A.P. CAHILL.

H.M.C.S. NADEN

ESQUIMALT

B.C.

C1[illegible]

20-7-40

SPRAYERS.

the new sprayer is much simpler than the old
their are only four parts
I the metal body
II the steel cap
III the steel plug
IV steel adjusting plug
the steel cap screws into the large end of the gun metal body. The back face of the steel cap makes a metal to metal oil tight joint with the end face of the gun metal body the steel plug fits into a recess at the back of the steel cap and prevents the oil passing directly from the annular receiving chamber to the whirling space.
The face of the collar on the plug holds a metal to metal joint with the face of the recess on the back face of the steel cap and is held in position by the pressure of the oil in the body of the sprayer

Passage of oil through the Sprayer
The oil entering the annular receiving space from the hollow gun metal body passes through the longitudinal holes in the steel cap. To the annular recess at the back of the steel cap flange. From their it is forced through the tangential holes drilled at the bottom of the same recess and by these holes and the shape of the whirling space which it now enters the oil is given a rotary motion the oil coming into contact with the inner edge of the exit hole is split into very fine particles the oil then leaves the exit hole in the form of a very fine spray of conical formation. The conical spray is produced by the cone end of the spindle in the ordinary sprayer. In the new type sprayer it is produced by the conical recess behind the

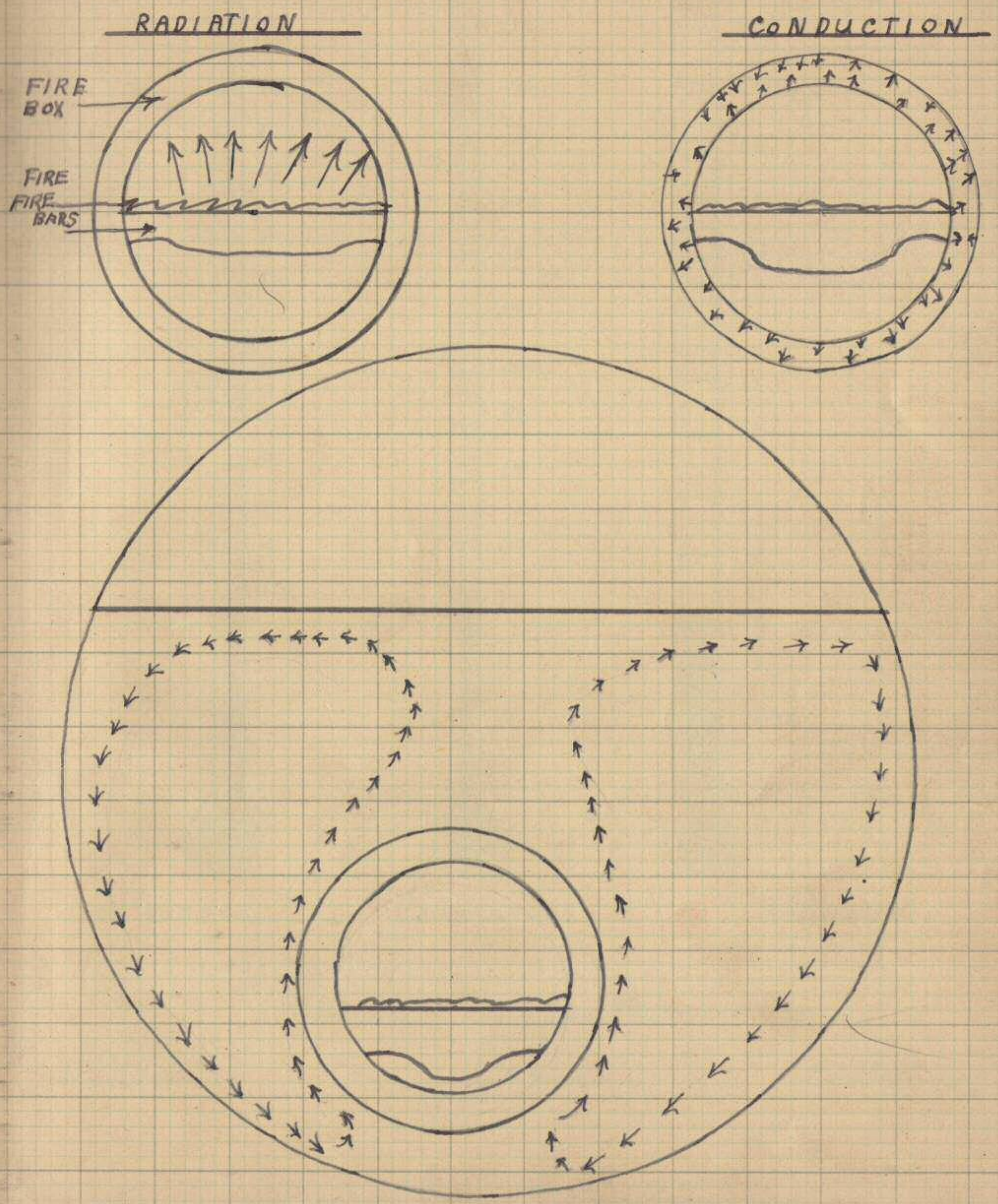
Exit hole It has been proved by experiment that the spray produced by the new patent sprayer is more finally divided than that produced by the ordinary service sprayer

Position of Sprayer

The sprayer is held in position by a (U) shaped Cradle bracket the Cradle it's self is secured to the angle bracket on the air box front by four bolts: two hinged Clips are provided on the Cradle to secure the sprayer rigidly in position the clips are secured by swivel bolts fitted with butterfly nuts (Spanner are unnecessary when removing the sprayer) one clips holds the body of the sprayer just behind the enlarged end the other Clips fits around the ~~end~~ recess in the boss of the adjusting wheel so preventing the wheel from moving backwards or forwards on the screw cut on the rear end of the body of the sprayer enabling it to give lateral movement to the sprayer. To unshift the sprayer ease back the wing nuts swing the bolts clear of the hinged Clips and lift the hinged clips clear of the body of the sprayer This method of holding removing and replacing the sprayer ensures (once the U-bracket has been properly adjusted) That it is always replaced in the Correct position after Cleaning changing the cap ore completely replacing. All sprayers of the new patent are exactly of the same dimensions.

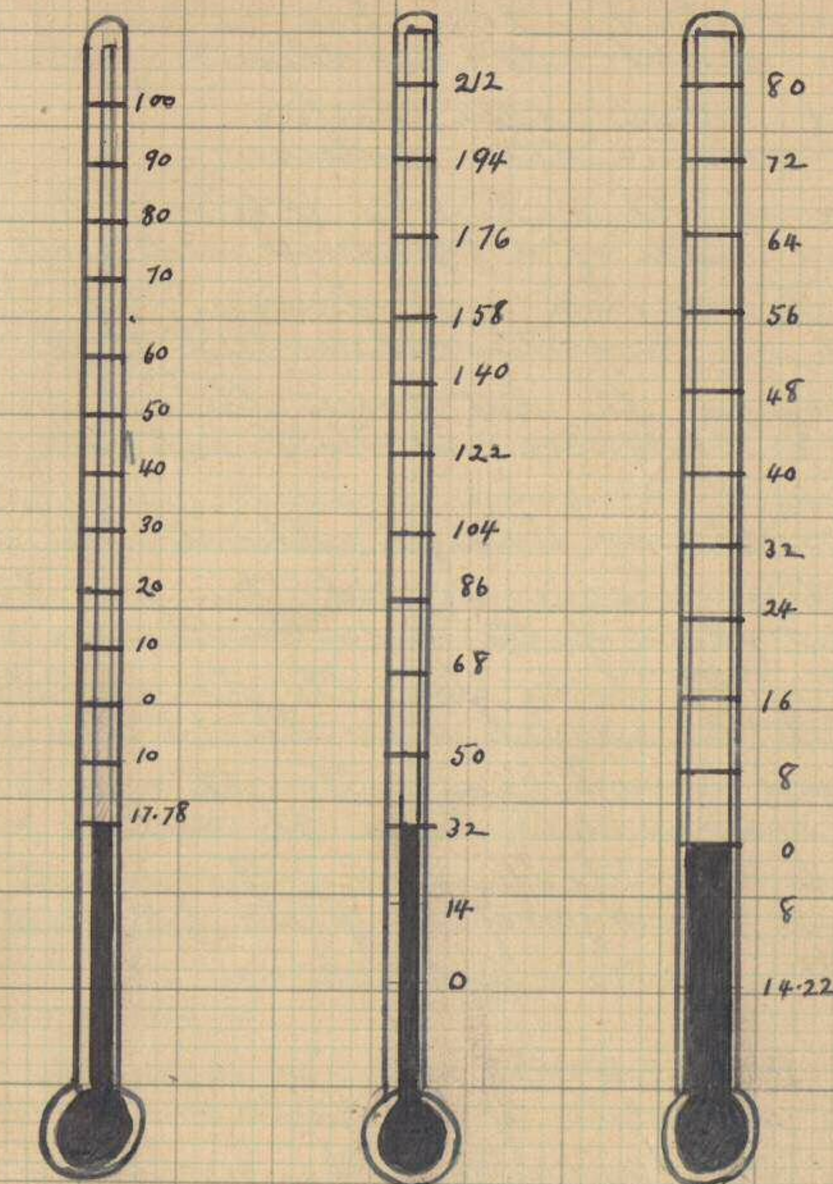
The adjusting wheel engaging with the threaded end of the body is provided to enable the sprayer cap to be adjusted with reference to the Combustion Cone. To obtain the correct Cone full of flame to make this adjustment ease back the butterfly nuts sufficient to allow the body of the sprayer to move freely in the required direction retightening the nuts when adjustment is complete.

TRANSFER OF HEAT



CONVECTION CURRENTS

THERMOMETERS



CENTIGRADE FAHRENHEIT RÉAUMUR

ABSOLUTE ZERO TEMPERATURES

- 274° - 461·2° - 219·2°

LECTURE II

The tank or cylindrical boilers in use in the navy may be divided into two classes.

I Single-ended return tube boilers
II Double ended return tube boilers

The commoner of these two is the single-ended type. These are made of a cylindrical shell with flat ends and contain one or more furnaces. The furnace connects with the combustion chamber and the combustion chamber discharges the hot gasses through a number of tubes into a smoke box and thence into the boiler uptake.
Each combustion chamber arranged either to take the gases from two furnaces, or each furnace has its own. The front plates of the combustion chamber and front plate of the boiler form the tube plates. About one plate in every five is thicker than the remainder and is screwed into the tube plates, these being known as stay tubes. The various parts of the boiler are fastened together by the means of rivetted joints, the edges of the plates being caulked to make them water-tight

BOILER STAYS

To prevent the end plates of the boiler and the sides and top of the combustion chamber from bulging under the effects of the internal pressure, a number of stay ~~tubes~~ rods and stay tubes are fitted. The end plates of the boiler where the nuts of the stay rods bear, are stiffened with steel plate washers. These are rivetted to the plates. The back of the combustion chamber is stayed to the back plate of the boiler and the sides of the combustion chamber are attached to the sides of the boiler and to one another. Special strong backs called dog stays are used to stiffen the combustion chambers top. The furnaces are usually corrugated to allow for expansion and the corrugation adds greatly to the strenght to resist crushing

HEATING SURFACES

In a cylindrical boiler the heating surface is made up of the following parts.

I Top of furnace above the grate
II Top of the Combustion Chamber
III Sides of the Combustion Chamber
IV The tubes

The back of the furnace and the bottom of the combustion chamber is partly covered by an inclined brick baffle. This wall directs the hot gases up into the combustion chamber and acts as a reservoir of the heat of combustion. This brick baffle is built three parts of the way up the back of the combustion chamber in order to protect the heads of the stays. Special bricks are fitted to protect the throat of the combustion chamber. To protect the ends of the tubes in the combustion chamber, ferrules are fitted in each tube.

WATER TUBE BOILERS

BABCOCK & WILCOX YARROW

The advantages of W.T. boilers over cylindrical boilers are —

I Carries higher steam pressure with safety
II Lighter for the same H.P.
III Capable of raising steam more quickly
IV Less danger and loss of power not so great in the event of damage to one boiler
V Defective parts easily replaced.

THE DISADVANTAGES

I More affected by irregular feeding and firing
II Not so easy to clean
III Do not last so long

BABCOCK WILCOX BOILER

Consists of a number of water Chambers or headers each front header being Connected by a number of straight tubes to a back header. Each front header is connected at the top by a short lenght of tube to a large steam and water drum and the bottom of the header is Connected at the bottom by two long return pipes to the steam and water drum where they enter above the water line. The tubes and header have an inclin of 16° so that the distance from the tubes to the fire boxes is greater at the back of the furnace at each end of the mud drum is attached a sediment Chamber with the usual blow down valves on it. There are two downcomer pipes at each end of the steam drum and one to the sediment Chamber. All the tube joints are expanded and their are no stays in the boiler. There are two types of this boiler in the navy

The large tube type with all the tubes 3 1/4 in Dia. and the mixed tube type with two bottom rows of 4 and the rest 1 1/8 diameter (except the return tubes at the top)

Doors are provided in bath back and front headers so that tubes may be examined and cleaned on the inside. The headers and tubes are staggered to prevent the gases from finding a straight ~~space~~ passage up between the tubes. the wing headers however, are not staggered and so a water wall is formed to protect the Casings.

YARROW BOILERS

This boiler Consists of a large steam drum at the top and two water drums at the bottom Connected by a number of straight tubes. The tubes are expanded at the ends into the drum tube plates. Their are two types of this boiler, the large tube type with 2" tubes and the small tube type with tubes 1" to 1 1/8" Dia. The small tube type is more often met with in the service than any other kind of boiler. The large tube type generally has two downcomer pipes and the two fire rows of tubes are slightly curved towards the furnace

YARROW - BOILERS - CONTINUED

It gives roughly twice the power of the small tube type. In the small tube type, no downcomers are fitted The water circulating up through the fire rows of tubes and the tubes further from the furnace. All three of the drums are now made Cylindrical in shape the feed water is led into the top or steam drum. There is a baffle on either side of the boiler, extending about one third of the way down the tubes. this baffle is made of wrought iron. The whole is enclosed in a casing of steel plates with asbestos lagging between them

— SUPER-HEATERS. —

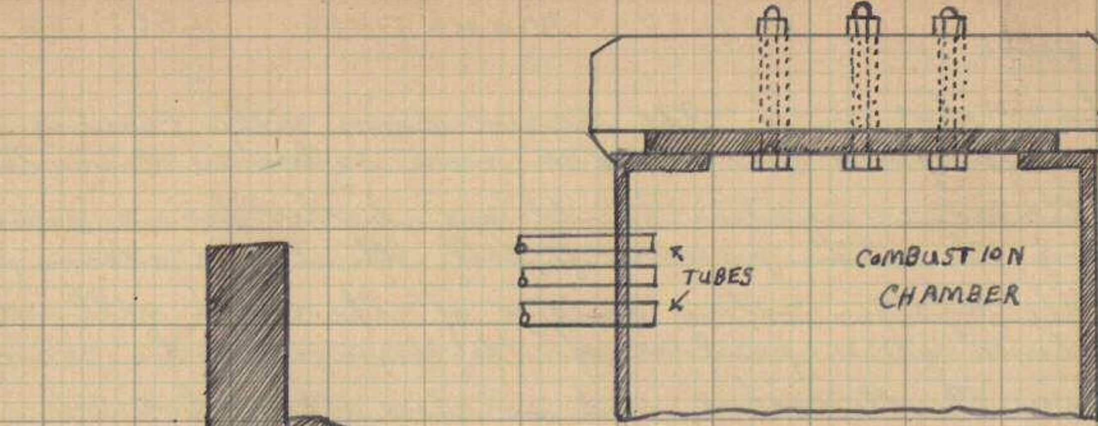
Are now fitted to these boilers either consisting of one or two barrels fitted with tubes which project into the uptake. Nearly all the mountings are Carried on the steam drum. When superheaters are fitted it carries the stop valve. The water level is ~~this~~ such that tops of all the tubes are under water or said to be drowned Zinc. slabs are fitted.

— WHITE FORSTER BOILER —

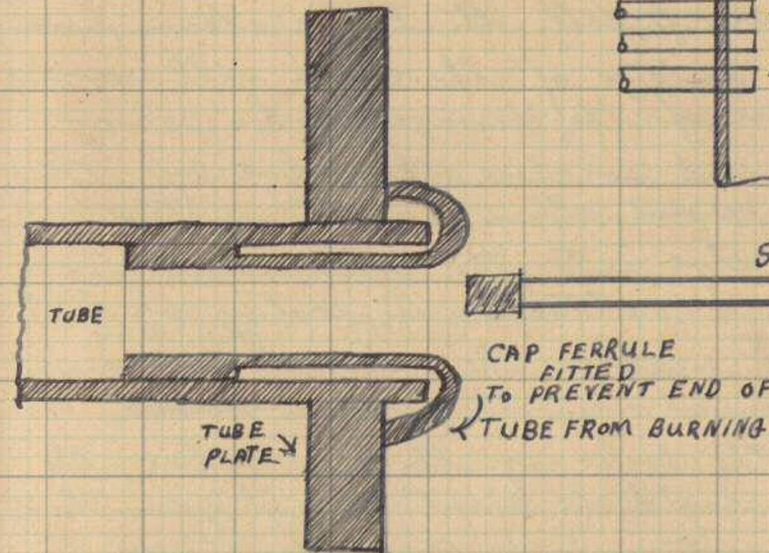
This boiler very much resembles the yarrow except that all the tubes are carved in such a manner that they can be withdrawn or put into place through the steam drum. This type of boiler is only met in steamboats. Another type found in steam boats and which is something similar in construction. is the mumford boiler. All the mountings of this boiler fitted to the steam drum, are carried on the front end door of the drum and are easily removed

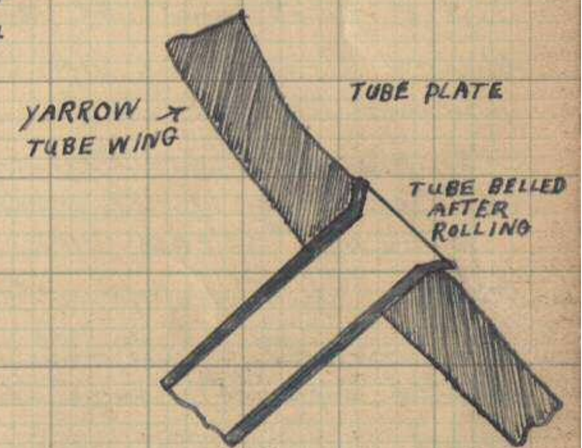
— BOILER CASINGS —

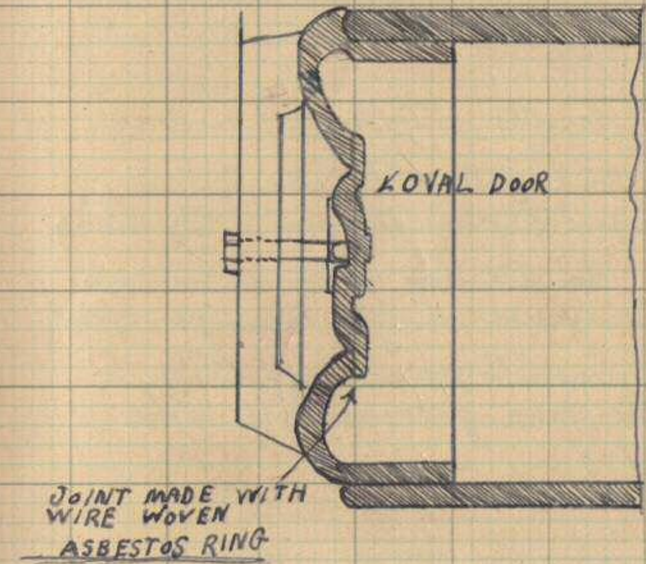
The boiler Casings of W.T. boilers have to be airtight in order to preserve the funnel draught.
The Casings Consist of steel plates fastened together by deep flanges, the flanges allowing the plates to be considerably bent and buckled without any injury to the airtightness of the boiler Casing.
The Casings are lagged with silicate cotton asbestos, or some other non-Conducting substance.
The furnaces are lined with fire brick or with fire brick tiles bolted to the casing.
Wire straps are fastened from the boiler shell to the bulkheads to absorb the shock of ramming or pitching. Distance pieces are fitted between the boiler shell and the bunker bulkheads to steady the boiler when the ship is rolling.

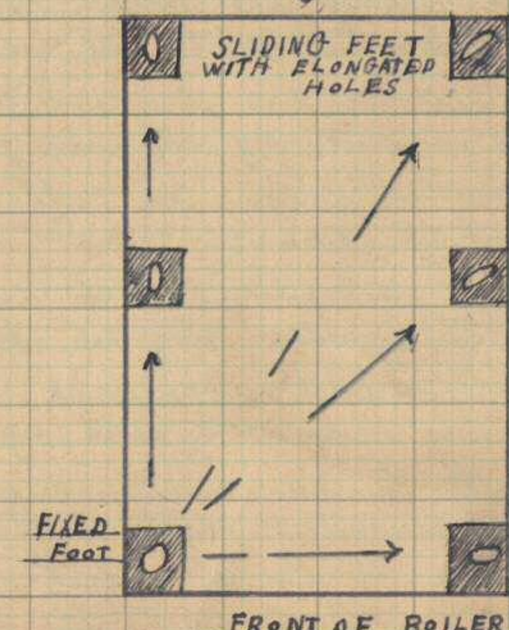


STAY TUBE









FRONT OF BOILER

BOILER MOUNTINGS LECTURE III

STOP VALVE

This valve is of the screw down, self closing type and will operate when two or more boilers are connected to the same system. Should one boiler become damaged causing the steam pressure to fall, the higher steam pressure of the system acting on top of the valve will overcome the lower steam pressure of the damaged boiler acting underneath the valve, and so close the valve of its own accord. This will prevent steam from the system getting past the stop valve into the boiler which is damaged. The valve can be rotated on its seating by a "T" handle and the wheel enables, the valve to be opened. The "T" piece must be removed when the valve is opened.

Before connecting up the boiler by the stop valve, the pressure in the boiler should be about 5 lbs higher than the pressure in the system, and this will assist in the opening of the valve.

INTERNAL STEAM PIPE

One end of this pipe is connected to the stop valve where it connects on to the boiler, and the other end is sealed up. it hangs in a horizontal position in the steam space along the steam drum and has a number of circumferential slots cut in the upper half, through which the steam has to pass. This prevents priming to a large extent by increasing the area from which the generated steam is collected.

SAFETY VALVE

Fitted in pairs, and relieves excess of steam pressure in the boiler. they are fitted in pairs for reasons of safety and convenience. If one valve hangs up, the other is available, and again, can be made sufficiently small to be easily kept in good state of repair. The valves are kept on their seatings against the boiler pressure by large spiral springs, whose tension can be adjusted to suit the desired blowing off pressure of the boiler

The pairs of valves should together, be large enough in area to allow excess steam to escape when the boiler is steaming, "All out" with every connection shut. This should be accomplished without an increase of more than 1% of blowing off pressure.

The valves have a flat seating with lips above it, and the lips offers a large area to the steam pressure, once the valve opens, and this ensures that the steam pressure will be considerably lower than the blowing off pressure by the time the valve is shut.

THE SAFETY VALVE

This valve is an improvement on the old type, having the following advantages

I Lighter and smaller

II Overhauling greatly simplified on removal of outer nuts, The fittings, comprising, springs, valve cage, valve, etc. can be removed complete and taken to workshops for overhaul

III Main valve opens against boiler pressure, and this assists in keeping it steam tight. The principal parts consists of the spring hooded pilot valve, and the main valve with its piston.

The boiler steam exerts a pressure on the under side of the pilot valve and steam passes to a chamber above the valve. The flow of steam past the enlarged part of the spindle through small holes to the atmosphere, carries the plate valve against ~~the~~ its seating on the underside of the casing, and the steam passes through a hole in the casting to the back of the piston on the main valve. The piston being slightly larger in area than the main valve, exerts the greater pressure, and so overcomes the main valve and opens it, and allows steam to escape to the atmosphere.

When steam pressure falls again, the pilot valve closes, and in so doing the enlarged part of the spindle carries plate valve from its seating, and steam escapes to atmosphere, then with the fall of steam pressure on back of the piston, the main valve closes, the spring assisting it. This is the action of one main valve on its corresponding pilot valve.
Full bore safety valves are fitted pairs. It will be seen from the foregoing description that the springs which control the safety valve pressure are those on the pilot valves.
The springs on the main valves are fitted solely to assist in keeping the valve on its space.
One pilot valve is set to blow off at slightly less pressure than the other usually a difference of three ~~pounds~~ lbs.

FEED CHECK VALVE

This is a screw down non-return valve for admitting water into the boiler.
Two are usually fitted, one main; one auxillary. The water enters the boiler from underneath side of the valve, and thus the valve is open when feed water pressure is greater than boiler pressure, and closed when boiler pressure is greater than feed water pressure. An internal pipe is fitted to convey feed water from the check valve to the coolest part of the boiler, and thus assists in good circulation. The internal feed pipe is perforated on one side, and its ends are blanked; in addition to being led to coolest parts of the boiler, care is taken when fitting up pipe that the perforations point away from the boiler surfaces; thus when water enters boiler it does not strike the shell of the boiler, an action which is likely to cause cracking of plates.

AUTOMATIC FEED REGULATOR - MUMFORDS.

Some form of automatically feeding the boiler with water is necessary in the case of water tube boilers, because of the rapid generation of steam, the small amount of water in the boiler and the necessity for keeping the level of water constant.
One of the best known forms of automatic feeding is the mumford and this type is generally used throughout the service. It consists of a float chamber fitted externally to the steam drum of the boiler. The chamber is in communication with the steam drum by means of two types; one leading from the steam space, and one from the water space, and in consequence of which the water level is identical to that in the boiler.
Inside the chamber is a steel float, balanced at one end and this float connects by a lever to a small valve called a needle valve. The needle valve box forms part of a float chamber, and one side of the needle valve connects by a small pipe to the suction side of the main feed pump, and the other side of the needle valve connects by a small pipe to the bottom side of the plunger of main feed check valve.
The main feed check valve used with the mumford automatic is of special construction. The upper portion is the same as the ordinary type screwed down, non return valve, but underneath, it has an extension spindle. On the end of which is a cast piston or plunger which in a chamber immediately below the valve seating. The piston is of loose fit in the chamber. The operation of the automatic feed is as follows.

(A) When water level in the boiler rises, with a corresponding rise of water level in the float chamber, the float rises and opens the needle valve, thus connecting both leak off pipes;

One from the main feed check valve box, and one to the main feed pump suction.
Thus the pressure on the underneath side of main feed check valve plunger is practically nil. In consequence of this the feed water when it ~~becomes~~ comes in between the feed check and its plunger, there exists both an upward and downward pressure, and so renders the feed check valve inoperative. Consequently no water passes into the boiler.

B/ When water level in the boiler falls, the float naturally falls too and closes the needle valve. The feed water from the main feed pumps comes between the check valve and valve plunger, and leaks past, and up the leak off pipe as far as the needle valve, which is now shut. pressure ~~accumulates~~ accumulates in the leak off pipe from the main feed check valve, and this added pressure on the underneath side of the plunger, lifts the feed check valve; this continues while the needle valve is shut. A cock is fitted on this leak off pipe from the main feed check valve, so that the main feed can be used without the automatic regulator, if so desired

THE WEIR BOILER FEED REGULATOR

DESCRIPTION

it is designed to give a steady feed into the boiler at all loads. for any given rate of evaporation the check valve "floats" in a corresponding position and allows a steady flow of water to enter the boiler varies, the check valve opens or closes and increases or reduces the area for the flow of water as necessary to suit the changing rate of evaporation.
The action of the regulator is as follows:-
When the float falls, due to a fall in the boiler water level, the needle rises cuts of the flow of water from the piston chamber through the leakage valve, and the pressure in the chamber rises due to the leakage of water into the chamber through the clearance between the piston and the cylinder. Immediately the pressure in the chamber rises above the pressure in the boiler, the valve lifts and allows feed water to pass into the boiler. The valve can only rise by the amount that the needle has been raised. Immediately the opening is uncovered the pressure under the piston falls below the pressure in the boiler and the valve commences to close.
When the water level in the boiler rises, the needle valve is lowered by the action of the float and the opening is uncovered and allows water to escape from the chamber, the pressure in the chamber falls below the pressure of the boiler and the valve falls to the same extent as the needle.
It will be seen that the valve and the piston are hydraulically constrained to move in the same direction and to the same extent as the needle, which is operated by the float.
A valve is provided, so that, when desired, the leak-off can be closed. The main valve then operates as an ordinary non return valve and the feed supply to the boiler can be regulated by hand. By adjusting the opening of the check valve on the boiler in the usual way.

ADJUSTMENT

The working water level in the boiler will vary from a top level, when no steam is being evaporated in the boiler, to a bottom level when the boiler is operating at its maximum rate of evaporation and the feed regulator should maintain a steady water level between the top and bottom water levels for any given rate of evaporation

Between no load and the maximum load.
Washers have been provided between the needle valve seat and the piston to enable the needle valve seat to be adjusted relative to the needle valve for the purpose of raising or lowering the water level as required.
To lower the water level the washers should be removed as necessary to obtain the desired level. If it is desired to raise the water level, washers should be added. A washer 1/16" thick alters the water level 1/16. Thicker washers will alter the water level a correspondingly increased amount.

— OPERATING INSTRUCTIONS. —

When the feed pump has been started, steam and water should be admitted to the float box by opening the isolating ~~valve~~ valves on the boiler.
The leakage cock on the regulator can now be opened and the rise and fall of pressure in the chamber under the piston should be tested by lowering and raising the float by means of the hand gear.
When the float is in its top position, the pressure under the piston should be well below the boiler pressure. When the float falls about one inch from the closed check position, the pressure under the piston should rise and closely approximate to the pressure of the feed pump discharge. If the pressure under the piston does not respond quickly to the rising of the needle valve, the supplementary cock should be opened slightly.

THE WEIR FEED REGULATOR CONT.

The handle for moving the float gear should be left in the vertical position so as not to interfere with the movement of the float during normal operating conditions. The float should be moved gently by means of the handle, care being taken not to allow the float gear to strike the stops in a violent manner.
The hand screw-down on the feed check valve can now be opened slowly and the feed pump will discharge water into the boiler until the water level corresponding to the closed check position is reached.
If the feed regulator is operating satisfactorily the pressure under the piston will be approximately at the pressure in the boiler when the valve is feeding. When the valve is falling, the pressure under the piston will momentarily fall below the boiler pressure, and for the closed check position the pressure under the piston should be well below the boiler pressure.
If it is desired to control the feed supply by hand instead of automatically, the leakage cock should be closed and the feed supply can be regulated by hand in the usual way by closing down the check valve to the desired extent by means of the hand wheel.

— GENERAL —

Incorrect functioning of the regulator may be shown by the water level in the boiler rising too high, by failure to pass sufficient water to maintain the water level in the boiler or by intermittent feeding.
The freedom of action of the float gear should first be checked by moving the float by means of the handle. The float gear should be sensitive to a very slight force on the handle.
It is assumed that the steam and water connections to the float box are open and quite free. The position of the water level in the float box can be determined approximately by the feel of the handle. The float box should be periodically blown out by alternately shutting and opening the steam and water connections on the boiler with the drain cock on the float box open.
Assuming the correct water level in the float box and the float gear is working quite freely,

The rise and fall of the pressure under the piston of the check valve should be examined with the supplementary cock closed with the float in its top position, the pressure under the piston should fall well below the boiler pressure.
If the pressure does not fall the needle valve seat is choked with some foreign substance or the needle valve does not leave the needle valve seat sufficiently to allow sufficient area for the leakage of water. This latter fault can be corrected by removing a washer or washers from between the needle valve seat and the piston.
If the piston pressure is above the boiler pressure the check valve will rise immediately the hand gear is raised and the boiler will become flooded.
Flooding the boiler may also be due to the check valve failing to close properly owing to grit between the check valve and its seat.
Failure ~~to close~~ to supply sufficient water to the boiler may be due to the valve not lifting sufficiently and opening the supplementary cock may have the desired effect. Intermittent feeding is clearly shown by the pressure under the piston fluctuating markedly above and below the boiler pressure and may be ~~due~~ due to a sluggish float gear or a sticky check valve.
This can only be remedied by removing and rectifying the faulty part.
The valve must work perfectly freely and any sluggishness in its actions will be indicated by unusually large variations in the fluctuations of the boiler water level. Sluggish action may be due to an accumulation of dirt or too fine clearances between the running parts. The needle valve must work perfectly freely, due to its own weight, when disconnected from the float gear

DISMANTLING

The feed check valve can be removed without disturbing any piping. The cover should be removed ~~without disturbing~~ and the feed check valve can be withdrawn by inserting an eye bolt into the tapped hole provided in the top of the feed check valve.
The needle valve can be removed without disturbing the float gear or any pipework. To remove the needle take off the float box cover. Remove pins at each end of the links between the float lever and the needle valve. (These pins are screwed into one of the links). Immediately the links are removed the needle valve can be withdrawn through the float lever.
Care should be taken to avoid damage to the needle valve when it is being withdrawn
To remove the float gear, the links and the needle valve should first be removed. Remove the hand lever crank. The nuts securing the float gear fulcrum bracket pushed back until the studs disengage from the needle valve guide. The float can than be removed from the float box.
When dismantling the needle valve and float gear, care should be taken to avoid nuts and pins falling into the water levelling pipe at the bottom of the float box.
If at any time it is desired to dismantle the valve body, the float gear must first be removed, because the support for the float gear is secured to the valve body by screws and must be removed from the float box with the valve body.

BLOW-DOWN-COCKS.

These are usually durance asbestos packed cocks fitted to the lower barrels or sediment chambers of boilers for blowing sediment out to the sea. The cocks are opened by detachable spanners fitting on the square of the plug, and are fitted in such a manner, that, after the spanner has been fitted on for opening the cock, it cannot be

Removed until the Cock is shut again.

These cocks are usually fitted in pairs and when blowing down the boiler, the cock next to the boiler is opened first and shut last.

This prevents scoring of the plug of the first ~~plug~~ Cock so that it shall always be in good Condition

RUNNING DOWN VALVE

Fitted to each lower barrel for running water from the boiler to reserve feed tank or bilges.

Sometimes used on small boilers for blow down

-AIR COCKS-

Asbestos packed. for admitting or expelling air.

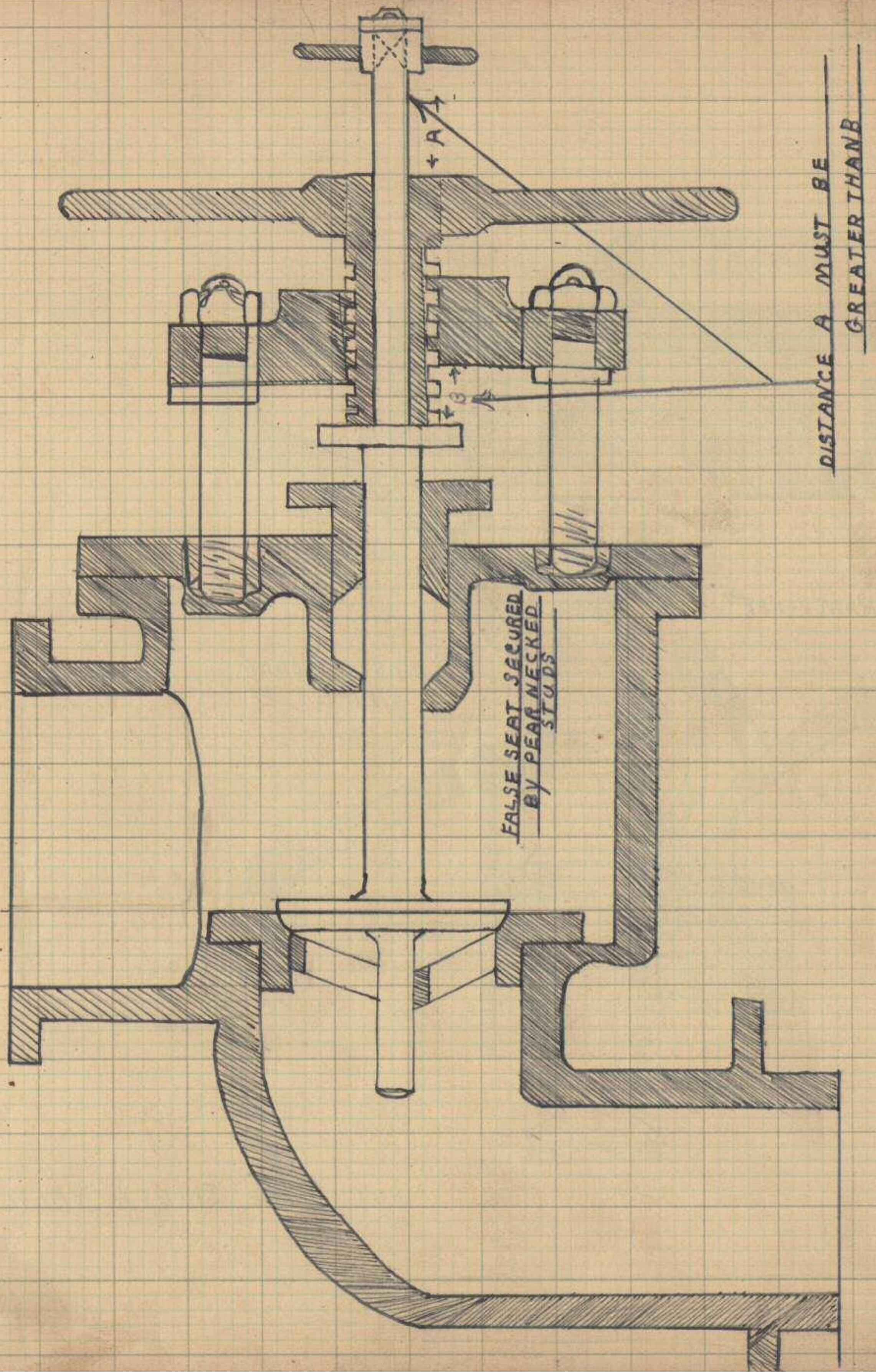
Placed at the highest part, to ensure expulsion of all air when pumping up boiler (W.W.)

- PRESSURE GAUGE AND COCKS -

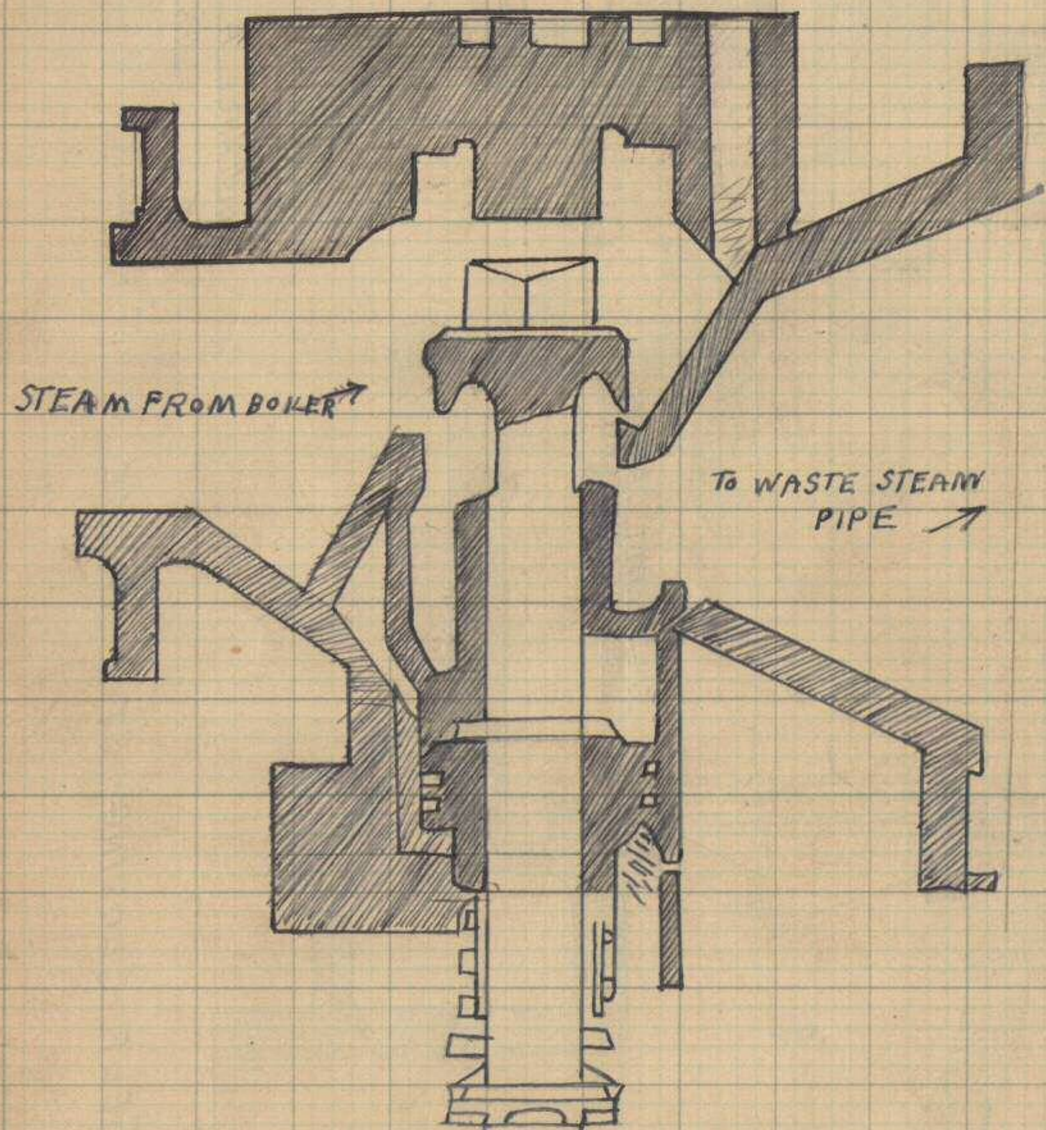
~~In~~ Two pressure gauges are fitted to each boiler. The Cock is fitted immediately next to the gauge so that pressure can be shut off the gauge in case of need, for renewal or repair. Usually, the pipe connecting the gauge to the boiler is fitted with a coil in it, so that the elliptical pipe ~~inside~~ in side pressure gauge shall be filled with water instead of steam.

-ZINC SLABS AND HANGERS-

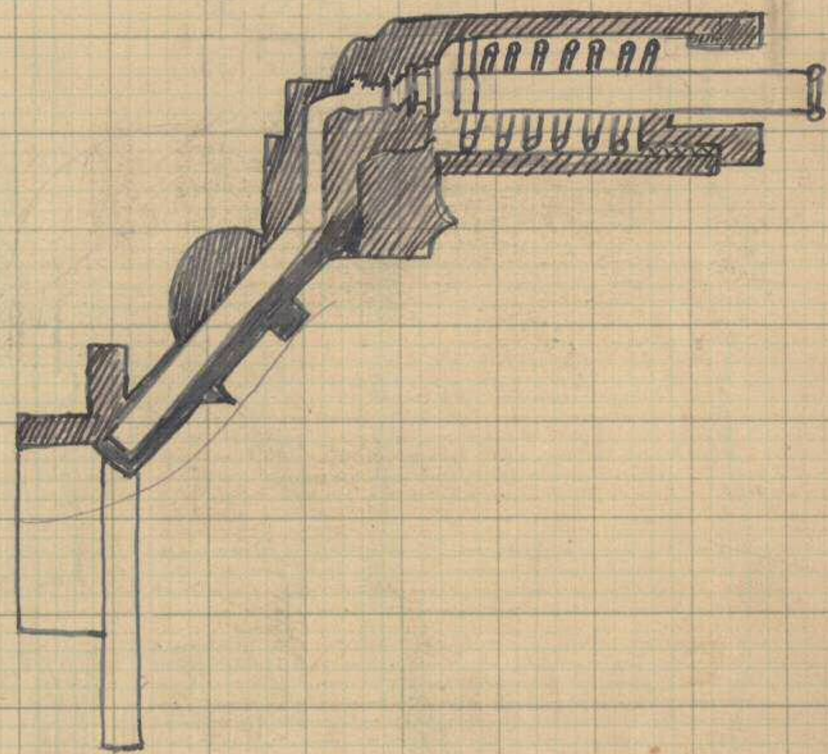
Fitted to prevent Corrosion. Cage fitted to the hangers in (W.T.) boilers to prevent tube Choking with scale from slabs

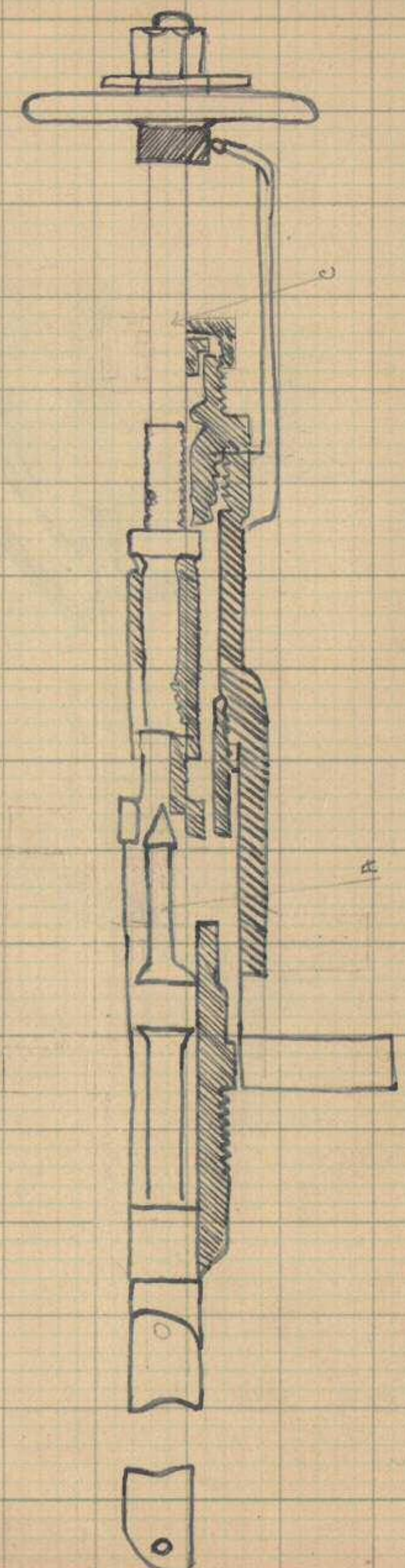


SELF CLOSING STOP VALVE

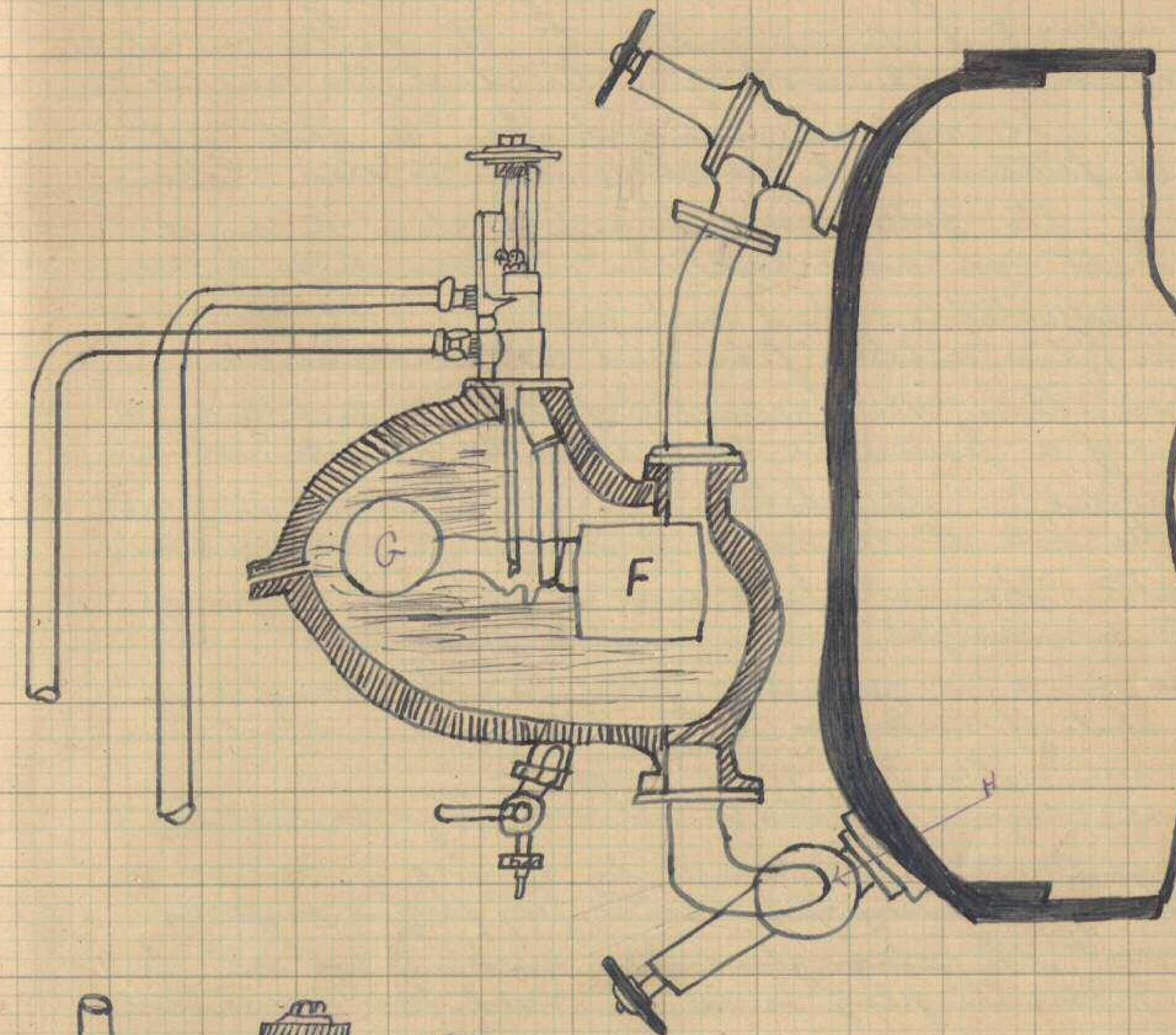


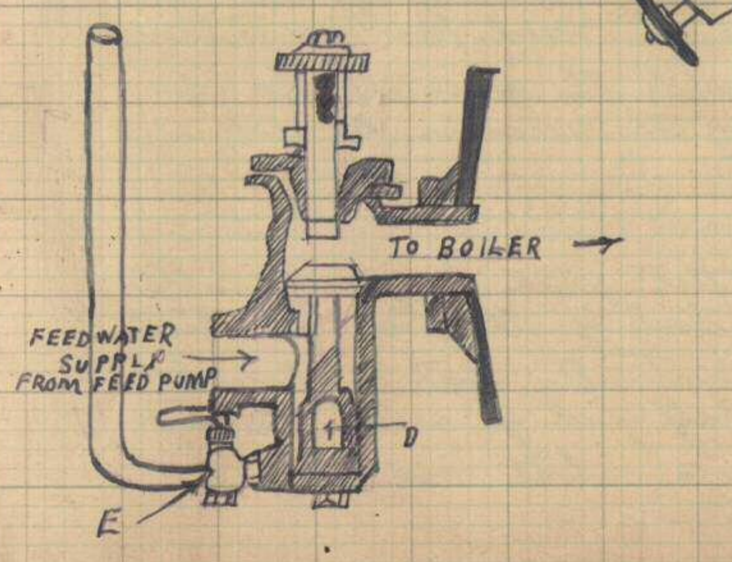
FULL BORE SAFETY VALVE





MUMFORDS FEEDREGULATOR





LECTURE IV — WATER GAUGE MOUNTINGS —

Water gauge mountings consist of a glass tube mounted in two gunmetal mountings, each of which each of which is connected to the boiler one above and one below the working water level. To enable the glass to be replaced when broken, a shut off cock is fitted on each mounting; their is also a drain cock in the bottom mounting. The glass is made steam tight and water tight in the mountings by means of an adjustable gland and packing in the form of washers; two asbestos fibre and one rubber washer in between them, are generally fitted in each gland. In case of a fracture in the glass tube a ball-valve is provided in the bottom mounting, which is forced over the hole at the bottom of the gauge glass by rush of water. The ball falls aside ~~of~~ out of the passage, by its own weight, when the glass is replaced. A ~~wide~~ wire is generally fitted to the handle of both shut-off cocks, so that watchkeepers can close them at once when the glass breaks. Screwed plugs are fitted to the mountings so that the passage can can be cleaned by a wire if necessary. On the top mounting a special safety plug is is fitted to prevent the ~~plug~~ glass from working up out of place. When the plug is in its correct position it should be clear of the glass 3/16 while the glass should be hard down at the bottom of the recess in the bottom mounting.

