My Notes

Loose Leaf

Note Book

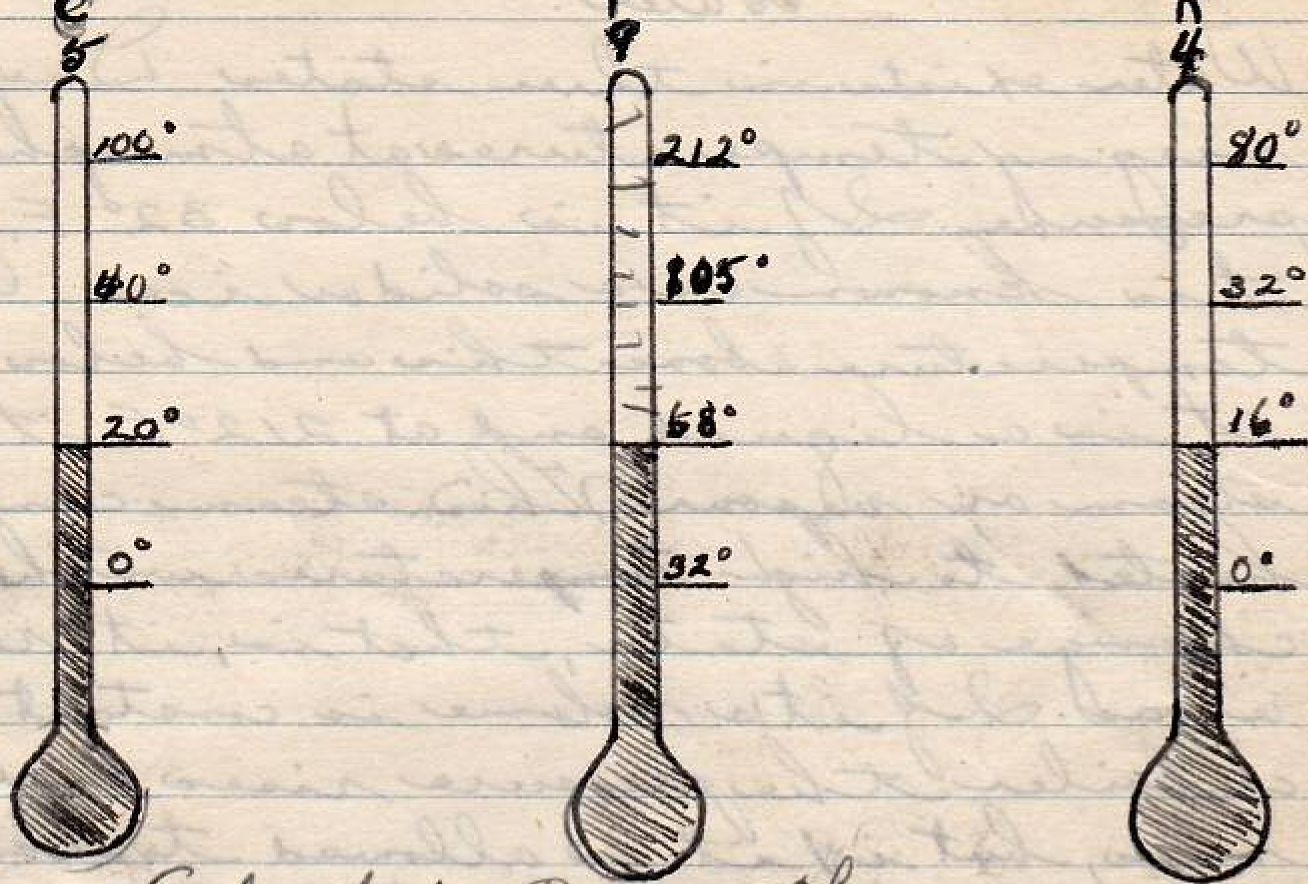
PROPERTY OF
STO. I E. G. HERBERT
RAMILLIES BLOCK.
H.M.C.S. CORNWALLIS.

STEAM
ENGINEERING

E. HERBERT
V-85870

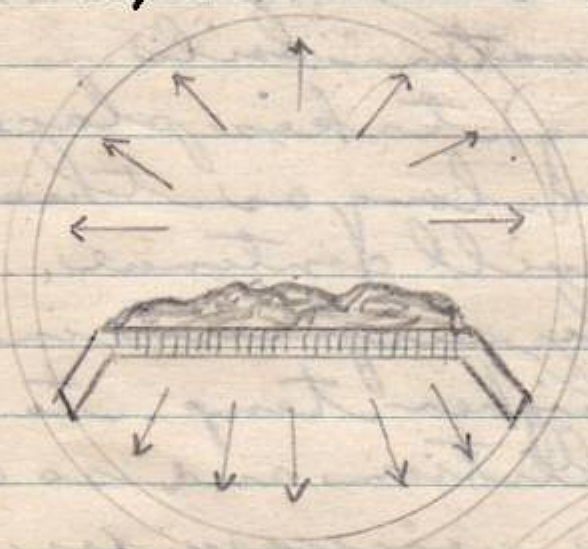
STEAM ENGINEERING

Centigrade Fahrenheit Reaumer.

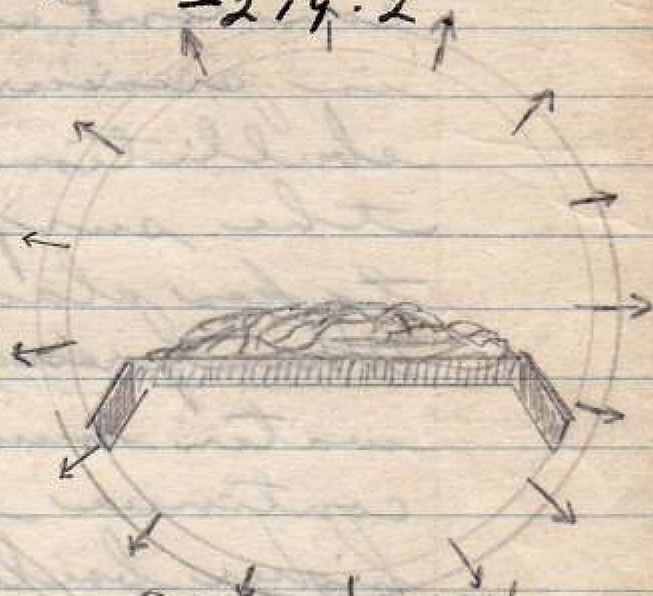


Absolute Zero Temp.

-274° -461.2 -219.2



RADIATION



CONDUCTION

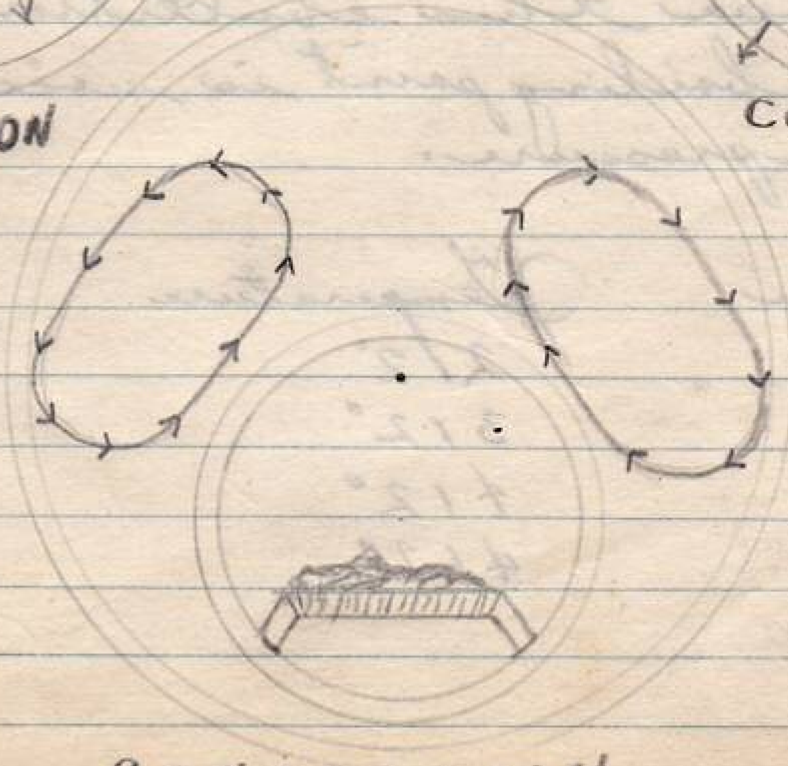


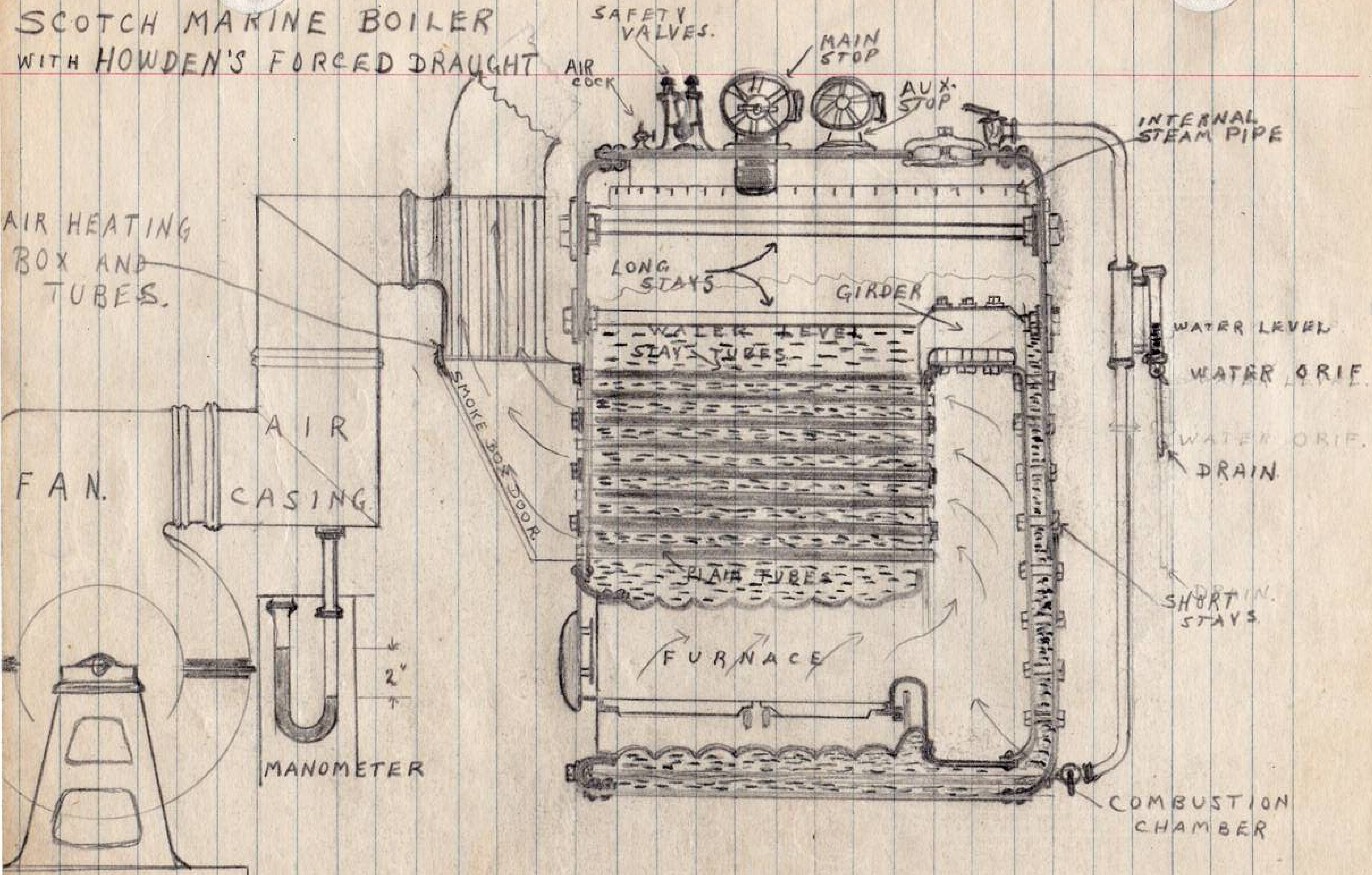
DIAGRAM No 1. CONVECTION

Water.

Water exists in three states. Due to varying temperatures at atmospheric pressure. If it is below 32° F. it is known as a solid or ice. At any temperature above this and below 212° F. it is a liquid and at 212° F it becomes steam or vapour. This steam can be heated to high temperatures without change of state, that is, it remains a gas. If it's volume is constant as in a boiler the pressure rises and temp. rises, but if it is allowed to pass off as it is made, the temp. remains constant at 212° F. and there is no rise in pressure. When water boils ebullition (bubbling) takes place on the surface and as long as this takes place boiling will continue. When pressure on the surface is increased water must reach higher temp. to continue this ebullition and so a higher boiling point is necessary for a higher pressure.

