambers.

5. *Bulges.*—In every case of bulging, early steps should be taken to thoroughly clean all the internal surfaces from any scale, grease or deposit, and generally (unless the bulges are very prominent) it will not be necessary to force them back, as the possible advantage obtained would be more than counteracted by the severity of the treatment in doing so.

### 159.

1. *Water-tube Boilers to be kept free from Deposits, &c.*—Care is to be taken that water-tube boilers are kept as free as possible from all deposits, and from grease or other foreign matter in suspension. The presence of these, either by interposing a non-conductor, by repelling the water from contact with the heating surfaces, or by obstructing or impeding the circulation, is liable to cause overheating and rapid destruction of the tubes. They also tend to produce agitation and priming, and from this cause alone to seriously diminish the production of steam.

2. *Tubes to be cleaned, searched, and washed through.* On every possible occasion, attention should be paid to the thorough cleaning of the heating surfaces.

Where thorough internal cleaning is impracticable, the parts subjected to the greatest heat should have the first attention. All deposits and obstructions within or upon the tubes should be removed by means of scrapers, wire brushes, flexible searchers, or other suitable instruments. All loose scale or other deposits in the steam drums, feed collectors, sediment or float boxes, headers and all other parts, should be entirely removed.

3. *Indications of overheating of Tubes.*—Overheating of a tube may produce exterior discoloration, change of longitudinal configuration, local bulging, or a gradual increase of diameter. These indications should be frequently looked for, by inspection of the exteriors of the tubes, and by applying suitable plate gauges to them. Any indication of overheating should be followed by internal examinations.

4. *Tubes to be Clear.*—The Engineer Officer should satisfy himself that every tube is clear before closing a boiler.

5. *Fusible Plugs, Belleville Boilers.*—In a Belleville boiler conical plugs of fusible metal are screwed into certain junction boxes. If one of these should be blown out when the boiler is under steam, it should at once be replaced by a temporary plug forced in by a special tool if there are no signs of overheating. The temporary plug should be removed at the first opportunity, the thread in the hole cleared out, and a new plug inserted.

Where the original full depth of the thread in the junction box, by which the fusible plug is held in place, becomes worn; the hole should be plugged and the full thread renewed in a fresh hole. An adaptor screwed into the junction box, for carrying the fusible plug, and which can be readily cleaned and renewed, may be fitted where the junction boxes are suitable.

6. *Boiling out Water-tube Boilers with Caustic Soda.*—If there is any doubt or difficulty as to the complete removal of scale or deposit from the interior of the tubes of water-tube boilers by ordinary means, the boiling of a solution of caustic soda in the boiler for several hours will facilitate such removal. As soon as the soda solution has been removed, the boiler should be again boiled out, and finally washed out with clean fresh water, in order to remove all traces of the soda solution.

## 160.

1. *When Boilers require Cleaning.*—The period during which a boiler may be used without being cleaned depends upon various circumstances, and the Engineer Officer must determine for himself, knowing the service on which the ship is employed and the conditions under which the boilers are worked, when it is necessary to clean the boilers, he being responsible for their being kept clean and free from undue deposit. (See Art. 211 *et seq.*)

2. *Cleaning Boilers. E.R. Register.*—The Engineer Officer is to report to the Captain whenever he considers it is necessary to remove the deposits which may have formed in the interior of the boilers, in order that they may be cleaned at the earliest opportunity the nature of the service on which the ship is engaged will permit. In all cases where the cleaning is delayed the particulars are to be noted in the Engine-room Register, with a reference note in the Quarterly Report at the end of the Register. (See Art. 55.)

## 161.

*Cause of Corrosion.*—The corrosion which occurs in the interior of boilers is probably due to one or more of the following causes:—

- (a) In boilers under steam, the air and gases admitted with the feed water or when filling boilers.



- (b) Moist air and gases in boilers not kept quite full of water, free from air; or not kept dry while the boilers are not in use.
- (c) An acid condition of the water arising from the admission of sea water or fatty substances, either with the feed or when filling boilers. Vegetable acids may sometimes be contained in shore water.
- (d) Galvanic action originating in differences of material used in their construction.
- (e) Insufficient observance of the preventive treatment referred to in Arts. 156 to 180.

The corrosion which occurs in the external parts of boilers generally arises from among the following causes:—

- (f) A wet condition of parts which are in the way of leakage from doors, seams, joints, tube ends, and the various valves and cocks upon or near the boilers.
- (g) A wet condition of parts in contact with brick work or lagging owing to leakage or the use of hoses when washing out or filling boilers.
- (h) Moisture falling into the funnels.
- (j) Deposits of damp soot, as at the lower ends of inclined tubes where exposed to moisture from leaks or from the funnels.
- (k) Incautious use of the fire extinguishers.
- (l) Wet ashes allowed to lie in contact with the boilers.
- (m) The moisture arising from bilges deposited chiefly upon the under sides of exposed surfaces.
- (n) Insufficient use of protective coatings of oil or paint.

## 162.

1. *Boilers not in Use to be kept Filled.* *E.R. Register.*—All boilers not in use, or not open for examination, cleaning, or repair, are to be kept quite full with fresh water in an alkaline condition from which air has been expelled by boiling, and are to be so kept until within 24 hours of being required for steaming. In any other cases in which the boilers are not kept full, the Engineer Officer is to state the reasons for the course adopted, in the remarks on the record of daily treatment of boilers inserted at the end of each month in the Engine-room Register. Boilers of steam boats may be treated under Art. 163.

2. *Protection from Frost.*—Steps are to be taken to avoid risk of damage to the boilers from frost during the winter months by keeping airing stoves alight, or by other means, in addition to keeping, as far as practicable, all cowls and other openings to the stokeholds closed.

3. The Engineer Officer is to ascertain once a week, or oftener, whether the boilers which are filled with water are quite full, by means of the air-cock fitted on the top of each boiler.

## 163.

*Preservation of Boilers.*—In special cases, in which for a particular reason the boilers cannot be kept full of fresh water, one of the following methods may be used for internal preservation:—

- (a) *Empty and closed with Charcoal or Coke.*—Each boiler should be thoroughly dried by ordinary airing stoves, and all doors put on and finally the lower mudhole and manhole doors. Through these latter holes, perforated trays or small bogies containing burning charcoal or coke are to be placed in the boiler, which is then immediately to be hermetically closed. The intention of this method is that all the

oxygen should be consumed, so that, if the boiler be perfectly tight, no internal decay can ensue.

- (b) *Empty and closed with Dry Lime.*—The boiler should be dried as well as possible by ordinary airing stoves, and from 2 to 3 cwt. of quicklime (say,  $\frac{3}{4}$  cwt. per furnace), in shallow sheet-iron trays, be placed on the bottom of the boiler and top of the tubes. A shallow sheet-iron tray of burning coal, well coked, is to be then introduced into the boiler. The boiler should then be closed.

The object of burning coked coal is to consume at once as much as possible of the oxygen of the air inside the boiler, by which the efficiency of the lime is increased.

- (c) *Salt Water and Zinc.*—In the case of old tank boilers only, if the zinc slabs in the boilers are in good condition, clean, properly fitted, and in proper quantity, the boilers may be filled with clean salt water.

The zinc plates must be cleaned and refitted at six-monthly intervals.

- (d) *Open and kept Warm.*—Should steam be required in any of the boilers, it will be found more conducive to the preservation of the boilers not required to keep them open and warm. When this is necessary, they are to be thoroughly dried out, and airing stoves should be placed in the ashpits of each boiler every day.

These fires should be moved from ashpit to ashpit so as to prevent any serious difference of temperature at different parts of the boilers, but the temperature of the whole should at all times be above that of the surrounding atmosphere.

#### 164.

1. *Zinc Slabs suspended in Boilers. E.R. Register.*—Zinc slabs are to be suspended in convenient parts of all boilers, and the Engineer Officer on each inspection of the boilers is to examine these slabs and their attachments, and to note their condition in the Engine-room Register. In Belleville boilers, rolled zinc angle bars are to be placed in all economiser tubes.

2. Special care must be taken:—

- (a) To ensure perfect metallic contact between the zinc slabs and stays or part of the plating of the boiler to which the zinc is attached, by the surfaces in contact being filed bright and firmly bolted together.
- (b) To place the slabs in such positions that every portion of the surfaces may be protected.
- (c) To replace by new slabs any found upon examination to be much deteriorated. (See Art. 167.)

#### 165.

1. *Number of Zinc Slabs.*—It has been found by experience in tank boilers that the number of zinc slabs required to be suspended in boilers for their thorough preservation is such as to give 3 square inches of zinc surface for each square foot of tube surface; and when the number has not been fixed by the Admiralty, this should be the proportion adopted.

2. This proportion, however, is intended merely as a guide and not to interfere with any alteration of position or number which appears to be desirable, as directed in Art. 166, for the arrest of oxidation.

3. About one-sixth of the whole quantity in such boilers should be distributed in the steam space to protect the surfaces there, when the boilers are full of water.

4. The zinc slabs in boilers of exceptional construction will be specially arranged both as to number and position.

## 166.

1. *Cause of Oxidation.*—If corrosion manifests itself at any part, it will probably be found that the nearest zinc slab is too far away from this part, in which case the position of the zinc should be altered, or an additional slab introduced; or the protection may have ceased by the zinc being decayed or not in good contact with the iron or steel.

2. *Portland Cement.*—In addition to making the zinc slabs efficient, any places where signs of corrosion have appeared should be thoroughly cleaned and scraped to remove all rust and oxide, and coated with not more than one coat of Portland cement. A strong solution of soda should be used to clean the surfaces and mix the cement. Portland cement, however, is not to be used on any heating surface, or on the portion of the steam drum of a water-tube boiler below the water level.

## 167.

*When Slabs are to be Renewed.*—Slabs of rolled zinc are to be used, and they should be renewed as soon as the zinc is reduced by wear to about half the original thickness. Any of the slabs which become bent or distorted should, however, be removed at once as inefficient. Worn and defective slabs are to be returned into store as *zinc slabs, old*.

## 168.

*Zinc in the Steam Space.*—Zinc slabs are to be fitted in the steam space to protect the surfaces (the plating especially) above the working level when the boilers are full of water. To maintain as much as possible the efficiency of the zinc, it is desirable to fit new slabs there from time to time, the old slabs from the steam space being cleaned and used to replace those which become worn out below the working level.

## 169.

*Examination of Slabs.*—Immediately after the usual trials of new boilers or of boilers thoroughly repaired, the zinc in them is to be carefully examined, renewed and refitted as necessary; and care taken that, when the ship is commissioned, there is not only the number of slabs as stated above, but that the zinc is good and well fitted.

## 170.

1. *Corrosion to be reported by Letter.*—Whenever corrosive action has been discovered in a boiler, the circumstance is immediately to be reported by letter to the Commander-in-Chief or Senior Officer for the information of the Admiralty. The Captain is also to state the conditions under which the boiler has been worked, and the measures which have been taken to prevent further deterioration, and what, in his opinion and in that of the Engineer Officer, has been the cause of the decay.

2. *Report on Corrosion.*—The report should state whether the boiler has usually been filled with sea water, fresh water from the shore, or distilled water; what mode of treatment is adopted when not in use; the exact position and extent of the corrosion with rough sketches; an outline tracing showing the number

and position of the zinc slabs in the boiler ; the date when the boiler was last examined, and zinc slabs re-fitted, and whether they are now in good condition and in contact ; and any other particulars which may throw light on the matter.

3. *Tracings*.—In transmitting tracings to the Admiralty, showing the positions of the zinc slabs in the boilers, care is to be taken to number each slab in all views, and to send at least two views, so that the positions may be readily ascertained.

### 171.

*Bolts, &c. of Mountings of Boilers*.—Whenever a boiler undergoes examination, attention is to be paid to the bolts and fastenings of the boiler mountings, both inside and outside the boiler, to make sure that they are not becoming decayed.

### 172.

To maintain as far as possible continued efficiency in the boilers the Engineer Officer is to observe the following:—

- (a) *Daily Rise of Density of Water in Boilers*.—Every means is to be taken to prevent the admission of sea water into the boilers. A daily rise of density of the water in the boilers should be regarded as an indication of such admission, and the cause should be sought for at once. Some possible causes of the rise of density are:—Improperly packed condenser tubes ; perforated or split condenser tubes ; defective jointing of condenser tube plates ; priming of evaporators ; sea connections in communication with suction pipes of feed pumps.
- (b) *Fresh Water for "Make-up."* *Loss of Fresh Water*.—To enable high-pressure boilers to be worked over prolonged periods, it is essential that they should be filled with fresh water and that a supply of fresh water should be available for "make up," as the daily loss of steam under the best conditions of ordinary working is considerable. In addition to the losses occurring during the passage of the steam through the engines, &c., there is to be apprehended the further loss of water direct from the boiler through the sea connections. These latter, therefore, are to be always kept in a thoroughly efficient condition, so as to prevent any leakage through them, and the Engineer Officer should make every effort to reduce the waste.
- (c) *Sea Water for Make-up Feed*.—The arrangements for making and carrying distilled water for boilers are such that sufficient distilled water can always be obtained for make-up feed when the evaporating plant is kept in good order and properly worked, and the machinery is in an efficient condition as regards wastage of feed water. The use of sea water for boiler feed is therefore only admissible in cases of emergency, and should a case arise in which a sufficient supply of distilled water cannot be maintained, the speed of the vessel should under ordinary circumstances be reduced till the difficulty is overcome. If compelled to use sea water even for a short time, the first possible opportunity should be taken of thoroughly cleaning the boilers.
- (d) *Use of Shore Water in Boilers*.—Good shore water may be used generally for filling boilers and for make-up feed ; if it contains more than the usual quantity of matter in suspension or solution or has been found to produce corrosion, it is not to be used. When using shore water the boilers should be thoroughly cleaned out at short intervals to prevent the heating surfaces and tubes becoming unduly coated.

- (e) *Washing out Boilers.*—Shore water should be used for washing out water-tube boilers of the small tube type, but there is no objection to the use of clean sea water for washing out boilers of the large tube type, if fresh water from the shore cannot be readily obtained. When sea water is used for washing out purposes, it should not be run in from shallow depths nor at the latter part of ebb tide.
- (f) *Shore Water carried in Reserve Tanks.*—Water carried in the reserve feed-tanks should not, except in cases of emergency, be delivered direct to the boilers, but should be pumped into the main feed-tanks through the filters, in order that it may become heated by the higher temperature of the feed-water, thus tending to expel any air present.
- (g) *Use of Shore Water exclusively.*—On all occasions when it may be necessary to use shore water exclusively for feeding water-tube boilers in use for auxiliary purposes, the condensers not being in use, the automatic feed-chambers and sediment collectors, if fitted, should be frequently blown through, and these boilers should at the end of each week's working, or as required, be opened out and cleaned if necessary, so that no accumulation of deposit in tubes and other internal parts takes place.
- (h) *High Feed-water Temperature.*—As the production of fresh water by means of distillation of sea water is accompanied by the disengagement of carbonic acid gas, which has an injurious effect on the boiler tubes, it is important that a high feed-water temperature be maintained. The use of good shore water for making up the feed supply, when easily obtainable, will reduce that part of the corrosion which is due to this agency.

## 173.

1. *Test of Water in Boilers.*—The water in the boilers in use and in the feed tanks is to be tested for density every four hours, and for alkalinity as often as is considered necessary, but not less than once a day.
2. *Nitrate of Silver and Sensitive Hydrometer.*—The nitrate of silver solution and sensitive hydrometer are to be used frequently to detect the presence of sea water in the feed tanks and boilers.
3. *E.R. Register.*—The results of the foregoing tests are to be noted in the Engine-room Register.

## 174.

1. *Excessive Rise of Density. E.R. Register.*—When fresh water from the reserve tank or distilled water from the evaporators is used to make up losses, there should be no rise of density under ordinary circumstances, but should a rise of density take place, this should be specially noted and a statement made in the Engine-room Register of the probable cause and the steps taken to reduce it.
2. *Limits of Density.*—In water-tube boilers of the small tube type, having regard to the fact that a rise of density is liable to cause priming, a rise of density of  $\frac{1}{16}^{\circ}$  per day, or an eventual density of  $\frac{5}{16}^{\circ}$ , should be considered excessive (the density of sea water being  $10^{\circ}$ ).
3. *Presence of Sea Water.*—Any indication of the presence of sea water in the boilers or feed-tanks should be at once investigated and prompt steps taken to make good the defect.
4. *Density, if Sea Water used.*—As a rule, if sea water necessarily has access to the boilers, brining, blowing down, or emptying is unnecessary until the density of the water in the boilers reaches  $25^{\circ}$ ; but it should not be allowed to exceed  $40^{\circ}$ .

## 175.

1. *Preservation of Tank Boilers. Soda.*—In the case of tank boilers, should the water in the boilers be in an acid condition, a small quantity of soda should be used to neutralise the acidity. The soda should be put into the condenser or hot well, from which it will be pumped into the boilers with the feed-water. If the water of any individual boiler exhibits acid properties, a solution of soda should be put into the boiler in question.

In ships fitted with a combination of cylindrical and water-tube boilers, soda is not to be put into the boilers through the feed system while any of the water-tube boilers are under steam. The amount of lime passing into the cylindrical boilers is to be restricted to that sufficient to maintain the water in a slightly alkaline condition.

2. Soda is not to be used in boilers under steam when the water is alkaline nor when it is neutral unless it shows a tendency to become acid, but when boilers are filled for preservation, a slightly alkaline condition should be maintained.

3. *E.R. Register.*—The total weight of soda used, and the proportion which it bears to the weight of the water in the boilers into which it has been introduced, is to be calculated for every 24 hours, and noted in the Engine-room Register.

## 176.

1. *Water-tube Boilers. Lime.*—Whenever water-tube boilers are under steam, lime is to be dissolved in the feed-water and introduced into the boilers to assist in their preservation. The object in view, besides facilitating the deposit of grease in the mud drums, is to maintain the water in the boilers in a slightly alkaline condition. The water should on no account be allowed to become acid, and a merely neutral condition should be avoided.

2. *Amount of Lime.*—The amount of lime to be used is to be the least quantity required to maintain the water in the boilers in a slightly alkaline condition, whilst at the same time ensuring the deposition of any oil or grease in the water. The total quantity used per 24 hours is on no account to exceed 2 lbs. per 1,000 full H.P. of the boilers in use, except in the case of Belleville boilers, in which the maximum amount should not exceed 3 lbs. per 1,000 full H.P. of the boilers in use.

With the various fittings in correct working order, considerably less than the above amount should be sufficient, and in order to minimise the quantity necessary, any sea water leakage in the condensers is to be remedied at the first opportunity, the quantity of oil used on the piston rods and slide rods should be limited to that absolutely essential, and in the case of forced lubrication engines careful attention is to be paid to the arrangements for preventing the leakage of oil from the crank chamber to the cylinder and slide casings. Whenever it is found impracticable to obtain the required conditions without exceeding the quantities as specified above, the circumstances should be reported to the Admiralty.

3. *Lime to be Dissolved.*—The lime should be dissolved as far as possible, in buckets, strained, and the chalky liquid poured into the lime tanks, or into the feed-tanks where lime tanks are not fitted. A portion of the lime will be found to be insoluble in water, and this heavy residue should be thrown away. The amount of lime introduced should, as far as practicable, be regulated according to the amount of feed water delivered. Where a continuous addition of lime cannot be arranged, small amounts at frequent intervals should be introduced and the

addition of large quantities at a time avoided. It is very desirable that the lime be thoroughly mixed with the feed water before the latter passes through the feed filters.

4. *Lime supplied in Air-tight Drums.*—Lime will be supplied in air-tight drums, and it is absolutely necessary that it be kept in the drums and not exposed to the air in open top tanks, as it absorbs  $\text{CO}_2$  from the air and loses its preservative qualities.

5. *Gauge Orifices.*—Care should be taken that the orifices between the gauges and boilers are kept free from any accumulation of lime, and they should be ascertained to be clear whenever the boilers are opened for examination.

6. *Filling up Boilers.*—When filling boilers after steaming or examination, the feed-water should have an extra quantity of lime dissolved in it to ensure the water being distinctly alkaline.

7. *E.R. Register.*—The total weight of lime used, and the proportion which it bears to the full H.P. of the boilers into which it has been introduced, is to be calculated for every 24 hours, and noted in Engine-room Register.

### 177.

1. *Change of Water. E.R. Register.*—The water in the boilers should be retained without change as long as possible, whether the fires are, or are not alight; and it should only be removed when necessary, such as for examination, cleaning, or repairs; or changed when dirty, excessively salt, or acid. When boilers are wholly or partially emptied for these purposes, an entry is to be made in the Engine-room Register, in the column for remarks, stating for which of these purposes the water was removed and the density.

2. *Cleaning.*—Whenever boilers are emptied after having been in use, they are, when practicable, to be opened out, washed down, examined, and cleaned of any deposits found.

### 178.

*Boilers to be subjected to equal Wear.*—On ordinary service it is generally necessary to use only part of the boilers, and the work should be arranged so as to eventually subject all boilers to a practically equal amount of wear.

### 179.

*Boilers not to be emptied by Blowing out. E.R. Register.*—Tank boilers are not to be emptied by blowing out, except in cases of extreme urgency, as such a practice causes leaky tubes and joints, but the water is to be allowed to remain until it becomes cool before the boilers are emptied. Cold water is not to be pumped in for the purpose of reducing the pressure of steam or of cooling the water preparatory to running it out. The length of time allowed between letting fires die out and emptying the boilers is to be entered in the Engine-room Register.

### 180.

1. *Treatment if kept Empty.*—Whenever a boiler is emptied it should be at once thoroughly dried out. For this purpose airing stoves should be placed in the furnaces (or ashpits where more suitable), and kept constantly alight, and they should be moved about so as to maintain all parts of the boiler at a temperature above that of the surrounding atmosphere. Such doors at the

top and bottom of a boiler should be removed as will ensure an upward current of the warm air within and an exit for the vapour.

2. The boiler should be again completely filled with fresh water as soon as possible after examination or repair. (See Art. 162.)

3. Whenever a boiler is empty its fires are not to be kept laid.

### 181.

*Fresh Water taken on Board for Boilers. E.R. Register.*—When fresh water is taken on board for filling boilers, or for filling the reserve feed-tanks, it should be taken on charge by the Engineer Officer. The amount received is to be inserted on the date of receipt in the Engine-room Register. This is not to include any water supplied for drinking, washing, or ship purposes.

### 182.

*Amount of Water in Feed-tanks. E.R. Register.*—The amount of water the main and reserve feed-tanks contain should be ascertained and noted in the Engine-room Register every four hours. The air-pipes should be kept clear so that enclosed air may not prevent the tanks being properly filled. When filling, sufficient time should be given and observation made to ensure that all air is expelled and that the tanks are full.

### 183.

1. *Tubes, &c. to be kept free from Soot.*—Care is to be taken to keep the tubes, smoke boxes, &c., free from soot, and suitable small doors should be fitted in the bottoms of smoke boxes or in the casings of water-tube boilers to afford means of removal of such accumulations as take place there.

At low rates of combustion, under some circumstances, heavy deposits of soot and ash dust are liable to collect on the flame baffles and on the flatter parts of the uptakes, instead of being carried up the funnels. To keep the boilers ready for developing their full power, more frequent cleaning of the baffles and tubes will be necessary under such circumstances. When fires are being burned down for cleaning, a quicker draught by means of the fans, for a few minutes, will assist in dislodging such deposits and preventing choking of the uptakes. Due regard must be given to maintaining the steam-tightness of the tube connections.

2. *Cleaning Boiler Tubes.*—The boiler tubes, and all other parts exposed to the action of the fire, are to be swept and thoroughly cleaned as soon as possible after the fires have died out.

3. Smoke box doors and casings should be carefully examined periodically to ascertain that the joints are air-tight, and that there is no leakage of air into the combustion spaces.

### 184.

*Steam Tube-cleaning Apparatus.*—The steam tube-cleaning apparatus fitted in ships having small tube water-tube boilers is for use in cases of emergency and during war time, and is then only to be used when the fires are alight in the boilers.

### 185.

1. *Boiler External Parts.*—All accessible parts of the outsides of the boilers and the bottoms of the ash-pits are to be frequently inspected and always kept in



good order, and the lower parts are to be coated with red and white lead or other protecting substance, such as tar applied hot.

2. *Plates left Unlagged.*—If the lagging be taken off from any part of the boilers, the part exposed is to be painted and the lagging is to be replaced as soon as possible; or, if the plates have to be left unlagged for any reason, they must be frequently painted to prevent corrosion from water lodging on them.

### 186.

*Boiler Mountings.*—All the cocks and valves on the boilers are to be kept in good order so that no leakage may take place into the boilers not in use. When not in use they and their gear should be worked once a week.

### 187.

*Safety Valves. E.R. Register.*—Safety valves should be lifted off their seats once every ten days, and the lifting gear should be worked without lifting the valves once a day. This procedure is to be followed both when under steam and when not under steam, and a notation to that effect inserted in the Engine-room Register.

### 188.

1. *Blow-off Cocks, and Spanners.*—The Engineer Officer is to see that the guards and feathers of the blow-down cocks and spanners are always kept in good condition, so that there may be no danger of the cocks being left partially open when the spanners are removed.

2. Where double valves are fitted in the blow-down system, the valve next the boiler should be opened before, and closed after, the opening or closing of the valve more remote, in order to reduce the scoring action on the inner valve to a minimum.

### 189.

1. *Precautions before opening Boilers.*—Before taking off the doors from a boiler which may contain steam, steps should be taken to ensure a complete absence of pressure by opening the following, viz.:—The safety valves, air-cock on the top of the boiler, and the test or water-gauge cocks in the steam space.

2. *Foul Air in Boilers.*—Care should be taken that whenever boilers are opened, sufficient time is given to allow any foul air to escape, and that before anyone is allowed to enter the boilers, the purity of the air is ascertained as directed by Art. 351.

3. *Explosive Mixture in Boilers, Evaporators, &c.*—The possibility of an explosive mixture of hydrogen and air being present when boilers, condensers, evaporators, &c., are opened, should be borne in mind, and before using a light, means should be taken to diffuse the air contained in the boiler or other vessel opened.

### 190.

1. *Precautions against Accidents to Men.*—Whenever men are employed in one boiler whilst steam is up in another, Engineer Officers are to take such steps as will prevent accidents. The main and auxiliary stop-valves, safety-valves, feed-valves, brine and blow-off valves, and any other valve or cock by which steam or hot water could enter the boilers in which men are employed, are to be shut and

secured against being accidentally opened. The Engineer Officer of the watch is to be responsible for these precautions being carried out before he allows any men to enter the boilers, and he is also to be responsible during the time they are so employed. The same precautions are to be enforced whether the men in the boilers are part of the ship's company, or are workmen from the shore or from another ship. Similar precautions are to be taken whenever men are employed near a boiler or pipe where they are liable to injury from escaping steam by the inadvertent opening of a valve.

2. When stop-valves, &c., are secured in the shut position, for the protection of men working in boilers, re-making steam pipe joints, &c., great care is to be taken to guard against accident arising from the accumulation of hot water in the pipe system, owing to the secured valves leaking slightly, or being insufficiently screwed down on their seatings. To ensure proper drainage, pipe joints near the secured valves should be broken, if necessary.

### 191.

*Corrosion at Bottoms of Boilers.*—The boiler-room bilges are to be kept free from water, so that the bottoms of the boilers may not suffer corrosion from the wash of the bilge-water. Should any signs of corrosion be found in the bilges, a little slacked lime should be placed in them, as this has been found to stop corrosion and prevent injury to the hull of the ship.

### 192.

1. *Changes of Temperature.*—Great care should be taken to prevent sudden changes of temperature in boilers having water outside the tubes; steam should be raised as slowly as practicable and the smoke-box doors should not be opened suddenly, as a rush of cold air affects the ends of the tubes, which, being so much thinner than the tube plates, are liable to shrink and so cause leakage. In cases of emergency only, steam may be raised in from two to three hours, the longer time being allowed for high-pressure boilers.

2. *Water-Tube Boilers.*—In boilers of the water-tube type, however, steam may be raised more rapidly; but except in cases of emergency, steam should not be raised in any type of water-tube boiler, whether using coal or oil fuel, in less than two hours. In addition, sufficient time should be given for thoroughly warming up the engines before attempting to move them under steam (*see Arts. 94, 197*).

3. *Oil Fuel.*—In boilers fitted for burning both oil fuel and coal, oil fuel is not to be used for raising steam.

4. *Dampers.*—When uptake dampers are fitted they are to be used when sweeping tubes, or opening smoke-box doors for any purpose.

5. *Instructions.*—The instructions for the management of water-tube boilers are to be followed as regards details not contained in the Steam Manual. A.C.L. No. 14. C.N.<sup>2</sup> 8479—1906.

### 193.

1. *Valves to be opened gradually.*—Stop-valves should be opened gradually, both when admitting the steam to the engines and when admitting steam into any fresh systems of steam pipes (*see Art. 197*), and the safety-valves should never be opened suddenly to their full extent.

2. *Boiler Pressure.*—In vessels fitted with reducing valves in the main steam pipe, the pressure of steam in the boilers when the engines are stopped should not be allowed to exceed the working pressure of the engines, as there may be a slight leakage of steam past the reducing valves.

## 194.

1. *Orders to Stop Engines.*—When orders are received to stop the engines, the steam pressure should, if possible, be prevented from rising too high by shutting the ash-pit dampers, and if necessary, by gradually opening the silent blow-off. With water-tube boilers of the small tube type, ease the fans and open the stokeholds.

With Belleville boilers, open the tube-box doors, and ease furnace blast. With tank boilers, the safety valves and smoke-box doors should only be opened when absolutely necessary, and then not suddenly but gradually.

2. *Fire Extinguishers.*—The fire-extinguishers fitted to boilers of the water-tube type should only be used in cases of emergency, as their use injures the tubes by causing them to become pitted on the outside. These fittings should, however, be tried cautiously once a week.

## 195.

*Precautions when Boiler is Injured.*—When any water-tube boiler is suspected to be injured to such an extent that fires should be drawn, the fire doors are not to be opened to commence this operation until the safety-valves have been lifted, stop-valves closed, and the steam pressure reduced below 50 lbs. While the reduction is being effected the fire and ash-pit doors should be closed, and where so fitted the extinguishers should be used. *Vide also Arts. 272 and 329.*

## 196.

*Automatic Ash-pit Doors.*—When steaming, automatic ash-pit doors, if fitted, are always to be in use. They are not to be opened so wide as to interfere with automatic closing in case of injury to a boiler, except during such operations as cleaning fires, &c., after completion of which, the doors should be replaced in their automatic working position.

## 197.

1. *Stop-valves when Fires are Lighted.*—As soon as practicable after the fires are lighted, the stop-valves are to be opened so as to allow the hot air and the steam as it rises to circulate through the engines and warm them gradually.

Care is to be taken, in thus withdrawing steam from a newly-lighted-up boiler, that the water level is not unduly lowered before the pressure is sufficient to work the feed-pump.

2. *Drainage of Valve Boxes and Steam Pipes.*—Care is to be taken by properly draining the safety and stop valve boxes to prevent an accumulation of water in them, whether arising from condensation when raising steam, or by water coming down the waste steam pipe when not under steam. As accidents have occurred from the accumulation of condensed water in portions of the steam pipes, great care is to be taken to keep these pipes effectually drained, especially before opening the stop-valves of any boilers in which steam is up, or before opening valves to admit steam from one steam pipe to others.

The smallest sufficient opening of the stop valve is to be at first given, and is not to be increased until it has been again ascertained that the pipes are thoroughly heated and drained.

3. At the first sign of water-hammering in the pipes, the valve should be closed, and the necessary steps taken to ensure the pipes being properly drained before again opening out.

## 198.

1. *Whitewash*.—Whitewash is not to be used on the funnels, casings, bunkers, or on any of the exterior steelwork of the boilers.

2. Before painting steelwork care is to be taken that all the rust and dirt are thoroughly removed, so that the paint may be applied to the clean surface of the steel, and thus preserve it from corrosion.

## 199.

1. *Colour of Funnels*.—The funnels are to be painted neutral grey unless ordered otherwise.

2. *Funnel Guys*.—The funnel guys are to be examined, and adjusted if necessary, once a week when the vessel is in harbour, and daily when under way.

3. *E.R. Register*.—A notation is to be made every Saturday in harbour and daily at sea in the Engine-room Register of the condition of these fittings and that the above has been complied with.

## 200.

*Precautions against Fire*.—The following precautions are to be taken to guard against fire:—

(a) *Backs and Sides of Boilers*.—The spaces at the backs and sides of the boilers are at all times to be kept clear, and on no account is anything combustible to be placed on the top of the boilers or in contact with them.

(b) *Examination of Air Spaces*.—The air space between the uptake and casings of the boilers is to be frequently examined, in order that accumulations of soot or coal dust may be prevented.

## 201.

1. *Water-gauge Fittings*.—In view of the vital importance of the efficiency of the water-gauge fittings of boilers, every precaution is to be taken with regard to these fittings.

2. The Engineer Officer of a ship or the Engineer Officer in charge of the machinery of steamboats not attached to ships, is to take the necessary action to ensure that only glasses of the correct dimensions required for the various purposes are drawn from store, that all the proper glass is used for any particular purpose, and that they are properly packed, kept clean and well lighted.

3. In every case in which a boiler in use is placed under the care of a Petty Officer or man, the Engineer Officer in charge is to ascertain that the Petty Officer or man is fully instructed in the correct methods of testing and renewing gauge glasses and able to carry out these operations satisfactorily.

4. When a gauge glass is renewed, the fitting is to be examined at the time, or as soon after as possible, by an Officer of, or above, the rank of Artificer Engineer, or, where so circumstanced, by the Chief or Engine-room Artificer in charge of the machinery of the ship.

## 202.

1. *Responsibility for Working Level*.—The responsibility for the proper working level of water in the boilers should be definite, and persons in charge of

the feeding arrangements of boilers should be instructed to observe and work by both gauge glasses of a boiler, so that any considerable differences in their indications may be investigated and put right.

2. *Shortness of Water.*—Care should be taken that any person placed in charge of the feeding arrangements of boilers is fully instructed as to the action to be taken in the case of a boiler becoming short of water, and in addition, all ratings in stokeholds should be authorised to close the draught plates of a boiler should they see no water showing in the gauge glasses, at once reporting the occurrence to the person responsible for the feeding of the boilers.

### 203.

*Automatic or Self-closing Stop Valves.*—The self closing stop valves fitted to boilers and steam pipes are to be frequently cleaned and worked so as to ensure their efficient automatic closing should the necessity arise. In the event of accident, the extension of serious injury among officers and men may by these means be prevented. The Engineer Officer is to ascertain that, with the closing gear in the wide-open position, the spindles are in all cases of sufficient length to admit of the valves closing on their seatings without fouling the cross handles. Whenever any of these valves or their spindles are repaired it is to be carefully ascertained, after the valve is completed and in place, that the spindle remains of sufficient length to give a clearance of not less than  $\frac{1}{4}$  inch between the handle on the valve spindle and the wheel of the opening gear, and that the valve will freely close in all positions of the gear.

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## EXAMINATION OF BOILERS.

### 211.

1. *Examination of Boilers. E.R. Register.*—Once in each quarter at least all boilers, with the exception mentioned in Clause 2, are to be thoroughly examined internally and externally, excepting under fixed lagging, and a complete description of their internal and external condition and cleanliness inserted in the Engine-room Register.

2. *Special Service Vessels.*—In the case of Special Service Vessels with reduced nucleus crews, boilers which have not been in use are to be examined at intervals not exceeding twelve months, the examinations being so arranged that one-fourth of the boilers in each group or stokehold is examined each quarter.

3. The examination is to be considered of the greatest importance, and it is to be fully borne in mind that the Lords Commissioners of the Admiralty are dependent upon these reports for obtaining a correct knowledge of the state of the machinery.

The report should always include statements:—

- (a) Whether there are any signs of corrosion, and, if any, the depth, extent, and situation, distinguishing between that previously reported (whether extending or not) and that not previously reported. Corrosion of tubes is to be mentioned separately.
- (b) The condition of the water side of the tubes as regards deposit, stating thickness and nature of the same.
- (c) Particulars of deposits on all other parts, and date when last found to be clean.

- (d) In water-tube boilers, whether tubes are all clear, with date of completion of last searching of tubes in each boiler. The amount and kind of matter removed by searching should be given.
- (e) Whether the slits of internal steam pipes and all orifices for the admission or exit of water or steam are clear.
- (f) Whether there are any cracks, laminations, thinness, deformation, leaks, or other defects or signs of weakness; noting especially any discoloration by fire, bulging, swelling, or other distortion of water tubes.
- (g) Particulars of any deposit on the fire side of water tubes.
- (h) Condition and efficiency of zinc protectors and their attachments.
- (i) Date of last previous thorough examination.