(KLINGER-WATER-GAUGES-)

These consist of a stout flat pane of glass, bolted into a gunmetal holder, the back of the glass. in contact with the water is groved vertically with V shaped groves. When the glass is half full of water the top half. of the glass appears white and the bottom half black

— WINDOW-PANE-GAUGE-GLASS —

This glass consists of two panes of stout flat glass and made water tight in a gunmetal holder, with a water space between them. The water level can be clearly seen by looking through both glasses. Two glasses should be fitted to each boiler:- and the following points should be noted when attaching them to the boiler:-

I The bottom of the glass should be several inches above the highest heating surface.

II The gauge should not be fastened to any part of the heating surface. as steam bubbles will rise and effect the water level

III The water level will also be affected if their is a rapid circulation past the gauge connection.

IV The gauge should be rigidly attached to the boiler and not to the casing

(NOTE) a difference of 1/10 of one lb. per sq. inch. pressure between the two ends of the gauge, will make a difference in the water level of about 2½ ins.

(TO REPLACE-A-BROKEN-GAUGE-GLASS—)

I Remove broken glass and old packing from the glands and see that the glands work freely in their place

II See that the holes in the mountings are clear

III See that the new gauge glass is clean, free from flaws and the right lenght.

IV Pack bottom gland first, with the washers see that the glass cannot be lifted out of the ~~recess~~ bottom recess when the top cap plug is in place.

V Tightened by hand, while glass is held up 1/16 from bottom mounting

VI pack top gland and test for tightness

VII warm through glass very slowly

— TESTING OF BOILER-GAUGE-GLASS —

It is most important that water gauge glasses should indicate correct water level in boiler. Petty officers on taking over a watch, should always ascertain that all orifices are clear. this can be done in six motions It is always advisable not to work the cocks more ~~that~~ than is necessary

BLOWING-THROUGH-GLASS —

I Shut water Cock
II open drain cock steam blows through and indicates steam and drain cocks clear
III Shut steam cock
IV open water cock water blows through indicates water clear.
V Shut drain cock
VI open steam cock water should take up its level quickly

When the water level is not apparent in the glass proceed as follows. Never guess where the water level is

I Shut water cock
II Shut steam cock
III open drain cock water or vapor in glass will pass to bilge
IV Close drain cock
V Gradually open water cock if no water shows in the glass boiler is very short of water— If water rises in glass level is above water cock orifice.
VI open steam cock— If water remains at top of glass then the boiler is two full

PROCEDURE IF SHORT OF WATER

Ease up fuel supply to boiler. Depending on the circumstances, It may be necessary to shut off fuel supply entirely. Increase speed of feed pumps Put auxillary feed supply on boiler. When water shows in the glass, fuel supply may be increased.

— PROCEDURE-IF-TWO-MUCH-WATER —

Priming may result and all sprayers and all feed should be shut off the boiler. Warn engine room to open all drains. Blow down boiler until water level is visible. Start up sprayers. When level is at half a glass, ~~feed supply may be increased~~. And open up feed as necessary Both the above conditions are very dangerous and they should not occur if the water tenders pay proper attention to their one and only duty. In either of these two cases, attention of the engine room artificer on duty in the boiler room for mechanical details is to be drawn to the necessity of adjusting the automatic regulators.

In both cases attention is to be paid to main and auxillary stops ~~valued~~ valves to ensure that there is no possibility of valves blowing back if steam pressure from either boilers had closed the valve whilst the ~~valve~~ boiler has been temporily out of action.

HIGH POWER STEAMING

When a boiler is being steamed at approximately full output, circulation is very rapid and the water in a state of violent ebullition. It must be realized that the amount of water present in the boiler is then 60% of what it would be when steaming at normal speeds.

If the circulation is checked through some unforseen circumstances such as temporary failure of oil supply, great care is necessary before restarting the boiler. Checking of circulation will cause the water in the boiler to subside and although furnace conditions will be practially ready to continue at full speed, conditions internally will not be ready until water level is again showing a half glass of water. Sprayers must be put on gradually and when circulation has been reestablished the boiler may again be worked at full output.

Failure to take these precautions would probably overheating of the boiler tubes at upper ends with consequent distortion. (over)

In all such Cases the Engineer of the watch is to be immediately informed

LECTURE V — MAIN ENGINES —

The usual type of main Engine is the triple expansion with three or more cylinders. The Cylinders are arranged alongside one another, vertically above the ~~the~~ crankshaft being supported by a number of Columns which at their lower ends are attached to Cast steel sole plates. These sole plates are secured to each other by fore and aft Cast steel frames or angles, and are fastened down to the ships inner bottom by a number of holding down bolts.

The sole plates are lined up in their places by means of Cast iron chocks placed beneath them. The front Columns are generally made of forged steel, while the back Columns are made of Cast iron or Cast steel. The ~~flat~~ back Columns support a large flat surface forming the 'ahead guide' two strips bolted on this surface forming forming the astern guide. attached to the front Columns are brackets for the drain valve levers and Jacket seperators or water bottles. The Columns also support bearing of weight shaft, air pump levers and reversing engine.

Each cylinder is a seperate casting and includes the following fittings

(1) Slide valve Casing
(2) Bottom Covers
(3) Brackets to which the Columns and other cylinders are fitted
(4) Bosses for drains, reliefs and indicator cocks

CYLINDER AND LINER

The cylinders are fitted with an internal liner made of closed ~~grained~~ Cast iron or ~~steel. It has a~~ The liner is bolted down to the bottom of the cylinder whilst at the top it is jointed with a copper band or ring to allow for expansion and keeps that end of the liner steam tight. The top Cylinder Covers are made of cast steel and with a man hole through which the interior of the Cylinder may be inspected. In large cylinders an inspection door is fitted for the same purpose in the bottom cover. sight doors are generally fitted to valve casings.

PISTONS

A piston is generally a cone ~~cast~~ shaped casting made of steel. It has a cast iron ring called a junk ring which holds in place the piston packing ring. The H.P. and I.P. pistons are fitted with carrier rings containing two or more spring packing rings, which depends on their ~~on~~ their natural spring to keep them hard up against the cylinder walls. Special rings with a restricted outward movement are fitted in many HP pistons to prevent excessive wear between the rings and liner when the ring is new.

The L.P. piston is generally fitted with one broad ring cut on the slant, the cut being kept steam tight by means of springs against the liner. The piston fits on a coned end of the rod and the nut securing ~~liner~~ it is prevented from slacking back by means of a cotter, keep plate or split pin. The piston is prevented from turning by a small feather

CONNECTION ROD

At the foot of the piston rod is fitted the cross-head block; it carries a detachable slipper and shoe, as well as the journal for the top end of the connecting rod. It is the link between the reciprocating piston and the revolving crank. It transmits the thrust of the steam on the piston through the shaft to the propeller. Two half brass one in the connecting rod and one in the cap are seperated by gunmetal distance pieces and their brass liners so that when the bolts are tightened up, the brasses are a working fit on the crank pin journal the top end generally has two bearings which ~~are~~ are similarly adjusted to fit the Cross head journals. In small engines, for strenght the top end of the Connecting rod has a gudgeon fastened in it. In this Case the piston rod end has a split bearing to fit the gudgeon pin journal. The connecting rod bolts and other important bolts of the main engines are reduced in diameter where possible to the diameter of the bolt at the bottom of the threads, this gives the bolt a nearly uniform strenght throughout.

MAIN BARING BRASSES

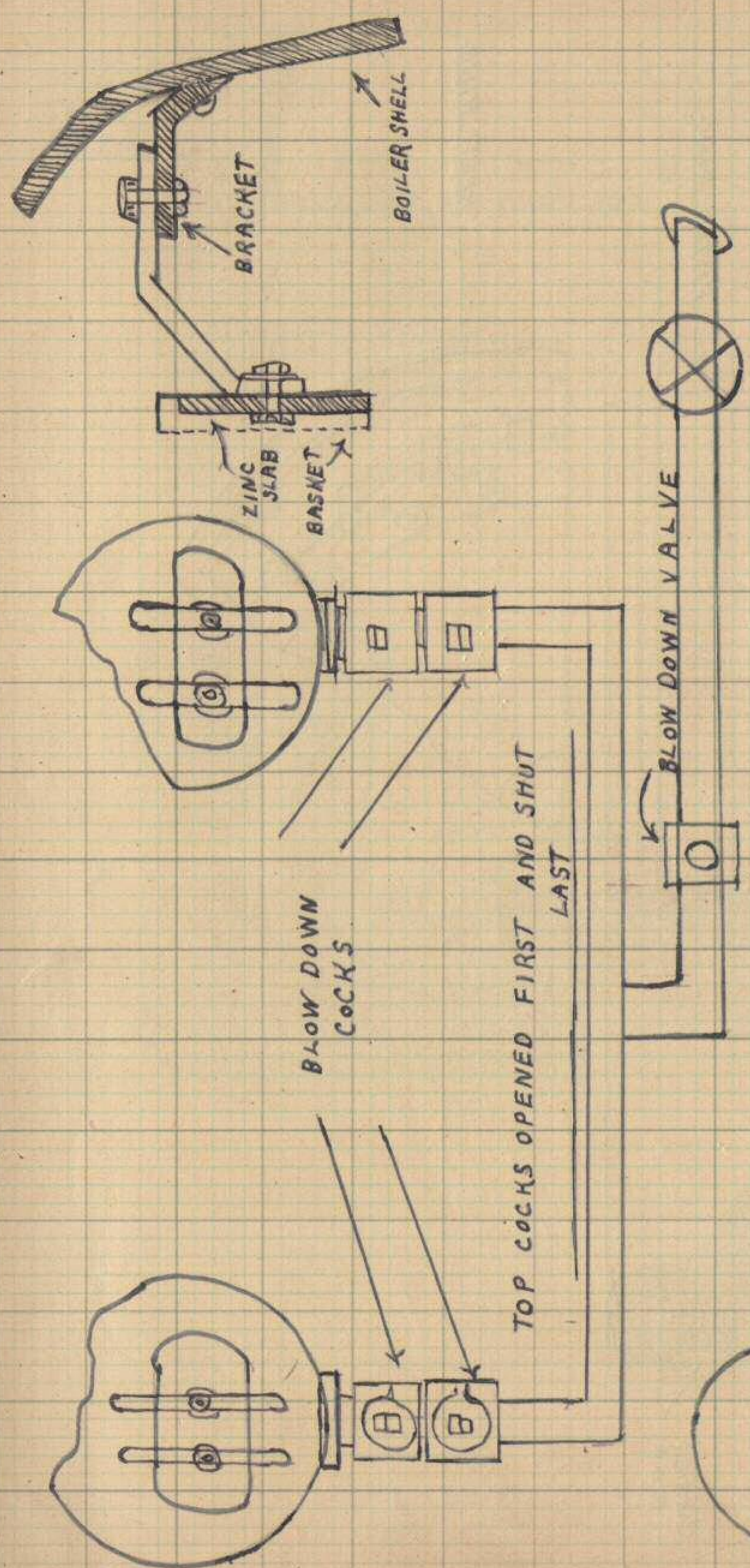
These are adjusted in the same manner as the Crank brasses, the top half brass having a water surface through it to keep it cool

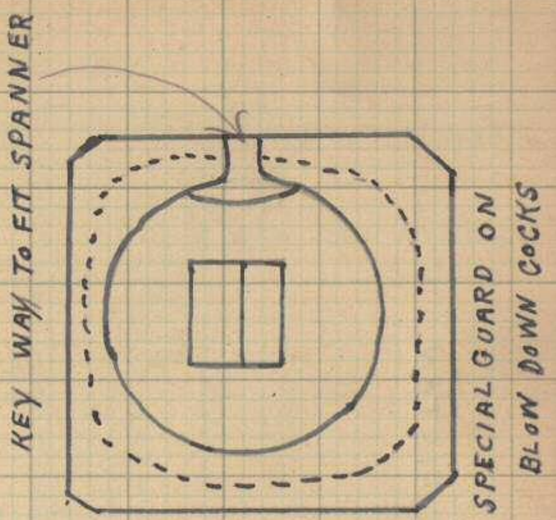
PLUMER BLOCK

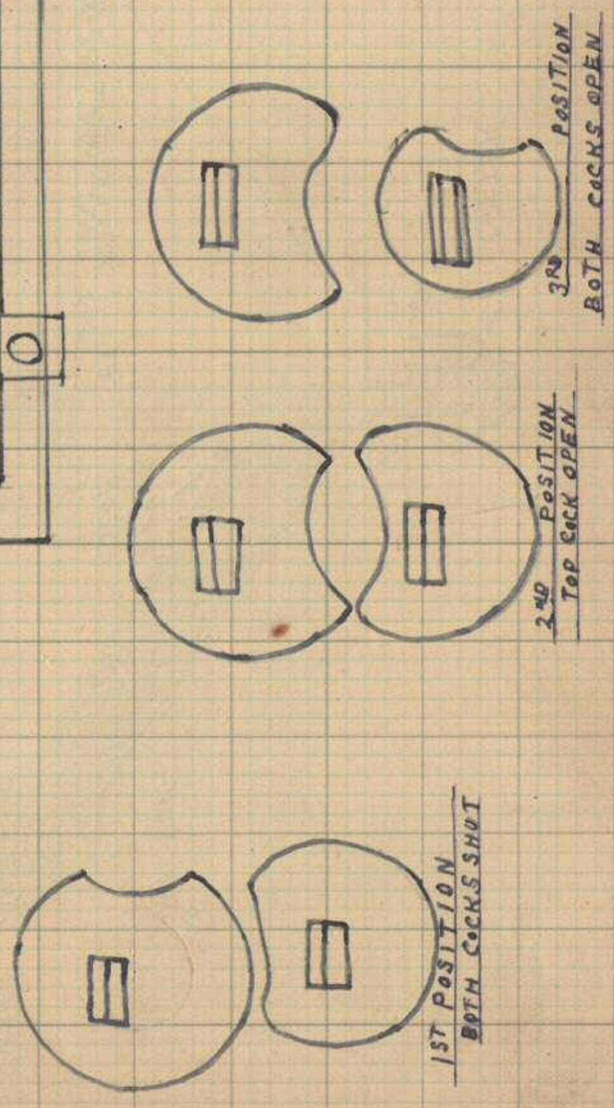
These are fitted on the fore and after ends of the thrust block. Also at intervals along the shafting. The bottom half of the brass only bears on the Cast, the top half being quitt clear and merely acting as a cap. This is all the bearing that is necessary as their is no tendency for the shaft to lift.

THRUST BLOCK

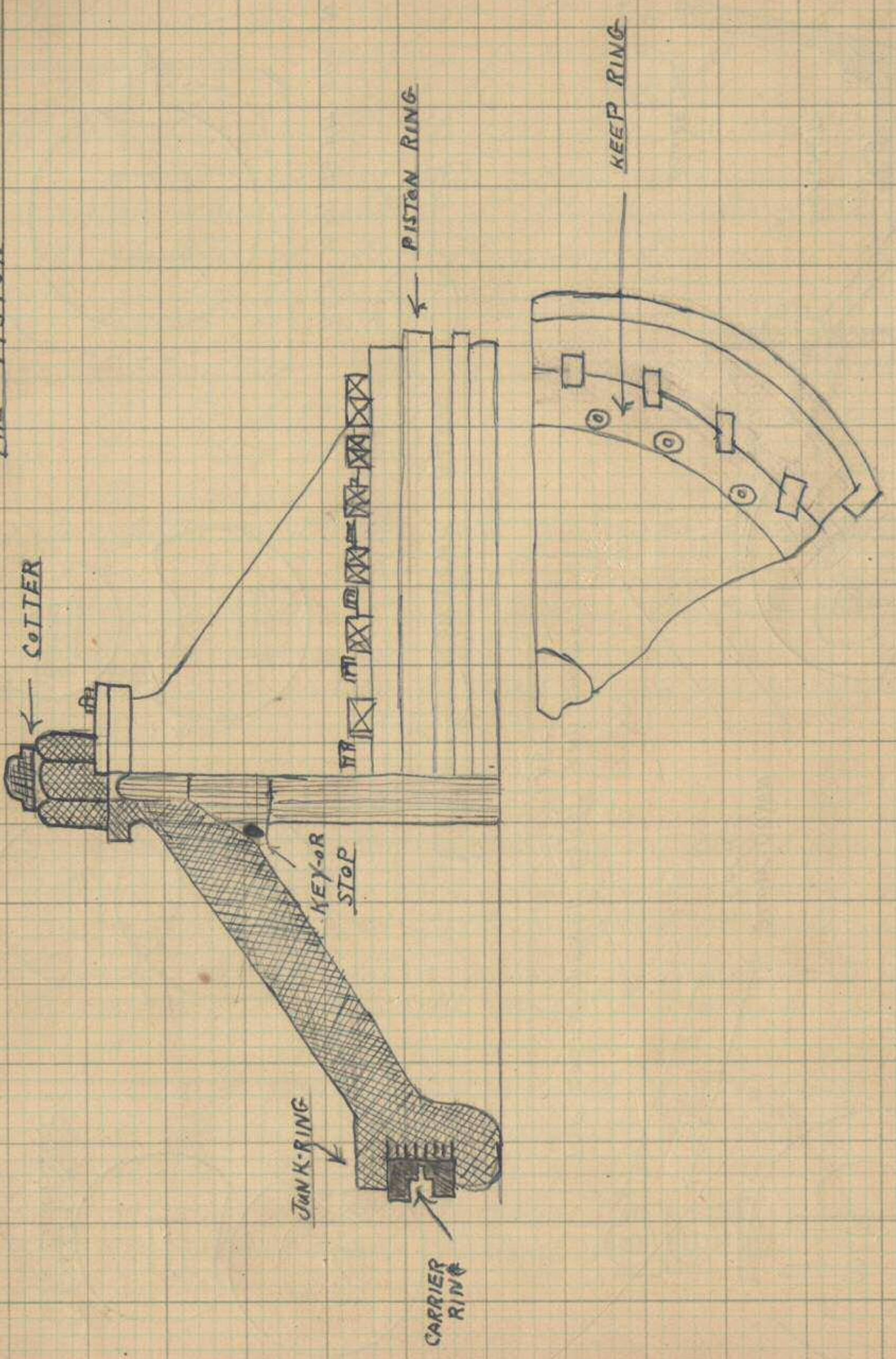
At the after end of the crankshaft a thrust block is fitted. A number of collars are turned on the shaft and bear against the white metal surface of a number of horse shoe collars. Long screwed bolts are fitted at each side of the thrust block with a number of check nuts provided for the purpose of setting the shaft end also for holding the shaft in position. The thrust block is bolted down to three or four frames secured to the bottom of a ship, and its duty is to transmit the thrust of the propellor to the ship. The inside of the block forms a bath of oil in which the collars run the horse-shoe collars are sometimes made hollow and a water service to the hollow shoe keeps it cool when running



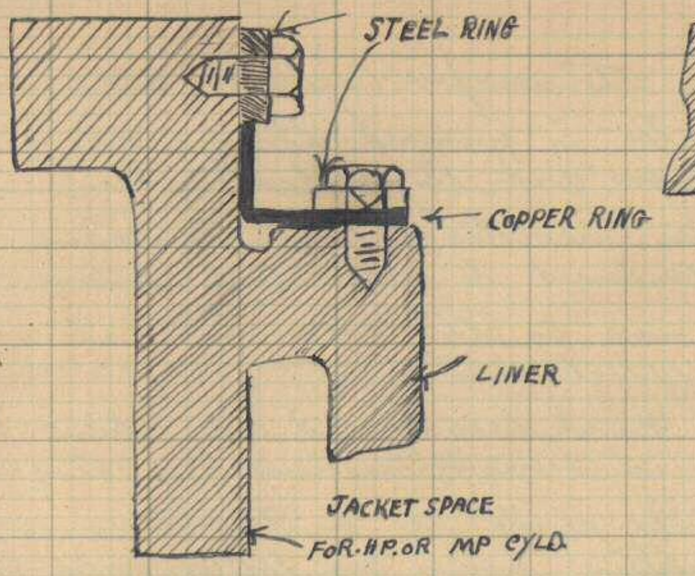


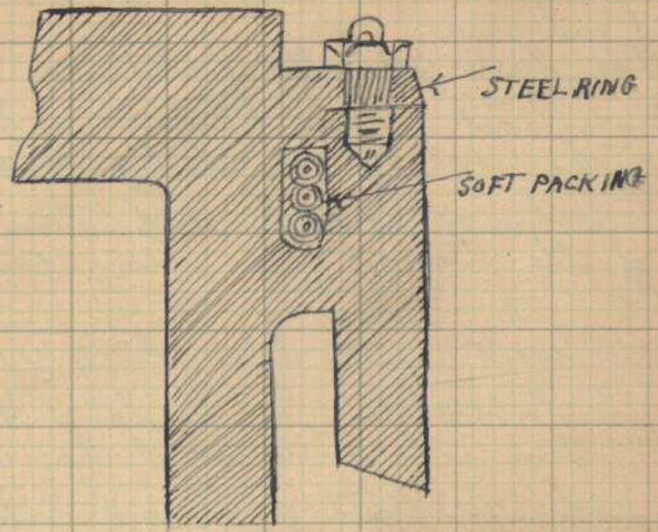


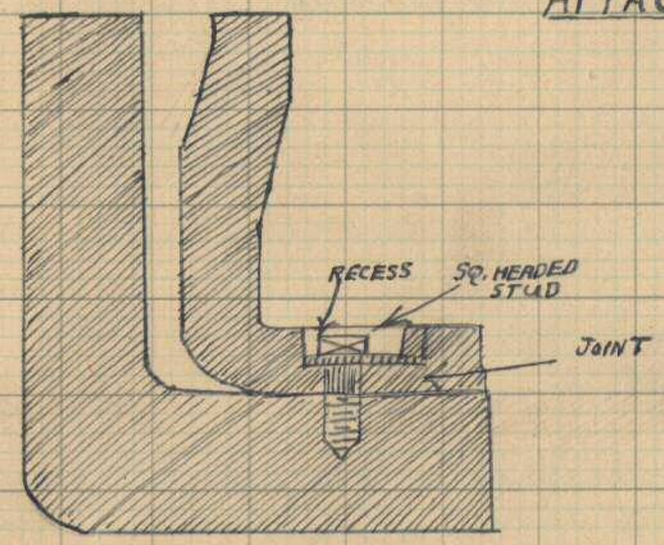
THE PISTON

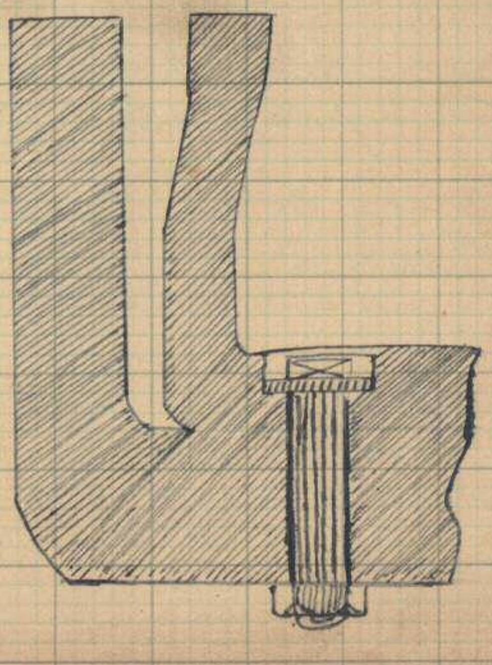


ATTACHMENT OF CYLINDER LINERS









READ STD. MANUEL PAGE 33

LECTURE VI

Condenser

The type generally fitted in the surface Condenser with horizontal tubes. Cooling water is pumped through the tubes by the circulating pumps and the exhaust steam strikes a baffle and then circulates around the outside of the tubes, thus being condensed to water and falling to the bottom of the Condenser as the corrosive action of salt water has little effect on it.

The tube plates are made of Naval brass) and are about 1" thick the tubes are of special brass 5/8 internal Dia. Stay rods are fitted from one tube plate to another to prevent them from bulging. Small stuffing boxes are fitted with screwed glands and ferrules are provided

F.
You are trying hard but be neat in your sketches and make them in ink, take your time
H.B. Wt. Eng.
26 July 1940

Weight of boiler plates per Sq. ft. from 1/8 of an inch to 1 1/8 inch thick

THICK	1/8	3/16	1/4	5/16	3/8	7/16	1/2	9/16
WEIGHT QRS LBS	Q. L.	Q. L.	Q. L.	Q. L.	Q. L.	Q. L.	Q. L.	Q. L.
	0 . 5	0 7 1/2	0 . 10	0 12 1/2	0 . 15	0 17 1/2	0 . 20	0 22 1/2

THICK	5/8	11/16	3/4	13/16	7/8	15/16	1 inch	1 1/8 inch
QRS-LBS	Q L	Q L	Q L	Q L	Q L	Q L	Q L	Q L
WEIGHT	0 . 25	0 27 1/2	1 . 2	1 . 4 1/2	1 . 7	1 . 9 1/2	1 . 12	1 . 17

ACIDS FOR SOLDERING

Muratic or Hydrocloric

To solder galvanized metal use raw acid. The most essential thing in soldering and welding is to have the job perfectly clean.

To kill raw acid put it in an earthen or lead vessel and drop pieces of zinc in it until it stops boiling

TEMPERING STEEL TOOLS.

For cast iron for boring cylinders turning rolls or any large cast iron let the tools be as hard as clean water can make them minding not to heat the steel more than a cherry red

Wrought iron large tools for turning and boring to be heated to cherry red and tempered to a very dark straw colour

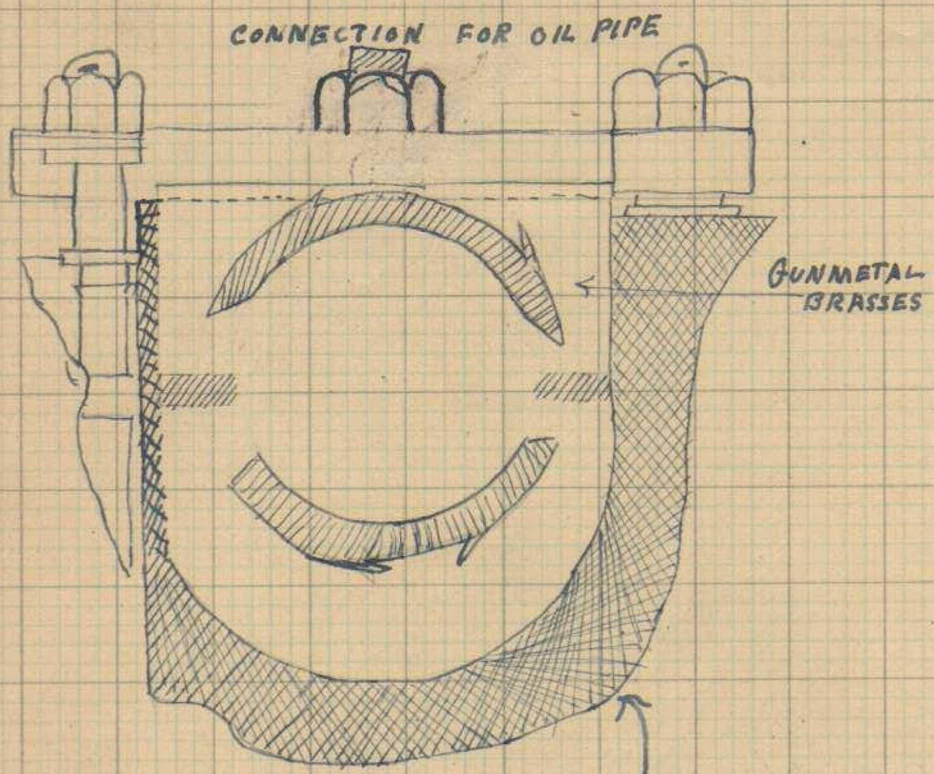
CASE HARDENING

The most common plan for case hardening consists in the insertion of the articles among horn or leather cuttings bone dust or animal charcoal, in an iron box provided with a lid luted with clay which is then put into a furnace and its contents suddenly immersed in cold water.

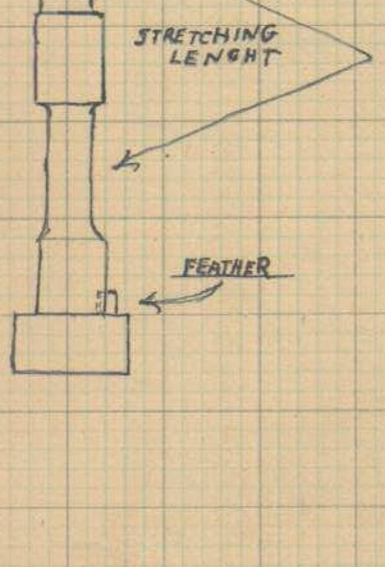
Many articles may be case hardened by prussiate of potash and pound it to a fine powder, then heat the article to a dull red heat and sprinkle upon it sufficient of the prussiate of potash. Then return it to the fire for a minute or so and finally immerse in water ~~till~~ until cold.

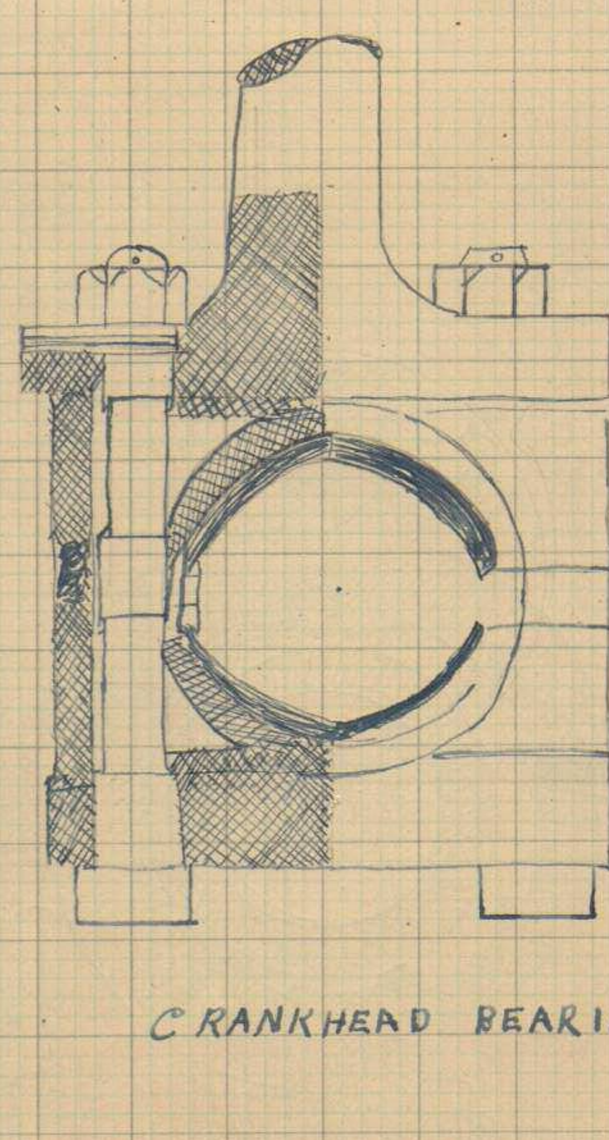
Water in all cases must be 60° F

MAIN BEARING (RECIP ENG)



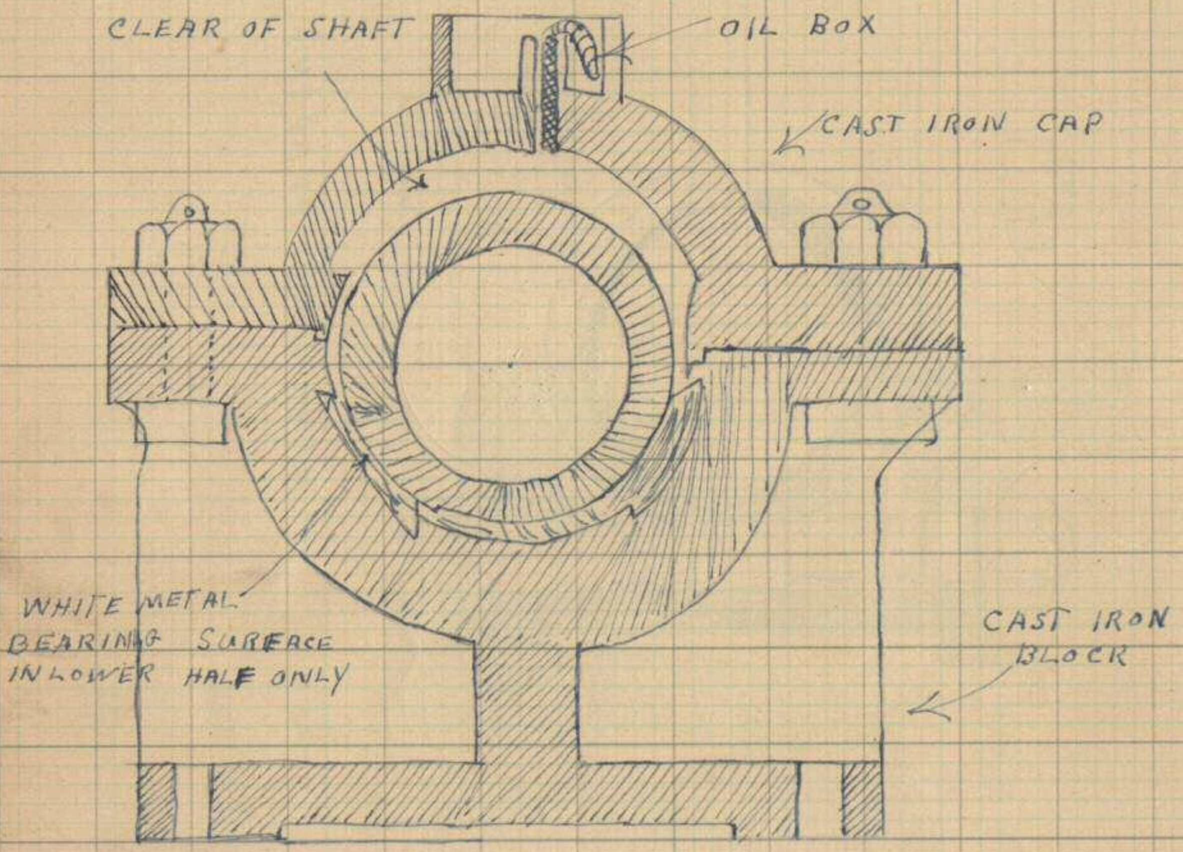
CRANK HEAD BOLT





CRANKHEAD BEARING

PLUMER BLOCK



CONDENSER

The type generally fitted is the surface Condenser with horizontal tubes. Cooling water is pumped through the the tubes by the Circulating pumps and the exhaust steam strikes a baffle and then circulates around the outside of the tubes. Thus being Condensed to water and falling to the bottom of the Condenser. Brass or gunmetal is used in the Construction of the Condenser as the Corrosive action of salt water has little effect on it.
The tube plates are made of Naval brass and are about 1" thick the tubes are of special brass 5/8 internal Dia. Stay rods are fitted from one tube plate to another to prevent them from bulging. Small stuffing boxes are fitted with screwed glands and ferrules are provided in the tube plates to keep the tube joints watertight and allow the tubes to expand. Small ~~ledges~~ ledges are fitted inside the screwed ferrules to prevent the tubes from working out of the tube plate the tubes are supported at about the middle of their length by a division plate. The Condenser cover next to the water inlet from passing right through the outlet.
Steel or Cast iron slabs are fitted in the sea water side to prevent Corrosion. The mountings on a Condenser are: Safety valve, Vacuum gauge, Air Cock, Supplementary teeth, drain water-gauge glass.

STEAM JACKETS

A space between the Cylinder and liner is called the steam jacket. And Can be fitted with steam for warming up the engines before use, or for preventing Condensation, particularly in the L.P. Cyld. when the engine is running. A reducing valve is sometimes fitted to Control the pressure of steam which Can be seen on a gauge Connected to the jacket. The Jacket is drained through a water bottle fixed to the Column which is fitted with a gauge glass and a hand Controlled drain cock, draining to the feed tank or Condenser

DRAINS

Asbestos packed drain Cocks are fitted to the cyld. and valve casings so that any water which may Collect Can be drained away to Condenser or bilge

RELIEF VALVES
These are fitted to both ends of the Cyld. to prevent any danger arising from priming or excessive steam pressure.

BY PASS VALVES
These valves are fitted to admit steam M.P. or L.P. Cyld. when the H.P. Crank is on dead Centre, thus symplifying the starting of the engine. They are sometimes Called starting valves and Can be worked from the platform

REVERSING GEAR
This is fitted to bring the ahead and astern ecentric rods in line with the valve rod so that the engine Can be run in either direction. The ecentric rods are fastened one at each end of a curved double link and upon these link bars slides the link block which in turn, is secured to a suitable bearing in the end of the valve rod. Each double link is Connected by two drag links to an arm keyed to the weigh shaft A steam engine worked by a lever from the platform revolves a wheel by means of worm gearing. A pin in this wheel is Connected to another arm on the weigh shaft by means of a drag rod. For every Complete revolution of the wheel, the link gear is moved from full ahead to full astern and back again to full ahead. This is Called the all round reverse gear.

(METALIC-PACKING)
Metalic packing is nearly always used in the glands of piston and valve rods. It has the following advantages over soft packing

(A) Remains steam tight with very little wear of friction

(B) The pressure of the packing on the rod is easily and accurately adjusted by means of springs

(C) The packing floats in the gland, will remain steam tight even if the rod is slightly out of line. In L.P piston And valve rods Are Combination form of packing is used in the gland Consisting of turns of metalic packing at the top of the gland and turns of soft packing at the bottom also a running down valve to empty Condenser of sea water

(CIRCULATING-PUMP)
Read Sto. manual Page (33)

This pump is a Centrifugal pump driven by a steam engine. The pump Consists of a Casing shaped like a snails shell in which an impeller with curved arms is revolved. Water is admitted Around the Centre of the impeller and is flung by the revolving arms against Casing, round which it travels until it reaches the inlet to the Condenser. Centrifugal pumps As now fitted Can discharge from 1500 to 2000 tons of sea water per hour. A Circular hole of 12" Dia situated 16 ft below the water level will allow 15 tons of water to enter a ships in one hour.

AIR PUMP
READ Sto Manual page 33. and 36

This is a single acting pump made of gunmetal and fitted to remove water, steam and air from the Condenser. The pump rod is Connected to a bucket plunger which works airtight in the barrel. There are three sets of valves Called foot. Bucket and Head valves.

ACTION OF AIR PUMP
On the up stroke, the bucket valves Close and a vacuum is formed between the bucket and foot valves. When there is less pressure between the foot and bucket valves than there is in the Condenser, the foot valves open and water And air rush in, ~~whilst~~ whilst the water on the top of the bucket is being lifted out through the head valves On the down stroke, the head and foot valves Close and the water below the bucket passes through the bucket valves. It is important that there should be very little Clearance between the bucket and foot valves and the smaller the space the better the vacuum. It should be noted that even if the Air pump is perfect a perfect vacuum Cannot be obtained in the Condenser because of the pressure necessary to lift the valves. The volume of steam as it enters the Condenser is roughly 1000 times greater than the same weight of Condensed water so that the Condensing of the steam Causes the vaccum in the Condenser which is maintained and increased by the Action of the Air pump

—CAUSES OF A BAD VACUUM—

(1) Not enough Circulating water Choked weed traps
(2) Air Cock leaking or air getting into Condenser
(3) Air pump defective - Air pump valves covered with grease or air pump glands leaking
(4) Leaky tubes
(5) Condenser too small
(6) Too much steam
(7) Leaky pistons and slides. (Reciprocating Ships).
(8) Glands improperly steam packed

(EXHAUST—VALVES)

Are fitted to main Condensers either when there are two Condensers to each set of engines or when their is only one Condenser in each engine room and it is used for auxillary purposes in harbours.

THE AUXILIARY EXHAUST SYSTEM

The auxillary exhaust pipes run along both sides of the ships and end in the auxillary or main Condensers. No screw down bulkhead valves are fitted but there are generally several N.K. Valves so that the steam can only travel towards the Condenser. Several small relief valves are fitted in various parts of the pipe to give warning of exess pressure They lift at 26 and 30 lbs per sq. inch and are sometimes Called sentinel. A screw down valve is also fitted between the waste steam pipe and the exhaust pipe for use when the ship is in dock or when Circulating water is not available. This is Called the atmospheric exhaust valve

CLOSED EXHAUST SYSTEM

Closed Exhaust is the Keeping of a pressure in the exhaust pipe instead of allowing the exhaust steam from the auxillary engines to go straight to the Condenser. By fitting a spring loaded valve in the exhaust pipe, so that the steam has to pass it before reaching the Condenser, a pressure may be raised to 24 or 28 lbs. per sq. inch and the steam made to do useful work in the evaporators or the L.P. Receivers when the main engines are running.