Pressure	Temperature	Latent Heat B.T.U.'s
14.7	212°	966
80	312°	895
280	412°	822
300	417°	818

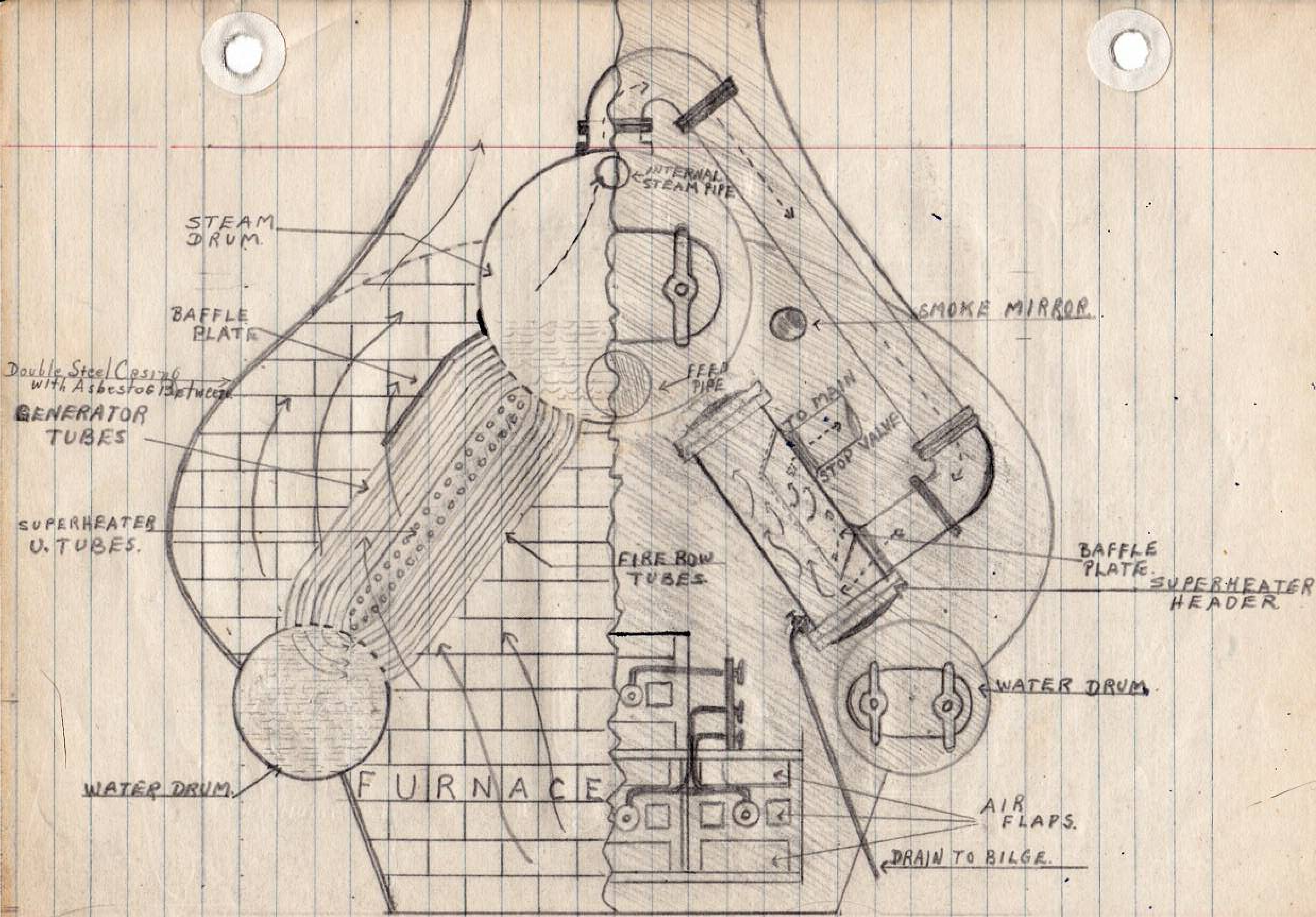
SCOTCH MARINE BOILER
WITH HOWDEN'S FORCED DRAUGHT



DIA. 2.

Description of Scotch Marine Boiler-
The boiler consists of a cylindrical shell formed of steel plates rivetted together. Each end of the cylinder is closed by a flat circular end plate, flanged over to fit inside the cylindrical shell and secured by rivets. The furnace or furnaces are made of corrugated steel tubes which open into a combustion chamber at the back of the boiler. A number of steel tubes, called smoke tubes open into the combustion chamber and connect it with ~~and~~ the smoke box at the front of the boiler. All flat surfaces are stayed, to prevent distortion. The end plates, above the level of the combustion chambers and between the furnaces are supported by longitudinal stays. The height of water in the boiler, is kept above the top of the combustion chamber. Either fuel oil or coal can be used in this type of boiler. The hot gases from the furnaces pass up the combustion chambers, through the tubes to the smoke box, and then through the uptake, the funnel.

Water surrounds the tubes in the boiler and is thereby heated by them to the boiling point causing steam to be formed in the top of the boiler where it is carried off by an internal steam pipe out through the main stop.



YARROW BOILER
FITTED WITH SUPERHEATERS

DIA. #3.

Engineering Notes.

Yarrow Type Boiler-

This boiler consists of a large cylindrical steam drum ~~pump~~ at the top, and two smaller cylindrical water drums at the bottom, connected by a number of tubes forming an inverted V shape. The tubes are expanded at the ends into the drum tube plates. There are two types of this boiler, the large tube type with two inch tubes and the small tube type with tubes one inch to one and three eighths inches in diameter. The small tube type is more often met with in the service than any other kind of boiler.

The water is fed into the top or steam drum through an internal feed pipe. The water level is such that the tops of all the tubes are under water, or said to be drowned. Zinc slabs are fitted in all drums to resist corrosion. 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. Wire straps are fastened from the boiler shell to the bulkheads, to absorb the shock of ramming or pitching when the ship is rolling.

Distance pieces are fitted between the boiler shell and the bulkheads to steady the boiler. Rivetted on the bottom of each water drum, are two or three supporting brackets, known as boiler feet. The boiler feet rest on a flat surface, on the boiler bearer on each side and are held down by keep plates which keep the boiler in position but allow some movement for expansion.

Advantages of Water Tube Boilers Over Cylindrical Boilers –

(1) Lighter for the same horsepower.
(2) Capable of raising steam more quickly due to faster circulation, and less water capacity.
(3) Defective parts, easily replaced.
(4) Strength for weight: pressure heating surfaces of smaller dimensions and nearly all cylindrical.

Disadvantages –

(1) More affected by irregular feeding.
(2) Water must be pure (distilled)
(3) Owing to a higher evaporative power requires greater control of fuel supply

change is known as combustion or burning. Thus to complete combustion in the furnace a sufficient amount of air is supplied. If sufficient amount of air is not supplied, useful heat is wasted, by passing through the funnel as smoke. Black smoke flowing at the funnel opening, indicates lack of oxygen.

Forced Draft.

Forced draft is the mechanical means that the air (oxygen) is supplied to the furnace in sufficient quantities to maintain a steady burning power. Two systems of forced draft are used, known as the open stokehold, and the closed stokehold. In the open stokehold the fan supplies the air through a trunk to the furnace front. This system is often referred to as the Howden System.

In the closed stokehold system, air pressure is maintained in the entire boilerroom by fans attached to the deckhead which draw air from the atmosphere. Pressure in the boiler room enters the furnace through draught plates and air flaps. Air locks are provided to allow access to and from the boiler room without loss of air pressure. Boiler room air pressure is measured by an air pressure gauge.

Combustion

If raised to a sufficiently high temp. both carbon and hydrogen will combine with oxygen and in each case the combination gives rise to a large quantity of heat. This chemical

Water (cont'd.)
One cubic foot of distilled water weighs 62½ lbs. and one cubic ft. of sea water weighs 64 lbs. Therefore one cubic ft. of sea water contains 1½ lbs. of solid matter dissolved in it or about 4 ozs. 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% epsom salts
5% plaster of Paris.
4% other matter such as chalk, silica etc.

Boiler Notes -: Boiler Mountings:

(1) Main stop valve controls the passage of steam from boiler to main steam line.

(2) Safety valves: When pressure in boiler exceeds working pressure the safety valve allows it to escape to the atmosphere. Fitted in pairs and one is set from three to five pounds higher.

(3) Auxiliary stop valve - Controls the passage of steam to auxiliary machinery.

(4) Main feed check valve - Checks supply of water to the boiler.

(5) Superheater stop valve - Controls passage of steam to main turbine.

(6) Auxiliary feed check valve - Used in case of failure of main feed check.

Air cock - Used to allow air to enter or escape from the boiler when pumping up or running down.

Blow down cock - Used to blow dirty water out to sea when the boiler is under steam.

Running down valve - Used to run the boiler down to "W" or to empty for cleaning.

Superheater drain - Used for draining superheater when flashing up from cold.

Scum valve - Used to draw off any scum or impurities on top of the water.

Hydrometer test cock - To draw off water used for testing for purity.

Internal steam pipe - Collects the steam at the top of the boiler and passes it through the main stop.

Smoke mirror - If the light in the back of the boiler cannot be seen, then fires are smoking.

Internal feed pipe - Situated at the bottom of the boiler and feeds the water evenly throughout the boiler through perforations situated in the top of the pipe.

Sliding feet - Used to allow for expansion of the boiler.

Internal scum pan - Water is lowered below this pan and the scum is left in the pan whence it is blown out to sea by the scum valve.

Tests for Boiler Feed Water.

It is most important that the boiler feed water should be maintained in a very slightly alkaline condition

(i) Test for Alkalinity -: Methyl Orange turns yellow

One drop of Phenol Phthaline in a test tube of water will turn slightly alkaline water, a pink colour. A deep shade of pink (red) will indicate strong alkalinity. Safety precaution - Phenol Phthaline is highly inflammable. Red Litmus Paper turns blue.

(ii) Tests for Acid -:

Methyl Orange turns pink in an acid sample. Blue Litmus paper turns red in an acid sample.

(iii) Test for Salt -:

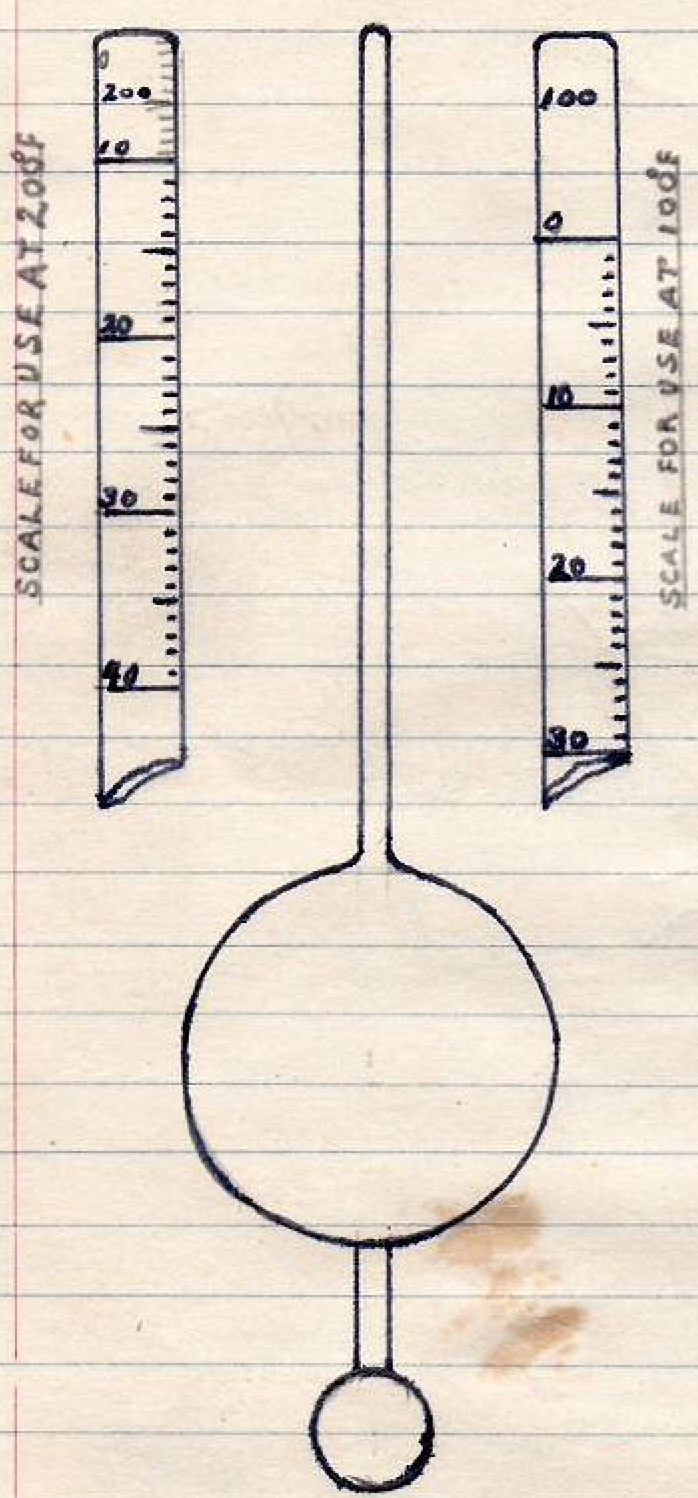
Feed water is to be tested frequently for the presence of salt, using one or two drops of nitrate of Silver solution. Salt is indicated by a white cloud being precipitated. If the water is free from salt, no change will be observed.