4. If deposits, corrosion, or other defects are found, a statement of the steps taken, or to be taken, should be made. If defects are so slight that no action is necessary it should be stated.

5. The condition described should generally be that found when the boiler was opened, unless the boiler had been empty and open from the beginning of the quarter.

6. On closing the boiler its condition should again be recorded if such condition differs in any particular from that previously described as directed by the foregoing paragraph; it should also be stated what repairs, replacements, cleaning, &c., had been carried out.

7. *Report of Examination. Form 353 D.*—The report of the examination of each boiler is to be made on Form 353 D. which is to be inserted in the Engine-room Register on the day on which the examination was completed.

8. Should the nature of the service upon which the vessel is employed absolutely prevent the above examinations being made, or in any way curtail them as regards any boiler for the whole quarter, a notation to that effect is to be made on the page for the "Abstract of the working of the boilers" and initialled by the Captain.

9. Complete or partial examinations should be made at any other time as necessary to comply with the regulations or to obtain an assurance of the thorough efficiency of the boilers in respect of all matters mentioned in clause 3.

10. Before closing a boiler all rust, scale, or other deposits should be removed and the zinc protectors and connections renewed as necessary.

11. Where the doors or covers on boilers are of the flanged type secured by bolts or studs and nuts; the thickness of the asbestos jointing rings, or rings of similar material, is not to exceed one-eighth of an inch, and where such jointing rings require holes punched in them, special care should be taken in their fitting. In all cases the jointing surfaces are to be examined and ascertained to be true before the joint is made.

## 212.

1. *Examination of Cylindrical Boilers.*—Cylindrical boilers are to be examined and cleaned internally whenever the boilers have been in use for at most 21 days from the date of the last thorough cleaning. Should the nature of the service upon which the vessel is employed necessitate an extension of this period, the power developed except in case of emergency, is to be limited by air pressure not being used, until the examination and cleaning have been carried out.

2. Clause 1 does not apply to the boilers of Tugs and Yard Craft.

## 213.

1. *Water-tube Boilers. Small tube type.*—In vessels fitted with water-tube boilers of the small tube type, that is the tubes of which do not exceed one and a

half inches in internal diameter, the boiler tubes are to be examined internally whenever the boilers have been in use for, at most, 21 days from the date of the last examination and cleaning. For this purpose every tube should be searched by passing through it a wire brush or other suitable instrument.

2. In every case where a boiler is opened for examination, or other purpose, steps are to be taken to ensure that every tube is clear before closing the boiler.

3. The tubes should also be frequently examined on the fire side. Distortion of the tubes and any increase of diameter are signs of overheating, and when these are observed the boiler should be opened out and examined internally. Swelling of the tubes next the fire can be detected by passing a plate gauge over them, and this should be frequently done.

## 214.

1. *Water-tube Boilers. Large Tube Type.*—Water-tube boilers of the large tube type, in which fires have been lighted should be opened and examined at intervals not exceeding six weeks. The interval may be reckoned from the date of first lighting fires after the first thorough internal cleaning and examination of the boiler.

2. When a boiler is opened for examination the following doors should be removed :—

- (a) All top and bottom doors of elements.
- (b) One end door of steam collector.
- (c) Two or more doors on feed collectors.
- (d) Top and bottom doors of sediment and float chambers.
- (e) One or more additional doors from each of the elements.

It will be convenient to remove these doors in a diagonal direction so that tubes at all heights may be seen. An arrangement for the selection of these diagonals should be so planned that in the course of a year every tube will have been examined.

If necessary other or all doors may be removed to be assured of the condition of the tubes. Any drain plugs fitted to steam collectors should also be removed.

3. Any dirt or deposit observed in the tubes should be removed by washing or other means.

4. In addition to the examinations directed by Art. 211 the following should be examined at least quarterly :—

- (a) All internal fittings of steam collectors as far as possible.
- (b) Non-return valves at bottoms of down-take pipes.
- (c) Connecting pipes from elements to tops and bottoms of water-gauge fittings.
- (d) Internal levers of float gear.
- (e) Floats to be examined, and weighed if necessary, to see that they are not water-logged.
- (f) Supports which carry the back ends of elements, casings under brickwork and back and side casings.
- (g) Sediment chambers and blow-down fittings.

5. The lower tubes should be frequently gauged for any deviation from straightness, and if any deflection is detected the tubes should be thoroughly examined internally.

## 215.

1. *Thornycroft Boilers of "Daring" Type, &c.*—In examining Thornycroft boilers of the "Daring" type, or boilers in which, owing to the shape of the tubes, the pressure tends to force the tube out of the plate, particular attention should be

paid to the attachment of the ends of the tube. When the projection of the tube through the plate is worn away to such an extent that the wear extends into the rolled part of the tube, or when the tube is materially thinned in the rolled part, it should be renewed.

2. *Precautions when renewing Tubes.*—When renewing defective tubes secured by rolling, each tube hole should be inspected to see that it is parallel and to the proper gauge. When the tubes are put in place in the boiler, the ends should project through the tube holes not less than  $\frac{3}{16}$ ths of an inch, and, before they are expanded, the ends are to be well coned by a solid or roller drift. Each tube end should be inspected to see, not only that it has been well rolled on the inside of chamber, but that it is expanded close to the edges of the tube holes on the outside.

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## WATER PRESSURE TESTS.

### 217.

*Water Pressure Test of Boilers.*—The boilers of His Majesty's ships and vessels are to be tested by water pressure, at the intervals herein-after specified, and in the manner described.

### 218.

1. *New Boilers.*—In the case of new boilers, or boilers repaired for a period of four years, the boilers are to be tested by water pressure at the end of two years' service, and subsequently at half-yearly intervals. In the case of Special Service Vessels with reduced nucleus crews, the interval between the tests may be extended to twelve months, but before proceeding on sea service or passage trial, a water-pressure test should be carried out if an interval of more than six months has elapsed since the last test.

2. The greatest interval between consecutive water pressure tests of any boiler is to be two years.

3. *Repaired Boilers.*—Boilers which have been repaired for shorter periods of service are to be tested by water pressure at the end of six months' service, and subsequently at half-yearly intervals, except in the case of Special Service Vessels with reduced nucleus crews, when the interval between the tests may be extended to twelve months.

4. *Torpedo Boat Destroyers, &c.*—Boilers of torpedo boat destroyers, torpedo boats, and steamboats are to be tested by water pressure at the end of six months' service, and subsequently at half-yearly intervals.

5. All boilers are to be tested by water pressure on the completion of the drill test.

### 219.

1. *Careful Examination to be made. Boiler Deflection.*—During the application of water pressure the boilers are to be carefully examined, and boiler deflection meters are to be used for ascertaining the deflections in the furnaces, combustion chambers, or any part of the boiler as may be considered necessary. The meter should be fixed in position with the pointer at zero before the pressure is applied, and observations as to the amount of deflection taken as the pressure increases, care being also taken to notice whether the meter is extended or compressed. When the pressure has been taken off the boiler, the position of the pointer should be observed to ascertain whether there is any permanent set.



2. Whenever a steam pump is used for testing boilers or steam pipes by water pressure, all connections between the boiler or pipe under test, and any pipe containing steam, are to be cut off by means of blank flanges.

3. In water-tube boilers having curved tubes, observations should be made with a view of detecting any change of configuration of the tubes.

4. In water-tube boilers, except those with nearly horizontal tubes, the holding-down bolts are to be kept sufficiently free to admit of the horizontal movement of the feet of the boiler due to changes of temperature.

## 220.

1. *Regulating the Test Pressure.*—Where the load on the safety-valve is 90 lbs. per square inch or less, the test pressure is to be double the load; where the load on the safety-valve is above 90 lbs. and less than 180 lbs., the water pressure is to be 90 lbs. per square inch greater than the load; and where the load is 180 lbs. and above, the test pressure is to be 50 per cent. above the load.

2. *Weakness, how to be dealt with.*—Should, however, any indications of probable permanent deformation be observed during the application of the pressure, the test is to cease and the weak parts are to be strengthened as necessary. If this is not practicable, a *new test pressure* 20 lbs. below that at which permanent deformation commenced is to be adopted, and the *new working pressure* must be that which corresponds to the new test pressure, according to clause 1, except in the case of locomotive boilers, where the new working pressure is to be half the new test pressure in all cases. The load on the safety-valves is to be reduced to the new working pressure.

Whenever a new working pressure is adopted for any reason, the stops as required by Art. 376, clause 5, are to be fitted before working the boiler under steam.

## 221.

*Testing by Drilling, &c., not to be discontinued.*—The test by water pressure is intended to supplement, not to supersede, the occasional testing by drilling and other means to ascertain the wear and waste. Should the latter test reveal unusual thinness of any plates, the water pressure is to be very carefully applied, in order that injury may not be caused by over-pressure.

## 222.

1. *Report of Water Pressure Test.* Form S. 355.—The report of the result of the test is to be forwarded in duplicate on Form S. 355 to the Commander-in-Chief or Senior Officer of the Fleet or Station to which the vessel belongs. After examination by the Engineer Captain, or where no Engineer Captain is borne, by the Engineer Officer of the Flagship, one copy is to be forwarded to the Secretary of the Admiralty without delay, and the other retained by the Commander-in-Chief or Senior Officer; a copy is also to be placed in the Captain's Ship's Book.

2. In giving the estimated durability of the boilers, with such repairs as can be done on the station, a separate statement of the estimated durability of the boiler tubes is to be inserted, and any further information which may be considered necessary to enable a more complete estimate to be formed of the state of the boilers is to be given.

*Estimated Durability of Tubes and Boilers.*—The estimated durability of the tubes and boilers is to be calculated from that which was ascertained at the last drill test as reported on S. 356 or S. 356b, and a notification to this effect, and the date of the last drill test, is to be inserted on Form S. 355.

*E.R. Register.*—In every case where this durability is less than three years, special attention is to be called to the fact by a note in red ink on the form, or by a separate letter; and also in the Engine Room Registers, and in all other reports.

3. *E.R. Register.*—The date of the test, and whether satisfactory, are to be inserted in the Ship's Book, and in the Engine Room Register.

## DRILL TEST, OR TEST FOR WEAR AND WASTE.

### 226.

1. *Test for Wear and Waste.*—Boilers of all ships are to be examined and tested by drilling and other means, to ascertain the extent of wear and waste of the several parts, by an Engineer Officer other than the Officer in whose charge they are, at the intervals herein-after mentioned and in the manner described.

2. *Examining Officer.*—The Examining Officer should, if possible, be senior to the Officer in charge of the boilers, except when the former is an Engineer Officer of a Dockyard; but when no Officer senior to the Officer in charge is available within the time specified by Article 227, the Engineer Officer of the ship should test the boilers himself.

3. Responsibility for drill tests to rest with—

#### *For*

Dockyard - -	All vessels undergoing an extensive refit. (The test to be carried out entirely by the Dockyard without assistance from the ship's staff.
Engineer Captains of the respective Divisions of the Home Fleet.	All ships attached to the respective divisions of the Home Fleet, including Special Service Vessels. (The crew of any vessel of the Home Fleet undergoing such boiler test to provide the necessary labour for this purpose.)
Destroyer Depôt Ships of respective Flotilla Divisions.	All Destroyers attached to the Respective Flotilla Divisions of the Home Fleet and Destroyer Depôt Ships. (The crews of the Torpedo Boat Destroyers of the respective Flotilla Divisions, as directed by the Captains (D), to assist the special staff of the Destroyer Depôt Ship in the performance of all work in connexion with boiler tests, &c.
Engineer Rear-Admirals on the staffs of the Commanders in-Chief of the Home Ports.	All Torpedo Boat Destroyers, Torpedo Boats, Harbour Ships and Establishments, their tenders and steam-boats, and all other vessels attached to the respective Port Divisions, and in which no Engineer Captain of Engineer Commander, for staff duties, is borne. The skilled staffs borne in the Parent Ships and Flotillas, and the complements of the vessels concerned, will carry out the drill tests as far as possible. Where the work is beyond the capacity or the staffs and complements referred to, it is to be undertaken by the Mechanical Training Establishments assisted, where necessary, by supernumerary Engine-room Artificers. Should these arrangements be found inadequate in any case, a report of the circumstances is to be forwarded.

## 227.

1. *When Test is to be made.*—The boilers are to be drilled or tested for wear and waste at intervals of not less than 18 months, nor more than two years; and the first test is to be made as soon as convenient after the boilers have been in use 18 months.

2. *Boats' Boilers.*—Boats' boilers are subject to the same rules as main boilers as regards these tests.

3. The Engineer Officer of the ship is to report when the test is due, so that arrangements may be made for its taking place without delay.

## 228.

*Assistance to be given by Engineer Officer.*—The Captain is to direct the Engineer Officer of the ship to afford every facility and render every assistance in the examination, causing the boilers to be prepared and such plates to be drilled and other work carried out as the Examining Officer may consider necessary.

## 229.

1. *Number of Boilers to be tested.*—Unless the Examining Officer considers it necessary, not more than one boiler in four, in the case of tank boilers, and not more than one boiler in each watertight compartment in the case of water-tube boilers, need be drilled or otherwise tested for wear and waste, preference being given to those which are considered most worn; but all the boilers are to be examined. Separate detailed reports are to be forwarded for each boiler tested.

2. *Description of Deposit, Zinc, &c.*—A description of the appearance, thickness, and nature of the deposit at different parts of the boilers is to be given in the report; the condition of the zinc slabs, and the probable number which will require renewal are also to be reported.

3. *Defects. Corrosion.*—Should there be any internal or external defects, or symptoms of corrosion, the report is to state what they are, and the steps that are being taken to make good the defects or arrest corrosion.

4. *Funnels and Uptakes.*—As funnels and uptakes are liable to internal and external corrosion, and are particularly liable to deterioration, their condition, and that of their fastenings, is also to be reported at the same time.

5. *Wear and Waste excessive.*—Whenever the test and examination reveal a state of unfitness for use at the pressure given by the safety-valve load, and repair cannot at once be effected, the circumstances are to be inserted in the report, specifying the safety-valve load which is considered proper for a working pressure. Action is to be taken as prescribed in Articles 220 and 221.

6. When testing cylindrical boilers for wear and waste some of the tubes in each boiler tested should be drawn, to enable a correct estimate of their probable durability to be given.

## 230.

1. *Water-Tube Boilers: Small Tube and Yarrow Large Tube.*—Water-tube boilers of the small tube type and Yarrow large tube type are to be tested for wear and waste as follows:—

- (a) The large tubes and reservoirs which form the main structure of the boiler are to be drilled for thickness.
- (b) At least two generating tubes should be removed from each side of the furnace, one from the row next the fire, and one preferably from the

row farthest from the fire whenever this can be done without removing the intermediate tubes.

Should the Inspecting Officers consider that any additional tubes should be removed in order to form a correct estimate of the durability of the boiler, this should be done. The tubes so drawn are to be cut into suitable lengths, cleaned, and weighed, and their weight per foot run inserted in the form. Parts are also to be cut longitudinally to enable their internal condition and thickness to be determined.

(c) The boiler casings and furnace fittings are to be carefully examined.

2. When the period of the estimated durability of the tubes of these boilers is within six months of expiration, a further wear and waste test is to be carried out, and the result reported, to enable a decision to be given as to whether the tubes are fit for further service before any re-tubing is undertaken. In any case, where the tubes have failed to last for five years' service, an explanation respecting the short life of the tubes is to accompany the report.

### 231.

*Water Tube Boilers: Large Tube Type, except Yarrow Boiler.*—Water-tube boilers of the large tube type, excepting Yarrow boilers, are to be tested for wear and waste as follows:—

(a) The steam and feed collectors and mud drums are to be drilled for thickness.

(b) Two generator tubes are to be removed and two economiser tubes if so fitted. In all cases one of the generator tubes is to be taken from the top row. These tubes are to be cut into suitable lengths, cleaned and weighed, and their weight per foot run inserted in the form. Parts of the tubes are also to be cut longitudinally, to enable the internal condition and thickness to be determined. The position of the tubes selected for removal and examination is to be such as will ensure a reliable estimate being made of the whole of the tubes.

Should the Inspecting Officers consider that any additional tubes should be removed in order to form a correct estimate of the durability of the boiler this should be done.

(c) Junction boxes, downcomers, and sediment chambers, &c., are to be carefully examined internally.

(d) The boiler casings and furnace fittings are to be carefully examined.

### 232.

1. *Report of Examination and Test.*—The detailed results of the examination, together with a statement showing the previous treatment of the boilers, Forms S. 356, or S. 356B, and S. 356A are to be forwarded to the Commander-in-Chief or Senior Officer of the fleet-division or station to which the vessel belongs. After examination by the Engineer Captain or Engineer Commander borne for staff duties, or where no Engineer Officer for staff duties is borne, by the Engineer Officer of the Flag Ship; they are to be forwarded to the Admiralty for the information of their Lordships, a copy being retained by the Engineer Officer of the ship; a copy is also to be furnished to the Engineer Captain attached to the fleet-division or squadron.

2. *Estimated Durability to be given.*—In every case the estimated durability of the boilers is to be given together with a separate statement of the estimated durability of the boiler tubes.

It is most important that accurate estimates should be furnished of the durability of the tubes on every occasion of drill tests and water tests in order

that timely steps may be taken to provide in advance the tubes required for retubing.

3. *Water-Tube Boilers.*—In the case of water-tube boilers the estimated durability is to be given of the several portions, such as reservoirs, permanent tube connexions, steam generating tubes, casings, back casing and supports, furnace fittings, uptakes, and funnels.

4. *Concurrence of Ship's Officers in Report.*—The Captain and Engineer Officer of the ship are to state on the Report of Examination whether they do or do not concur in the opinions expressed therein. If they do not, they are to forward a separate report stating their reasons for not concurring.

### 233.

*Reports when tested at a Home Yard.*—When the boilers of any ship in commission are tested by the Officers of one of the Home Yards, Forms S. 356 or S. 356B, and S. 356A are to accompany their report. The officers of the ship are to furnish the information required in Form S. 356A; but their concurrence or otherwise is not required in the report on Form S. 356 or S. 356B. A copy of the Dockyard report is to be furnished to the officers of the ship, and also to the Engineer Captain attached to the fleet or squadron to which the ship belongs.

### 234.

1. *Engineer Officer to examine all the Boilers. E.R. Register.*—Whenever the boilers are tested the Engineer Officer of the ship is to make a separate examination of the boilers and the result is to be recorded in the Engine-room Register.

2. *Omission off Drill Test.*—If for any reason any portion of the prescribed test or examination is omitted, the reason is to be stated and the boilers are to be examined as thoroughly as possible, and reports forwarded on Forms S. 356 or S. 356B, and S. 356A.

3. *Ship's Manual.*—The date and particulars of the drill or wear and waste test are to be inserted in the ship's Steam Manual.

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## SCREW PROPELLERS.

### 241.

*Bronze or Gun-metal Propellers.*—Bronze or gun-metal screw propellers of all steel ships are not to be coated with composition, but are to be kept bright. As this may result in a tendency to galvanic action between the propeller and the hull, special attention is to be paid to the coating of the hull and to the cleaning of the zinc protectors in this vicinity, in order to prevent oxidation or pitting of the hull, an extra coat of protective composition being applied to the portions considered liable to corrosion. These vessels are to be carefully watched and any serious deterioration in the above respect is to be immediately reported to the Admiralty.

### 242.

1. *Zinc Protectors.*—Zinc protectors against galvanic action are to be fitted near the propellers of all steel ships where the propellers are of bronze or gun-metal. The protectors are to be of sheet zinc, and are to be left bright and unpainted. The steel under them is to be coated before they are put on. Means are to be taken to ensure metallic contact between the zinc and the steel; and the protectors are to be so fastened that they can be easily removed and renewed when required.

2. *Examination of Zinc Protectors. E.R. Register.*—The Engineer Officer is, on the examination of the propeller, to see if these protectors are in good order, and their condition is to be noted in the Engine-room Register. If the zinc has been injured in any way, the defects should be made good on the first opportunity.

### 243.

1. *Examination of Propeller Shafting in Dock.*—Whenever a screw ship is docked an examination is to be made of the outward portions of the propeller shafting and couplings. The outboard propeller shafts are to be carefully examined as soon as practicable after the ship is docked, and any corrosion not previously observed is to be reported at once so that the necessary action may be taken without delaying the undocking of the ship. The wear of the lignum-vitæ bearings, both in the stern tube and after bracket, is to be ascertained and the amount recorded. If the manholes on the shaft casings are not convenient in size or situation for making the examination readily, this fault is to be remedied when a convenient opportunity offers.

2. *Corroded Shafts.*—The corroded portion of the shaft is to be thoroughly cleaned by scraping, washed with a hot solution of soda, and when dry, coated with three coats of red lead paint, each coat being given time to dry before the next is applied. Finally one coat of each of the protective and anti-fouling compositions used on the ship's bottom is to be applied over the red lead.

3. *E.R. Register.*—The examinations are to be noted in the Engine-room Register.

### 244.

*Turbine Propellers.*—In the case of turbine engines special precautions are necessary to prevent any shock being transmitted to the turbine dummy or thrust block, when removing or replacing propellers, and before doing so, one coupling should be disconnected, and the after length of shafting shored from a convenient bulkhead.

### 245.

1. *Screw Shafts bound in Bearings.*—It having been found that screw shafts sometimes become bound in their bearings, the following instructions, in regard to this subject, are to be attended to.

2. *Weight to turn the Screw.*—When a screw ship is placed in dock for examination or repair for a sufficient length of time to allow a test to be made, the weight required to turn the screw will be ascertained by the Chief Engineer of the Dockyard as a test to show whether the shaft is free to revolve in the lignum-vitæ bearings of the stern tube, and whether the bearings are truly in line.

3. *Ships not to be kept in Dock.*—The ship is not, however, to be kept in dock for the express purpose of making this test, unless there are grounds for believing that the shaft is bound; and the test need not be applied oftener than once in two years.

4. *Result of First Test to be stamped on Screw.*—When the test has been applied for the first time to a screw, the weight required to move it should be stamped on it in the following manner: "750 lbs. at 8 ft. radius moved screw (January 1, 1893), Portsmouth."

5. *Disconnecting, &c., of Couplings.*—The disconnecting and connecting of the couplings are to be carried out by the Officers of the ship, except in the cases of new ships, or of ships in the Dockyard Reserve. In the case of new machinery this is to be done by the Contractors.

## 246.

1. *Engine-room Register*.—The first test of the propeller as well as all subsequent ones is to be entered at the end of the Engine-room Register, and in the ship's Steam Manual in the page provided.

2. *Comparisons of Tests*.—On all occasions of testing the propeller subsequent to the first one, the Engineer Officer, on making his notation in the Engine-room Register, will make a comparison with the previous tests, and with the original test as stamped upon the propeller. Should there be any great difference in the amount of weight required to move the shafting, he is to take steps to have the cause of the differences fully investigated, and note the facts of the case in the space appropriated for special remarks in the Engine-room Register.

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ADDITIONAL ARTICLES APPLICABLE TO TORPEDO BOAT  
DESTROYERS AND TORPEDO BOATS.

## 261.

*Instructions for Guidance*.—Engineer Officers in charge of the machinery of Torpedo Boat Destroyers and Torpedo Boats are to be guided by the general instructions contained in the Steam Manual as far as they are applicable to these vessels, except when otherwise directed in these special articles.

## 262.

*Thinness of Plating*.—The Officers in charge of these vessels should constantly bear in mind that they are built of very thin steel, and that the utmost care is required for their preservation.

## 263.

1. *Paint*.—No portion of the hull of the vessel should on any account be devoid of paint or other anti-corrosive composition ordered to be placed on it. The whole of the paint or composition should be kept in good condition.

2. *Periodical Examination*.—Whenever practicable these vessels are to be docked for cleaning and re-coating every six months.

3. *Vessels coated with Composition*.—The condition of these vessels, however, is to be very carefully watched. The whole of the surfaces, both inside and outside, are to be frequently examined, and should the paint or composition be found defective, the places should be carefully cleaned and re-coated.

4. *Zinc Protectors*.—To reduce the amount of corrosion to a minimum, should any of the inside of the vessel be bare of paint or composition, pieces of zinc are to be placed on the inside of the vessel, at about every five or six feet apart, as low down in the vessel as possible, so as to be immersed in bilge water should there be any. The zinc should be in metallic contact with the frames of the vessel, or other part of the structure if preferred.

## 264.

1. *Engineer Officer to examine Machinery*.—The Engineer Officer on taking charge of the machinery of one of these vessels is to satisfy himself that the boilers are in a good and efficient condition before attempting to raise steam in them.

2. *Boilers*.—A careful examination is to be made of all the fittings in connexion with the boilers, the boiler-room and bunkers; all doors, flaps, &c., especially such as are liable to become distorted by heat, and the boiler tubes should be examined for distortion, &c.

3. *Boiler Fittings*.—The internal steam pipes must be examined to see if they are clear, and, if necessary, the boilers thoroughly cleaned and washed out with fresh water. The safety-valves and springs should be examined and the steam pressure gauges tested, and every boiler-tube should be searched to see that it is quite clear.

### 265.

1. *Fresh Water to be used in Boilers*.—Fresh water is to be used for filling and feeding the boilers. When fires are lighted the height of water in the boilers should not be less than half glass in the water gauges, and the water should be subsequently maintained as high as is found to be consistent with absence of priming.

2. *Raising Steam*.—Except in cases of urgency, steam is to be raised slowly, so that the boilers and the engines may not be subjected to any undue strains, and to prevent any possibility of forcing the fires the boiler-room hatches are to be kept open. The safety-valves are to be lifted occasionally while the steam is rising, and after it is raised, to see that they are free in their seats and that the springs continue in proper working order. The safety-valves should also be lifted occasionally when the vessel is under way for the same reason.

3. Great care should be exercised in lifting the safety-valves to avoid injury to the valves and seats by dirt and scale being blown through them; and where the machinery is in charge of an Engineer Officer, the procedure as to lifting the safety-valves may be modified as allowed by Art. 187.

### 266.

1. *Engines to be drained*.—Soon after the fires are lighted the cylinders and steam pipes should be cleared of water, and the stop-valves slightly opened to allow of the engines being gradually warmed. The drain cocks should be opened frequently, and care taken to clear the cylinders of water before attempting to move the engines. The separators and jackets should be kept clear of water at all times. All steam stop-valves are to be opened gradually.

2. *Auxiliary Engines*.—As soon as there is sufficient steam, the fan, circulating, and air-pump engines are to be set running slowly.

3. Before proceeding, the emergency valves, if fitted, are to be tried and proved to be in an efficient condition.

### 267.

1. *Steering Engine and Steam Pressure*.—Before proceeding under way, the steering engine should be worked, the rudder chains examined, and, if slack, the adjusting screws regulated, or links cut out as necessary. The lowest pressure required to work the steering engine with the vessel at full speed is to be noted in the Appendix of the Ship's Steam Manual, and the steam pressure in the boilers should never be allowed to fall below this when under way.

2. *Steering Gear*.—The whole of the steering gear should, at short intervals, be thoroughly lubricated. Whenever any change is made in the position from which the vessel is steered—viz., from forward wheel to after wheel, or *vice versa*—great care must be taken that the rudder is placed amidships, and that the indicators agree before steering from the new position.



Constant attention is to be paid to the steering gear, in order to ensure that coincidence between the helm and the indicators is maintained. (*See also* Art. 124.)

### 268.

*Water in Boilers.*—When the vessel is under way care is to be taken to keep the water in the boilers at a constant level. The water-gauge glasses are to be frequently blown through. The main feed pumps are to be kept in use and their action constantly watched. Should it become necessary to examine the valves of the feed pumps care is to be taken to ascertain that the non-return valves on the boilers and the feed suction valves or cocks are properly shut.

### 269.

1. *Machinery not to be strained.*—To prevent any unnecessary straining of the machinery when the vessel is under way, the steam should not be maintained at a greater pressure than is necessary to ensure the required speed and the proper handling of the steering engine. The generation of steam is to be regulated by the speed of the fans and not on any account by opening the furnace doors.

2. *Air Pressure.*—When the pressure of steam to be used is decided upon, the air pressure in the boiler-rooms is to be kept as nearly constant as possible, but is not to exceed the air pressure obtained on contractors' trials.

### 270.

1. *Stoking.*—Great care is necessary in stoking the boilers of these vessels in order to ensure economy and to prevent flame being formed at the top of the funnels. Forcing the fires should always be avoided; fresh coal should be put on as regularly and uniformly and in as small quantities at a time as possible, and the furnace door is not to be kept open longer than is absolutely necessary. Pricking the fire should be resorted to as little as possible, and should be done from below the bars. Whenever it is necessary to level the fire by means of the rake, the air pressure should be reduced while it is being done.

2. The fire should not be so thick as to prevent a sufficient supply of air for combustion from passing through the bars, and it should be maintained as clear and incandescent as possible. An attempt to increase the rate of production of steam by putting on a large quantity of fuel at one firing and driving the fans faster will tend to produce flaming from the funnel.

3. The automatic ash-pit doors are on no account to be secured in the open position.

4. *Ash-pans.*—The ash-pans are to be kept clear of ashes, and are to be well supplied with water.

### 271.

1. *Fresh and Distilled Water.*—In consequence of the limited supply of reserve feed water, the following precautions should be taken to prevent its waste; careful stoking to prevent priming, constant attention to the feed-pump and other glands, and to the pressure of the steam to prevent blowing off at the safety-valves. (*See* Art. 194.)

2. The hot-wells and condensers should always be kept free of water.

3. The steam ejector is not to be used to clear the bilges of water except in cases of emergency or when the fresh water thus lost may be speedily replenished.

Special precautions are to be taken not to use the steam ejector on the bilge unless the sluice valve on the boat's side is open and no one near the orifice,

## 272.

1. *Leakage in Boilers.*—Should a serious leak occur in any boiler, the ash-pit and furnace doors should be kept closed, and the pressure of the steam at once reduced by driving the engines as fast as circumstances will permit, by blowing steam into the condenser, and by increasing the feed. The safety-valves should be lifted and the fires quenched as soon as possible. The fans should be kept at work, and the boiler-room hatch should be kept closed. If the steam pressure is not sufficiently reduced to admit of the furnace doors being opened and the fires drawn; the men are to leave the boiler room and the fire extinguishers are to be kept in use. (See Arts, 195, 273, 328, and 329.)

## 273.

*Boiler Tube Leak Drill.*—The Boiler Tube Leak Drill (see Art. 329), which has been formulated to meet the emergency of a sudden leakage in the boiler tubes, and to ensure the prompt and intelligent handling of the safety appliances on such occasions, is to be adopted for use.

A copy of the drill form is to be posted in each Engine-room and Stokehold, and should be embodied in the Station Bills.

It is to be practised weekly if convenient, and in the case of Instructional Boats it is to be practised at least twice with each class under instruction.

## 274.

*Mineral Oil only to be used.*—In consequence of the lightness of construction, and the high speeds at which these engines work, increased care is necessary in attending to the various working parts. As a rule the engines can be worked without any lubricant for the internal parts, but if found necessary at the higher speeds the amount used should be limited to the lowest possible quantity. (See Arts. 104, 105.)

## 275.

1. *Reserve Feed-tanks.—Use of Sea Water.*—The vessel should never proceed on any service without the reserve feed tank being filled, and it should be refilled at every opportunity. Whenever it becomes absolutely necessary to use sea water and priming ensues, the engines are to be eased as much as possible, and care is to be taken to test the density of the water, which is not to be allowed to exceed 40°. When sea water has been used, the boilers should be well washed out with fresh water as soon afterwards as possible, and each tube should be thoroughly searched. (See Art. 172.)

## 276.

*Ventilation of Bunker.*—Should the bunkers at any time, when the vessel is under steam, get very hot, advantage should be taken of any opportunity when stopping or going easy to ventilate them by taking off one or more of the bunker lids and keeping the boiler-room hatch closed, with the fan at work for a short time. Coal sacks, firewood, or other combustible materials are not to be stowed in the boiler compartments.

## 277.

1. *Water not to be changed in Boilers.*—It is undesirable to change the water in the boilers more than is absolutely necessary, but should a long run at a high rate of speed be anticipated, the boilers should be washed out and refilled before starting.

2. With new boilers, it may be necessary to change the water several times until they are quite clean. Oil, tallow, or disinfecting powder are not on any pretext to be put into these boilers. (See Art. 177.)

### 278.

*When Engines are finished with.*—When the engines are finished with, all connexions between engines and boilers and the sea are to be closed. The furnace doors and air-flaps are to be shut, and if it has been possible to burn down the fires to any extent before stopping the funnel covers should be put on so that the fires may die out very gradually. Should the steam rise while this is being carried out, the silent blow-off should be opened sufficiently to prevent any waste of steam at the safety-valves. (See Art. 108.)

### 279.

*Orifices to be kept clear.*—The orifices and gratings of all sea inlets are to be kept clear of weed and other obstruction; weed-boxes when fitted to the sea inlets are to be frequently examined and cleaned if necessary. The condenser doors should be removed occasionally to examine the tubes, and clear them if necessary.

### 280.

*Condenser Tubes.*—In vessels that are much under steam the eduction and air-pump suction pipes are to be removed once a year and the condensers examined and cleaned. Should the tubes be found coated with grease the condensers may be cleansed with a hot solution of soda, or, in preference if time permits, the tubes may be drawn. (See Art. 116.)

### 281.

*Internal Parts.*—Unless it is expected that the vessel will be under steam again in a few days, the pistons and slide valves of main and auxiliary engines which have been running should be examined and drawn if found necessary, and all the rubbing surfaces cleaned and lightly coated with heavy filtered mineral oil or grease; they should then be replaced and the engines made ready for steaming when required.

### 282.

*Steam Pipes to be Tested.*—The fact should be kept in view that the engines of torpedo boat destroyers and torpedo boats are lightly constructed, and that the joints, especially those of the steam pipes, are subject to injury from vibration. The main steam pipes, together with any other pipes which appear to suffer in this way, should therefore be tested at the same time and to the same pressure as the boilers. Where practicable the joints of steam and feed pipes should be surfaced and made with red lead paint, with red lead jointing mixture, or with copper wire gauze and red lead; if made with sheeting, the spaces for the bolt-holes are to be punched out with the punches supplied, and are not to be cut out with a knife. The bolts should be well fitted in the holes of both flanges.

### 283.

*Precautions in Cold Weather.*—In cold weather all necessary precautions to prevent injury are to be taken by keeping the engines and pipes thoroughly drained, or where this is impracticable, by warming the engine-room and boiler-rooms,

**284.**

*Corrosion of Cylinder Covers.*—The cylindrical covers of torpedo boat destroyers and torpedo boats should be examined periodically, and any corrosion or decay arrested by scraping, painting, or other means. When these vessels come in hand for thorough refit, the lagging of the cylinder covers is to be removed, and the covers examined and thoroughly painted.

**285.**

1. *Stern Shafts.*—In the case of torpedo boats fitted with reciprocating engines other than those mentioned in clause 2, and torpedo boats fitted with turbine machinery, the tail shafts and intermediate shafts running in wet tubes, if so fitted, are to be withdrawn at six months and again within twelve months after the last occasion of docking previous to the acceptance of the machinery from the Contractors and subsequently at intervals not exceeding twelve months. The intermediate shafting working through tubes, if so fitted, is to be withdrawn at periods not exceeding two years. When the stern tubes or intermediate tubes are of steel the interiors are to be thoroughly cleaned and scraped, and, when the surfaces are thoroughly dry, are either to be painted or filled with hot linseed oil, and allowed to stand for some time before the shafts are replaced. The water lubrication channels in the stern bushes are always to be examined and cleared prior to replacing the shafts.

2. Torpedo Boats Nos. 98, 99, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, and 117, and any succeeding boats similarly fitted with machinery of destroyer type and size, are to be treated as destroyers and governed by the Regulations in clause 3.

3. In the case of torpedo boat destroyers, the longest period which is to be allowed to elapse before withdrawing the stern shafts for examination is not to exceed three years.

**286.**

*Propellers.*—The steel blades and fastenings of propellers, and bolts holding stern bushes when so fitted, are to be frequently examined, and are to be kept constantly painted or coated with the same composition as applied to the vessel. The zinc protectors on the stern of the vessel are to be examined on every possible occasion, and renewed when necessary. (*See Art. 241.*)

**287.**

*Spare Gear.*—It is desirable not to keep more spare gear on board each vessel than is necessary, and the number of parts kept will depend upon the nature of the service on which the vessel is to be employed; a few articles which are in frequent demand, such as fire bars, india-rubber valves, gauge glasses, &c., should always be on board. The remainder of the articles are to be kept either on board the ship to which the vessel is attached or in store, as may be ordered.