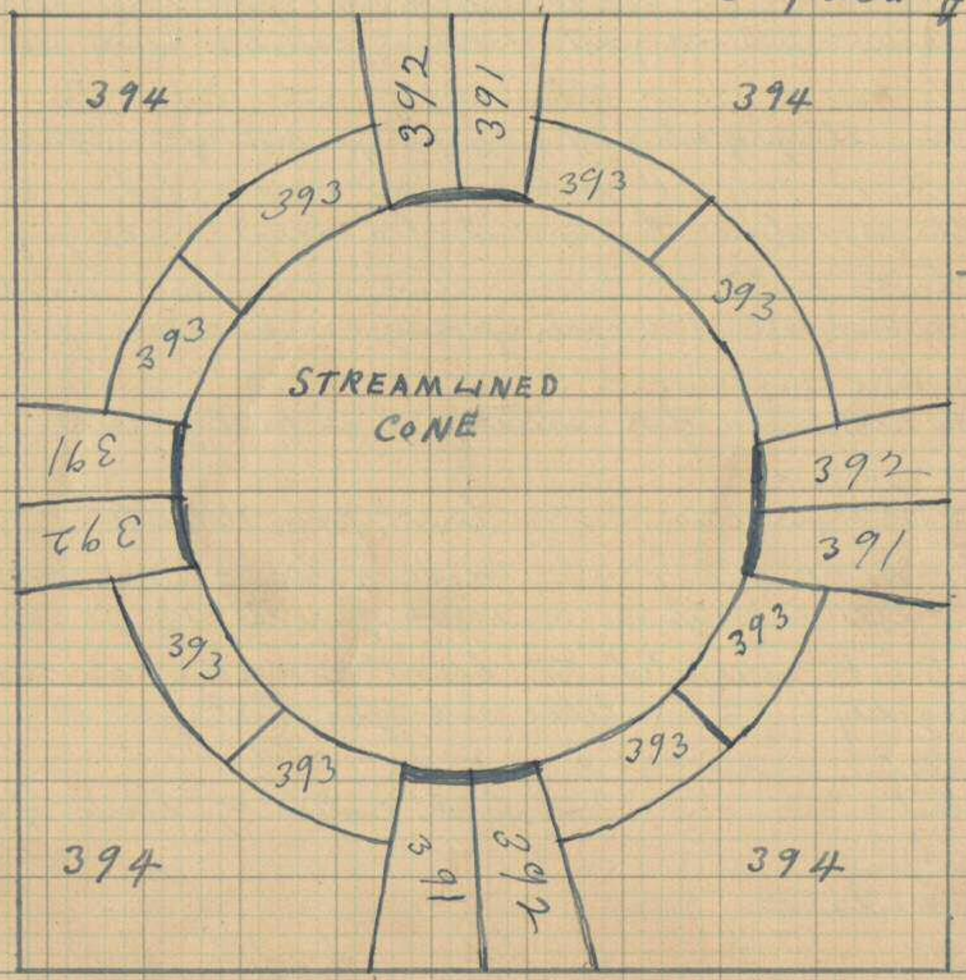
ADVANTAGES OF CLOSED EXHAUST

(1) The steam in the system may be employed to heat the water in the evaporators.
(2) Auxillary steam leaking past the valves and pistons of any engines will do useful work in the evaporators.
(3) There will be less scale on the evaporator coils due to the low temperature of primary steam
(4) More economical for the same amount of fuel

—DISADVANTAGES OF CLOSED EXHAUST—

(1) Condensed steam Collects in the exhaust pipes of the auxillary engines which are not in use Causing leakage of water through the engine glands.
(2) The back pressure causes the auxillary engines to work unreliably.

Comprised of 20 bricks



PATT	
391	4
392	4
393	8
394	4

BRICKLAYING INSTRUCTIONS

(Q) What are the Component parts of mixture used in service bricklaying
(A) One part of fireclay one part Crushed brick
(Q) How is fine mixture made up and what is it used for
(A) The fine mixture is made up of one part fireclay and one part crushed brick. Both the fireclay and the Crushed brick are passed through a 1/16 mesh seive then thoroughly mixed in a dry state until no streaks appear the mixture is then brought to a plastic state by adding water in the proportion of 24 pts of water per cent of mixture. Fine mixture is used for bonding and pointing
(Q) How is the coarse mixture made up and what is it used for
(A) The Coarse mixture is made up of one part fireclay passed through 1/16 seive and one part of Coarse Crushed brick passed through a 1/4 mesh seive. Thoroughly mix when dry and add water in the proportion of 12 1/4 pts per cent of mixture. Coarse mixture is used for stopping and patching
(Q) What is the proceedure at the end of a large bricklaying repair
A Dry off slowly with an airing stove or spread wood over the furnace and set it alight. If any cracks appear, fill them up with a fine mixture.
Q What are the Components of a suitable high quality brick for an oil fire furnace.

A	Salica from 63% to 75%		Lime from 3% to 6%
	Magnesia " 3% " 6%		Oxide of iron 2.2% to 2.7%
	Alumina 22% " 35.3%		Potash of soda 4%

Q What are bricks subjected to before acceptance in H.M. Navy
(A) Structural rigidity - - - - - before and after heating
(2) Dropping test - - - - - " " " "
(3) Cooling test - - - - Hot bricks cooled by blast of ~~Cold air~~ cold air
(4) Depth of Glaze
(5) Cutting properties
(6) Parosity test - - - - - - - before and after heating

The brick is weighed after being thoroughly heated and dried. It is again weighed after soaking in water then the formula

$\frac{WW - WD \times 100}{WD}$ WW Weight wet / WD " Dry

Must not exceed 10%

(Q) What material is used behind the brickwork and why
(A) Asbestos millboard because it is a non conductor of heat
(Q) How are brick bolts secured and why
(A) Finger and thumb tight with one flat of the spanner to allow for expansion
(Q) What sort of bolts are used in the service
(A) Cone headed bolts, Hook bolts Wildish pattern bolts for wildish bricks
(Q) What is the fusing point of the mixture and the average temparature of an oil fired furnace.
(A) Fusing point of mixture is 3038 deg. F. the average temp. of an oil fired furnace is 2800 deg. F
(Q) If no pattern 13 or 13A bricks are available how would you build an arch for a Cyld. boiler.
(A) Cut pattern and bricks to the required size
(Q) Decribe the different types of bonding you have met
(A) Common:- All stretchers with one header at the opposite end of each course. stretchers being necessary to stagger the joints
(2) English:- Alternate courses of stretchers and headers, a Closer being fitted next to each end header.
(3) Flemish:- Alternate stretchers and headers along each course a Closer being fitted next to each end header.
(Q) What are the pattern numbers of bricks for the Cone of County Class Cruisers, and all new ships.
(A) Pattern numbers 35, 36, 37, and 38,
Q What are the tools for service bricklaying
(1) Two trowels - - - - one large and one small
(2) Brick hammer - - - - With one or two cutting edges
(3) Cupping tool - - - - for bolt heads ~~turning~~ stopping
(4) Holding Key - - - - to prevent bolt heads turning
(5) Bolster - - - - - - for cutting large brick
(6) Hollow drill - - - - - - for drilling holes in brick

(7) Wood mallet - - - - - - - - for Closing all joints
(8) Two seives - - - - - - - 1/16 and 1/4 for sifting mixture
(9) Wood rammer - - - - - - - - for stopping bolt holes and patching
(10) Spanner
(11) Two foot rule

Furnace brickwork as used in the admiralty boiler total weight of average bricking - - - 7 tons

FRONT Thickness of bricking to be 4" thick to height of highest Combustion tube, after this 2" thick

-BRICKS USED-

PATT. 35, 36, 37, 38, for Cones } 4" thick
" 25 and extension PATT 33 }
" 21A " " " 32 } 2" thick
" 21 " " " 34 }

-BACK-

Thickness of bricking to be 4" thick to height of highest Comb. tube, then 2" thick

-BRICKS USED-

PATT.

25 and extension 33
21A " " 32
21 " " Patt. 34 Ventilating

-SIDES-

Thickness of bricking to be 4" thick for a distance of 6 ft from the front bricks then 2 1/2 thick to the back bricks

-BRICKS USED-

PATT.

25 - - - - - - - - - 4" thick
24 - - - - - - - - - 2 1/2 thick

(FLOOR OR BRICKPAN) Two layers of brick
Top layer - - - - - - - - 2 1/2 thick
Bottom layer - - - - - - - - - 2" thick

(BRICKS USED) BRICK-PAN

PATT

24 A - - - - - - - - 9" X 9" X 2 1/2"
1 - - - - - - - - - - 9" X 4 1/2" X 2 1/2"
21 B - - - - - - - - - 9" X 9" X 2"
20 - - - - - - - - - - 9" X 2 1/2" X 2"

(TOP OF FURNACE) one row of bricks 2 1/2 thick (BRICKS-USED) PATT (24)

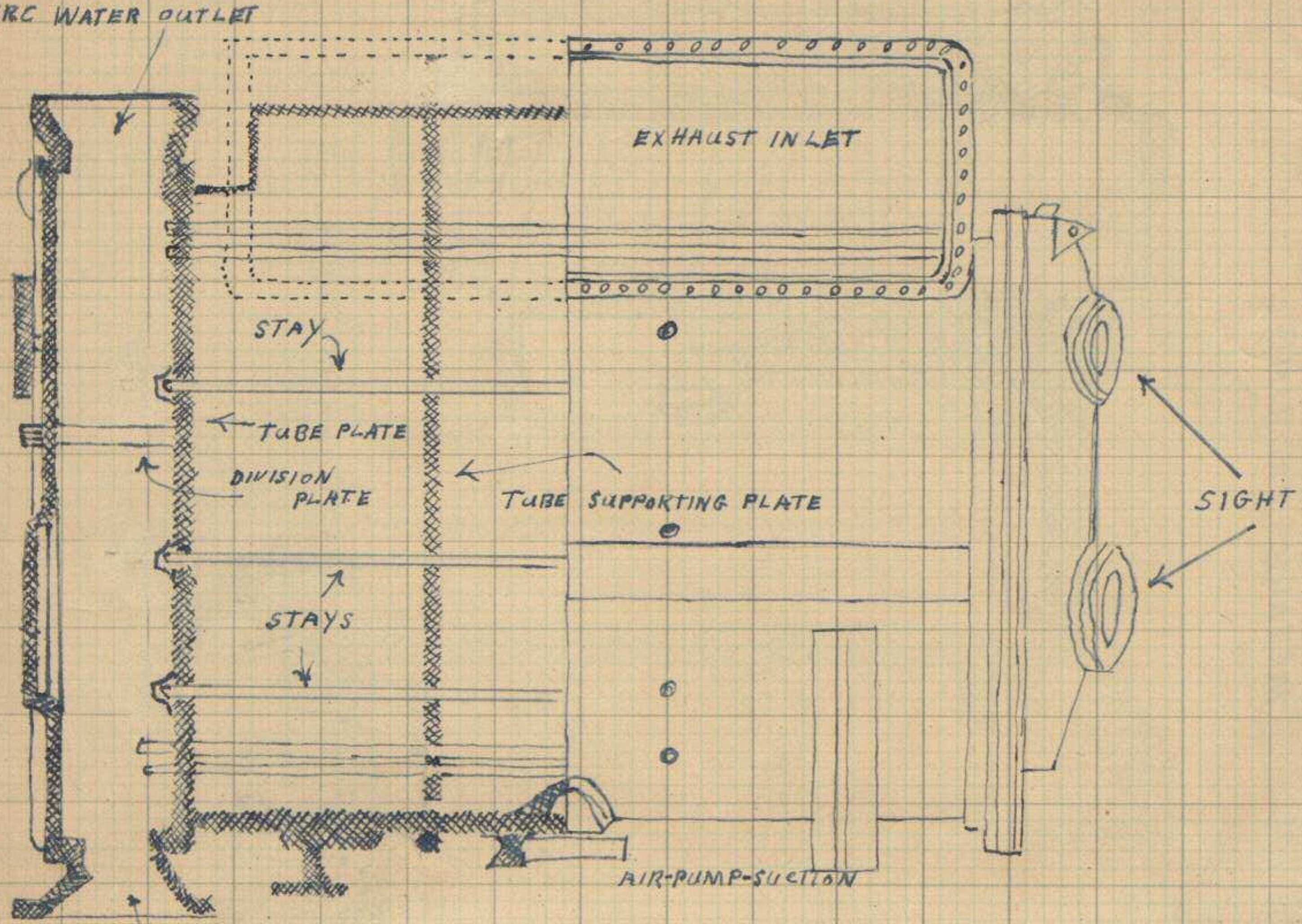
PATT-No	BOILER	SIZE	REMARKS
13	Admiralty	9" X 4 1/2" X 2 1/2"	floor solid
13	Cylindrical	9" X 4 1/2" X 2 1/2"	
13A	- - - - - - - - -	" " "	Tapered
20	Admiralty	9" X 4 1/2" X 2"	floor solid
21	" "	9" X 9" X 2"	air and bolt holes
21A	" "	9" X 9" X 2"	bolt holes only
21B	" "	9" X 9" X 2"	floor solid
24	" "	9" X 9" X 2 1/2"	bolt hole
24A		9" X 9" X 2 1/2"	floor solid
25		9" X 9" X 4"	bolt hole
32		18" X 9" X 2"	extension for 21A
33		18" X 9" X 4"	extension for 25
34		18" X 9" X 2"	extension for 21

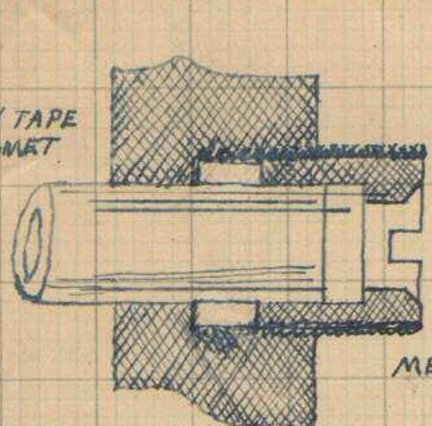
36 Cone bricks for County Class Cruisers.
37 - - - - - - - - - - - - - - - - -
38 - - - - - - - - - - - - - - - - -

Imports from England for H. M. Service
Coal - Iron - Salt - Copper - Lead Tin - Zinc.
Slate - Fuller-earth

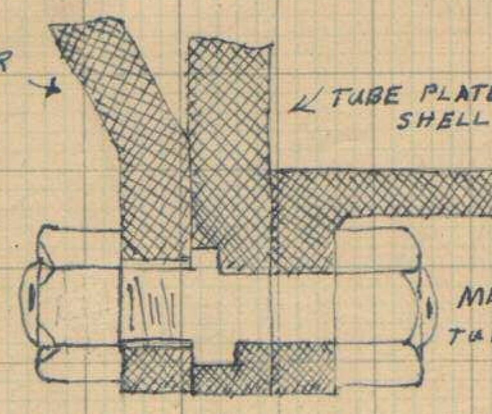
Coal is made up of the following —
Nitrogen - Oxygen - Carbon - Ash - Sulphur
Hydrogen

WEIR-UNIFLUX CONDENSER

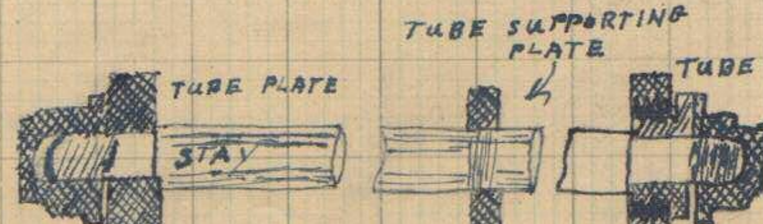




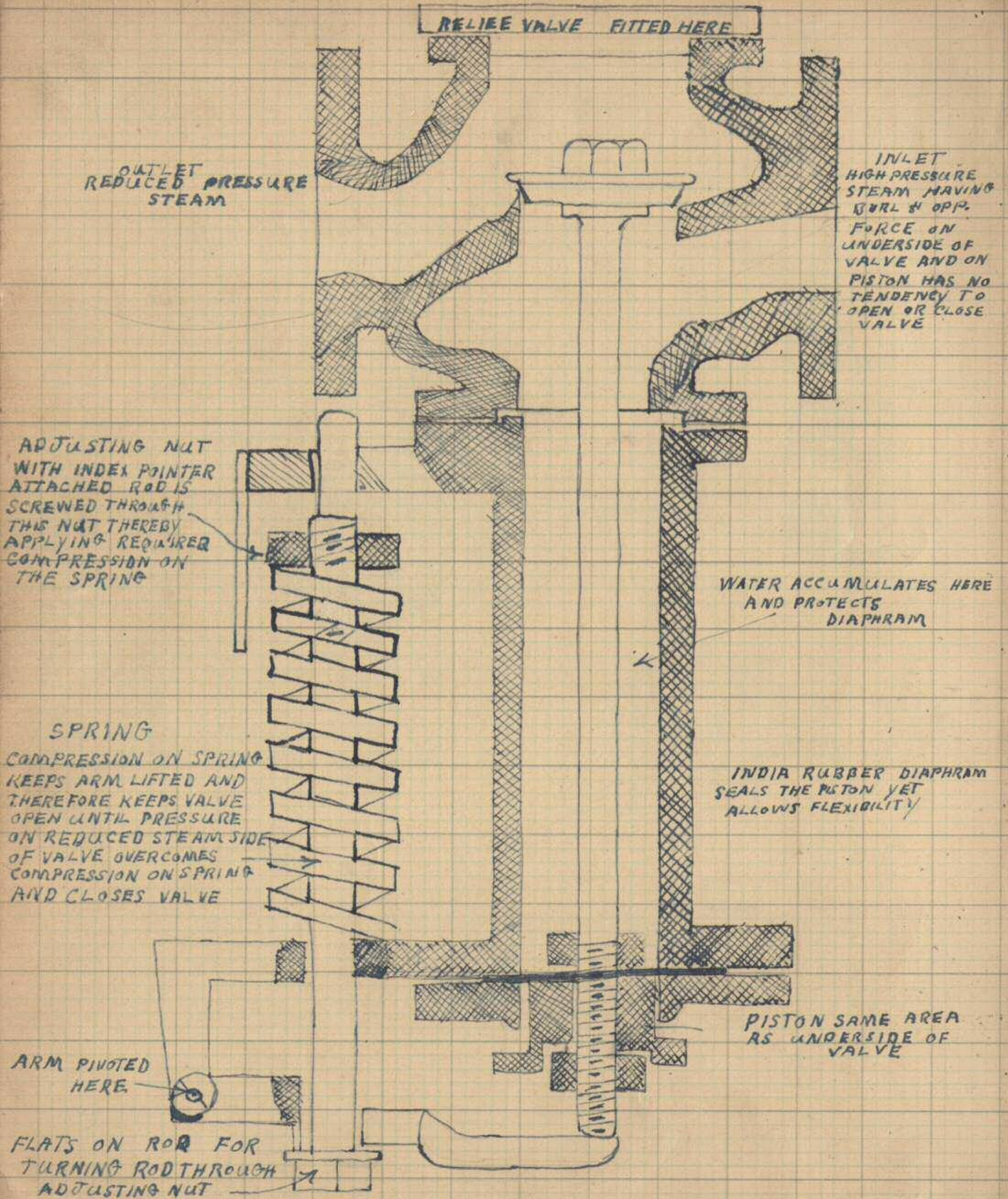
METHOD OF SECURING TUBES IN PLATE



METHOD OF SECURING TUBE PLATE AND COVER

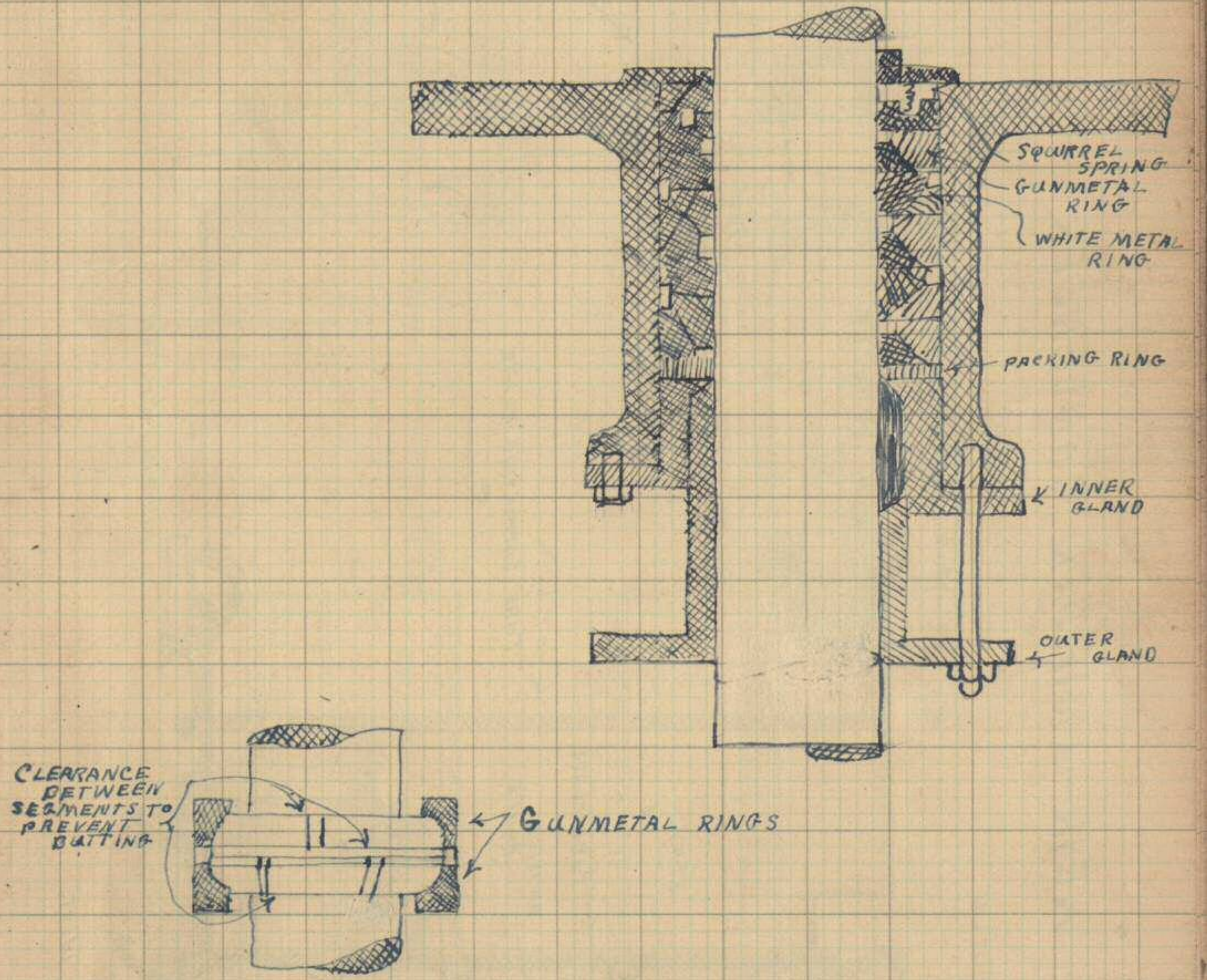


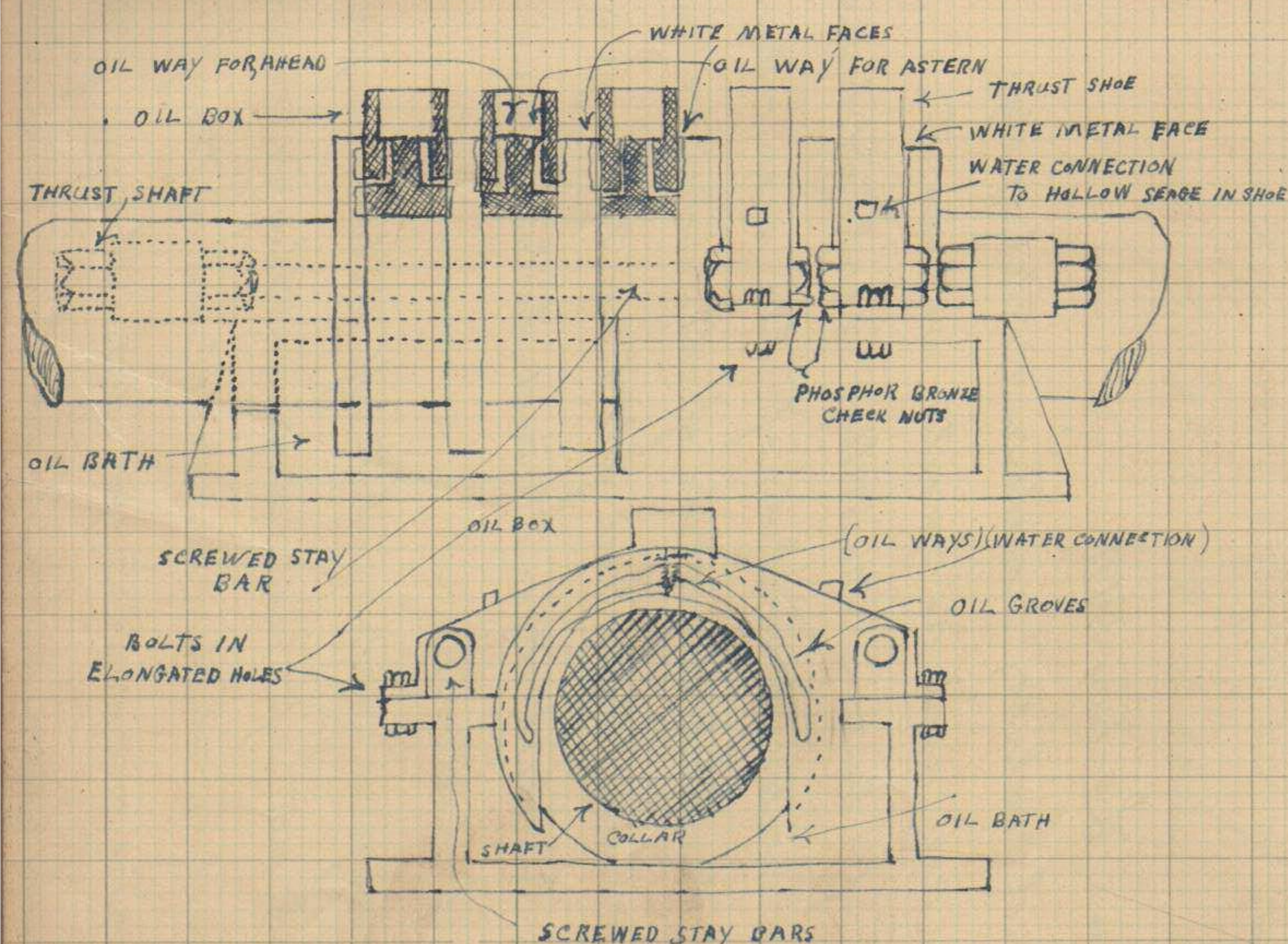
CONDENSER STAYS



AULDS REDUCING VALVE

METALIC PACKING





HORSHOE TYPE THRUST BLOCK

F/

You are not trying otherwise you would copy your words in such a manner that they would be able to be read by anyone

[illegible]

2 Aug 40

Main Steam Lecture VII

Sectional valves, sometimes called group valves, are used as master valves to a group of boilers. Generally, each stokehold has a sectional valve of the screw-down type. Bulkhead valves of the screw-down, self-closing type are fitted on the engine room bulkhead. One to each boilerroom or group of boilers.

Emergency or main shut-off valves are fitted to each set of main engines. They are screw-down valves which can be closed either from the engine room or upper deck. They are fitted with a by-pass valve to level up the steam pressure on the both sides of the valve. The valves in some cases are are butterfly valves fitted with a lever on the end of which is a weight fixed to the bulkhead by means of a tiper pin; by withdrawing the pin, the weight drops and closes the valve in case of accident.

Regulating or throttle valve is an equilibrium valve or a double beat valve or balanced valve so that it may be opened against a full pressure of steam. At low powers, its work is done by a manoeuvering valve which is a small screw-down valve fitted as a by pass to the main regulating valve.

AUXILLARY STEAM SYSTEM

The main steam pipe and valves as a rule only only supply steam to the main engines and the most important auxillary engine, such as

Main feed pumps, main air pumps, main circulating pumps, steering and reversing engines. For the remainder of the auxillary engines and as a duplicate supply to the important engines mentioned above, an auxillary steam pipe is lead around the machinery space with branches to the engines.

If the boilers are not fitted with auxillary stop valves, an auxillary sectional is fitted alongside of each main sectional valve; by this means each boiler can be connected to the main or auxillary steam pipe. Screw-down stop valves are fitted on each bulkhead to enable these parts of the pipe which are not in use to be shut off from the remainder.

Expansion joints are fitted to allow for the expansion and contraction of steam pipes.

It is usual, either to fit a bend in the pipe if the pipe is small or to fit an expansion joint if the pipe be larger. Expansion joints consist of two castings, one sliding inside the other, the joint between the two being kept steam tight by means of a stuffing box and gland, two long screwed stays being provided to keep the two parts from seperating.

(SEPERATORS)

The steam seperator is fitted to prevent water passing through to the engines from the boilers. It consists of a large steel chamber in which is placed a division plate or a number of baffles (the division plate is sometimes called a diaphram). Water is unable to follow as closely as the steam round the corners of the baffles so it falls to the bottom of the seperator. Automatics and hand blow-outs valves are fitted to drain the water into the condenser, hot well or feed tank

(STEAM-TRAP)

This is used to prevent the escape of steam from the drain pipes of an engine or drain drain pipes of a steam pipe. The usual form of steam trap is a cylindrical vessel containing a light pan. Condensed water enters from the drain pipe through the pipe through the inlet and falls to the bottom of the trap outside the pan. The pan is thus buoyed up and a valve fastened to its inner bottom closes the hole at the bottom of the outlet pipe. The water generally fills the trap and overflows into the pan. When the pan is nearly full, it sinks and the pressure in the drain pipe throws the water out into the outlet. When the pan is nearly empty, it floats again and the outlet is closed. This action is continued as long as the trap is in working order.

(FEED WATER LOSSES)

Are caused by leaky joints and glands on steam pipes, feed pipes, boilers and engines, safety valves, and relief valves, blow down valves and drains to the bilge. If the feed tanks are full, the rolling of the ship will sometimes cause the loss of feed water.

(HEAT-LOSSES)

Of the total heat contained in the fuel only 70% is used in the boilers. Of this 70% only 20% is used in the engines nearly all the heat being wasted in the condenser warming up the circulating water.

If the propeller only uses 50% of the energy passed on by the engines, the actual useful work done in pushing the ships along is only a small fraction of the energy present in the coal. The losses of heat in the condensers may be reduced by expanding the steam as much as possible until it is at a low temperature and pressure. The loss may be reduced also by keeping the feed water at a high temperature so that it will need less heat when it reaches the boilers. A limit is reached to the gain which may be affected in this way as the vacuum in the condenser will be spoiled and the feed pumps will not always lift hot water. For these reasons, the temperature is limited generally to 150 F

(FEED FILTERS)

These are fitted to seperate oil and grease from the feed water. Each filter consists of a box containing a number of screens covered with toweling, through which the water has to pass on its way from the air pumps to the feed tank. The oil finds its way to the condenser and so on into the boilers, through the various piston and valve rod glands.

Screw down valves are fitted at the various boilerroom bulkheads in order to shut off the pipes and pumps which are not in use.

It is important to make sure that the steam traps are in good working order and that all drain cocks and pipes are clean because the pressure of water in the steam pipes and engines will cause leaky joints and loss of water.

(COURSE OF STEAM AND WATER)

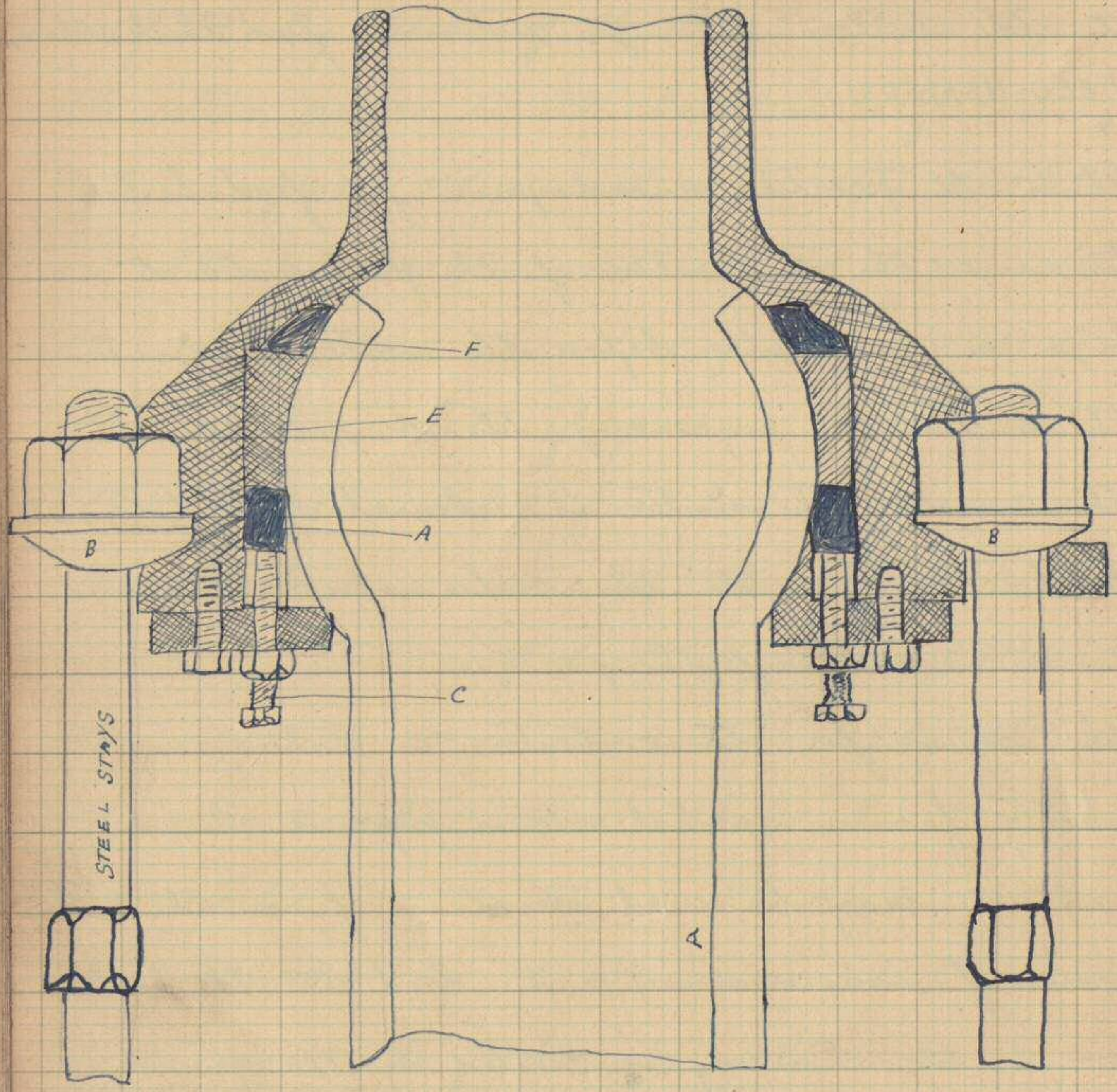
The steam formed in a boiler leaves the steam drum through the internal steam pipe and stop valve, passing through the main sectional valve and thence to the main

steam pipe on which the main isolating valves are fitted. By means of the main steam pipe, the steam passes to the bulkhead self-closing and emergency stop valves on the bulkhead in the engineroom and thence to pass through the main steam seperator (if one is fitted) to the master valve (if parsons turbines) to the regulating valve from here it passes to the H.P. turbine through the nozzle control valves if turbines of curtis type are fitted.
Thence to the L.P. turbine and so by the exhaust trunk into the condenser. The exhaust steam is converted into water in the condenser whence it is sucked by the air pumps which discharges it through the feed water filter where any grease is extracted to the feed heater and then into the main feed tank. From the feed tanks the feed pumps pump the water through further feed heaters in the ships of the latest design into the boilers through automatic feed check valves.

(FEED-HEATERS)

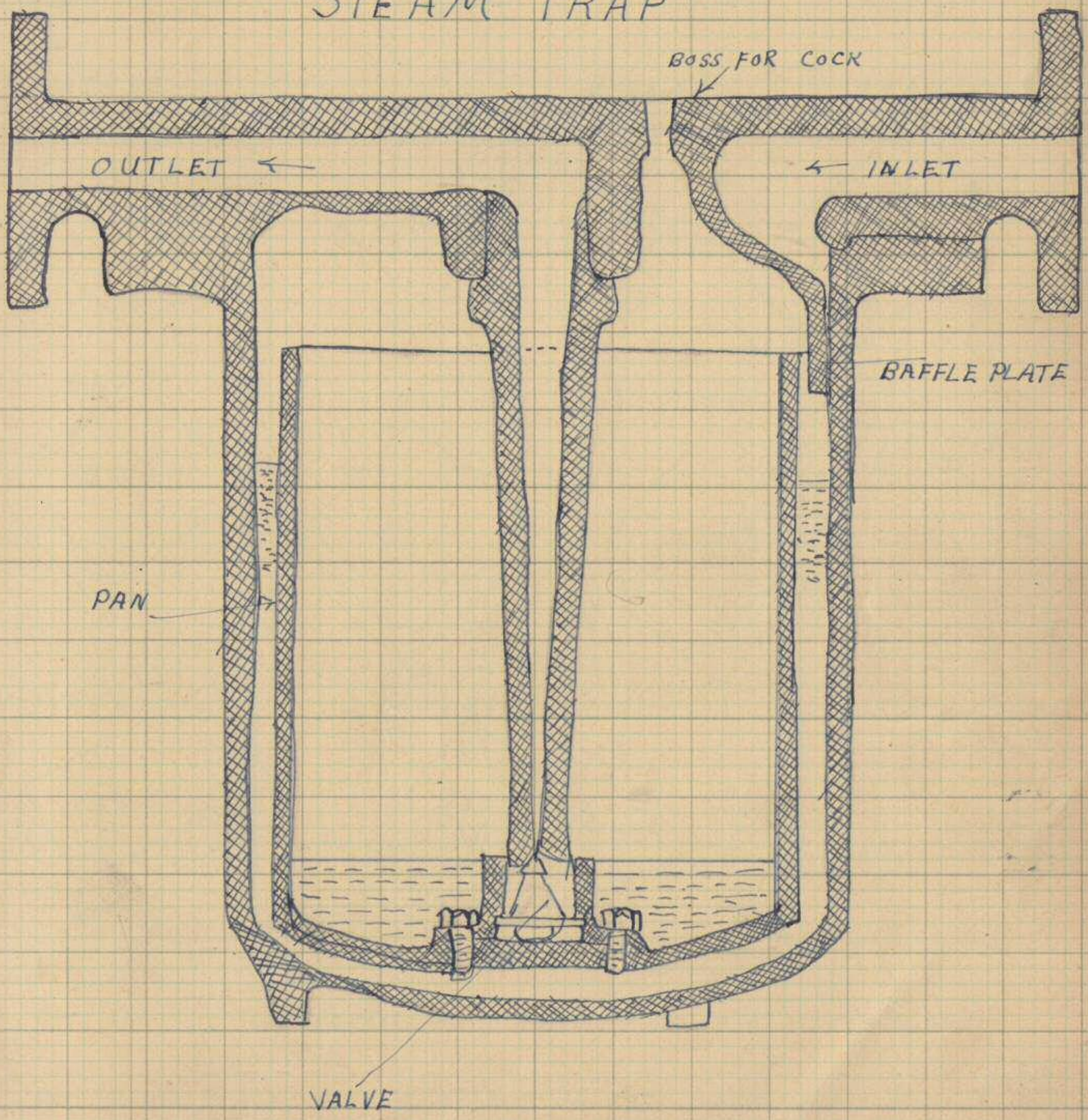
It is the practice nowadays to fit feed heaters to raise the temperature of the feed water to as high as practicable before the water goes into the boiler. By increasing the temperature, thus, the air in the water is released and does not find its way into the boiler where it would cause corrosion of the parts.
The steam for these heaters is taken sometimes directly from a special steam pipe or closed exhaust may be used or steam from the coil drains of evaporators, and lead to the heaters. Considerable economy is created by this practice.

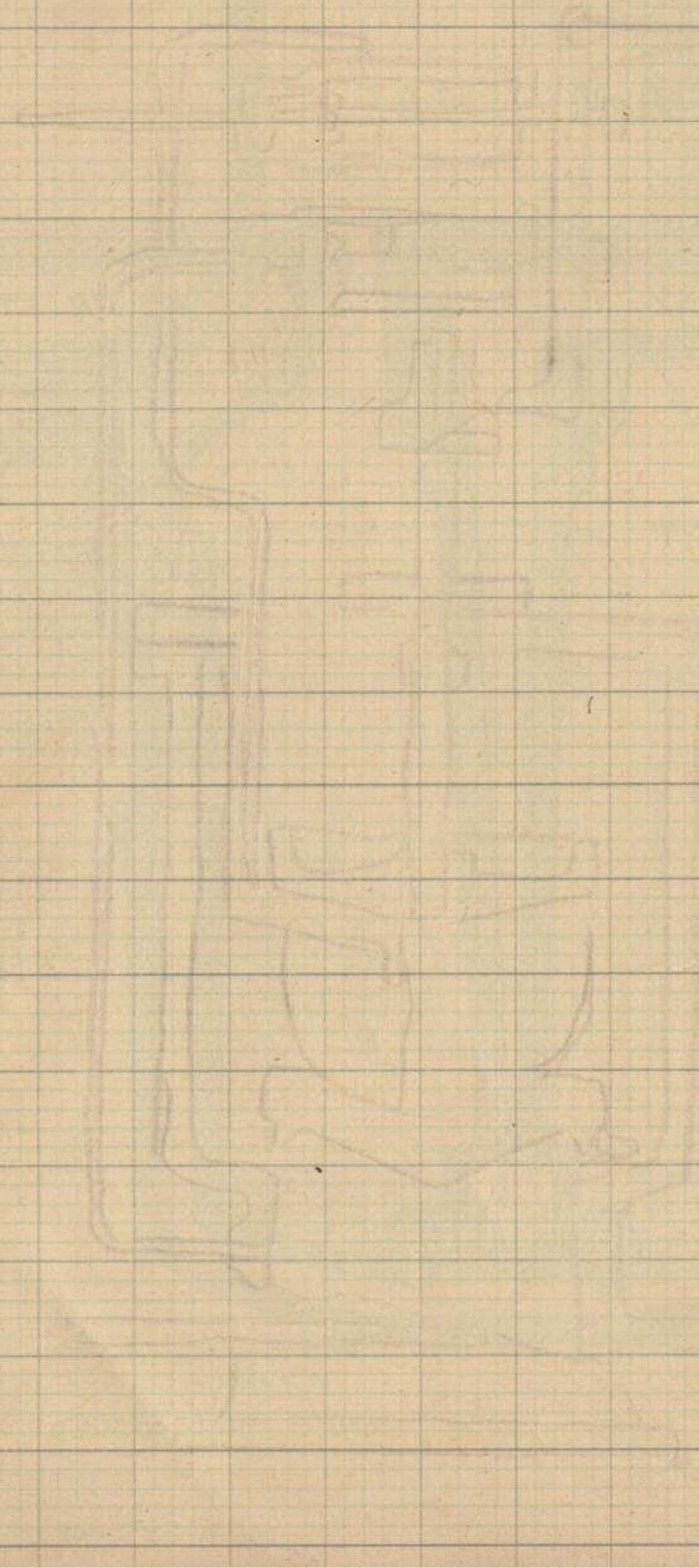
BALL EXPANSION GLAND

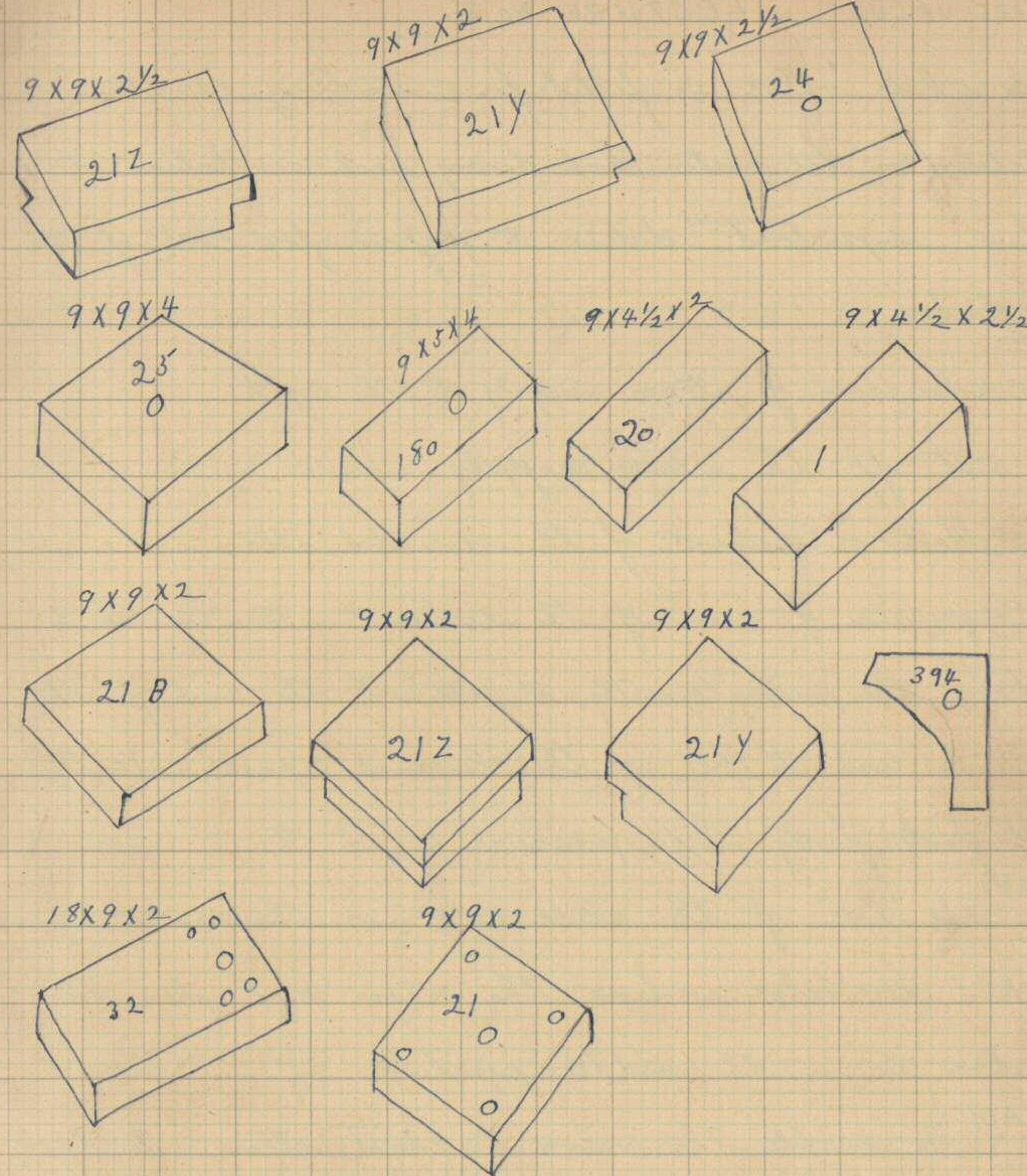


A - SWIVEL PIPE
B - COTTER BRASS WASHERS
C GLAND COMPRESSION SCREW
D - GLAND RING
E PACKING
F NECK BUSH (BRONZE

STEAM TRAP







PAT. No 21Z UNDERCUT ON 2 SIDES TO FIT COR. OF BRICK PANS

PAT No 21Y - - - - - - 1 SIDE - - - - SIDES - - - - - -

SLIDE VALVE LECTURE No 8

The slide valve is fitted for controlling the steam acting on the piston and during each revolution it has four important duties to perform for each of the cylinders:

(1) Admission of steam supply to the cyld.

(2) Cut off the steam supply.

(3) Release or exhaust of the expanded steam.

(4) Compression of some of the exhaust steam so as to bring the piston quietly to rest at the end of the stroke and to fill up the clearance space with steam of ~~fault~~ fairly high pressure.

(LAP) The "lap" of the slide valve is the amount by which the valve overlaps the steam port when the valve is in the middle position.

(LEAD) To enable the valve to admit steam into the cylinder when the piston is at the end of its travel the valve must be ahead of the piston so that when the piston is ready to begin its stroke the valve will have moved to open. This is called "lead". This can be done by placing the eccentric sheave on the shaft 90° ahead of the crank.

When the valve is given "lap" and "lead" the eccentric sheave must be still further through an angle called the angle of advance. The effect of giving "lap" to a valve is to enable the steam to be used expansively instead of the steam being allowed to enter the cyld. all through the stroke it is cut off and made to expand by the early closing of the valve. By increasing the "angle" of advance" or by "linking up" all the operations of the valve can be made earlier by reducing the "angle of advance" or by "linking out" the operations of the valve are made later. The astern eccentric sheave is placed on the shaft similarly to the ahead eccentric, but in advance of the crank in the opposite direction of working.