(iv) Test for Density -:

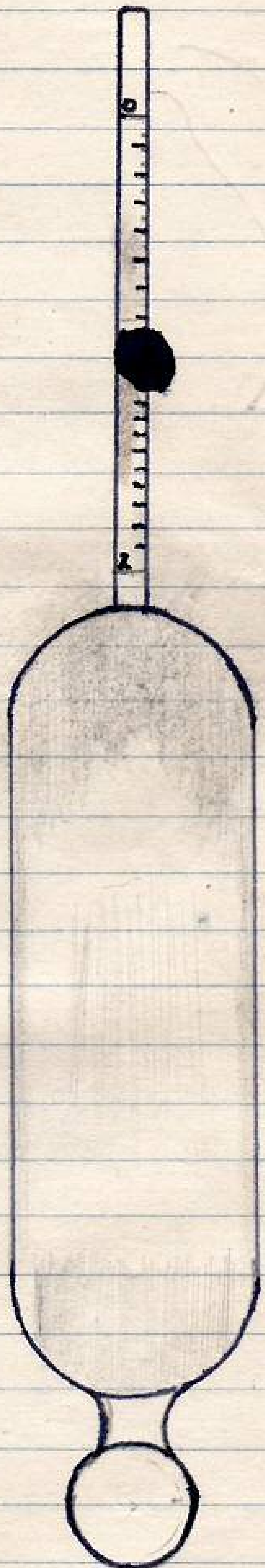
The sensitive hydrometer is used for testing boiler feed water. It is used at one hundred degrees F. The reading should be nil in pure water, should not read more than 3/10 of one degree. The brass hydrometer is used for testing evaporator brine. Used at 100° F or 200° F.

Test for Water in an Oil Fuel Tank
A paste known as Gage O pinkish in colour is smeared on one side of a sounding rod or gauge tape. After immersion in the oil to be water tested for the desired time the paste becomes bleached white where it had been in contact with the water. The amount of bleached paste is therefore, the amount of water in the tank.
Prescribed periods of immersion -:
(1) Five seconds for gasoline and light oils
(2) Thirty seconds for diesel fuel and lubricating oils.
(3) Sixty seconds for heavy fuel and heavy lubricating oils.

Changing a Broken Gauge Glass.
(i) Shut off steam and water cocks and open drain
(ii) Remove guard, safety plug, top and bottom gland nuts, gland, old packing and broken glass.
(iii) See that new glass is free from flaws and correct length.
Replace gland nuts, gland and packing. and insert top end into top mounting and lower into lower mounting.
(iv) Replace top plug and check that glass has not less than $\frac{1}{8}$" of vertical freedom to allow for expansion.
(v) Screw up gland nuts hand tight.
(vi) Warm glass by opening steam cock slightly keeping drain cock open.



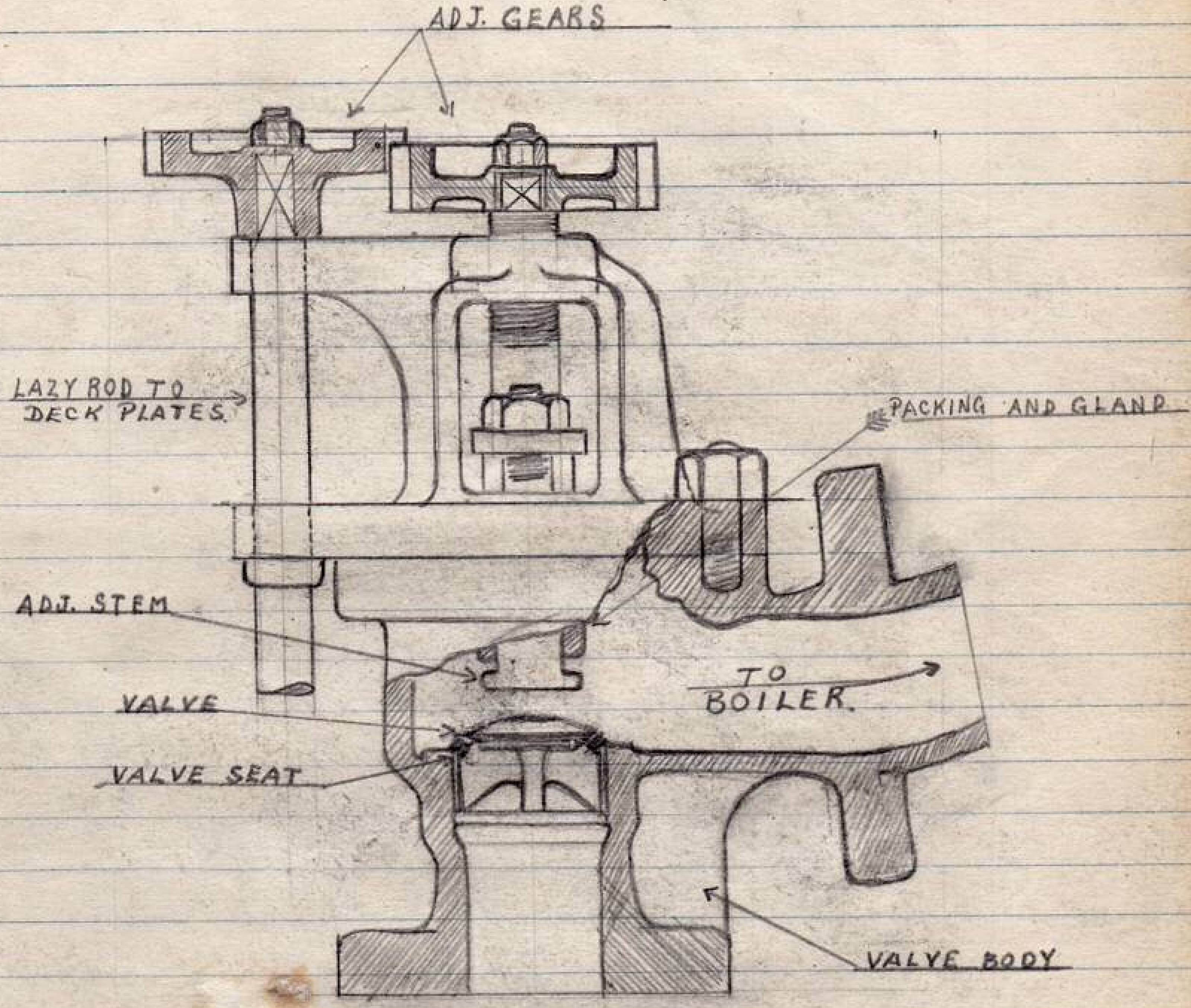
BRASS HYDROMETER.



SENSITIVE HYDROMETER

DIA. #4.

(vii) Tighten up gland nuts and replace guard.
(viii) Test gauge glass.



DIA #5. FEED CHECK VALVE

Drawn by F.G.H.

PRIMING —:

(i) Water level too high in boiler.
(ii) Rapid decrease in pressure. ~~due~~ to increasing the speed of the engines too quickly.
(iii) Impurities in the water (high density) such as oil on the surface
(iv) Forcing the boiler

(v) Uneven firing in the stokehold.
(vi) Pitching and tossing of the ship.

Action to be taken when priming occurs:-
1. Cut the fires (eg turn off sprayers)
(ii) Ease main feed check to a closed position.
(iii) If water doesn't come down, open blow down cock at engineer officers discretion.

Water below water cock orifice
(i) Notify engine room.
(ii) Cut your fires.
(iii) Slow down the feed pump.

Water below water glass nut but above water orifice -
(i) Ease down on your firing.
(ii) Increase speed of pump.

Blowing Down Guage Glasses —

(i.) Shut off water and steam cocks and open drain.

(ii) Open steam cock slowly and close it when steam is heard roaring in the bilge

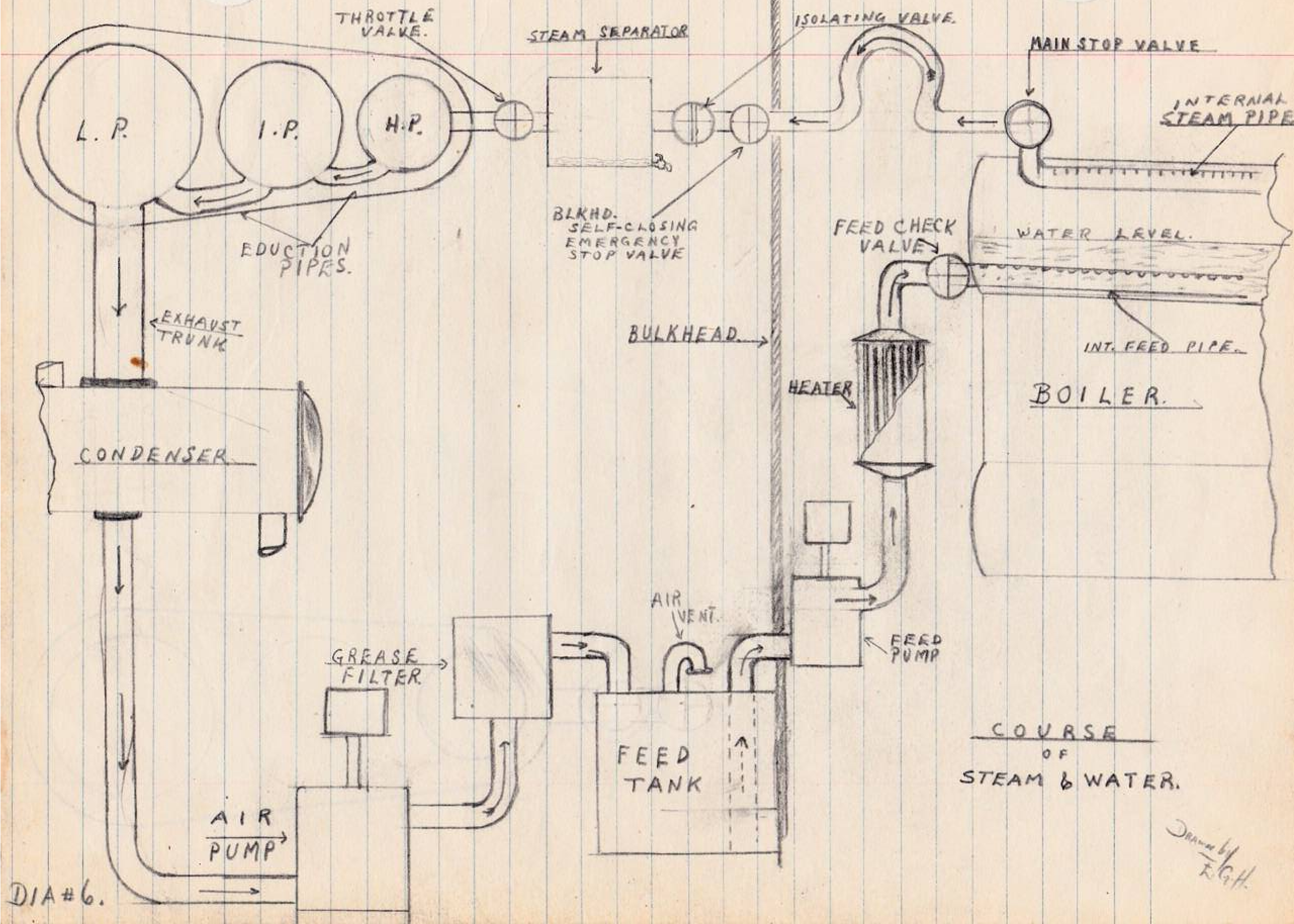
(iii) This indicates that steam orifice and drain pipe are clear.

(vii) Open water cock slowly, roar in bilge indicates water orifice is clear, close water cock.

(iv) Close drain cock

(v.) Open water cock slowly, due to steam pressure on top of water in boiler, water will rise to top of glass. If no water appears in glass, water is below water cock orifice

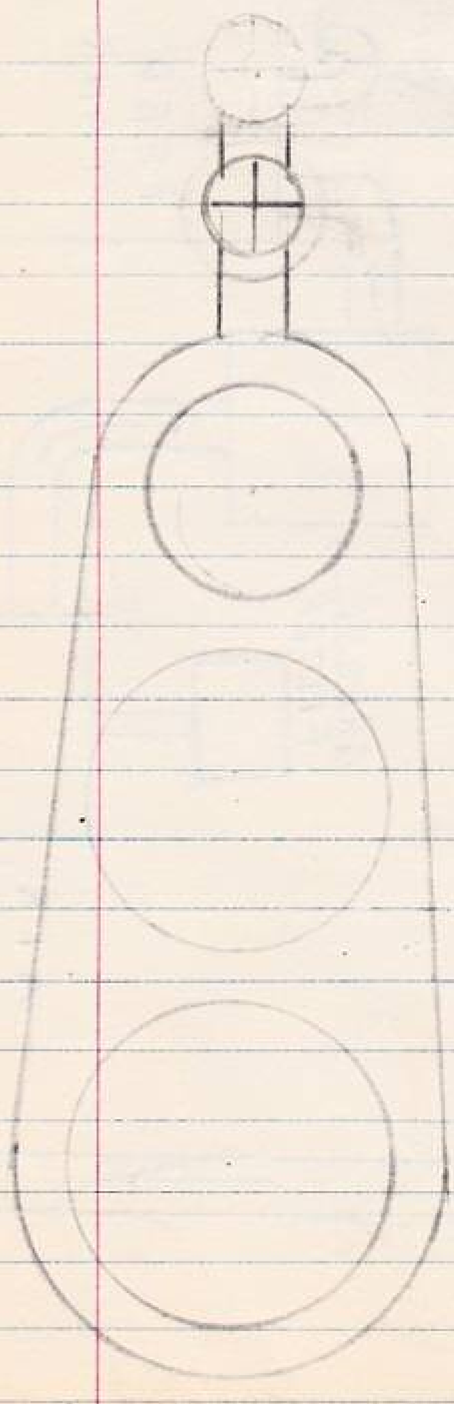
(vi) If water has appeared in glass, open steam cock slowly. The water in the glass will come down to the level in the boiler. If water level cannot be seen water is above steam cock orifice.



COURSE OF STEAM & WATER.

Drawn by R.G.H.

DIA #6.



Composition of Fuel.

Petroleum is a mixture of a large no. of compounds of carbon with traces of other substances. From petroleum we obtain by distillation, petrol, paraffin, diesel oil, lubricating oil, and boiler oil.