**288.**

In all telegrams and correspondence respecting torpedo boats, *the class* of boat, as well as the distinguishing number, is always to be stated.

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TORPEDO BOAT DESTROYERS AND TORPEDO BOATS IN  
RESERVE: PRESERVATION OF MACHINERY  
AND BOILERS.

**301.**

1. *Examination and Treatment of Machinery and Boilers.*—Before any torpedo boat destroyer or torpedo boat is put out of commission and placed in Reserve, the machinery and boilers are to undergo a thorough examination, and any defects reported, and, if possible, made good at once. If this is not practicable the defects are to be made good as soon as possible after the vessel is put out of commission.

2. *Records of Examinations, Tests, &c.*—A record of the examinations, tests, repairs, and treatment of the machinery and boilers whilst in Reserve is to be kept in the Office of the Chief Engineer of the Dockyard for reference.

3. *Boilers.*—Boilers are to be dealt with as laid down in Arts 159 *et seq.*, 211 *et seq.*, 217 *et seq.*

**302.**

1. *Examination of Bilges, &c.*—The bilges are to be cleaned, the bunkers cleared of coal, and the interior of the vessel examined throughout, the lining of the bunkers being removed for that purpose if necessary.

2. *Condition of Vessel.*—The vessel is to be put in every respect in as good a condition, both as regards her machinery and her cleanliness, as when she was first brought into use.

**303.**

1. *Machinery, how to be kept.*—The engines are to be kept so far disconnected that the interior parts may be periodically inspected; but all joints of doors, covers, &c., are to be kept in such a condition as will permit of the engines being got ready for steam at a few hours' notice.

2. The working parts of the engines are to be kept properly connected and adjusted, so as to be ready for working at once if required.

3. All packing is to be kept ready and attached to the several glands, so that it may be speedily put into its place, and the engines of each vessel are to be turned several revolutions at least once a week.

**304.**

1. *Special Care of Torpedo Boats and Destroyers.*—Torpedo boat destroyers and torpedo boats will require most careful treatment while in Reserve, and their machinery when in use will require to be managed with more than usual care and skill. Torpedo boats are, when not in use, to be housed if practicable.

2. *Coating of Bottoms.*—The bottoms of those vessels in Reserve which are not in use are not to be coated with red lead, nor with experimental compositions, but are to be coated with one coat each of protective and antifouling compositions when considered necessary.

**305.**

1. *Re-coating. Condition and Examination. Report of Examination.*—When coated with approved compositions, they need not be docked or hauled up for re-coating oftener than once in six months. The condition of these vessels, however, is to be very carefully watched, and the whole of the surfaces, both

inside and outside examined as frequently as practicable, and should the composition be found defective the places are to be carefully cleaned and re-coated. A report showing that the examination has been made should be sent to the Superintendent as soon as it has been carried out.

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## INSTRUCTIONS RELATING TO TORPEDO BOATS AT FOREIGN DEPÔTS.

### 309.

#### MAINTENANCE.

1. At those ports where there is a Reserve, the hull and machinery of the torpedo boats not in commission are to be in charge of the Reserve Officers ; at other ports the Dockyard Officers are to take charge of them.

2. The following Engine-room staff will be appointed for the care and preservation of the hulls and machinery of each first-class torpedo boat.

- 1 Chief or Senior E.R.A.,
- 1 Stoker Petty Officer,
- 1 Stoker, 1st class.

These men should have had experience in the working of torpedo boat machinery, and on all occasions of the boat being used for exercise by the staff of ships visiting the port, they will attend to give assistance, if required, in the working of the machinery.

3. The care and preservation of the gun mountings, torpedo carriages, and tubes of all torpedo boats at foreign depôts are to be undertaken by the Engineer Officer of the Reserve or Dockyard responsible for the machinery of the boats, in accordance with clause 1.

4. The care and preservation of other electrical and torpedo fittings are to be undertaken by the Torpedo Gunner appointed to the Reserve for this purpose.

If there is no Torpedo Gunner, the above fittings will be in charge of the Engineer Officer.

5. At foreign depôts, where there is an Engineer Officer specially appointed to the Torpedo Store, the torpedoes and their stores are to be in his charge ; at other yards the Chief Engineer of the yard is to be in charge of them, and responsible for their being kept in a thoroughly efficient condition and suitable provision for their stowage, maintenance, and repair, in the Dockyard, is to be made under his superintendence.

6. At depôts where there is a Torpedo Lieutenant stationed, he is to frequently inspect the whole of the torpedo gunnery and deck fittings of all the torpedo boats at that depôt, and report the result of such inspection to the Naval Officer in charge ; at other depôts, the Torpedo Lieutenant of the flagship is to make these inspections ; in the case of the portions of the torpedo and gunnery fittings for which the Engineer Officer is responsible under clauses 3 and 4, these inspections and reports are to be jointly made by the Torpedo Lieutenant and the Engineer Officer.

#### MACHINERY INSTRUCTION.

7. Opportunities are to be taken, when the ships of the various squadrons are at foreign depôts, to give their Engine-room staffs practice in the first-class torpedo boats stationed at those ports.

If possible, the practice for each set of men under instruction is to consist of 10 runs, two of which should be made so as to reach as nearly as possible the full power obtained on the contractor's official trial, and the others at powers varying from one-half to three-quarters full power.

The Engine-room staffs of the ships detailed for practice are to be instructed in the working of the machinery and boiler by the Engineer Officer of the Reserve or Dockyard responsible for the machinery of the boats, in accordance with clause 1, or by a competent subordinate detailed by him.

8. A Lieutenant is always to be in command of a torpedo boat when exercising with a crew detailed from any ship for this purpose.

#### WHITEHEAD TORPEDO INSTRUCTION.

9. Whitehead torpedo instruction, as regards parting, preservation, and adjustment of torpedoes, is to be imparted to a sufficient number of Engineer Officers and Engine-room Artificers as may be detailed by the Commander-in-Chief, by the Chief Engineer of the Dockyard, or the Engineer Officer of the Torpedo Store where there is one specially appointed.

The instruction as regards the running and management of torpedoes is to be imparted to the Officers and men of the squadron by the Torpedo Lieutenant of the depôt, or flagship if present, or by the Torpedo Gunner specially appointed for Reserve duties, or in charge of torpedo boats.

10. Ships visiting a foreign depôt may exercise their torpedoes from the torpedo boats stationed there, on application and if convenient, but it is desirable on these occasions that the boats should be manned by their proper Engine-room staff, as far as the working of the machinery is concerned.

A thorough knowledge of the working of the boat should be attained before carrying out practice with torpedoes.

11. After being used for torpedo practice by the crew of any ship, the boats are to be left clean and in proper order by that crew, but the regular staff appointed to the boats are to keep them always in a clean and efficient state.

#### PERIODICAL RUNNING AND TORPEDO PRACTICE.

12. No torpedo boat stationed at a foreign depôt is to go for more than six months without being run by the Reserve or Dockyard Officers, to ensure that everything is in efficient working order as regards hull and machinery, and on each occasion the boat is to be run for one hour at least, without stopping, at maximum power, as defined in clause 7.

13. Torpedo practice is to be carried out at least once in six months from each torpedo boat at a foreign depôt, 12 runs within the prescribed limits as to accuracy being made from the boats at full cruising speed, and every torpedo carriage tube, and dropping gear, is to be used on such practice.

14. The Senior Naval Officer present is to make the necessary arrangements for carrying out the above periodical running and torpedo practice.

#### REPORTS OF RUNNING AND TORPEDO PRACTICE.

15. On the 1st of January and 1st July in each year a report is to be sent to the Admiralty giving:—

- (1) Dates on which each boat was run, with duration of run and highest speed attained.
- (2) By whom run on each occasion, *i.e.*, by Reserve, Dockyard, or ship in commission.

- (3) Numbers of Engine-room ratings trained during the preceding six months, specifying the ships to which they belong.
- (4) Details of torpedo practice carried out, on Form 195 (Half-yearly Report of Torpedo Exercise).
- (5) Reports of any accidents or failures of machinery or torpedoes.

These reports are to be made out by the Engineer Officer of the Reserve or Dockyard responsible for the machinery of the boats, in accordance with clause 1, and the Torpedo Lieutenant jointly, where a Torpedo Officer is stationed, and in other cases by the Engineer Officer, the parts relating to the running of the boat, and to torpedo practice, being signed by the Lieutenant in charge of the boat, and the Officer superintending the torpedo practice.

They are to be forwarded by the Commander-in-Chief, but where there is a permanent Senior Naval Officer they should be compiled under his direction, and he should be responsible, under the Commander-in-Chief, for the proper carrying out of the above orders.

## TORPEDO BOATS AND STEAM BOATS.

### 311.

The general instructions contained in the Steam Manual are to be followed as far as they are applicable.

### 312.

1. *Boats fitted with Machinery.*—The Engineer Officer is responsible for the efficiency of the engines and boilers fitted in any torpedo boat or other boat attached to the ship in which he is serving.

2. When a steamboat is transferred from one Ship to another, or to a Dockyard, copies, with the latest details, of Forms S. 353D (Examination of boilers), S. 355 (Water pressure test of boilers), S. 356B (Drill test of Boilers), together with Form S. 353B or S. 467A (Tube history sheet of water-tube boilers), and a list of boiler and engine defects, are to be forwarded to the Ship or Dockyard to which the boat is being transferred.

### 13.

1. *Examination of Boilers.*—The boilers of steam boats are to be examined in accordance with Arts. 211, 213 and 215, with the exception of those in constant use which are to be examined and cleaned at least once a month.

2. The bottom of the boiler outside is to be examined occasionally, and when necessary, thoroughly cleaned and painted to prevent deterioration, the surface contiguous to the bilge being protected by a coating of tar.

### 314.

*Thornycroft Boilers.*—The following precautions are to be observed in the working of water-tube boilers of the Thornycroft type fitted in steam boats in which the upper ends of the generating tubes are above the working level:—

- (a) When raising steam or waiting orders, the water in the steam drum should cover the mouths of two or three of the lowest rows of generating tubes; and no attempt should be made to get steam quickly by burning wood, oily waste, or any other substance, which would expose the dry part of the tubes to the action of flame.



- (b) When steaming, the water level should be kept as high as possible without causing the boiler to prime.
- (c) In order to guard against water passing over to the engines, the boiler stop-valve should only be opened sufficiently wide to pass the required quantity of steam, and care should be taken to start the engines slowly, and gradually work up to the speed required.

### 315.

1. *Safety Valves*.—The Engineer Officer is responsible that the safety valves and gear of all steam boats are frequently inspected to ascertain that they are in proper working condition, and whenever steam is raised for the first time after an interval of more than ten days the safety valves are to be carefully examined.

2. The condition of the safety valves and water gauges, feed valves, &c., should be ascertained from time to time while the boat is working, and great care taken to keep all fittings in a thoroughly efficient state.

### 316.

*E.R. Register*.—The number of hours any steam or motor boat has been in use is to be noted in the Engine-room Register.

### 317.

*Defects of Steam Tenders*.—All defects of steam tenders and steam and motor boats are, as far as possible, to be made good by the artificers of the ships to which the tenders or boats are attached.

### 318.

1. *Trials of Boats*. D. 408 and 408a.—The trials of torpedo boats after undergoing repair, or torpedo boats and other steam or motor boats when new and not previously tried, are to be carried out at the measured mile, and, as far as circumstances will permit, under the same conditions as ships when undergoing their full-power trials on the mile, the same forms being used for the report on which the class and length of the boat is to be stated.

2. *Examinations after Trial*.—Examinations of the machinery after trial are to be made as in the case of ships.

### 319.

1. *Printed Instructions*.—The printed instructions contained in Form S. 358 are to be strictly observed, and every person in charge of torpedo boats or other steam boats on detached service is to be provided with a copy of these instructions.

2. The Engineer Officer will consider it his duty to satisfy himself that any Engine-room Artificer, Mechanician or Stoker Petty Officer who may proceed in any boat on detached service is thoroughly acquainted with the proper method of working the engines and boiler, and that he is quite conversant with the printed instructions.

### 320.

1. *Torpedo Boats returned from Ships, Treatment of*.—If a torpedo boat has been attached to a ship, the Engineer Officer of the ship is to make good the defects as far as possible before the boat is returned. The engines are to be thoroughly disconnected, the whole of the working parts are to be cleaned, oiled,

re-connected, and re-adjusted. The internal parts, including condensers, hot-wells, air and circulating pumps, pipes, &c., are to be drained out and cleaned, and all doors and covers are to be so left that periodical examinations may be made of the interiors.

2. *Propeller Shaft*.—The after part of the propeller shaft is to be withdrawn, so that it may be cleaned and oiled, and the stern tube is to be dried out and painted, or otherwise put into a state of preservation as soon as possible before the shaft is replaced.

3. *Boiler*.—The boiler, if of the locomotive type, is to be thoroughly boiled out with fresh water and soda in the proportion of 7 lbs. per ton, and, after boiling for at least 4 hours, blown out with steam at a pressure not exceeding 10 lbs.

After being boiled out, the boiler should be brushed and washed down with a hose or hand pipe, and any sediment about the furnace water space extracted through the sight and plug holes. It should then be thoroughly examined, and the fire-box and tube-plate properly gauged to ascertain if they have received any injury during the time the boat has been under steam.

4. If the boiler is of the water-tube type, all the tubes are to be searched by the wire brushes or other means provided, and the steam and water collectors scrubbed with wire brushes. The boiler should then be brushed out and washed down, and all sediment cleaned out of the water pockets. It should then be thoroughly examined, and the tubes inspected on the fire side to see if any distortion has taken place.

5. The boiler is then to be gently warmed to a temperature well above that of the atmosphere so as to dry it thoroughly, and it is then to be preserved by one of the processes enumerated in Arts. 162, 163 for the preservation of boilers.

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## STEAM BOATS ON DETACHED SERVICE.

INSTRUCTIONS WITH WHICH ALL MEN IN THE ENGINE-ROOM DEPARTMENT OF THESE BOATS ARE TO BE MADE THOROUGHLY ACQUAINTED.

WORKING OF MACHINERY OF BOATS WITH OPEN STOKEHOLDS, AND  
FITTED WITH FRESH-WATER TANKS.

### 327.

1. Fresh water is to be used for filling and feeding the boiler. When the fire is lighted, the height of the water in the boiler should not be less than half glass in the water gauge, and the water should be subsequently maintained as high as is found to be consistent with absence of priming. As little oil as possible to be used, especially for internal lubrication, and then heavy filtered mineral oil only.

2. Steam is to be raised very slowly, except in cases of urgency.

3. When the fire is lighted, drain the steam pipes and cylinders, and then open the stop-valves a little to gradually warm the cylinders and cylinder jackets.

4. Lift the safety valves occasionally whilst getting up steam, and whilst under way.

5. Clear the cylinders of water before starting, and keep the jackets clear of water at all times.
6. Keep the water level in the boiler constant, and blow through the water-gauge cocks occasionally.
7. Use the main feed pumps. If the pumps are not drawing the hands of the feed pump pressure gauges will be stationary and the hot-well will overflow; get the pumps to work by opening the pet cocks.
8. If no cocks are fitted in the feed delivery pipes, the feed pump air vessels are not to be taken off while steam is up, before it is ascertained by disconnecting the pressure gauge on the feed pipe, and opening its cock, that the non-return valve on the boiler is shut; see also that feed suction valves are shut.
9. If the boiler primes, ease the engines as much as possible.
10. Fill up the fresh-water tanks at every available opportunity.
11. The density of the water should be frequently tried, and any rise should be at once reported. Sea water is not to be used in the boiler except on emergency. When it is used the density is not to exceed 40, and the boiler is to be opened and cleaned as soon after as possible.
12. The boiler is not to be emptied by blowing out.
13. The boiler is not to be emptied except for examination, cleaning, and repairs, and the water is to be changed as seldom as possible while it remains clean.
14. The fire is not to be kept laid if the boiler is empty.
15. When the engines are no longer required, the cocks and valves are to be closed, and, if there is no objection, the fire is to be allowed to die out.
16. *E.R. Register*.—The number of hours per day that the boat is in use is to be noted in the Engine-room Register of the ship to which the boat belongs.

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### TORPEDO BOATS, AND OTHER BOATS WITH STOKEHOLDS UNDER PRESSURE.

#### 328.

The following instructions are to be observed in addition to those in Art. 327, with the exception of clause 15.

1. Before lighting the fire see that the smoke-box doors, the doors in the bulkheads forward and aft of the smoke-box, and the bunker covers are securely shut, and deck plates or covers over boilers properly jointed; and the air flaps to ash-pit, and on deck, are in perfect working order.
2. As soon as there is sufficient steam, set the air pump when independent, circulating pump, and fan engines to work slowly, and keep the stokehold hatch open to ventilate the boiler-room and to prevent forcing the fire.
3. Keep the condenser and hot-well clear of water by the means provided; pump the water into the boiler feed tank or overboard, as required.
4. The fire-bars must at all times be kept well covered with coal.
5. Prick the fire from under the bars, and great care is to be taken to avoid large holes forming in the fire.

6. Put on fresh coal as regularly as possible, and do not keep the furnace door open longer than is absolutely necessary.

7. The air pressure must be kept as constant as possible, and is not to exceed 3 inches of water. Frequent alterations of the air pressure should be avoided. When cleaning the fire, ease or stop the fan engine.

8. If the steam pressure gets too high, blow off steam into the condenser, opening the silent blow-off as gradually as possible.

9. The generation of the steam is to be regulated by the speed of the fan, and not on any account by opening the furnace door.

10. The cylinders require little or no lubrication, and in any case oil should be used as sparingly as possible, in order to prevent injury to heating surfaces of the boiler on account of oily deposits.

11. Heavy filtered mineral oil is to be used for lubricating the cylinders and piston and slide rods.

12. Keep the ash-pans well supplied with water when so fitted, and clear of ashes.

13. The air flaps to ash-pit fronts are on no account to be kept open, except when pricking the fire or raking out ashes.

14. If a serious leakage occurs in the boiler, the directions given at Art. 329 are to be generally observed so far as the circumstances require. *See also* Arts. 195 and 272.

15. When the engines are no longer required, the steam is to be blown into the condenser, opening the silent blow off as little as possible, the cocks and valves closed, the iron funnel cover put on, *and the fire allowed to die out*, and care taken that the steam pressure does not rise very high with the fire remaining in the furnace.

16. Special precautions are to be taken not to use the steam ejector on the bilge unless the sluice valve on the boat's side is open, and no one near the orifice.

### 329.

#### BOILER TUBE LEAK DRILL.

The following drill for use in Torpedo Boat Destroyers and Torpedo Boats has been formulated to meet the emergency of a sudden leaking of a tube in the boilers, and to ensure the prompt and intelligent handling of the safety appliances on such occasions :—

#### STOKEHOLD.

When the order is given, "Leak in the Furnace of No.            Boiler," the Stoker Petty Officer or Leading Stoker of the stokehold is to—

- (1) See that the fire and ash-pit doors, whether automatic or otherwise, are closed and secured.
- (2) Increase the speed of the fan engine.
- (3) Open the safety valves on the injured boiler.
- (4) Cautiously open the fire extinguisher on the injured boiler, or, if fitted for oil-burning, quickly shut off the supply of oil to the burners.

To ensure the greater safety of the men in the stokehold, he will be responsible that the stokehold hatch is not opened from below, and that the furnace doors of the injured boiler are not opened till the pressure in that boiler is below 50 lbs. He is to take special care that the water level in the other boilers in use in that

stokehold is kept at the correct height, the tendency being for all the feed water to go into the injured boiler.

The Stoker in the stokehold is to—

- (5) Increase the speed of the feed pump.
- (6) Start the auxiliary feed pump.
- (7) Open the auxiliary feed valve on the injured boiler, and if other boilers in the same compartment are alight, close the main feed valve on the injured boiler.
- (8) Shut the stop-valves on the injured boiler.

In the absence or any inability of the Stoker Petty Officer or Leading Stoker to perform his duties, the Stoker firing defective boiler is to take his place, and the remaining Stoker is to carry out the duties detailed for the Stoker in the stokehold. In the case of one Stoker only being available, he is to carry out the whole of the above duties as expeditiously as possible.

Where ash-pit doors have to be entirely removed for drawing ashes, great care should be taken to replace them as soon as possible (Art. 196).

#### ENGINE-ROOM.

The Engine-room Artificer, in the engine-room, on hearing the safety-valves lifted, and seeing at the same time a rise of air pressure or a sudden fall of steam pressure, is to—

- (a) Station a man to prevent the stokehold hatches from being opened from deck, and to shut off, if necessary, the oil supply to the burners when fitted for oil fuel.
- (b) Increase the supply of feed by using reserve tanks.
- (c) Increase the speed of the feed pump if fitted in the engine-room.
- (d) Cautiously open the silent blow-off to the condenser.
- (e) Work the engines as fast as circumstances will permit.
- (f) Inform the Stoker Petty Officers of any other stokeholds in which boilers are in use, that an accident has occurred, so that particular attention may be paid to the water in these boilers.

When an order is given "Leak stopped," the ratings in the stokehold are to revert to the conditions existing before the drill, by reducing the speed of the fan engine, shutting the safety valves, fire extinguisher, &c., &c., and the Engine-room Artificer is to pursue a similar course in the Engine-room.

*Note.*—The steps laid down in this drill are only to be put into actual practice when the leak is serious, *i.e.*, likely to endanger persons in the stokehold when the fire doors are opened. In the case of a lesser leakage the fact should be immediately reported to the Engine-room for the Engineer Officer to decide whether the boiler is to be shut off.

If the drill be practised when engines are not under way, the Engine-room Artificer will modify his instruction as requisite.

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#### HULLS OF SHIPS IN GENERAL.

##### 331.

1. *Quarterly Examination.* Form S. 180.—In steel ships every accessible part of the outer skin or shell, of the ribs or frames, and of the inner skin, is to be carefully inspected once in each quarter by the Engineer Officer and the Carpenter, who are to make a joint report as to the condition of the several compartments,

and of the cement and paint work ; but in case of disagreement, they are to make separate reports, or to specify on their joint report any special points of difference. In composite ships this inspection is to be made once in each half-year.

2. The report is to state the steps taken to remedy any defects that may have been discovered.

### 332.

*Half-Yearly or Annual Survey.* Form S. 180.—In addition to the quarterly inspection of the accessible parts as directed in Art. 331, the Engineer Officer and the Carpenter are to make a more extended survey annually, or in cases where the bottom plating generally does not exceed  $\frac{1}{4}$  inch in thickness half-yearly. They are to examine as far as possible and report on Form S. 180—

- (a) On the inside coating of the outer bottom plates or places ordinarily inaccessible, such as holds, store-rooms, and coal-bunkers, and which are to be made accessible for inspection from the keel to the load water-line ;
- (b) If the ship has a double bottom, or if the spaces under the engines and boilers are accessible, the state of the whole of the cement and paint below the load water-line throughout the ship and both surfaces of the inner bottom ;
- (c) On the state of the cement upon every part of the inside plating and riveting of the outer bottom of the ship up to the turn of the bilge, and of the paint or varnish of the plating and riveting above that height and elsewhere throughout the ship ;
- (d) When any pipes in connection with the engines and boilers, and liable to contact with bilge water, are of lead, brass, or copper, that they are well painted or varnished and perfectly covered with canvas painted over, and made waterproof.

### 333.

*Blank Return.* Form S. 180.—If it be found impracticable for any reason to carry out the examinations ordered in Articles 331 and 332, a blank return is to be forwarded with a notation that it has been found impossible to carry out the survey. It is also to be stated, if possible, the date when the survey will be carried out.

### 334.

1. *Treatment of Hulls of Steel Ships.*—Generally the inside of the plating and riveting of the outer bottom of a *steel* ship up to the turn of the bilge is covered with cement or other approved material to an extent sufficient to ensure good drainage and to protect the riveting ; and all parts of the plating and riveting above this height, and all the remaining framing and plating throughout the ship, should be thoroughly painted or varnished.

In ships in which the double bottom plating and riveting are not covered with cement or similar materials, small drainage holes are cut close to the outside flanges of the longitudinal and frame angle bars ; these holes should be periodically examined to see that they are clear. In these ships cement is only used before and abaft the double bottoms where absolutely necessary to prevent the accumulation of water.

2. *Treatment of Hulls of Composite Ships.*—In *composite* ships the flanges of the outer angle irons of the frames, keels, &c., are to be coated to a sufficient extent to cover all the fastenings up to the turn of the bilge with cement or other approved composition ; and the wood planking is to be similarly

coated as far as the turn of the bilge unless special orders to the contrary shall have been given. All the remaining parts of the frames, bearers, beams, &c., which are of steel, should be thoroughly coated with paint or other approved material.

### 335.

1. *Cork in Compartments.*—In ships having compartments in which cork or patent fuel is permanently carried, the frames and plating in such compartments are to be periodically sighted to ascertain their condition.

2. The cork stowed beneath the manholes is to be removed to such an extent as will allow a few of the frames and the deck plating to be seen, and the space thus cleared is to be blocked off and the cork restowed within it in such a manner as to be easily removed.

3. At intervals of six months, the manhole covers are to be taken off, and, should water be found to have collected on the deck, an early opportunity is to be taken to remove such portions of the cork as may be necessary to allow the frames, &c. to be scraped and painted.

### 336.

1. *Constant Examination of Hulls.*—The insides of *steel* ships in their double bottoms, wings, and under the boilers and engines, as well as the inner portions of the several compartments, &c., and the frames and other steel work of the hulls of *composite* ships, being subject to injury from moisture wherever the anti-corrosive composition originally applied has been removed, constant and careful examinations of all such parts of ships in Dockyard Reserve are to be made.

2. *Hull to be Examined Quarterly.*—These examinations are to be so arranged that every accessible part of the inner and outer skin, frames, keelsons, longitudinals, boiler or shaft bearers, and all other steel work of the hull shall be examined and reported on at least once a quarter. They are to be conducted by the Engineer Officer and Carpenter of the Ship.

3. *Quarterly Reports.* S. 180.—These Officers are to make a quarterly report on the established form as to the condition of the several compartments or spaces and of the cement and paint work. The date of the examination of each part is to be shown and the condition in which it has been left. Should any part be reported in an unsatisfactory condition the steps which are being taken to remedy it are to be noted. Each of the Examining Officers is to sign and be responsible for the whole of the report, and if they disagree they are either to make separate reports or to specify on the report any points of difference.

### 337.

1. *Defects.*—In the event of any dampness, want of anti-corrosive composition, or any other defect being discovered, immediate measures are to be taken to remedy the same by drying the steel work, applying fresh composition, cement, or paint, or by adopting such other measures as may be necessary for keeping the steel in proper condition.

2. *Rust.*—Care is to be taken in all cases to remove rust from the steel by hammering, scraping and thoroughly cleaning before paint or other material is applied.

3. Care is to be taken in ships sheathed in wood not to break off the points of the sheathing bolts by heavy blows of the chipping hammer.

**338.**

1. *Lime*.—In cases where it may be found impossible to completely dry out any of the compartments, bilges, or wings, to enable them to be coated with composition, paint, or cement, well slaked lime is to be placed in the water contained in such parts of the ship.

2. Care is to be taken that unslaked lime is not used for this purpose as it would injure the coatings of composition, paint, or cement.

**339.**

*Inner Bottom Plating*.—To prevent the excessive wear of the inner bottom plating under the engines and boilers of ships, more especially in the upper surface of such plating, due apparently to the fretting action of ashes and to hot water removing rust scale as formed, the plating is to be frequently examined, and, wherever rust is found to be forming or where the paint is abraded, the surface is to be thoroughly scaled, cleaned, and dried to ensure the paint being adhesive, and then coated with three coats of red lead.

**340.**

*Whitewash*.—No whitewash or distemper is on any account to be used on any portion of the steel work.

**341.**

*Distinguishing Marks on Bulkheads, &c.*—A uniform system of nomenclature is to be observed for the several partitions enclosing watertight compartments:—

- (a) The transverse bulkheads are to be distinguished by the numbers of the stations at which they are situated, placed on each side of the bulkhead.
- (b) The longitudinal watertight bulkheads are to be distinguished by the two numbers of the transverse bulkheads at which they terminate, such as 19, 33, &c., as well as by such other marks (Middle Line, Magazine, &c.) as may appear necessary.

Where the longitudinal bulkhead is continuous through more than one space bounded by transverse bulkheads, each portion of the longitudinal bulkhead should be marked with the stations of the transverse bulkheads bounding that portion.

- (c) The watertight doors leading from one main compartment to another are also to have distinguishing marks placed on them, using the numbers of the bulkheads to which the doors are fitted, and the words Starboard, Port, &c., as may be necessary to clearly indicate the position of the door in the ship.

The watertight doors leading to the smaller compartments, store-rooms, &c., will not require further marking than the label-plate placed over or near the door indicating the compartment itself. The marking of the deck indicator plate should correspond with the marking of the door.

- (d) All the distinguishing marks and numbers on the bulkheads and doors are to be of raised brass in conspicuous characters and placed in prominent positions.
- (e) The above particulars are to be shown in the drawings of the watertight compartments furnished by the Dockyards to the Captains of ships, and on these drawings the various compartments are to be named to indicate, as far as possible, their chief appropriation, such as Magazine Compartment, Torpedo-room Compartment, &c.



## 342.

1. The following drawings will be supplied to ships. The drawings when supplied are to be accompanied by a reference sheet giving a list of the drawings and specifying the particular officer to whose fixture list they will be added :—

*Carpenter :*

- (1) Holes in bottom showing by figured dimensions the sizes and positions of all openings to the sea.
- (2) Arrangement of watertight compartments, on a scale of  $\frac{1}{16}$ -inch to a foot, giving the positions of all watertight doors, sluice valves, and deck plates.
- (3) Pumping, flooding, and draining arrangements on a scale of  $\frac{1}{8}$ -inch to a foot, with reference numbers, and an index giving the service of all the pipes.
- (4) Arrangement of ventilation, with a written description of same.
- (5) Expansion of inner bottom plating, giving the position of butts and edges, and the figured thickness of each plate.
- (6) Expansion of outer bottom plating, giving the position of butts and edges, and the figured thickness of such plate.
- (7) Tabular statement of watertight compartments (Form S. 1299) to be kept in a wooden case supplied for the purpose.
- (8) Profile, plan and midship section of ship, showing transverse and longitudinal positions of bilge keels, and side docking keels; also the draught marks in their correct positions and other information required for docking purposes.
- (9) Sketch of rudder giving full figured dimensions.
- (10) Plans for Navigating Officer showing the capacities of water-ballast compartments, hydraulic tanks, feed tanks, reserve feed tanks, oil fuel storage compartments, provision rooms and spirit room.
- (11) Sketch of rig, as fitted, on scale of  $\frac{1}{16}$ -inch to a foot.
- (12) Arrangement of torpedo net defence, as fitted.
- (13) Profile (framed) showing punping, flooding, and draining arrangements and watertight compartments (in ships with gun-rooms only).

*Torpedo Gunner :*

- (14) Navyphone and metaphone circuits with positions of batteries, and call-bell circuits with positions of motor generators and switchboards (book form).
- (15) Electric gun circuits (including dynamo firing circuits motor generators and their switchboards, if fitted).
- (16) Electric torpedo circuits.
- (17) Electric motor circuits.
- (18) Electric light circuits.
- (19) General arrangement of motors and controllers.
- (20) Motor generators and fire-control switchboards.
- (21) Submerged torpedo tubes.
- (22) Capstan and windlass, if motor driven.

*Gunner :*

- (23) Course of ammunition (if the ship be a Battleship or a 1st Class Cruiser).
- (24) Stowage of magazines and shell rooms.
- (25) Hydraulic pipes and gun working machinery.

*Engineer Officer :*

- (26) Capstans or windlasses, engines, and motors, and instructions for working.
- (27) Electric light machinery and instructions for working.
- (28) Hydraulic pumping engine and instructions for working.
- (29) Magazine cooling machinery and instructions for working.
- (30) Ice making or refrigerating machinery (and motor if so driven) and instructions for working.
- (31) Air-compressing machinery (and motor if so driven) and instructions for working and testing.
- (32) Main and auxiliary machinery, boilers, &c., supplied in accordance with the lists of the machinery specification.
- (33) Engineers' pipes.
- (34) Coal-bunker fittings and ventilation.
- (35) Oil fuel fittings and ventilation.

*Linen-backed uncoloured sunprint copies of :*

- (36) Holes in bottom.
- (37) Watertight subdivisions.
- (38) Pumping, flooding, and draining.
- (39) Arrangement of ventilation.

2. All drawings are to be accompanied by full directions in writing for their use.

3. *Drawings to be Amended and to be Returned.*—Whenever a ship is placed in commission after building, repair, fitting, or refitting, the drawings (and directions) in question are to be prepared, renewed, or amended, as the case may be, and given to the Captain, who is required to carefully preserve the drawings during the commission.

4. The instructions contained in the foregoing clauses of this article are to be complied with for Torpedo Boat Destroyers and 1st Class Torpedo Boats so far as applicable.

**343.**

*Thickness of Plating.*—Should the ship be surveyed or repaired during her commission and the thickness of any of her plates ascertained, such thickness is in each case to be carefully recorded with the date in written words upon the copies of the expansions of outer and inner bottom plating, with a view to ascertaining and recording past or future deterioration.

**344.**

1. *Survey of Hull by Dockyard Officers.*—In addition to the periodical inspections and surveys held by ship's officers, the Dockyard Officers will carry out surveys on H.M. Ships in accordance with the instructions contained in Articles 345 and 356.

2. The Commanding Officers of Ships in Commission or in Commission in the Home Fleet should raise the question when surveys by Dockyard Officers are due to be carried out.

3. Should it be quite impracticable for the ship to be examined by Dockyard Officers when the periodical Dockyard Survey is due, the fact should be reported by the Captain to the Senior Officer and a survey should be carried out by the Engineer Officer and Carpenter of another ship and reported by them in the prescribed manner.

4. *Assistance by Ship's Company.*—When Dockyard Surveys are being carried out in ships in Commission or in Commission in the Home Fleet, the ships' companies are to clear the store-rooms, bunkers, double bottoms, and other compartments, &c., as necessary; also scrape and clean all parts to be surveyed and perform any lifting, lowering, or transporting required.

5. *Opening of Confined Spaces.*—The responsible Officers of ships will be informed by the Yard Officers when it is proposed to open up any confined space for survey or for any other purpose.

6. *When Ship has been Strained.*—If any ship has been strained, or it is believed that water has been lodging in any part of her, or there is any reason to think that the hull is defective, a thorough survey of the places likely to be affected is to be made, whether the periodical survey is due or not.

### 345.

1. *When to be Surveyed by Dockyard.*—Dockyard Surveys similar in nature and extent to that described in Article 346 will be carried out in H.M. Ships at the periods stated:—

- |   |                |
|---|----------------|
| (a) Battleships and all Cruisers, armoured and protected,<br>1st and 2nd Class - - - - -  | Quadrennially. |
| (b) 3rd Class Cruisers, Scouts, and other small vessels with<br>plating of over $\frac{1}{4}$ -in. (10 lbs.) thickness - - -                | Biennially.    |
| (c) Torpedo Boat Destroyers, Torpedo Boats, and other<br>small vessels, with plating of $\frac{1}{4}$ -in. thickness and<br>under - - - - - | Annually.      |

2. *Submarines.*—Special examinations will be carried out in Submarines as may from time to time be approved. The ballast tanks are to be surveyed once every year by Dockyard Officers, and every six months by vessel's staff, and the result reported on Form S. 180.

3. The instructions contained in Articles 344–346, relating to Dockyard Surveys, are not applicable to Stationary or Harbour Service vessels, or those on the list for subsidiary service.

### 346.

1. *Dockyard Survey: Nature and Extent of*—When carrying out a Dockyard Survey the nature and extent of the examination of the plates and frames is to be such as will admit of a report on Form S. 180 being rendered on its completion, and it should include:—

- (a) *Steel Ships' Hull.*—In steel ships the removal here and there of a small portion of the linings, &c., in order that a general opinion may be formed of the state and condition of the hull as well as the double bottoms generally, especially under the boilers. Portions of the coal bunkers are to be cleared as necessary.

(b) *Sheathed Ships' Hull.*—In sheathed ships the removal of portions of the metal sheathing to enable the condition of the caulking to be ascertained. Holes should be bored in a few places along the garboards as a means of detecting the presence of water between the skins.