PISTON SLIDE VALVE

The piston slide valve generally admits steam to the cylinder past its inside edges and is turned on inside fed valve and its eccentric is placed diametrically opposite to the eccentric sheave of ~~the~~ a valve taking steam on the outside edge

ADVANTAGE OF PISTON-VALVE OVER FLAT VALVE

(1) Larger opening to steam with the same amount of travel

(2) Reduced wear between the valve and valve casing

(3) It is lighter less friction no relief ring required

(4) With a piston valve there is less leakage of steam at the glands

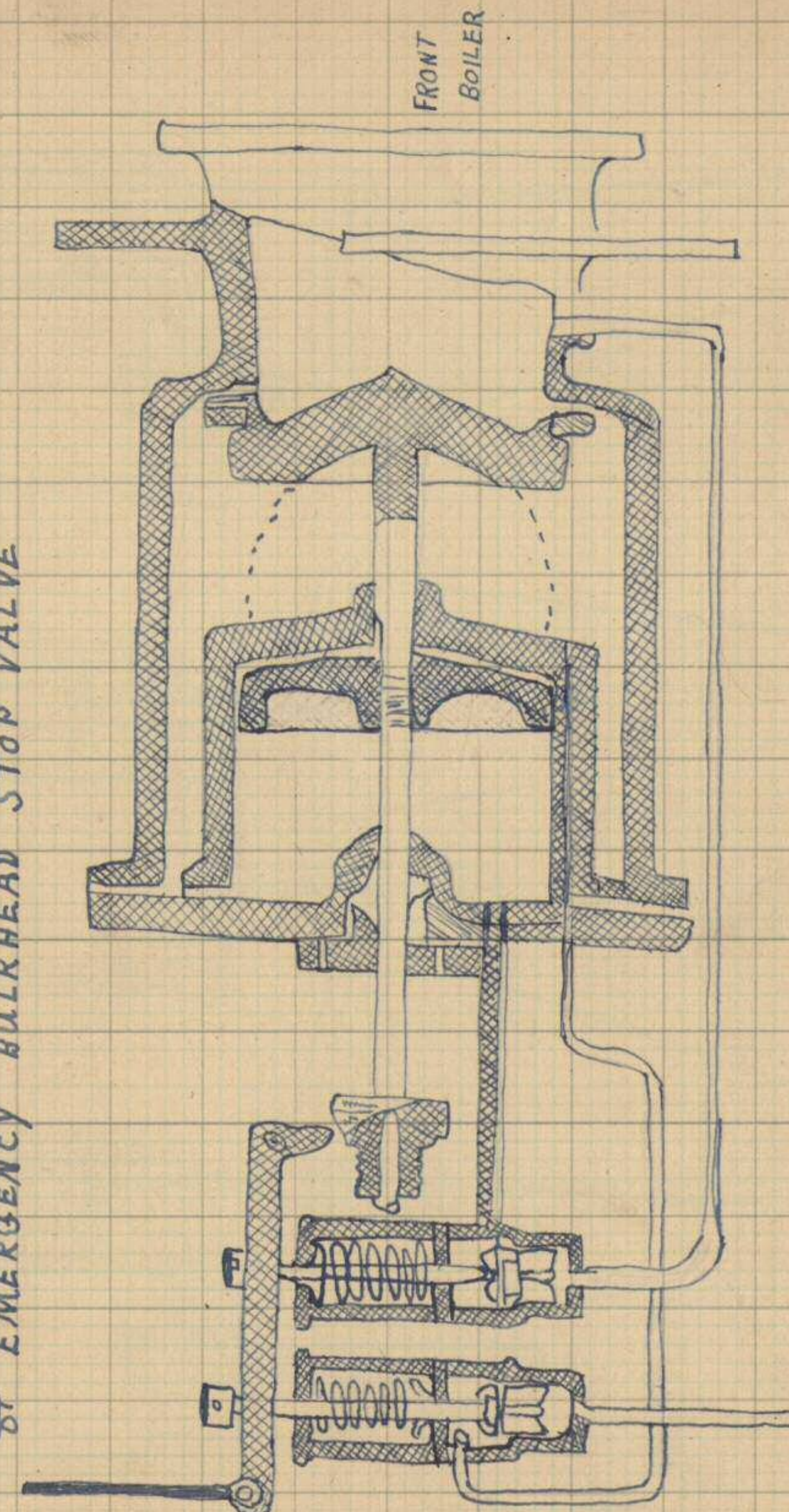
DISADVANTAGES

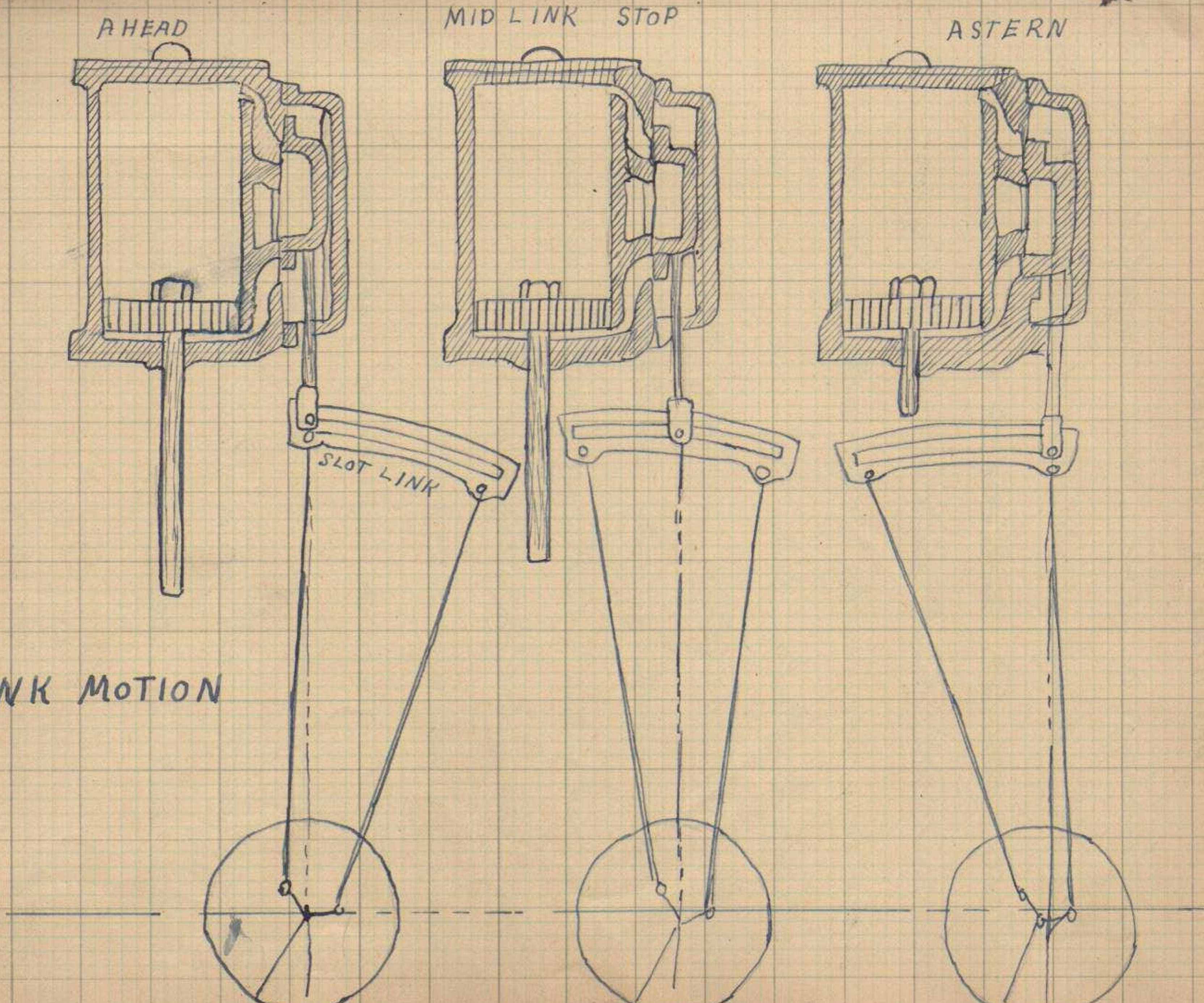
(1) Greater Clearance space at each end of cyld. due to the length of the steam port

(2) Piston valve casings increase the total length of a set of main engines

COBURN McNICHOLL SELF CLOSING

& EMERGENCY BULKHEAD STOP VALVE





LINK MOTION

BRICKING A BOILER

In bricking a boiler out completely. see that the furnace is cleaned up properly. All old asbestos millboard & old bricks removed examine all brick pans & spectacle plate for necessary repairs. See that all brick bolts nuts run freely.

Prepare all bricks & asbestos millboard as required. Commence laying millboard in brick pans taking care that each section fits snug. Then lay bottom layer of bricks in pans using pattern nos. 21Z & 21Y which are specially cut to fit corners and sides of pans make sure that the bricks are staggered that the lines do not meet (only one way) in the sloping pans & and opposite in the centre using pattern no 21 when required. Then commence bricking up the back of the furnace use pattern no 25 with pattern no 33 at the end of each row up to the 11th row

Then pattern no 32 at the end of each row until with pattern no 21A in between. Brick up sides with pattern no 25 - 6 ft back from the front & and then use pattern no 24 the remainder of the way. From the first layer of the floor use pattern no 25 modified with no bolt hole up to the first cone bricks. Brick out each cone taking care that the bricks fit snug with a thin layer of ~~hytempite~~ between the bricks never use more than 1/8 thickness of hytempite unless it is absolutely necessary. In between the lower set of cones & the upper section pattern no 180 is used. upwards from the tops section of cones. pattern no 21A is used with pattern no 32 at the end of each row cut to fit with a clearance from the ~~tubes~~ tubes to allow for expansion. As the slope of the casing ends a pattern no 34 bricks is used which is an extension brick for pattern no 21 and is used for ventilation purposes in conjunction with the two small airing doors on the bottom of the front casing each side of the wing sprayers.

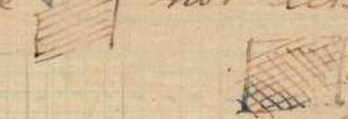
After the front sides + back are completely bricked the top layer of the floor is then laid with 1/8 space between all bricks but no hytempsite is used or asbestos millboard is used between the metal casing and all bricks as it is a non conveyor of heat and ~~no protection~~ so protects the metal casing througout.

Care must be taken when bolting up all bricks just hand tighten the nuts and turn one flat only ~~watik~~ with a spanner the holes in the bricks are then filled with hytempsite to protect the bolt heads from being burned away.

A complete examination of all bricking should be made of all bricking at every available opportunity + add necessary repairs made good

Do not ~~use~~ mix hytempsite too thin best results are obtained by keeping it fairly thick. a thin coating can be used around each cone on completion

G/ When Sketching shade away with one line not like this



[illegible]

9 Aug 40

					SOME USES
Soft plastic	White metal	69	29 1/2	1 1/2	Small Bearings
Very strong	Manganese Bronze	1 % iron 1 %	40	56	Propellers
	Naval Brass	1	38	61	Valves Spindles
tough	Gunmetal	10	2	88	Bearings Pump bodies
strong	Phosphor Bronze	4	1/10 of 1 %	95	Turbine blades incorrodable unlined bearings

1 Guards are fitted to the shaft to protect it from wire or rope

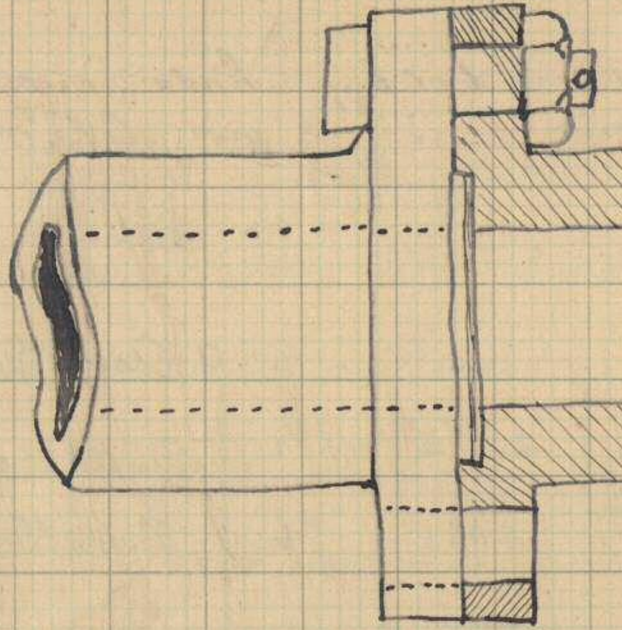
2 To measure the wear in A bracket bearing generally wood wedges is driven in and measured on removal

(3) The lifting holes are generally plugged with wood

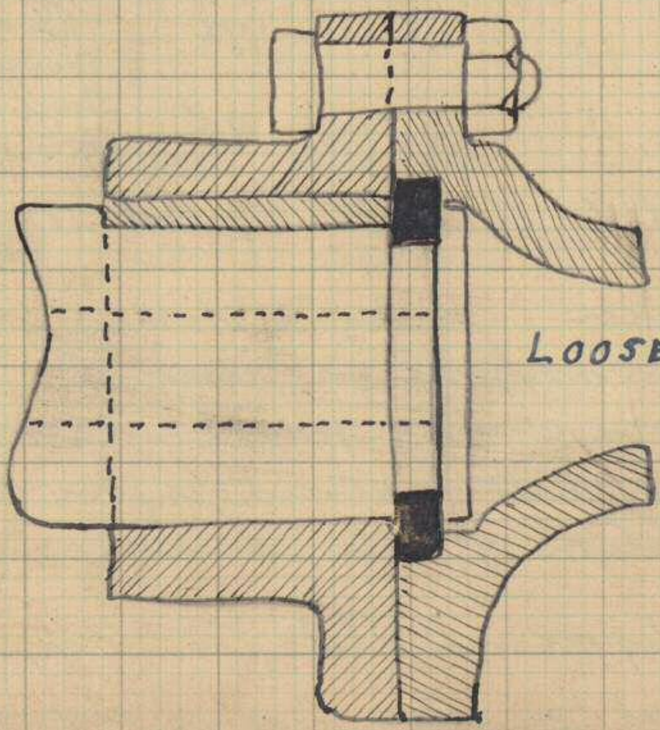
(4) Markings on the shaft inboard inform you when docking the position of the blades

5. If a ship is copper sheathed the bronze blades may have suffered on there leading edges and the

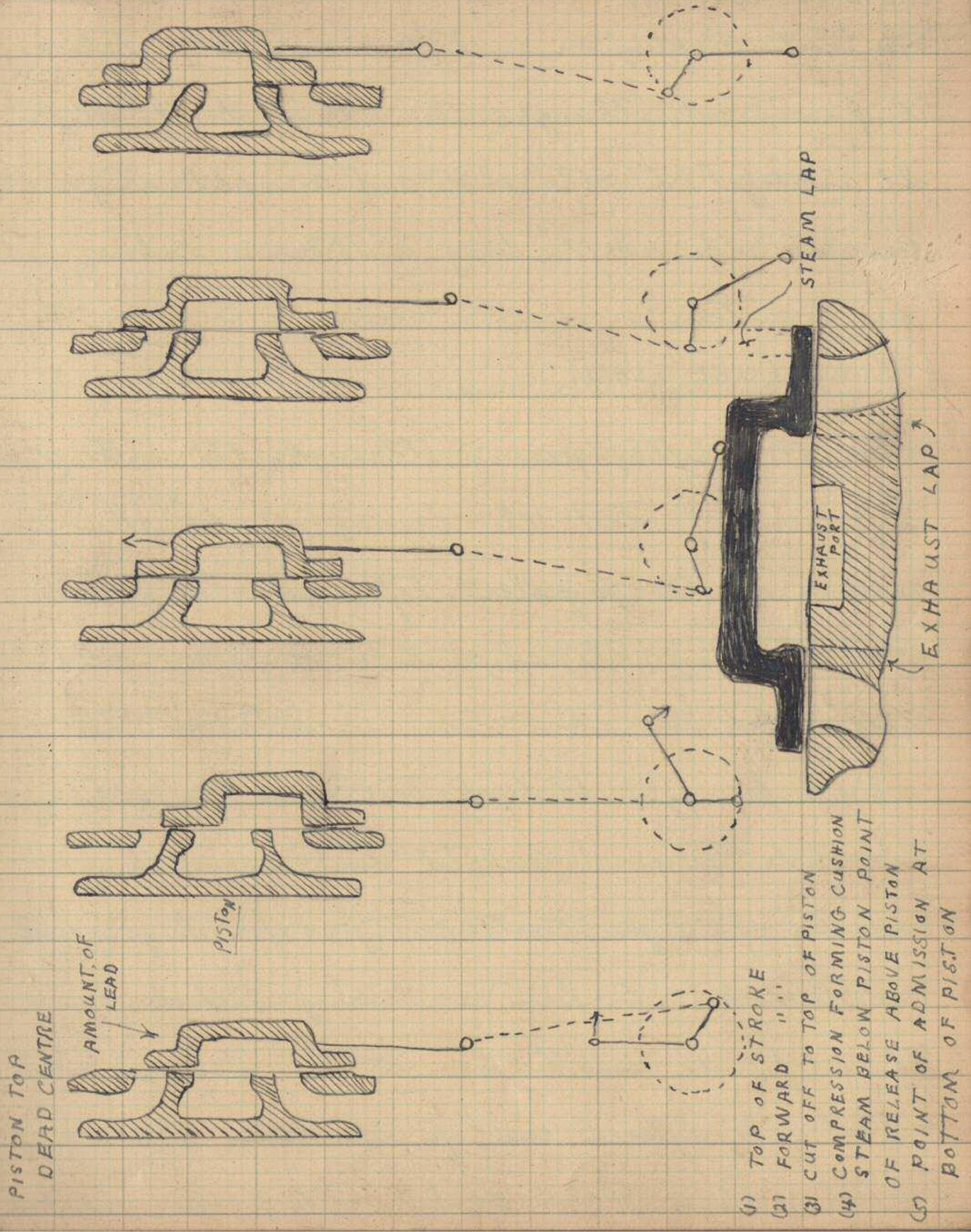
back of the blades: These are smoothed down the edges trimmed and any holes are attended too.



SOLID COUPLING



LOOSE COUPLING



LECTURE NO 9

THE LOOSE COUPLING

The last Coupling on a shaft immediately before it passes out through the stern of the ships. It is keyed to the ship, and a split ring prevents the shaft being withdrawn when going astern

(STERN TUBE GLAND)

Where the shafting passing through the hull it is necessary that the bearing should allow for rotation of the propeller shaft and also prevent water entering the ships hull. a hollow steel tube called the stern tube is rivetted to the ships framing and bored true when in position. The tube carries a gunmetal bush in which a number of lignum vitae strips (for large vessels) are dovetailed to form a bearing surface for the shaft. In smaller vessels the bush is white metal. The inboard end of the stern tube is fitted with a gland packed with packing soaked in tallow. The seawater is then allowed to fill the spaces between the lignum vitae strips, but is prevented from entering the ships by the packing in the gland. Should the bearing become heated, sea water can be circulated through it by opening a cock fitted to the inboard end and allowing water to flow through into the screw alley.

A. BRACKET

Outside the ships after the shaft has passed through the stern tube, there is generally a length of shafting, with the propeller secured to its extreme end. The weight of the shaft and propeller thus requires a bearing to support it and to prevent the shaft from bending. This bearing takes the form of a frame, known as the bracket and is built up in the frame, similar to the stern tube bearing, being lubricated likewise by sea water.

THE PROPELLER

Each blade of a screw propeller may be regarded as a small portion of thread of great pitch and depth. When revolved the propeller advances through the water just as an ordinary screw advances through a piece of wood. As water is a fluid and not solid medium the propeller does not actually advance through a distance equat to the pitch one revolution. The percentage loss is called the slips of the propeller.

(THE PITCH)

The pitch of a propeller is the distance the screw would advance in one revolution if working in a solid body such as a nut.

The diameter of the propeller is the diameter of the circle swept over by the tops of the blades.

The slip is the difference between the speed of the propeller and the speed of the ships, or it may be called, the difference between the distance the propeller should drive the ships and the distance the ships travels in one revolution

THE-BLADES

The blades radiate from a common boss which is coned internally onto a corresponding cone on the end of the tail shaft. The propeller is prevented from turning relative to the shaft by keys and is secured in position by a large nut. Propellers are usually made of manganese or phospher bronze to withstand the action of salt water.

(ZINC PROTECTORS OUTBOARD)

To protect the propeller shaft, which is made of steel, from the corrosive action of the sea water, the shaft passing through the stern tube, right up to the propeller is closely encased in a gunmetal sheath. The propeller itself is secured on a cone shaped at the end of the steel shaft. The gunmetal sheath stops short at this cone, but the sheath is let into the boss of the propeller. Between the A bracket and the propeller is a zinc ring which

Is affected by the corrosion instead of the steel work

-ADVANTAGES OF SCREW PROPELLER OVER PADDLE-WHEELS-

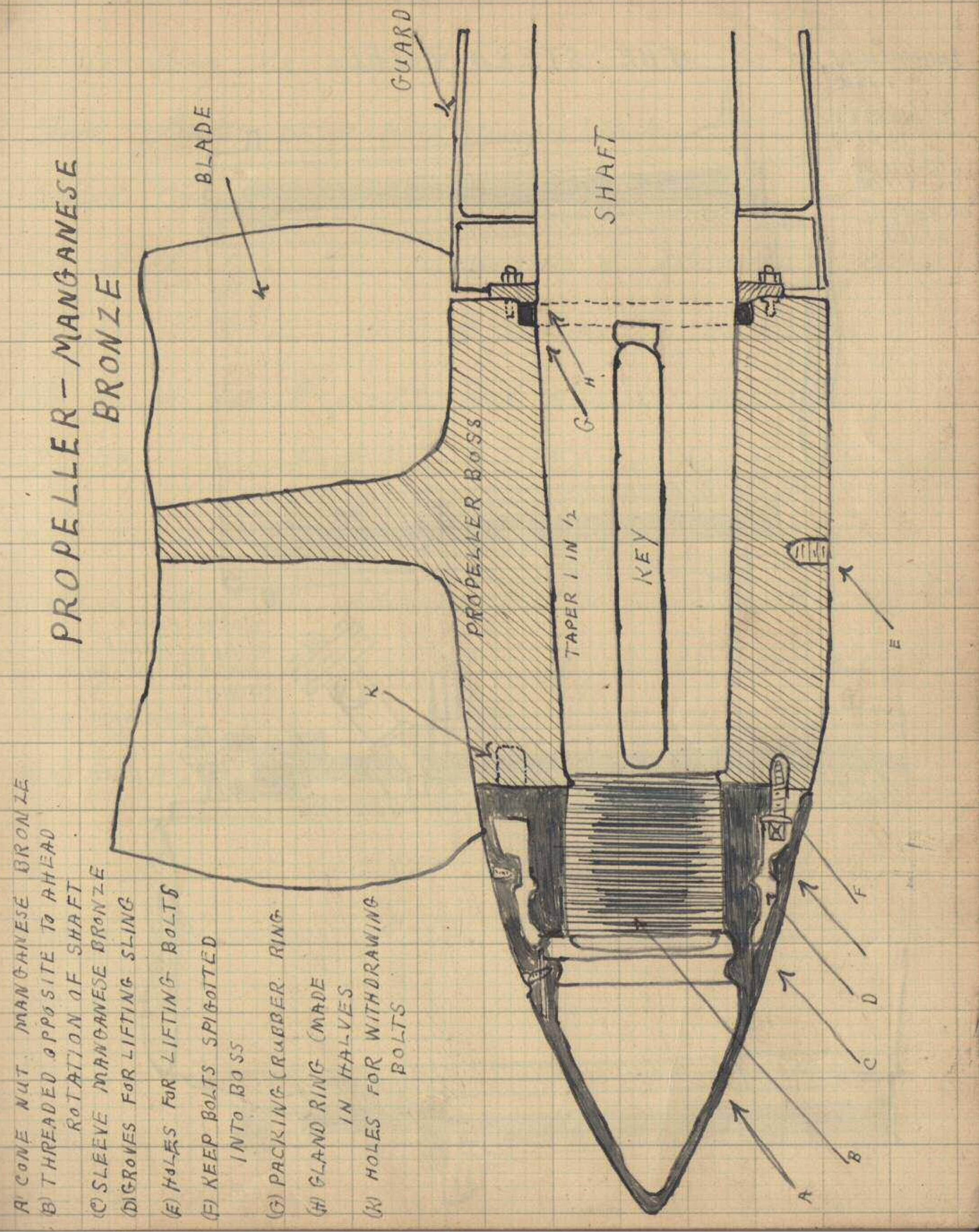
(1) It acts on a greater quantity of water
(2) Safe from gun fire
(3) Engine can be placed entirely below the water line.
Very little affected by change of trim

(DISADVANTAGES)

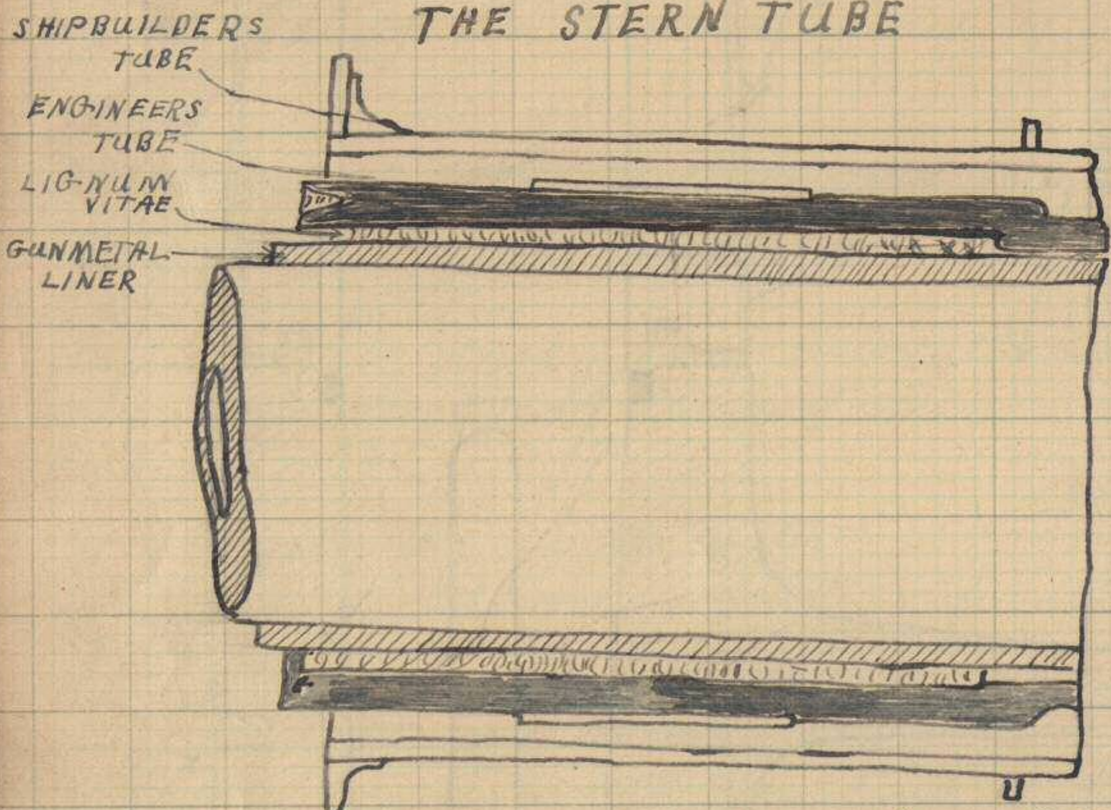
(1) It acts obliquely in the water
(2) The speeds of the various particles of water acted upon by the different blades are not the same
(3) The screw acts on the water that has already been set in motion by the ships
(4) The screw increases the resistance of the ships by preventing the water closing in behind or astern

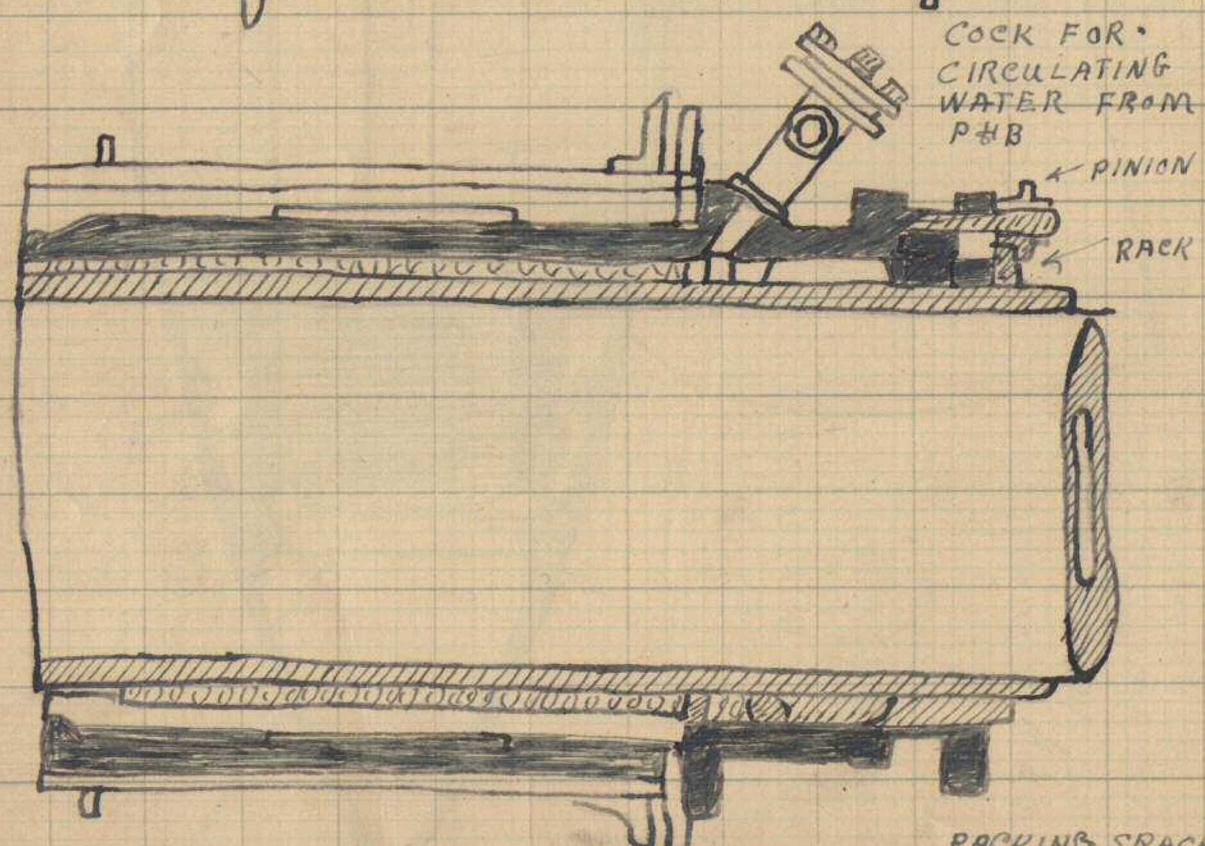
The first propeller consisted of a single screw thread cut round the boss
The following improvements were made:

(1) The number of threads or blades were increased to 3 or 4
2 The Dia: of the boss was made large to prevent Churning of the water by the roots of the blades
(3) The ends of the blades were rounded to reduce the friction at the rapidly moving blade tips



THE STERN TUBE





FEED PUMPS LECTURE No 10

These may be divided into two kinds

(1) Two cylinder or duplex pumps (Donkey)

(2) Single cylinder pumps (weir)

In both types the pumps are double acting force pumps with two sets of valves for each end of the pump barrel piston and plunger rods being directly secured to each other, no cranks or connecting rod being used. In the duplex pumps the slide valves are of the ordinary flat or piston valve type being worked by a system of levers attached to the piston rods.

WEIRS PUMP This is the principal single cylinder pump and steam is admitted to each end of the steam cylinder by means of two valves, one main and one auxillary.

The main valve is cylindrical in shape and works horizontally. Its two ends work steam tight in two cylinders in caps into which steam can be admitted

through the finger ports to drive the valve over.
The main valve is simply a slide valve with two steam ports and an exhaust port on a cylindrical face. The back of the main valve has a flat surface upon which the auxillary valve works.
The auxillary valve controls the steam ports by admitting steam into the caps to drive the main valve over, and when the main valve is over to the left steam enters the top of the cylinder.
The auxillary valve also cuts off the supply of steam through the main valve to ends of the cylinder.
It is also designed to give compression when the main valve is driven over, so that it shall not come against the ends of the caps with force enough to do any damage. Two by pass ports are cut in the edges of the caps and they can be turned so that the ports come in line with the steam ports on the back of the main valve, allowing the steam to be admitted

to the cylinder after the auxillary valve has cut off the supply. They should only be used when starting the pump and should be closed once the pump is warmed through.
The pumps cylinder is a gunmetal casting with a seperate liner which can be removed for renewal or reboring.
The suction and delivery valves are machined out of solid gun metal and are fitted in two seperate castings, held in place together with the guards for the valves by a stud through the cover of the valve box.
The discharge valves are fitted with light springs which prevent the valves from getting "stuck ups" after each discharge stroke.
The suction valves seating has a small hole drilled through it so that the pump can still move slowly against a closed discharge valve. an air vessel is fitted on the suction side of the pump to absorb shock.

CARE AND MAINTAINANCE

The steam cylinder must be carefully warned through before the pumps is started. If this is not done, the main valve is likely to stick due to unequal expansion. Care should be taken that all lock nuts on the slide valve spindle are correctly adjusted and tightly locked.

CARE AND MAINTENANCE

Glands should ~~are~~ not be too tightly packed or the rods may become bent and scored. Valve faces should at all times be kept true and flat and well lubricated. The suction and delivery valves should be kept tight because any leakage will ~~call~~ cause a loss of efficiency and increase unnecessarily the speed of the pumps, causing a greater wearing of the moving parts.

FIRE AND BILGE PUMPS

These are generally weirs pumps but are designed to work at a lower pressure than the feed pumps, fire main pressure being usually about 60 lbs per sq. inch. The suction and delivery valves are of Kinghorn type. Each pump has near it in the Eng. room a suction box and in this box are a number of seatings and valves. ~~If the feed water is~~ Below each valve is a suction pipe leading either to a special compartment or to a main suction.

Below each valve is a suction pipe leading either to a special compartment or to a main suction.

Each pump has two suction valves which are connected to its own suction and the other to the sea. Cross connecting pipes and valves are fitted between the suction boxes.

(DOWNTON HAND PUMPS)

Are fitted in some of the older class of ships and these are connected to the main suction pipe. The main circulating pumps may be used as a bilge pumps for clearing the Eng. room bilges of water but this method is only resorted to when large quantities of water are involved such as leakage in bilge from a hole in the ship's side or bottom.

The water is drawn through the circulating bilge suction valve and discharged overboard through

The Condenser. Steam ejectors are also fitted in ships for clearing the bilge of water.

(FAN-ENGINES)

Read Sto. manuel Page 36

Various Kinds of engines are used for supplying forced draught; these are usually

Reciprocating - (forced lubrication)

turbo and Electric

The pressure of forced draught used in boiler rooms is from 1" to 4" of water measured in a "U" shaped glass tube by means of a sliding scale fitted between the legs of the "U" ~~shaped glass tube~~ for ordinary speeds 1" to 2" on the scale is quite sufficient but for full power, the pressure may reach 4" of water in the U. tube and this is equivalent to 1/28 of a sq. inch air pressure approx.

(ELECTRIC-LIGHT-ENGINES-)

Three types are generally used in the Royal Navy These are

Reciprocating - (forced lubrication)

Turbo and Diesel The latter being an internal Combustion engine.

The reciprocating engine commonly used is the two Cylinder Compound engine and the H.P and L.P. slide valves are worked from a comon excentric. The engine cranks are placed at 150 degrees to each other. The forced lubrication is supplied by a small pump worked of the eccentric and the oil used is special mineral. The steam supply to the engine comes through a reducing valve which ensures a constant pressure being maintained at the engine throttle valve and this valve in turn is controlled by a governor worked from the end of the crank shaft for maintaining a constant speed of the engine. The turbo Eng. for electric light are of various types such as the parsons, Brown, Curtis and De laval and in most ships these turbo Dynamos are party self-Contained in as much as they are ~~indifferent~~

independant of the exhaust system of the ships
Each turbo has its own Condenser Circulator and air pump and the air pump discharge leads to the feed tank filling system or in the event of a leaky Condenser, to the bilge. The steam, as with the Reciprocating engine is admitted through the reducing valve to maintain a constant pressure being supplied. Beyond the engine throttle valve, nozzles are fitted which can be opened up above more than normal load is required.
Governor gear is fitted for maintaining constant speed and speeds of Turbo Dynamos vary from 3000 revs per minute on the Parsons type to 10000 revs, per minute on the De Laval type. In the engines running at 3000, this speed actually transmitted to the armature shaft but on those running at 10,000, gearing is fitted for reducing the armature shaft speed to 750; internal Combustion engines fitted for electric are usually of the 6 cylinder type; with air blast ejection Governor gear is fitted and the action of this is to lessen the fuel feed as the engines speed up.

(STEERING-ENGINE)

Read Sto manual Page 38 to 42

This is a two cylinder engine (not Compound) with two lapless piston slide valves worked by two eccentrics as a distance from one eccentric.
The ~~eccentric~~ engine cranks are set at 90° apart so that the engine is capable of starting from any position.
The reversing of the engine is accomplished by means of a differential valve which interchanges steam and exhaust openings on the slide valve casing so that steam can be admitted first outside valve and secondly, inside thus giving two directions of motion to the engine.
The steering wheel on the bridge moves the control shafting and moves differential valve from its centre position, thus admitting steam to cylinders and —

starting the engines. The differential valve is brought back to the centre position by means of the hunting gear, thus stopping the engine.

TELEMOTOR GEAR AND HUNTING GEAR
(HUNTING GEAR-)

It will be seen if steering wheel operates the differential valve an amount corresponding to the movement of steering wheel. As soon as steering engine begins to move, the hunting gear begins to return the differential valve to its neutral position and this neutral position is attained when the steering engine has given the rudder the desired amount of helm. This hunting gear consists of a threaded spiral geared to the engine crankshaft at one end and connected by lever to differential valve at the other end. suppose the differential valve to be moved ½" upwards from neutral position the engine ~~becomes~~ begins to move and on doing so, works the gear wheel attached to the hunting gear spindle and thus, in consequence, moves the spindle which, naturally, brings the spindle differential valve down again to its neutral position and on its reaching that point, the steering engine stops. The differential valve is moved downwards from its neutral position. The hunting gear acts in the same way with the exception that the differential valve with this time be drawn upwards instead of downwards.

(TELEMOTOR-GEAR)

This is hydraulic system which connects the steering wheel on the various positions for steering throughout the ships to the steering engine and controls the steering engine's movements;- Attached to the steering wheel by means of a rack and pinion, is a piston working on a cylinder containing a mixture of water and glycerine. This is called the transmitting cylinder and both ends of the cylinder are connected by small pipes to a receiving cylinder situated near the steering engine. A plunger working in working in the receiving cylinder is connected by means of links and an actuating shaft to the differential valve of the engines. Immediately the steering wheel is moved, a certain quantity of the liquid is displaced by the movement of the plunger. This quantity is transmitted through the pipe to the receiving cylinder at the steering engine and the plunger is thus moved a corresponding amount. This of course, moves the differential valve. The system must must be kept fully charged and all air excluded by means of plugs, air can be expelled. A small hand pump enables the system to be charged. All joints, glands and plunger leathers should be kept tight to prevent loss of movement in transmitting

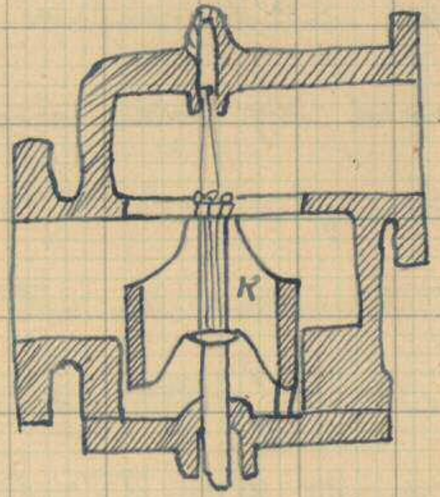
(CONTROL SHAFTING)

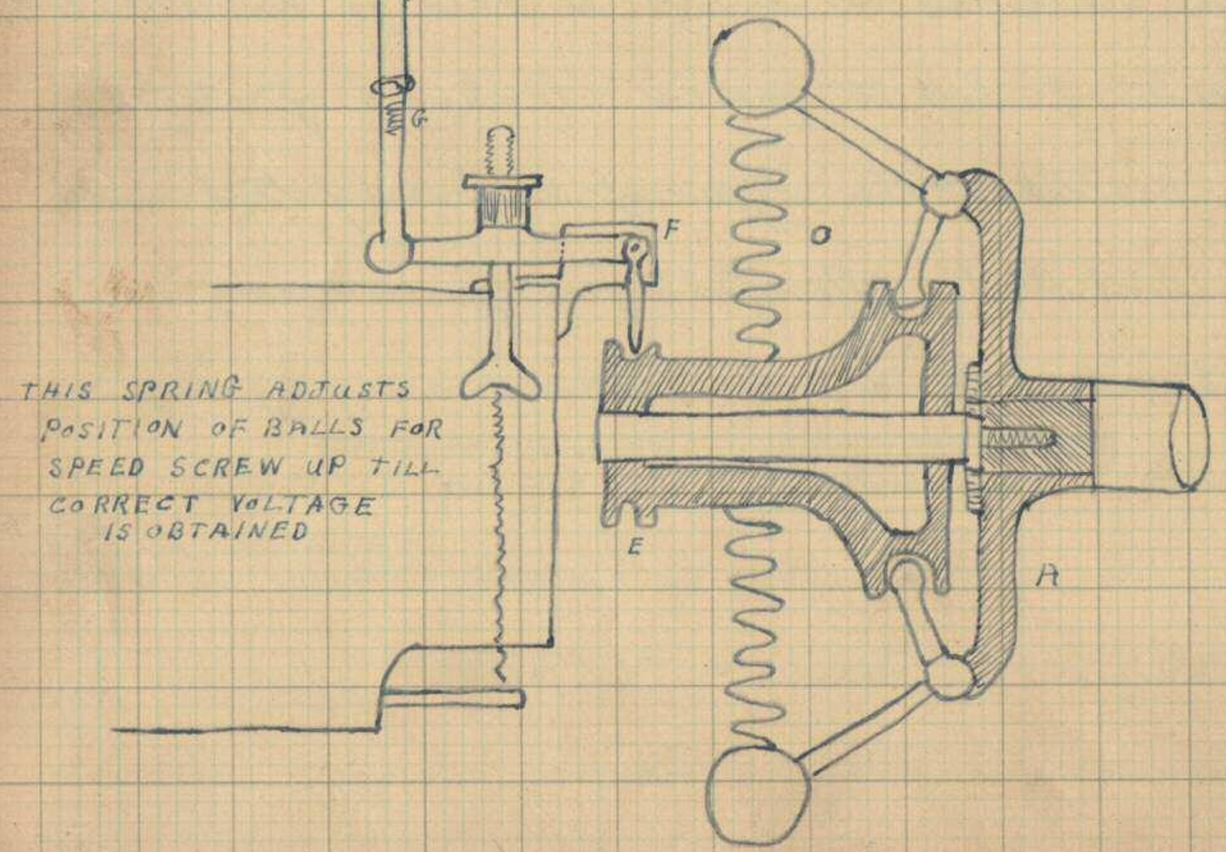
This is another means of transmitting movements of steering wheel it consists of lengths of shafting coupled together. Shafting is revolved by steering wheel, and the movement is conveyed to the engine control valve.

(CAPSTAN ENGINE)

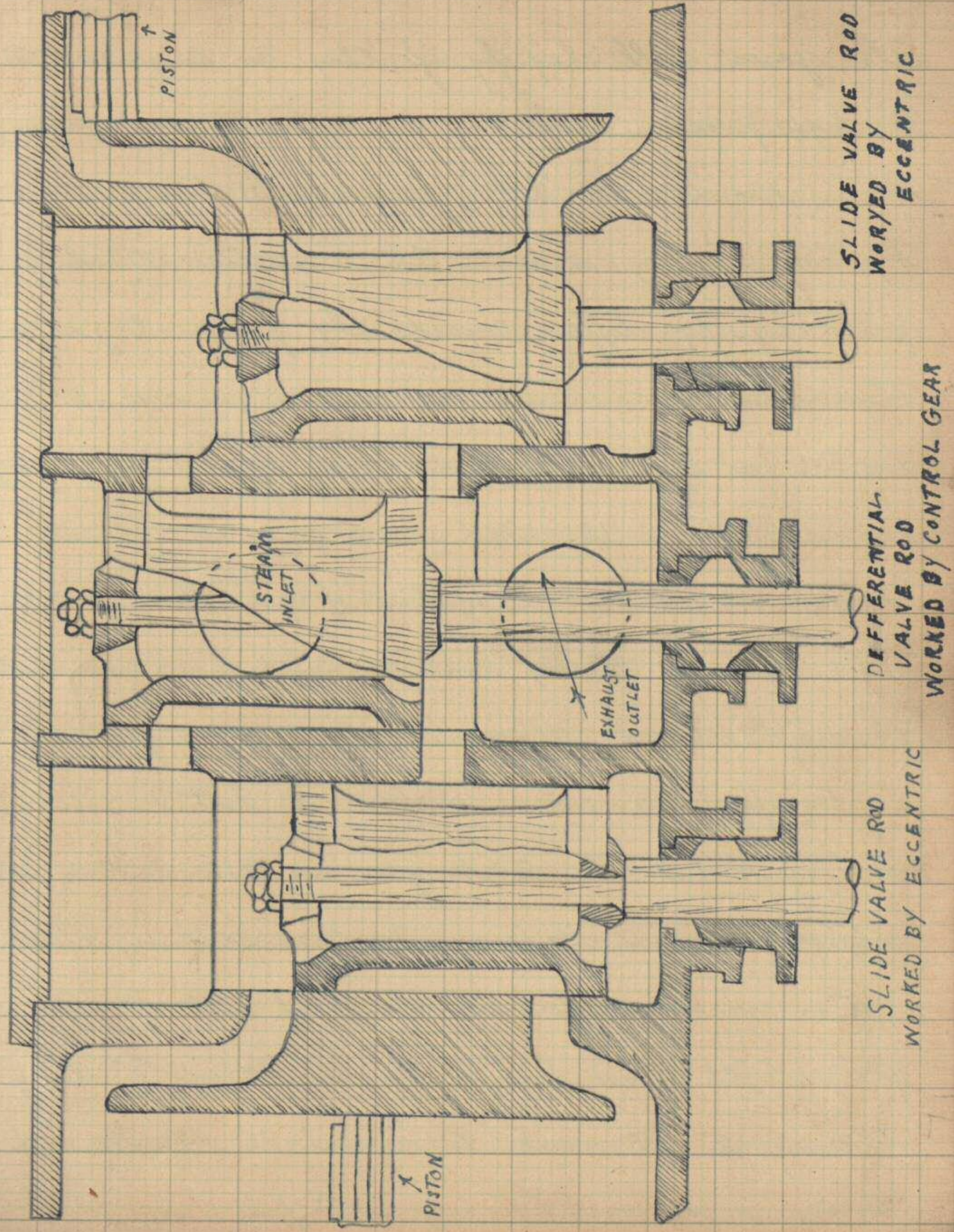
This is a two cylinder engine and has two lapless cylindrical slide valves. Cranks set at 90°. The engine is reversed by means of a differential valve or by means of a clutch on the cable deck. The differential valve in this case differs from the one used on the steering engine for it is not fitted with Hunting Gear but is worked by a hand controlled lever. It is also given a small amount of laps to prevent leakage of steam when central. Other types of engines fitted with hand controlled differential gear for reversing are: Winches, Coal hoist, turning and reversing engines.