Coal consists of carbon with a varying quantity of hydro-carbon compounds and some combustiable matter. If coal is heated most of the hydro-carbons pass off in the form of gases. Most of the gases obtained by distillation of coal are used as coal gas, but a small quantity can be condensed to form liquid fuels. The remains when the volatile matter has been distilled off, is known as coke.

Advantages of Oil over Coal.

(i) Superior evaporation.
(ii) Regularity of combustion.
(iii) Facility of shipping and less space for stowing.
(iv) Reduction of boiler room staff.
(v) No loss of fire through cleaning.
(vi) No frequent opening of furnace doors
(vii) Absence of ash.

Disadvantages of Fuel Oil Over Coal.

(i) Dependant on foreign supply.
(ii) Increased cost
(iii) Greater risk of fire.
(iv) Loss of bunker protection and loss of fuel in case of a shell hole.

(v.) Complicated and weighty plant required to burn it.

(#1.) Calorific Value.

Is the amount of heat developed by the complete combustion of a pound of fuel, expressed in British Thermal Units.

One B.T.U. is the amount of heat required to raise one pound of fresh water to one degree Fahrenheit.

Calorific Value of Oil:-
Between 18,500 to 19,000 B.T.U.'s.

Calorific Value of Coal:-
Between 13,800 to 14,500 B.T.U.'s.
depending on the quality.

Flash Point - The point at which oil fuel is sufficiently heated to light temporarily. Naval Standard 195°F.

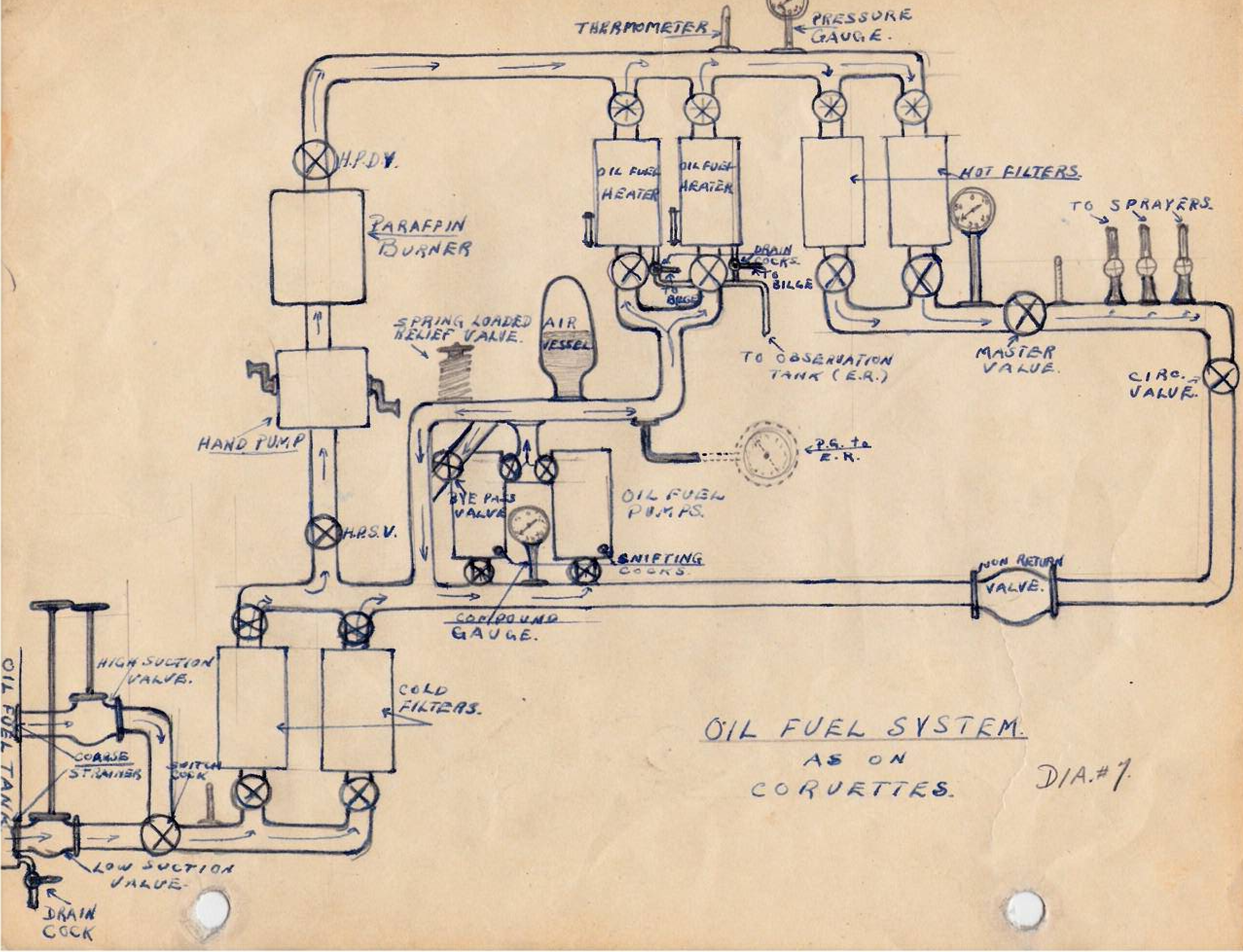
Ignition Point - The point at which the oil fuel is sufficiently heated to ignite and continue burning.

Causes of Black Smoke.
(i) Insufficient amount of air (oxygen)
(ii) Oil temp. too low.
(iii) Dirty or defective sprayer.
(iv) Dirty cones.

Causes of White Smoke.
(i) Too great an air supply. (oxygen.)
(ii) Air in the oil.
(iii) Water in the oil.
(iv)

Pulsation - (i) Air pressure too low
(ii) Oil temp. too high. (vapour in system)
(iii) Oil pressure too high.
(iv) Insufficient air in the air vessel.

Explanation The oil burns unsteady, with a series of small explosions which cause the boiler front to pulsate It can generally be stopped by increasing the air pressure.



OIL FUEL SYSTEM.
AS ON
CORVETTES.

DIA. #1.

Auxiliary Machinery -
The following is a list of the auxiliary machinery generally fitted in turbine-driven warships :-

Feed Pumps - for supplying water to the boiler.

Forced-draught fans for supplying the air for the combustion of the fuel in the boilers.

Oil fuel Pumps for supplying the fuel to the sprayers in ships with oil fired boilers. These pumps are also used for transferring oil fuel from one tank to another in ships where special oil-fuel transfer pumps are not fitted.

Main Circulating Pumps for circulating sea water through the main condensers, in which the exhaust steam from the engines is condensed. These pumps also supply cooling water for lubricating oil and drain coolers. They can be used to pump water from the engine-room bilges, if the engine-room is flooding due to damage to the ship.

Air Pumps or Extraction pumps and air ejectors, for removing the condensate and air from the condensers.

Forced lubrication pumps for supplying oil to the bearings of the main engines.

Water service pumps are fitted in some ships for circulating sea water through coolers, when the main circulating pumps are not running. In other ships, the fire and bilge are used for this.

Feed-water transfer pumps or overflow tank pumps for pumping boiler feed water from one tank to the other.

Feed-heater drain ~~pipes~~ pumps are fitted in some ships for pumping drain water for feed water heaters back into feed system.

Steering engines or motors for working the rudder for steering the Ship.

Capstan engine for working the anchors and cables. In addition to the forward capstan the larger ships have another capstan aft for handling mooring wires etc. The after capstan is always electrically driven.

Fire and bilge pumps for supplying the water to the fire service mains and for pumping out water from the bilges. Electrically driven pumps outside the machinery spaces, are called hull and fire pumps.

Salvage pumps for pumping overboard, large quantities of water in the case of damage to the ship. Steam ejectors may be fitted in some compartments for this purpose.

Electric generators for supplying electricity for lights and for electric motors.

Evaporating plant for making fresh water for washing and drinking, and for feed water to the boilers.

Refrigerating plant for cooling the cold rooms for the stowage of meat and vegetables and for making ice.

Magazine-cooling plant for cooling the magazines, this is not fitted in the smaller ships.

Ventilating fans for the ventilating machinery compartments etc. Supply fans are those which pump fresh air into a compartment, while those that remove foul and hot air, are called exhaust fans.

Air compressors for compressing air for use in torpedoes and for the air blast of guns.

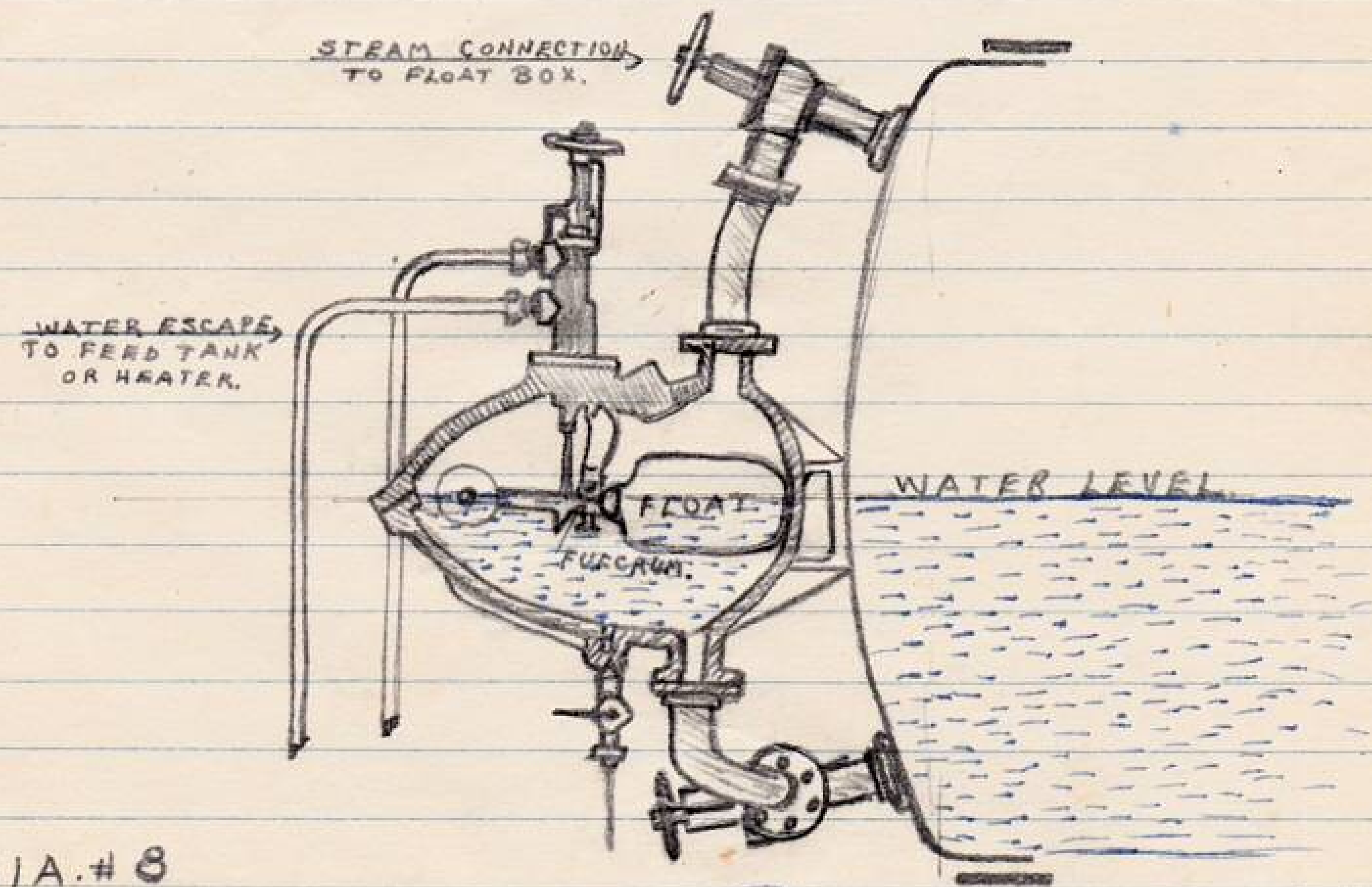
Hydraulic pumps for supplying water under pressure for operating the hydraulic machinery in the gun turrets of battleships.

Mumford Feed Regulator.

The necessity of automatic feeding has been incurred through rapid generation of steam from W.T boilers of small water capacity. The automatic generally fitted in the service, is the Mumford

This feed regulator is designed to lift the feed check only when the water level falls below set level. This is obtained by the fitting of the special feed check valve. Solid with the feed check valve of the normal design, is a piston of the same diameter as the valve seating. The piston being fitted with a slight clearance in a cylinder bore beneath the valve seating bore. The discharge from the feed pump is admitted between the valve and the piston, and in consequence the pressure exerted upwards and downwards is the same and the valve is therefore in equilibrium and forced down on it's seating by the boiler pressure above the valve. The space below the piston is connected by a pipe to the automatic regulator. This fitting consists of a float chamber bolted on to the front of the steam drum of the boiler so that the normal water level half fills the chamber with water, as it is connected by pipes and screw down valves to the steam and water spaces of the drum. The chamber is fitted with a detachable cover which incorporates a fulcrum standard on which a steel float and balance is mounted; which controls the movement of the needle valve which works in the needle valve box bolted to the cover.

The pipe from the underside of the feed check piston is connected above the needle valve seating and in consequence, when the water level is high the needle valve is held from it's seating by the lifting of the float, and the feed water passing the feed check piston then leaks away by a leak off pipe back to the feed pump suction.



DIA. #8

MUMFORD FEED REGULATOR.