2. *Machinery.*—No regulated survey of definite parts of machinery, boilers, and general equipment will be made, but any specific survey of particular parts or fittings in connection with the machinery or equipment which it is not possible for the ship's staff to carry out, and which they may represent to be necessary or expedient, may be undertaken by the Dockyard if included in the Pink List, Form (S. 340). When a vessel is paid off for refit in Dockyard Reserve without a nucleus crew, or when between eight or nine years old, reckoned from the date when commissioned with nucleus crew as a new ship, a general survey of the machinery, &c., will be made, such survey in effect becoming the "opening up and examination" stage of the thorough refit to follow.

3. *General Orders.*—In addition to the parts specially mentioned to be surveyed, the general orders that have been issued from time to time in connection with the survey of the hull, machinery, and equipment, are to be carried out.

4. *Report.*—On the completion of each survey, Form S. 180 is to be forwarded by the Dockyard Officers to the Admiralty, enclosed in Form D. 51, on which is to be indicated in a concise manner the state and condition of the vessel as ascertained. When Ships in Commission or in Commission in the Home Fleet are surveyed, the concurrence of the Officers of the ship should be stated in the Report.

### 347.

1. *Reserve Feed Tanks, Preservation of.*—The bottoms of reserve feed tanks are, except when otherwise directed, to be well covered with a thick layer of Portland cement as hard as practicable, say, not less than 2 inches thick, and the sides and top are to be left unpainted, but well protected by zinc slabs in immediate contact. (See Arts. 115 and 164.)

2. *Arresting Corrosion.*—Where corrosion is found to exist in reserve feed tanks of ships in commission, which cannot be arrested by the means authorised above, the surfaces affected are, after being thoroughly dried, to be treated with mineral oil. The oil is to be applied with a short brush, care being taken to use as little as possible, and to ensure that the tanks are free from surplus oil before water is run into them. Heavy filtered mineral oil should be employed for the purpose in those vessels to which a supply of this kind of oil is allowed.

3. When feed tanks are opened up for examination and cleaning, particular attention should be given to the strainers fitted to the suction pipes, and it should be ascertained before closing the tanks that the orifices of these strainers are clear.

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## PRECAUTIONS WHEN CLEANING THE DOUBLE BOTTOMS OF STEEL SHIPS.

### 351.

The following precautions are to be observed while men are engaged in cleaning and coating the double bottoms of a steel ship, and in every other confined space including boilers, and coal bunkers which men have to enter :

(a) *Naked Lights.*—When opening up a confined space, no naked light is to be used inside the space or within 20 feet of the opening until it has

- been ascertained by means of a safety lamp that it does not contain explosive gases. Every bay of a confined space is to be so tested.
- (b) *Air Fans*.—The air fan with hose is to be freely used for pumping in fresh air before the men are sent down, and while they are at work.
- (c) *Precaution before Entering Compartment*.—A Chief Stoker or Stoker Petty Officer is to be responsible under the Engineer Officer in charge of the party that no man enters a compartment except as required by paragraph (q) until a lighted candle has been placed inside it, and has been found to burn clearly and steadily for at least 5 minutes.
- (d) *Compartment with only One Exit*.—Still greater caution is required when the compartment has only one exit.
- (e) *Communication*.—Communication is always to be kept up between the men in the inner compartment and those who have access to the outer air.
- (f) *Light Burning Dimly*.—The men are to be warned that they should leave a compartment immediately the lights begin to burn dimly; candles only are to be used by the party as a surer test than lamps, since it might be thought that lamps burn dimly for want of trimming.
- (g) *Danger of Bogies, &c.*—Every man working in confined spaces should be specially cautioned as to the danger of taking bogies or burning fuel into such places.
- (h) Persons using safety lamps should be carefully instructed as to the uses of these lamps for ascertaining the condition of the air in any confined space, bunker, or tank, in respect to the presence of dangerous gases.
- (j) It should be understood that such gases may be inflammable or explosive, or they may be dangerous to breathe without being inflammable or explosive.
- (k) The non-explosive gas is usually heavier than air, and remains in the lower part of a space, whether closed at the top or not.
- (l) The inflammable or explosive gases may be heavier than air, and also remain in the lower part of a space, or they may be lighter than air and collect in the upper part of a closed space.
- (m) In the presence of the non-explosive gas, the flame of the safety-lamp burns dimly or is extinguished. When inflammable or explosive gases mixed with air are present, the flame and the space inside the wire gauze of the safety lamp must be carefully watched for unsteadiness or additional flame. When air in sufficient quantity to produce explosion is not mixed with the inflammable gas, the flame of the lamp may be extinguished by the gas.
- (n) For the safe use of a safety lamp as a means of testing the state of the air in any space which contains inflammable or explosive gases, it is necessary not only that the gauze be sound and undamaged, but also that the lamp be carried steadily and shielded from draught, that the wire gauze be kept clean and free from soot or coal dust, and that the lamp burn with a clear flame while outside the space to be tested.
- (o) When using a safety lamp for ascertaining that the air in any confined space does not contain explosive gases as required by paragraph (a); the absence of gases dangerous to breathe must also be ascertained by means of the safety lamp.
- (p) If the flame of the lamp is unsteady, increases in size and is drawn upward with a fine point; if it burns dimly, or goes out, the space is dangerous, and is not to be entered until it has been thoroughly ventilated. The safety lamp is to be extinguished or withdrawn without delay.

(g) Before men enter any compartment, bunker, tank, or boiler which is not already known to be free from dangerous gases—

i. A locked safety lamp is to be tried as far inside the opening of the confined space as the lamp can be held without losing sight of the flame.

ii. The lamp is first to be held in the upper and then in the lower part of the space, being lowered by a line, if necessary, to reach the bottom of the space.

iii. If the lamp will burn steadily in those positions, the compartment may be entered. The flame of the safety lamp is then to be tried in the upper and lower parts of each bay of the compartment, keeping up communication with those outside the compartment. Should any indication of the presence of dangerous gas be observed, the space is to be quitted immediately, and is to be further ventilated until the lamp will burn steadily in all parts of the space. During the test, should the person using the safety lamp fail to keep up communication with those outside the compartment, steps are to be promptly taken to bring him out and force fresh air into the space.

2. Special care is to be taken that every man in the ship is made acquainted with these precautions.

The foregoing instructions as to the use of safety lamps and naked lights in bunkers and other confined spaces, are to be hung up in a conspicuous place on the stokers' mess deck and in the stokers' bath rooms.

3. Candidates for advancement to the ratings of Chief Stoker and Stoker Petty Officer should be questioned in the above instruction by the Engineer Officer, and should show a good knowledge of the same before being considered qualified to hold a higher rating. The fact that he has such knowledge should be noted on his passing certificate.

### 352.

1. *Red Lead.*—In view of the injurious effects of red lead on men employed in confined spaces, this paint is not to be used in such places to any great extent. Oxide of iron paint (unless other approved material be supplied) is to be used in double bottoms, wing passage and other confined places on board ships, but red lead should be used for painting the portions of frames, girders, &c., where the use of this material will not be injurious to the men.

2. *Instructions for Use of Red Lead.*—In cases where the use of red lead may still be necessary, the instructions in force in His Majesty's Dockyards (Art. 353) are to be followed as far as may be applicable to the service afloat.

### 353.

*Instructions respecting Red-leading.*—Extract from the Instructions in force in His Majesty's Dockyards, for the guidance of men who are employed scaling in the double bottoms, store-rooms, or other confined places where red or white lead paint has been used.

1. *Cleanliness.*—To prevent the introduction of lead paint through the skin, minute attention to cleanliness is necessary. The face and hands should be washed, the mouth rinsed, the hair combed several times in the day, and the whole body frequently bathed. The working clothes should be made of canvas, and washed once a week at least; they should be worn as little as possible after coming out, and some light and impervious cap should be worn to protect the head.

2. *Food*.—Care should be taken that none of the poison is admitted into the system with the food. The workpeople, therefore, should not take their meals where scaling has been going on, and should wash their hands and lips before eating.

3. Plenty of fat or oily food should be eaten, *e.g.*, bacon.

4. *Orangeade*.—A large wineglassful (3 oz.) of sulphuric acid orangeade is to be taken daily by each man.

5. *Breathing*.—The entrance of the poison into the air passages during respiration should be guarded against. A mask of muslin or bunting is useful where it can be worn.

6. *Issue of Orangeade*.—The materials for the orangeade are to be issued by the Medical Officer on the daily requisition of the foreman employed on the work.

7. The Medical Officer is to keep an account of the daily issues, and to send a copy with his annual account of medicines, &c.

8. The use of the orangeade is to be compulsory, and it is to be taken to the men at their work.

9. No man is to work for more than two days a week on red-leading.

10. This work is not to be compulsory for any man who objects to it.

11. All men employed on red-leading are to appear before the Medical Officer at least once a week.

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#### PRECAUTIONS AGAINST INJURY FROM GALVANIC ACTION.

##### 357.

1. *Precautions against Galvanic Action*.—All possible precautions are to be taken to avoid galvanic action from the proximity of copper or metal bilge pipes or other pipes to the steel skins or frames of ships.

2. *Galvanic Action from Pipes, Roses, &c.*—Bearing in mind the fact that galvanic action between copper, brass, or lead and steel will be set up, not only by contact between the two metals, but also whenever there is a metallic connection, however circuitous and extended, between them, accompanied by immersion in the same bilge or sea water, care is to be taken that the lower pieces of bilge suction pipes or their roses in any part of a steel or composite ship are in no case made of copper, lead, or brass.

*Bilge Pipes*.—All pipes in connection with the engines and boilers which are necessarily of copper or brass, and to which bilge water may obtain access, are to be well painted or varnished and then covered with new canvas, painted over, and so made waterproof.

4. *Bilge Suction Pipes*.—The lower end of each bilge suction pipe should be of galvanised iron, and proper strainers of galvanised iron should be fitted to prevent choking. Care is to be taken that no copper or brass pipes in the bilge rest in contact with the steelwork of the ship.

##### 358.

1. *Zinc Protectors*.—The Engineer Officer is to see that zinc protectors are fitted to the underwater fittings for Downton pumps, flooding valves, &c., of ships with steel bottoms, in general accordance with the instructions for fastening Kingston valves and sea cocks to skins of ships. Every opportunity is to be taken to see that these protectors are maintained in an efficient condition.

2. *Protectors not to form Part of Joints.*—Care is to be taken that where these protectors (which only protect by their own decay) are required to protect the skins of ships internally from the action of the bilge water in the neighbourhood of metal fittings, the protectors form no part of any of the joints. (*See also Arts. 241 and 242.*)

## STEAM TRIALS OF SHIPS.

### 361.

The following trials are to be carried out under the conditions specified in the Articles referred to :—

- (a) Preliminary trial. *See Art. 381.*
- (b) Contractors' trials. *See Arts. 383-389.*
- (c) Commissioning trial. *See Arts. 391-396.*
- (d) Turning trials. *See Art. 400.*
- (e) Thorough repair trial. *See Arts. 401-407.*
- (f) Partial repair trial. *See Arts. 411-414.*
- (g) Special measured mile trial. *See Arts. 415-421.*
- (h) Trials at reduced powers. *See Arts. 425-433.*
- (i) Passage trials. *See Arts. 441-451.*
- (k) Paying off trial. *See Art. 456.*

### 362.

1. *Notice of Trials to Admiralty. D. 550.*—Whenever the date of a *Contractor's Commissioning, Thorough Repair, Special measured mile, Paying off or, Turning* trial is fixed, application for approval is to be made to the Commander-in-Chief, or Superintendent (according to the class of trial) on Form D. 550, and notice is to be sent to the Admiralty in sufficient time for an Officer to attend the trial should it be deemed necessary.

2. Contractors' and Measured Mile Trials should be carried out as near the load draught and trim of the vessel as practicable, unless otherwise directed.

### 363.

1. *Responsibility for Management of Machinery, &c.*—In general, the persons to be placed in charge of the engines and boilers of ships during steam trials are those who have previously had them under their care and control. Specific instructions are given in reference thereto under each class of trial. When the ship is in commission, the machinery during any trial is to be under the charge of the Engineer Officer of the ship.

2. *Vigilance.*—All Officers concerned in the steam trials of ships and in the management of their machinery are to exercise the strictest personal attention and vigilance to ensure that everything is maintained in proper working order.

3. The Engineer Officer of the ship should always be present during steam trials.

### 364.

1. *Action on Emergency.*—In all cases of steam trials, the Engineer Officers and Chief Petty Officers on watch are to be well acquainted with the positions, construction and uses of the various stop valves and boiler fittings and are to be ready to act in case of emergency. They are to observe the pressure of steam and height of water in all the boilers from time to time. Men should be stationed at the emergency valves where so fitted.



2. *Precautions.*—Should they observe anything to indicate danger in any boiler, they are to take immediate steps to check the generation of steam in that boiler, calling the attention of the person in charge of the engines and boilers to the circumstance, and reporting it at once to the Officer in charge of the trial, and the Engineer Officer of the ship.

3. *Report as to Safety of Boilers.*—They are generally to note all such points as have reference to the safety of the boilers, reporting promptly the fact of anything going wrong to the Officer in charge of the trial and Engineer Officer of the ship.

4. *Stokers.*—When stokers of the Royal Navy are employed, Engineer Officers or Chief Petty Officers are to take charge of them, and are to see that the wishes of the person in charge of the engines and boilers, as to the working of the fires, are carried out; but they are not to interfere with stokers not belonging to the Navy.

### 365.

*Presence of Officers attending Trial.*—It is to be distinctly understood that the presence of Officers—Admiralty or other—appointed to attend the steam trial does not in any way relieve the persons who have the charge of the engines and boilers from any responsibility.

### 366.

1. *Indicator Diagrams.*—In the case of trials of ships with reciprocating engines indicator diagrams are to be taken as specified, under the supervision of an Officer who will be responsible that the diagrams are properly taken, that they are carefully measured and the calculations accurately made, and that all the necessary information as to time, revolutions, steam pressure, vacuum, &c., which should be taken at the same time as the diagrams, is noted upon the cards, which he is to initial.

2. *Mean I.H.P.*—The mean power deduced from these records is to be taken as the indicated horse power developed on the trial.

3. *Diagrams.*—Any other diagrams beyond those specified are to be taken when necessary for the satisfaction of the Officers responsible for the trial.

4. *Precautions.*—Care is to be taken to ensure that the indicator pipes are free from all obstruction.

### 367.

1. *Records of Revolutions, Steam Pressure, &c.*—An accurate record of the various particulars as to revolutions, steam pressure, vacuum, temperature, &c., required by the report of trial is to be entered in the several columns of that report. These records are to be made for each run on the measured mile.

2. *Counters.*—The revolutions are to be taken by two counters for each set of engines. The counters are to be noted by different observers and the results compared.

3. *Water to be Tested.*—In all trials, the feed water, boiler water, and water made by the evaporators are to be tested by nitrate of silver and sensitive hydrometer, both at the beginning and end of the trial, and the results reported on Form D. 408. The necessary articles will be provided by the trial party.

### 368.

1. *Speed.*—At the commencement of any steam trial under way, except the *Special measured mile trial*, and the *Preliminary trials*, the patent log is to be put over and the result at the end of the trial recorded in the report, together

with the speed ascertained by any runs which may have been taken on the mile, by bearings or by any other available means.

2. *Helm*.—Care is to be taken to avoid putting the helm over more than is absolutely requisite during a trial.

### 369.

1. *What constitutes a Satisfactory Trial*.—In order to constitute a satisfactory trial of a ship the requisite horse-power must have been maintained for the full time specified for the particular trial. The water used upon the bearings should not have exceeded that supplied by the ordinary "water service" fitted, and the engines and boilers must be in all respects ready and fit to continue running at full speed after the trial.

In the case of new ships no water is to be used upon the bearings during the official steam trials, the permanent fittings only are to be used for the supply of oil, and lubricator boxes are to supply the oil by means of the ordinary worsteds only.

2. All water-tight doors in the machinery department are to be closed except only such bunker doors as are necessary for the coal supply.

3. *Variation from Power*.—If any considerable variation from the average power occurs during the trial, especially if it be a reduction below the horse-power required, its duration, amount, and the causes which have produced it are to be stated in the report.

4. *Safety of Ship*.—If it should be necessary for the safety of the ship to ease or stop the engines for a time, a trial will not necessarily be vitiated thereby.

### 370.

1. *Regulations for Measured Mile*.—When in the course of an ordinary trial ships are put on the mile, attention is to be paid to the regulations on this head in Arts. 415, 416, and 418.

2. *Force of Wind*.—The results given by runs upon the measured mile cannot, as a rule, be relied on when the force of the wind exceeds three.

### 371.

1. *Trial of Auxiliary Engines*.—Telegraphs and other means of communication, the steering, capstan, feed and fire engines, and every engine connected with the movement of the vessel must in all cases be tried before the vessel proceeds under way; the feed pumps to be tested as to their fitness to pump when the pressure of steam in the boilers is at its maximum, and every boiler feed valve used and tested.

2. *Stopping and Starting Trials*.—Stopping and starting experiments should be carried out, and any other trials required to ascertain the efficiency of the steam and hand starting and reversing gear, before any full-power steam trial is concluded. Emergency valves, where fitted, should also be tried.

### 372.

1. *Preliminary Report to be sent by First Post*. D. 408.—A preliminary report of every Contractors' and thorough repair trial, containing as much information as can be given without delaying its transmission, is to be forwarded to the Controller of the Navy by the next post after the completion of the trial.

2. In the case of ships fitted with reciprocating engines, a set of original indicator diagrams, showing about the average power developed, is to be forwarded with the preliminary report, but the diagrams need not be inked in or calculated. In ships fitted with turbines, the average shaft horse-power should be stated if measurements have been obtainable during the trial.

3. The report as agreed upon by the Officers attending the trial is to be made out and forwarded by the representative of the Engineer Rear-Admiral on the staff of the Commander-in-Chief of the port to which the ship will be attached. It is to be considered essentially preliminary and subject to correction in details.

### 373.

1. *Full Report to follow.* D. 408 and 408a.—The full report of each trial is to follow the preliminary report with the utmost possible despatch.

2. *Signature of Report.*—In the case of Contractors' trials and thorough repair trials, the report is to be made out by the Engineer Rear-Admiral at the port, or his representative; and is to be signed by him and the Captain and the Engineer Officer of the ship. In the case of a ship built or repaired by contract, the report is also to be signed by the Hull and Engineer Overseers; and in the case of a ship built or repaired by a Dockyard, by the Captain, Chief Constructor, Chief Engineer, and Electrical Engineer of the Dockyard. The report is to be forwarded through the Commander-in-Chief of the port to which the vessel is attached.

3. *Diagrams.*—All particulars called for on the form are to be given in the spaces provided. Original indicator cards, with the diagrams marked top and bottom, and, if the trial is a measured mile trial, a tracing of the screw propeller, are to be annexed to the report. In ships fitted with reciprocating engines, diagrams are to be taken at half-hourly intervals during trials under way not exceeding four hours in duration, and at hourly intervals during trials above four hours in duration, under the supervision of an Officer deputed by the Engineer Rear Admiral on the staff of the Commander-in-Chief of the port to which the ship is attached. Copies of four average sets taken during the trial are to be forwarded with the report of trial. *Vide Art. 120.*

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## EXAMINATIONS PREVIOUS TO STEAM TRIAL.

### 375.

1. *Boilers, &c.*—All ships which have been for six months or longer without having had steam raised in them are, before being taken out for trial, to have the boilers and steam pipes as far as the engines tested by water to the test pressure as laid down in Art. 220. *See also Art. 218 as to Special Service Vessels.*

2. *Water-tube Boilers.*—In ships fitted with water-tube boilers of the small tube type, a complete search of the tubes internally is to be made before steam is raised.

### 376.

1. *Safety-valves, Pressure Gauges.*—Shortly before steam is to be raised in any ship not in commission for a trial of her machinery, the whole of the safety-valves are to be taken out for examination, and the pressure gauges tested in the presence of the Engineer Officer of the ship, and representatives of the Officers who will attend the trials.

2. *Safety-valves*.—If the engines and boilers are new, the safety-valves will be taken out by the Contractors for examination and measurement in the presence of the Engineer Officer of the ship.

3. *Load on Safety-valves*.—The springs are to be tested in order that the exact load upon the valves may be entered in the records and reports, and it is to be seen that the valves and their seats are in good order and that the valves are sufficiently free.

4. *Responsibility for Valves being properly in Place*.—The Engineer Officer of the ship is to see personally that the safety-valves are properly put in place and the gear connected. He is to make a correct record of the results of the examination in the ship's Steam Manual. A record of the examination and results will also be kept in the office of the Chief Engineer of the Dockyard.

5. *Precautions when Screwing Down Springs*.—The Engineer Officer of the ship is to be especially careful that the valves are not screwed down more than will be sufficient to load the valves to the approved pressure. He is also to see that stops are fitted to prevent the springs being screwed down inadvertently or by unauthorised persons.

### 377.

1. *Wood to be Cleared from Boilers*.—Previous to lighting fires, and actually while fires are being lighted, a strict search is to be made on the tops of the boilers, in the casings, and in all spaces around and between the boilers, to ensure no planks, shores, stagings, or wood of any kind being left where there would be any possibility of their becoming ignited.

2. *Certificate to this Effect*. D. 552.—The Engineer Officer is to note that this has been done on the certificate handed by him to the Engineer Rear-Admiral or his representative under Art. 378.

### 378.

1. *Stop-valves to be Open*.—On the day of the trial, and before the fires are lighted, the Engineer Officer of the ship must be fully satisfied that all the necessary communication valves are open and that the steam and water gauges are in good working order.

2. *Safety-valves to be Tested*.—Before steam is up to working pressure the safety-valves are to be lifted from their seats in his presence and tested in such a manner as to satisfy him that they are in good working order.

3. If not more than ten days have elapsed, and if the valves or their gear have not been disconnected, overhauled, or gagged since last tried under steam, the actual lifting of the valves may be dispensed with, but the Engineer Officer must be satisfied that the valves are in working order and the lifting gear must be worked without moving the valves.

4. *By whom to be Signed*.—If the engines and boilers are new, a certificate to the above effect is to be signed by the Contractors or their agent in charge of the trial. If the Chief Engineer of the Dockyard is in charge of the trial, the certificate is to be signed by him; and in all cases it is to be countersigned by the Engineer Officer of the ship.

5. *Ship not to Weigh Without*.—This certificate is to be submitted to the Officer in command, who will not allow the ship to be got under way until he has seen it, and is to be given to the Engineer Rear-Admiral attending the trial or his representative.

**379.**

*Men entering Boilers, Precautions.*—Should it, for any reason, become necessary during the preparation of a ship for trial, or at any other time, to send stokers or workmen of any kind into a boiler in which steam is not raised, great care is to be taken to prevent any possibility of hot water or steam finding its way into the boiler in which the men are employed, and the precautions laid down in Art. 190 are to be strictly observed.

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**PRELIMINARY TRIALS.**
**381.**

1. *Preliminary Trials.*—On the completion of new machinery by Contractors, or of repairs by Contractors or the Dockyard, preliminary trials under steam are to be made, as often as necessary, to satisfy those who are responsible for the trials that everything is in proper working order and fit for the official trials.

2. *Trials at Moorings or Alongside.*—Care is to be taken that the engines are never worked so as to run any risk of damaging the moorings, basin walls, or jetties to which they may be secured. When tried in basins ships should be fastened stem on to the wall. At Sheerness preliminary trials are never to take place at moorings.

3. *Auxiliary Machinery.*—A thorough trial of the *whole* of the auxiliary machinery is to be made; every engine is to be worked, and the feed pumps tested as to their fitness to pump when the pressure of steam in the boilers is at its maximum, every boiler feed and boiler stop valve being used and tested.

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**CONTRACTORS' TRIALS.**
**383.**

*Conditions of Trial.*—Contractors' trials are to be carried out in accordance with the conditions relating to trials as defined in the machinery specifications, and subject to the general instructions for steam trials.

**384.**

*Responsibility for Management of Engines and Boilers.*—The Contractors are to have charge of the engines and boilers during the trials; but it is to be clearly understood that the officers appointed to attend the trials will, at all times, be responsible that the regulations for the conduct of the trials are never deviated from.

**385.**

1. *Officers to Watch Proceedings of Contractors.*—The Officers appointed to attend the trials are carefully to watch the proceedings of the Contractors and of their agents, and to see that nothing is done, or omitted, which (either by act or omission) would endanger the safety of the ship or the lives of those on board. (See Art. 364.)

2. The trials will be run under the supervision of the Engineer Rear-Admiral or his representative on the staff of the Commander-in-Chief of the port to which the ship is attached who will be responsible for the reports. (Arts. 372, 373.) The responsibility for the acceptance of a new Torpedo Boat Destroyer will rest with the Officer appointed to command and the representative of the Engineer Rear-Admiral at the Port.

3. A representative of the Chief Engineer of the Dockyard (in the case of Dockyard built ships), or the Engineer Overseer (in the case of Contract built ships), will attend the trials.

4. *Coal*.—The coal must be of description approved by the Admiralty.

### 386.

1. *Fuel left on Board after Trials*.—The quantity of fuel left on board by Contractors when trials are completed will be taken over by the Admiralty, and an agreement as to quantity is to be arrived at between the Engineer Overseer of the ship and a representative of the Contractor. The certificate as to the agreed quantity is to be forwarded to the Admiralty by the Engineer Overseer of the ship without delay, together with certified copies of the Contractor's invoices, &c., showing the price paid for the coal. Subsequently, the proportion of this quantity which is expended up to the time the ship is commissioned is to be reported to the Admiralty (N.S. Coal). The balance left on board when the ship is commissioned will form a first charge in the Engineers' Consumable Naval Store account.

2. *Lubricating Oils for Navigating Purposes*.—The Engineer Overseer will arrange with the Contractors to provide a sufficient quantity of lubricating oils for navigating purposes, the description and quantity proposed to be supplied, and the price being previously submitted for Admiralty approval. The quantity of oil left on board on completion of trials is to be dealt with as in the case of fuel.

### 387.

*Special Trials*.—The following trials may be made at any time before or after the full-power trial, but the *Contractors'* trials are not to be considered complete until they have been carried out:—

- (a) *Stopping and Starting*.—Stopping, starting, and reversing engines from full speed, and any other trials required to ascertain the efficiency of the steam and hand starting and reversing arrangements. Emergency valves, where fitted, are also to be tried.
- (b) *Auxiliary Feed Pumps*.—The auxiliary feed pumps are to be used as the principal means for feeding the boilers, for at least 10 hours during the 30 hours at the higher power.
- (c) *Working Engines Expansively*.—In reciprocating engines, trials with the slides linked up as the Engineer Officers attending the trial may think necessary to test the arrangements for working expansively and to ascertain the indicated horse-power which can be developed under such conditions. Steam pressure as may be ordered to be maintained at the engines for these trials.

### 388.

1. *Circulating Pumps with Bilge Suctions*.—In ships fitted with circulating pumps to which bilge suction have been attached, a special trial and report are to be made of their action as bilge pumps before the machinery is certified as in all respects fit for service at sea.

2. This trial is not to be carried out until the trials of the main engines have been completed.

## 389.

*Telegraphic Report.*—At the conclusion of a Contractor's trial a telegraphic report is to be made to the Controller of the Navy, stating:—

- (a) Horse-power realised.
- (b) Speed realised.
- (c) Whether the machinery worked satisfactory or not.
- (d) Whether the boilers worked satisfactorily or not.
- (e) Average steam pressure in boilers.
- (f) Average air pressure in boiler-rooms, and vacuum in condensers.
- (g) Average number of revolutions per minute of main engines.
- (h) Consumption of coal per horse-power per hour for all purposes.
- (i) Estimated water loss per 1,000 horse-power per 24 hours for trials of eight hours' duration and above. If unusually great an explanation of the causes of the loss should be furnished.

## COMMISSIONING TRIAL.

## 391.

1. *When to be made.*—The *Commissioning* trial is to be made as soon as convenient after a ship has been commissioned or re-commissioned; and the date will be arranged by the Commander-in-Chief.

2. *Object of Trial.*—The object of the commissioning trial is to show whether the machinery is, in all respects, efficient and ready for service.

## 392.

1. *Duration of Trial.*—The trial is to be run for a short period at three-fifths the authorised full power.

2. *Measured Mile.*—The ship may be put upon the measured mile in the course of the trial if considered desirable.

3. *Starting and Stopping Trials.*—The trial should include experiments to ascertain the efficiency of the starting, stopping, and reversing arrangements.

4. *Description of Coal.*—The coal used should be that from the ship's bunkers.

## 393.

*Ship's Indicators to be used.* D. 408.—During this trial if the ship is fitted with reciprocating engines, diagrams are to be taken by one of the Engineer Officers belonging to the ship, with the indicators supplied for the ship's use; and a notification that this has been done, and that the indicators are efficient and likely to continue so, is to be made on the report of trial.

## 394.

1. *Form S. 350.*—After the commissioning trial has been satisfactorily completed, the Captain will make a report on Form S. 350 that the ship is in all respects ready for sea. This report is to be made in triplicate, the original being inserted in the ship's book, and the duplicate and triplicate being forwarded to the Commander-in-Chief for transmission to the Admiralty and the Admiral Superintendent respectively.

2. *Repairs by Dockyard.*—The trial will be attended by representatives of the Engineer Rear-Admiral or Engineer Captain at the port, and in cases where important repairs have been carried out the trial will be also attended by the representatives of the Chief Constructor, Chief Engineer, and Electrical Engineer of the Dockyard, according to the nature of the repairs made. Where no important repairs have been made there is no necessity for the Dockyard Officers to attend.

### 395.

1. *Passage Trial.*—Advantage is to be taken of the first convenient opportunity to run a passage trial as ordered in Arts. 441 to 450. This trial is not to be postponed beyond three months from date of commissioning or re-commissioning.

2. Before carrying out the first quarterly passage trial in new ships, an opportunity will be afforded, if possible, for making a preliminary trial at such speed as may be considered desirable by the officers of the ship, to ensure satisfactory adjustment of the bearings for high speed.

### 396.

The above orders as regards the commissioning trial do not apply to ships commissioning for service in the Home Fleet with nucleus crews.

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## TURNING TRIALS.

### 400.

*Turning Trials. D. 500.*—One or more turning trials of ships are to be made as opportunity offers before the vessel leaves to join her station on the occasion of a first commission, or after a general refit, and the results reported on Form D. 500.

*S. 347.*—Further trials are to be carried out within six months of the date of commissioning, and the results reported on Form S. 347.

It is of great importance that every care should be taken when making these trials, in order that the results may be obtained and recorded as accurately as possible.

These trials are to be made in fine weather, and if possible when there is neither wind nor tide to affect the results.

One copy of the results is to be placed in the Captain's Ship's Book, and one copy is to be forwarded to the Admiralty for information.

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## THOROUGH REPAIR TRIAL.

### 401.

*When to be made.*—This trial is to be made before a ship in the charge of the Admiral Superintendent of a Dockyard is commissioned, whenever the machinery has undergone a thorough repair, whether by the Dockyard or by contract, and it is to be carried out as soon as the repairs are completed, the preliminary trials have taken place, and the persons responsible for the efficiency of the repairs are satisfied that the engines and boilers are in all respects ready for a full-power trial.



## 402.

*Object of Trial.*—The object of this trial is to ascertain whether the repairs have been efficiently performed, and if the engines and boilers are in all respects ready for service, and whether the indicated horse-power is obtained with any undue loss of efficiency. For this purpose the engines are to be linked up, and the cylinder jackets used sufficiently to obtain a satisfactory comparison with the results recorded on the original trials of the ship.

## 403.

1. *Officers in Charge.*—When the ship has been repaired at a Dockyard, the Chief Engineer of the Dockyard is to have charge of the engines and boilers during the trial.

2. When the ship has been repaired by contract, the Contractors or their agents are to be in charge. The Chief Engineer of the Dockyard or his representative, and the Engineer Officer of the ship, are to watch the trial to see if the repairs have been executed in a satisfactory manner.

3. The Engineer Rear-Admiral on the staff of the Commander-in-Chief of the port to which the ship is attached or his representative, is to attend the trial, whether the ship is repaired by contract or by Dockyard, and will be responsible for the reports (Art. 372, 373).

## 404.

1. *Duration of Trial.*—For all ships fitted with water-tube boilers of the large tube type or cylindrical boilers, the authorised full power is to be developed for eight hours.

2. In ships fitted with water-tube boilers of the small tube type the specified full forced draught power is to be developed for the same period as on the original Contractors' trials.

3. In torpedo boat destroyers and torpedo boats the thorough repair trials should be of three hours' duration, and the power to be developed should be 90 per cent. of the Navy List power for destroyers, and 90 per cent. of the Contractors' full power for torpedo boats, provided that in the case of destroyers the receiver pressures do not exceed those obtained on the Contractors' full-power trials when new (*see* Article 444). Should it prove necessary, in order to obtain the 90 per cent. of the Navy List power, to exceed the receiver pressures obtained in the Contractors' full-power trials, the power to be developed is to be limited to that corresponding to the Contractors' trial receiver pressures.

4. The limitation in Clause 3, as regards power to be developed, does not apply to destroyers of the "River Class" and subsequent designs; in these cases the trials should be made at as near full power as possible consistent with not exceeding the receiver pressures obtained on the Contractors' trials.

## 405.

*Special Trials.*—The following trials may be made at any time before or after the full-power trial, but the *thorough repair* trial is not to be considered complete until they have been carried out:—

Stopping, starting, and reversing engines from full speed, and any other trials required to ascertain the efficiency of the steam and hand starting and reversing gear.

## 406.

*Coal to be used.*—The coal used should be of approved quality.

## 407.

1. *Trial after Repairs at Foreign Yard.*—Whenever a ship in commission is tried under way after repair at a foreign Yard, the machinery is to remain under the charge of the Engineer Officer of the ship.

2. The Chief Engineer of the Yard, or his deputy, with as many Dockyard workmen as he may consider necessary, will attend the trial to watch whether the repairs have been effected satisfactorily.

## PARTIAL REPAIR TRIAL.

## 411.

*Duration of Trial.*—When the machinery of a ship in commission or in charge of the Admiral Superintendent has undergone a partial repair at a Home Dockyard it will generally be sufficient to make a trial of four hours' duration for ships and two hours' for torpedo boats and torpedo boat destroyers at about 90 per cent. of the authorised full power.

2. When the repairs have been slight, the trial itself may be dispensed with if the Engineer Captain of the Fleet, Fleet Division or Squadron to which the ship is attached or is about to be attached and Chief Engineer of the Dockyard do not think it necessary, and the Captain and the Engineer Officer of the ship are satisfied that the repairs have been efficiently performed, and are prepared to certify to that effect without it.

3. *When longer Trials are required.*—If the partial repair should have been of more considerable importance, similar trials to those laid down in Art. 404 for ships which have undergone a thorough repair are to be carried out, except that the power to be developed need not exceed 90 per cent. of that required after thorough repair.

4. *Charge during Trial.*—The Engineer Officer of the ship is to be in charge of the machinery during these trials.

## 412.

1. *Responsibility for the Reports.*—Representatives of the Engineer Captain of the Fleet, Fleet Division or Squadron to which ship is attached or is about to be attached and of the Chief Constructor and Chief Engineer and Electrical Engineer of the Dockyard will attend the trials. For trials referred to at cl. 1, Art. 411, the Engineer Officer of the ship is to make out the report on Form S. 346. Reports D. 237 A., S. 339 A., are not to be signed before the trial has been completed.

2. In ships with reduced crews assistance may be given as necessary for obtaining records and preparing the reports.

The reports are to be signed by the Captain and Engineer Officer of the ship and forwarded through the Commander-in-Chief of the port to which the ship is attached.

In the case of prolonged trials referred to at cl. 3, Art. 411, the Engineer Rear-Admiral at the Port, or his representative, will *also* attend and be responsible for the Reports on D. 408 and 408a as provided at cl. 3, Art. 372, and Art. 373.

## 413.

*Coal.*—The coal used should be that from the ship's bunkers.

## 414.

*Trials of Torpedo Boats and Torpedo Boat Destroyers.*—When torpedo boats and torpedo boat destroyers have been put out of commission on account of hull defects or have been paid off in order to release naval ratings during repairs not of an extensive character, the machinery is to remain in the charge of the Engineer Officer, who should if possible arrange that any necessary examinations and adjustments are completed before the vessel is paid off, leaving only the work of care and maintenance and of making good actual defects to be done during the period the vessel is in the charge of the Admiral Superintendent. On the completion of the repairs, the officers of the ship and of the Dockyard having previously satisfied themselves that the engines and boilers are in a condition of readiness for trial, a short trial at reduced power sufficient to test the repairs made to the hull and fittings, to show whether the machinery is in any way affected by the repairs to the hull and that it is in all respects ready for service, is to be carried out. *Vide Art. 23-461 et seq.*

## SPECIAL MEASURED MILE TRIAL.

## 415.

*When to be made.*—Whenever a *Special measured mile trial* is ordered either in lieu of, or in addition to, any other class of trial, the following directions are to be carried out; and the same Officer or other person will have charge of the machinery, and the same stokers will be employed, as if it had been an ordinary steam trial, that is to say, according to the class of trial to which it is added, or which it supersedes.