DYNAMO ENGINE GOVERNOR GEAR





THE DIFFERENTIAL - VALVE



REFRIGERATING MACHINERY

All gases will liquefy if they are compressed to a high pressure, and the heat generated by compressing the gas known as the "heat of compression") taken away by some cooling medium. The temperature at which gases liquefy differs considerably for each gas; those which we are concerned - amonia gas or N.H.3. and Carbon-di-oxide or C.O.2 being respectively 266 deg. F. and 88 deg. F.. The general terms given to indicate this, is the "Critical temperature" of gas. Thus if the water used, for cooling some compressed C.O.2. is above 88 deg. F., the gas will not liquefy under any compression in liquefying, a certain amount of heat, known as "latent heat" has to be given up. This heat is not noticeable - cannot be measured on an ordinary thermometer but is necessary for the change of state to take place. With these liquids there is always a strong tendency to get back to normal - to expand and become a gas again - taking heat from surrounding objects, air etc. In order to make this change. It is because of this tendency that use is made of N.H.3. or C.O.2 and sometimes air, in refrigerating machinery. In a refrigerating plant, are three divisions, the evaporator in which the liquid amonia or carbon-di-oxide is converted into a gas, by being allowed to expand: the compressor by which the gas so expanded is pumped from the evaporator, through spring loaded non-return valves, thus compressing it, discharging it through a separator, by which any oil is extracted, to the condenser. Here the compressed gas is cooled down by circulating water outside the coils, and so is converted again into a liquid. The gas circuit is a completely closed one, of the coils in the evaporator, and condenser, and pipes in connection with the compressor. By means of a regulating valve a small quantity of liquid is allowed to pass into the evaporator coils. This liquid is ~~allowed to pass~~ finds itself in a place

Where it can expand rapidly. To expand it requires a little heat. This is supplied by a solution of Calcium chloride and water (known as Brine) in which the coils are immersed. The expanded gas thus makes the brine colder and colder as more liquid is let ~~into~~ in to evaporate, the gas being taken away by the compressor to be made liquid again in the condenser, by this means is obtained a very cold liquid which can be used in the following ways.

(A) To pump through pipes round an insulated room for the storage meats, provisions, etc.

(B) To pass through coolers, similar to small surface condensers round the outside of the tubes of which air is passed, which air is passed which is used to cool the magazine

(C) To pass around pans containing water to make ice.

The brine is used because of its low freezing point. Calcium chloride being very soluable in water sufficient can be dissolved in a given quantity of water to reduce the freezing point well belo zero, therefore it keeps liquid at the lowest temperatures worked on the machine. It is the best medium to use, as a solution of common salt and water or ordinary sea water more quickly carrodes the steel or iron pipes used on the circuit. The amount of Calcium Chloride in the water should be 2½ lbs to every gallon; that is, one gallon of brine should weigh 12½ lbs giving a density of 1.25. If the machine is used on magazine cooling only the temperature of the brine is not so low, usually between 50 and 60 deg. F. and the density of the brine may be less than making ice, about 1.12. The air circuit for magazine cooling is such that by means of a motor fan the air in the magazine is drawn out and discharged through the cooler into the magazine again at another point, thus providing a continuous supply of cold air to the magazine. As amonia gas acts rapidly on ~~gas~~ brass and copper all pipes of the gas circuit, pressure gauges etc. In an NH_3 plant are steel, and all joints of lead.

Joints in a CO_2 system are of copper and gas system also usually of copper. The working pressures vary for each gas. The condenser and evaporator pressures respectively for each gas being, NH_3 — 170 lbs per sq. inch and 30 lbs. per sq. inch and 2000 lbs. per sq. inch (water pressure test only)

HYDRAULIC PUMPING ENGINE

This is an engine of horizontal tandem compound type, which has two sets of steam cylinders with cranks at right angles to each other. The H.P cylinder is placed between the L.P. cylinder and the shaft; the L.P. piston having two rods which pass through C chambers cast on the H.P. Piston rod and pumps ram are also secured. The slide valves are arranged on the tops of the cylinders and are both driven by one eccentric through a rocking shaft and levers. as the piston rods and pumps ram are connected to the same cross head, most of the force of the steam is transmitted directly to the water in the pumps. No fly wheels are fitted and the resistance of the pumps being constant it is necessary to maintain full steam pressure for nearly the whole stroke. The point of "cut off" is at 95% of the stroke. The pump piston has a sectional area equal to twice that of the ram and is kept tight in one direction by two L "Leathers".

This ensures a constant pressure on the ram packing thus avoiding leakage and also in drawing of air between the packing and the rod on an "instroke". air ~~between the packing~~ in the system causes irregularity of working and may seriously increase stresses in the various parts. The speed of the engine is governed by the pressure of discharge through the medium of a spring loaded piston connected to

The steam throttle by a system of levers, so that the engine maintains a steady discharge pressure. Special tanks are fitted for the water, which is kept isolated from any other water system in the ships. The pumps takes its suction from these tanks, the water being returned to the tanks again after use, thus working in an inclosed circuit. Argolene oil is mixed with the water to prevent it from feezing in cold weather; the oil also prevents corrosion of machinery and the pipes and keeps the leathers soft and pliable as well as lubricating the various parts.

AIR COMPRESSING MACHINERY

Compressed air up to a pressure of 3500 lbs per sq. inch is supplied for use in torpedoes by special air compressors. A type of compressor in use is constructed with two compressing cylinders arranged side by side in a casing and a steam cylinder underneath the compressor plungers and piston rod being connected to a cross beam kept in place by guides is actuated from below by the piston, and link arms connect it to a crank shaft in the bed of the engine which carries the eccentric gear for working the slide valve of the steam cyld. A pump for circulating sea water for cooling the compressed air between the various stages is also driven by cross beam. Each compressing cylinder is utilised for two stages of compression, the lower pressure and high pressure below the plungers respectively. Air from the atmosphere with a little distilled water and "torpoyl" is drawn into the first stage above the larger plunger through the inlet valve which is covered with fine gauge. It is compressed on the next stroke and discharge through an inner cooler into the next compression stage and so on through the third and fourth stages and each stage as the volume decreases the pressure rises. As the air passes from each stage it is kept cool by sea water circulated around the ~~to~~ intercoolers.

From the last intercooler the air is discharged into a seperator column where water and oil in the air is seperated out, this mixture is blown out at intervals through a drain on the bottom of the column.
The distilled water, which is supplied by a small condenser fixed to the ~~condenser~~ engine and the "Torfoyl" which enters the first stage with the air serves to keep the fibres which pack the plungers and glands soft and pliable and also lubricate the internal parts.
The fibres in the plungers and glands, and the inlet and discharge valves between the stages should be kept in good state of repair to insure efficient working of the compressor. The Clearance between the plungers and the ends of compressor cylinders should be fine as maintaindd.

— LUBRICATION —

The following oil used in the K.P. for lubrication purpose.
Heavy mineral oil. For cylinder lubrication and for piston and slide valves and rods it is also suitable for gear boxes of motor boats
Compound Marine Engine oil. For all main and auxillary machinery for lubrication of bearings not ~~forced~~ fitted for forced lubrication.
Special service mineral oil. For all main and auxillary machinery fitted for forced lubrication, including diesel driven dynamoes submarine engines. Mineral oils are obtained from crude petroleum by a process of distillation; in this way we obtain Benzine, Gasoline, petrol, and a number of oil varying in viscosity from pariffin to heavy mineral oil, each one of these dependent upon the temprature of crude petroleum, that for Benzine being from 55 to 60 degrees and as the temperature of the crude oil rises the other spirits and oils are obtained in vapour form and afterwards liquified

Not all these oils are suitable for lubrication purposes. The object of lubrication is to provide a thin film of oil between the two bearing surfaces, so that they can be kept apart, thus providing a fluid "cushion".

A good lubrication should posses the following qualities:

(1) a sufficient "body" or thickness to withstand pressure without being squeezed out.

(2) Have as little friction between its particles as is consistent with sufficient "body"

(3) Retain its "body" at temperature at which it is used.

(4) must not dry up and leave a gummy residue.

(5) Must be free from dirt and grit

The most efficient of lubrication is by a system of forced lubrication. This adopted for dynamo engines, fan engines, and a number of other fast running engines, including internal combustion engines. a small pump is fitted to an eccentric which supplies oil from the well in the bed of the engine to the bearings at a pressure

In turbines installations however seperate pumps take oil from a drain tank, discharge it through filters and coolers then through a system of pipes, each bearing receiving oil at a pressure from 8 to 10 lbs. per sq inch. This oil then drains away to a well in the bearings casting, through a return pipe back to the drain ~~pipe~~ tank, where it is again used. Care must be taken to remove any water which may accumulate in the drain or settling tank by means of a small pump provided. Water easily seperates from oil, and the oil should be frequently tested with sensitised paper which shows the presence of water by white spots on the brown surface of the paper.

OTHER OILS IN GENERAL USE ARE:-

Torpoyl. a light oil used in Torpedoes and air Compressors

(Sperm oil) is not used)

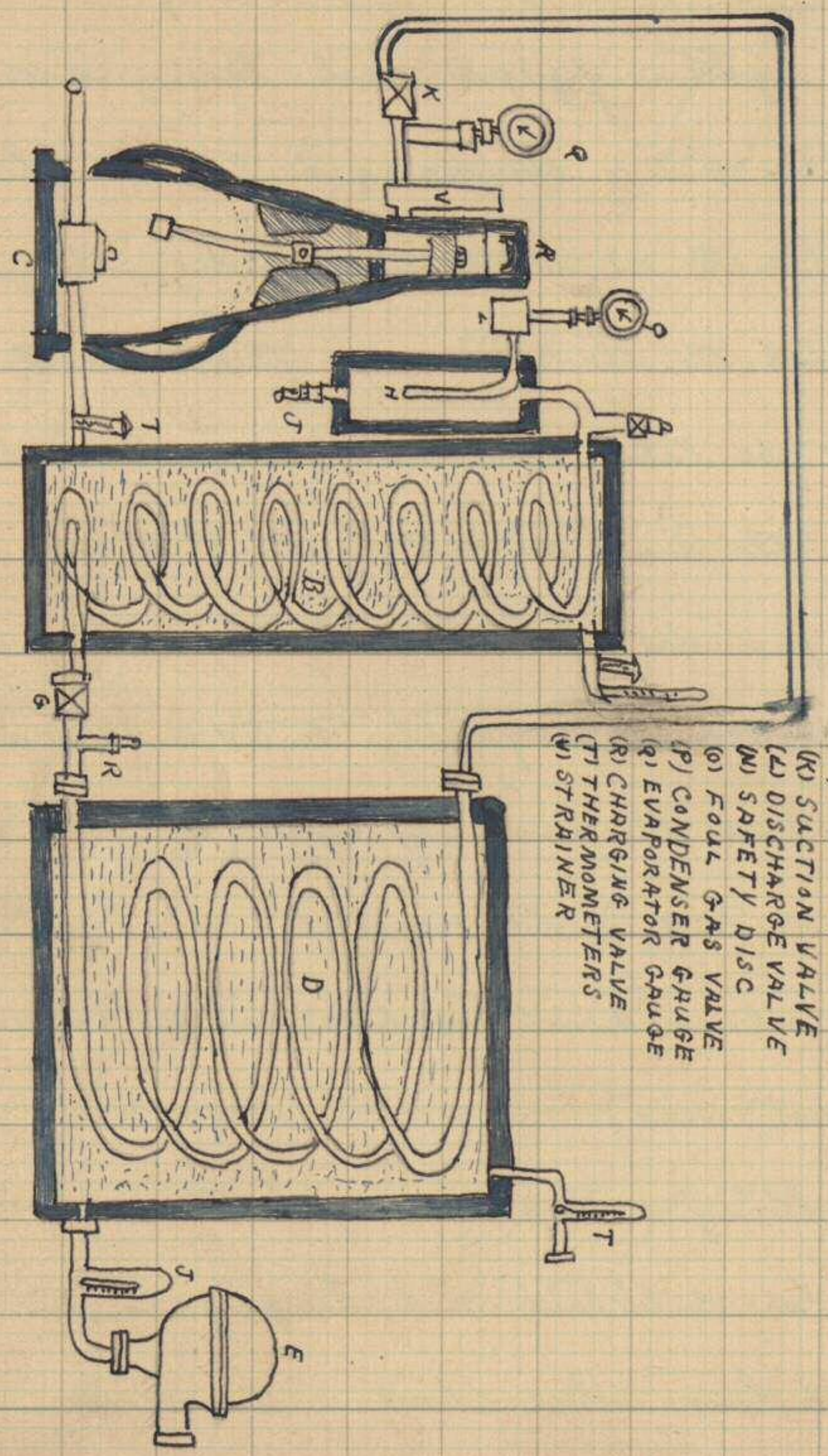
(Neatsfoot. for) softening and preserving leather

(Mineral Sperm). for bulkhead and hanging lamps

(Rapeseed) for hand lamps where above is unsuitable.

(Argolene) for Hydraulic systems to prevent the water freezing.

DIAGRAM CO_2 REFRIGERATING MACHINE



(A) COMPRESSOR
(B) CONDENSER
(C) CIRCULATING PUMP
(D) EVAPORATOR
(E) BRINE PUMP
(F) FLY WHEEL
(G) REGULATING VALVE
(H) SEPERATOR
(J) DRAIN VALVE
(K) SUCTION VALVE
(L) DISCHARGE VALVE
(M) SAFETY DISC
(O) FOUL GAS VALVE
(P) CONDENSER GAUGE
(Q) EVAPORATOR GAUGE
(R) CHARGING VALVE
(T) THERMOMETERS
(W) STRAINER

— HYDRAULIC-JACK —

Principle of working

If two plungers be connected to a space completely full of water, plunger A being one sq inch in end area, and plunger B 10 sq inches; then downward load of 11 lbs. on the small plunger will cause an upward thrust of 10 lbs on the larger plunger. The pressure of 1 lb per sq. inch end area, will cause a pressure throughout the water of 1 lb. per inch. This pressure acts upon the ten sq. inches of end area of the large plunger, and so causes the upward thrust of ten lbs

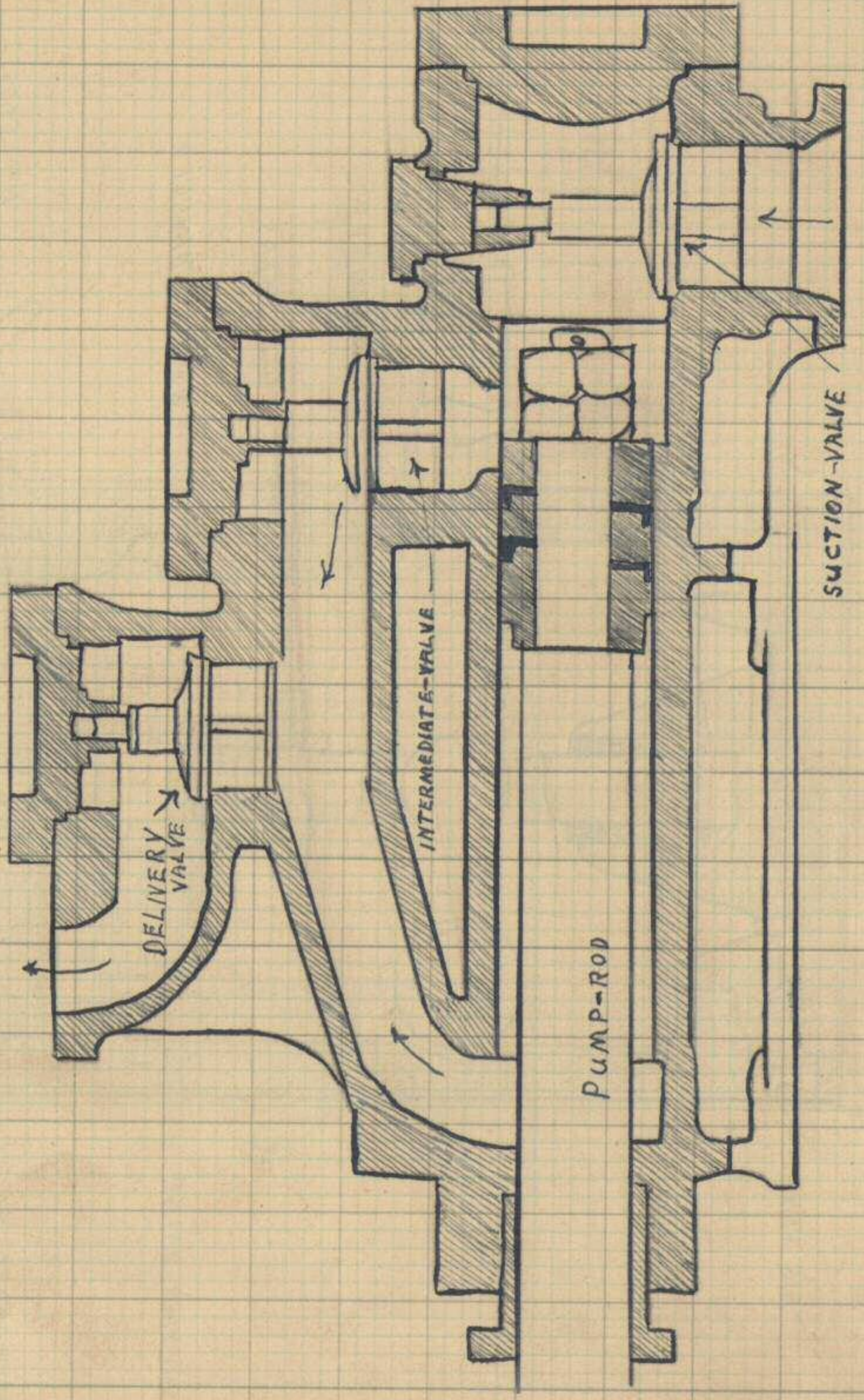
HYDRAULIC-JACK-CONSTRUCTION

(A) Ram
(B) Pump plunger.
(C) Cistern.
(N & D) Serrated faces on casting.
(E) Paul for operating plunger
(F) Spindle for operating plunger
(F) Spindle for revolving pawl
(H) Pump suction valve
(K) Pump delivery valve
(L) Lever for operating "P"
(M) Screw for (C)
(Q) Space above ram
(S) Screw for releasing pressure and lowering ram
(V) Vent holes in casing

ACTION   HYDRAULIC—JACK

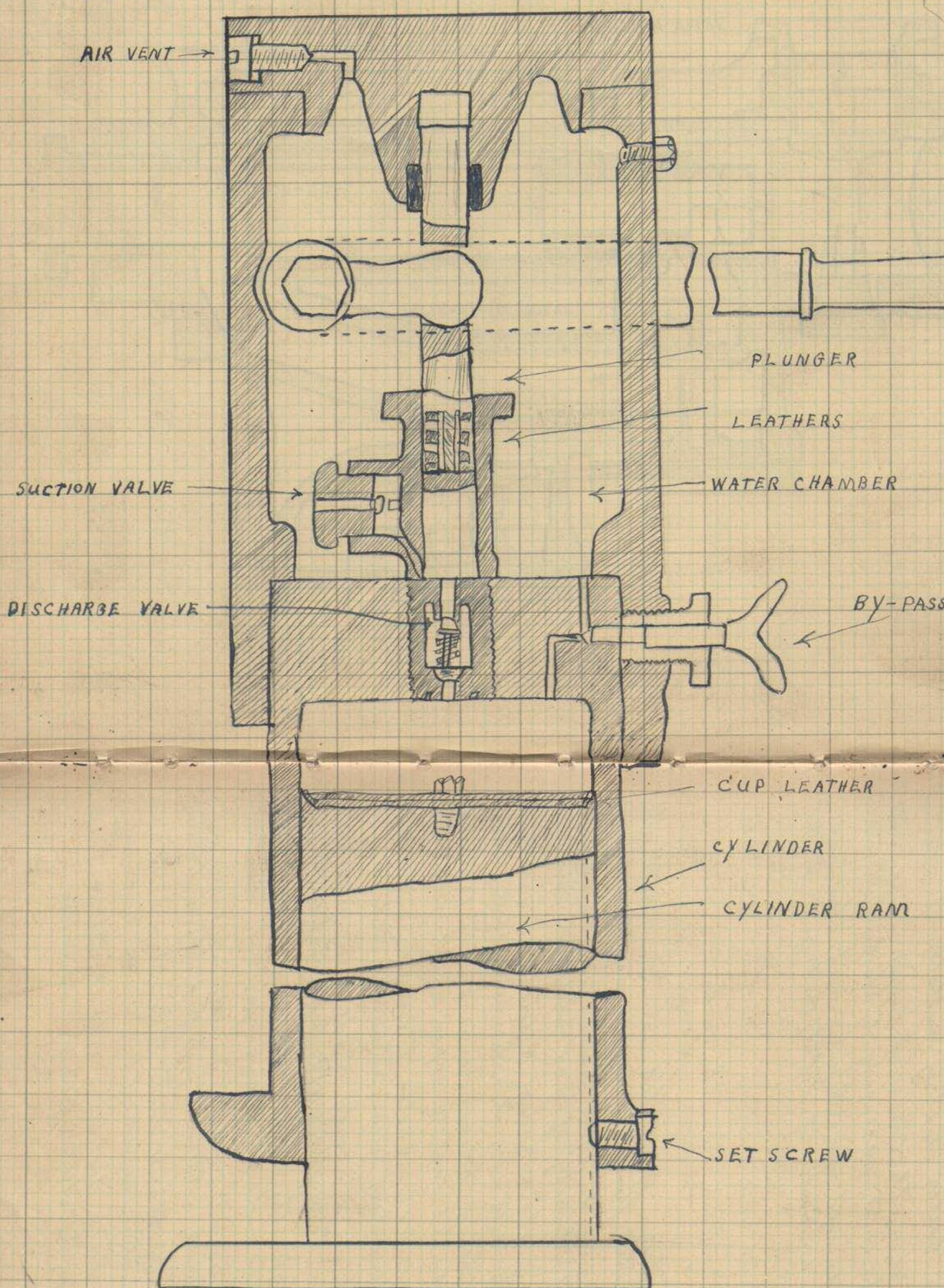
Cistern C being filled with glycerine and water in proportion of three parts to one, and load to be lifted placed "N or D" thum screws are tightened. Pump plunger is operated by (F) and lever (L) and on up stroke, takes suction from Cistern (C) through valve (H) discharging on down stroke, ~~takes suction~~ through valve (K) to space (Q) on top of ram, Thereby forcing casing to rise above ram and lift load. Limit of height is reached when water flows from (Q) through vent hole (W) to lower casing. Thumb screw (S) is slackened allowing the liquid to pass back to Cistern through passage in casing, thus pressure (Q) escapes and allows casing and load to drop.

Ram and plunger are made water tight by means (L) leathers. A greater load may be lifted at (N) than at (D) as a load at D tends to bend the Jacket.



HYDRAULIC — PUMP

HYDRAULIC — JACK



LECTURE 12 — EVAPORATORS

Evaporators were first introduced when the bad effect of salt water was discovered. In the earliest examples of evaporators one of the ships boilers was used, but this plan was quickly given up, because of the difficulty of removing scale from the boiler heating surfaces. A special evaporator was then fitted, with coils of copper tube fitted with steam to supply the heat necessary to boil the water. The coils can easily be removed for chipping and cleaning. The shell of the evaporator is made of either cast gun metal or steel plates.

PRIMARY STEAM

This is the name of the steam in the coils

SECONDARY STEAM

This is the name of the steam generated in the shell of the evaporator. The feed water, from the sea, is supplied by a feed pumps and can be regulated by a hand feed check or by an automatic. To prevent density of sea water or brine, in the shell from rising above 30deg, a portion is removed by the brine pump, and regulated by the brine valve, the brine in the shell also being blown down every 12 hours. The secondary steam passes through a vapor valve which is fitted to control pressure in the shell, then goes into the condenser or distiller. The secondary steam is passed into a distilling condenser which is a vessel made of ~~a~~ galvanized steel plates, fitted with two tube plates and brass tubes. Cold sea water is circulated through the tubes, and so condenses the secondary steam on the outside. The surfaces of the tube plate and the tubes are tinned over to prevent verdigris poisoning. The condensed fresh water is pumped by a distilling pump through a measuring tank into the ship's tanks. One single cylinder steam engine is often used to work all the pumps necessary for a distilling plant. These include the feed pump, Brine pump, Distiller pumps, Circulating and fresh water pumps

TO START UP AN EVAPORATOR

(1) Warm through the pump engine
(2) Open inlet and discharge valves to all pumps
(3) Start pumping engine slowly
(4) Pump up or down the water level to rather under the correct height
(5) Open coil drain
(6) Open primary steam to coils and gradually open vapour valve
(7) As the pressure rises in the shell, slowly regulate speed of pumps and valve openings
(8) Test the density of the water in the evaporator and the freshness of the distilled water
(9) Set the primary steam and coil drain valves to the correct opening
(10) Set the vapour valve

When it is necessary to clean the evaporator coils, the door of the shell must be first opened. After that, if the coils are not attached to the door, they must be seperately detached and cleaned.
When the coils are replaced they should be tested with steam before the door is ~~opened~~ jointed
In every type of evaporator it is more satisfactory to remove the coils to clean them. In the Weirs evaporator, care should be taken on replacing the coils, that the small hole in the end of each coil is on the bottom

LOW PRESSURE EVAPORATORS

Condensation of the low pressures, temperatures and density and the sulphates of lime and magnesium which are deposited shows, at once, the advantage of the use of low pressure steam in the coils, and of a density below 30deg. in the shell. The evaporators now fitted on board ships are of low pressure type, with a maximum coil pressure of 25 lbs., and an automatically regulated feed density of 25 degrees. Since the evaporators are worked at a vacuum of about 10" in the shell, the brine cannot be blown out of the ship to the sea or bilge, but must be removed by means of a brine pump, and the brine has to be

Partially Cooled in order to allow the brine pumps to deal with it. In Weirs low pressure evaporator, these two objects are affected by means of a Combined feed and brine pumps and a brine cooling chamber. A valve on the discharge pipe from the feed pump can be lifted by means of a spindle, worked by the pumps steam valve lever. The spindle Can be adjusted to lift this valve at any point of the stroke, after ~~the stroke~~ half the stroke has been Completed. Directly the valve is lifted the feed water passes into the brine Cooling Chamber, mixes with hot brine and is removed by the brine pumps on the down stroke, In this way the proportion between the feed water put into the evaporator and the brine taken out Can be kept Constant or can be regulated to keep the density constant

(NOTE) By using steam of a low pressure and temperature in the Coils much less scale is deposited on the coils, than with high pressure steam and Consequently the density Can be kept very low in the shell.

THE WATER LEVEL—

The water level is regulated by means of a hollow float, which opens the feed inlet valve against the action of an internal spring or weight, when the level falls; when the water level rises the spring is able to lift the float and shut the valve.

SPRING LOADED VACUUM CONTROL VALVES

These are of the piston ~~type~~ valve type fitted to regulate the pressure in the shell when working on Condenser.

WEIRS LOW PRESSURE EVAPORATOR

The bottom half of the shell is made of cast gunmetal and the upper half or steam dome is made of steel or rolled brass plate. The Coils are made of solid drawn Copper and arranged to lay horizontally. Each end of the Coil has a union nut which screws on to an adaptor. These adaptors have a flange for jointing material, and fit into a header, which forms part of the Evaporator Casting. They are secured into position by screws which screw into the adaptor from the outside, and made steam tight by a joint under their heads. The header is in three divisions divided by partitions cast inside it. One partition is vertical and the other horizontal. The first divides the header into inlet and outlet sides, and the second divides the inlet from the drain, so that steam enters the inlet, goes through the coils to the outlet, and from there through the bottom coil to the drain. The aperature in the outlet adaptor of each coil is smaller than the inlet, except the bottom coil, where both are the same. A hinged door is fitted to the front of the evaporator, opposite the coils to allow their being removed for cleaning. Circular baffle plates or hoods, as they are called, are fitted over the coils to prevent priming

—NORMANDY EVAPORATOR—

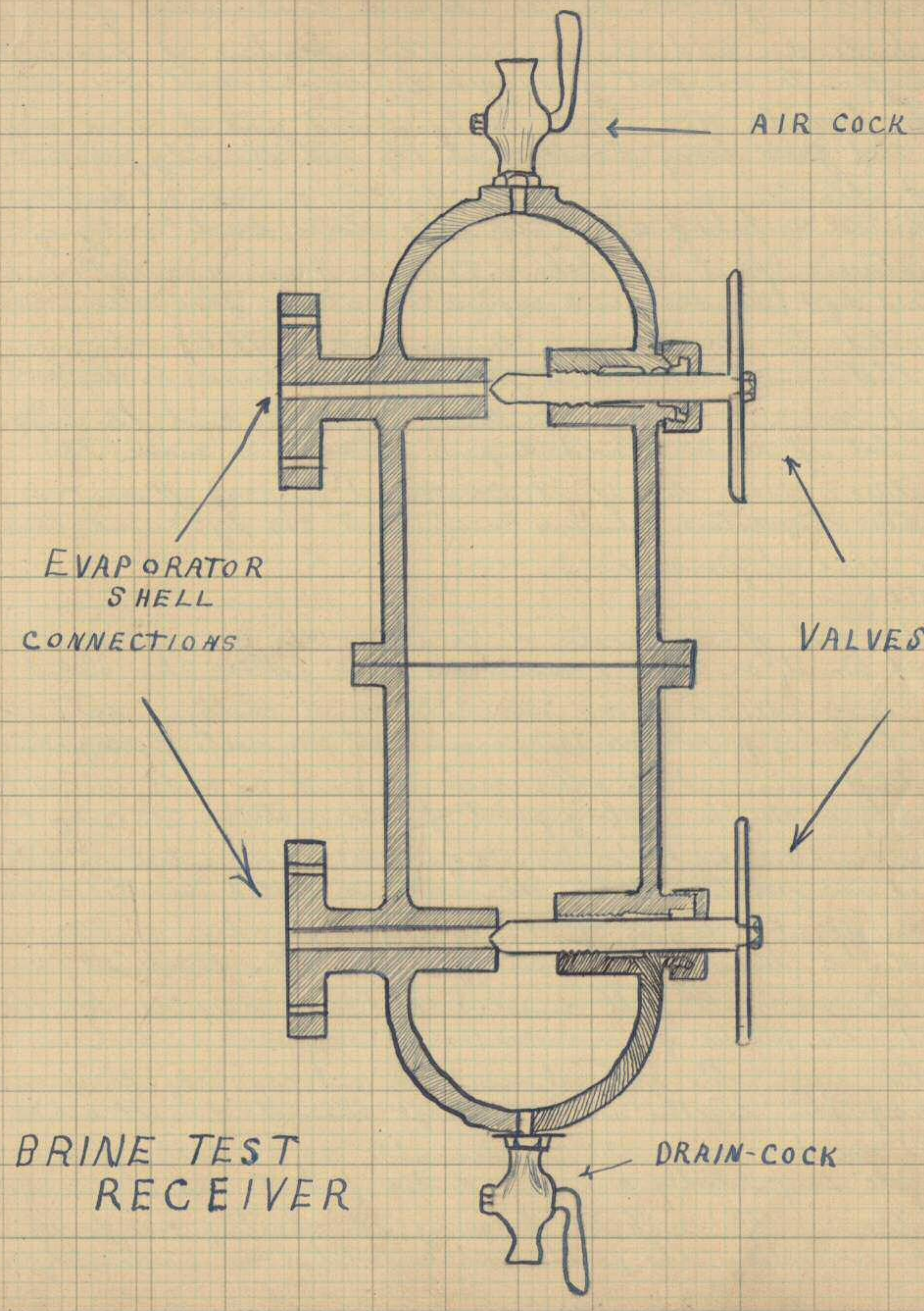
The steel is made of galvanized steel plate, and the tubes are straight, vertical and expanded into the tube plates. The tube plates are each bolted to a hollow chamber, which in turn is attached to the primary steam inlet pipe and the coil drains, respectively, by flanged joints. When the door of the evaporator shell is removed and these joints broken, the tubes and the two Chambers may be swung out of the evaporator in a vertical hanger, and be removed for cleaning. Feed water is pumped in through a feed regulating Chamber, fitted with a float feed, supply being from the hottest point of the shell of the distiller.

—KIRKCALDY'S EVAPORATORS—

The tubes are arranged in vertical spiral coils, and are attached to steam and drain chambers. These chambers form a part of the cast gunmetal door.

— CAIRD AND RAYNER'S EVAPORATORS —

The tubes are arranged in horizontal Coils. The Coils are attached at one end, to a steam chamber Cast in the door, and at the other end to a portable drain-header. All the latest evaporators, except Normandy, have been seperately attached by means of a union nut and Cone joint, so that any tube may be detached from the header and a spare one replaced.



BRINE TEST
RECEIVER

LECTURE XIII

Pure water is formed by the Chemical Combination of two gases, hydrogen and oxygen, in the proportion of two parts of hydrogen to one part of oxygen by volume, and is indicated by the formula H_2O. It is rarely formed pure however, various salts and gases being dissolved in it, and the only practial way of obtaining pure water is by the process of distillation. This Chemical Compound exists in three states, due to varying temparatures. If it is below 32 deg F. It is a solid, and above 212 deg. F. It becomes a vapour or steam. This steam can be heated to almost any temperature without change of state that is, it remains a gas; if its volume is kept constant, as in a boiler, the ~~bater~~ pressure increases and the temperature rises, but if it is allowed to pass off as it is made the temperature rises, but if it is allowed to pass off as it is made the temperature remains constant at 212 deg. F. and there is no rise of pressure.

SEA WATER

One cubic foot of sea water contains 1.5 lbs of solid matter dissolved in it, or about 5 ounces in each gallon. This solid matter is made up of various salts and chalky substances in the following proportions: 76% common salt, 10% salts of magnesia, 5% plaster of paris and 3% other materials such as chalk, silica etc. The density is 10%. The boiling point of sea water is 213.2 deg. F and increases 1.2 deg. F for every 5 ozs. per gallon solid matter contained in solution. When sea water is boiled so that steam is given off, the density gradually increases, because there is less water to dissolve the existing salts. When the density reaches 45 deg. no more salt will dissolve and any surplus will be deposited. The plaster of paris makes a hard scale, which is deposited upon the internal surfaces and can only be removed by chipping. This together with a large amount of salt which is deposited makes sea water undesirable as a boiler feed water. This scale is practically a non-conductor of heat and so in addition to thickening the material forming the heating surfaces it leads to overheating the parts and a total loss evaporated power. Sea water has also a corrosive action which is due to the breaking up of salts held in solution caused by heat and the presence of slightly dissimilar metals. This creates an acid, then the boiler is similar in every respect to a galvanic cell and the action goes between the metals. Therefore fresh water, distilled if possible, is used with boilers. With W.T. boilers, however distilled water is necessary as the slightest deposit of scale upon the internal surfaces of the tubes would lead to dangerous overheating, which would be in time. lead distortion and bursting of the tubes. In cylindrical boilers overheating leads to the collapse of a combustion chamber. Distilled water is neither ~~heated~~ acid or alkaline, but to prevent the slightest tendency to acidity it is kept alkaline by the addition of a little lime dissolved in the water

CORROSION IN BOILERS CONDENSERS

Corrosion is a word meaning "to wear or eat away gradually" usually by chemical action. With boilers and condensers the principle causes are:-

(1) The presence of oils and grease in the water
(2) Acids present in the water
(3) Dampness of plates and the air surrounding them
(4) The presence of salts as in sea water

(No 1) The presence of animal and vegetable oils and fats give rise to various acid which are formed when on the application of heat these oils break up into their components in addition to acids which are absorbed by the water, a greasy very acid substance is deposited along the water line and so gives rise to what is known as pitting.

(2) Acids present in the water make galvanic conditions: a small electric current is set up between the metals however slightly dissimilar with consequent of eating away one and depositing on the other

(3) Perfectly dry air or pure water with no air dissolved in it is harmless to metals, but a damp steel plate with oxygen of the air will rapidly become rusty, showing that such conditions will set ups corrosion.

(4) Sea water: This effects Condensers as well as boilers. A galvanic cell is formed by two different metals in an acid solution. Sea water is weak acid. and by decomposition of salts on heating up becomes a stronger acid: also it has much air dissolved in it. Thus by using sea water in the boilers as ~~fed~~ feed water and in the condenser as a cooling agent, conditions are set for rapid corrosion in both boilers and condenser.

PREVENTIVE METHODS – BOILERS

All sea connections are kept in good order. Condensers and air pump coolers are kept perfectly tight. Heavy mineral oil only is used for internal lubrication and on piston rods.

Zinc-Slabs are kept in good condition with perfect metallic contact with shell. All internal surfaces are kept free from scale or deposit, all pitting etc. being scraped out, and external surfaces of tubes and shell dept free of soot. All feed water is kept slightly alkaline with lime. When not in use boiler is pumped to W.W. and at slight pressure.

When steaming, heated feed water. (Not more than 150 deg. F. is used thus expelling air from the water. When empty and open, airing stoves are placed in the furnaces.

-CONDENSERS-

Casings and tube plates are made of gunmetal, tubes and ferrules of special brass 70% Copper, 29% Zinc, 1% tin and doors of Cast iron. Zinc slabs are fitted in the inlet valve orifice steel slabs on the doors and on the tube plates. The tube plate is cement washed. In lubricating oil coolers, where the sea water is on the outside of the tubes and the oil to be cooled passes through the tubes, a few steel rods are fitted inside the tubes.

TESTS OF FEED WATER-

The following are the tests employed

Silver nitrate test

When one or two drops of this solution are applied to a test tube of water, the presence of salt is shown by a white cloud forming instantly, dropping to the bottom of the tube.

LITMUS PAPER TEST

These papers are of two sorts, red and blue. In an acid sample a blue paper will turn red and if alkaline a red paper will turn blue. These papers are kept in an air tight amber glass bottle to prevent them turning colour in contact with the air.

PHENOL-PHATHALENE TEST

A drops of this liquid will turn an alkaline sample a bright pink, but the presence of acid is indicated by a slight greyish tinge. The better test for acid is Methayl orange which turns the sample a bright pink. Should the sample be alkaline Methayl orange will turn it yellow. The Hydrometer is used for testing density of water.

DENSITY AND ~~GRAVITY~~ SPECIFIC GRAVITY

Density: When any two or more bodies of different materials (but having the same volume) are found to contain different quantities of matter, that body which contains the greater quantity is said to be of greater density than the other.

Specific Gravity ÷ This is the weight of a given volume of a substance when compared with the weight with an equal volume of distilled water. Water is adopted as the standard and pure water at 60 deg. F always has the same weight whenever weighed. The density solid, liquid or gas, is stated to be the quantity of matter to the cub foot; the density of wrought iron is 480 and of oil fuel 66.

NOW – Specific gravity $= \dfrac{\text{Weight of a volume of substance}}{\text{weight of an equal volume of water}}$

" " of iron $\frac{480}{62.5}$

Specific gravity of oil fuel $\frac{66}{62.5}$

It will be noticed that specific gravity and specific density Are represented by the same numbers, but it must be clearly understood that gravity refers to weight, and density to quantity of matter. In engineering practice the correct working of several appliances is dependent upon the proper densities of the liquids. Thus for water in boilers the correct density is zero; the standard of pure water; the brine in working evaporates 28, and the brine is refrigerating circuit 1.25; good oil should be about .9 or .92. For determining these densities, hydrometers are used. The construction is practically the same for all kinds, each having a floating bulb, weighted at the bottom, so that it floats in a vertical position, and a graduated stem. Some are made of glass and some of brass. The brass or common hydrometer has a stem graduated on both sides, the stem being flattened along its length. One side is marked for 200 deg F and the other side for 100 deg F. These definite temperatures are fixed as being the most suitable, and when testing a liquid it must be at the temperature marked on the hydrometer, as if the liquid is hotter or colder it is less or more dense than the graduations indicated. The graduations on the 200° side read to 40 and those on the 100° side to 30.

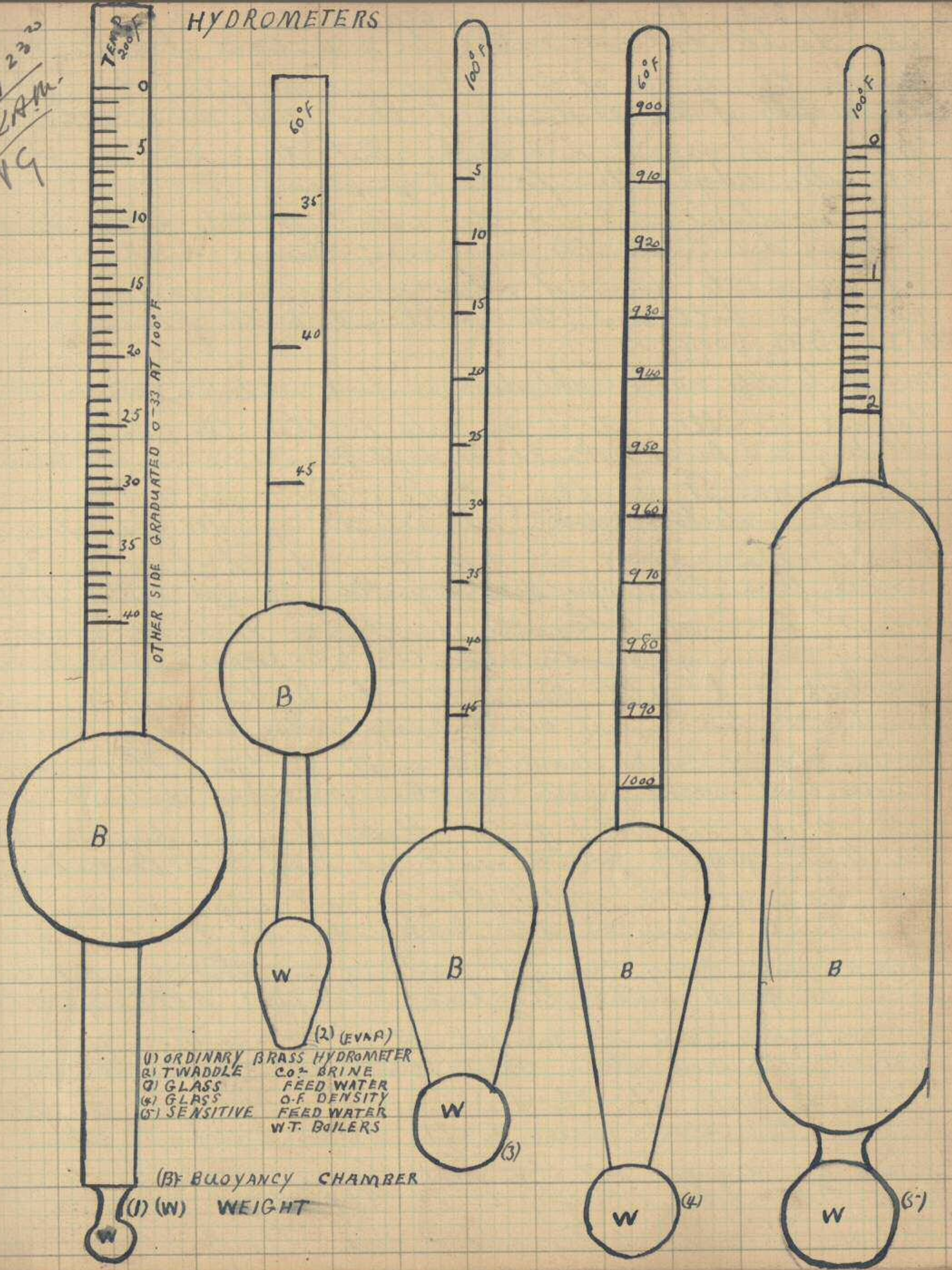
THE SENSITIVE HYDROMETER

Is made of glass and graduated for two temperatures only 100°. As the name indicates, their is not a great range for which it can be used and so is used water only slightly dense. It reads from zero up to 2° and each of these deg. is subdivided into 10, so that very slight changes of density may be recorded. There are other forms of hydrometer in use. The Waddell is used for the calcium chloride solution used in a cooling circuit. And another form is the one supplied for testing the mixture of water and glycerine used in telemotor systems, but these are marked definitely for the special solutions and may not be used for any other liquids.

NOTE

Sea water contains 1/32 part of solid matter, so that hydrometers are often graduated to show densities of 0, 1/32 - 2/32 and so on. a density of 2/32 representing the presence of solid matter equal to twice that contained in sea water. The usual Naval hydrometer is graduated in deg. each degree representing the presence of 1/10 the solid matter in sea water. Ten deg; therefore represent the density of sea water, or 1/32 part of solid matter; zero will represent fresh water and 40° represents a density caused by the presence of four times the solid matter in sea water.

Aug 23rd
KAM
VG



DOUBLE BOTTOMS LECTURE XIV

The double bottoms extend for a distance of about three quarter the length of the ship, and are fitted to increase the safety of the ship. Some of these spaces are used for reserved feed tanks or oil fuel tanks, but it is necessary to specially adapt them for such purposes.

All compartments should be watertight. The outer double bottoms drain into the inner ones, through a sluice valve. The manhole doors of these spaces are screwed with nuts and bolts and the door hinged to the frame

WATERTIGHT DOORS

Owing to the watertight doors which slide in guides being tapered slightly, it is important that the guides and sliding surfaces should be kept clean. Care should also be taken against anything fouling the rack and pinion. ~~Hinged watertight doors~~ of screwed spindle gear, for closing these doors in case they should have to be worked from the upper deck or position. Hinged watertight doors must be regularly examined, to see that the rubber lining is in good order and that the dogs are properly set, washered and split pinned. All bunker doors and armoured shutters are to be kept closed except when actually required. When closing bunker doors, care must be taken that door guides and working parts are clean from any obstruction, When covers are fitted to the floors of upper bunkers they are to be properly jointed with red lead. W.T. Compartments and drainage. All watertight compartments are connected by sluice valves on the bulkheads. In the event of any compartment being damaged, nothing in that compartment is to be opened until the leak is stopped, although all compartments can be pumped out by connecting ups. Drain valves with non return valves underneath to prevent the return of water if the drain valve is left open, are fitted to drain the various places to the bilges underneath them, which are pumped out by means of main suction. Main Drain - This belongs chiefly to the older type of ships, and extends from the after end of each the forward boiler room to the forward end of each engine room. It is a pipe of about 15" Dia" Water from each boiler room bilge is admitted through a sluice valve and then a non return valve to this pipe where it is allowed to flow as far as the engine room bulkhead. At this point a sluice valve is fitted covering the end of the branch, but this fitting is on the bulkhead and not on the pipe. On each boiler room just over the main drain, a sluice valve is fitted. Similarly the engine room bilges are connected by a sluice valve on the mid line bulkhead. A sea connection is fitted for flushing and pumping through the main drain. In modern ships this is not fitted. The engine room bilges are D.B. under them can be pumped out by the fire and bilge pumps, or the main circulator, and the boiler rooms and D.B. under them are pumped out by seperate engines. Each main W.T. Compartment outside these spaces is fitted with a special motor driven pumps (See stoker manual page 79) Special portable electrically driven pumps are brought into the compartment for cases of great emergency. These are brought into the compartment and the pump lowered to hose connection using ups, and over ships side for discharge. Downton pumps for working by the ships side for discharge. Downton pumps for working by hand can be connected by hoses for flooded compartments, (See Sto- manual, page 150) Some small quantities of water in engine room, boiler room, and screw alley, are emptied through suction pipes led directly from the F. and bilge pumps to wells in the lowest part of those bilges. The fire and bilge and Downton suction connect with the main suction pipe running fore and aft of ship. Branches from this lead to each compartment in the hold, and D.B's S, D, N.R, V, and F.V. magazine are not connected to the main suction but reserve feed tanks and oil fuel tanks are not permantly connected to the main suction, to avoid accidental flooding. In each, a branch is fitted to the bottom with a S.D.N.R. and F.V. to be connected by hose to the main suction

SCREW DOWN NON RETURN & FLOODING VALVES   STD. MANUAL P/151

This only differs from the ordinary boiler stop valve in its action and construction. When full open, it is not a non return valve. An index on the spindle shows the position in relation to the valve spindle screwed down.