Water Tight Doors, Hatches and Valves.
As many water tight doors, manholes sluice valves, air escapes, sounding tubes etc as possible are to be kept closed at all times. Every door, hatch, scuttle, ventilation valve, gas flap, fan and all openings through which gas or water may enter the ship, are to be marked as follows.

x openings which may be closed consistent with leaving the ship in a condition that the routine can go on efficiently and indefinately.

Y further openings which must be closed to bring the ship to the <u>action</u> condition.

Z. further openings which must be closed to bring the ship to the highest possible state of defense against gas.

O. those openings not marked X, Y or Z

As a general guide, the conditions under which the openings should be closed, are as follows.

X. When an attack is a possibility but not an immediate probability.

X and Y i.e. the first degree of action readiness, (eg. action stations at sea or aircraft attack likely in harbour.

X, Y and Z During a gas attack.

Lubricants.

Special mineral lubricating oil for main and auxiliary machinery including forced lubrication reciprocating engines of ships (except where otherwise stated.) Also for shafting and general purposes. Water will separate readily from this oil. This oil can be mixed with heavy filtered mineral oil if a higher viscosity is desired. Water will not then separate so readily from the mixture.

Compound Mineral Lubricating Oil.

For external parts of reciprocating engines not fitted with forced lubrication. Water will not separate readily from this oil.

Heavy Filtered Mineral Oil.

For use in impermeators and on piston and slide rods. Water will not separate from this oil.

Stern Tube Lubricant.

For lubrication of stern tubes

Neatsfoot and Cod Oil.

A dressing composed of Neatsfoot and Cod oils in equal parts, is used in the preservation of leather articles.

Taking Over a Watch.

(1.) Check the water level.

(2) Check the bilges for water level.

(3) Check pressure on boiler, oil fuel system and draught gauges. Check

(4) Check sprayers in use and see that spares are ready.

(5) Check which fuel and water tanks are in use and which are to be used as standby.

(6) Check oil level in fan engines, also check oil pressure gauges on same.

(7) Check oil save alls, deck for cleanliness and to make certain that no loose gear is laying around.

(8) Check temp. by thermometers on oil fuel system and on inlet and outlet side of feed water heater.

(9) Check auxiliary feed pump for being warmed through and ready for use.

(10) Check engineer officer's orders and boiler room register to see if orders have been carried out properly and to see if any changes are to be made during your watch.

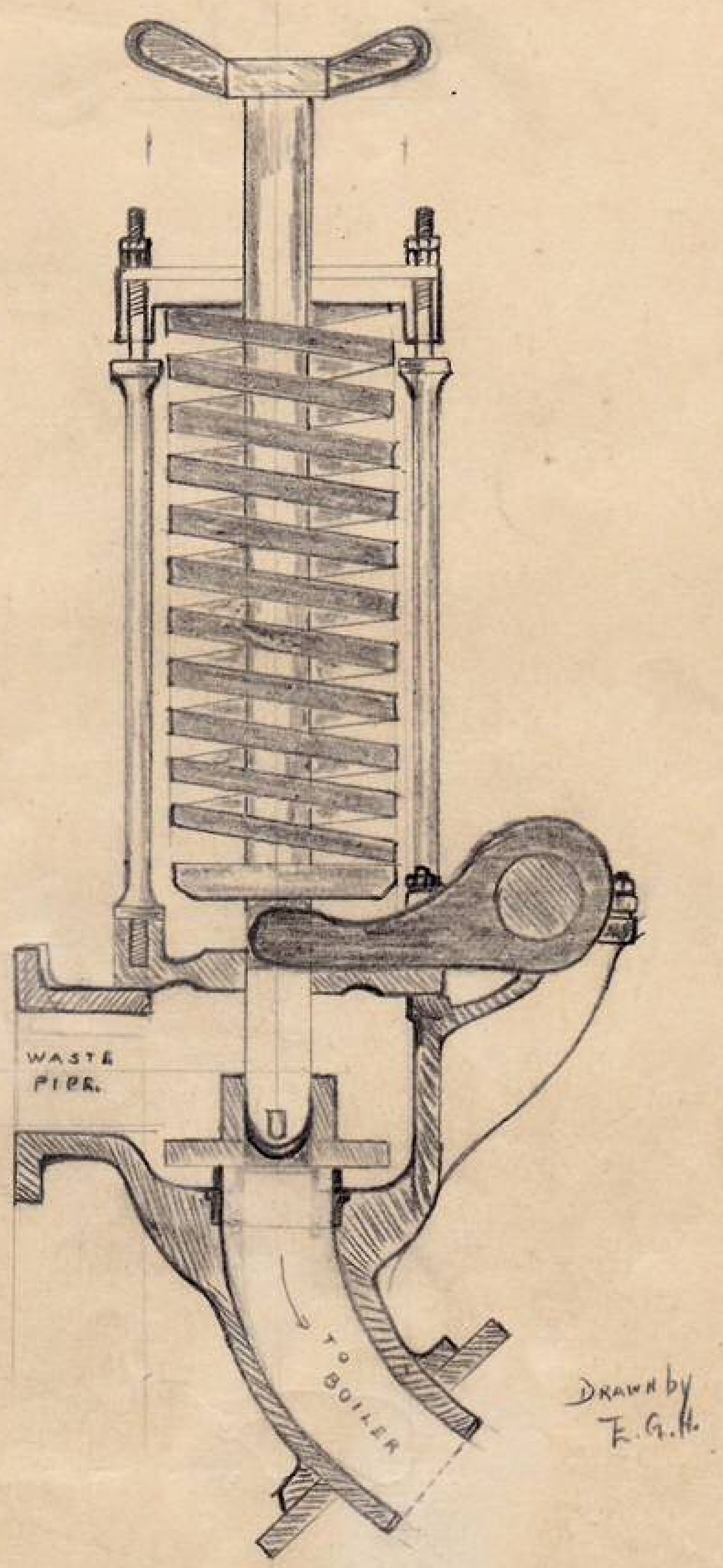
Pipe Colours -:

Venician Red - Fire Service Mains

Chrome Yellow - Main service, main suction and salt water service.

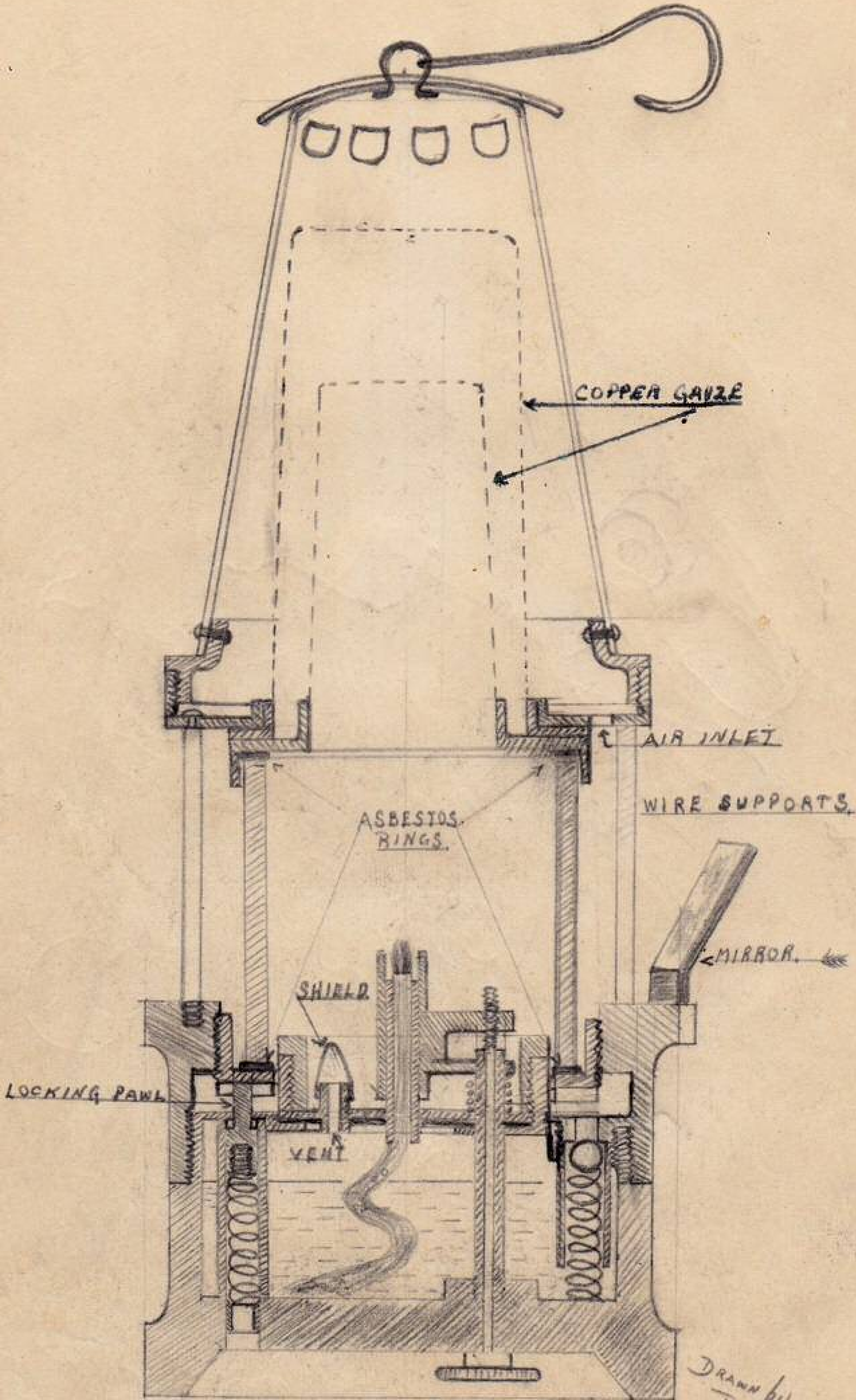
Spectrum Blue - Fresh water.

Pink pipe with black flange - For flooding and draining.



HIGH-LIFT SAFETY VALVE

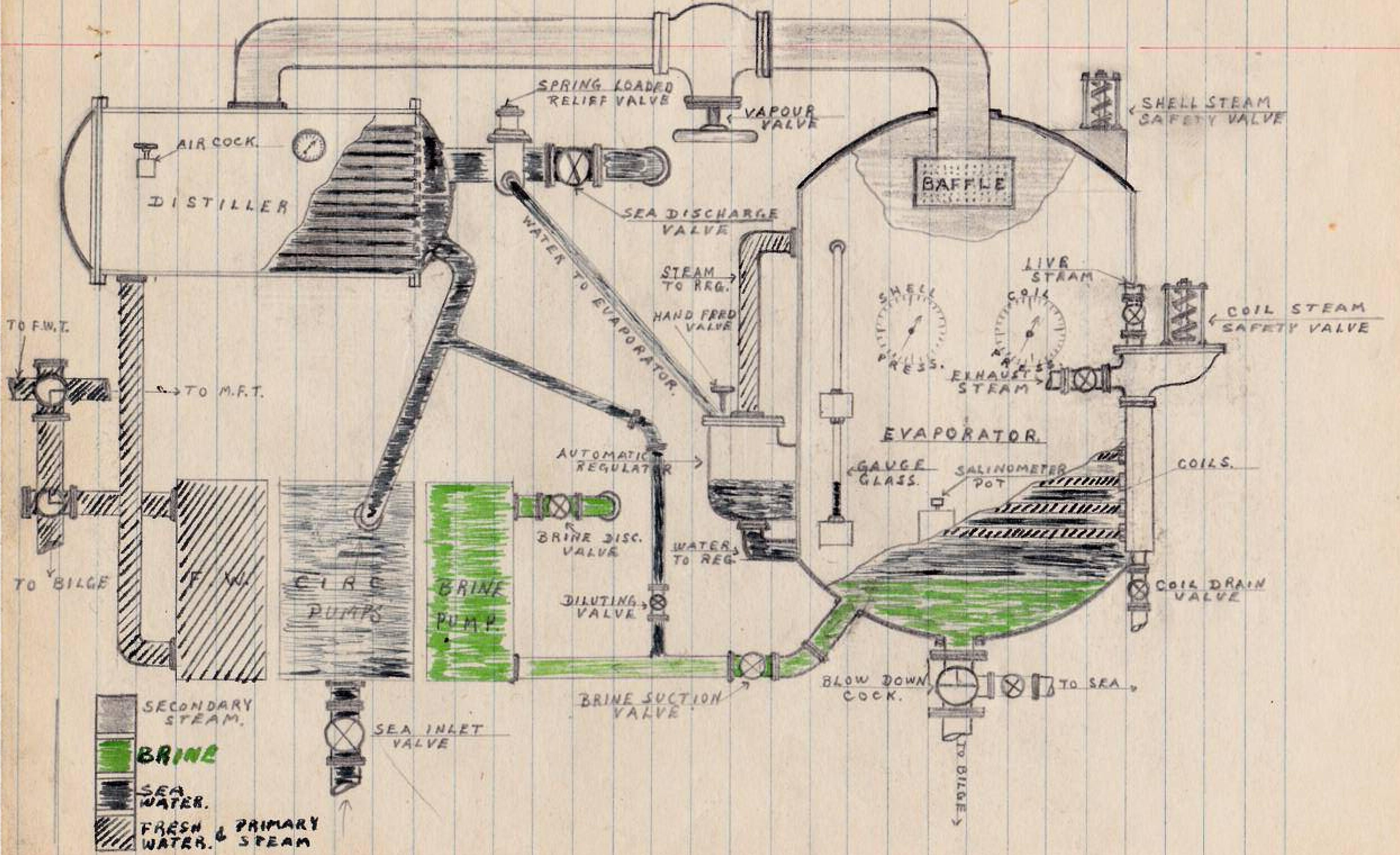
DIA # 9.