## 416.

*Steam Cornet.*—The steam cornet is to be carried at the main truck, or on a pole if no masts are on board, as a signal to all vessels to keep clear of the course; and every precaution is to be taken to avoid accidents.

## 417.

*Coal.*—The coal used should, if practicable, be that specially ordered for steam trials.

## 418.

1. *Number of Runs to be made.*—Four or six runs are to be made at each of the various powers or speeds as may be ordered, the object being to ascertain the relation between the horse-power and speed of vessel at definite powers or rates of speed.

2. *Series of runs to be on same Tide.*—Each series of runs should be uninterrupted and be completed while the tide is running in one direction.

3. *Room to get Speed before each Run.*—In the intervals between the runs the ship is to be taken well away from the mile so as to ensure the attainment of the

required speed on the next run; and in turning back the helm should not be put hard over if it can be avoided.

4. *Power to be Developed Continuously.*—During the series of full power runs the engines and boilers are to be worked at full power, not only when running the mile, but during the whole of the intervals between the several runs; the maximum power to be obtained being ordered by the Admiralty.

#### 419.

1. *Steam to be Kept at a Maximum.*—Previous to commencing the full-power runs, the speed of the engines is to be so regulated that the steam pressure in the boilers may be maintained at a maximum until the whole of the runs are completed; and the steam is not, under any circumstances, to be even partially shut off while off the course for the purpose of securing a higher result while on it.

2. *Reduced Speeds. Number of Boilers.*—During the runs at reduced speed the revolutions should be kept at a uniform rate, so that the indicated horse-power developed during each series of runs may be as nearly constant as possible. The number of boilers to be used is to be such as will ensure ample steam while working at the revolutions required.

#### 420.

1. *Trial to Cease if Defects occur.*—If, during the trial, any defects occur in the machinery or ship, the trial is to cease, and the ship to be at once removed from the mile, a new series of runs being commenced when the defects shall have been made good.

2. *Priming.*—If the boilers should prime so that they cannot be worked at full power, even at the close of the trial, it is to be considered as unsatisfactory, and the trial is to be repeated.

#### 421.

*Force of Wind.*—As a rule, the trial should not take place when the force of the wind exceeds 3.

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### TRIALS AT SEA AT REDUCED POWERS.

#### 425.

1. *Object of.*—With a view of obtaining standard information of the steaming capabilities of vessels at various powers, trials under steam of long duration and steady power are to be made as early as possible in each commission, the engines being worked under the most economical conditions. Advantage should be taken of the ordinary passages made by the vessel to carry out these trials. In order to ensure average results these trials should be carried out in moderate weather and when the ship's bottom is fairly clean.

2. *Curves of Performance.*—The speeds of ships obtained from time to time at various revolutions per minute of the propellers (*i.e.*, the revolutions per knot), should be carefully ascertained at different mean draughts of water, conditions of the ship's bottom, and states of the sea. From the horse-power indicated at various revolutions under moderate conditions of weather, with fairly clean

bottom and average draught of water; standard curves of performance should be constructed by the Engineer Officer, from which the power and consumption of fuel can be estimated for any required speed of the ship. The results thus recorded will assist in the comparison of performances referred to at Art. 91, and will enable any falling-off in economy to be more readily observed. Standard curves, giving the speeds, horse-powers, and fuel consumptions are to be inserted in the Ship's Manual, and a copy attached to the Engine-room Register forwarded each quarter. In ships where means of indicating the power developed are not provided, the curves are to be constructed from the various speeds and consumptions of fuel.

## 426.

*Powers at which to be made.*—The chief powers for which this information is to be specially obtained are at 40 per cent., 20 per cent., and 10 per cent. of the authorised full power. Also, in order to localise the most economical speed, further trials at 15 per cent. and 5 per cent. of the same power, or such other power as may be considered desirable. The data for 60 per cent. of the unit power will be provided by the quarterly passage trials.

## 427.

1. *Coal Expenditure for the Auxiliary Machinery.*—To determine with some degree of accuracy the coal consumption for the auxiliary machinery, trials should be made with the most important engines when in harbour, and when using a boiler specially for auxiliary purposes. In the case of the electric light, air compressing, hydraulic and other engines, this can be readily obtained.

2. *E.R. Register.*—These trials should be repeated about half-dozen times for arriving at mean results; they are then to be tabulated, and inserted in the Ship's Steam Manual and Engine-room Register.

## 428.

*Accuracy in measuring the Coal Consumed.*—When making these trials, the coal should be measured with special care, and should, as far as possible, be so used from the bunkers that the quantity expended on a run may be checked by reference to the bunker space emptied. As far as possible, the bunkers and boilers should be so selected and the duration arranged, that a trial may extend over the whole period of working out these selected bunkers from full to empty. The quality of coal should be good.

## 429.

*Economy of Fuel.*—The instructions as regards economy of fuel, contained in Arts. 91–93, are to be strictly attended to. Subject to the conditions of service, as few boilers as possible should be in use, consistent with economy.

## 430.

*Results of Trials. Form S. 346. E.R. Register.*—When a trial is completed, the particulars should be filled in on Form S. 346, altering the headings of columns as necessary, to indicate the character of the trial. This form should be sent as soon as possible to the Admiralty for information, and a copy attached to the Engine-room Register.

## 431.

*Indicator Diagrams.*—In ships fitted with reciprocating engines indicator diagrams are to be taken at least daily, the power being maintained as constant as possible throughout the trial. If any variation is absolutely necessary, sufficient diagrams should be taken to afford a means of obtaining the correct average power. Two average sets of these diagrams are to be forwarded to the Admiralty with the report of trial.

## 432.

1. *Speed.*—Whenever an indicating log is available, it should always be used instead of the common log, the speed being obtained from the distance made good through the water during the trial.

2. In taking the speed with the common log the utmost care must be taken in heaving the log, and a very long line should be used, the time-glass being turned once or twice, or, preferably, a watch used, so as to ensure the utmost accuracy.

3. The speed obtained should be checked by comparison with the revolutions made by the engines per minute.

## 433.

In determining the most economical rate at which to make a voyage, the coal expenditure for auxiliary purposes should be taken into account.

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PASSAGE AND FULL-POWER TRIALS AT SEA.

## 441.

1. *Passage Trials.*—In order to ensure that the machinery is kept in efficient order, and to give opportunities of training the Engine-room Complement in working the engines at high speeds, trials are to be carried out as laid down in Arts. 441–451.

2. When passages are not made during the prescribed period giving opportunities for carrying out the trial, the ship will, if the exigencies of the service permit, proceed to sea specially for this purpose.

3. The distance run through the water during the trial should be ascertained as correctly as possible both by indicating log and by observations of the ship's positions taken throughout the trial, due allowance being made for currents.

## 442.

1. *Ships with Full Complements. Duration of Trial.*—Ships in commission with full complements are to make a trial once a quarter of not less than 24 hours' nor more than 60 hours' duration.

2. During this trial the engines are to be worked for a period of eight hours at, but not exceeding, the authorised full power, and the remainder of the trial is to be made at three-fifths the authorised full power, except as stated in Clause 3.

3. In ships fitted for burning oil fuel and in which the full power is obtained with coal alone, the engines are to be run for eight hours at the authorised full power using coal only, and the remainder of the trial at three-fifths the authorised

full power using coal only, unless the use of oil fuel and coal in all boilers concurrently is considered necessary for training the engine-room complement, in which case the engines may be run for any period not exceeding eight hours, at four-fifths the authorised full power using coal and oil, and the remainder of the trial at three-fifths the authorised full power using coal only; the total duration of the trial being limited to 24 hours. During the four-fifths trial the amount of oil used at any time in any boiler is not to exceed 30 per cent. of the total fuel being used in that boiler.

4. In ships fitted for burning oil fuel and coal, in which the full power is not obtained with coal alone, the engines are to be worked for a period of eight hours at the authorised full power, and the remainder of the trial is to be made at three-fifths the authorised full power burning coal alone, the total duration of the trial being limited to twenty-four hours. During the full power trial the amount of oil being used at any time in any boiler is not to exceed 30 per cent. of the total fuel being used in that boiler.

5. Once each year four-fifths the authorised full power may, at the discretion of the Commander-in-Chief or Senior Officer, be maintained for a period of, but not exceeding, 30 hours, in lieu of the trial ordered in Clauses 2, 3, and 4, the stokers being in three watches, and assistance given from deck as laid down in Arts. 59 and 60. In ships fitted for burning oil fuel, oil fuel and coal may be used, but the amount of oil used at any time in any boiler is not to exceed 30 per cent. of the total fuel being used in that boiler.

#### 443.

1. *Ships with Reduced Complements. Duration of Trial.*—Ships in commission with reduced complements, with the exception of those commissioned for temporary service pending refit by a Dockyard, are to carry out a trial of, but not exceeding, 24 hours' duration, once a year, the Engine-room complements being supplemented as necessary.

2. During this trial the engines are to be worked for a period of four hours at the authorised full power and the remainder of the trial, except in ships fitted for burning oil fuel, is to be made at three-fifths the authorised full power.

3. In ships fitted for burning oil fuel, four-fifths the authorised full power is to be maintained for eight hours, oil fuel and coal being used, but the amount of oil used at any time in any boiler is not to exceed 30 per cent. of the total fuel being used in that boiler. The remainder of the trial (12 hours) is to be made at three-fifths the authorised full power using coal only.

4. *Special Service Vessels.*—Special Service Vessels are generally to carry out a trial once a year, but the case of each ship is to be referred to the Admiralty shortly before the trial becomes due, for decision as to the duration of the trial and the power to be developed

#### 444.

1. *Scouts, Destroyers, and First Class Torpedo Boats. Full Complements.*—Scouts, Torpedo Boat Destroyers, and First Class Torpedo Boats in commission with full complements, when not employed on instructional or other duties which involve periodical running at high speeds, are to carry out a trial once a quarter.

2. *Scouts. Duration of Trial.*—In Scouts the duration of the trial is to be of four hours, and full power should be maintained.

3. *Torpedo Boat Destroyers and First Class Torpedo Boats. Duration of Trial.*—In Torpedo Boat Destroyers previous to the "River" Class and First Class Torpedo Boats fitted with reciprocating engines, 90 per cent. of the full power, and in the "River" Class Destroyers and subsequent designs, Torpedo Boats and other vessels fitted with turbine engines, in which measurements of the power developed are not obtainable, the full power is to be maintained for two hours, provided the receiver pressures and revolutions per minute do not exceed those obtained on the Contractor's trials.

4. *Scouts, Destroyers, and First Class Torpedo Boats. Reduced Complements.*—Scouts, Torpedo Boat Destroyers, and First Class Torpedo Boats, in commission with reduced crews, with the exception of tenders to Gunnery, Torpedo, and Submarine Depôt ships and Royal Naval Colleges at Osborne and Dartmouth, are to carry out a trial every six months of four hours' duration at half to three-quarters full power, the Engine-room complements being supplemented as necessary. Torpedo boats attached to Torpedo School Ships or to R.N. Colleges, and running periodically at high powers, will not be required to run quarterly trials or to forward Forms S. 346.

5. *Destroyers. Trial after Refit.*—In the case of Torpedo Boat Destroyers in Commission with reduced crews, when a trial immediately after refit by a Dockyard has been carried out, the next trial should take place at the expiration of six months, or as soon after as possible, from the date of the refit trial and not from the date of the preceding periodical trial.

#### 445.

1. *Coast Guard Ships.*—Ships employed on Coast Guard Service or employed as tenders with reduced complements, are to carry out a trial at the authorised full power once a year, of not less than four hours' duration, the Engine-room complements being supplemented as necessary.

2. *Surveying Service.*—Passage trials are not to be made by vessels employed on Surveying Service.

3. *Submarine Depôt Ships.*—Sea-going ships for service with submarines should carry out an annual trial of four hours' duration at four-fifths the authorised full power.

#### 446.

1. *Indicator Diagrams.*—Except in Scouts, Torpedo Boat Destroyers, and Torpedo Boats, in ships fitted with reciprocating engines, one representative set of Indicator Diagrams which has been taken during each four hours of the authorised full power trial, and one set during each eight hours during the remainder of the passage trial, are, with the usual particulars marked on them, to be forwarded to the Admiralty with the report of trial.

2. The indicated horse-power shown on the report is to be the mean power of the whole period of the trial based on the mean revolutions per minute during that period. See Article 425 as to curves of speed and consumption.

#### 447.

1. *Lubrication.*—The engines should be worked up gradually to the power to be maintained, and the lubrication of the bearings should be carefully attended to.

2. It is expected that the engines and boilers will always be kept in such good order as to render them fit for making a full power trial at any time, but such parts



as stuffing-boxes, escape valves, air and feed pump valves, and the bearings of the crankshafts and connecting rods should more especially be watched and kept in good order, to ensure satisfactory results being obtained.

3. *Air Pressures*.—The air pressures during the authorised full power trial are not to exceed those given in Art. 56.

#### 448.

*Stokers*.—Stokers should be worked in three watches, and when this is not done explanatory reasons should be given in the report of trial as to the necessity for the adoption of any other course; assistance may be obtained from deck for trimming coal, &c., if necessary. (See Art. 60.)

#### 449.

*Report of Trial. Form S. 346. E.R. Register*.—The results of the trial are to be rendered on Form S. 346, and a copy of the report is to be entered in the Engine-room Register. In Scouts and Torpedo Boat Destroyers fitted with reciprocating engines and other vessels in which the power developed cannot be indicated or measured, the receiver pressures are to be recorded in lieu of the indicated horse-power.

#### 450.

*Full Power Trials*.—The Commander-in-Chief will order a full power trial in any case in which he may consider it desirable that such a trial should be made, but this trial is not to exceed in power or duration those laid down in Arts. 442 to 448.

#### 451.

1. *Desirability of Discontinuing Full Power Trials*.—If in the opinion of the Engineer Officer the machinery and boilers are in such a condition as to render it desirable, with reference to the prolonged efficiency of the ship for the general work of the Station, not to subject them to a full power trial, such trial may be omitted at the discretion of the Captain and with the approval of the Senior Officer present.

2. *Report of Omission of Trial. Form S. 346*.—A report, on Form S. 346 of the omission of the passage trial, is to be forwarded without delay at the end of the period during which the trial should have taken place. The report, besides containing reasons for the omission, is to contain a statement as to the fitness of the boilers and machinery to carry out the trial if required, when the reasons for the omission are other than those due to defective boilers or machinery. The results obtained at the first trial at sea and a full report of the last seagoing or other trial, with remarks, are to be inserted. The reasons for each omission of trials subsequent to the last seagoing trial, are to be inserted in the column provided for "present trials."

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### PAYING-OFF TRIAL.

#### 456.

1. *Duration of Trial*.—As soon as possible after a ship's arrival and before she comes into harbour to be paid off, a full-power natural draught steam trial of at least one hour should be made, if practicable.

2. *By whom to be Attended.*—The usual Dockyard Officers are to attend to watch the trial, and should be previously furnished, if possible, with the supplementary list of defects, if any (*see* Art. 66). The results obtained to be reported on Form S. 346.

3. If the ship is to be paid off and recommissioned for Service in the Home Fleet, the Engineer Captain of the Division of the Home Fleet to which the ship is to be attached or his representative should also attend the trial and should be furnished with a copy of the list of defects.

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## SHIPS PAYING OFF.

### 461.

1. *List of Defects.*—On a ship receiving orders to pay off, the Engineer Officer will prepare full detailed statements of all defects known to exist in his department, as well as of all alterations or additions he may have to suggest, and these lists are to be sent in as laid down in Arts. 66. 68.

2. He is also to report any defective ventilation of the engine and boiler rooms, with such remedies as his experience may suggest.

3. *Report of Alterations made and proposed.*—A report is to be made through the Commander-in-Chief of any alterations that have been made in the ship which the Captain considers have proved advantageous to her, together with any suggestions likely, if adopted, to effect a further improvement in the ship. This report is to be sent to the Admiralty.

4. In cases where a survey is due (*see* Arts. 344–346–414) arrangements should be made for the bunkers to be as clear as possible of coal on arrival at the paying-off port.

### 462.

S. 356A. *E.R. Register.*—When a ship is paid off at home or abroad an Abstract on Form S. 356A of the treatment of the boilers during the commission up to the date of paying off is to be attached to the Engine-room Register.

### 463.

*Stokers not to be Withdrawn from Engine-room Department.*—The stokers are not to be withdrawn from the work immediately connected with the Engine-room department, and are to be at the sole disposal of the Engineer Officer in charge to enable that officer to get the department clean and in proper order previous to inspection.

### 464.

1. *Inspection before Paying Off.*—The Captain of a ship ordered to be paid off and re-commissioned for service in the Home Fleet with a nucleus crew, is to report to the Rear-Admiral Commanding the Division of the Home Fleet when the ship will be ready for inspection prior to paying off. *Vide* Art. 414.

2. *Report of Inspection. D. 23.*—This inspection will take place the day before the ship is paid off, or, if more convenient, the same day. The result is to be reported to the Commander-in-Chief on the form provided for the purpose, for transmission to the Admiralty, and a duplicate of the report is to be sent to the Superintendent.

## 465.

1. *Examination of Hull and Machinery.*—A ship ordered to be paid off and re-commissioned for Service in the Home Fleet is to be examined by an Officer deputed by the Rear-Admiral Commanding the Division of the Home Fleet and the Engineer Captain of the Fleet to which the ship will be attached, in conjunction with the Captain and Engineer Officer of the ship, the result being reported on the Report of Inspection (D. 23), (see Art. 464).

2. If, during the examination, it should be found that the condition of the hull or machinery is such as to render the ship, in the opinion of the Examining Officers, unfit for re-commissioning, an immediate report to that effect is to be made to the Commander-in-Chief, for transmission to the Admiralty.

3. Any assistance which may be required by the Engineer Captain in carrying out this examination is to be furnished from the nucleus crews of ships in the Division of the Home Fleet or from the Dépôt on Commander-in-Chief's approval.

4. *Main and Auxiliary Machinery, &c.*—Such parts of the main and auxiliary machinery, boilers, and boiler mountings as may be directed by the Examining Officer are to be disconnected for survey. If the various parts are found to be fit for service, they will be re-connected and left in all respects ready for use at immediate notice.

5. *Engines and Boilers of Boats.*—Engines and boilers of steam boats of ships paying off are to be dealt with as above directed, and, if defective, are without delay to be dealt with on a list of defects with a view to immediate repair.

## 466.

*Ship Paying off to Re-commission.*—A ship ordered to be paid off and re-commissioned for Service in the Home Fleet with a nucleus crew, is, if no survey is due (see Arts. 344-347-414), to be completed with coal and stores. Only such stores are to be landed as require to be replaced or repaired, these latter being dealt with under the ordinary regulations governing the return of stores.

## 467.

1. *Inspection before paying off into Dockyard Hands.*—The Captain of a ship under orders to pay off into Dockyard hands for refit is to report to the Superintendent and the Captain of the Dockyard when the ship will be ready for inspection prior to paying off.

2. *Report of Inspection.* D. 23.—This inspection should take place the day before the ship is paid off, or, if more convenient, the same day; and is to be carried out by the Captain of the Dockyard, Chief Constructor, Chief Engineer, Electrical Engineer, and Naval Store Officer, in conjunction with the Captain and Engineer Officer of the ship. The result is to be reported to the Superintendent on the form provided for the purpose, for transmission to the Admiralty, and a duplicate of the report is to be sent direct to the Commander-in-Chief.

## 468.

1. *Inspection before Paying Off into Dockyard Hands.*—At the time appointed for the inspection of a ship which is to pay off into Dockyard hands for refit she should be thoroughly clean throughout, the bilges and double bottoms should be dry and clean and in a thorough state of preservation, having the paint surfaces in good condition.

2. *Copy of Report of Survey, &c.*—Copies of the last report of survey, and the last report of inspection of accessible places (S. 180), are to be supplied to the Dockyard Officers.

3. *Opening up of Machinery.*—The whole of the main and auxiliary machinery and boiler mountings are to be opened out, and a thorough inspection of them is to be made; and such parts are to be re-connected, after examination, as may be ordered by the Chief Engineer of the Dockyard. Generally the manhole doors of the cylinders, condensers, and boilers are to be left off; and all other water and steam reservoirs and tanks are to be dried out and painted for their preservation. The boilers are to be opened for inspection after being thoroughly cleaned and dried, fires being used for this purpose. *Vide Art. 414.*

4. All stores not condemned as unserviceable, are to be retained for further use in the ship on the account charge of the Engineer Officer, and they are not to be returned into store at the Dockyard.

5. All serviceable stores are to be kept on board the ship, or, if necessary, placed in a suitable lay-apart store in charge of the Engineer Officer.

6. In order that serviceable stores may not be removed from a ship to a lay-apart store unless necessary, the store-rooms of a ship ordered to undergo refit in a Dockyard will be surveyed, repaired, cleaned and painted as necessary before the general overhaul is commenced.

7. All coal and oil fuel is to be removed from the ship unless otherwise ordered. The work is to be done by the crew.

#### 469.

1. *Ineffective Vessels.*—If the ship is ordered to be paid off and placed in the list of Ineffective Vessels, *i.e.*, “ships of comparatively small fighting value,” with a view of being brought forward for service again if necessary the machinery is to be dealt with as follows:—

(a) *Main Engines.*—Pistons and slide valves to be opened out, oiled, and replaced, cylinders and slide casings to be oiled out and covers replaced but not jointed, all packings to be drawn, all parts cleared of water, steel rubbing surfaces to be covered with mineral grease, and all bright work to be coated with white lead and mineral oil.

(b) *Boilers.*—To be emptied, dried out, and preserved by the dry lime process. (*See Art. 163, par. a.*)

(c) *Auxiliary Machinery.*—Cylinders to be opened out and preserved, all packing to be drawn, and all bright parts to be coated with white lead and mineral oil.

(d) *Hydraulic Machinery.*—Tanks to be emptied and preserved with mineral grease, pipes to be drained, all packing and leathers working on steel surfaces to be removed.

(e) *Air Compressing Machinery.*—Circulating water tanks to be emptied of water and preserved with mineral grease, separator columns to be drained, all packing and leathers working on steel surfaces to be removed, and all springs to be preserved with mineral grease.

(f) *Stores.*—To be removed as ordered.

(g) *Coal.*—To be removed unless otherwise ordered.

(h) *Miscellaneous.*—Engines-rooms, boiler-rooms, screw passages, and all machinery, bilges, and inner bottoms are to be thoroughly cleaned.

2. *Sale List.*—If the ship is ordered to be placed on the Sale List for breaking-up purposes—

(a) The machinery is to be left as nearly as practicable complete, with engines, boilers, and spare gear.

- (b) All such fittings are to be removed as may be of use—
- (1) as plant in the Dockyards or for fitting in other vessels, for which an early use is foreseen, *e.g.*, self-contained auxiliary engines ;
  - (2) for utilisation as old metal, *e.g.*, screw propellers and spare blades ; gun and torpedo racers and index plates ; loose brass covers, telegraph and other pedestals ; evaporator, distiller, and condenser tubes ; lubricator and water service fittings.
- (c) The engine-rooms, boiler-rooms, screw passages, and all the machinery, bilges, and inner bottoms are to thoroughly cleaned.
- (d) All coal is to be removed unless otherwise ordered.

3. *Sale List*.—If the ship is ordered to be paid off and placed on the Sale List, to be sold "All standing as she lies" for further service, the procedure is to be as laid down in clause 2, except that no stores or fittings are to be removed, which must of necessity be replaced by the purchaser.

#### 470.

*Inspection of Torpedoes and Electrical Fittings*.—All torpedo and electrical machinery and fittings belonging to ships paid off into the Dockyard hands for refit are to be inspected and tried with steam up by the Dockyard Officers before paying off.

A full report of the result is to be made in duplicate to the Commander-in-Chief, who will transmit a copy to the Superintendent of the Dockyard. Any modifications or alterations considered desirable are to be included in the report.

#### 471.

1. *Survey of Machinery after Paying off*.—Immediately after a ship has been paid off into Dockyard hands for refit, unless the examination has been held before the Captain and the Chief Engineer of the Dockyard will make a minute and careful survey of every part of her machinery and boilers. *Vide* Art. 414.

2. *Engineer Officers to remain for Survey*.—The Engineer Officer will be detained for the purpose if the survey is not completed, and in signing the report it is recognised that he certifies only to that part which relates to the repairs or alterations necessary or recommended for the machinery or boilers.

3. *Water Test of Boilers and Machinery*.—After the paying off of a ship into the Dockyard hands for refit, the boilers are to be thoroughly examined and tested by the Dockyard Officers, but only such portions of the machinery should be tested by hydraulic pressure, and such portions of the spare gear tried in place, as may be considered necessary by the Dockyard Officers.

#### 472.

1. *Drawings to be returned*.—On paying off into the Dockyard hands for refit, the drawings enumerated in Art. 342, with the exception of machinery drawings not confidential, are to be returned to the Dockyard, the usual Form D. 526 being supplied for clearance of the charge. The ship's drawings are to be verified in the Dockyard before the ship is actually paid off and a report made by the officers concerned to the Superintendent as to their completeness or otherwise, in order that the necessary steps may be taken before the Officers separate.

2. *Drawings, &c., to be retained*.—The ship's Steam Manual, sketch book, and all sketches and drawings relating to machinery, except confidential drawings, are to remain in the ship except when the ship is placed on the list of Ineffective

Vessels or Sale list, when they are to be returned to the Dockyard. The Engineer Officer in charge of the machinery at the time the ship is placed on either of these lists is responsible that this is done.

## 473.

*Report as to the Engineer Officer's Performance of his Duty.*—When the machinery and boilers have been thoroughly examined, the Examining Officers have instructions to report whether from the condition of the machinery and boilers, with reference to the time they have been in use and other circumstances, the Engineer Officer appears to have paid proper attention to the care and management thereof, and in all respects to have duly performed his duty; and in cases where repairs have been creditably executed on board, and the state of the engines and boilers evidence superior qualifications on the part of the Engineer Officer, they are to report specially such instances for the information of the Admiralty.

## MISCELLANEOUS.

## 481.

*Pumps, Cocks, Valves, &c.*—The Downton, Electric Motor driven and all other pumps connected with the bilges or double bottoms and the pipes, valves, and cocks belonging to them, all watertight doors, sea-cocks, sluice, Kingston, and other valves are under the care of the Engineer Officer, who is responsible for their efficiency, and repairs will be performed by the Engine-room Staff, but in cases where the defects are beyond the resources of the ship, they should be included in the Defect List. The rigging of the pumps, care of the hoses, sounding different compartments, &c., are parts of the duty of the Carpenter. As many watertight doors, manholes, sluice valves, &c., as practicable are to be kept closed at all times.

## 482.

1. *Watertight Doors, Valves, &c.*—The sea-cocks of pumps are to be opened and closed daily. The watertight doors, except those permanently closed, sluice valves between the compartments, Kingston, flooding and other sea-cocks and valves, are to be opened and shut once a week, to ensure their being in good working order; but on no occasion is any one of them to be opened or shut except under the superintendence of one of the Engineer Officers, a competent Engine-room Artificer, or a Chief Stoker, who is to be held responsible for their being closed when not in use. (See also Art. 542.)

2. *Flooding Valves of Magazines, &c. E.R. Register.*—Flooding-valves of magazines, shell-rooms, store-rooms and spirit-rooms are to be worked weekly under the directions of an Engineer Officer. In vessels where the number of flooding valves is greater than can be conveniently and efficiently worked once a week, in accordance with the above directions, the valves, including locked valves, may be divided into two, three, or four groups, each group to be worked in rotation, and every valve to be worked, and the working gear cleaned and examined during the course of a month. The number and situation of the valves worked each week to be entered in the Engine-room Register.

3. As cases have occurred in which magazines have become accidentally flooded, apparently through an erroneous impression that the flooding valve is of necessity

hard down on its seat when the indicator stands at "shut" on the deck-plate, and also through insufficient observation of the flooding inlet to the magazine after the flooding valve has been screwed down, locked and covered, attention is drawn to the necessity of screwing the valve hard down on its seating in all cases, without reference to the exactness of coincidence of the indicator with the "shut" marked on the deck-plate. Although the gear is so fitted at first that the indicator stands exactly at "shut" when the valve is hard down on its seating, the indicator must be screwed somewhat beyond this position when the valve has become compressed and the backlash of the gearing has increased by wear to an extent which depends on the amount of compression and wear that has taken place.

4. *Inlet to be inspected.*—The effective shutting of the valve is in all cases to be ascertained by close inspection at the flooding inlet in the magazine after the valve has been screwed down, locked and the deck-plate cover put on. Nothing should be done to the valve or any part of its gearing or deck-plate after the inspection in the magazine as to watertightness has been made without making a subsequent inspection.

5. *Adjustment of Gearing.*—In all cases the various parts of the valve gearing, the thickness of the valve, &c., are to be kept in such adjustment as to admit of the valve-rod being locked when the valve is hard down on its seating.

6. *Inlets usually inaccessible.*—In such cases as valves for flooding wing bunkers where the inlets from flooding valves are usually inaccessible, the valves should only be worked when the bunkers are empty or the inlets otherwise accessible.

#### 483.

*Compartment damaged by Collision.*—In the case of a compartment damaged, by collision or otherwise, so as to admit water, the sluice valves on the bulkheads of this compartment are *not* to be opened until the ingress of water has been entirely stopped.

#### 484.

1. *Arrangements for closing Doors, &c., promptly.*—The Engineer Officer, besides preparing the Station Bill (Art. 71), is to take steps to ensure that every person under his control shall know his post and be capable of performing his duty, so that in case of emergency the watertight doors and sluice valves may be closed and the flooding-cocks and sea suction opened speedily and without confusion.

2. Those of the Engine-room Staff, who are not actually detailed for definite duty in action, are to be exercised so far as practicable during general quarters, in dealing with possible emergencies, in order that the Staff may become familiar with the steps required to be taken.

#### 485.

1. *Watertight Doors.*—Constant attention is to be paid to all watertight doors, valves, and fittings, to ensure them being in a state of thorough efficiency and watertightness, and they should always be kept clear for immediate closing. No fitting of any kind is to be allowed which will require to be removed before the doors can be shut. Certain doors are to be permanently closed, and doors fitted for facilitating the removal of certain parts of auxiliary machinery should be kept closed and watertight until actually required for use.

2. *Armoured Hatches*.—The securing of catches of all armoured hatches is to be carefully examined once a week. The angle bars carrying the catch are to be rendered immovable by riveting them to the bulkhead, and the keep screws to the securing catch are to be secured in place by riveting over their points.

The Weston purchases are to be kept shackled to the hatches and are to be similarly examined once a week, and should it be necessary to remove the Weston purchases for repair or other reason, the jigger or luff used to replace them is to be shackled to the attachments at both blocks to prevent its being accidentally unhooked.

3. All watertight doors and valves below the protective deck, automatic or otherwise, are to be closed by hand as soon as the anchor is off the ground, and not opened until the anchor is let go again except in the following cases:—

- (a) For purposes of ventilation for half-an-hour in the day or for as long as considered absolutely necessary by the Captain.
- (b) In parts of the ship which it is absolutely necessary to keep constantly ventilated, such as where men are employed or sleeping.

In both the above cases, men should be specially stationed to close by hand, if required, all openings which are of necessity left open.

4. At sea, doors are to be kept closed in the engine-rooms and stokeholds, with the exception of such bunker doors in each stokehold as the coal is being worked from.

5. The instructions contained in clause 4, are to apply for the present to the following classes of ships only:—

<i>Battleships.</i>	<i>Cruisers.</i>
Dreadnought.	Invincible.
Lord Nelson.	Minotaur.
King Edward VII.	Duke of Edinburgh.
Bulwark.	Drake.
Duncan.	Devonshire.
Triumph.	Monmouth.
Canopus.	Cressy.

and any future ships.

In ships other than the above, the doors referred to may be opened at sea, provided that men are stationed to close them at once, if required, deck hands being employed for this duty when the circumstances render this necessary.

All bunker doors, however, other than those from which the coal is being worked, are to be kept shut.

#### 486.

*Compartments to be tested periodically*.—The compartments of ships are to be tested periodically for watertightness. One compartment, selected by the Commander-in-Chief, will be flooded to test its efficiency once a year in each ship. If the compartment selected is a small one no previous notice will be given. If it is intended to test a large one, opportunity should be taken of the ship being in dock. The keel should rest entirely on the blocks, sufficient water only being removed from the dock to allow this being done, the vessel being adequately shored for that purpose by Dockyard staff as necessary. Due precautions are to be taken to remove any stores or fittings liable to damage.



## 487.

1. *Bilges*.—All bilges are to be kept thoroughly dry, especially in spaces below boilers. No refuse of any description is to be allowed to accumulate in them, nor in the double bottoms or other confined spaces.

2. *Main Drain*.—The main drain is to be flushed and cleaned regularly and frequently.

3. *Examination of Bilge Suction Valves*. *E.R. Register*.—The bilge suction valves of main circulating engines are to be examined and cleared at least once a quarter, and a notation that this has been done is to be made in the Engine-room Register.

## 488.

*Plugs to discharge Valves*.—When a ship is docked for the examination of the Kingston valves, sea-cocks, &c., the plugs for the discharge valves are always to be fitted in place. Except in the case of a new ship, or a ship in the Dockyard Reserve, this duty is to be carried out by the Officers of the ship. (*See Art. 27.*)

## 489.

*Water Ballast*.—Whenever water ballast is admitted into the ballast compartments of ships, care should be taken that the water is clean, and that the compartments used are kept quite full. No compartment is to be either filled or emptied without the knowledge of the Engineer Officer, who is responsible for the efficiency of the flooding-cocks, sluice valves, and pump suction. The Carpenter will sound the compartments morning and evening, and report their state.

## 490.

1. *Holes not to be cut without Authority*.—No holes not provided for in drawings or specifications furnished from or approved by the Admiralty, are to be introduced into any part of a ship without the concurrence of the Dockyard Officers; and in cases where the safety of a ship may be affected, no holes are to be made in any part of the hull without the special approval of the Admiralty.

2. *Valves for closing how to be worked*.—In cases where watertight bulkheads are cut through, the valves for closing the communication at the bulkheads should, if possible, be worked from a position immediately adjacent to that from which the watertight doors in the same bulkheads are worked.

3. *Position Plate for working Valves*.—In all cases a conspicuous plate should be put upon the deck platform or bulkhead close to each position for closing the watertight doors, stating in legible characters the position from which the adjacent valve or valves may be closed.

## 491.

1. *Hydraulic Jacks*.—Fresh water is to be used in hydraulic jacks on ordinary occasions. When it is probable that the temperature will be sufficiently cold to freeze water, spirit (rum) or glycerine in the proportion of one to two of water is to be mixed with the water in the jacks.

2. The jacks are to be pumped up once a week, the rams cleaned and oiled, and then run down. The jacks are at full height when the water comes out of the small hole behind the claw.

3. *Method of Charging.*—To charge a hydraulic jack, care is to be taken that the ram is quite home, and then the cistern is to be filled with clean water.

4. If the valves fail from disuse, screw up the lowering screw tight, then stand the jack upon its base, and pull the cylinder up upon the ram; this will cause a rush of water through the pump, and so cleanse it.

#### 492.

1. *Instruction of Stokers in Torpedo Boat Duties.*—Stokers, 1st and 2nd Class, will be trained in the working of machinery and management of boilers of torpedo boat destroyers or torpedo boats, and passed as qualified on giving proof of satisfactory proficiency, and a notation is to be made on their history sheets.

2. The instructions in these duties will be given by Engineer Officers under the directions of the Commodores of the Depôts at Portsmouth, Devonport, and Chatham, and the Senior Officer at Malta and Hong Kong, and other foreign dockyards where torpedo boats are stationed, and may also be carried out in torpedo boat destroyers attached to the various fleets, under the direction of the Commanders-in-Chief.

3. The length of training is to be ten working days, and during this time, at least ten runs of not less than four hours' duration should be carried out.