VALVE CLOSED

Spindle screwed half way. Button at bottom of spindle not lifting the valve hence water may pass from under the valve, but the valve will close if the water attempts to pass back. Spindle unscrewed full open. Valve open to water either way, that water may pass from tops to underneath.

PRESERVATION OF HULL

To prevent the plates of the hull from rusting on the insides, they should be painted with red oxide of iron or red lead. Zinc slabs are sometimes fitted low down in the bilge in metallic contact with frames and other parts of the structure.

TESTING AIR IN CONFINED SPACES FOR FOUL & EXPLOSIVE GASES   STD. M. 161

The air in confined spaces is apt to become impure. It may either be inert, will not support life or combustion or it may be explosive. This is due to bad or no ventilation. Consequently all such compartments must be tested before any attempt is made to enter them as well as allowing a certain time to elapse before entering to allow fresh air to circulate. Otherwise, serious or fatal accidents may occure. The tests applied are those of the safety lamp and not the naked light. It therefore, follows that the safety lamp must be the first tested

THE SAFETY LAMP

This consists of an oil reservoir fitted with a wick holder as in an ordinary lamp. A lamp glass made of stout glass and cylindrical in shape, the glass secured in place by a brass holder. Above the glass is a cylinder made of copper gauze wire, closed at the top. When the lamp is lighted and the glass and gauze secured in place, the flame is completely enclosed. In order to enable the lamp to burn, a small pipe through the oil reservoir supplies the air necessary for combustion. If the lamp is lowered into a space containing explosive gases, these gases will enter through the air supply pipe and the light wire will burn with a much longer flame, a small explosion will take place inside the lamp glass, thus showing the presence of explosive gases. The lamp should be immediately withdrawn and the space ventilated. The whole of the gas in the compartment does not explode because it has to be raised to its flash point before doing so and the temperature of the lamp flame is prevented from the heating of the surrounding gases by the copper gauze which conducts the heat away ~~of~~ gradually and gently as soon as it is formed. To test for gases a naked light is lowered into the compartment. If the light continues to burn, the air is good; if it burns with a long smoky flame, the air is poor and if it dies down and goes out, it proves the presence of gas which will not support combustion and consequently, life. Then the compartment must be thoroughly ventilated.

LECTURE XV   METALS FOR CONSTRUCTION

CAST IRON is the most useful of all metals used in construction following which come, wrought iron steel. copper., tin and various metals such as gun-metal, Bronze etc. Which are alloys of copper zinc and iron tin

Cast iron is obtained by fusing a mixture of iron ore and coke, (The province of the coke being to supply carbon in a blast furnace; and lime is added as a fuel to assist in fusing the metal and carbon. When the molten metal and carbon are fused, or combined, the mixture is run off from the furnace into sand moulds and allowed to cool. The result is pig iron. There are usually three kinds of pig iron, namely: grey mottled and white. Grey is the type of cast iron most generally used.

Cast Iron - Grey	Composition
Iron	90.24
Carbon Combined	1.02
Graphite	2.64
Silicon	3.06
Sulphur	1.14
Phosphorus	.93
Manganese	.83
	99.86

Total 99.86

When Cast iron is to be used for Casting, it has to be melted in a Cupola and alternate layers of coke and pig iron are mixed up with scrap iron and put into the Cupola which is heated from the bottom assisted by a strong air blast. Cast iron is noted for its brittle nature.

MALLEABLE CAST IRON

This is obtained by heating the Cast iron objects (after they have been Cleaned up) in a furnace of oxide of iron such as the scale from rolls. The oxide the oxide Combines with the Carbon in the Casting and Changes their Character until they resemble wrought iron. Malleable Cast iron is not so brittle as Cast iron

WROUGHHH IRON

This is the purest form of iron and is obtained from White pig iron by the process of puddling. The object of puddling is to entirely remove the graphite or uncombined Carbon and so reduce the Compound Carbon about 2.59%. Wrought iron is ductile but Cannot be tempered. The white pig iron is broken up and placed in a shallow furnace in close Contact with hammer scale, (oxide or iron) under the influence of a great heat, oxygen from the oxide Combines with the Carbon and silican in the pig iron. The residue is nearly pure iron and is worked into spongy masses by means of a puddle. These masses are called blooms. The blooms are then squeezed white hot under a steam hammer and formed into wrought iron bars. The hot iron forms a sticky mass when melted and therefore Cannot be cast but at a white heat, two pieces may be stuck or welded together

Composition of Puddling Bars

Iron	99.31
Carbon Combined	.30
Silican	.12
Sulphur	.13
Phosphorus	.14
TOTAL	100.00%

The division line between Cast iron and steel, and between steel and wrought iron is not very definite, but is usually based on a percentage of Carbon in the metal.

Cast iron Contains from — 2.2% to 5% Carbon

Cast steel Contains from — .25% to 1.7% of Carbon

Wrought iron Contains from — .25% to 1% of Carbon

STEEL

Is wrought iron with a Certain amount of Carbon added.

MILD-STEEL Contains about .1% to 2% of Carbon

TUNGSTEN

Is one of the rare metals. Sometime added to steel for making it very hard. It is also used for making filaments of electric globes

CHROME-STEEL

Is used for certain working parts of Diesel Engines and for high speed work generally.

CEMENTATION PROCESS OF MAKING STEEL

Bars of wrought iron are placed in the fireclay boxes and Charcoal dust is placed in the boxes so as to surround the iron. The boxes are then Closed up with the fireclay and subjected to a great heat in a furnace; a fortnight being required for the more highly Carbonized Steels. The steel may afterwards be hammered or rolled into shape or it may be cast after melting in a Crucible.

BESSEMER PROCESS

Melting Cast iron is poured into a covered Converter (Which is a steel ~~vat~~ vessel with a fireproof lining and air blown through the iron. The oxygen of the air Combines with the Carbon and silican and pure iron is left. The proper Amount of Carbon is Then obtained by stopping the blast and adding a special Cast iron Called Spiegleisen which Contains a known percentage of Carbon manganese The blast is then turned on again for a short time to ensure. ~~Steel~~ Steel run into moulds to form ingots.

SIEMENS MARTIN PROCESS

This is carried out in a regenerative furnace. The furnace itself is very similar to a puddling furnace, but beneath it are four chambers in which a number of fireclay bricks are fitted to form a grating.
Coal gas and air are admited through two right hand chambers and are ignited in the furnace. The heat of the flame melts iron, and an equal amount of wrought iron and steel scrap. (Each equal to the original charge of Cast iron) is added, so that eventually there is in the furnace three times as much steel as there was (Steel) in the first Charge
A little Spiegeleisen is also added. The flames and hot gases after leaving the furnace pass through the two left hand chambers and give up part of their heat to the bricks
When the bricks in the left hand chambers are white hot the direction of the flow is reversed, and the gas and air made to enter from the left. The heat stored up in the hot bricks is now given up to the entering gases and the waste heat from the furnace is stored up in the right hand side. To remove the blow holes. Whitworth introduced a hydraulic press in which the molten steel was compressed in the ~~ingnot~~ ingot mould and the gas escaped through the porous sides of the moulds

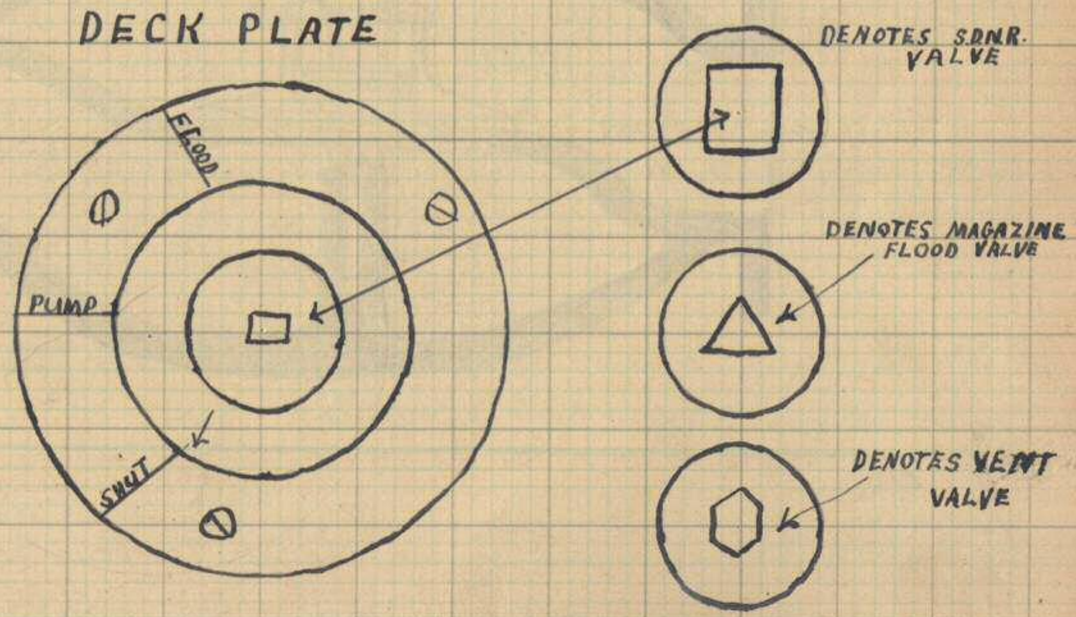
INSTANCES OF SHRINKING ON

Fork ends of small connecting rods have gudgeon pins shrunk on
Stern shafting is covered with gun metal sleeves which are shrunk on. The sleeve is first bored out slightly smaller than the shaft i.e. .0015 of the Dia. or .030" to the ft, then it is heated and slipped quickly over the shaft while it is hot. It is then cooled, and the consequent shrinking, tightly embraces the shaft.
The flanges of some wheels and tires are shrunk on.
Collars and arms and flanges are sometimes shrunk on to the shaft and spindles

EXPANSION OF METALS

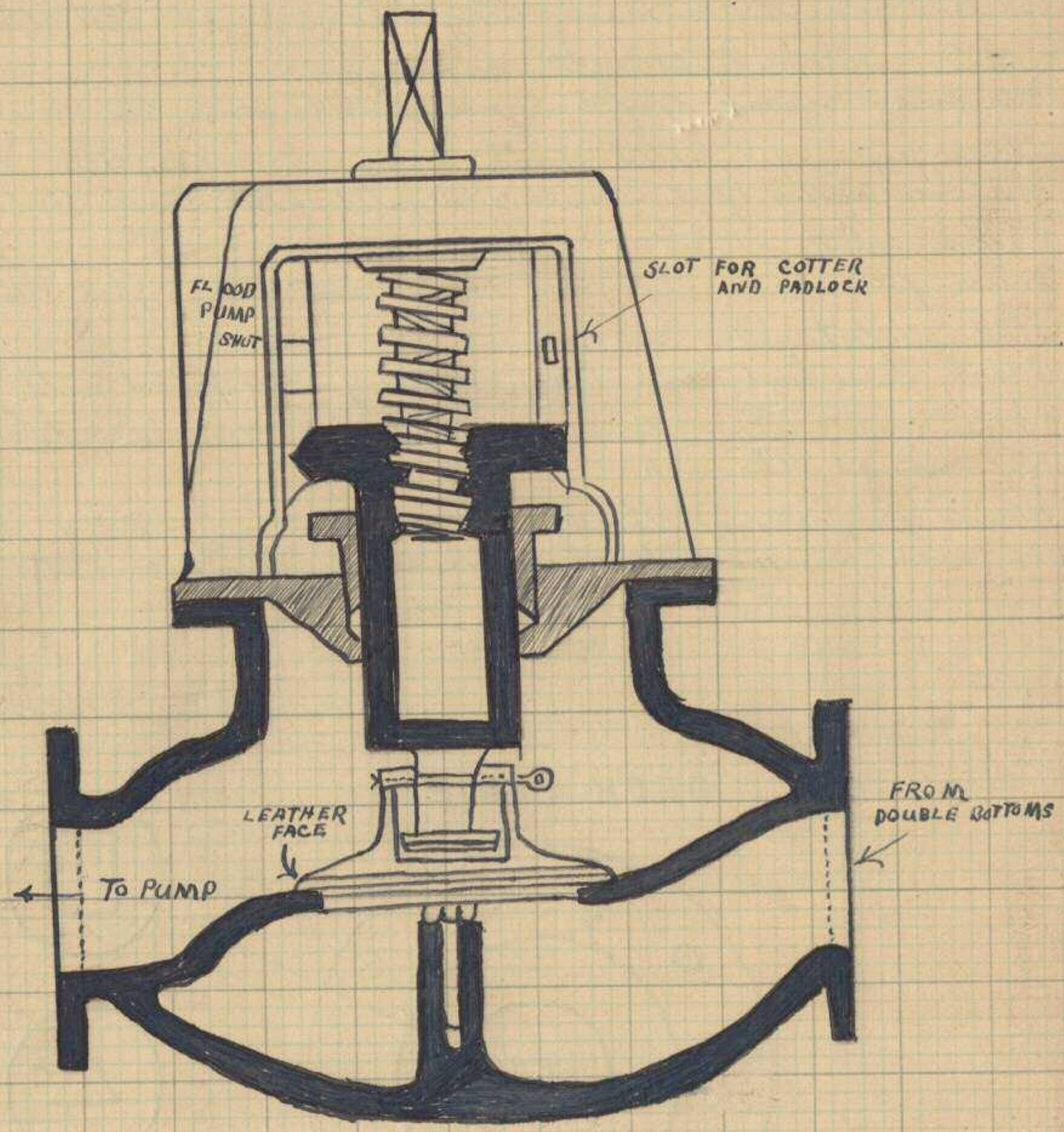
(1) Metals expand when heated, and there are many instances in Marine Engineering where allowance has to be made for this

(1) Funnels have adjustable guys
(2) Boiler Casings are made very elastic so that they may remain water tight after expansion.
(3) Fire bars are made to fit loosely between the bearer bars
(4) Steam pipes are fitted with expansion glands.
(5) Turbine Casing feet have elongated holes, and these feet are called sliding feet
(6) Boiler feet have elongated holes, and these feet are called sliding feet
(7) Crank, cross head, and main bearings are fitted with plentiful clearance to allow for cylinder movement when the engines are warmed through
Main Engines of the large reciprocating type have each as much as 3/16" side clearance when they are hot.



SCREW DOWN NON RETURN

AND FLOODING VALVE



GUNMETAL LECTURE XVI

This is an alloy of copper and tin. Soft gunmetal consists of 90% copper and 10% tin. Hard gunmetal consists of 82% copper and 18% tin. Zinc is often added to make it more malleable in the ratio of 84.25% 10.5% and 5.25% zinc.

Brass is alloy of copper

White metal 84 to 90% copper 3 to 8% antimony 1 to 8%

Naval brass. copper 62% zinc 37% tin 1%

EFFECT OF HEAT ON MATERIALS

Melting point temperatures

Cast iron	2100 F.	wrought iron	3000 F.
Steel	2700 F.	Copper	1966 F.
Gunmetal	1900 F.	Brass	1700 F.
Zinc	773 F.	tin	442 F.

Metals expand on heating and contract on cooling. The metal on expanding and contracting exerts so much force as to fracture some parts if the movement is restricted. The alteration of volume under different temperatures has to be especially considered by pattern makers and moulders and the designers of machinery. The pattern makers must make his pattern larger the following are the usual allowances made.

Cast steel	1/8" per ft.	Steel	3/16" per ft
Brass	3/16 " "	malleable cast	
Gunmetal	1/16 " "	Iron	3/16 per ft.

In the pattern shop construction rules are used. They are longer than the ordinary rules by the above dimensions. From the moulder's point of view two evils due to contraction are:

(1) Cracking or breaking of castings

(2) Warping due to uneven casting.

When the casting cools the particles of metal next to the surface tend to set themselves at right angles, as a result there is tendency to crack at a sharp corner of casting. This is avoided by the use of pellets, and for large castings which are to stand heavy pressures the pellets should be of large radius. To prevent warping great care must be taken to allow the casting to cool evenly. The heaviest part of the casting where there is most metal takes the longest time to cool and be uncovered in the mould first. When one part of any object whether it is a casting or not cools before the remainder it will put the part which is hot into compression and the object when cool, will be found to be bent convex to the side first cooled. Similarly, the tool smith, when he is hardening or tempering a tool, must always plunge it quickly into water and move it about so that it shall not be unevenly cooled. Want of care will warp or crack a tool when working with carbonizes steel care must be taken not to work on it at a temp. higher than cherry red (1650F) for at that temperature it is likely to be short.

With mild steel plate there is a tendency at the critical temp. (1570) corresponding to blue heat for the metal to be (hot short).

Moulding: before any article can be cast, a suitable mould is prepared from a pattern of the job.

(1) Green sand: Contains 85% to 90% silica, the result being clay and mangenesia, to make the sand bind well. For foundry work it is mixed with coal and charcoal dust and damped.

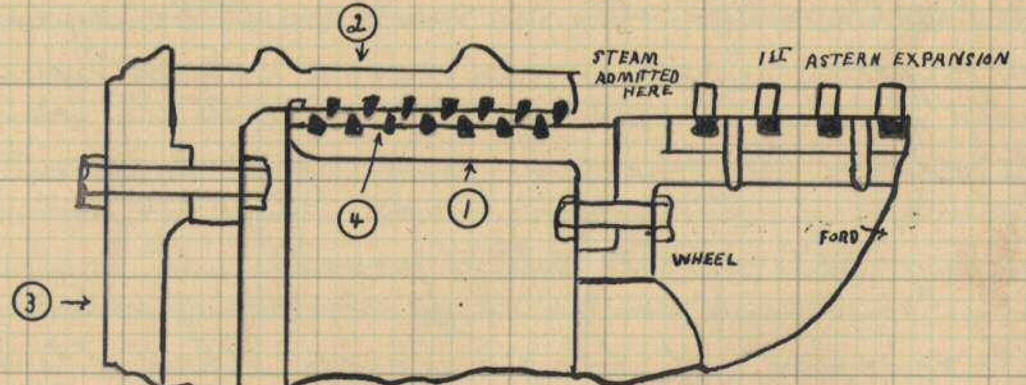
(2) Dry sand: is a mixture of old loam and rock sand. It is called dry sand because the mould is baked before the metal is run into it. It forms a firmer mould, does not alter its shape when the metal is poured into it, and produces firm clean castings.

(3) Loam: is a mixture of clay and rock sand, powdered charcoal, cows hair and chaff etc. Loam moulding is usually done without a pattern, a sweeping board being used to true the surfaces up which is afterwards baked and blackened with a mixture of coke, charcoal and water.

PARTING SAND: Is a dry powdered blast furnace cinder or brick dust, a thin layer of which is used to prevent the two halves of the mould from sticking together, the moulds for small articles are made in two moulding boxes, half the pattern being in each box. The pattern is half buried in the bottom box and the sand is rammed down hard around it. The surface is then sprinkled with parting sand and the top box is placed on the lower one and held in position by dowel pins. The top box is now filled with sand and rammed up tight, a hole being left in which the metal can be poured. A vent is made to allow the air to escape. These holes pierce the sand but do not touch the mould, they are made to allow steam from the damp sand to escape. The top box is now removed and also the pattern from the bottom box. The surface of the mould is then cleaned, repaired and coated with black lead.

When casting a pipe, cylinder or any hollow object it is necessary to use also a core made of dry sand or loam. This core is made either by ramming sand into a core box or by shaping the loam with a sweeping board. A pattern of the hollow articles to be cast is supplied with projections or points which leave an impression in the sand in which the core can be placed. When the core is a long one. It is supported by pieces of metal fitted between the core and the mould called chaplets which are burnt in the casting, or the core is shaped around the iron tube as a foundation.

Moulds of large regular shaped objects, such as cylinders are usually made in a pit in the foundry floor and are built up with brick work covered with loam, the whole being trued up with a sweeping board.



ASTERN TYPE OF DUMMY (RADIAL)
(1) ROTOR DUMMY (3) END OF CASING
(2) CASING " (4) RADIAL FIN RINGS

TURBINES

The most important engine used for propeling purposes in the R.N. is the turbine. This is a rotary engine in which a rotating motion is produced in the shaft by the direct action of the steam. Without such intermediate factors as piston rods, connecting rods and crank shafts. The turbine is of early origin as early as 130 B.C. Hero described a form of turbine in which the steam pressure inside a globe caused rotation by the action of the pressure upon bent nozzles. Water wheels and wind mills are a form of turbine in each case the pressure of the water on the buckets or blades, or the pressure of the wind upon inclined vanes of the wind mill causing rotating, which motion is transmitted through shafting to work the interior mechanism. The steam turbines however were not a sucess until De Laval a french engineer invented one in which a wheel carrying a number of curved blades or buckets was mounted on a spindle and carried in bearings. This wheel was then enclosed in a casing, which carried a series of nozzles, which directed the steam on to the blades. The nozzles were so constructed to allow for expansion causing a high velocity in the steam. This steam in striking the blades, by the direct impulse against the blades caused the wheel to rotate and a very high speed was obtained. This principle is still used with modification in modern turbo dynamos.

For propeling purposes, however, a slower speed and greater power is necessary. This lead to the invention of the parsons turbine. The great speed consquent upon the expansion of the steam in one stage is reduced by dividing the total fall of pressure into several stages, using in succession a large number of blades, each series or "expansion" of blades larger than the one before, and so keeping the speed within reasonable limits, and increasing the power which may be transmitted. The steam is first lead to an annular space, the circumference of the turbine. It then passes through a row of fixed blades with a high velocity, strikes the first row of moving blades, then traverses the curved surface of the blades, leaving them with an equal velocity in the opposite direction. The moving blades are therefore driven partly by impulse and partly by reaction or the force of the "take off".

The turbine proper consists of two main parts, the casing or cylinder and the rotor. The rotor consists of a round steel drum forged an ingot, into each end of which are "shrunk" steel wheels. Through the centres of these wheels are fitted spindles which form the bearings shaft of the turbine. The wheels are shrunk on the spindles and pinned with screwed pins or round driving pins half in the shaft and half in the wheel, the driving pins being prevented from coming out by a large plate covering the ends and secured by a nut or a set bolt onto the spindle. The rotor is then shrunk on the shaft and secured by a number of countersunk screwed rivetted pins. The spindles and rotor are then turned in a lathe and at given distances on the rotor groves are cut into which brass blades are fitted and kept in place by packing pieces which are caulked in place by special tools. The casing is a cast iron cylinder made in halves turned on the inside and of increasing Dia. at distances from the initial steam end to accomodate larger blades as the steam expands.

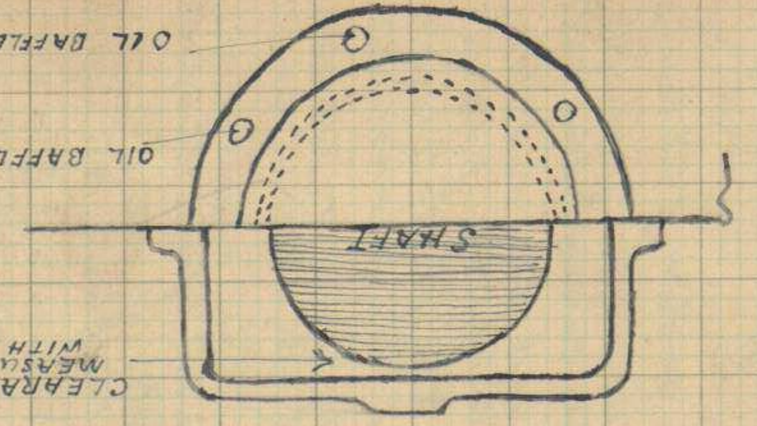
Grooves are cut in the casing and the blades fitted as in the rotor. Just when the whole is assembled the steam passes through fixed blades to another row of moving blades and so on through the turbine, the increases in blade dimensions being called "expansions" consisting of from four to six rows of fixed and moving blades. The exhaust after leaving the last row of moving blades passes to either a low pressure turbine or to the condenser through the reduction pipe. Turbines which are used for ahead movement cannot be reversed so that

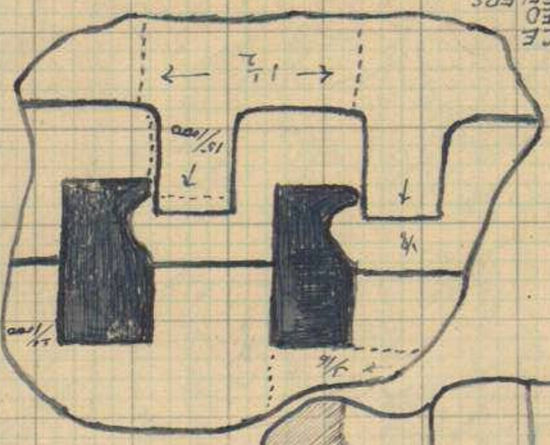
Another turbine has to be fitted with the blades at the opposite angle so that they will rotate in the opposite angle so that they will rotate in the opposite angle direction. An H.P. astern turbine is a seperate one fixed to the shaft but an L.P. or where only one astern turbine is fitted, the unit is fitted in the L.P. ahead casing at the exhaust end so that both exhausts are led into a common eduction pipe to the condenser.
To prevent steam escaping to the exhaust side of the rotor a dummy piston is fitted to the initial steam ends of the turbine, rotor.
Along the length of the piston are cut grooves of square and also in the dummy cylinder which is fitted in the casing over the piston.
Brass strips are fitted into these groves and are so constructed that the escape of steam from the steam side is lessened as it passed each succeeding strips and groove so that the ultimate escape is practicaly nil. The clearance between the edges of this packing and the faces of these grooves is to be not more than 30-1000. This form of packing is known as "facial" or contact type. Thus there are three uses of the dummy piston.
(1) prevent steam escaping to the hollow centre of the rotor to exhaust.
(2) Keeps initial steam pressure of the glands.
(3) The exposed portion of the rotor owing to the small Dia. of the dummy piston helps to balance the thrust of the propeller.
Where an astern turbine is fitted in the same casing, a different ~~rotor~~ form of dummy packing must be used as owing to the expansion of the rotor and the fact that the rotor is held in position at the fore and by the thrust block, allowance must be made for the rotor to expand in an after direction. The packing used is known as the ~~rings~~ radial or "fins" type. In bathe the dummy piston and cylinder, brass rings or fins are caulked so the alternatly there is a piston fin then a cylinder fin throughout the length of the piston, the clearance in each case being not more than 30,1000. The steam which escapes is wire drawn as it passes each succeeding fin and so a similar result is obtained as with the "facial" type.

PARSONS STEAM GLAND
is a gland fitted around the shaft at the junction of the casing with the shafts. It consists of a cast iron casing carrying a steel sleeve, the inner sleeve and the corresponding part of the shaft carrying a number of radial fins and the outer sleeve being planed and carrying a number of rams.
Bottom rings let into grooves out in the shaft. These rings are in halves and when placed in the grooves retain sufficient spring to keep them tightly against the walls of the sleeve.
Between the inner and outer sleeve is an annular space or pocket; steam can be led into or drained from this pocket so that under working conditions a feather of steam is seen issueing from the hood or outer end of the gland. An improperly packed gland is the chief cause of poor vacuum.

THRUST AND ADJUSTING BLOCK
This is fitted on the front end of the turbine. Collars are formed on the enlarged end of the shaft and thrust block is in two halves, the bottom half takes the unbalanced thrust ahead and the top half the similar astern thrust, 8 to 10 thow. for and aft clearance being allowed for efficient lubrication this block also preserves the dummy clearances. It is adjusted by semi circular brass strips, which are easily removed, thicker or thinner ones being inserted as required.

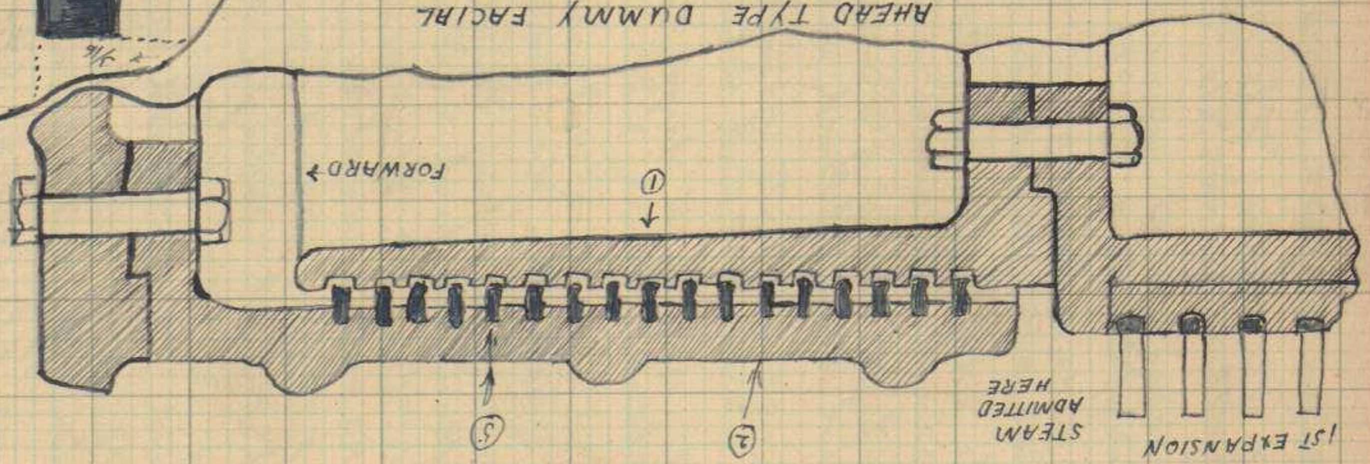
MICROMETER GAUGE
Is an instrument for determining the position of the rotor in a fore and aft position, so that the dummy clearances may be found. It consists of a long spindle passing through the casing front. The end is cut half way across and normally it rests against the stop



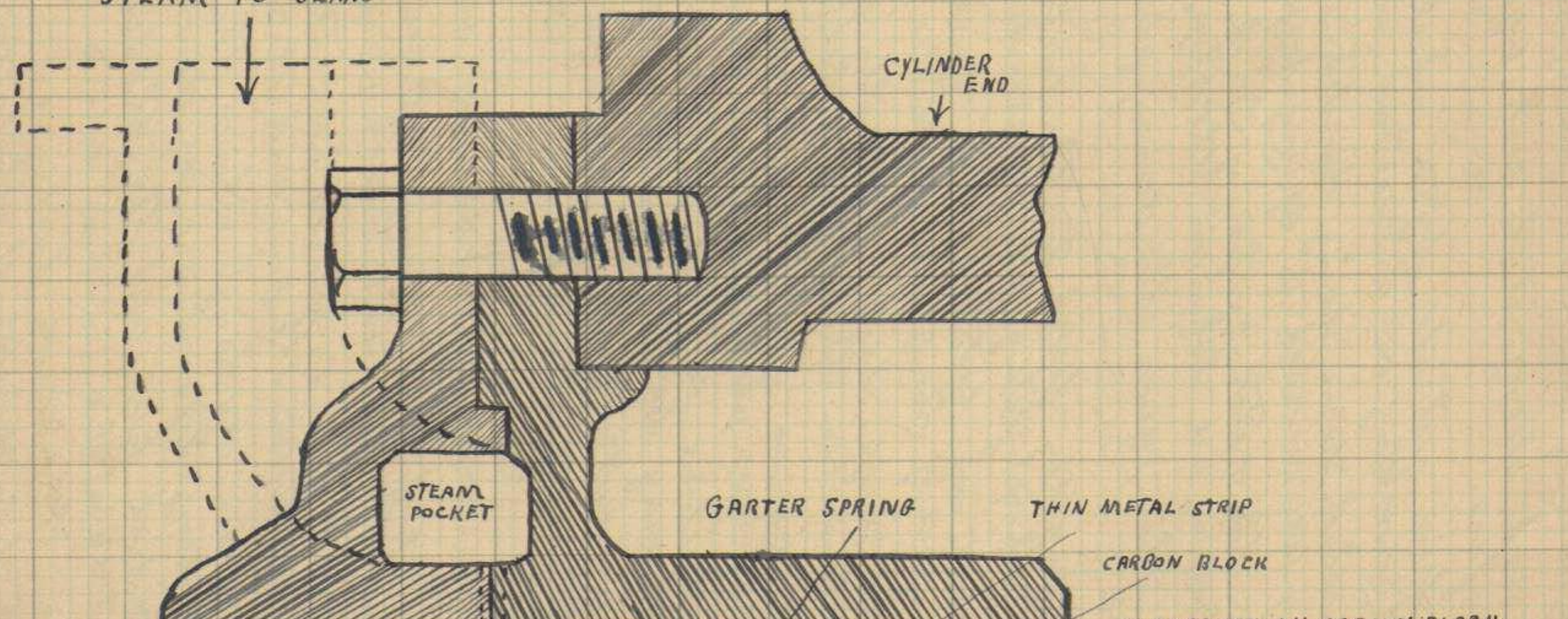


BRIDGE GAUGE BEDDED IN CASING

AHEAD TYPE DUMMY FACIAL
(1) ROTOR DUMMY (3) WHEEL DRUM
(2) CASING " (4) ROTOR "
(5) UNDERCUT BRASS RINGS



BROWN CURTIS TURBINE GLAND



on the Casing but a half turn on the spindle frees it of this stop and allows it to rest against the dummy piston surface.
It is actuated from outside by a wheel ~~rim being divided into a 100~~ working on a screwed sleeve 10 threads to the inch the wheel rim being divided into a 100 division. Thus they are recorded. A spring keeps the spindle up to the stop or the rotor. Comparing each reading taken with the previous one taken on the stop, i.e. the difference between them, gives the dummy packing clearance.

FINGER PLATE GAUGE

Is a steel plate rigidly fixed to the turbine casing at the fore end and projecting into a groove cut in the shaft. The clearance ~~in~~ between the face side of the plate and the face of the groove indicates the dummy clearance, the plate gauge being originally fixed to touch the face of the groove when the dummy packing rings were touching the grooves in the piston.
All micrometer and finger plate gauge reading should be taken when the turbine is thoroughly warmed through. Micrometer readings may be taken either when at rest or when running, but the finger plate gaude only when the turbine is stationery

BRIDGE GAUGES

These are the gauges which fit over the various journals when the top halves of the bearings are been removed. They fit in a special slot with dowel pins kept rigidly in place and a faced pin is placed over the shaft. Feelers are placed between the pin and the shaft and differences in previous readings show the wear of the shaft in the bearing. Excessive wear down endangers the tip of the radial fins and the blades

BROWN CURTIS TURBINES

These differ from the parson turbines in that the rotor is made up of a number of wheels on one shaft each in its own steam tight compartment, and each wheel larger than the previous the shaft which is hollow being increased in size to the larger wheels. These wheels are shrunk on the shaft.
The steam passes through a number of nozzles to the blades carried on the first wheel. Here the energy is expanded and the wheel is rotated by impulse. This steam then passes through another series of nozzles to the next wheel, and so on through the stages. Between the wheels diaphrams are fitted to keep each wheel stage steam tight the diaphrams being recessed into the casing and being made steam tight over the wheel hubs by gun metal sleeves with V shape grooves cut in them. Nozzles are mounted at the edge of the diaphram and expand and direct the steam onto blades in the wheels. The blading is purely of the impulse type allowing for no expansion of the steam. All Expansion takes place in the nozzles.
As there is no drop in pressure in each stage only when passing through the nozzles the blades tips clearance may be fairly large. No dummy pistons are fitted, and as the initial steam pressure comes on the glands as special type is fitted. In this type there is an inner and outer sleeve contained in the casing with the pocket between which can be steam packed or drained off as required. Recesses are cut in the sleeve into which fit carbon rings in segements restrained from turning by brass strips and bound on the shaft by garter springs. The wear of the segiments is permitted by clearance at the ends of the segiments. Unbalanced thrusts are taken by a thrust block fitted at the fore end of the shaft.
With Brown-Curtis turbines fine adjustments and tip clearances are not required, thus minimising the possibility of stripping and fouling. It is however a much weightier installation than a parsons. Experience has shown that the most efficient turbine is one which can be run at high speed 2000 to 3000 revs per minute.
Propellers to be efficient, to cut down slip and to prevent cavitation may not be run at a greater speed than 450 revs. Therefore gearing is necessary to connect turbine

With the propeller shaft. A thrust block is fitted to take the thrust of the propeller of the gearing, and the type of thrust block, has been introduced on account of the difficulty of lubrication of the multi-collar type. The thrust is taken by one of two sets of pads or Kidney pieces, which bear against the fore or after face of the collar. In back of each pad is a rounded pin which acts as a swivel pin, which bears against a steel face let into a gunmetal block fitted in halves around the shaft. A steel ring bears against the back of this gun metal block, the surface of which is curved.

A liner between the steel ring and a recess in the casting keeps the pads up to the surface of the collar, and clearance for lubrication between collar and pads may be adjusted by altering the thickness of this liner. In working the friction between the faces of the collars and pads causes each pad to tilt on its swivel pin, and so causes a wedge shaped opening for the introduction of oil which is supplied to the block at a pressure from the forced lubrication system plumer blocks support the weight of the shaft fore and aft of the block

SLIDING FEET

Allow for expansion of turbine casing rest on feet fixed to the framings on the other end is allowed to slide along in a form of slipper. An indicator is mounted between the slipper and the feet to indicate the exact amount of expansion

(DRAINS) All drains from the various stages and steam end of casing run into a common well fitted at the exhaust end of the casing. This is connected to a wet air pump and so pump dry. When running all drains into the well are kept shut, only the air pump suction being open. A high vacuum is absolutely necessary for the efficient running of the turbine and all causes of loss of vacuum should be investigated and removed if possible

A good vaccum is between 27" and 30". A turbine installation is lubricated by a forced lubrication system. Oil is pumped from a drain or settling tank through filters and coolers and by a system of pipes to each bearing. The main bearings and thrust blocks, are supplied by a seperate system from that which supplies the plumer blocks, in large ships so that in the even of flooding of compartments aft in which the plumer blocks are situated, the oil supplies may be shut off without endangering the turbine bearings.

Seperate pumps also supply oil to the gearing, but a bye-pass valve is fitted in supply oil from the main ~~steam~~ system is necessary. Each system is fitted in duplicate. The oil which is used in the bearings then drains away into the sumps or well in the casting of the bearing thence back to the settling tank from where it is used again. The pressure at which the oil is supplied to the bearings should be from 8 to 10 lbs sq. inch.

HORSE POWER:- This is the measure of the work done in an engine in a recip. The work done on a piston in a cylinder can be calculated from a diagram and the formula used is.

$$\text{I.H.P.} \quad \frac{2\,P.L.A.N.}{33000}$$

Where P. means average pressure in lbs sq. in.

L Length of stroke in ft.

A Area of the piston in sq. inch

N Number of revs. per minute

(NOTE) 2N represents the number of power strokes per minute.

The total work done in the several cylinders is added together and is then termed the I.H.P. of the engine. This does not allow for losses by friction in cross heads, crankshafts, thrust blocks etc. So that the I.H.P. is always more than the actual power transmitted through the shaft to the propeller.

With a turbine, however the only means of obtaining the horse power developed is by what is known as a torsiemeter, fixed on the shaft aft of the turbine or any gearing that there may be, as it is not possible to calculate the work done by the steam on the blades. When force is exerted on the shaft at one end and the shaft is held at the other end, a certain amount of twist takes place. Therefore when the turbine turns the shaft, the force on the propeller blades causes a twist to take place as the shaft revolves. Thus the higher the power transmitted the greater the twist of the shaft this twist is known as the torque.

The Hopkinsonthring torsienmeter is the usual type fitted in ships of the R.N. and consists of a sleeve on the shaft about three ft long. One end is fixed to the shaft and the other end is attached to a small mirror fitted diametrically opposite to another mirror fitted to a flange at this position. The first mirror mentioned is held on this flange by a swivel joint and in consequence any movement of the sleeve caused by torque will move this mirror and deflect the light which is shone on it from above on to a graduated scale, the reflections from the stationery mirror giving the position of the nought. By multiplying the number given on the graduated scale (0) by the shaft content (K) which is found by the makers when the shaft is made at the works, and the number of revs per minute (N), gives the shaft horsepower developed.

K. O. N. S. HP.

WARMING THROUGH TURBINES.

Steam pipes are led both from the auxillary steam and from the closed exhaust system to the front and after ends of the turbine for heating steam with which to warm through. The steam used passes through the turbine and heats up the casing and rotor uniformily, then passing to exhaust. The sliding feet indicate when the turbine has expanded to its maximum amount. A vacuum of about five inches should be kept to allow the steam to pass freely through but so as not to draw cold air through the glands.

Forced lubrication pumps should be running when the engines are warm and the steam pipes kept well drained to prevent a rush of water to the turbine, which is liable to strip the blades. Turning gear should be disconnected before warming through. All bearings should be examined for oil pressure by the small cock on the top of each which when opened, shows the presence of oil or an air pocket, and by the gauges fitted to each to indicate the pressure, which should be kept at 8-10 lbs per sq inch.

Theremometers are fitted to all bearings so that the temperature of each may be taken and checked regularly and often when running. A bearing should never be allowed to rise above 155° to 160° in temperature, as white metal begins to becomes plastic at temperatures exceeding this.