DIA # 10.

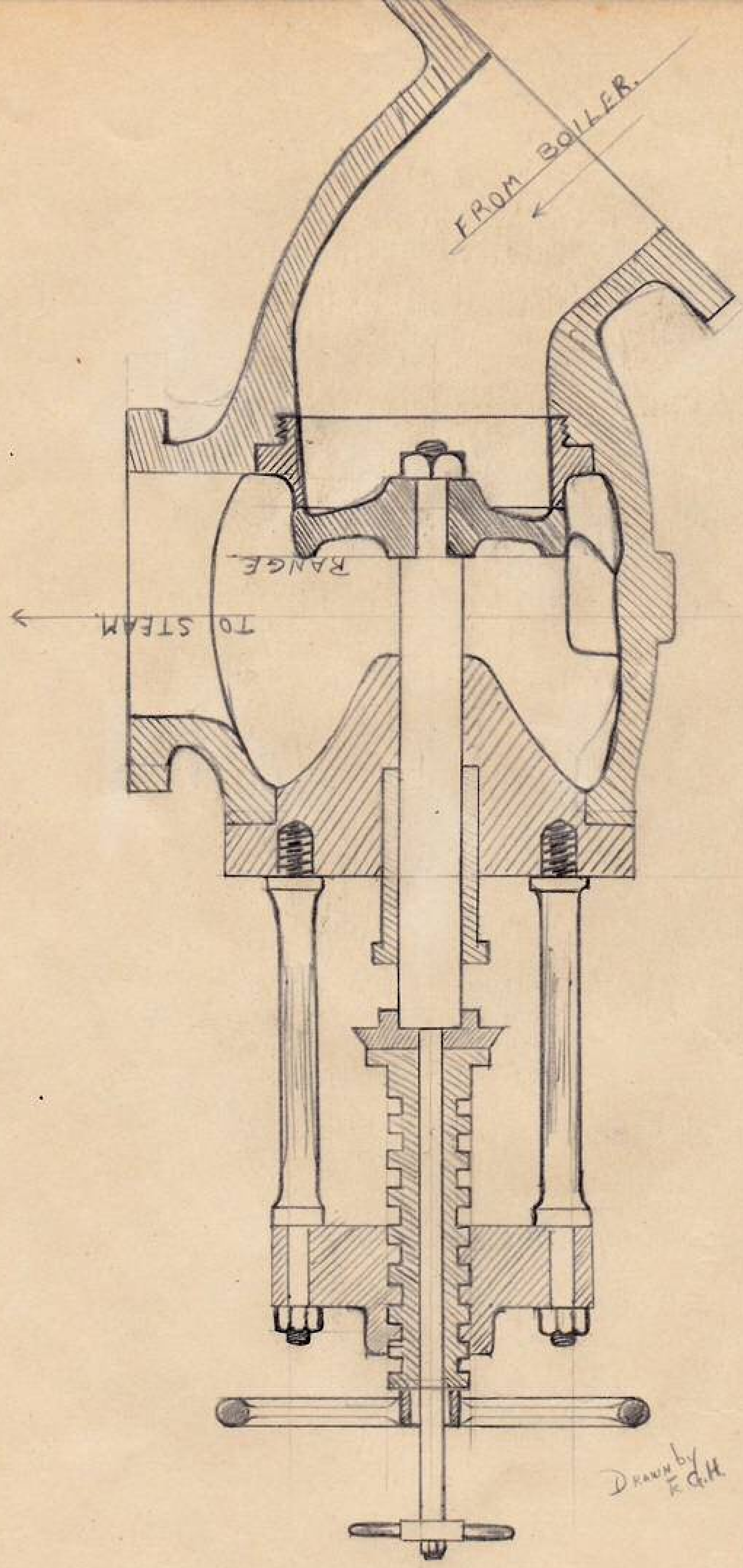
SAFETY LAMP

Drawn by
L.G.H.



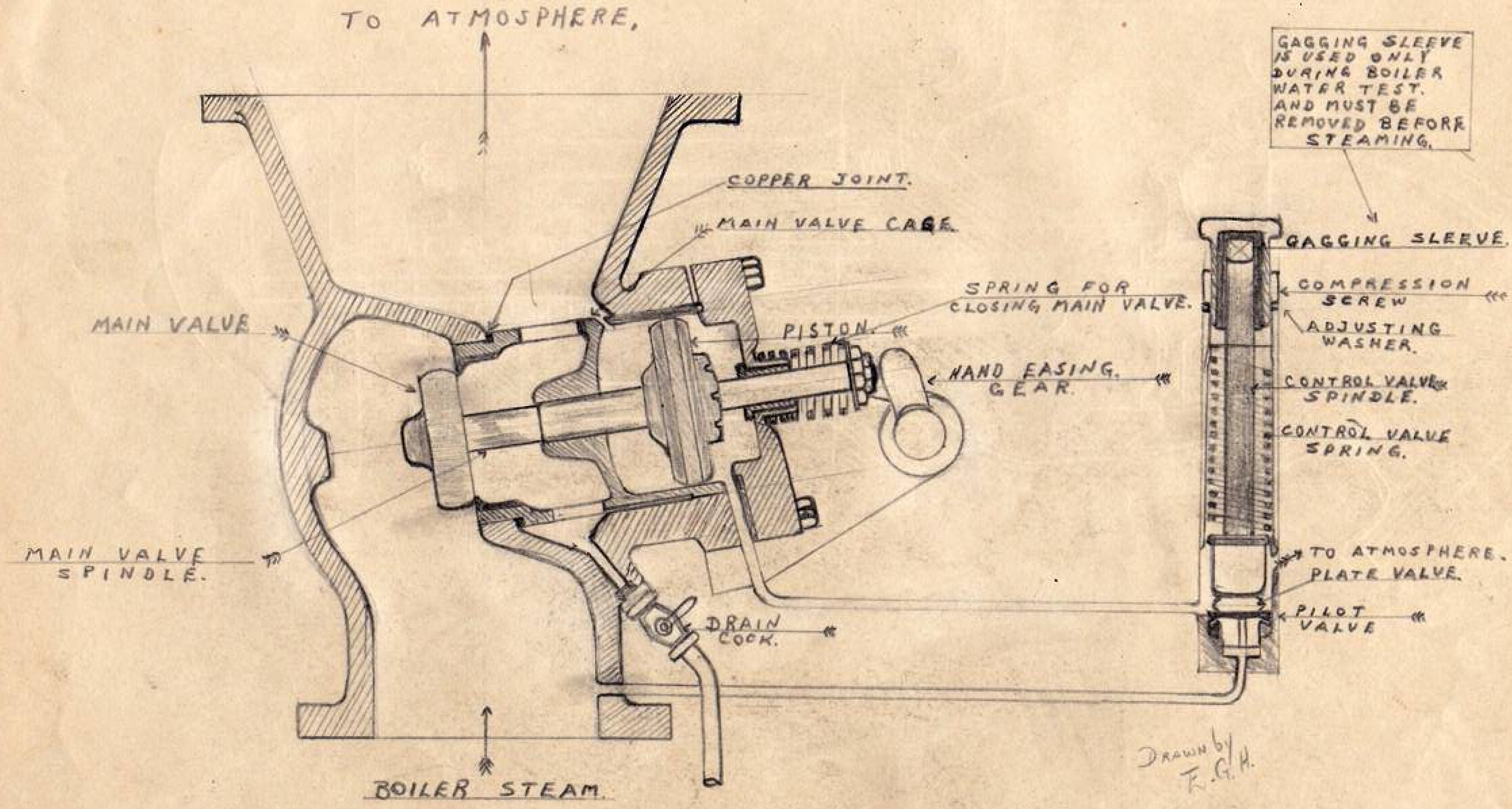
EVAPORATOR SYSTEM

DIA #11.



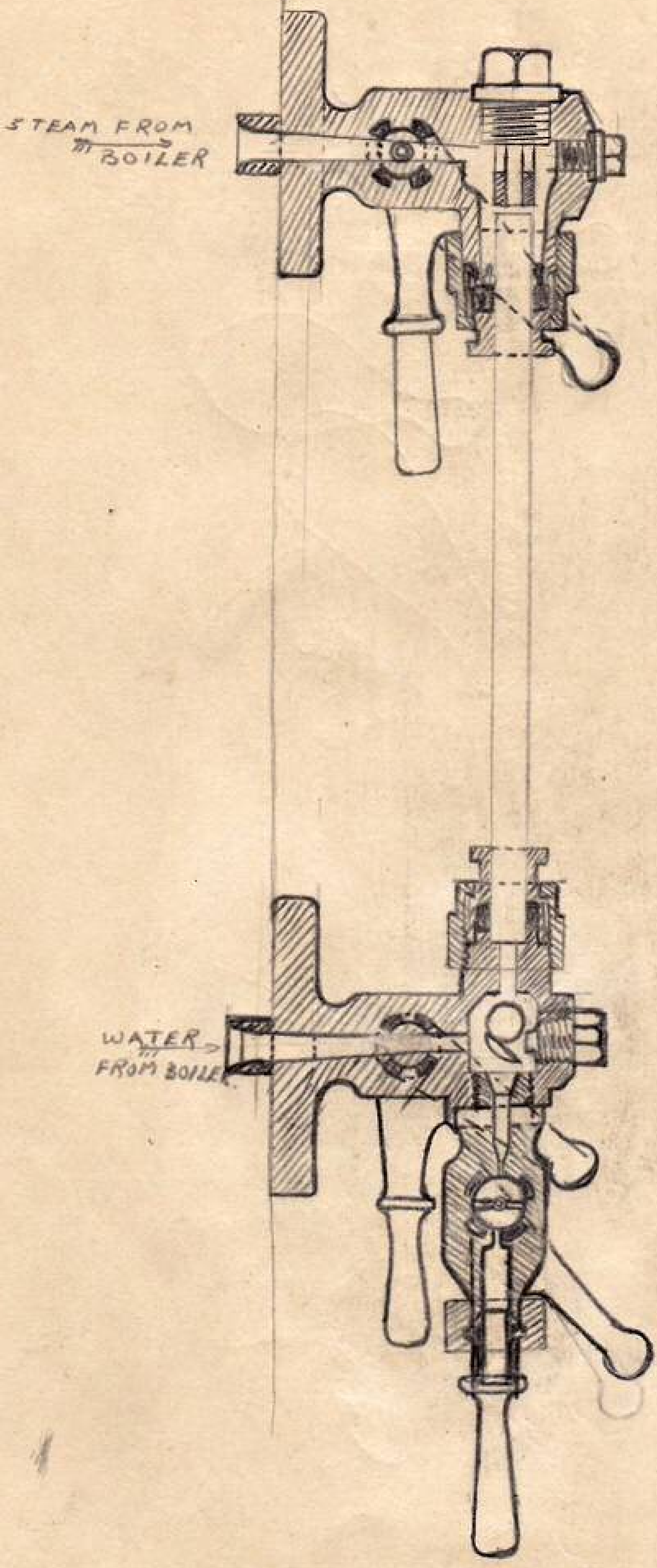
SELF-CLOSING
STOP VALVE.

DIA. #12.



FULL BORE SAFETY VALVE.

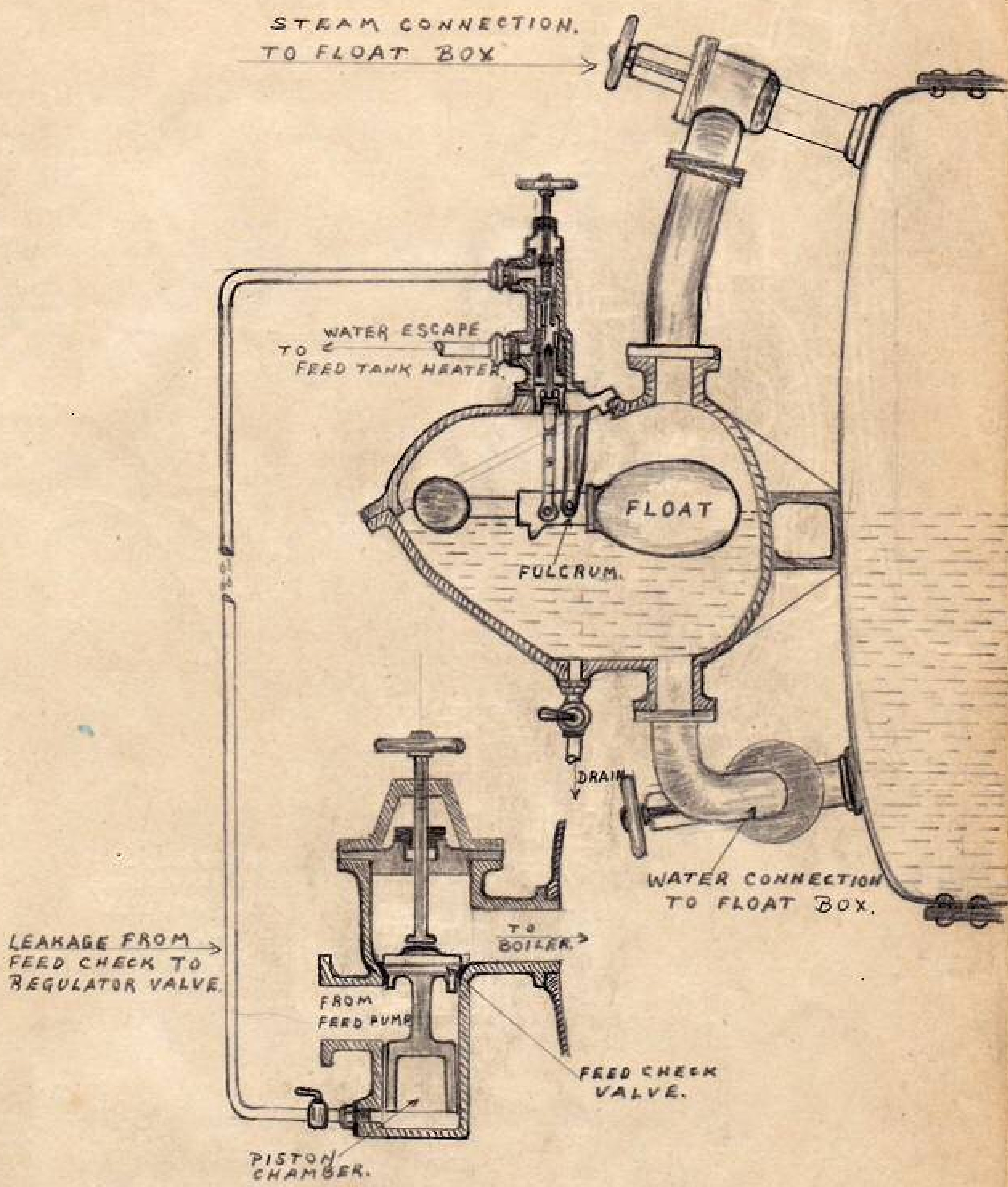
DIA. # 13.