4. Stoker ratings who have served for six months on board a sea-going vessel in commission, fitted with water-tube boilers of the small tube type, and who are able to keep steam satisfactorily when the engines are running at or near the authorised natural draught power on quarterly passage trials, may be passed as qualified without being required to undergo the special instructions prescribed in Clause 1.

#### 493.

*State of Wire Rope.*—The Engineer Officer should, by frequent examination, keep himself thoroughly acquainted with the state of all steel wire rope which is placed in his charge, and all such wire rope should be subjected to a dead load test at intervals not exceeding two years, and for this purpose, where necessary, the wire is to be unrove by the ship's artificers and sent to the dockyard for the test to be applied. But, wherever practicable, wire rope is to be tested by the ship's staff with appliances on board, and the Officers of the ship are to satisfy themselves as to the apparent condition of the rope before the test is made.

#### 494.

*Testimonials to Contractors.*—Certificates or testimonials are never to be given by any of the Officers of His Majesty's ships to Contractors or other persons from whom supplies may have been purchased.

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### COAL, COAL-BUNKERS, OIL FUEL, &c.

#### 506.

1. *Coal.*—The most important item of expenditure is fuel, and the Engineer Officers are to endeavour in every possible manner to economise its use.

2. *Economical Consumption to be ascertained.*—The Engineer Officer should ascertain the most economical rate of consumption per square foot of fire-grate, so that he may know exactly the number of boilers it will be necessary to keep in use for any required rate of speed.

3. *Appliances for Economising Fuel. E.R. Register.*—All appliances fitted for economising fuel are to be used, except under special circumstances, when the reasons for not using them are to be fully entered in the Engine-room Register.

### 507.

1. *Careful Stoking.*—The Engineer Officer of the watch is to pay particular attention to the careful and regular stoking of the fires, and see that the steam pressure and water level are kept constant, and that there is no waste by steam blowing off from the safety valves.

2. *Supply of Air.*—He is to give his best attention to all appliances which may be fitted for regulating the supply of air to the Boiler-rooms, for upon the judicious management of the air supply will often depend the whole difference between the perfect and imperfect combustion of the various descriptions of coal which are supplied to His Majesty's ships. (See Art. 56.)

3. *Small Coal.*—The small coal that falls through the fire-bars and all partially burnt coal should be reburnt, and the fires should not be unnecessarily forced or disturbed.

4. *Fenders to Ashpits.*—All ships with water-tube boilers, except torpedo boat destroyers, are fitted with fenders to their ash-pits, in order to prevent coal from being inadvertently pushed into the ash-pans and to facilitate shovelling.

### 508.

1. *Quantity received on Board.*—On receipt of coal on board ship, either from any of His Majesty's coal depôts, &c., or from Contractors, the Engineer Officer is to satisfy himself at the time that the quantity is substantially correct, and so far as possible, in case of supply from a contractor, that the quality is in accordance with the conditions of the contract.

2. *Coal in Lighters.*—If brought alongside in lighters, the contents of the lighters should be ascertained by measurement, except in the case provided for in Clause 6, and if delivered in bags or baskets, &c., the bags, baskets, &c., are to be counted, and 10 per cent. of the total number weighed, care being taken that those weighed are selected indiscriminately, and not in any special rotation.

3. *Differences.*—In proving quantities by this method, it is to be borne in mind that the result can only be approximately correct, even if the greatest care is taken, as the turn of the scale alone may make a considerable difference.

4. *Coal in Colliers.*—When coal is received direct from a collier, if there is substantial agreement between the quantity expressed in the Bill of Lading and that of the coal weighed out to the several ships ascertained as directed in Clause 2, a receipt is to be given for the Bill of Lading quantity.

5. *Settlement.*—Any difference of opinion as to the quantity, &c., is to be settled at the time of receipt. Any such settlement, whether with the Storekeeping Officer, Contractors, or Master of a collier, &c., is to be stated in detail upon the receipt given for the coal.

6. In whatever manner the coal is supplied, the weighing or other check of quantity, whether it takes place on shore or at the ship's side, shall be attended, whenever practicable, by an Officer or other person from the ship and an agent of

the Naval Store Officer or Contractors (as the case may be) at the same time, so as to ensure that an agreement as to the quantity supplied shall in all cases be arrived at on the spot. When the weight of the contents of lighters has been thus ascertained and it is not convenient to receive the coal on board immediately, precautionary measures—*e.g.*, sealing the hatches of the lighters, mooring the lighters near the ship, or setting a watch on them—are to be taken to prevent the contents from being tampered with. Whenever coal is sent alongside in lighters, the contents of which have not been already ascertained and agreed to by the ship's Officers, the agent of the Naval Store Officer or Contractors is to be called upon to produce a "boat note," or other memorandum, of the contents of each lighter, so that if there should be any deficiency of quantity, the particular lighter or lighters in which it occurs will be known at once and investigation facilitated accordingly. In the case where Dockyard lighters marked with load lines are used, the quantities in the lighters verified from the Dockyard Book kept for the purpose, are to be sent off with the Boat note and the attendance of the Agent of the Coal Depôt for the purpose of checking weights may be dispensed with.

7. Prior to commencing coaling operations the officer or other person in charge of the coaling gear is to count over to an Officer of the ship to be coaled all the articles in his custody and a voucher is to be presented for signature showing the number of each description on board. After coaling is completed the gear should be again counted in the presence of an Officer of the ship to ascertain the extent, if any, of the losses, and a final agreement should be arrived at in writing on the spot.

8. *Report after Coaling.* S. 229.—A report on Form S. 229 is to be made on each occasion of coaling direct from a collier, showing whether there has been any loss of coal or coaling gear, and whether any discrepancy occurred between the quantity of coal estimated to have been put on board and that ordered to be taken on charge. Instructions as to rendering the form are printed thereon.

9. Where no special instructions to the contrary have been inserted in the Captain's ship's book, the coal-bunkers may be completely filled. The "authorised" complement of coal simply represents the amount of coal which is taken for design purposes as the quantity to be carried at the estimated load line, and on the speed trials. (*See Art. 513.*)

## 509.

1. *E.R. Register.*—The description of the coal, the place from whence it was received, and the date of its being placed in the depôt or the collier are to be inserted in the Engine-room Register. Should different descriptions of coal be taken on board at the same time, the Officer superintending the coaling is to see that any necessary separation or admixture is effected, as far as possible, while the coal is being stowed in the bunkers.

2. The Captain will be furnished from Naval Establishments whenever storage arrangements render it practicable, or by the Contractors, with full particulars as to the exact description of all fuel, whence obtained, and the date of being placed in the Depôt or Collier, whenever coal or patent fuel is received from them.

## 510.

1. *Report when Quality of Coal is inferior. E.R. Register.*—If the coal supplied should appear to be of inferior quality, or should it be found to possess peculiar qualities as to waste, smoke, or difficulty in generating steam, full particulars should be carefully noted in the Engine-room Register, and a report,

by letter, immediately sent to the Admiralty, accompanied by all the particulars as to the name, source, and age of the coal.

2. If the coal is being received direct from Contractors the obligations specified in the conditions of contract should be ascertained and enforced.

### 511.

*Coal for Torpedo Boats and Destroyers.*—*Torpedo boats* when employed in actual war or in the yearly manœuvres are to be supplied with the special steam trial Welsh coal where it is kept in store, and at the other depôts with the ordinary Welsh coal hand-picked. When not so employed they are to be supplied with the ordinary Welsh coal not hand-picked. *Torpedo boat destroyers* are to be supplied with ordinary steam vessel Welsh coal for general service, and with hand-picked coal when the service on which the vessel is to be employed is such as to necessitate the occasional development of the highest possible speed and power.

### 512.

1. Before coaling commences, the coal remaining in the bunkers is to be carefully examined to ensure its being in a normal condition, and as far as is practicable, the coal lying in remote corners should be trimmed nearer the bunker doors so as to prevent quantities of coal remaining in bunkers for an unduly long period. During the examination of the coal the precautions laid down in Art. 514 are to be strictly observed.

2. *Gas in Coal Bunkers.*—Coal should not be taken on board wet, as moisture sometimes causes a rapid and dangerous generation of heat and gas. Before the decks are washed after coaling, the bunker covers are to be replaced, to prevent water passing into the bunkers; and the coal should always be kept as dry as possible.

3. *Ventilating Pipes.*—The ventilating pipes to bunkers, when so fitted, should be kept clear. Care is to be taken that the louvres fitted to these pipes are always locked and open for ventilation except when at work under forced draught.

The special keys provided for the locks on these louvres are to be in the custody of the Engineer Officer of the ship who is responsible for their use.

At least once a quarter, the bunkers are to be put under air pressure, by means of the stokehold fans, and the ventilation pipes cleared of accumulations of dust by opening the louvres and blowing through to the upper deck. For this purpose opportunities should be selected before coaling ship when no large quantities of dust are being raised in the bunkers. Should any pipes appear to be choked to an appreciable extent, they are to be cleared at the first opportunity.

4. *Coal-shoots.*—Directly after the coaling is completed, the Engineer Officer is to see that the coal-shoots are quite clear of coal.

5. *Properly closing Bunker Doors.*—Care is to be taken that rapidity of coaling is not allowed to interfere with the proper closing of any door in the bunker. The fact that all bunker doors are completely secured and made watertight is to be reported by the Engineer Officer to the Captain after coaling, and his attention is to be called to any difficulty experienced in closing them as the coaling proceeds. (*See also Article 517.*)

## 513.

*Stowage of Coal. Ventilation.*—The coal stowage in the bunkers is to be limited to the height of the lower edge of the beams, and the preservation of a vacant space for ventilation over the whole surface is to be thus secured. The contents of the bunkers are to be calculated on this basis.

## 514.

1. *Safety Lamps.*—No naked light, is to be used inside the coal-bunkers, or within 20 feet of any opening into the Bunkers, until it has been ascertained by means of a safety lamp, that they do not contain explosive gas, and special precautions in this respect are to be taken for a few days after coaling. In any case in which the distance of 20 feet is impracticable the distance maintained should be as great as possible.

2. The Engineer Officer is to satisfy himself personally that all Petty Officers and men of his department are specially instructed in the precautions necessary in these cases; and in considering candidates for advancement, their knowledge of this subject is to be ascertained by examination, and noted on their passing certificates. (See also Article 351.)

3. To prevent unauthorised interference with safety lamps when in use in dangerous places, the Engineer Officer, is to make arrangements for trimming the lamps before they are issued, and for the keys to be retained by some responsible person.

4. In ships with upper bunkers, on the first occasion after coaling, when opening the doors between the upper and lower bunkers, a safety lamp only is to be used, and the man holding it should remain on the deck above at the top of the coaling trunk while the door at the bottom is being unfastened, in order that the flame of the lamp may be observed and the lamp removed in the event of inflammable gas coming from the lower bunker into the trunks when the fastenings of the doors are slackened.

5. The portable electric lamp, fitted in bunkers, when not in use, is to be hooked up inside the box, switched to "off" and the box closed. Care is to be taken that lamp is not left where it can be covered by coal. If, by any accident, the lamps or circuits are buried so that they cannot be cleared, the holders should be disconnected from the socket, the box closed and cut outs removed from the feeding distribution box.

The good condition of the leads and connections of the portable electric lamps used in or near bunkers should be ascertained. Any leads or lamps liable to sparking should not be used.

## 515.

1. *Bunker Lids.*—Where coal-bunkers are not provided with permanent ventilating fittings, the lids are to be taken off four times a week and kept off for not less than three hours each time. Every precaution is to be taken to ventilate such bunkers before men are sent to work in them.

2. *Ventilation, Principle of.*—It should be borne in mind that to render the ventilation efficient, there must be at least two openings—one for the admission of pure air, the other for the escape of foul air—and, where the permanent ventilating fittings do not include both, the bunker lids are to be taken off periodically as specified above.

3. In all vessels which have fixed coaling shoots the bunker lids at the top of these shoots are to be removed for three hours every day for six days after coaling, and for three hours once a week afterwards.

4. *Time Lids are off. E.R. Register.*—The number of hours the bunker lids are off is to be noted in the Engine-room Register.

### 516.

1. *Bunker Ventilating Arrangements.*—Owing to the breaking up of the surfaces of the coal, the evolution of gas is very rapid during, and for some days after, the operation of coaling ship.

2. Directly after the coaling is completed, or on the cessation of coaling for the day, should the completing with coal extend over more than one day, the Engineer Officer is to satisfy himself that Arts. 512 to 515 inclusive have been complied with, that the inlet and outlet ventilating orifices in the bunkers are all clear, and that all ventilating valves and louvres are fully open; having done so, he is to report to the Commanding Officer that all bunker ventilating regulations have been complied with.

### 517.

1. *Bunker Doors, Armoured Shutters, &c.*—All bunker doors, armoured shutters, &c are to be kept closed, except when actually required for use. Whenever doors or shutters between upper and lower bunkers, or any other bunker doors, are about to be closed, the jointing surfaces of the doors or shutters and their framing, are to be thoroughly cleaned, under the superintendence of a trustworthy Petty Officer or higher rating; in the case of hinged doors, he is to see that the india-rubber of the door and the seating upon which it closes are in good condition and the clips properly set up, and where covers are fitted in the floor of the upper bunkers, he is to see that they are well jointed with red lead or other jointing material.

2. A report is to be made accordingly to the Engineer Officer.

3. When practicable, an Engineer Officer is to inspect all bunker doors, shutters, &c., after closing.

### 518.

*Temperature in Coal bunkers. E.R. Register.*—The temperature in the coal-bunkers and oil-fuel compartments is to be ascertained and noted in the Register every four hours when under steam, and once every twenty-four hours when not under steam, unless the temperature in them is found to be increasing, when it is to be obtained as often as considered necessary until the temperature is reduced to its normal condition.

### 519.

1. *Trimming Coal in Bunkers.*—Such arrangements are to be made as may be necessary for trimming the coal in the bunkers down to the bunker doors, during the intervals between steaming or when under easy steam; this is especially necessary preparatory to proceeding at a high rate of speed. The Engineer Officer is to keep the Captain informed of the general distribution of the coal in the bunkers, and the quantities available in close proximity to the stokehold bunker doors.

2. The Coal Trimmers are to be trained to fill the coal buckets, and be careful in tallying them, and the Chief Stokers, Stoker Petty Officers, and Leading Stokers are to consider it an important part of their duty that the coal is correctly charged.

3. *Stowage of Coal when preparing for Action.*—When preparing for action, as much coal as practicable should be stowed on the stokehold plates along the bulkheads clear of the fittings and without obstructing the firing.

4. *Bunker doors in Action.*—To enable the coal which is stowed on the stokehold plates to be readily replenished by opening the least possible number of doors during an action; the work of trimming, on leaving a coaling base with refilled bunkers, should be so arranged that in those bunkers which are nearest the boilers, an ample reserve of coal will be kept instantly available for use, if required in action.

5. To enable any bunker door to be closed quickly, after having been necessarily open before or during an action, care is to be taken that the amount of opening of vertical sliding doors is limited to the smallest amount necessary, and in the case of hinged doors, that the run of coal is cleared away as soon as possible.

6. When an action is imminent and before the ship is within range of the enemy's fire or becomes liable to torpedo attack; all bunker doors will be required to be closed and made watertight.

7. The stokehold staff should be frequently exercised in rapidly cleaning and closing all doors of bunkers, from which coal is worked, in order that preparation for action in this respect may be completed during the few minutes which may elapse between sighting and engaging an enemy.

8. By using oil fuel the opening of bunker doors during an action can be deferred for a much longer time than when coal alone is used. This is one advantage of oil fuel, and it is expected that by proper training of the staff the amount of smoke made under these conditions will be practically the same as when burning Welsh coal alone. There may, however, be circumstances in which it is known that the volume of smoke will be increased under these conditions; the course to be pursued should, therefore, in all cases be previously considered and decided by the Commanding Officer.

9. Arrangements should be made to keep the Engineer Officer of the watch informed as to whether the port or starboard bunkers are the less exposed in case the opening of bunker doors becomes unavoidable while the ship is exposed to hostile fire.

10. In ships not provided with ash-ejectors, ashes should be frequently cleared and sent up as the time of action approaches, in order that a rapid clearance may be made immediately before the action commences and the doors in the protective decks are closed. During an action ashes should be stowed in sacks wherever practicable in order to defer opening the doors in the protective decks as long as possible.

## 520.

1. *Coals, &c., for Culinary Purposes.*—The Engineer Officer is to supply coal and wood to the ship for culinary purposes, showing the expenditure of the same in his Store Accounts.

2. All casks and cases not specially ordered to be preserved are, when empty, to be broken up and used as fuel. A receipt from the Engineer Officer approved by the Captain, for the numbers of each description, is to be given to the Paymaster.

Each of the following quantities is to be considered as a fathom of firewood:—

- 54 Salt Meat Barrels; or
- 65 Salt Meat Half Hogsheads; or
- 70 Suet Casks.



## 521.

1. *Scale of Measurement.*—Whenever surveys are held on the remains of coal ashore or afloat, the following scale of measurement is to be adopted, viz. :—

1 ton of Welsh coal	- -	40 cubic feet.
1 ton of North Country coal	-	43 cubic feet.
1 ton of Patent Fuel	- -	36 cubic feet when systematically stacked on shore or in rectangular spaces on board.
1 ton of Patent Fuel	- -	45 cubic feet when shot into bunkers.
1 ton of Westport Coal	- -	44½ cubic feet.

2. *Quantity in Ship.*—This scale is also to be used to measure the weight of coal in bunkers and holds of ships. By making suitable marks for definite quantities on the bunker sides there will be no difficulty in ascertaining, at any time, the approximate quantity of coal in the bunkers, and they are to be frequently examined to verify the amount on charge.

*Note.*—The capacity marked by Dockyard on each bunker is calculated at 43 cubic feet per ton.

## 522.

*Coal used on Colonial Service.*—The coal expended on Colonial service, when directed by the Captain, is to be distinguished in the Store Accounts and a return of the quantities consumed and of the local rates at which the issues should be computed, duly approved by the Captain, and certified by him to be a transcript, as to quantities, of the Ship's Expense Accounts, will be forwarded on each occasion by the first opportunity to the Accountant-General of the Navy. A comparison of these returns will be made with the Store Accounts of the ship when received.

## 523.

*Precautions in Bunkers when Coaling.*—In coaling, if it should be desired to keep the cover of the escape scuttle in place, it should be left in the unlocked position, and the grating removed so as to facilitate escape from the bunker in the event of necessity arising.

## 524.

1. *Oil Fuel, Instruction in use of.*—Every precaution is to be taken to prevent accumulations of oil fuel on floor-plates or in the bilges.

2. When using oil fuel it should be heated so as to have a temperature of about 200° F. at the burners. Unduly heating the oil renders it liable to decomposition, attended by a deposition of carbon tending to choke the heater tubes, filters, and pipes. When easing down or steaming slowly, care should be taken that the steam inlet valves to the heaters are regulated so as to adjust the temperature.

3. Every care is to be taken to prevent leakage of oil through the tube ends of the oil heaters. If leakage does occur, the oil is liable to mix with the feed water and cause damage to the boilers. The oil pressure should be, whenever possible, lower than that of the steam supply to the heaters, and the water-collectors are to be occasionally drained in order to test the absence of oil in the water.

4. After using oil fuel, and before again lighting up, care is to be taken that ashpits and furnaces are well ventilated.

5. When burning coal and oil, care should be taken to prevent accumulations of coal in front of air cones, and coal should be kept well clear of the dead plates.

6. The whole of the oil system between the pumps and the sprayer spindles should, on all occasions after overhaul, before the oil is heated, and before lighting up, be put under the maximum working oil pressure by means of the pumps, in order that any leakage may be detected.

7. When a sprayer is lighted the oil supply should always be turned on gradually. A sprayer should never be left in place disconnected, and, if it is removed for any length of time, a screwed plug should be inserted in the union at the end of the supply pipe.

8. Should a leakage of oil occur, the oil supply is to be immediately shut off by means of the stop valves provided and the oil pump stopped. Engineer Officers are to impress upon their staff the importance of this action, and are to see that they understand how to carry it out.

9. In ships fitted with oil-burning arrangements and arrangements for discharging oil fuel through the common filling pipe by means of the oil fuel pump, the pressure at the pump is to be limited to 40 lbs. per square inch when using this discharge, by adjusting the pump relief valve.

10. The outputs of the sprayers fitted to the same boilers, are in some cases different in different positions with regard to the furnaces. The outputs of sprayers and their respective positions should be noted in the ship's Steam Manual.

11. The steam side of the heaters not in use should be kept dry, the drains left open to the bilge, and any drainage frequently observed in order to detect leakage of oil.

12. Where oil fuel pipes are subject to the heat of stokeholds or steam-pipes, valves should be opened as necessary for preventing pressure arising from expansion of the oil.

13. Pressure gauges fitted in the oil fuel system should generally be left uncovered to enable any pressure to be observed.

14. In the instruction of Engine Room Ratings in the burning of oil fuel, Engineer Officers are to be guided by Memoranda N.S. Coal 35/1892 of 17th February 1908 and S. 359 August 1909.

15. In ships fitted to burn oil fuel arrangements are to be made for the instruction of Engineer Officers and Engine Room Ratings in the construction of the fittings and of the proper methods of working them efficiently. The Engineer Officer should frequently test the knowledge of the men so instructed.

16. In ships fitted for burning coal and oil fuel, oil fuel may be used for instructional purposes both at sea and in harbour. In harbour it may be expended at the rate of three tons per week. At sea it may be used for an average of about 48 hours per month for three months at the beginning, and for an average of about 24 hours per month for the remainder of the vessel's commission. The oil fuel is to be burnt in one boiler room at a time in conjunction with coal, and its use is to be discontinued when a sufficient number of officers and ratings are trained in the fleet or squadron to which the ship is attached. The proportion of oil fuel to coal consumed at sea may be varied as found convenient. At the maximum rate at which it is burnt in any boiler the quantity of oil per hour is not to exceed 30 per cent. of the combined fuel required per hour when developing the authorised full power of that boiler. The use of oil fuel for short periods in all the boilers concurrently is dealt with in Art. 442, clause 3.

17. Precedence in training should be given to Chief or other P.O.s. When ratings have qualified the fact is to be noted on their service certificates.

18. Only those officers and ratings who have qualified in oil fuel are to be employed in giving instruction. In ships fitted to burn oil fuel, should the number of qualified ratings be insufficient for giving the instruction; qualified ratings for this purpose are to be temporarily lent from another ship in exchange for an equal number of unqualified ratings. Arrangements are also to be made for temporarily detaching ratings for instruction, in order to increase the number of those qualified in the use of oil fuel. A course of instruction will usually occupy about 10 days for a class of 12 ratings.

### 525.

*Internal Combustion Engines.—Flash Point.*—The oil supplied for internal combustion engines fitted in H.M. ships and ship's boats has a flash point of not less than 200° F. No oil of lower flash point is to be used in connection with these engines. Mineral Colza is to be used where necessary for cleaning valve spindles, &c.

### 526.

1. *Oil Fuel Compartments.*—The oil fuel compartments are provided with permanent air pipes, and naked lights are not to be brought into the vicinity of their outlet ends.

2. Only portable electric lights or safety lamps are to be used in oil fuel compartments, and these compartments are only to be opened in the presence of an Engineer Officer. It should be ascertained that the electric leads and connections of the portable lamps in use are in good condition and that no sparking is likely to occur. Locks or special spanners are provided for securing valves and manhole doors of these compartments. The Engineer Officer is to be responsible for the safe custody of the keys and spanners.

3. It should be noted that a great difference exists in the ventilation of oil fuel compartments and that of ordinary coal bunkers. In the latter case the gases produced are generally lighter than air, and are consequently dissipated by a supply of fresh air over the top of the coal, with an outlet also at the top. The vapours however, in oil fuel compartments are heavier than air, and are not displaced by ordinary ventilation.

4. Before any compartments which have contained oil fuel are entered, they are to be cleared of oil as far as practicable by the oil fuel pump, and are then to be pumped dry by the hand residue pump. To expel any foul air or gases, and to assist in clearing out the residue, the compartments are then to be filled with sea water from the fire-main through the oil-filling pipes. Care is to be taken that the compartments are quite full by observing the head of water at the funnel break in the filling pipe, water being run in until the level remains constant at the funnel break. The compartments are then to be pumped out as dry as possible, and the operation repeated if considered necessary.

5. In addition, the instructions contained in Article 351 are to be strictly observed.

### 527.

1. *Patent Fuel.*—Patent fuel stowed in confined spaces as additional protection is only to be used as fuel once in each two years' commission, and as near as

possible at the end of the commission, in order to facilitate inspection of such spaces, and to facilitate any necessary work being done on them. Except under these circumstances it should only be used in cases of emergency.

2. Under no circumstances is patent fuel to be stowed in confined spaces except when perfectly dry.

3. Spaces fitted for containing patent fuel, and not fitted with permanent ventilating arrangements, should not, under ordinary circumstances, be used for the stowage of coal. Should it, however, be necessary in case of emergency to utilise these spaces for coal, every precaution as to a possible explosive mixture of gases being present at any subsequent opening of the spaces is to be taken.

## OIL.

### 528.

1. *Oil for Lubrication.*—The Engineer Officer will adopt the best method at his disposal to ensure that the oil used for lubrication is not wasted. He is to ascertain that the oil-ways and distributing grooves in all bearings are sufficiently large, and that they are always clear, that the lubricator worsteds are of the best proportions as to length and thickness, are properly adjusted, and of sufficient number. The height of the oil in the oil boxes should be definitely ordered for the powers developed, and carefully maintained with the minimum variation possible as even a slight variation in the oil level has a considerable effect on the quantity of the oil supplied by the worsteds to the bearings. He is to see that efficient save-alls are fitted with proper means for draining them so as to prevent oil falling into the bilges, and he is to utilise, as far as possible, the oil collected from the save-alls for some purpose connected with the preservation of the machinery.

2. *Tallow.*—Only a small quantity of tallow and mineral grease will be supplied for the machinery where surface condensers are fitted, to be used for keeping the engines and spare gear from rusting, and for the lubrication of those parts of the machinery (other than the internal parts) where it may be more effective than oil and for greasing packing.

### 529.

*Oil for Lighting.*—The Engineer Officer is to supply oil for lighting purposes, except Mineral Sperm which will be supplied by the Carpenter, showing the expenditure of the same in his Store Accounts.

### 530.

*Stowage of Rapeseed Oil.*—Every care is to be taken to prevent the rapeseed oil intended for lighting purposes on board ship being spoilt by admixture either with other oil or with water, or by exposure to the air, the rust of iron, or other extraneous influences; and to ensure that the iron tanks and cans are perfectly clean and dry before rapeseed oil is placed in them.

### 531.

1. *Tanks for Oil.*—The tanks for the storage of rapeseed oil for lighting purposes are not to be fitted with connections to any other tanks in which other

kinds of oil are stored; and the Engineer Officer is to see that each tank is distinctly marked with the description of oil it is intended to contain; and if the tank is fitted to be filled from the deck, to see that the covering plate is distinctly marked.

2. No cement or enamel is to be used in any of the oil tanks.

3. Whenever an oil tank is emptied, the opportunity should be taken to clean it thoroughly, to ensure that when fresh oil is taken on board the oil shall not be impaired by any refuse remaining in the tank. Means should also be taken to see that the gauge-glass fittings are clean and efficient.

### 532.

*Oil for Steering Gear, &c.*—Mineral oil should be used for lubricating steam steering gear, watertight doors, &c.

### 533.

All oils, except Linseed and Sperm, required by the Carpenter, Boatswain, and Gunner will be drawn as required from the Engineer Officer.

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## PRECAUTIONS IN CASE OF RAMMING.

### 536.

*Insecure Gear.*—Before going into action all articles which might be thrown down or displaced by the collision are to be secured or so disposed of that no injury can be done to the machinery or to the Officers and men in the engine or boiler-rooms.

### 537.

1. *Precautions to prevent Water passing to Cylinders.*—Precautions should be taken to prevent the water passing from the boilers into the engines when the collision takes place should it have a tendency to do so, by keeping the separator empty and allowing the blow-off cock of the separator to remain open at the moment the blow is expected to take place; it may also be allowed to remain open until the engines are safely reversed.

2: *Separators, &c.*—Where a separator is fitted with an automatic blow-out valve, this valve should be wedged open in anticipation, and the hand-worked valve opened at the moment of collision or of stopping the engines. Men should be stationed at the emergency valves where so fitted.

### 538.

*When Engines are to be Stopped.*—Orders should be given so that the engines may be stopped just before the blow is delivered, and the Engineer Officer is to hold the engines in readiness to go astern as quickly as possible.

### 539.

*Precautions after Collision.*—Immediately the order is given to go astern the cylinder drain cocks should be opened, and the steam should be admitted to the

engines cautiously until everything is seen to be correct, when they should be put at the required speed as quickly as possible.

#### 540.

*Stop-Valves to be only Partially Opened.*—It will also be advisable to station a man at each of the main stop-valves to shut off any or all of the boilers, should it become necessary; and in order to facilitate this operation, the valves should not be kept open more than is necessary to supply the steam required by the engines.

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### PRECAUTIONS AGAINST FIRE.

#### 541.

1. *Appliances for Extinguishing Fire.*—The Engineer Officer is to pay special attention to all the appliances under his charge for extinguishing fire, and frequently to examine them personally to see that they are in a state of thorough efficiency and ready for use at a moment's notice.

2. *Engine-room Staff to be acquainted with Pumps, &c.*—He is to take steps to ensure that the Officers and men of the Engine-room Department, especially those detailed as part of the Fire Brigade, are thoroughly acquainted with all the pumps, cocks, suction, and pipes for use in case of fire. He is to see that all hoses, spanners, and other apparatus under his charge are stowed in convenient positions, and as near as possible to the places where they will be required.

#### 542.

*Pump Suctions may be kept Open.*—As it is a matter of vital importance that, in case of fire, a supply of water should be readily obtained, some or all of the Kingston valves and sea suction cocks for the Downton or electric bilge pumps, may, with the approval of the Captain, be kept open permanently should there be nothing in the arrangement of the fittings or watertight compartments to render it objectionable. To ensure that such cocks and valves are in good order, they are to be worked at the same intervals as the others (Art. 482).

#### 543.

*Combustible Matter not to be placed in Ventilators.*—No oakum, paper, articles of clothing, or any other combustible matter, is to be allowed to be placed in the ventilators, or in any holes or ledges that are not easily seen, as a fire might be caused by the spontaneous combustion of any of these articles. All ventilators are to be periodically examined to guard against accumulations of rubbish.

#### 544.

*Care in Extinguishing Lamps.*—Lamps should never be extinguished by means of a piece of oakum or rag put on the flame, as portions of the burning wick are likely to adhere unobserved to the oakum, which smouldering for a time, may eventually burst into flame.

## 545.

*Use of Mineral Oil.*—No mineral oil of any kind, except as may be approved, is to be used for lighting purposes.

## 546.

*Lights to be Extinguished.*—Care is to be taken that all lights that have been used by Dockyard or other artificers are properly extinguished.

## 547.

1. *Spontaneous Ignition of Cotton Waste, &c.*—Cotton waste which has been used as wipings for oil is very liable to become ignited through the heat developed by the rapid oxidation of the oil; and it has been demonstrated by experiment that this action is not confined to drying oils, such as boiled and raw linseed, rape, &c. All the oils, except mineral, must, therefore, be considered as more or less liable to cause the spontaneous ignition of cotton waste and similar fibrous or other porous materials.

2. *Greasy Wipings to be Destroyed.*—Cotton waste, and other wipings saturated with oil or grease, are to be destroyed immediately after use.

## 548.

1. *Iron Bins.*—All lockers and bins, in which wipings or other combustible materials are deposited, are to be constructed of iron, in order to guard as much as possible against accident from fire.

2. *Storage of Oil, Tallow, Cotton Waste, &c.*—Oil, tallow, and cotton waste and other wipings are to be kept in the iron tanks supplied for the purpose, which should be placed as far from the boilers or steam pipes as convenience will permit.

## 549.

1. *Storage of Inflammable Liquids.*—A special store-room should be appropriated for spirits of turpentine, varnishes, &c., and, where this cannot be done, fittings for the stowage of these inflammable liquids should be provided in the spirit-room.

2. *Inflammable Liquids to be Stored in Spirit-room.*—Spirits of turpentine, varnishes, compositions for the ship's bottom, and any other highly inflammable liquids specially allowed are to be stowed only in the spirit-room, or store-room specially appropriated *into which no lights are to be allowed.* They are never to be drawn off from any cask or vessel anywhere but on the upper or main deck, and this is to be done during the day-time, and away from any fire, and lights also if possible; but if a light be absolutely necessary, a safety lamp is to be used.

3. The casks and cans used for each description of oil and composition are to be painted the distinguishing colour authorised for each; and when issued to ships must be fitted with screw bungs or lids in accordance with the established patterns.

4. Inflammable stores are only to be drawn and kept on board in the approved casks, drums, or cans; and a label designating the liquid with the words "Inflammable—no light to be brought near this," is to be attached before issue to every cask, drum, or can, which contains any inflammable liquid.

5. Oils and tar are also to be drawn in iron casks, &c., with screw bungs.

6. No cask, &c., containing oil, varnish, or other liquid, is to be completely filled, but sufficient space is to be left to allow for the expansion of the liquid under increase of temperature.

7. All casks and cans are to be drained out immediately after emptying. The screw bungs and screw lids are to be carefully cleaned and oiled, and they are to be at once screwed up tightly so as to exclude the air and keep them clean till again required for use.

#### 550.

*Nightly Report as to Condition of Tanks, Casks, &c.*—At evening quarters, the responsible persons are to ascertain and report that all tanks, casks, drums, &c., containing inflammable liquids in use are in good condition, do not leak, and are stowed in their proper places, with their taps properly turned off or bungs screwed down.

#### 551.

1. *Condition of Coal Bags.*—The condition of all strops and coal sacks and bags (particularly the beckets) is to be examined after each occasion of coaling, and in cases where the coals sack or bags are seldom used they should be examined at intervals of six months, and any which may be found to be defective should be repaired or renewed as necessary.

2. Used coal sacks and bags are to be opened out from time to time, as fine coal dust remaining in them may generate heat.

3. In stowing the bag lockers, the bags should be stacked in bundles in such a manner as to admit of circulation of air among the bags. For the preservation of the bags, frequent attention to the dryness and ventilation of the locker is to be given.

#### 552.

*Acids.*—Acids are not to be kept near any article of an easily inflammable character, nor where they can damage other stores.

#### 553.

1. *Fires caused by Electric Lighting.*—As any danger of fire from electric lighting can only be due to improper fitting of the circuit, or neglect of the necessary precautions in the working of the light, the strictest attention must be paid to instructions contained in circulars bearing on the subject, and in the Torpedo Manual.

2. The electric light engine should be run at a speed to give, at the terminals of the machine, the voltage specified, but if, for any reason, it is desirable to exceed this voltage, there is no objection to the engine being run at 5 p.c. above the maximum revolutions marked on the dynamo, unless any undue distress is observed in the electric light engine, in which case the fact should be reported.

#### 554.

*Printed Notice to Precautions against Fire.*—A printed copy of the "Precautions against fire" is to be hung up in the Engine-room.

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## CLERICAL DUTIES.

## 561.

*Clerical Duties.*—The Engineer Officer is responsible for the correct fulfilment of the clerical duties of his department.

## 562.

1. *Quarterly Report in E.R. Register.*—The Quarterly Report of the state of the machinery at the end of the Engine-room Register is to contain all the information required in the form; and as it is most desirable that specific information should be given of the probable time during which the efficient working of the machinery and boilers may be depended on without having recourse to a shore establishment for repairs, the word "uncertain" is on no account to be used with regard to such particulars, but the closest approximation is to be made that his knowledge will admit of. If the time be dependent on accidental circumstances, such explanation should be added as may enable the Professional Officers of the Admiralty to draw their own conclusions.

2. *Examinations and Defects. E.R. Register.*—The dates of all examinations are to be given at the end of the Register; and any special defect in the machinery is to be particularly noted in the spaces provided for recording defects.

## 563.

1. *Transmission of Registers.*—When the ship is under steam, the fair register is to be sent to the Captain as soon as possible after noon each day; and at the end of every quarter it is to be forwarded to the Commander-in-Chief or Senior Officer of the Station or Squadron, for examination and transmission to the Admiralty.

2. *Register not to be closed.*—When a ship is paid off to be re-commissioned at once, the Register is not to be closed but transferred to the new Engineer Officer, who will continue it to the end of the current quarter and forward it as directed.