TURBINE MAIN BEARING

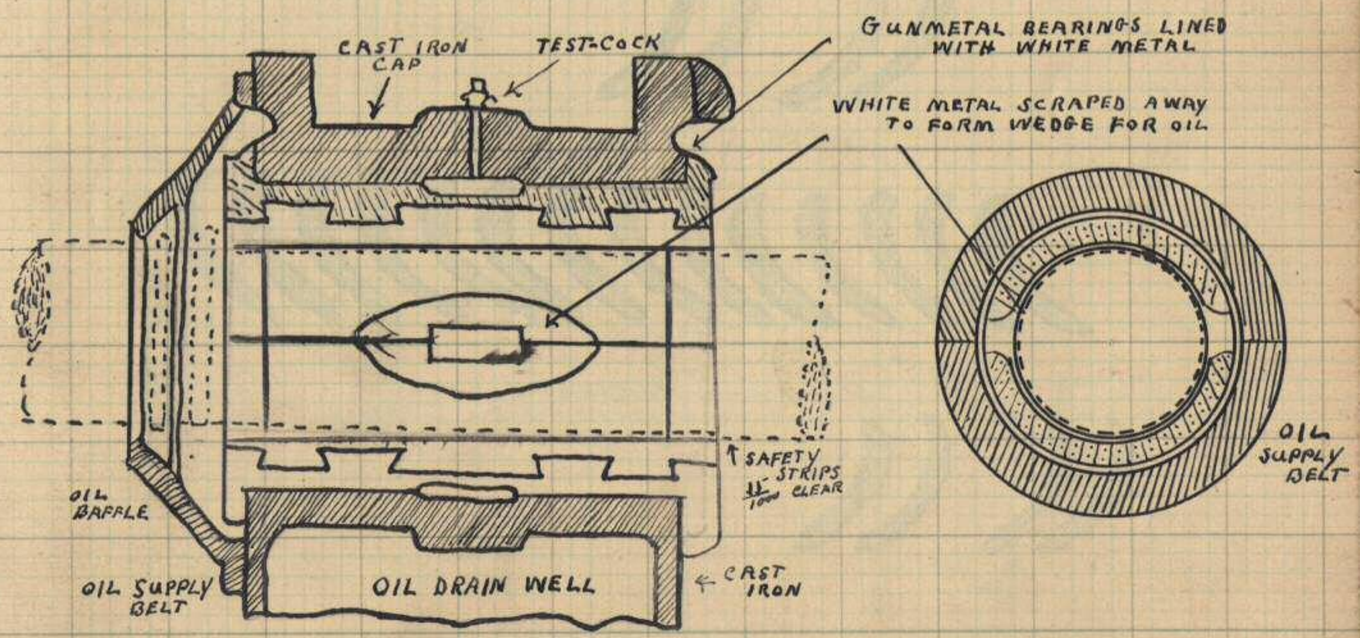
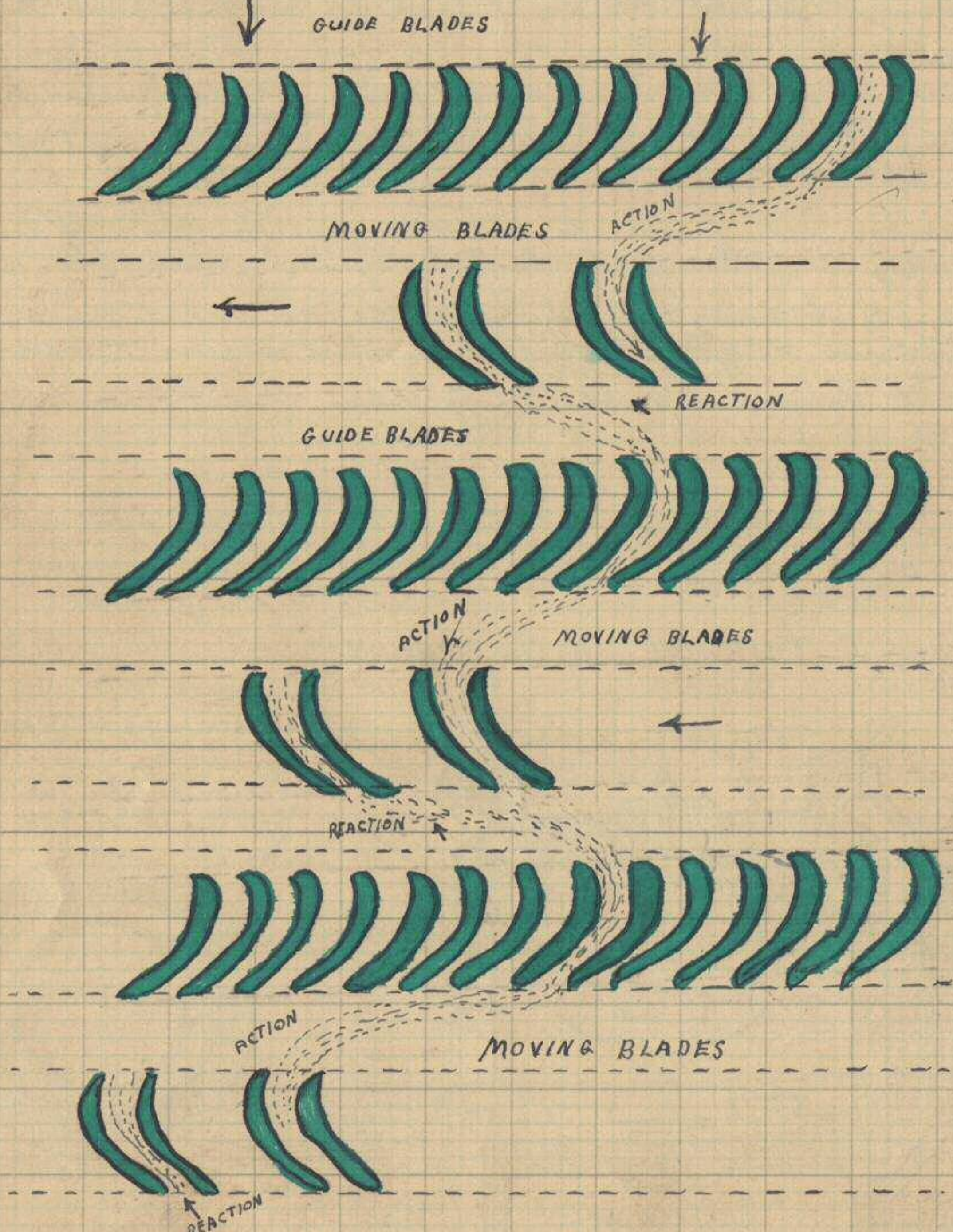


DIAGRAM SHOWING ACTION AND REACTION OF STEAM ON BLADES



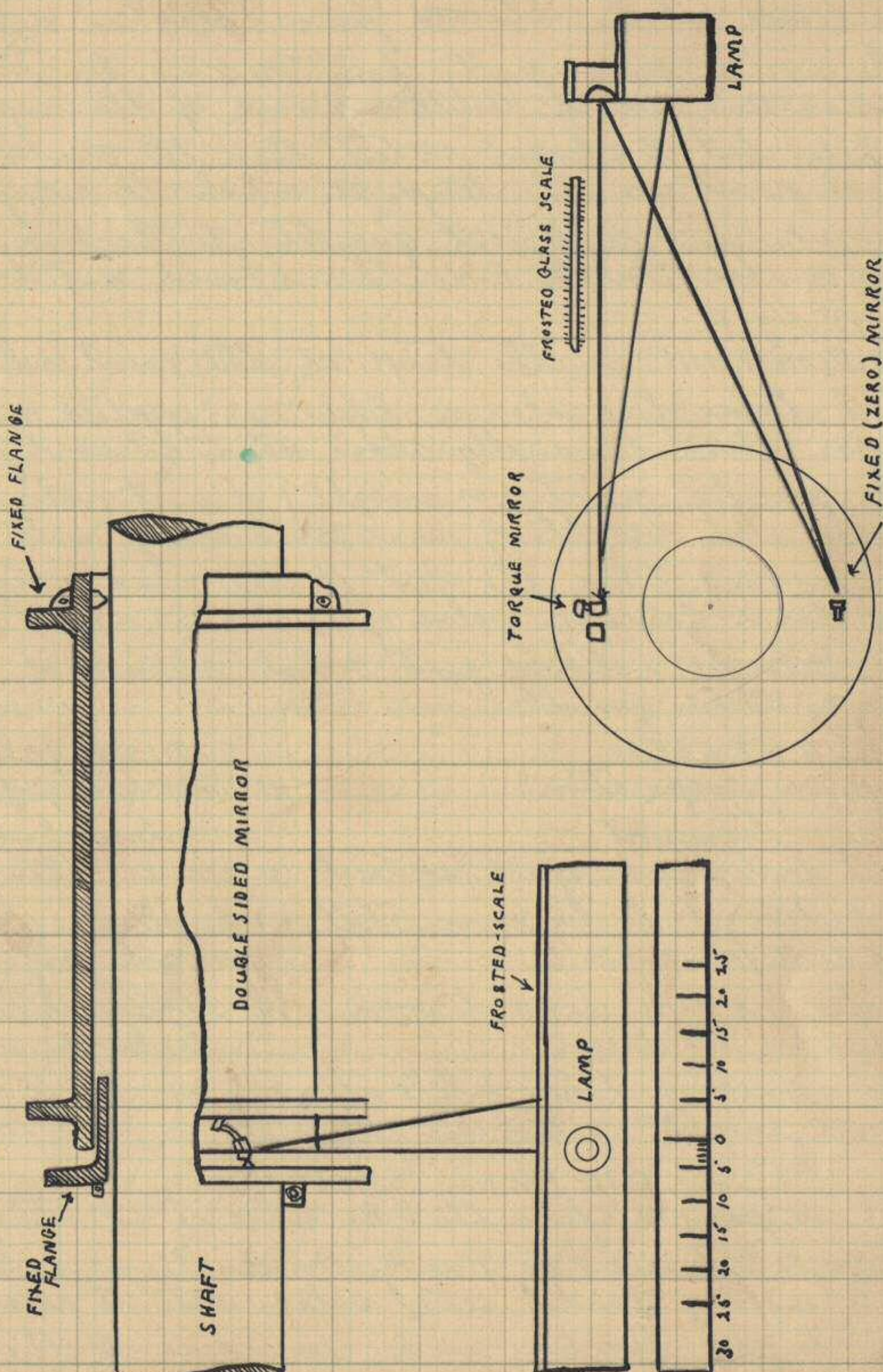
$S.H.P. = K.O.N. = \frac{K \times O \times N}{33000}$

K = CONSTANT OF SHAFT

O = TORQUE READING ON TORSION METER

N = NO OF REVS PER MINUTE

HOPKINSON THRING TORSION METER



OIL FUEL LECTURE XIX

Oil fuel used in the R.N. is the residue after the crude oil has been distilled to produce lighter oils.
The crude oil is obtained from wells in different parts of the world, principally from Mexico, Burma, Rumania Texas and Persia. Another source of the supply is from shale, but to lesser extent than the crude petroleum.
Flash point is the temp. at which the oil fuel gives off vapour in sufficient quantity to become momentarily inflamable. In the R.N. this should not be less than 175 deg. F
IGNITION-POINT is the temp. at the point which the oil fuel takes fire when a light is applied and continues to burn this is usually about 40° to 50° above flash point.
The specific gravity (or weight) of unit volume compared with unit weight of same volume of water is about 95.
It gives 1.4 times the heat of the same weight of coal, and has a Calorific value of 19.500 B.T.U.S. per lb.; while the Calorific value of good Welsh steam coal is only 14,500 B.T.U.S. per lb

ADVANTAGES	DISADVANTAGES
(1) Superior evaporation	(1) uncertainty of obtaining replenishments
(2) Easy transport	
(3) Less boiler room space required	(2) Dearer than Coal
(4) Reduction of boiler room staff	(3) Complicates boiler room machinery
(5) No dust or ashes	
(6) Safe no fire doors to open	(4) additional risk from leakage
(7) No fires to clean	
(8) No sweeping tubes while steaming	(5) Increases weight of same
(9) more complete control of steam	

OIL FUEL SYSTEM

Oil is pumped from the D.B. where it is stored, sucked through strainers to pump. On discharge side of pumps is a spring loaded relief valve set to pressure from 30 to 150 lbs. sq. inch. According to the pressures required. If 100 lbs. pressure is required for working S.L. valve is set to this, then if pump exceeds 100 lbs. The S.L. valve lifts, and allows exess of oil to escape back to the pump suction. On the discharge side of the pumps is an air vessel through which the oil passes to the cold filters and then to the heaters, where its temp. is raised to about 200°F. From here it passes through the hot filters to the distributing box at the side of the boiler. This box contains a number of valves corresponding to the number of sprayers on the boilers. A theremometer on the top of the box registers the temp. of the oil as it passes from the valve to the sprayer at the mouth of the air cone. The oil is atomised in the sprayer and discharged through small tangential holes into the furnace of the boiler in the form of a hollow cone of fine spray ~~with a whirling motion~~. It mixes with the air from the slats in the cone and is ready for combustion in the furnace. The correct proportion of air to oil is obtained when a light can be seen at back of boilers through the uptake window reflected upon mirrors fitted.

SMOKE-POINT is obtained when the slightest trace of black smoke can be seen in the uptake, any decrease of air supply causing black smoke and an increase produces a clear uptake. By further increasing the air supply white smoke is produced.

COLD-AND-HOT-FILTERS

These are identical in size and shape and the same mesh steel wire gauze is used in each. The body of the filter is made of steel and contains two perforated cylinders, one inside the other, with the steel wire wrapped around them of 32 and 24 mesh respectively on the inner and outer cyld.
These filters are fitted in pairs with valves on each so that one filter can be cleaned while the other one is in use. Pressure gauges are fitted on the inlet and outlet to indicate a choke. Hot filters are necessary to remove the carbon that forms in the oil after heating that might otherwise choke the sprayers

HEATER OIL FUEL

This is necessary to reduce the viscosity of the oil so that it can be easily atomised or broken up into very fine particles by the sprayer. Also by raising the temperature produces more ready ignition of the oil when it leaves the sprayer. The heater is similar in construction to the condenser.

It is made of rolled steel with seamless steel tubes rolled into the tube plates. The oil circulates through the tubes and steam is admitted to the enclosed space around the tubes thus heating the oil to the required temperature. The steam pressure in the heater should be kept higher than the oil pressure, and to ensure this and at the same time maintain the correct oil ~~pressure,~~ temperature three drains are fitted. The drain lead to a bottle which is connected by a three-way cock to the drains, one leading to the bilge and the other to the reserve tank. Normally the heater is drained to the R.F.T. But on the slightest trace of the oil leak the drain is changed over to the bilge. The tubes of the heaters are fitted with retarders to prevent the oil passing straight through, thus more effective heating is obtained.

EMERGENCY-VALVE is fitted in the system and enables the whole system to be shut off. This valve can be worked from the outside of the boiler room.

MASTER-VALVES

Are fitted in the system to control the oil supply to each boiler.

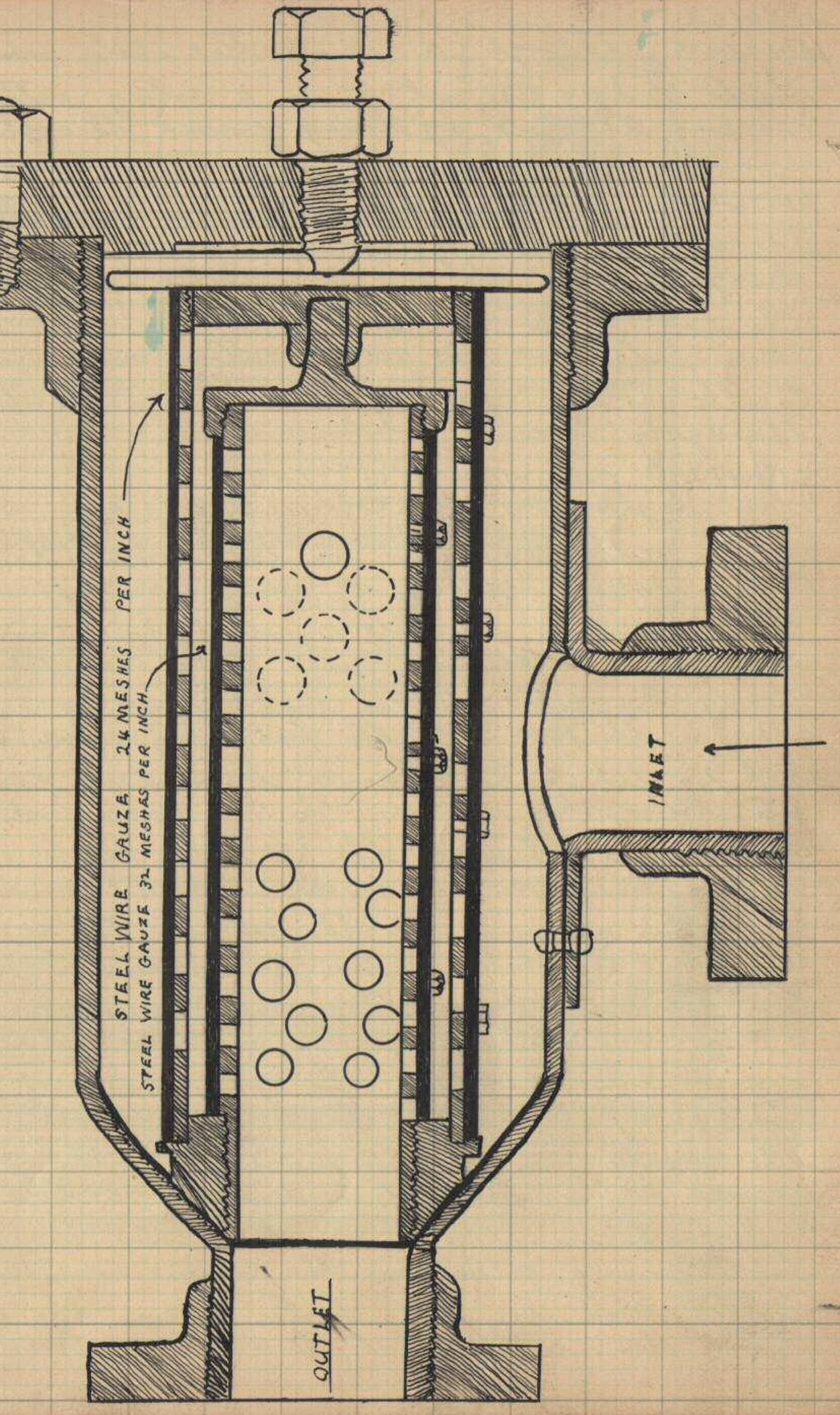
THERMOMETER-BOX.

Is fitted between the master valve and the sprayers to indicate the burning temperature of the oil from which the heater is regulated.

THE SPRAYER

The function of this is to deliver the oil into the air cone in the form of fine spray, so that air necessary to complete the combustion can be easily mixed with it. The spray is formed by passing the oil under

OIL-FUEL-FILTER



SPRAYER OIL FUEL

Pressure through a small true hole which has keen inside edges. The oil given a rotary motion, before reaching the hole by being passed through inlet holes in the sprayer cap which are tangential to the circumf.

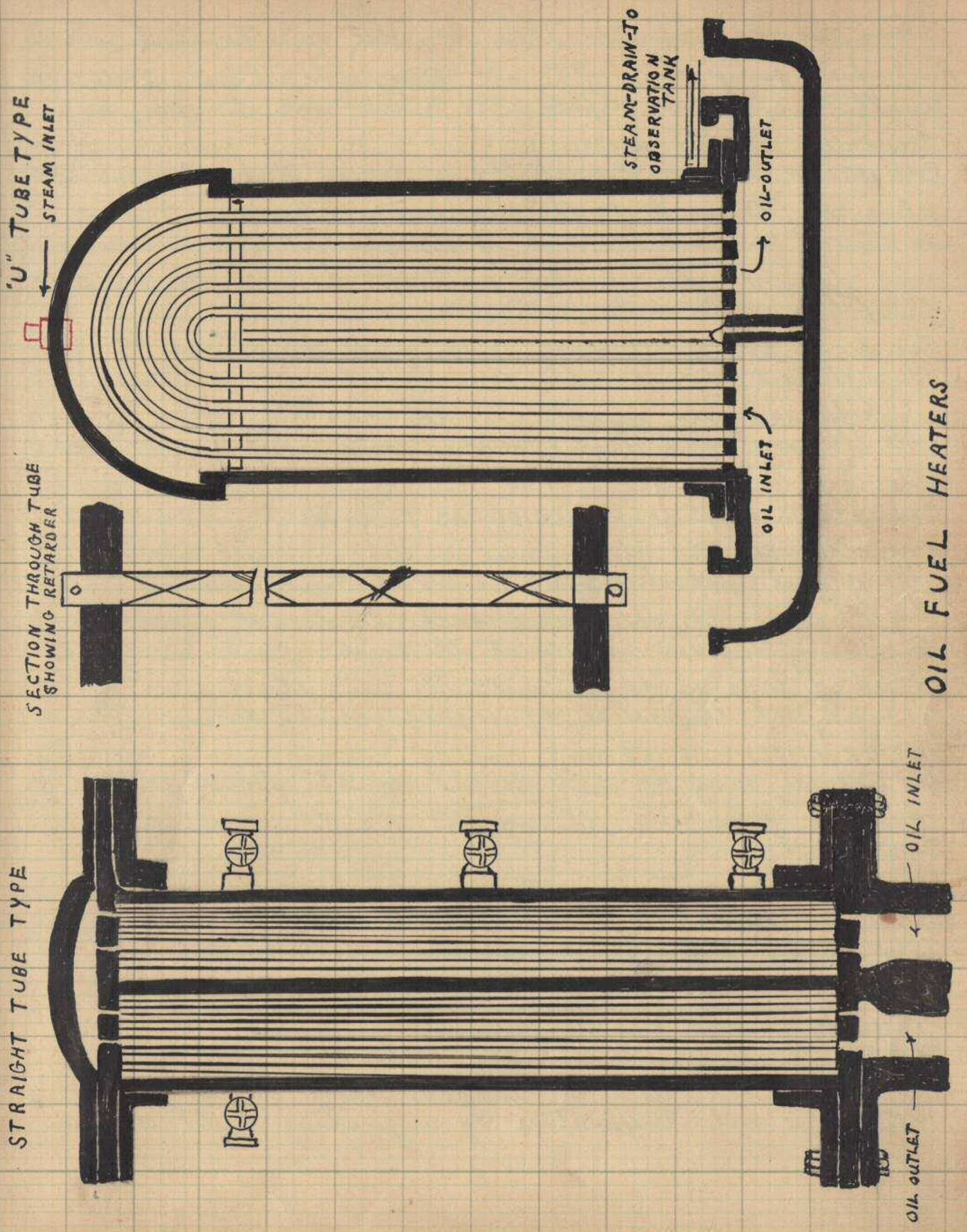
AIR-CONE

The oil on leaving the sprayer enters the furnace through an air cone. Air is supplied partly with oil at the end of the cone and partly through lateral slits. These slots give the air a rotary motion in opposition to the rotary spray of the oil thus the two are thoroughly mixed

"LIGHTING UP WITH A "U" TUBE

When lighting up from cold, a U tube must be used. One of the centre sprayers in the bottom row is removed and a special lighting up sprayer is shipped. A steel U tube, having a flexible armoured hose connected to each end is inserted in the top of the cone, one flexible end being connected to the lighting up sprayer, and the other to the pipe from the distributing valve box.

Oil is fed to the sprayer by a hand pump discharging into the system between the air vessel and cold filters and passes through the U tube before reaching the sprayer. Waste soaked in oil is kept burning in the air cone, thus warming up the oil in the U tube to a temperature at which it can be sprayed. This temperature can be read by a thermometer placed between the U tube and the sprayer. When oil is hot enough the sprayer is opened, and the spray entering the cone is ignited by the waste. After a few ~~minutes~~ minutes the waste can be dispensed with, the heat from the sprayer being sufficient to keep the U-tube hot. When sufficient steam shows the usual auxillary engines for condensing plant in the engine room should be started, and in the boiler room the fan engine should be started first to avoid a back flash.



Steam should should then be put on the heaters and oil fuel pump. When the oil temperature is raised to 140°F another should be lighted, the U tube and its sprayers connected in its place.

PULSATION This is caused by a series of explosions taking place at the end of the combustion tube, due to bad mixture of air and oil, and if allowed to become excessive may damage the boiler casings. This is attributable to the following causes:

(1) Too high an oil pressure causing fluctuations
(2) insufficient air in the air vessel.
(3) insufficient air supply to the cone
(4) Oil temperature to high causing formation of vapour in the system.

PULSATION MAY BE REMEDIED AS FOLLOWS

(1) By reducing the oil pressure as far as speed requirements will permit (pulsation often ocurs at high speeds).
(2) By charging the air vessel with the correct quantity of air
(3) Increasing the air supply at the cones by increasing the speed of fans or opening out the air flaps.
(4) Reducing oil temperature by adjusting heater drains

INTERMITTENT BURNING

The sprayer may be extinguished by the following

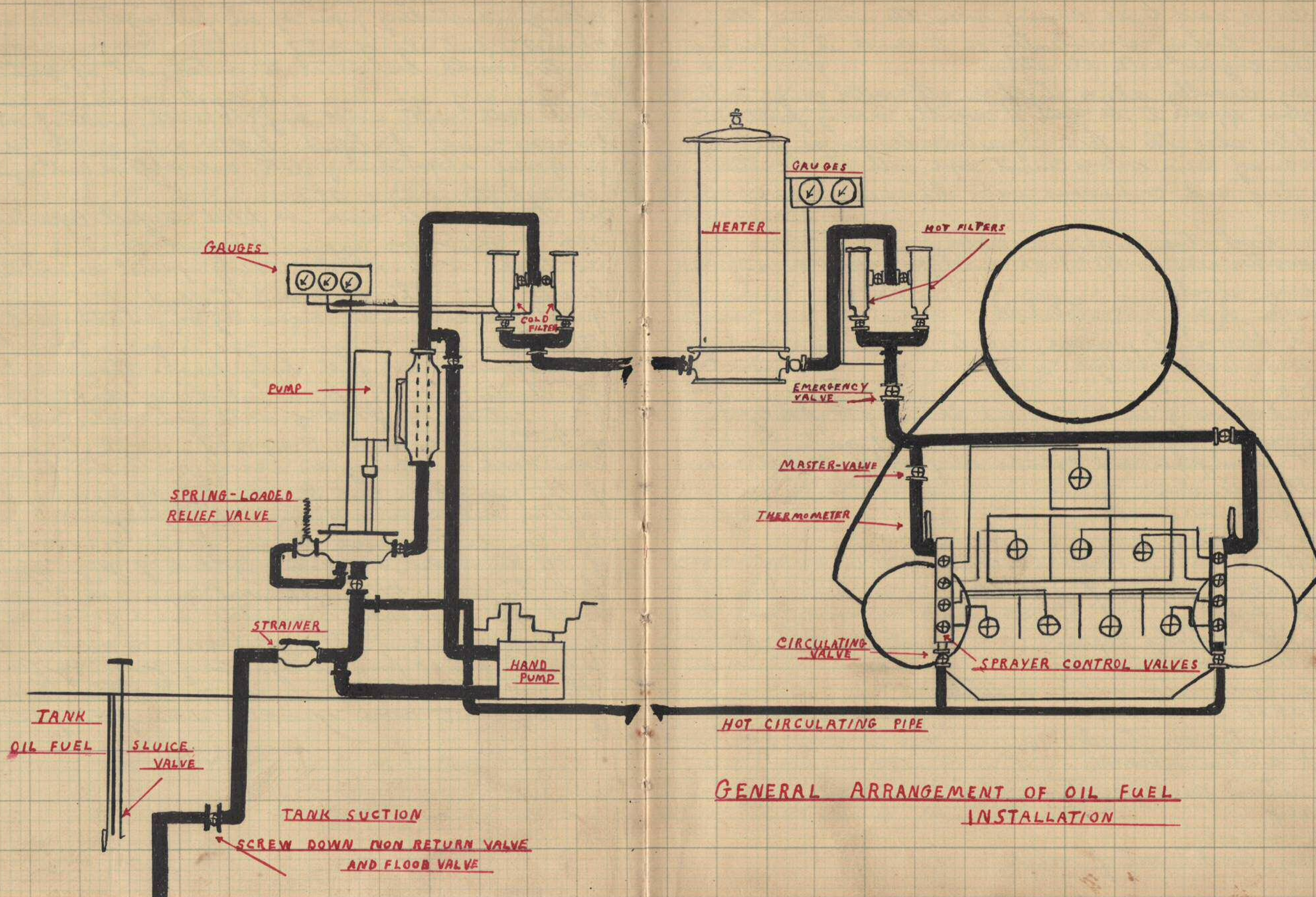
(1) presence of air in the system due to overcharge air vessel.
(2) Presence of water in the system due to (A) leaky heater (B) Water in storage tanks
(3) Oil temperature to low

REMEDIES

(1) Properly charge the air vessel
(2) For (A) change over to standby heater or reduce steam pressure with drain on bilge (B) change over to fresh tank
(3) Increase oil temperature by adjusting heater drains.

MISCELLANEOUS

Fittings, including pipes of oil fuel system are made almost entirely of steel.
Joints should be metal to metal, but if jointing material is necessary, red lead and copal varnish or asbestos coated with soft soap may be used, joints of manhole doors are made of liquid leather. Nuts securing doors are of special shape having slots across them and require special spanner to remove them.
Oil tanks should never be filled to full capacity, only 95% to allow for expansion of oil. Presence of water in tanks is found by using special sensetised paper, lowered into the tank on the end of a sounding rod. Special precautions are necessary on entering oil fuel tanks in case dangerous gas is present.
The vapour of oil fuel being heavier than air lies on the bottom of the tanks which are ventilated before being entered by flooding with sea water and pumping out. This process is repeated several times if considered necessary air vessel on the discharge side of the pumps. Air can be admitted by opening a small snifting valve on suction side of pumps.
Air can be released by opening the air cock on top of the air vessel, or opening top cock of gauge glass. Oil fuel tanks are fitted with vent pipes which usually reach the upper deck, terminating in a goose neck or bend. The end of the goose-neck is covered by wire gauze to prevent possible ignition of gases by flashes from the guns. Naked lights should at all times be kept clear of these vents more specially when filling tanks.



GENERAL ARRANGEMENT OF OIL FUEL INSTALLATION

PRIMING - ITS CAUSES, EFFECTS AND REMEDIES — LECTURE XX

A boiler is said to be priming when the water in the boiler is boiling so violently as to cause it to go over to the engines with the steam.

Priming usually shows itself in the water gauge when the glass appears to be full of rapidly moving froth or bubbles also the steam seperators become so full that the ordinary drain valves cannot cope with it and there is a long and continuous water hammering.

CAUSES

(1) Water level too high in boiler
(2) Impurities in water. (High density or grease on surface
(3) forcing boiler
(4) Uneven firing in stokehold
(5) Rapid decrease of pressure, due to increasing speed of engines too quickly

EFFECTS

(1) Water hammering in engines and steam pipes, likely to cause cracked cylinders and pistons, bent piston rods, burst steam pipes and cylinder relief valves to lift.
(2) Faulty vacuum
(3) Damage to air pumps
(4) Loss of water

(REMEDIES)

(1) Slow down engine if possible.
(2) Check fires
(3) Open all cylinder drains.
(4) Open all seperator drains.
(5) Close boiler stops valves a little

COURSE OF OIL FUEL

(1) Sluice valve on tank
(2) Tank suction strainer
(3) Non return pump suction valve
(4) Pump
(5) Air vessel
(6) Spring loaded relief valve

COURSE-OF-OIL

(7) Cold filter
(8) Heater
(9) Hot filter
(10) Shut-off or emergency valve
(11) Thermometer
(12) Sprayer master valve
(13) Sprayer
(14) Air cone

AIR-VESSEL

Is to maintain a steady discharge pressure and avoid pulsation. It is not advisable to keep too much air in the air vessel as a decrease of pressure may cause it to expand and pass over with the oil, thus extinguishing sprayers.

VISCOSITY

Is the adhesion of particles of the oil to each other. It is reduced by heating of oil

OIL FUEL JOINTS

Should be made metal to metal or, if jointing material is necessary, of asbestos smeared with soft soap.

Liquored leather is used for jointing tank doors.

SYSTEM

Should be tested to 150 lbs. per sq. inch.

WHEN TAKING OVER STOKE-HOLD WATCH (OIL FUEL)

(1) Oil fuel tanks in use and quantity of oil in them
(2) Oil fuel pumps working correctly
(3) Filters and heaters in use and all in working order
(4) Temperature at which oil is being burnt
(5) Air pressure in stokehold
(6) Smoke mirrors and lights correct.
(7) Air boxes cleaned and sprayers burning properly.
(8) Spare sprayers cleaned and ready for shipping
(9) Sand box full in case of fire
(10) Try heater drains for leaks

IN ALL STOKEHOLDS

(11) What valves and steaming connections are open.
(12) Feed pumps and automatic working correctly
(13) Water level and gauge glasses correct
(14) Fans running correctly
(15) Auxillary feed pumps warmed through and creeping
(16) Amount stop valves are open
(17) Certain tools ready for emergency
(18) Amount of water in reserve feed tanks
(19) Gauge glass lamps trimmed and lighted
(20) Depth of ~~oil~~ water in bilge and if any oil present

WEIRS CONTRAFLO BOILER FEED REGULATOR

Shown in figure, maintained steady flow of feed water into the boiler at all loads. For any given rate of evoporation, the valve floats in a corresponding position. When the rate of evoporation varies, the valve immediately responds and increases or reduces the area for the flow of water as necessary to suit the changing rate of evaporation. The automatic feed check valve A, similar to an ordinary non-return valve with the addition of a spindle terminating in a piston B, which works in a cylinder C. formed in the check valve seating. The piston B is an easy working fit in the cylinder C, so that a small quantity of water can be allowed to flow from the feed pump discharge line F into the piston chamber D, so that an additional quantity of water can be passed into the chamber to supplement the water leakage past circumference of piston B, (B) is same area as valve A

ACTION

When float U. falls, needle H rises, cuts off flow of water from piston chamber D through opening K to the feed tank and pressure in the chamber D rises due to the leakage of water into the chamber through valve E and clearance between piston B and cylinder C. immediately the pressure in the chamber D rises above the boiler pressure. The valve A lifts and allows feed water to pass into the boiler. The valve A can only rise by the amount that needle valve H has been raised because immediately the opening K is uncovered, the pressure under B falls below boiler pressure and the valve A commenses to close. When the water level in the boiler rises, the needle valve, H. is lowered by the action of the float and opening K. is uncovered and allows to escape from the chamber D. through opening K to feed tank. The pressure in D then falls below the boiler pressure and valve falls to the same extent as needle valve.

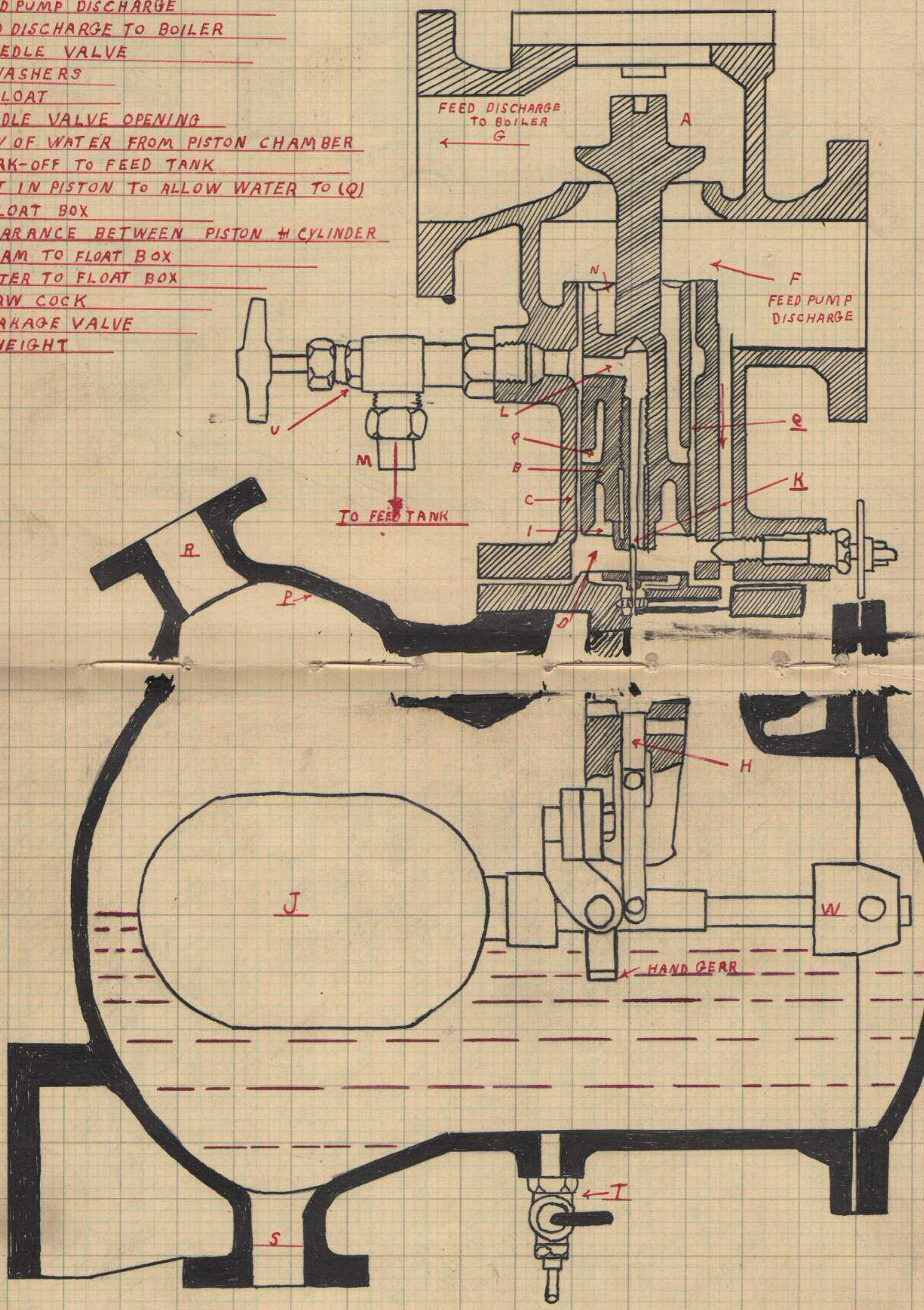
It will be seen that the valve A. and the piston B. and constrained hydraulically to move in the same direction and the same extent as needle valve H. which is operated by the float and for any given position of the needle valve H The valve A is maintained in equilibrium in a corresponding position. The working water level in boiler varies from the top level when no steam has been generated in the boiler, to a bottom level when the steam is operating at its maximum rate of evoporation and feed regulator maintains a steady water level between top and bottom for any given rate of evoporation between no load and maximum load. The float is contained in a box P. which should be fixed as closely as possible to the boiler.

This box is placed in communication with the boiler by means of steam and water levelling pipes R, and S. attached to steam and water spaces of the boiler by suitable valves. The pipes M are provided with a leakage discharge cock U, so that, when desired, the leak off to the feed can be closed. The valve A, then operates as an ordinary non-return valve and can be regulated by hand in the usual way. A handle, not shown, is provided so that float J, can be moved up or down in order to test the working of the valve.

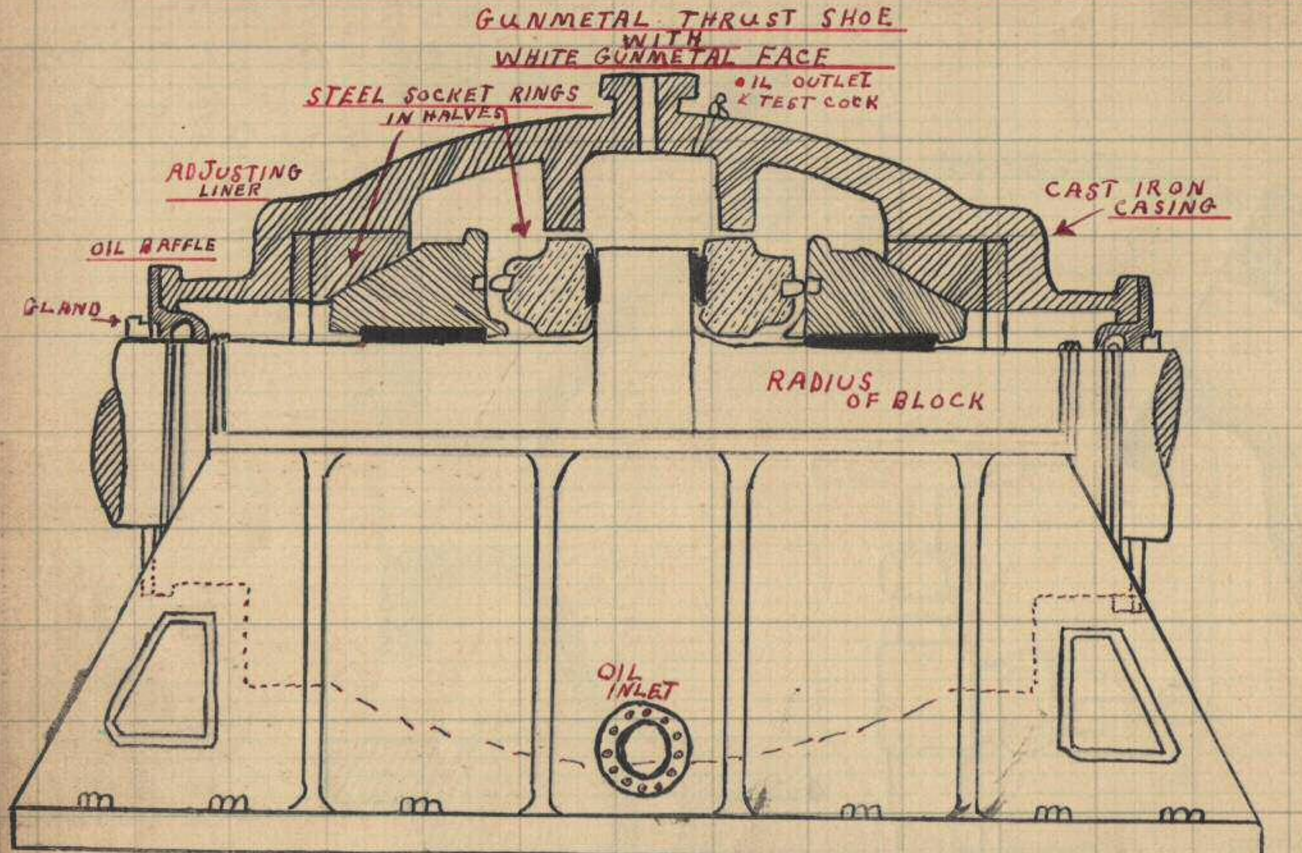
"THE WEIR CONTRAFLO"

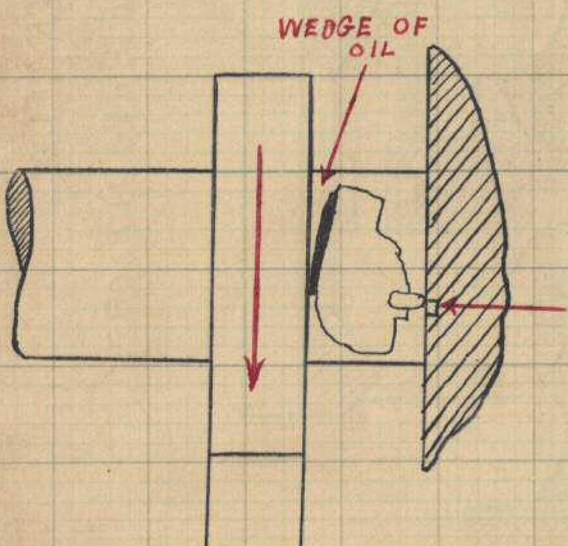
BOILER FEED REGULATOR

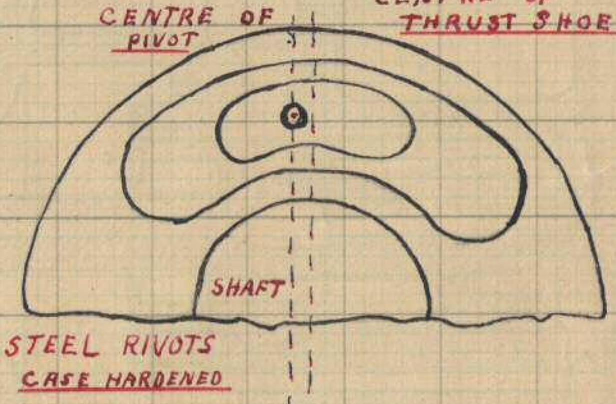
(A) CHECK VALVE
(B) PISTON
(C) CYLINDER
(D) PISTON CHAMBER
(E) SUPPLEMENTARY VALVE
(F) FEED PUMP DISCHARGE
(G) FEED DISCHARGE TO BOILER
(H) NEEDLE VALVE
(I) WASHERS
(J) FLOAT
(K) NEEDLE VALVE OPENING
(L) FLOW OF WATER FROM PISTON CHAMBER
(M) LEAK-OFF TO FEED TANK
(N) CUT IN PISTON TO ALLOW WATER TO (Q)
(P) FLOAT BOX
(Q) CLEARANCE BETWEEN PISTON & CYLINDER
(R) STEAM TO FLOAT BOX
(S) WATER TO FLOAT BOX
(T) DRAW COCK
(U) LEAKAGE VALVE
(W) WEIGHT



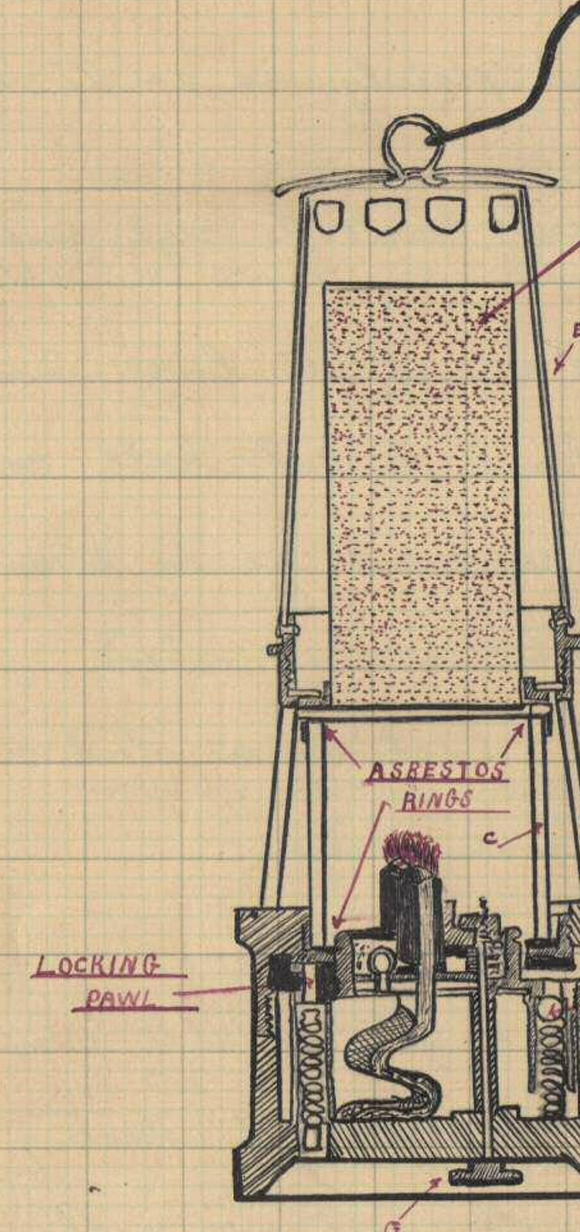
MICHELL SINGLE COLLAR THRUST BLOCK







SAFETY LAMP



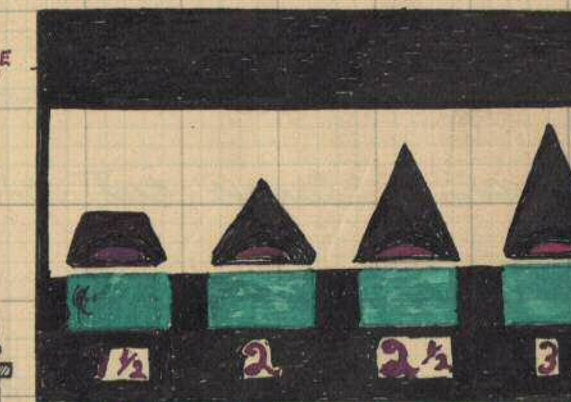


FIG 28 FIG 29 FIG 30 FIG 31

These figures show the appearance of "caps" visible in air containing 1½% 2% 2½% and 3% of firedamp respectively

TO CUT A HOLE IN A BOILER PLATE

To cut a hole in a boiler plate, you first rub chalk over patch to be cut out, and then use centre punch and mark plainly so as to make no mistake

1st Chalk and then describe circle to size marking clear

2. use centre punch so as not to loose mark

use a cross cut chissle to cut hole cutting to slope and then undercut so as to make a good clean cut. Cutting in a V shape

to cut a small hole such as a stud or bolt hole use a round nose chissle

PUTTING TUBES IN A BOILER

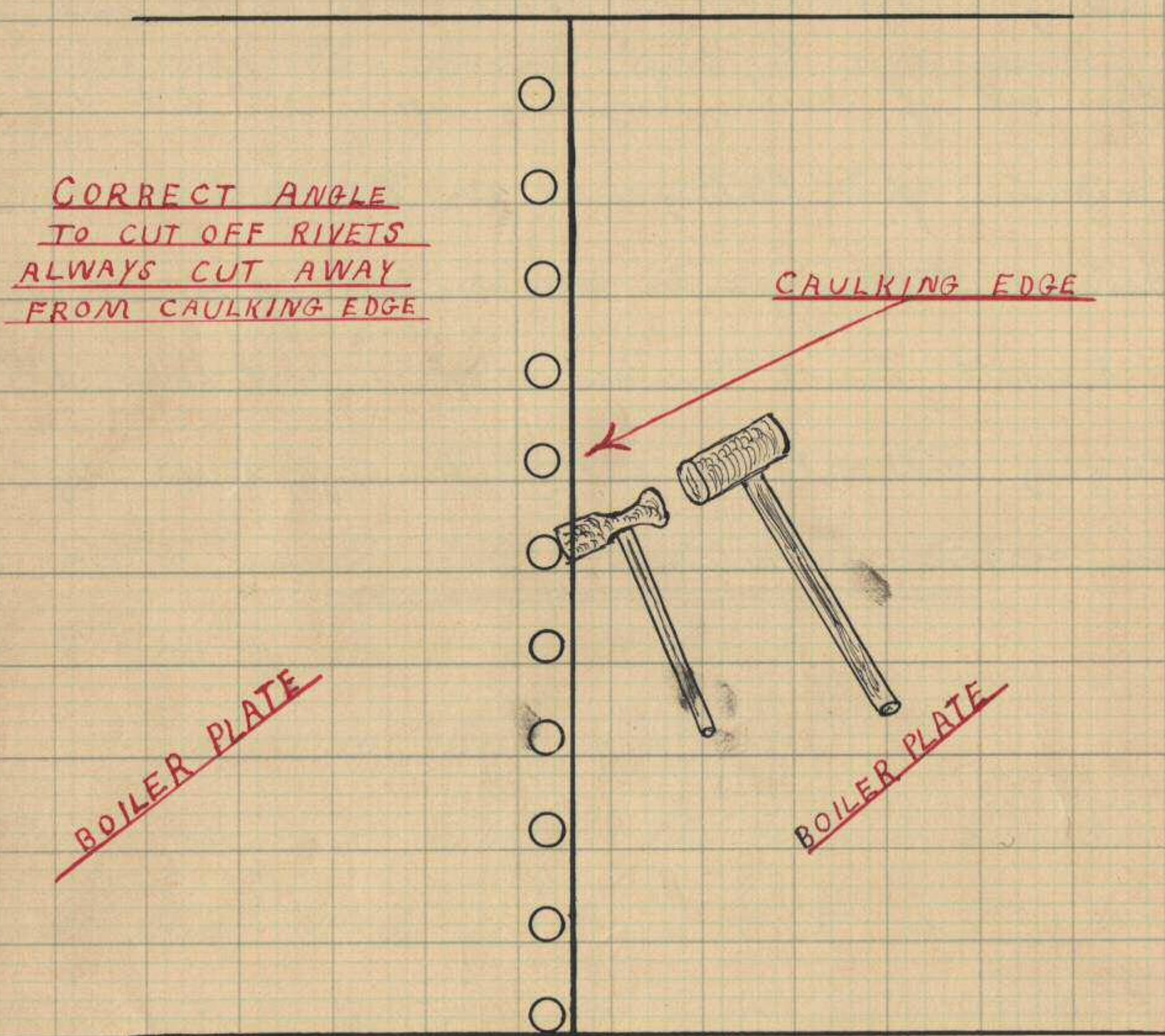
Always measure tube to the outside Diameter first thing to do is to aneal it, heating to a cherry red so as it will beat over without splitting, after making cherry red immerse in any dry substance such as ashes slack lime and leave to cool.

TO CUT HOLE IN BOILER PLATE

The main object is to exclude the air which contains moisture. Make sure tube sheet is perfectly clean and free from burs etc. To hold tube in place when expanding wedge tube in back tube sheet making wedges out of nails. Anything up to 2½" tube takes 3/16 projection for beating over 2½ takes ¼.