DRAWN by E.G.H.

DIA #14.

WATER GAUGE.



MUMFORD AUTOMATIC
FEED REGULATOR.

DIA #15.

mil = $\frac{1}{1000}$" - circular mils Cm
1 inch = 1000 mils.

Size B.& S.	Dia Inches.	Area Cm	Res. Ohms. Per. 1000'	Weight lbs. per 1000 ft.
10	·1019	10380	·999	31·43.
11	·0907	8234	1·260	24·92
12	·0808	6530	1·588	19·77
13	·0720	5178	2·003	15·68.

1 Amp. requires from 508 to 2000 Cm cable

N. B.

A wire which is 3 times smaller than another, has twice the resistance and one half the weight and area. Also a wire which is ten sizes smaller than another, has ten times the resistance and one tenth the weight and area.

10 Copper wire has the following approx. values
— 1 ohm. R. per. 1000' at 20°C.
Dia. ·10"
Cross section 10,000. Cm
Wt. 31·4 lbs. per 1000 ft.

Ohm's Law. (Sign ω)

A current flowing in a closed circuit, is directly proportional to the force or voltage, and inverseley proportional to the resistance of the wire

Resistance	Voltage	Current.
Ohm	Volt	Amperes.
R.	E	I.

Milliampere = $\frac{1}{1000}$ of an ampere.

Microamperes = $\frac{1}{1,000,000}$ of an ampere.

Kilovolts = 1000 volts. or Kv.

Condenser ⊣⊢ (Capacity)

Megohm = 1,000,000. ohms.

$\frac{110V}{11\omega} = 10$ amperes.

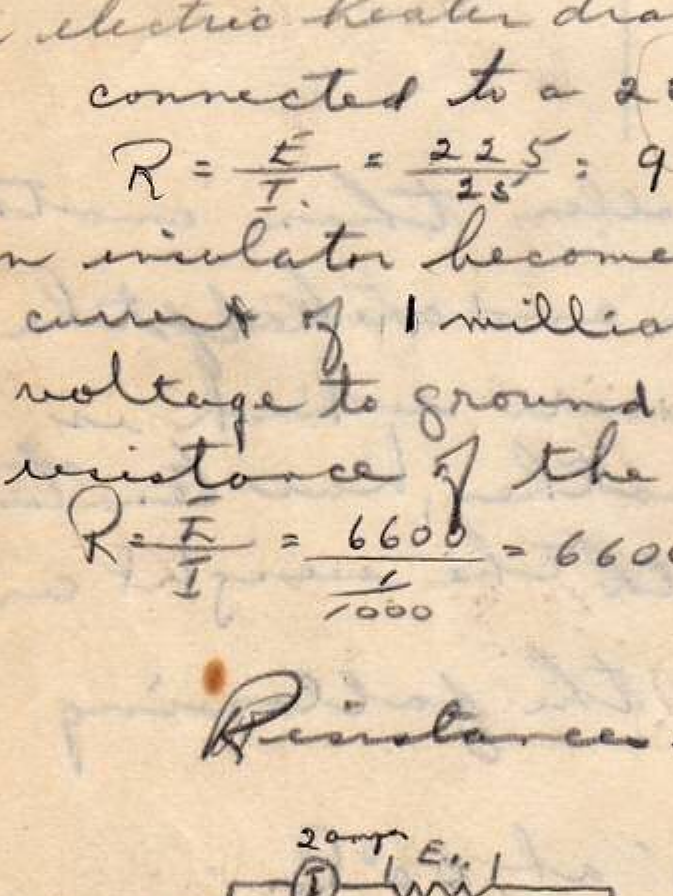
An electric heater draws 25 amperes when it is connected to a 225 v. source. What is it's R.

$R = \frac{E}{I} = \frac{225}{25} = 9$ ohms. (ω)

An insulator becomes wet and allows a leakage current of 1 milliamperes flow to ground. The voltage to ground is 6600 volts. What is the resistance of the insulator.

$R = \frac{E}{I} = \frac{6600}{\frac{1}{1000}} = 6600 \times \frac{1,000}{1} = 6,600,000$ Ohms $= 6.6$ mega.

Resistances in Series.



E1. = 10 ω
E2. = 20 ω
E3. = 30 ω

(1) $I = \frac{E}{R} = \frac{120}{60} = 2$ amps.

$E_1. = I \times R = 2 \times 10 = 20$ volts

$E_2. = I \times R = 2 \times 20 = 40$ volts.

$E_3 = I \times R = 2 \times 30 = 60$ volts.

Sum Total 120 volts.

1. 110 volts are app. across a circuit having a R of 22 ohms. How much current will flow.

2. An electric iron draws 5.5 amperes at 110 V. What is the R.

3 An electric furnace draws 55 amps. at 1100 V. What is the R.

4. An electric soldering iron has a R of 5.0 ohms and requires 2.2 amps. to heat it to the req. temp. At what V. must it be operated.

5. A tel. headset as used in radio work has a R. of 2000 ohms. It is damaged by being accidently connected across a 90 V. battery. How much current flowed through the headset. Give the ans. in milliamps.

Answers:

C 1. $I = \frac{E}{R} = \frac{110}{22} = 5$ amps.

C 2. $R = \frac{E}{I} = \frac{110}{5.5} = 2$ ohms.

C 3. $R = \frac{E}{I} = \frac{1100}{55} = 20$ ohms.

4. $E = IR = 5.0 \times 2.2 = 11.0$ volts.

5. $I = \frac{E}{R} = \frac{90}{2000} = .045$ amps. = 45 milliamperes.

The total resistance in a series circuit, is the sum total of all resistances in that circuit.

Deductions—

① Voltage drops in the series circuit add up to voltage source.

② Voltage drops across resistances is proportional to resistances.

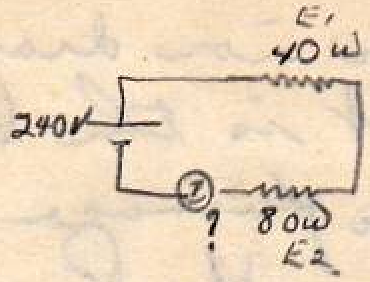
① E is completely used up in a closed circuit.

② E drops across each resistor according to ohms law.

$I = \frac{E}{R} = \frac{240}{120} = 2$ amps.

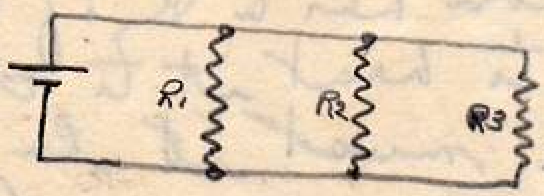
$E^{①} = I \times R = 2 \times 40 = 80$ volts.

$E^{②} = I \times R = 2 \times 80 = 160$ volts



Resistances in Parallel — 1 = Conductance.

①



$R_1 = 10.$ $R_2 = 20$ $R_3 = 30.$

$= \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$G = \frac{1}{10} + \frac{1}{20} + \frac{1}{30} = \frac{6+3+2}{60} = \frac{11}{60}$ mhos.

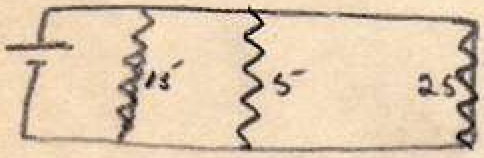
$R = \frac{1}{G} =$

When you have all resistors being equal, the total R in a parallel circuit is the value of one resistor divided by the total number of resistors.

② Resistors 2 in number.

$R_1 = 5$
$R_2 = 20.$

$= \frac{R_1 \times R_2}{R_1 + R_2} = \frac{5 \times 20}{5 + 20} = \frac{100}{25} = 4$ ohms.



$= G = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{15} + \frac{1}{5} + \frac{1}{25}$

$= \frac{5+15+3}{75} = \frac{23}{75}$ mhos $= \frac{75}{23}$ ohms $= 3 \ldots$

In Parallel Circuit

① I total = sum of individual currents

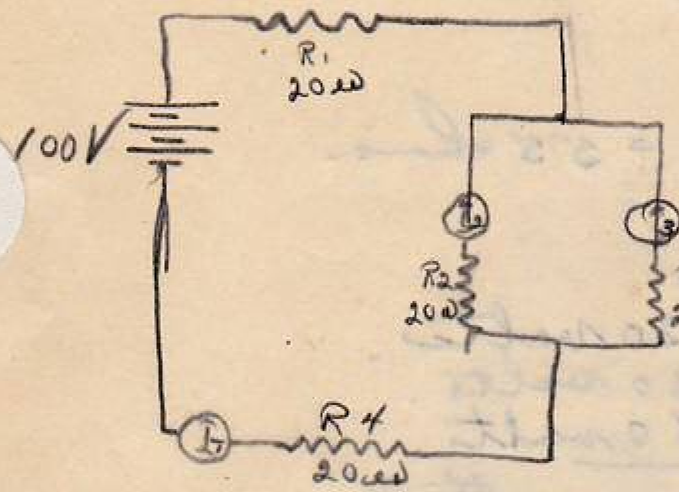
② The voltage source is applied across each R.

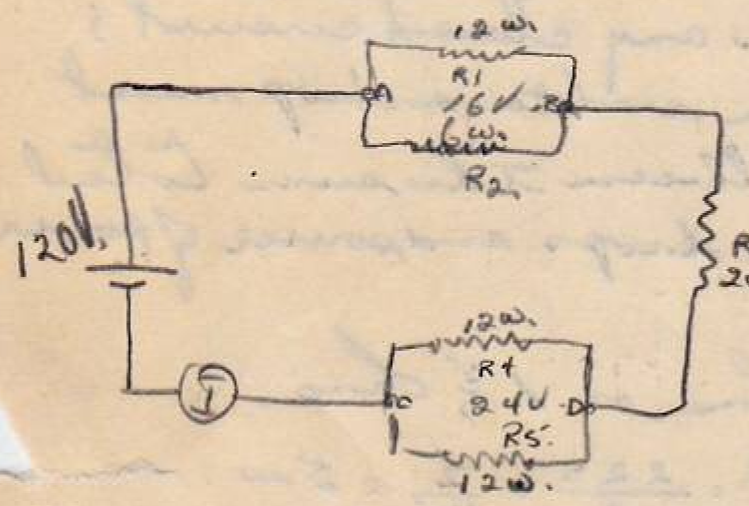
③ The current flow is proportional to the resistance value.

Kirchoffe's 1st. Law. —

Current flowing to a point is equal to the current leaving it.

Series Parallel Circuit.





$R_{C.D.} = \frac{12 \times 12}{24} = 6\omega.$ $R_T = 4 + 20 + 6 = 30\omega.$

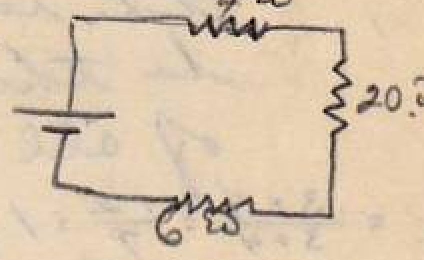
$R_{A.B.} = \frac{6 \times 12}{18} = 4\omega.$ $I_T = \frac{E}{R_T} = \frac{120}{30} = 4$ amps.

$E_{A.B.} = IR = 4 \times 4 = 16V$

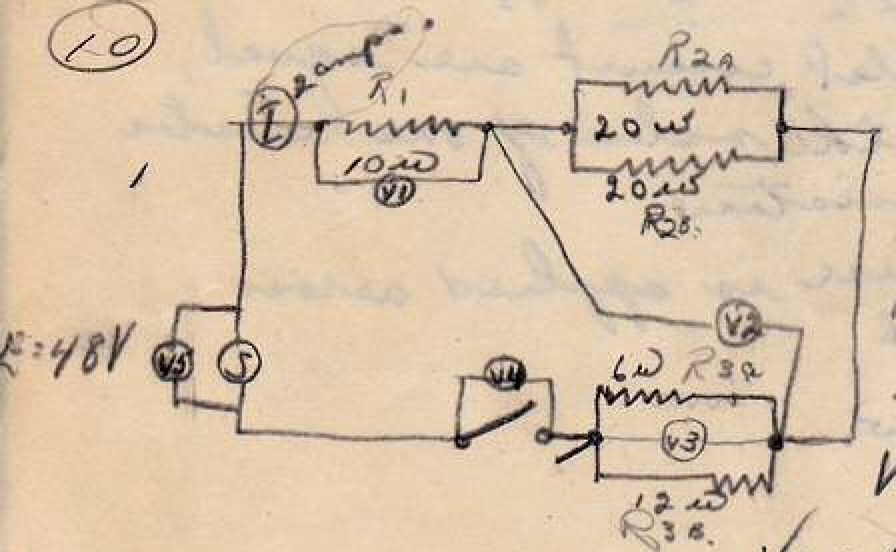
$E_{B.D.} = I R_3 = 4 \times 20 = 80V.$

$E_{C.D.} = IR = 4 \times 6 = 24V.$

$T.E = 120V.$



(10)



$R_1 = 10\omega$

$R_2 = \frac{20 \times 20}{20 + 20} = 10\omega$

$R_3 = \frac{6 \times 12}{6 + 12} = \frac{72}{18} = 4\omega$

$R_T = 10 + 10 + 4 = 24\omega.$

$I = \frac{E}{R} = \frac{48}{24} = 2$ amps.