3. *Rough Engine-room Register.*—A rough Engine-room Register is to be kept in the engine-room, and the necessary observations recorded in it as they are taken. In all ships having two engine-rooms separated by a watertight bulkhead two rough Engine-room Registers are to be kept when under way, one in each engine-room. One of these is to be kept by the Engineer Officer of the watch, and is to contain all the necessary particulars of the working of the engines and boilers, and the second by the watchkeeper in the other engine-room, and is to contain a record of all the required particulars that take place in that engine-room.

These Registers are to be used in compiling the fair and duplicate copies of the Engine-room Register, and are to be kept in the ship for a period of about three months after the date of the last entry made in them, or for any longer period if the Captain considers it necessary. For further instructions relative to the method of keeping the Engine-room Register, and the entries to be made therein, see the first three pages of the Register.

In the event of a collision with any vessel, other than one of His Majesty's Ships, the rough Engine-room Register is to be preserved until it has been ascertained that no legal proceedings will take place with respect to such collision, or until after the completion of the proceedings.

4. *Duplicate Register.*—The duplicate Register is to be an exact copy of the fair Register, all the information contained in the latter being inserted in the former, with the exception of the specimen sets of diagrams. The particulars of the diagrams attached to the page provided in the fair Register are to be inserted on the corresponding page in the duplicate Register.

5. *Duplicate Registers to be kept.*—When a ship is paid off the duplicate Engine-room Register for the commission are to be retained on board and preserved for reference during the subsequent commission.

6. The duplicate Engine-room Registers for the last commission need only be retained on board during the next commission, those for previous commissions being destroyed.

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## STORES, AND STORE ACCOUNTS.

### 566.

1. *Responsibility for Care of Stores, &c.*—When an Engineer Officer is appointed for charge of machinery in a ship, he is also to take charge of and be responsible for all Engineers' fixtures, spare gear, and stores on board.

2. *Stores in Torpedo Boats and Destroyers.*—In torpedo boat destroyers, and torpedo boats, all stores of every description, fixtures, and spare gear are to be in charge of the Engineer Officer of the vessel, if one is borne. In boats where no Engineer Officer is borne, the stores, &c., are to be in charge of a Warrant Officer or such other officer as may be directed to take charge of them.

### 567.

1. *Instructions as to Stores and Store Accounts.*—The principles to be followed as regards supply, custody, care, stocktaking, survey for condition, and return of stores and fixtures, are defined in Chapters XXXII., XLV., and XLVI. of the King's Regulations, and detailed instructions on these subjects are comprised in the Memoranda to the Sea Store Establishments, Fixture Lists, Forms of Account, &c.

### 568.

1. *Standard Templates, &c. for Special Stores.*—Arrangements are in force for maintaining a standard set of templates, samples, &c., for each vessel in the Navy for stores of special descriptions which can only be obtained by furnishing contractors with information of this nature.

2. *Modifications in.*—It is important that the Engineer Officer should assist as necessary in the prompt supply of the first set of standards; and, if an alteration made in the fittings of a ship modifies a standard template, &c., that he should at once forward a new standard template, &c., to the Naval Store Officer of the Yard from which he draws his supplies.

### 569.

1. *Special Sea Stores.*—A six months' supply of articles, supplied as sea stores, which are of special sizes and descriptions not in general expenditure, *e.g.*, asbestos

rings, special packings, glass tubes and brushes, &c., is maintained at the Home Dockyards for each ship in the Home, Channel, and Atlantic Fleets 1st, 2nd, 4th, and 5th Cruiser Squadrons and Torpedo Flotillas attached to the Home and Channel Fleets.

*Supply at Foreign Dockyards.*—A 12 months' supply is maintained at Foreign Dockyards for the ships on the station, with the exception of the Atlantic Fleet and 2nd Cruiser Squadron.

2. *Information to be furnished by Engineer Officers.*—The Engineer Officer is, in the first instance, to furnish to the Home Yard at which the ship is to be stored an estimate of the probable requirements for 12 months in cases where the allowance is not defined or the expenditure will be irregular. If after sufficient experience it appears desirable to revise this estimate, a communication should be made on the subject to the Naval Store Officer of the Yard from which supplies are drawn. The Naval Store Officer should also be informed of any special stores subsequently introduced for use in the ship of which a 6 or 12 months' reserve stock should be maintained.

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## PARTICULARS OF MACHINERY.

### 575.

Particulars of the engines, boilers, and other machinery as are necessary to give a fair knowledge of their construction, age, repairs, &c., are to be noted by the Engineer Officer, under the various headings, at the end of the Manual in the Appendix.

(a) *Engines.*—Particulars as are required under the various headings, the horsepower, number of revolutions, &c., obtained on the contractor's trials, and on the several trials referred to in Arts. 425 *et seq.*, any peculiarities in the construction of the engines, and any method of working that has been found most beneficial. If the engines be compound or triple expansion engines, the most efficient grades of expansion in the different cylinders for the various powers should be noted; also the most effective pressures in the steam jackets.

(b) *Boilers.*—Particulars as are required under the various headings: positions of auxiliary cocks, valves, and pipes; peculiarities of construction of fittings; dates and nature of repairs; best method of treatment of boilers, &c. If any sign of corrosive action has been discovered it should be noted, with the part of the boiler in which found, and the nature of the action. If the boilers have been drilled, or otherwise tested for wear and waste, the thickness of the plates, &c., at the different parts at that time should be noted.

(c) *Propeller.*—Particulars as are required under the various headings, and whether the pitch is uniform or increasing. The different tests of the screw, in order to determine whether or not the shaft is bound, should be noted in these pages, with dates of the test

(d) *Miscellaneous.*—Particulars of the different auxiliary engines in the ship; motors in the main machinery compartments; positions of the watertight doors; flooding and other sea-cocks and valves; Downton or electric bilge pumps; leads of the suction pipes; compartments of the double bottom, with the positions of the cocks and valves for filling and emptying them and such other information relative to these fittings as may be necessary to give a fair knowledge of their position and

uses. The compartments fitted to carry oil fuel and a reserve supply of fresh water for boiler purposes and the amounts they contain.

(e) Any other information about the engines, boilers, or other machinery which is considered important should be noted in these pages, so that, if there be any change of the Engineer Officer, the Officer taking charge may be able to get such a preliminary knowledge of the machinery that the survey may be facilitated and be more complete.

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## APPENDIX.

*See Article 575.*

## DETAILS OF ENGINES OF H.M.S.

Type of engine	.	.	.	.	.	.
Makers of engine	.	.	.	.	.	.
Date when engines were new	.	.	.	.	.	.
Maximum working pressure	.	.	.	.	.	.
Diameters of cylinders	.	.	.	.	.	.
Constants of cylinders :—			H.P.		I.P.	L.P.
Port engines-	.	.	.	.	.	.
Starboard ditto	.	.	.	.	.	.
Length of stroke	.	ft.	ins.			
Clearances of pistons :—		H.P.	I.P.	L.P. For <sup>d</sup> .		L.P. Aft.
Port engines	{	ins.	ins.	ins.		ins.
top						
bottom		ins.	ins.	ins.		ins.
Starboard ditto	{	ins.	ins.	ins.		ins.
top						
bottom		ins.	ins.	ins.		ins.
Diameters of shafting :—						
Bearings of crank shaft	.	.	.	.	ins.	.
Bearings of crank pin	.	.	.	.	ins.	.
Bearings of propeller shaft	.	.	.	.	ins.	.
Bearings of crossheads	.	.	.	.	ins.	.

DETAILS OF TURBINES.

Type of turbine . . . *Parson's Marine (reaction)*  
 Makers of turbine . . . *Sainfield's Govan*  
 Date when turbines were new . . . *1911*  
 Maximum working pressure . . . *170 lbs.*  
 Collective Horse Power—Ahead . . . *45,900* . . . *14/10/12*  
 " " Astern . . . *19,507* . . . *15/10/12*

Outer.		Inner.	
Port.	Starboard.	<i>P</i>	<i>S</i>
300.5	301	290	289.5
225	226	220	220.

Number of revolutions at full power—Ahead . . .  
 " " " Astern . . .

Turbine.	Maximum Receiver Pressures.	Diam. of Rotor.	Diam. of Cylinder.	Tip clearances of Blades.	Number of rows of blades in each expansion.						
					1st.	2nd.	3rd.	4th.	5th.	6th.	
H.P.	170	98	ins.	Numbers.	16	13	13	13	13	13	
L.P.	15	105	<i>Various</i>	12, 3, 4, 5, 6 62, 50, 55, 60, 65, 70	8	8	8	7	7	7	
Cruising	-	-		-	70, 75, 80, 100, 100, 100	-	-	-	-	-	-
H.P. astern	170	8 1/2		1, 2, 3, 4	6	6	6	6	-	-	
L.P. astern	25	7/6	40, 40, 45, 50 65, 70, 70, 70	6	6	6	6	-	-		

Diameter of shafting :—

Bearings of turbine shaft

ins.

{ H.P. ahead 18 1/2"  
 { H.P. Astern 18 1/2"  
 { L.P. 21"

Bearings of propeller shaft 21 3/4" ins.



PARTICULARS OF SLIDE VALVE SETTING.

	Ahead, Links in Full Gear.							Ahead, Links Midway between Full and Mid Gear.										
	Admission.	Cut off.	Release.	Compression.	Maximum opening to Steam.	Lead.	Lap.	Travel of Valve.	Admission.	Cut off.	Release.	Compression.	Maximum opening to Steam.	Lead.	Lap.	Travel of Valve.		
	Percentage of piston stroke.							Inches.										
HIGH.	Port	Top -	Bottom -	Starboard	Top -	Bottom -	Port	Top -	Bottom -	Starboard	Top -	Bottom -	Port	Top -	Bottom -	Starboard	Top -	Bottom -
	Starboard	Top -	Bottom -		Port	Top -		Bottom -	Starboard		Top -	Bottom -		Port	Top -		Bottom -	Starboard
INTERMEDIATE.	Port	Top -	Bottom -	Starboard	Top -	Bottom -	Port	Top -	Bottom -	Starboard	Top -	Bottom -	Port	Top -	Bottom -	Starboard	Top -	Bottom -
	Starboard	Top -	Bottom -		Port	Top -		Bottom -	Starboard		Top -	Bottom -		Port	Top -		Bottom -	Starboard
FORWARD LOW.	Port	Top -	Bottom -	Starboard	Top -	Bottom -	Port	Top -	Bottom -	Starboard	Top -	Bottom -	Port	Top -	Bottom -	Starboard	Top -	Bottom -
	Starboard	Top -	Bottom -		Port	Top -		Bottom -	Starboard		Top -	Bottom -		Port	Top -		Bottom -	Starboard
AFTER LOW.	Port	Top -	Bottom -	Starboard	Top -	Bottom -	Port	Top -	Bottom -	Starboard	Top -	Bottom -	Port	Top -	Bottom -	Starboard	Top -	Bottom -
	Starboard	Top -	Bottom -		Port	Top -		Bottom -	Starboard		Top -	Bottom -		Port	Top -		Bottom -	Starboard

Sequence of Cranks \_\_\_\_\_ Do the piston valves take steam on the inside or outside?

Are the acting eccentrics attached to the following ends of the links? \_\_\_\_\_ Type of valve gear \_\_\_\_\_

## CONDENSERS.

Type of main condensers . . . *Surface* . . .  
 Type of auxiliary condensers . . . *Surface* . . .  
 Number of main condensers . . . *4* . . .  
 Number of auxiliary condensers . . . *2* . . .

## Tubes of condensers:—

	Main.	Auxiliary.
No. in each . . . . .	<i>5951.</i>	<i>5470.</i>
External diameter, ins. . . . .	<i>5/8"</i>	<i>5/8"</i>
Thickness, W.D.G. INS. . . . .	<i>.048</i>	<i>.048"</i>
Length . . . . .	<i>10 ft. 0 ins.</i>	<i>5 ft. 0 ins</i>

Is circulating water passed around or through the tubes  
 of the main condensers? . . . . . *Through*

Is circulating water passed around or through the tubes  
 of the auxiliary condensers? . . . . . *Through*

Weight of circulating water in each main condenser,  
 tons . . . . . *5 T. 4 cwt. 0 qrs. 13 lbs*

Weight of circulating water in each auxiliary condenser,  
 tons . . . . . *2 T. 19 cwt. 1 qr. 4 lbs.*

Method of fitting protective slabs in the main condenser,  
 with number and description of same . . . . . *Part of the slabs are bolted to gunmetal brackets fixed to end of tube plate stays, and the remainder to gunmetal brackets fixed to tube plates.*

Method of fitting protective slabs in the auxiliary  
 condenser, with number and description of same . . . . . *9 - steel plates 6" D x 1/2"*  
*12 do do do*

MAIN AIR PUMPS.

	Dry.	Wet.
Number of air pumps	4.	4.
Length of stroke of pump	20 ins.	20 ins.
Diameter of barrel of pump	33 ins.	33 ins.
Diameter of steam cylinder	18 ins.	one cyl. 15 wet ins.
Clearances at ends—Top	ins.	ins.
„ „ Bottom	ins.	ins.

VALVES OF MAIN AIR PUMPS.

Valves.	No.	Description.	Sizes.	Lift.	Total Area through Openings.
Dry :—					
Foot	7	Kueghorn	8 1/8"		
Head	7		7 1/16"		
Plunger	7		7 1/2"		
Wet :—					
Foot	7	do			
Head	7		do		
Plunger	7				

THRUST BLOCKS.

Type	Solid, in halves, of C.S. with 1% - bronze adjusting rings			
Number of thrust collars on each shaft	14		18	
Diameter of thrust shaft in block, ins.	16 3/4		16 3/4	
Outside diameter of collars, ins.	23		23	
Area of thrust surface on each collar, sq. ins.	181.77		181.77	
Total thrust surface on each shaft, sq. ins.	2544.7	2363	3271.5	3090
	TOP	BOTTOM	TOP	BOTTOM
	INNER		OUTER	

## STARTING ENGINE.

Type - - - - -

Description of reversing valve - - - - -

Number of pistons and description of packing ring - - - - -

Diameter of cylinders, ins. - - - - -

Length of stroke, ins. - - - - -

Type of gear - - - - -

## TURNING ENGINE.

Type - - - - -

Number of pistons and description of packing ring - - - - -

Diameter of cylinders, ins. - - - - -

Length of stroke, ins. - - - - -

Method of disconnecting the engine - - - - -

Time to turn main engines one revolution at      revs. per min.

*If Motor Driven.*

Number and type of motor - - - - - . 4. series.

Description and dimensions of brushes - - - - - . C. 1 1/2" x 7/8" x 5/8"

Method of disconnecting the motor - - - - - . NIL

If enclosed in a watertight casing - - - - - . YES.

BOILERS.

Type . . . . . B. + VV.

Maker's name . . . FAIRFIELDS . . . . .

When new . . . . . 1912 . . . . .

Number of boilers . . . . . 31 . . . . .

Dimensions of boiler (over all) . . . VARIOUS . . . . .

Casings of . . . STEEL PLATE, 13 LSG, EXTERNAL PLATES  $\frac{1}{16}$ " HOT. ZINC

Lagging of . . . Asbestos mats 2" thick on steam drums

Type of furnace . . . . .

Number of furnaces in each boiler . . . One . . . . .

Total number of furnaces . . . . . 31 . . . . .

Dimensions of furnaces	6 12' 11" x 6' 11"	2 13' 8 3/4" x 6' 11"	2 10' 7" x 6' 11"	1 11' 4 1/2" x 6' 11"	10 12' 4" x 6' 11"	70 13' 1 1/2" x 6' 11"
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Grate surface per furnace, sq. ft.	89.32	94.80	73.19	78.66	35.29	90.74
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Total grate surface in ship, sq. ft. . . . . 2711.24 . . . . .

Number of combustion chambers in each boiler . . . One . . . . .

VOLUMES.

Dimensions of combustion chambers	6-415.	} 1 - 367.	} Cut-off	
	2-436.			10 - 396.
	2-340.			10 - 414.

BOILERS—continued.

Weight of water in each boiler at working height, tons	} 2.1 section 20 do 1.7 do	W.W	W
		77-6.cwt	47-6.cwt
Weight of water in each boiler when full, tons -		6-19.	4-2
		5-19.	3-10.
Weight of water in one boiler to alter water level six inches at working height, tons -			

TUBES OF BOILERS.\*

Description	Fire rows included	Next rows	Remainder			
Material	S.D. Steel	S.D. Steel	S.D. Steel			
Number in each boiler	3-33	3-68	3-528			
Total number in all boilers	20-89	20-80	20-624			
Length, extreme	8-41	8-84	8-656			
	12.07.	24.76.	19.312.			
Diameter, external	7'-10"	7-10"	7-10"			
Diameter, external	3 15/16"	1 13/16"	1 13/16"			
Thickness W.D.G.	250.	144.	128.			
Sealing Surface	0ft. 9746	783500	Total	793260	0ft.	

ZINC SLABS.

Size	12" x 6" x 1/2"	6" x 4" x 1/2"			
Number in each boiler	12	5			
Total number in all boilers	372	153			

\* If of the small tube type a diagram similar to the sketch plate in use at the Dockyards should be drawn on one of the blank pages of this Appendix.

BOILERS—continued.

Plates of Boilers.	Material.	Thickness.	
		When new.	Last Drill Test.
Shell plates - - - - -			
Front tube plates - - - - -			
Back of Boiler - - - - -			
Combustion chamber tube plate - -			
Combustion chamber other plates - -			
Furnaces - - - - -			

If of the Water-tube Type.

—	Material.	Dimensions.	Thickness.	
			When new.	Last Drill Test.
Steam chest - - - - -	<i>Steel plates</i>	$3-11\frac{3}{8} \times 3-0$ $20-13\frac{5}{16} \times 23-0$ $8-14-0\frac{3}{4} \times 23-0$	$1\frac{1}{8}$ in way of tubes $\frac{19}{32}$ remainder $\frac{27}{32}$ ends.	
Tube plates (upper) - - - - -				
Tube plates (lower) - - - - -				
<i>M+A</i> Head drums. <del>Water pockets</del> - - - - -	<i>Steel plates Lap-welded</i>	<i>See Drawing 76 &amp; 78.</i>		
Downtakes - - - - -	<i>Solid drawn steel</i>	$7-2\frac{3}{4} \times 4\frac{1}{4}$ <small>Ext. Dia</small>	$\frac{1}{4}$ "	
Return tubes - - - - -	" "	$7-4\frac{7}{8} \times 4\frac{1}{4}$ $5-6\frac{3}{4} \times 2\frac{15}{16}$	$\frac{1}{4}$ " .192"	
Headers, back - - - - -	<i>Lap-welded steel</i>	$7-4\frac{3}{4} \times 6\frac{3}{4} \times 5\frac{1}{2}$	$\frac{17}{32}$	
" front - - - - -	" "	$6\frac{1}{2} \times 6\frac{3}{4} \times 5\frac{1}{2}$	$\frac{17}{32}$	

Number of water pockets in each boiler:—

Any alterations due to wear, &c., to be inserted in red ink.

OIL FUEL FITTINGS.

SPRAYERS AND AIR CONES.

	Water-tube Boilers.					Cylindrical Boilers.
	Group.					
	A.	B.	C.	D.	E.	
Number of sprayers and air cones to each boiler	1 } 3. 2 } 3 } 4 } 5 } 2	3	3	3	3	= 90.
Diameter of sprayer exits	.075	.075	.075	.075	.075	
Outputs of sprayers open 1 1/4 turns with Texas oil at 200° F. at 150 lbs. pressure per sq. in.	300	300	300	300	300	per hour.
Do. do. at 25 lbs.	130	130	130	130	130	do.

Internal diameter of Air Cone at large end - 11 1/4"  
 Type of sprayer fitted - Single orifice

OIL FUEL HEATERS.

	Size.			
	I.	II.	III.	IV.
Total number	4	4	2	
Length of tubes	5' 4 3/4"	4-5 1/4"	3' 8"	
External diameter of tubes	3/4"	3/4"	3/4"	
Thickness and material of tubes	80 W. D. S. Steel			
Number of tubes per Heater	74	46	74	
By what pumps can the oil left below the suction of the oil fuel pumps be removed from the oil fuel tanks?	Bdgel Pump Hand Pump			





VALVES OF BOILERS--*continued.*

Diameter of main feed-valves, ins.	-	-	-	-
Diameter of auxiliary feed-valves, ins.	-	-	-	-
Type of blow-down cocks or valves	-	-	-	-
Diameter of ditto, ins.	-	-	-	-
Type of automatic feed regulating gear	-	-	-	-

For details of feed pumps, see page 155.

## PROPELLERS.

Description and number	-	<i>Solid H.</i>	-	-
Number of blades	-	<i>3.</i>	-	-
Diameter	-	<i>Inner</i>	-	<i>10 ft. 10 ins.</i>
	-	<i>Outer</i>	-	<i>10 ft. 3 ins.</i>
Pitch	-		-	<i>11 ft. 2 ins.</i>
Range of pitch	-	<i>Nil</i>	-	ft. ins. to ft. ins.
Total blade area in each propeller, sq. ft.		<i>55.5 inner.</i>		
		<i>46.0 outer.</i>		
Immersion of upper blade when drawing	-		-	ft. ins. aft.

WEIGHTS REQUIRED TO MOVE THE SCREWS.

Port Screw.				Starboard Screw.			
Date.	Radius. Ft. ins.	Weight in lbs.	Whether packing in stern gland had been withdrawn.	Date.	Radius. Ft. ins.	Weight in lbs.	Whether packing in stern gland had been withdrawn.
10-1912	3 - 5	Inner 1088 Outer 1344	Yes	10-1912	3 - 5	Inner 1120 Outer 1120	Yes

## AUXILIARY MACHINERY.

## AUXILIARY AIR PUMPS.

Number and type of auxiliary air pumps - *Weiss Monotype 2*  
 Diameter of barrel of pump and stroke, ins. *28" x 18"*  
 Diam. of steam cylinder, and description of piston packing rings - *14"*

## VALVES OF AUXILIARY AIR PUMPS.

Valves.	No.	Description.	Sizes.	Lift.	Total area through openings.
Foot - . . . .		<i>Kugeln</i>	<i>6 3/4"</i>		
Head - . . . .		<i>do</i>	<i>6 1/2"</i>		
Plunger - . . . .		<i>do</i>	<i>6 1/4"</i>		

## WORKSHOP ENGINE.

Type of engine - *Electric*  
 Number of pistons and description of packing rings - -  
 Diameter of cylinders and stroke, ins. - . . . .  
 Minimum steam pressure required - . . . .

## STEERING ENGINES.

Number and type of engines - *Napier, single. 2.*

Number of pistons to each engine and description of packing rings *2.*

Diameter of cylinders and stroke, ins. . . . . *18" x 14"*

Description of automatic gear . . . . . *Worm & screw, from shaft*

Maximum angles of rudder hard over to port - *35°* to starboard *35°.*

Minimum pressure at which engine could be worked . . . . .

## CAPSTAN ENGINES (FORWARD).

Number of engines . . . *One.*

Type of engine . . . *Simple. (Harfield)*

Number of pistons and description of packing rings *2.*

Diameter of cylinders and stroke, ins. . . . . *15 x 10.*

Type of capstan . . . *One centre line, 2 driven by ~~the same~~*

Can the engines be readily disconnected to allow the capstan to be worked by hand, and how? . . . . . *Yes, by ~~hand~~*

Maximum steam pressure allowed for heaving in . . . . . *190 lbs.*

Maximum revs. per min. allowed with slack cable, and speed of cable

## CAPSTAN ENGINES (AFT).

Number and type of engines . . . . . *electric*

Number of pistons and description of packing rings . . . . .

Diameter of cylinders and stroke, ins. . . . .

Type of capstan . . . . .

Can the engines be readily disconnected to allow the capstan to be worked by hand, and how? . . . . .

## ELECTRIC LIGHT MACHINERY AND DYNAMOS.

Number and type of engines . . . *3 Howden Compound enclosed*

Number of pistons to each engine and description of packing rings . . . *2*

Diameters of cylinders and stroke, ins. . . *N.P. 14 1/2" L.P. 22" x 10"*

Revolutions of engines per minute *400* . minimum steam pressure required

Number and type of dynamos . . . *3 Siemens*

Power of dynamos, . . . . . *900* amperes at *220* volts.

## DISTILLING APPARATUS.

Maker of evaporator and number fitted *Carid. & Rayner. 4*

Capacity of each evaporator per day (i.e., gained fresh water), tons (a) 80. Total *320* tons (a).  
 (a) When clean. (b) When cleaning is necessary, tons (b) - - - - - " " (b).

Method of fitting protective slabs, with number and description *Attached to inner doors  
 2 - 12" sq x 1/2" steel*

Maker of distilling condenser and number fitted *Carid. & Rayner - 2*

Capacity of each distilling condenser per day, tons - - - - - 160 Total *320* tons.

Method of fitting protective slabs, with number and description of same *Attached to inner doors  
 4 in each door  
 Steel 6" diam x 1/2"*

Number and type of pumping engines fitted for distiller circulating water and fresh water - - - - - 2

Diameter of steam cylinders and stroke, ins. - - - - - *9 1/2 x 15*

Diameter of fresh-water pump, ins. *5"* and of circulating pump, ins. *13 1/2"*

Number and type of pumping engine fitted for evaporator feed water and brine - - - - - 2.

Diameter of steam cylinders and stroke, ins. - - - - - *5 1/2 x 15*

Diameter of feed pump, ins. *Fed from circ. pump* of brine pump, ins. *5 1/2"*

## FORCED DRAUGHT ENGINES.

Number and type of engines . . . . . 30. Allen's Forced lubrication

Description of slide-valve . . . . . solid

Diameter of cylinders and stroke, ins., and description of piston rings . . . . . 6'2" x 4'2"

Diameter of fan . . . . . 7 ft. 0. ins.

Position of each such engine in the ship *In fan flats under lower deck.*

Revolutions at authorised full power . 300 using  $\frac{3}{4}$ " ins. of air pressure

*If Motor Driven.*

Number and type of motor . . . . .

Description and dimensions of brushes . . . . .

Diameter of fan . . . . . ft. ins.

Position of each motor in the ship . . . . .

If enclosed in a watertight casing . . . . .

## BLOWING ENGINES.

Number and type of engines . . . . . 5 Brotherhoods enclosed

Number and diameter of steam pistons and cylinders, ins., and description of packing rings . . . . . 10 x 6" str

Number and diameter of pump barrels to each engine and length of stroke, ins. . . . . 17 x 6



VENTILATING ENGINES.

Number and type of engines . . . . .  
 Description of slide-valve . . . . .  
 Diameter of cylinders and stroke, ins., and description of piston packing . . . . .  
 Diameter of fan, and whether exhaust or supply . . . . .  
 Position of each such engine in the ship . . . . .  
 Maximum revs. per minute, and minimum steam pressure required . . . . .

*If Motor Driven.*

Number and type of motors . . . . . 16  
 Description and dimensions of brushes . . . . . Carbon.  
 Diameter of fan, and whether exhaust or supply . . . . . Supply 4-35" exhaust, 4-40"  
 Position of each such motor in the ship *On lower deck.* 4-25" 4-30"  
 If enclosed in a watertight casing . . . . . *Yes*

ASH-HOIST ENGINES.

Number and type of engines . . . . . *Nil*  
 No. and diameter of cylinders to each engine, and stroke in ins.  
 Description of piston packing rings . . . . .

*ejectors*  
 ASH-EJECTORS.

Number and type of ejectors . . . . . 5 *Ston's*  
 Capacity of each ejector . . . . .  
 Number and type of ejector pumps . . . . .  
 Number and diameter of steam cylinders to each engine, and description of piston rings . . . . . 1-9" x 5' *str*  
 Number and diameter of pump cylinders and stroke, ins. . . . . 1-8 1/2 x 5.  
 Description of ejector cock . . . . .  
 Description of valve in ship's ~~side~~ *Bottom* . . . . . *Gate sluice.*

AIR-COMPRESSING MACHINERY.

Number and type of machine . . . 3. General engine & boiler Coy.

Number and diameter of steam cylinders in each and description of piston rings fitted . . . 1-4"

Number and diameter of barrels of air-compressor . . . 1 3/16" 2 9/16" 4 5/16" 8 3/8"

Number of compressions and length of stroke, ins. . . 4-6"

Capacity of each machine . . . 20 cubft at 2500lbs in comin

Capacity of each set of air reservoir tubes, and working pressure . . . 10 cubft.

Number of tubes in each set and number of sets . . . 6-4 sets

Number and positions of submerged torpedo tubes . . . 2 in submerged flat aft.

COAL-HOIST ENGINES.

Number and type of engines . . . . .

Number and diameter of cylinders to each. Length of stroke, and description of packing rings . . . Nil.

BOAT-HOIST ENGINES.

Number and type of hoists . . . . . Electric.

Number and diameter of cylinders to each hoist and stroke in ins. . .

Diameter of winch barrel, ins.; number of turns of wire and total length barrel will take without overriding, feet . . . . .

If Hydraulic.—

Type of purchase engine . . . . .

Type of topping engine . . . . .

Diameter of rams, main, ins. . . . .

„ auxiliary, ins. . . . .

Diameter of winch cylinders, ins. . . . .

REFRIGERATING MACHINERY.

Number and type of machine - - - - 1. Pulsometer Co.  
 Capacity of each machine - - - - 50,000 B.T.U.  
 Length of stroke, ins. - - - 6"      Revolutions per minute 120

ICE-MAKING MACHINES.

Type of machine - - - - Nil.  
 Capacity of each machine - - - -  
 Length of stroke, ins. - - -      Revolutions per minute -  
 Weight in lbs. of one charge -      Number of charges carried -

MAGAZINE COOLING MACHINERY.

Number and type of machine . . . 4 Pulsometer Coy. CO<sub>2</sub>  
 Capacity of each machine - - - -  $\left. \begin{matrix} 2 - 50,000 \\ 2 - 20,000 \end{matrix} \right\}$  B.T.U.  
 Length of stroke, ins. - - - 6"      Revolutions per minute 120  
 Weight, lbs., of one charge of CO<sub>2</sub>  $\left. \begin{matrix} 48 \\ 20 \end{matrix} \right\}$  lbs.      Number of charges carried 6

	<del>Steam</del> Electric	Compression.	Expansion.
Diameter of cylinders :-	H.P.	I.P.	
Refrigerating machinery - - -			2 3/4"
Ice-making machines - - -			
Magazine Cooling machinery - - -			2" & 2 3/4"

HYDRAULIC MACHINERY.

PUMPING ENGINES :

Number and type of hydraulic pumping engines . . . . . 2.  
 Number of pump barrels to each pumping engine . . . . . 2.  
 Diameter of cylinders, ins., and description of packing rings *M.P. 14 1/2 L.P. 28"*  
 Diam. of pumps, ins. *5.2* Stroke in ins. - *20* Hyd. working pressure *1000* lbs. per sq. in.  
 Number of engines in the ship worked by water-power . . . . .

FORCED LUBRICATION AND OIL FUEL PUMPS.

	Forced Lubrication Pump.	Oil Fuel Pump.
Maker of pumps and number fitted	<i>Weirs 8.</i>	<i>Weirs 12.</i>
Diameter of steam cylinders, ins., and description of piston packing rings	<i>{ 4 of 6 1/2" 4 of 4"</i>	<i>{ 6 of 7 1/4" 4 of 6 2 of 4"</i>
Number and diameter of pump barrels and length of stroke of each pump	<i>{ 4 of 15" 4 of 12"</i>	<i>{ 6 of 9" 4 of 7" 2 of 10" { 30 for 10 pumps 40 " 2 " }</i>
Revolutions or double strokes at full speed	<i>{ 23 20.</i>	
Capacity in <del>gallons</del> <i>Tons</i> per hour	<i>{ 31.2 8.5.</i>	<i>{ 6 of 6 4 of 4 2 of 6</i>

OIL ENGINES.

Diameter and number of cylinders . . . . . *Nil*  
 Length of stroke, ins. . . . .                      Revolutions per minute . . . . .  
 Maximum explosive pressure . . . . .

Load	Full	$\frac{3}{4}$	$\frac{1}{2}$	$\frac{1}{4}$	0
Air injection pressure, lbs. per sq. in.	—	—	—	—	—

Air pressure for starting engine . . . . .  
 Size of smallest hatchway through which largest part will pass . . . . .

AUXILIARY MACHINERY.

DETAILS OF ARRANGEMENTS OF PUMPS.

Name of Pump.	Number.	Cylinders.		Impellers or Barrels.		Revolutions at Full Speed.	Length of Stroke.	Where Connected.		Capacity.	
		No.	Diam.	No.	Diam.			Suctions.	Discharges.		
Main Centrifugal -	4	1	14"	1	40"	260	12'	Sea	Condenser -	5893 each	
Auxiliary Centrifugal -	-	-	-	-	-	-	-	-	-	-	
Main Feed -	8	1	15 3/4"	1	11"	13 D.S. per min	6-21" 2-18"	Feed tank Reserve "	Boiler	46 each	
Auxiliary Feed -	8	1	15 3/4"	1	11"	13 D.S. per min	6-21" 2-18"	Feed tank Reserve tank	Boiler	35 each	
Main Fire and Bilge -	9	1	13"	1	11"	27 D.S. per min	16"				45 each
Auxiliary Fire and Bilge -											
Drain Tank -	-	-	-	-	-	-	-	-	-	-	
Hotwell -	-	-	-	-	-	-	-	-	-	-	

State whether single or double acting by S. or D. against the name of the Pump.



## FLOODING ARRANGEMENTS.

State briefly the methods of flooding each of the following spaces :—

## MAGAZINES:

4" Ford	by	S. D. V.	off	C.	Seacocks
Saluting	by	do	do	19	do
Small arms	by	do	do	19	do
A. 12"	by	do	do	C	do
P 12"	by	do	do	7	do
Q 12"	by	do	do	H	do
R 12"	by	do	do	G	do
4" Aft	by	do	do	J	do
Guncotton	by	do	do	L	do

## SHELL-ROOMS:

A 12"	by	S. D. V.	off	C	Seacocks
P 12"	by	do	do	J	do
Q 12"	by	do	do	H	do
R 12"	by	do	do	K	do

FLOODING ARRANGEMENTS—*continued.*

## TORPEDO PISTOL TANKS:

*From S.D.V. off A seacock*

## SPIRIT ROOMS:

*From S.D.V. off B seacock*

DOUBLE BOTTOMS:  
AND  
WING COMPARTMENTS

Wings 36-39 Nil above platform deck  
 " " " under platform deck through suction.  
 D.B. " " Through suction pipe  
 " 39-65 S.D.V. from A bilge pump inlet  
 " 78-82 " " B " " "  
 " 106-108 Hose from C " " "  
 " 137-147 S.D.V. from G seacock



## FLOODING ARRANGEMENTS—continued.

## DOUBLE BOTTOMS AND WINGS:

D.B. 208 - 221 Through suction from 2. Pumps  
 " 221 - 229 " " " " "  
 Wing 208 - 218 " " " " "  
 218 - 229 Through sluice from compartment  
 166 - 182 " " " " "  
 182 - 194 } Through S.D.V from inlets 15 ft  
 194 - 208 } in each after engine room

D.B. Compts used as R.<sup>2</sup>.T. - cannot be flooded  
 " " " " O.<sup>2</sup>.T. flooded by hose thru  
 -combined residue suction & flooding pipe.

STEAMBOATS.

Description and No. of the Boat.	BOILERS.				Whether closed or open Stokholds.
	Type.	Date when new.	Estimated H.P.	Principal Dimensions.	
Steam Pinnace N <sup>o</sup> 225. (124 P. 12.)	Mumford	1911	180		Closed.
Steam Pinnace N. 257. 2 <sup>nd</sup> P. 13	Mumford	1911	180.		Closed.

STEAMBOATS.

Description and No. of the Boat	Single or Twin Screw.	ENGINES.				Revolutions per Min. Contractor's Trials.
		Type.	Diameter, H.P. Cylinder.	Diameter, L.P. Cylinder	Length of Stroke.	
Steam Pinnace No 233.	Single	C.P.D. Engines Lubricated	6 1/2"	13"	8"	600
Steam Pinnace	Single	C.P.D. Engines Lubricated	6 1/2"	13"	8"	600



## PUMPING ARRANGEMENTS.

Describe briefly the system of pumping out and draining each of the following spaces, stating the pump (by its number) to be used:—

DOUBLE BOTTOMS: Except those used for P. & O. <sup>main</sup> tanks, are pumped out by a separate pump for each compartment.

36-59	C.	Electrical Pump
59-65	A.	Bl. Room steam budge pumps.
78-82	B.	" " " " "
97-106		" " " " "
106-108	C.	" " " " "
137-147	D.	" " " " "
208-229	D.	Electrical Pump.