Rollers on tube expander are made on a slant so as it will travel inward expanding tube and enlarging tube at same time turning hand tight using own discretion

BOILER MAKERS NOTES



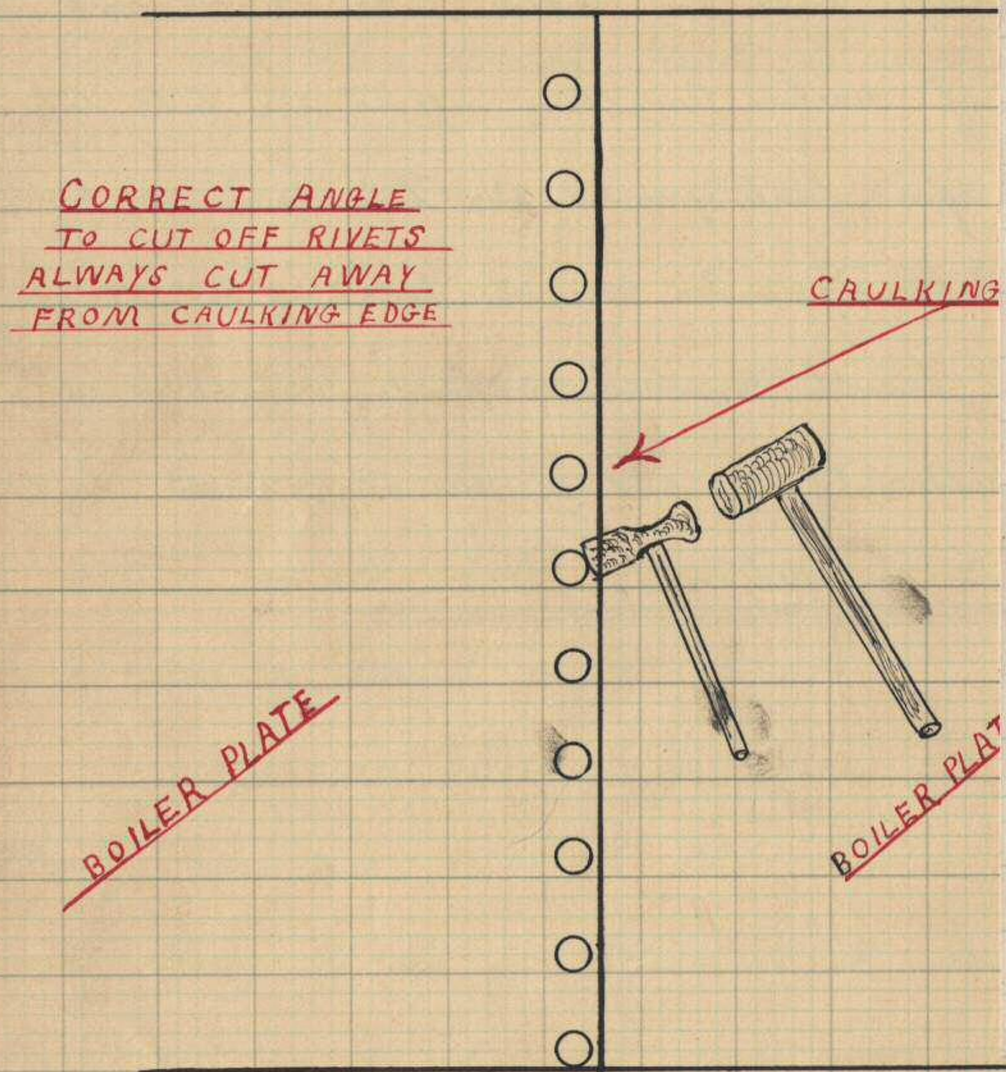
MICHELL THRUST

In this the latest type of thrust block the pressure is taken up by a set (5 to 8) of loose pads fitted in the panels of a containing frame ring or cage which forms the block.

The pads which are segmental in shape, are adjusted to allow a slight rock or wabble by being pivoted at or near their centre, and the effect of this slight accomadating motion is to allow a liberal oil film clearance between the bearing surfaces of the block when in motion. A steel button with a hard rounded point serves as a pivot on which the pads cant over when acted on by the thrust pressure and oil surface.

The shaft contains a single thrust column, one side serving for ahead thrust and the other for astern thrust. As the collar revolves the oil is forced ~~out~~ up continuously to the surface of the pads or blocks. The result of which is

BOILER MAKERS NOTES



C TO F - F TO C

$C = \frac{5}{9}(F - 32)$

$F = \frac{9}{5}C + 32$

F TO R - R TO F

$R = \frac{4}{9}(F - 32)$

$F = \frac{9}{4}R + 32$

R TO C - C TO R.

$R = \frac{4}{5}C$

$C = \frac{5}{4}R$

MICHELL THRUST

In this the latest type of thrust block the
pressure is taken up by a set (5 to 8) of loose
pads fitted in the panels of a containing frame
which forms the block.
ch are segmental in shape, are adjusted
slight rock or wabble by being
near their centre, and the effect
t accomadating motion is to allow
il film clearance between the bearing
the block when in motion. a steel
hard rounded point serves as a
ch the pads cant over when acted on
t pressure and oil surface.
ntains a single thrust column,
ving for ahead thrust and the other
for astern thrust. as the collar revolves the oil
is forced ~~out~~ up continuously to the surface of
the pads or blocks the result of which is

That the pads will take a pressure per sq inch ten times greater than that of the ordinary thrust block without distress (500 lbs per sq inch in place of 50). The segmental pads are usual of gunmetal with whit metal bearing surfaces. The bearing blocks are adjusted to the correct setting by means of flat rings also of a spherical ring of steel with hardened steel contact points to bear against the back of pads. On geared down turbines the steam pressure on the blades acting in one direction only requires to be balanced, so that the michell thrust is fitted on the turbine shaft in addition to the heavier type fitted on the main shaft to take the actual propeller thrust. The main shaft thrust is made in exact duplicate on each side of the shaft collar to take both ahead and astern thrust. The principal of the michell bearing is that of "pressure oil filled lubrication" that is to say the rubbing or friction surfaces are ~~on~~ entirely seperated by a high pressure oil film. There is no metalic contact, consequently an enormous reduction in friction at moderate speeds there is practicaly none. The pressure of oil film is generated automaticaly by the rotation of the shaft no auxillary pumps is necessary. One of the essential conditions for the mainteance of a pressure oil film between two lubricated surfaces is that the surfaces must have a slight inclination to each other so that the opening at which the oil enters is greater than that at which it leaves.

In the ordinary thrust bearing they are parallel. The thickness of the oil film in the michell is sometimes less than 1000th of an inch and this film will withstand a pressure of 500 or even 600 lbs per sq inch without squeazing out and allowing metalic contact. It is necessary that the faces of the blocks be perfectly straight and no oil grooves be cut in the face as this would allow the oil to escape The special feature of the michell is that the stationary bearing surface is divided into a number of segments, each seperate from the other, not a continuous surface as in the ordinary thrust. Each block is prevented from rotating by stops and pivots on the rounded end of a pin or screw in any direction each block is beveled or stepped on the back surface to allow it to tip on a radial line. Main advantage of a michell thrust is friction is not increased at running at extreme speeds heat is not generated owing to the use of one thrust collar only, therefore there is very little expansion. adjustment is very much simplified. In the ordinary horseshoe type thrust block there are forty necessary adjustments the michell for the same power will have only twelve. The housing consist of one main casing and

examination of the blocks is possible without the removal of any cover or any interference ~~of~~ with the block adjustments. both the supporting bearings and the thrust blocks are lubricated from the oil well from which the thrust collar revolves, the casing is kept half filled with oil for this purpose

DIESEL ENGINES

The engine will not start

(1) Check fuel tank

(2) Fuel supply line oil spray nozzles

(2) faulty Clearance between valves rocker arms and cams

(3) leaky inlet or exhaust valves

(4) Stuck piston rings or engine turning over too slowly

(5) faulty oil feed pumps delivering insufficient quantity of oil

Running troubles

(1) Fuel supply insufficient

(2) Air or water in the fuel piping

(3) Fuel pumps valves out of order

(4) Low injection air pressure

(5) Engine over loaded

(6) Governor not acting correctly

(7) Fuel valves fouled

Smoky Exhaust

(1) Cylinders not receiving an equal amount of fuel

(2) Load too heavy

(3) Too much lubrication of the cylinders or exhaust valves

(4) Too late fuel injection

(5) Fuel oil unsuitable or contains water or air

(6) Improperly adjusted fuel valves

(7) Broken or weak fuel valve springs

(8) Exhaust pipe obstructed

(9) Low Compression pressure in cylinders

Engine knocking or pounding

(1) Inefficient combustion or irregularities in the compression due too to early injection of the fuel

(2) Loose piston pin or fly wheel

(3) Warm main bearings

(4) Worn or broken piston rings or seized pistons

(5) Carbon deposits of cylinder or piston head

Engine fails to Carry its rated load

(1) Leakage of one or more of the fuel pumps plungers

(2) Leakage of fuel pumps gaskets or valves

(3) If engine is equipped with Bosch fuel pumps the racks on the governor regulating lever are not correctly adjusted

(4) Low Compression in one or more cylinders

(5) Dirty oil fuel filter

Fuel pumps troubles

(1) Air in fuel line or pumps

(2) Leaky fuel pumps check valves

(3) Sticking suction or delivery valves

(4) Leakage around pumps plungers

(5) Fuel oil too thick (Should be heated)

(6) Improper timing of fuel pumps

Fuel Valve troubles Cause

(1) Smoky exhaust

(2) Loss of power

(3) Pre ignition or knocking

(4) Irregular engine operation

(5) Carbon deposit in Combustion Chamber

Cooling water troubles

(1) These occur mainly where sea water is used for Cooling A scale is deposited on the Cylinder walls preventing the Cylinder heat being transferred to the water. This must be scraped off throug the various inspection plates in the water jackets

Lubrication Oil

(1) A sufficient depth of oil must at all times be maintained in the Crank case

(2) Oil filters must be cleaned regularily and the oil should be completely changed at stated periods

(3) Succesful running of a Diesel Engine depends to a very great extent on the state quality and quantity of the lubricating oil

VG
20 Sept 40
[illegible]

WEIRS CLOSED FEED SYSTEM

The primary feature of this system is that the feed water from the moment it leaves the condenser until it reaches the boiler is contained in a closed circuit, so that no opportunity is presented for the absorption of air, and the whole of the feed water from the feed tank drains etc. is subjected to the deaerating effect of the condenser before passing into the circuit.

as a result feed water is rendered non-corrosive

advantages claimed for the system

(1) Prevents corrosion in the boilers steam pipes and fittings

(2) The total weight and space occupied are reduced

(3) The feed tank can be placed lower in Engine room

(4) The air ejector gives the highest vacuum with very small weight and with minium space occupied

(5) Being automatic when manouvering it requires no special attention

SYSTEM CONSIST:- of the following parts

(1) Water extraction pumps (Turbo or motor driven)

(2) Air ejector

(3) Float Controlled supplementary feed valve

(4) Circulating valve (Hand Controlled)

(5) Feed water pumps (Turbo driven)

(6) Feed water heater

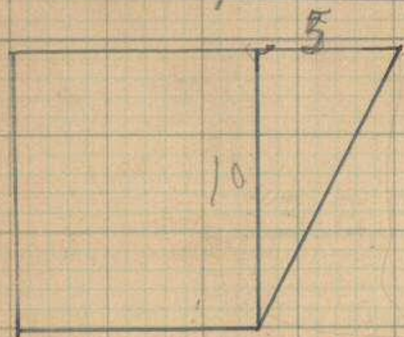
(7) Drain cooler

(8) Ejector Condenser

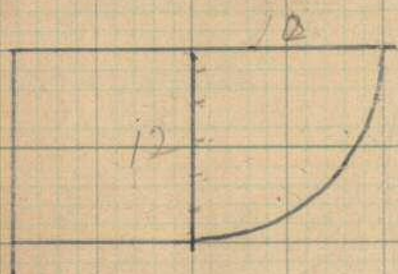
In the Condenser the Condensate falls to the bottom and any air or uncondensable gases rise to the top, where, by means of baffles they are led to the suctions of steam operated air ejectors. The ejectors maintain the vacuum in the condenser. A definite level of ~~Condensing~~ Condensate is kept at the bottom of the Condenser (which acts as a hot well.) By means of an automatic supplementary and overflow ~~device~~ device the condensate is pumped from the bottom of the Condenser by an extraction pump

Which is rotary (motor or Turbo)
The extraction pump discharges the condensate to the air ejectors, where it acts as a cooling medium absorbing heat from the ejector steam
The condensate passes through a drain cooler where it absorbs heat from the feed heaters, next it passes through an L.P. heater where it is heated by closed exhaust to about 130° F thence to the suction of the turbo driven feed pumps.
All this machinery is fitted in the engine room from the feed pumps discharge the water passes to the boiler rooms where it is further heated in the H.P. feed heaters before it passes ~~tho~~ to and through the automatic feed regulators to the boiler.
The feed heater drains after passing through the drain cooler are further cooled in the ejector condenser before passing into the main feed tank

Volume of Coal bunker

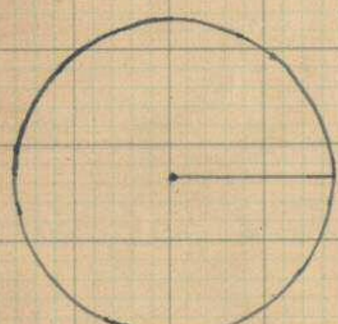


Area of rectangle + area of angle



Area of rectangle + $\frac{\text{area of circle}}{4}$

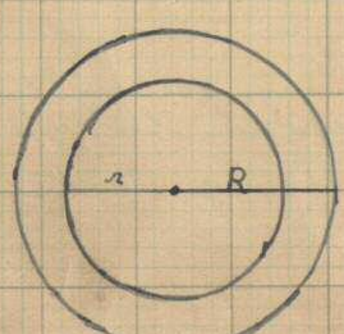
area of a circle



is equal to πR^2 ~~square~~ where
pie is equal $\frac{22}{7}$
The Circumference is π x Diameter

The area of an annulus
Is the difference between two circles
having the same centre

Area of Annulus = $\pi R^2 - \pi R^2$

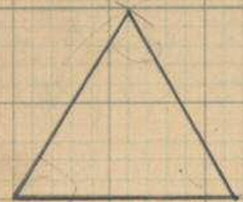


Volume of a Cylinder = Area of one end x by height

πR^2 x alt

The area of curved circles of cylinder is
equal to circumference x height or πD x hight

19 Sept 1940
79.
ABM



Kind of triangle

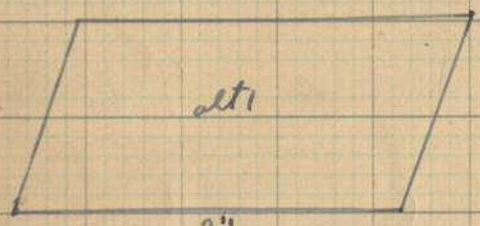
Equilateral triangle

Kind of angles

all angles equal to 60°

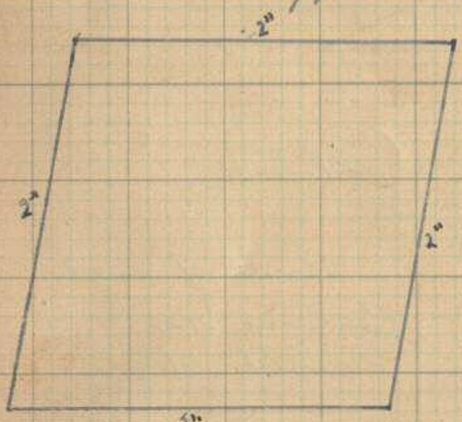
The area of a parallelogram

A parallelogram is a four sided figure with the opposite sides parallel



Area is = to base × alt
= 2 × 1
= 2 Sq inches

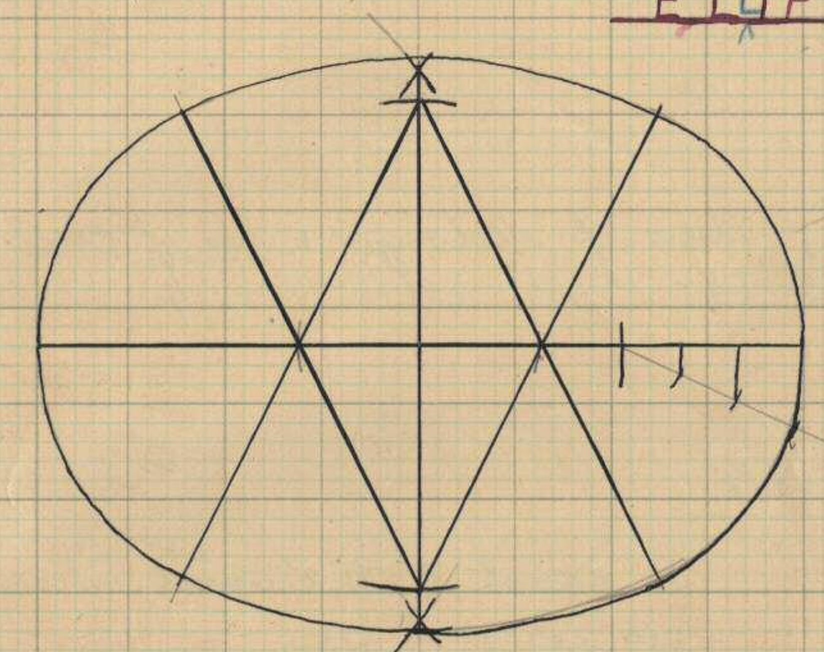
Area of a Rhombus a Rhombus is a four sided figure with the opposite ~~sides~~ sides equal and parallel



Area is equal to

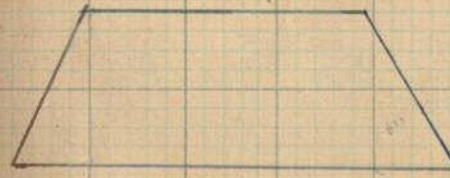
Area = base × alt
= 2 × 2
= 4 Sq inches

ELLIPSE



Trapezium

A trapezium is a four sided figure with one pair of opposite sides parallel



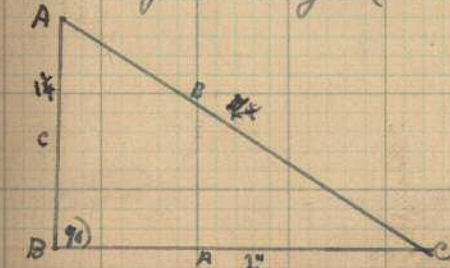
$$\text{Area} = \frac{\text{sum of parallel sides}}{2}$$

multiply by the alt

The right angled triangle

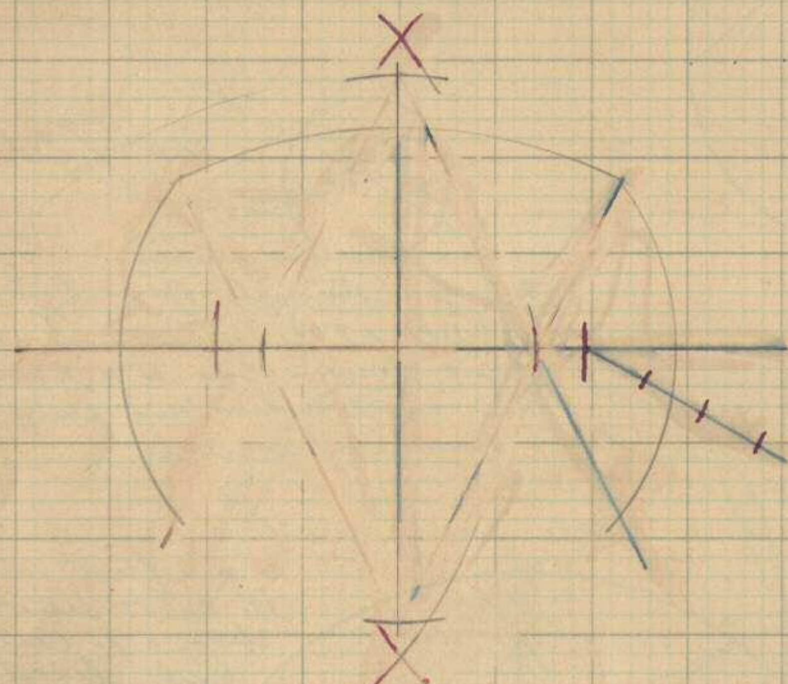
A right angled triangle is one containing one right angle

The side opposite the right angle is called the hypotenuse



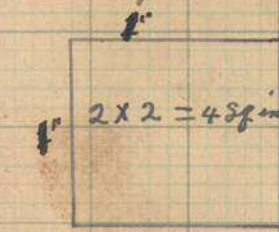
$b^2 = c^2 + a^2$

$(1\frac{1}{4})^2 + (2)^2$



MENSURATION

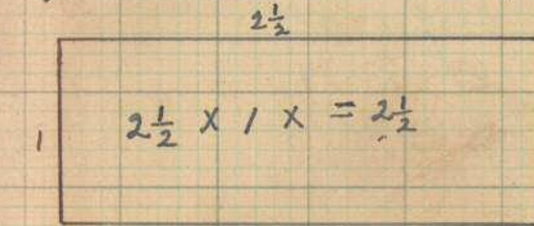
(1) Area of a square



area of square = length multiplied by breadth but since the length equals the breadth, area equals length $(\text{length})^2$

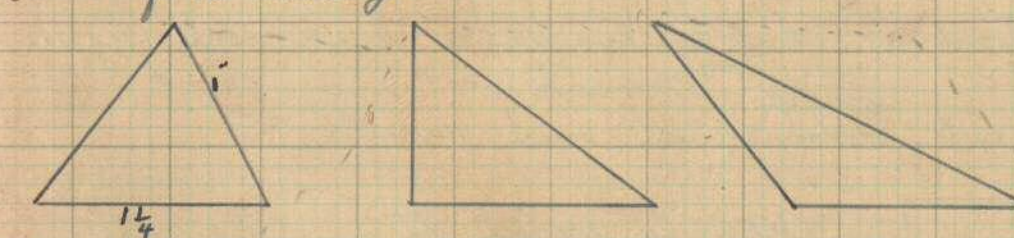
(2) Area of rectangles

a rectangle is a four sided figure with all its angles 90°



Area of rectangle = length times Breadth

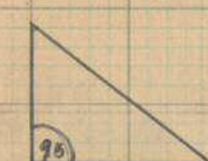
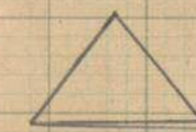
3 Area of a triangle



A triangle is a three sided figure

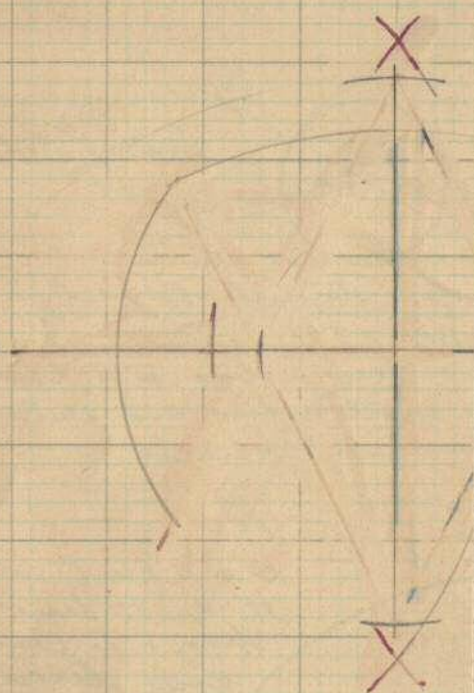
The area of a triangle is equal to $\frac{\text{base} \times \text{altitude}}{2}$

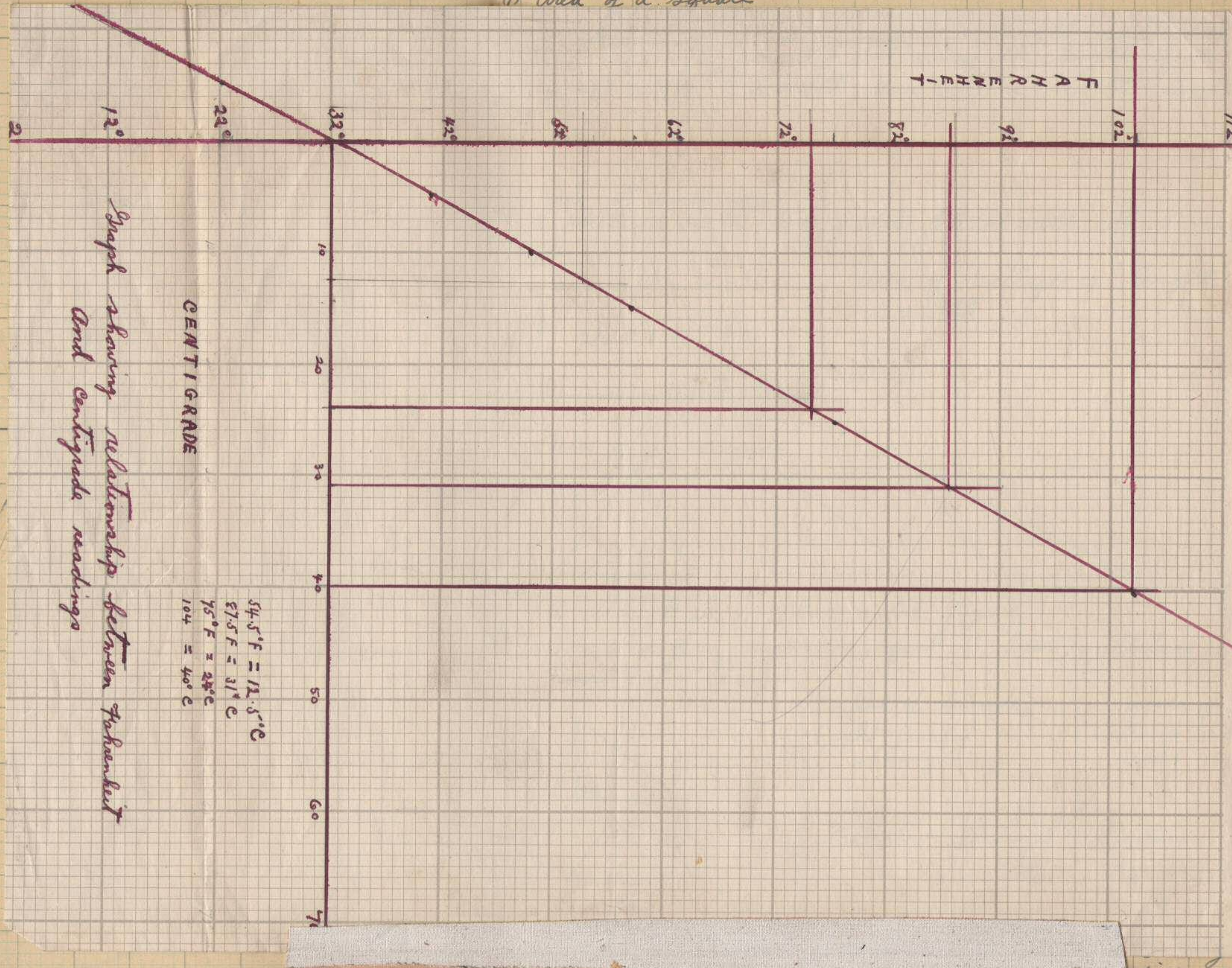
(4) Properties of a triangle

	Kind of triangle	Kinds of angles
	Right angled triangle	Contains one right angle
	Isosceles triangle	Contains two equal angles
	Scalene triangle	All angles different

MENSURATION

(1) Area of a square





by
the
2

les

times

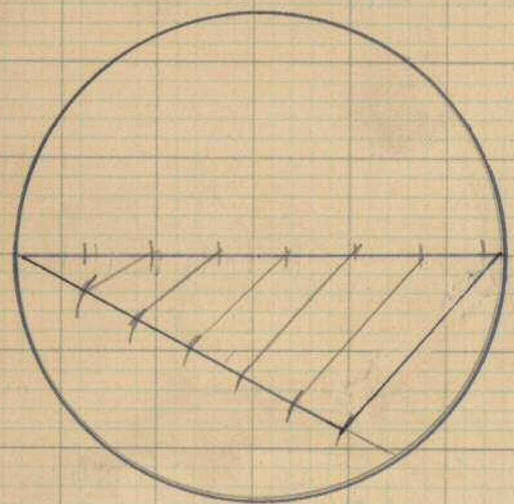
ngles

le

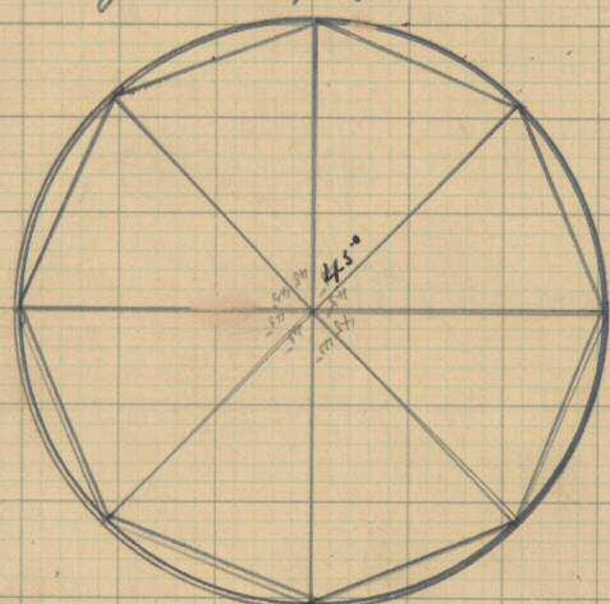
two
gles

les
different

To Draw a regular Heptagon

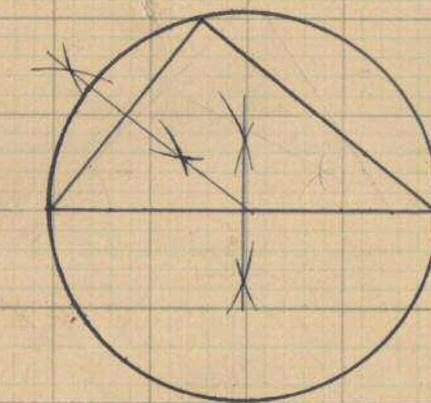


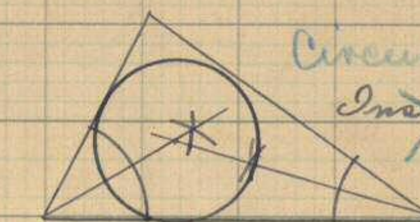
To draw a regular Heptagon



To draw the inscribed circle

ABC is a Triangle bisect angles B.C. let bisectors meet at O. from O drop a perpendicular to one of the sides with this perpendicular as the radius and centre O describe a circle

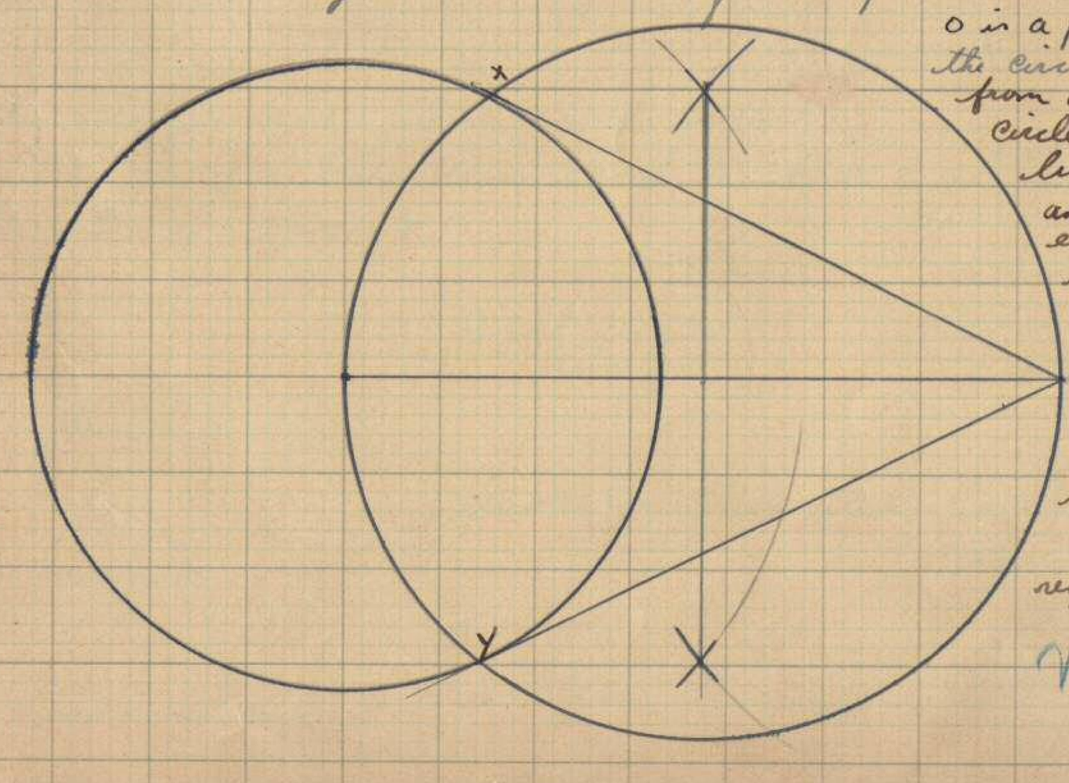




Circumscribed
~~Inscribed~~ circle

A.B is a triangle Bisect A B and B.C let bisection meet at O from O draw a line to A B an C with this as the radius and centre O Describe a circle

To draw two tangents to a circle from a point



O is a point outside the circle draw a line from O to centre of circle bisect this line from centre and with radius equal to one half the line describe a circle cutting the previous one at X and Y join O X and O Y then O X and O Y are the required tangents

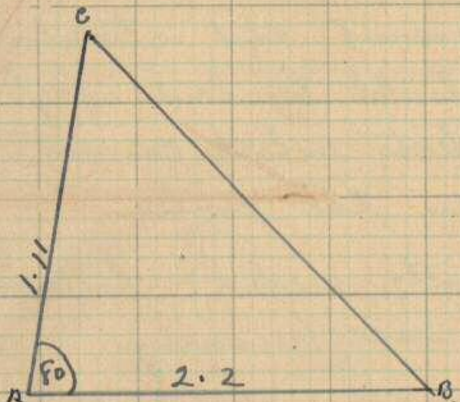
V.G.

WB4

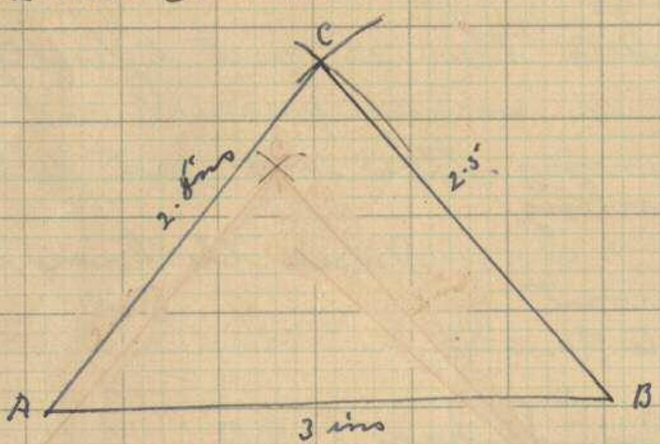
Drawing figures to scale

(A) Triangles

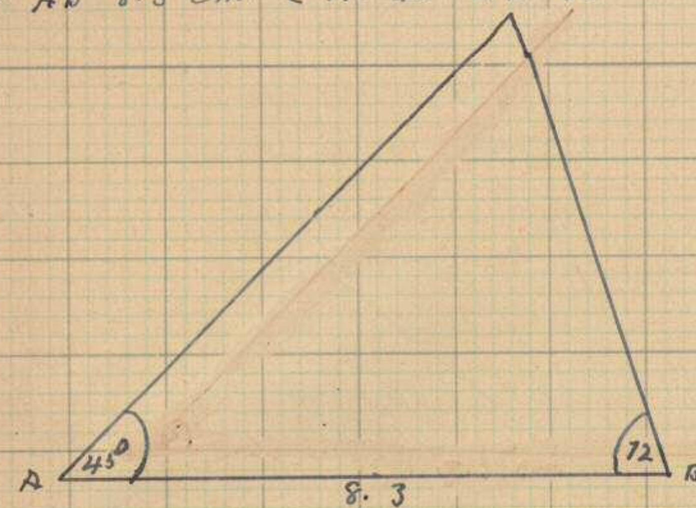
∠ ABC = 80°, AB = 2.2 ins BC = 2.9 ins.



BC = 2 ins CA = 2 ins AB = 3 ins

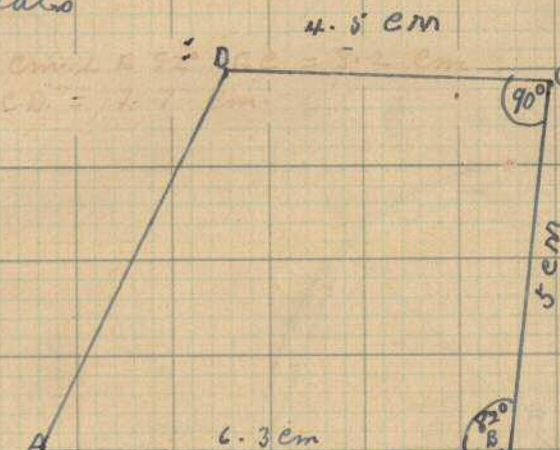


3/ AB 8.3 Cm. ∠ A = 45° ∠ B = 72°

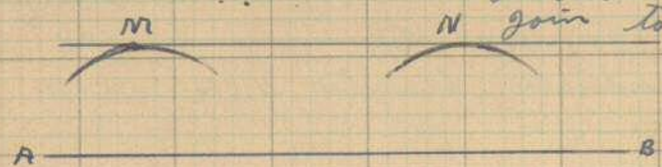


Quadrilaterals

AB = 6.3 Cm
∠ B 82° BC = 5 Cm
∠ C 90° CD 4.5 Cm

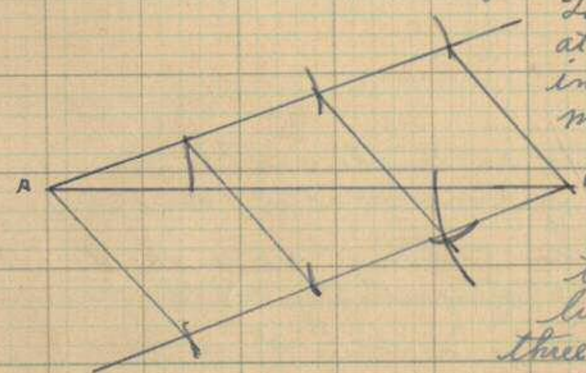


(4) To draw a line parallel to another



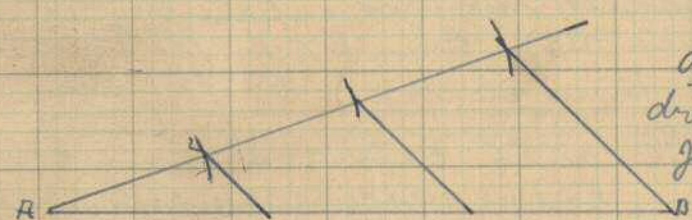
With centres anywhere along A B describe two arcs on the same side of A.B. join together the tops of the two arcs then M N is the required line (M.N) is realy the tangent to the two arcs

(5) To divide a line into any number of equal parts



To divide A.B. into three equal parts at A draw a line and mark this off into three equal divisions. at B. make an angle equal to one the one at the other end and divide that into three divisions similar to the one at the top. Join together the various points along the two lines. Then A B will be divided into three equal parts

(2)



at A draw a line and divide it into three equal parts Join the third part to B place the set square along this line then draw two other lines parallel to this through the divisional points Then A.B. will be divided into three equal parts

Model of a service letter reporting defect of a steamboat

Mess 2,
H.M.S. Powerful,
Devenport.
July 31, 1940

Sir:

I have the honor to submit that steamboat No. 9, of which I am in Charge, should be laid up for repairs and overhaul as their are defects which cannot be rectified while steam is in the boiler.

The following repairs are urgently needed:- boilers require Cleaning and brickwork of furnace renewing.

Main bearings are very much worn and require remetaling.

Owing to these defects their is great difficulty in keeping up steam to working pressure and when the engines are running their is a great deal of vibration and Knocking

I have the honor to be
Sir
your obedient servant
J. J. Jones Sto. P.O.

Eng Com. Sampson D.S.O.
H. M. S. Powerful
Devenport

PROPORTION

How far will a train travelling at the rate of 45 miles per hour go in 18 minutes

In 60 minutes the train goes 45 miles
" 18 " " " ? "

Distance $= \frac{\overset{9}{\cancel{45}}}{1} \times \frac{\overset{3}{\cancel{18}}}{\underset{\underset{2}{\cancel{10}}}{\cancel{60}}} = 13\frac{1}{2}$ miles

Answer $13\frac{1}{2}$ miles

PERCENTAGE

We have to remember that 100% is the whole thing then ¼ of the whole thing = ¼ of 100% = 25%

Express 3/8 as a percentage

We have $3/8 = 3/8$ of 100%

$= \frac{3}{\underset{2}{\cancel{8}}} \times \frac{\overset{25}{\cancel{100}}}{1}$

$\frac{75\%}{2} = 37\frac{1}{2}\%$ answer

PITCH OF PROPELLER

Pitch 22 ft

No. of rev. per min. 100

Dist boat goes per min 22×100

" " " " hour $22 \times 100 \times 60 =$ ft

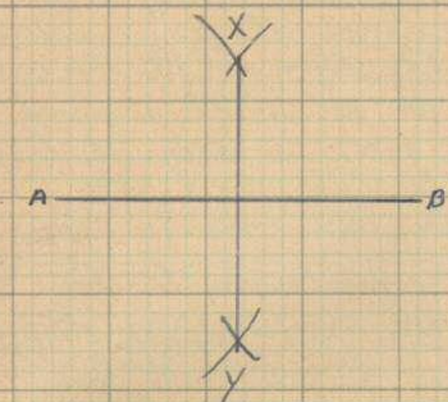
Dist. in nautical miles $\frac{22 \times 100 \times 60}{6080} =$ Knots

Allowing for slips

$\frac{92}{100} \times \frac{22 \times 100 \times 60}{6080} = 19.9732$

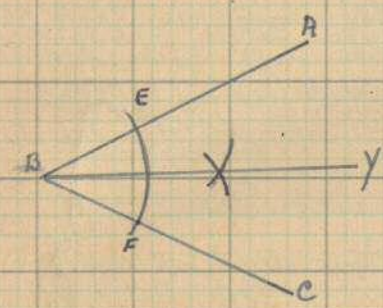
Geometry

Y Bisection of a line



Whith Centres (A) and (B.) describe two arcs intersecting at (X) and (Y). Join (X) and (Y). Then X-Y is the perpendicular bisector of (A) and (B)

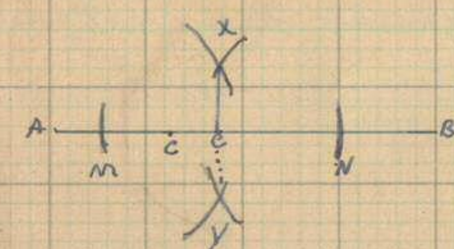
(2) Bisection of an angle



A.B.C. is an angle with Centre B. and any Convenient radius describe an arc. Cutting A.B. and (B)(C) at (E) and (F) Respectively. With Centres (E) and (F) and any Convenient radius describe two arcs intersecting at (Y). Join (B)(Y). Then BY is the bisector of the angle A.B.C.

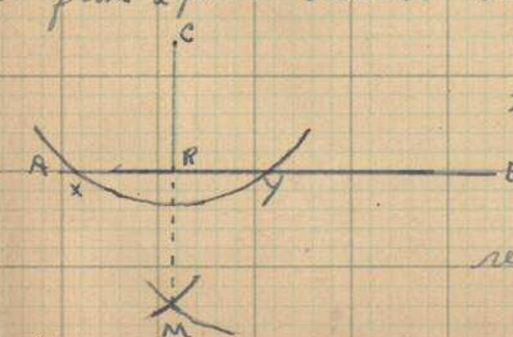
Construction of a Perpendicular

A from a point in a line



With centre C and any convenient radius describe two arcs on A.B. on either side of C. With centres M and N and a little longer radius describe two arcs intersecting at X and Y Join X C then X.C. is perpendicular to A.B.

(B) from a point outside the line



With Centre C and any convenient radius describe an arc cutting A.B at X and Y with centres X and Y and any Convenient radius describe two arcs intersecting at (M) Join C.M. let C.M. cut AB at R. then C R is the required line

Addition of fractions to add fractions they must be brought to a Common multiple or L.C.M.

$\frac{1}{2} + \frac{1}{4} + \frac{1}{3} + \frac{1}{5} + \frac{1}{6}$

$$\frac{30+15+20+12+10}{60} = \frac{87}{60} = 1\frac{27}{60} \text{ ans } 1\frac{9}{20}$$

This rule also applies to subtraction you must find the L.C.M.

$\frac{1}{2} - \frac{1}{3} = \frac{3}{6} - \frac{2}{6} = \frac{1}{6}$ Ans 1/6

For Multiplication or division no L.C.M. is needed the numerators and denominators being rendered down to the lowest fraction

Div.

$\frac{4}{9} \div \frac{2}{27} = \frac{4^2}{9} \times \frac{27^3}{2_1} = \frac{6}{1} = 6$ Ans 6

Decimals

In any Computation of decimals the most important part is the decimal point the point must always be kept in a vertical line

```
101·425        166·348
  1·438        142·239
  2·57          24·109
  3·04
108·473
```

Multip of decimals the number of figures to the right of the point must be counted

3·426 X 2·18 X 4·34

```
  3·426           7·46868
   2·18              4·34
 27408           2987472
 3426           2240604
6852           2987472
7·46868        32·4140712
```

For division of decimals the point is moved to the right on both figures until the division is brought to a whole figure 4·752 ÷ 2·14

```
       2 .216
2·14)4·752
     428
      472
      428
       340
       214
       1360
       1284
         74
```

averages

Is the result of dividing the sum of the quantity by the number of them

Ex a ship travels 100 miles in 4 hrs the average speed per hour is $\frac{100}{4}$ or 25 miles per hour

or $1000 saved in 10 years average amount saved per year $\frac{1000}{10}$ = 100 per year

Square root

the sq. root of any figure is the number multiplied by itself to make the original figure

5 X 5 = 25 so is the sq. root of 25
9 X 9 = 81 " " " " " 81

The sq. root of 187389

```
4)187389(432·88
   273
83 2489
    7600
862  731600
8648
86568
```

Proportion

Percentage

ABY

July 1940

REDUCTION OF QUANTITIES

Reduce 60483 lbs to tons

```
2240) 60483 (27
      4480
      15683
      15680
          3
```

27 tons 3 cwt

ADDITION

```
 5876
 4321
 7482
 6543
24222
```

SUBTRACTION

```
975382
 54230
921152
```

MULTIP.

```
   5674
    246
  34044
 22696
11348
1395804
```

Reduction of quantities means to change the units or units in which a quantity is ~~equal~~ expressed

Reduce is used in an up sense as well as in down tons are reduced to ounces and we also reduce ounces to tons 3 miles 5 furlongs 28 yds to ft

```
3 ~~m~~. 24 fur.
  5
29 x 660 ft = 19140 + 84 = 19224 ans
```

Division

```
    689.33
12) 8272
    72
    107
     96
     112
     108
      40
```

ans 689.33

To find the H.C.F of two or more numbers

Ex find the H.C.F of 6893 and 6441

```
6893 (6441
6441
 452) 6441 (14
      452
      1921
      1808
       113) 452 (4
            452
```

Ans 113

The last number you divide by is the H.C.F