Voltage drop on:

$V_1 = E = IR = 2 \times 10 = 20$ volts.

$V_2 = E = IR = 2 \times 10 = 20$ volts.

$V_3 = E = IR = 2 \times 4 = 8$ volts.

$V_4 = 0$ Reading.

$V_5 =$ 48 volts.

Current flow in: $R_1 = I = \frac{E}{R} = \frac{20}{10} = 2$ amps.

$R_{2a} = I = \frac{E}{R} = \frac{20}{20} = 1$ amp.

$R_{2b} = I = \frac{E}{R} = \frac{20}{20} = 1$ amp.

$R_{3a} = I = \frac{E}{R} = \frac{8}{6} = 1\frac{1}{3}$ amp.

$R_{3b}.\ I = \frac{E}{R} = \frac{8}{12} = \frac{2}{3}$ amp.

① $I = \frac{E}{R} = \frac{110}{11} = 10$ amps.

② Ohm's Law can be applied to any D.C. or A.C. circuit which has straight resistance.

③ $R = \frac{E}{I} = \frac{110}{5.5} = 20$ ohms. ✓

④ $E = IR = 50 \times 2.2 = 110$ volts. ✓

⑤ Total R. = 10 ohms + 15 ohms. + 30 ohms. = 55 ohms.

$I = \frac{E}{R} = \frac{110}{55} = 2$ amps. ✓ Same

6. Voltage drop across $R_1 = E = IR = 2 \times 10 = 20$ volts.

" " " $R_2 = IR = 2 \times 15 = 30$ volts.

" " " $R_3 = IR = 2 \times 30 = 60$ volts. ✓

Total E = 110 volts. ✓

Since total voltage is used up in any closed circuit; the remaining unknown voltage drop must be the difference between the sum total of all known voltage drops and source of power.

⑦ ① $R_T = \frac{3 \times 4}{3+4} = \frac{12}{7} = 1\frac{5}{7}$ ohms.

② $G = \frac{1}{3} + \frac{1}{4} = \frac{4}{12} + \frac{3}{12} = \frac{7}{12}$ mhos. $= \frac{12}{7}$ ohms. or $1\frac{5}{7}$ ohms.

③ $R_T = \frac{15 \times 15}{15+15} = \frac{225}{30} = 7\frac{1}{2}\omega = \frac{15 \times 7\frac{1}{2}}{15+7\frac{1}{2}} = \frac{112\frac{1}{2}}{22\frac{1}{2}} = \frac{225}{2} \times \frac{2}{45} = 5\omega$.

When all resistors in a parallel circuit are equal, the total R. is equal to the value of one resistor divided by the total resistors.

⑧ Yes. - The total voltage source is applied across each circuit.

$R_T = \frac{10 \times 15}{10+15} = \frac{150}{25} = \frac{6 \times 30}{6+30} = \frac{180}{36} = 5\omega$.

$I_1 = \frac{E}{R} = \frac{60}{5} = 12$ amps.

$I_2 = \frac{E}{R} = \frac{60}{10} = 6$ amps.

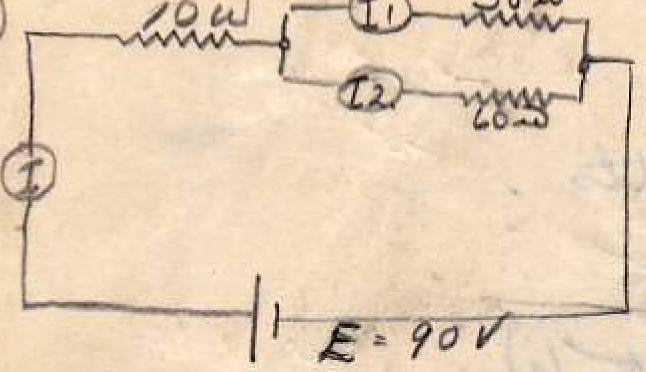
$I_3 = \frac{E}{R} = \frac{60}{15} = 4$ amps.

$I_4 = \frac{E}{R} = \frac{60}{30} = 2$ amps.

Yes - Kirchoff's law states that current flowing to a point is equal to the current leaving it.

(10) Parallel resistances total the current in the series
All voltmeter readings would read the same with switch open, that is the pressure at voltage source.

(11) (a)



$R_1 = 10\,\omega$

$R_2 = \frac{30 \times 60}{30 + 60} = \frac{1800}{90} = 20\,\omega$

$R_T = 10\,\omega + 20\,\omega = 30\,\omega$

$I = \frac{E}{R} = \frac{90}{30} = 3$ amps.

E at $R_2 = I \times R = 3 \times 20 = 60$ volts.

$I_1 = \frac{E}{R} = \frac{60}{30} = 2$ amps.

$I_2 = \frac{E}{R} = \frac{60}{60} = 1$ amp.

(11 b) Watt Rating of 30 ohm resistor = 1 Watt = 1 amp × 1 volt.

E at $I_1 = I \times R = 2 \times 30 = 60$ volts.

Watts $= I \times E = 2 \times 60 = 120$ watts.

1 Calorie = 1 gm to 1°C.

1 B.T.U. = 1 lb. to 1°F.

1 Dyne = 1 gram to accelerate 1 cm/sec. | 2.54 cm = 1"

= 1 ERG.

10,000,000 Ergs = 1 Joule

Power or Watts = E × I

1 Amp. through 1 ohm for 1 sec. uses up 1 watt.

1 lb. of water to 1°C = 4.2 Joules. = 4.2 watts

1 lb. of water to 1°F = 1054 Joules. = 1054 watts.

1 H.P. = 550 ft. lbs. of work.

778 ft. lbs. = 1 lb of water to 1°F, or 1054 watts.

or 1 B.T.U.

If 778 ft. lbs = 1054 watts,

1 H.P. or 550 ft lbs $= 1054 \times \frac{550}{778} = 746$ watts,

∴ 1 H.P. = 746 watts,

H.P. = 550 ft. lbs per sec or 550 #/sec.

1 Calorie = 4.2 Joules, energy to raise 1 gm. 1°C.

Power is a measure of Rate.

Energy is a measure of Quantity.

1000 Watts = 1 K.W.

746 Watts = 1 H.P.

$\therefore$ 1 K.W. = 1 HP $\times \frac{1000}{746}$ = 1·34 H.P.

30 K.W. $\times \frac{4}{3}$ = 40 H.P.

40 H.P. $\times \frac{3}{4}$ = 30 K.W.

1 microwatt = $\frac{1}{1,000,000}$ watts.

1 milliwatt = $\frac{1}{1000}$ watt.

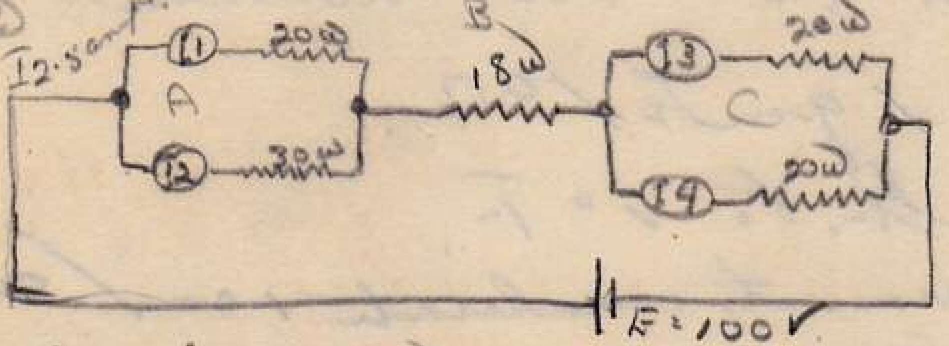
1000 watts = 1 Kilowatt or 1 K.W.

1000 Kilowatts = 1 Megawatt.

Output over Input = Efficiency rated in %.

QUESTION (2)

ANS. (2)



A - $R = \frac{20 \times 30}{20 + 30} = \frac{600}{50} = 12\,\Omega$

B - R = 18 Ω

C - $R = \frac{20 \times 20}{20 + 20} = \frac{400}{40} =$ 10 Ω

$R_T =$ 40 Ω

$I_T = \frac{E}{R} = \frac{100}{40} = 2{\cdot}5$ amps.

V drop on A = E = IR = 2·5 × 12 = 30 volts.

Classification of Fires.

To extinguish a fire it is necessary to eliminate one of three factors and it is done as follows -

Heat - by cooling

Oxygen - by ~~et~~ smothering.

Fuel - by elimination

Classes of fires.

A - WOOD AND WOOD PRODUCTS.

B. - INFLAMMABLE LIQUIDS.

C. - ELECTRICAL FIRES.

Class A fires are fought mainly with water. Either by extinguishers, stirrup pumps or hose methods. Calcium chloride is added to water containers to prevent freezing.

Soda acid extinguishers contain 2½ gals. of ~~mixture~~ water contained in a copper canister reinforced. A two foot rubber hose with a lead nozzle is attached. Inserted in the top of the tank is a leaden wire cage containing a bottle of sulphuric acid. The top of extinguisher is a ring cap fitted with a rubber gasket. This serves as a stand while in use. This cap is threaded and screws onto the neck of the tank.

To charge this container, mix 1½ lb. of bi-carbonate of soda in 2 gals. of water thoroughly, pour this mixture into the container then fill to water line with water. Next place 4½ ozs of sulphuric acid in bottle and replace stopper. Place bottle in leaden wire cage and hang inside the container. Replace iron ring on top, screwing down tight, making sure that rubber gasket is in place.

To discharge, turn the container upside down and play the hose at the base of the fire.

To charge an anti-freeze extinguisher, follow manufacturers directions.

Class B fires can be extinguished by foam, either from small hand extinguishers, large ones, or the hose method, where a foam mixture is added to the water in the hose line. The 2½ gal. extinguisher consists of a reinforced lead lined tank and can be distinguished by the red top or ring cap. They create a pressure up to 350 lbs. under working conditions. Inside this tank is found a cylinder, 2½ inches in diameter, approx 2 ft long. To charge, place a solution of "B" in outer chamber with 1¾ gal. lukewarm water. Mixture "B" is bi-carbonate of soda and licorice root or molasses to form a foam stabilizer. Mix solution "A" (aluminum sulphate) in 2¼ pts. of water and pour this into inner container. Replace this in extinguisher after making sure, lead stopper is in place then replace ring caps making sure gasket is in place. To discharge do same as with soda acid. i.e invert and play hose over fire. Through a chemical change the aluminum sulphate reacts with the bi-carbonate of soda forming CO^2 gas in bubbles which are held together by the presence of licorice root or molasses.

In recharging all of the above extinguishers always be sure that all parts are thoroughly cleaned.

CO^2 extinguishers -

These are found in four, 7½, 10, 15, and 20 lbs. sizes. Carbon dioxide is compressed to a liquid and placed into the extinguisher which is equipped with 2 ft. of heavy duty hose. The carbon dioxide being an inert gas displaces the oxygen around the fire, smothering it. If found to be 1 lb. or more less than correct weight. the extinguisher must be recharged. Can be used on electrical fires.

Class C

Vaporizing liquids - (carbontetrachloride) (Pyrene) This type is usually found in the one quart hand pump size. Also made in two gallon pressure type.

Carbontetrachloride (C.T.C.) is a liquid of unknown formula, it will not conduct electricity. When it comes in contact with an open flame, it will break down forming phosgene gas which is heavier than air, therefore excluding the oxygen from the fire and smothering it. Care should be taken in using this liquid as phosgene gas is poisonous.

Dry compound - This type of extinguisher comes in three sizes, using 7½, 12, and 20 lbs of dry compound. Exting. contain a cartridge of carbon dioxide for means of dispelling the compound.

Components of air - Nitrogen 78.05%
Oxygen 20.94%
Carbon Dioxide .03%
Argon

OLD TIME
FRI. - 8.30 - 9.00.
DIAL - 1345 KC.

Oxygen O^2 1.105.
Carbon Dioxide $C.O.^2$ 1.529.,
Carbon Monoxide C.O. 0.967
Ammonia $N.H^3$ 0.597
Hydrogen Cyanide H.C.N 0.697
Methyl Chloride CH^3CL 0.920.
Phosgene C.O.C.L2
Acetylene C^2H^2 0.906.
Sulphur Dioxide $S.O^2$ 2.264
Smoke
Organic Vapours
Acid Gases.

23 g at Luke

50
2.2
100
100
1100

.2
5.5)11.0

2 × 2 = 4

.045
200)9.000
800
1000
1000
0

2)009
1090

.045
2).090
8
10
10

1500

E × I = Watt.

V110 × I? W1500/110 = 150/11 = 13.63636 ..., 13½ amps.