## WING COMPARTMENTS

36-59	None fitted to these above platform deck under platform deck by C. Electric pump
166-182	Drained to wing abaft.
182-194	} by after eng room budge pump & portable hose
194-208	
208-218	D. Electrical pump
218-229	Drained to wing fore

PUMPING ARRANGEMENTS—*continued.*

SPIRIT-ROOMS: *Nil.*  
*Portable pumps.*

TORPEDO ROOMS: *(Submerged)*  
*Drawn to tanks below which is pumped*  
*out by C. electrical pump.*

TORPEDO PISTOL TANKS: *Same as above.*

PUMPING ARRANGEMENTS—*continued.*

MAGAZINES:

*Nil*  
*(Portable pumps)*

SHELL-ROOMS

*A*  
*B*  
*C*  
*D*

} *Drained to space below*

EXTRACT FROM REPORT OF TRIALS.

Rate.	Ship's Draught.	Speed in Knots.	Revolutions per Minute.				Torque.	<del>I.H.P.</del> S.H.P.	No. of Boilers in Use.	Fuel, per Hour per H.P.	Fuel in Tons, per day.			* Duration of full Fuel Supply.	Remarks (with Date of Trial).
			Port.	Starboard.	Inner.	Outer.					Making good the Distance.	Auxiliary Purposes.	Total.		
1. Full power, forced draught.	26-1 <sup>1</sup> / <sub>2</sub> 24-8 <sup>1</sup> / <sub>2</sub>	25.99	300	290	301		45900	31	1.27			689	6 3/4	14.10.12.	
2. Full power, authorised natural draught = unit.															
3. Maximum continuous steaming = 60 per cent. of unit, H.P.															
4. 40 per cent. of unit, H.P.															
5. 20 per cent. of unit, H.P.															
6. 15 per cent. of unit, H.P.															
7. 10 per cent. of unit, H.P.															
8. 5 per cent. of unit, H.P.															
9. Most economical speed.															

\* To be calculated on the coal equivalent of total fuel used, the calorific value of oil fuel being taken as 1 1/4 times that of coal.



## DRAWINGS, TRACINGS, &amp;c.

Admiralty No. of Drawing.	Ship's No. of Drawing.	Subject.

## DRAWINGS, TRACINGS, &amp;c.

Admiralty No. of Drawing.	Ship's No. of Drawing.	Subject.

## DRAWINGS, TRACINGS, &amp;c.

Admiralty No. of Drawing.	Ship's No. of Drawing.	Subject.

DRAWINGS, TRACINGS, &c.

Admiralty No. of Drawing.	Ship's No. of Drawing.	Subject.

DETAILS AND TESTS OF SAFETY VALVES.

Date of Examination.	Distilling No. of Boiler.	Distilling No. of Safety Valve.	Details of Valves.			Details of Springs.						Area of S.V. in square ins.	Area of R.G. in square feet.	Dead Load applied to produce the Working Pressure.	Working Pressure in lbs. per square in.	Compression due to Load corresponding to Working Pressure.	Compression actually set at (cold).	Pressure per sq. in. corresponding to the compression in previous Column.	Total compression, with Springs set, as in Column.	Total Load, with the compression of the previous Column.	Pressure per square in. corresponding to Load in previous Column.	
			Diameter.	Lift.	Lift by Hand Gear.	Section of Wire.	Inlet Diameter of Coil.	Number of Coils.	Length of Spring (uncompressed).	Working Pressure in lbs. per square in.	Compression due to Load corresponding to Working Pressure.											Compression actually set at (cold).
17-4-12	A3-4-12 Remanufactured A1	1	3 1/2	7/8"	3/8"	2 1/2	17 1/4	9.62	89.32	2405	250	3 1/2	2694	2694	2694	2694	2694	2694	2694	2694	2694	2694
	A2	1	3 1/2	1 1/16"	1 1/16"	12 1/4	16 1/8	8.396	89.32	2074	250	4	2618	2618	2618	2618	2618	2618	2618	2618	2618	2618
	A3	1	4 1/2	7/8"	2 1/2	12	17 1/4	9.62	78.66	2405	250	4	2694	2694	2694	2694	2694	2694	2694	2694	2694	2694
	A4	1	3 1/2	"	"	12	17 1/4	9.62	78.66	2405	250	4	2694	2694	2694	2694	2694	2694	2694	2694	2694	2694
	A5	1	3 1/2	"	"	12	17 1/4	9.62	78.66	2405	250	4	2694	2694	2694	2694	2694	2694	2694	2694	2694	2694
	B1	1	3 1/2	1 1/16"	1 1/16"	12 1/4	16 1/8	8.396	73.19	2074	250	4	2618	2618	2618	2618	2618	2618	2618	2618	2618	2618
	B2	1	3 1/2	"	"	12	17 1/4	9.62	73.19	2074	250	4	2618	2618	2618	2618	2618	2618	2618	2618	2618	2618
	B3	1	3 1/2	"	"	12	17 1/4	9.62	73.19	2074	250	4	2618	2618	2618	2618	2618	2618	2618	2618	2618	2618
	B4	1	3 1/2	"	"	12	17 1/4	9.62	73.19	2074	250	4	2618	2618	2618	2618	2618	2618	2618	2618	2618	2618
	B5	1	3 1/2	"	"	12	17 1/4	9.62	73.19	2074	250	4	2618	2618	2618	2618	2618	2618	2618	2618	2618	2618
	B6	1	3 1/2	"	"	12	17 1/4	9.62	73.19	2074	250	4	2618	2618	2618	2618	2618	2618	2618	2618	2618	2618
	C1	1	3 1/2	"	"	12	17 1/4	9.62	73.19	2074	250	4	2618	2618	2618	2618	2618	2618	2618	2618	2618	2618
11-4-12	C2	1	3 1/2	"	"	12	17 1/4	9.62	73.19	2074	250	4	2618	2618	2618	2618	2618	2618	2618	2618	2618	2618
	C3	1	3 1/2	"	"	12	17 1/4	9.62	73.19	2074	250	4	2618	2618	2618	2618	2618	2618	2618	2618	2618	2618

as designed

Date of Examination.	No. of Distinguishing Boiler.	No. of Distinguishing Safety Valve.	Details of Valves.		Details of Springs.				Area of S. V. in square ins.	Area of F. G. in square feet.	Dead Load applied to produce the Working Pressure.	Working Pressure in lbs. per square in.	Compression due to Load corresponding to Working Pressure.	Compression actually set at (cold).	Pressure per sq. in. corresponding to the compression in previous Column.	Total compression, with Valves full open and Springs set, as in Column.	Total Load, with the compression of the previous Column.	Pressure per square in. corresponding to Load in previous Column.	
			Lift.	Fitted by Hand Gear.	Section of Wire.	Inside Diameter of Coil.	Number of Coils.	Length of Spring (uncompressed).											
1874	23	1	3 7/8"	1 3/16"	124	16 1/2"	8.264	2074.250	33	2691	2602	2648	2628	2693	2670	2601	2648	2628	2693
	24	1	"	"	"	"	8589	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	21	1	"	"	"	"	8288	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	22	1	"	"	"	"	9077	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	23	1	"	"	"	"	9006	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	24	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	25	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	26	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	27	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	28	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	29	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	30	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	31	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	32	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	33	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	34	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	35	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	36	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	37	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	38	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	39	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	40	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	41	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	42	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	43	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	44	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	45	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	46	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	47	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	48	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	49	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	50	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	51	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	52	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	53	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	54	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	55	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	56	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	57	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	58	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	59	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693
	60	1	"	"	"	"	8588	"	"	376	2608	2602	2628	2693	2670	2601	2648	2628	2693

DETAILS OF SPRING LOADED VALVES.

Type of Valves.	Number.	Diameter.	Load in lbs. per Square Inch.	Material.	Shape and size of Section.	Mean Diameter of Coils.	Length of Spring Uncompressed.	Number of Coils.	Compression necessary to produce the Working Load.
<i>Substit</i> Cylinder relief valves	H.P.	3 1/2"	170	Steel	□ 3 3/32"	3 1/2"		14	
	Int.I.P.	4 1/2"	15	"	" 3 3/64"	4"		7	
	Aff.L.P.	3 1/2"	25	"	" 2 5/64"	3 1/2"		9	
Receiver relief valves	H.P.								
	I.P.								
	L.P.								
Jacket relief valves	H.P.								
	I.P.								
	L.P.								
Auxiliary exhaust relief valve to— Condenser <i>Substit</i> L.P. receiver Atmosphere		8 1/2"	Adjustable	"	" 1 1/2"	7"	16 3/4"	9	1 3/4"
		9 3/4"	"	"	" 7/16"	5"	10 1/4"	9	1 1/2"
		4 1/4"	30.	"	" 9/16"	4 1/2"	10 5/8"	10.	1 1/2"
Relief valve to F. and B. pump discharge									

2626  
3 7/8  
3 1/8  
2619  
2631  
2646

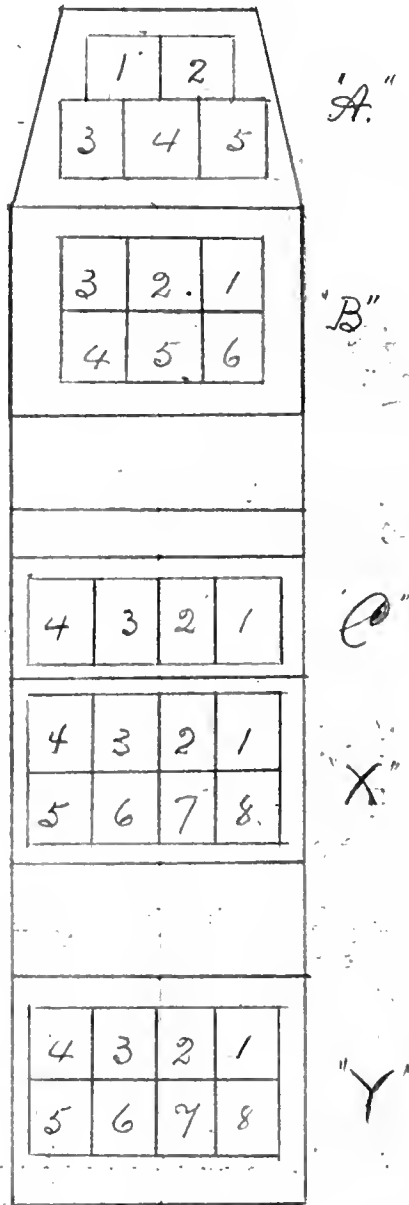
3 1/8  
3  
8529

2  
3  
65  
2  
8

BOILERS.

Plan, with numbers, of main boilers.

The forward boilers are to be shown at the top, and the port boilers on the left.



Numbers appropriated to boilers of steam boats, with the number and description of boat.

N<sup>o</sup> 32 To Steam Pinnace N<sup>o</sup> 255.  
 N<sup>o</sup> 33 D. N<sup>o</sup> 257.



DOUBLE BOTTOMS.

Plan, with capacities of each.

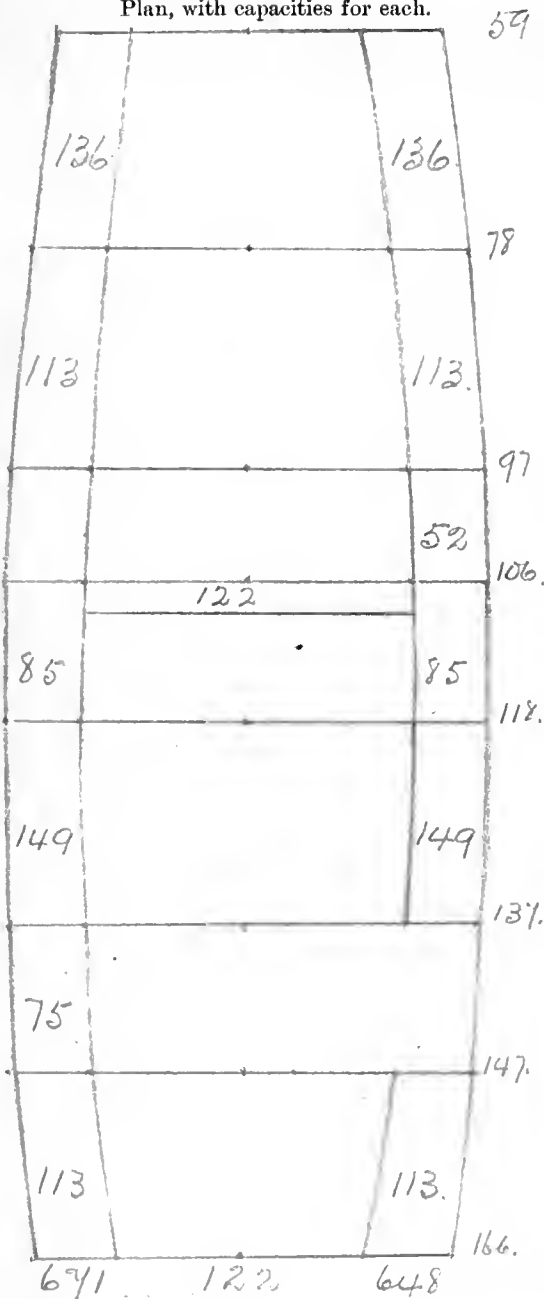
Double bottoms fitted as reserve feed tanks to be marked R.F.T. and those appropriated for oil fuel to be marked O.F.T.

	D.B.			59
O.F.	R.F.	R.F.	O.F.	
35	35.7	35.7	35.	
	D.B.			78
O.F.	R.F.	R.F.	O.F.	
47.	42.6	42.6	50.	
	D.B.			97.
D.B.	D.B.	D.B.	A.B.	
	D.B.			106
O.F.	R.F.	R.F.	O.F.	
38	28.6	28.6	38.	118
	D.B.			137.
O.F.	R.F.	R.F.	O.F.	
63	54.2	54.2	63.	
	D.B.			147.
	D.B.			
O.F.	R.F.	R.F.	O.F.	
56	54.5	54.5	56	166
R.F. 23.	O.F.	O.F.	R.F. 23.	174
O.F. 21	29	29	O.F. 21.	182
O.F.	O.F.	O.F.	O.F.	
29	27	27	29	194
O.F.	O.F.	O.F.	O.F.	
30	29	29	30.	203.

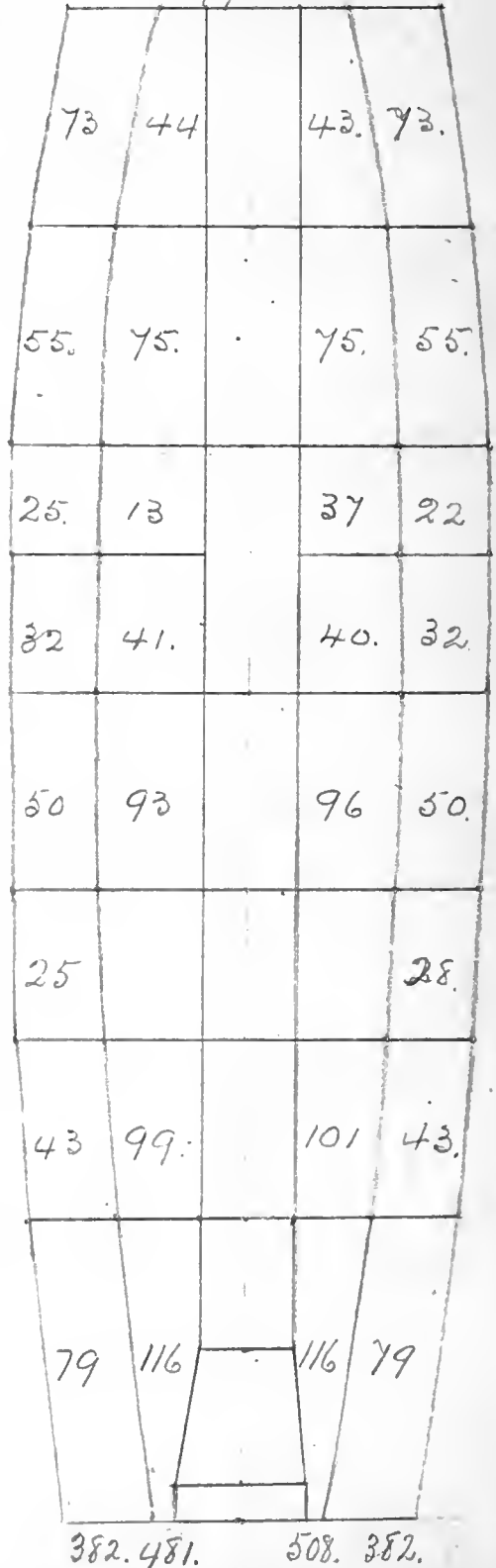
Oil  
Res Feed  
Over  
Tanks

COAL BUNKERS.

*Lower*  
Plan, with capacities for each.



*Upper.*



*Totals*  
671.  
122  
648.  
382.  
481.  
508.  
382  
3194. *Totals.*

208.





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	56	Air-pressure gauge.
	64	Quarterly return of work.
	67	Nature of repairs and defects.
	69	Examination of under-water fittings.
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	113	Machinery, examination of.
	114	I.R. valves, examination of.
	115	Tanks, feed-water, and zinc slabs, examination, &c., of.
	117	Protectors of condensers, examination of.
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	122	Auxiliary machinery, examination of.
	123	Telegraphs, examination of.
	124	Steering engine, telegraphs, &c., examination of.
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	162	Boilers, daily treatment, record of.
	164	Zinc slabs, condition of.
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	174	Density, rise of.
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	176	Water-tube boilers, lime used.
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	179	Boilers, pumping up or emptying, time between, after fires are out.
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	182	Main and reserve feed tanks, water in.
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and Steam Manual 1910.**

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1	1	39	39	81	69	120	121	169	164	201	197
2	3	40	40	82	68	121	122	170	166	202	198
3	3	45	45	83	56-58	122	123	171	167	203	199
4	4	51	51	84	79	123	124	172	168	204	200
5	4	52	52	91	91	124	125	173	165	205	201
6	2	53	53	92	92	125	Omitted.	174	169	211	211
7	5	54	54	93	93	126	128	175	Omitted.	212	213
9	9	55	55	94	93	127	129	176	171	213	214
10	10	56	82	95	92	128	130	177	172	214	215
11	11	57	87	96	Omitted.	129	131	178	174	217	217
12	12	58	78	97	94	130	132	179	173	218	218
15	15	59	83	98	94	131	133	180	175	219	219
18	18	60	84	99	95	132	131	181	176	220	220
19	19	61	85	100	96	133	107	182	177	221	221
20	20	62	86	101	97	134	135-140	183	178	222	222
21	21	63	88	102	103	151	151	184	179	226	226
22	22	64	60	103	93	152	152	185	180	227	227
23	23	65	71	104	104	153	153	186	181	228	228
24	24	66	72	105	105	154	151	187	182	229	229
25	25	67	74	106	108	155	155	188	183	230	230
26	26	68	75	107	Omitted.	156	156	189	184	231	231
27	27	69	76	108	109	157	157	190	185	232	232
28	28	70	77	109	110	158	158	191	186	233	233
29	29	71	61	110	111	159	159	192	187	234	234
30	30	72	80	111	113	160	Omitted.	193	188	241	241
31	31	73	73	112	114	161	160	194	189	242	242
32	32	74	81	113	115	162	161	195	190	243	243
33	33	75	72	114	116	163	162	196	191	244	245
34	34	76	62	115	117	164	163	197	192	245	246
35	35	77	63	116	118	165	157	}	193	251	}
36	36	78	65	117	119	166	166		198	194	
37	37	79	66	118	Omitted.	167	166	199	195	253	} Omitted.
38	38	80	67	119	120	168	170	200	196	254	

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255	Omitted.	299	287	340	341	387	387	428	428	475	471	
256		300	288	341	342	388	388	429	429	476	472	
257		301	301	342	343	389	Omitted.	430	430	477	473	
258		126	302	Omitted.	343	344	390	389	431	431	481	481
259			303		344	345	391	391	432	432	482	482
260	Omitted.	304	303	345	346	392	Omitted.	433	59	483	483	
261		305	304	346	347	393	392	434	60	484	484	
271	261	306	305	351	351	394	393	435	57	485	485	
272	262	309	309	352	352	395	394	436	433	486	486	
273	263	311	311	353	353	396	395	441	441-443	487	487	
274	264	312	312	357	357	397	396	442		488	488	
275	265	313	313	358	358	400	400	443	448-449	489	489	
276	266	314	314	361	361	401	401	444	446	490	490	
277	267	315	315	362	362	402	402	445	450	491	491	
278	268	316	Omitted.	363	363	403	403	446	447	492	Omitted	
279	269	317	316	364	364	404	404	447		493	492	
280	270	318	317	365	365	405	405	448	451	494	494	
281	271	319	Omitted.	366	366	406	406	449	444	506	506	
282	272	320	318	367	367	407	373	450		507	507	
283	273	321	319	368	368	408	407	451	445	508	508	
284	274	322	320	369	369	411	411	456	456	509	509	
285	275	323	Omitted.	370	370	412	411	461	461	510	510	
286	276	324		371	371			412	462	462	511	511
287	277	327	327	372	372	413	413	463	463	512	512	
288	278	328	328	373	373	415	415	464	Omitted.	513	513	
289	279	329	329	375	375	416	416	465		514	514	
290	280	331	331	376	376	417	217	466	464	515	515	
291	281	332	332	377	377	418	418	467	465	516	516	
292	112	333	334	378	378	419	419	468	466	517	518	
293	Omitted.	334	335	379	379	420	420	469	467	518	519	
294	282	335	336	381	331	421	421	470	468	519	520	
295	283	336	337	383	383	425	425	471		520	521	
296	284	337	338	384	384			472	469	521	522	
297	285	338	339	385	385	426	426	473	470	522		
298	286	339	340	386		427	427	474	Omitted.	522	523	



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1906.	1910.	1906.	1910.	1906.	1910.	1906.	1910.	1906.	1910.	1906.	1910.
523	524	530	Omitted.	540	540	547	547	554	554	569	569
524	526	531	532	541	541	548	548	561	561	575	} 575
525	527	532	533	542	542	549	549	562	562	576	
526	528	536	536	543	543	550	550	563	563	577	
527	529	537	537	544	544	551	551	566	566	578	
528	530	538	538	545	545	552	552	567	567	579	
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Hold & Double bottom Compartments.

Station	Name of Compartment	How pumped or Drained	How Flooded	Position of Workmen
Steer - 10.	W. T. Coupl <sup>r</sup>	Nil	Nil	Nil
10 - 18.	Carpenter's Store	4 1/2" suction from A pump.	Thro branch pipe valve & suction valve, in vicinity of pipe	At branch pipe foot valve, by locked handwheel
18 - 24	Provision Room	D <sup>o</sup>	D <sup>o</sup>	D <sup>o</sup>
24 - 32	Flour store	4 1/2 suction from B. Pump	D <sup>o</sup>	D <sup>o</sup>
32 - 36	Provision Room	D <sup>o</sup>	D <sup>o</sup>	D <sup>o</sup>
36 - 59 P & S	D.B. Coupl <sup>r</sup> 1 1/2" to 2" Long <sup>l</sup>	4 1/2" Suction from C. pump	D <sup>o</sup>	D <sup>o</sup>
36 - 59 P & S	D.B. Coupl <sup>r</sup> 2" to 5" Long <sup>l</sup>	D <sup>o</sup>	D <sup>o</sup>	D <sup>o</sup>
36 - 59 P & S	D.B. Coupl <sup>r</sup> above 5" Long <sup>l</sup>	D <sup>o</sup>	D <sup>o</sup>	D <sup>o</sup>
36 - 52	W. T. Coupl <sup>r</sup> under shell rooms	Thro 4" Sv on 52 Bhd	D <sup>o</sup> & 4" Sv on 52 Bhd	In the vicinity of valve
52 - 58.	D <sup>o</sup>	4 1/2" Suction from C pump	D <sup>o</sup>	At branch pipe by hand wheel

36-46 P.S.	W. Y. Comp <sup>ts</sup>	Thro 4" S.V. on 46 Bhd.	Nil	In the vicinity of the valve.
46-59 Port.	Searchlight store	4 1/2" suction from C. Pump	Thro branch pipe valve, suction pipe	At branch pipe by hand wheel
46-59 Star 45	Engineers store	D <sup>o</sup>	D <sup>o</sup>	D <sup>o</sup>
36-52	12" shell room	3" S.D.R. 1 in well at foot of hoist.	Thro 4" S.D.V. off seacocks.	By indicating deck plate (locked) & in vicinity of valve (locked) hand wheel.
52-55	4" Mag	Nil	Thro 4" S.D.V. off D. Seacock	D <sup>o</sup>
53 1/2 - 55	4" shell room	Nil	3" D <sup>o</sup>	D <sup>o</sup>
55-58.	Saluting Magazine	Nil	Thro 3" S.D.V. off D. Seacocks	D <sup>o</sup>
55-58.	Small arms Mag.	Nil	4" D <sup>o</sup>	D <sup>o</sup>
58-59.	Air space	Nil	Nil	Nil.
59-65.	D.B. Comp <sup>ts</sup>	4 1/2" suction from F.B. pump	4" Flood off engineers inlet.	At branch pipe by hand wheel
59-78 P.S.	Coal Bunker.	Thro door	do.	by locked hand wheel in boiler room
78-94 P.S.	D <sup>o</sup>	D <sup>o</sup>	D <sup>o</sup>	D <sup>o</sup>

78-82 P/S	D.B. Coupls	4 1/2" suction from Fr B. Pump	4 1/2" Flood off 7" seacock E	At branch pipe by hand wheel
97-98 } 97-106 }	Hydraulic Tank	4 1/2" suction from Fr B. pumps	3" pipe from rising main	At branch pipe by hand wheel
98-106	12" Shell room	Do	4" SDV off 7. Seacock	By indicating dash plate (locked) at bow deck in vicinity of valve by (locked) hand wheel
97-106 P/S	Wings	Port side by Flood pipe + hose connected to steam bilge pumps. Starboard thru door	4" flood off Eng inlet	By locked hand wheel in boiler room
97-106	Hydraulic Eng Coupls	4 1/2" suction from Fr B pumps	Nil	At branch pipe by hand wheel
97-106	D.B. Coupls	Do	4 1/2" flood off 7" seacock E	Do
106-108	Coal Bunker	Nil	Nil	Nil
106-118	do	Thru door	4" flood off Augment's inlet	By locked hand wheel in boiler room
118-137	Do	Do	Do	Do
137-141	switchboard room	Nil	Nil	Nil

137-147 P. S.	Wring	(Star <sup>4</sup> ) Thro flood pipes & hose connect- ing, led to steam bilge pump. (Port) Thro door.	4" Flood off Eng <sup>r</sup> inlet.	By locked handwheel in boiler room.
141-147.	Hyd <sup>ic</sup> eng <sup>r</sup> room	4 1/2" suction from F. B. pumps	Nil	At branch pipe by Handwheel
137-147	D. B. Coupls	D <sup>o</sup>	4 1/2" Flood off 6" seacock G.	D <sup>o</sup>
137-138. 137-147. 146-147 }	Hydraulic tanks	D <sup>o</sup>	3" pipe on rising main 1 salt water main.	D <sup>o</sup>
138-146	12" shell room	4 1/2" suction from F. B. pumps	4" Flood off "H" Seacocks	By indicating deck pla (locked) at main deck, in vicinity of valve by locke handwheel
146-147.	Air space	Nil	Nil	Nil.
147-166 P. S.	Coal bunker	Thro door	4" Flood off Eng <sup>r</sup> inlet	By locked handwheel in Boiler room.
166-182	Wring Coupl <sup>ic</sup>	4" SY on 182 Bhd.	4" SY on 182 Bhd	By locked handwheel in engine room
182-194 P. S.	W. V. Coupl <sup>t</sup>	Thro flood pipe & hose connected to steam Bilge pump	4" Flood off engine's inlet	D <sup>o</sup>
194-208. P. S.	W. V. Coupl <sup>t</sup>	D <sup>o</sup>	D <sup>o</sup>	D <sup>o</sup>
208-214 P. S.	Engine store	Nil	Nil	Nil.

208 - 214	4" Noag.	Nil	Thro 5" S.D.V. off J. seacock	By indication locked at main in vicinity of valve by locked hand wheel
214 - 229	12" Shell room	3" S.D. R.R. V. in well under hoist	Thro 4" S.D.V. off B. seacock	D°
208 - 218 P.S.	W.Y. Coupl	4" suction from D pump	Branch pipe & suction pipe	At branch pipe in vicinity of valve by locked hand wheel
218 - 229 P.S.	W.Y. Coupl	4" Sluice valve on 218 bulkhead	4" S.Y. on 218 bulkhead	in vicinity of valve by locked hand wheel
218 - 218	W.Y. Coupl	4 1/2" suction from D Pump	Branch pipe & valve & suction pipe	D°
208 - 221 P.S.	D.B. Coupl YK to 2 <sup>nd</sup> Longi	4 1/2" suction from D. Pump	D°	At branch pipe in vicinity of valve by locked hand wheel
208 - 229 P.S.	D.B. Coupl 2 <sup>nd</sup> to 5 <sup>th</sup> Longi	D°	D°	D°
208 - 218 P.S. 218 - 222	} Above 5 <sup>th</sup> Longi	D°	D°	D°
208 - 221		Shaft passage	D°	D°
221 - 229	W.Y. Coupl under shell room flat	4 1/2" suction from D. pump	Thro branch pipe valve & suction pipe	At branch pipe, fore valve in vicinity of valve, by locked hand wheel
229 - 235 P.S.	Drain tank	5 1/2" suction from E Pump	D°	D°
229 - 232	Pistol tank	Drain cock	2" S.D.V. off Seacock	By indication, locked at main in vicinity of valve, by locked hand wheel

234 - 235	Dry Gun cotton Magazine.	Nil	3" S.D.V off Seacocks	By indicating deck plate (locked) at main deck in vicinity of valve by handwheel Nil.
229 - 234	Submarine Mine Store	Nil	Nil.	Nil.
229 - 235	Torpedo Head Magazine	Nil	Nil	Nil.
235 - 239 P. S.	W. I. Coupl. 4 1/2" suction from E pump	4 1/2" suction from W. I. Coupl. 4 1/2" suction from E pump	W. I. Coupl. 4 1/2" suction from E pump	At Branch pipe Foot valve suction pipe in vicinity of valve, by locked handwheel.
239 - 242 P. S.	W. I. Coupl. 4 1/2" suction from I. Pump	4 1/2" suction from I. Pump	D.	D.
242 - Aft	to I. Coupl.	Nil	Nil.	Nil

### Platform Decks.

Stem - 10.	W. I. Coupl	Nil	Nil	Nil.
10 - 18	Boatswain's Store	do	do	do
18 - 24	D.	4" S.D. N.R. valve	Nil	By NW in vicinity of valve
24 - 33	Captain's gear Comp	4" S.D. N.R. valve	Nil	do
33 - 36	Spirit room	Nil	5" S.D.V. off B. seacocks	By indicating deck plate on main deck in the vicinity valve, by locked handwheel
36 - 50	W. I. Coupl	4" S.D. N.R. V	Nil	By NW in vicinity of valve
36 - 46 Stores	Provision Coupl.	Nil	Nil	Nil.

36-46	Handing Room	Nil	Nil	
40-52	12" Magazine	Nil	10" S.D.V off Seacocks C.	By indicating deck plate locked on main engine vicinity of sal. by main hand wheel
52-58	Transmitting Stn	Nil	Nil	Nil
52-55 1/2	Lower Conning Tower	Nil	Nil	Nil
50-59 Port	Mr. S. room & Telephone exchange	Nil	Nil	Nil
46-59 Star <sup>46</sup>	Engmeins Store	Nil	Nil	Nil
97-98	Air Space	Nil	Nil	Nil
98-106 P	Handing Room	Nil	Nil	Nil
98-106	12" Magazine	Nil	9" S.D.V off 7 Seacocks	By indicating deck plate locked hand wheel
97-106 S	Steam Dyn room	4" S.D.N.R.V	Nil	By H.W. in vicinity of valve
137-147 P	Do	Do	Do	Do
137-138	Air space	Nil	Nil	Nil
138-146 S	Handing Room	Nil	Nil	Nil
138-146	12" Magazine	Nil	9" S.D.V off H Seacocks	By indicating deck plate locked hand wheel
146-147	Air space	Nil	Nil	Nil
208-218	Engmeins Stores	Nil	Nil	Nil
208-214	4" Shell Room	Nil	3" S.D.V off J. Seacocks	By indicating deck plate locked hand wheel
208-216	Transmitting Station	Nil	Nil	Nil

214 - 229	12" Magazine	Nil	9" S.D.V. off N Seacock	By indicating deck plate locked handwheel
224 - 229	9" Small	Nil	3" S.D.V. off J. Seacocks	Do.
218 - 229 P + S	W. J. Compt	4" S.D. WRY P. Nil (S)	Nil	By H.W. in vicinity of valve
221 - 229	Handing room	Nil	Nil	Nil
229 - 235	Submerged Torpedo Room	Two 6" S.D. N.R. Valves	Nil	By H.W. in vicinity of valve
235 - 239	M.G. room	Nil	Nil	Nil
235 - 239	Electric Capstan Gear Compt	4" S.D. N.R. V.	Nil	By H.W. in vicinity of valve
239 - 252	Steering Compt	4" S.D. N.R. V.	Nil	By H.W. in vicinity of valve
252 - Stern	Lower paint store	Nil	Nil	Nil

Lower Deck

Stem - 10	W. J. Compt	Nil	Nil	Nil
10 - 18	Cordage room	Nil	Nil	Nil
18 - 24	Canvas room	Nil	Nil	Nil
24 - 27	Carpenter's store	Nil	Nil	Nil
27 - 29	Cable lockers	Two 4" N.R. V. into drain tanks under	Nil	Nil



29-32 1/2	Boarnies Slops	Nil	Nil	Nil
32 1/2-36	Chronometer Room	Nil	Nil	Nil
29-36	Paymaster's Slops	Nil	Nil	Nil
36-46 P	Distributing Stn	Nil	Nil	Nil
36-46 S	Electrical Store	Nil	Nil	Nil
36-45	Gunnery Store	Nil	Nil	Nil
45-52	CO <sub>2</sub> Machine & 4" S.D. N.R.V.	Nil	Nil	By H.W. in vicinity of
	Magazine's			valve
46-59 P	Provisions	Nil	Nil	Nil
46-59 S	Spare Armature Room	Nil	Nil	Nil
52-59	4" Ready use Magazine	Nil	By hose from nearest H.C. on S.W. main	Nil
59-65	Eugene's Store	Nil	Nil	Nil
59-78 P.S.	Coal bunkers	Nil	Nil	Nil
78-97 P.S.	Do	Nil	Nil	Nil
97-106 P.S.	Do	Nil	Nil	Nil
97-106	Gunnery Store	Nil	Nil	Nil
97-106	CO <sub>2</sub> M/c & Searchlight M/c	4" S.D. N.R.V.	Nil	By H.W. in vicinity of valve
106-118 P.S.	Coal Bunkers	Nil	Nil	Nil
110-118	Wireless Telegraph Office	Nil	Nil	Nil
118-134 P.S.	Coal Bunkers	Nil	Nil	Nil

137-147 P.S	Coal Bunker	Nil	Nil	Nil
137-147	Stowage for searchlight	"	"	"
137-147	Centre CO <sup>2</sup> M/c Compl	4" S.D. N.R.V	"	By H.W. in vicinity of valve
137-147	Gunner's stores	Nil	"	Nil
147-166	P.S Coal Bunker	"	"	"
166-194	D <sup>o</sup>	"	"	"
194-208	T <sup>o</sup> Distributing Stn	"	"	"
194-203 1/2	P. 4" Ready use Magazine	"	By hose from nearest H.C. on S.W. Main	"
194-208	S D <sup>o</sup>	"	<del>By</del>	"
203 1/2-208	Searchlight M-9s	"	Nil	"
194-204 1/2	Boat hoisting	"	"	"
208-231	Eng <sup>o</sup> Workshop	"	"	"
208-215 1/2	Announcers Workshop	"	"	"
215 1/2-222	Electricians do	"	"	"
222-231	CO <sup>2</sup> M/c	4" S.D. N.R.V.	"	By H.W. in vicinity of valve
231-235	14" Torpedoes	Nil	"	Nil
231-239	Refrigerating Room.	"	"	"
235-239	Flour Store	"	"	"
235-239	CO <sup>2</sup> m/c	4" S.D. N.R.V	"	By H.W. in vicinity of valve
239-248	Water	Nil	"	Nil
248-254	Paint Room	"	"	"
254-Store	Paint Store	"	"	"

