LINER "FRANCE"

PROPULSION MACHINERY

OPERATION AND MAINTENANCE

GUIDE VOLUME III

BOILERS

I - GENERAL DESCRIPTION

The steam generation plant of the liner "France" consists of 3 Penhoët natural circulation boilers with the following principal characteristics :

- maximum evaporating capacity	90 T/H
- corresponding fuel consumption	6.500 Kg/h
- working pressure	71,5 Kg/cm^2
- maximum pressure at superheater exit	64 Kg/cm^2
- maximum superheat temperature	500°C
- feed temperature	120°C
- combustion chamber volume	51,4 m^3
- direct heating surface	93 m^2
- bricked surface	24,4 m^2
- convection heating surface	416 m^2
- primary superheater surface	248 m^2
- secondary superheater surface	248 m^2
- Green economizer surface	513 m^2
- Penhoët economizer surface	559 m^2
- Air heater surface	1.560 m^2

COMBUSTION CHAMBER AND STEAM GENERATOR

The lateral surfaces and the back wall of the combustion chamber are lined with radiation generator tubes. The entire sole and water walls up to a certain height are lined with bricks and refractory cement.

The entire convection tube wall is situated in front of the superheater. It comprises 11 tanks of tubes. Between the 9th and the 11th tanks, a gap allows access to the front of the superheater.

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SUPERHEATER

The superheater is divided into two units : saturated steam leaving the upper drum enters the primary (low temperature) element. From there, it is led to the secondary (high temperature) element, where it is rised to its final temperature.

In the tubing connecting the primary and secondary superheaters, is situated a water injection temperature regulation device, consisting of two spray nozzles and a stainless steel protective jacket.

The water is drawn from the feed main and its injection pressure is regulated by a MECI automatic valve. Either the two nozzles may be used in parallel, or either one may be used on its own. The upper nozzle has a greater diameter and output capacity than the lower one.

The superheater headers are compartmented in such a way as to cause the steam to circulate through two passes, in series, each set occupying half the height of the superheater.

In the primary superheater, the tubes and headers are built of carton steel ; in the secondary superheater, the headers are built of steel containing 0.5 % chrome and 0.5 % molybdenum. The tubes of the lower pass are of steel type Chromesco I(0.5 % Cr and 0.5 % Mo), and three of the upper pass are of EM II steel (1.25 % Cr and 0.5 % Mo).

The superheater supports are designed to be replaced without necessitating dismantling of the tube bundles. They are of moulded alloy containing 25 % chrome and 12 % nickel. At the front of the secondary superheater, they are protected from the direct radiation of the steam by a stack of bricks.

ECONOMIZERS

On leaving the primary superheater, the steam immediately enters the economizer which consists of two parts (fig.1):

- a Penhoët type economizer with bare steel tubes,
- a Green type economizer with tubes ringed with cast-iron fins.

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The Penhoët type economizer is itself divided into two tiers . Each tier consists of 4 units mounted side by side ; each unit may be dismantled individually and is free to slide longitudinally along its sub-frame. In the units of the lower tier, the tubes are fitted with longitudinal fins.
The Green economizer consists of 10 tanks of tubes placed one above the other.
On leaving the Green economizer, the feed water passes through a pre-heater before being introduced into the Penhoët type economizer. This pre-heater consists of a loop of piping of 107/127 diameter placed within the steam drum. Its function is to maintain the feed water, when this is at a low level in the boiler, at a high enough temperature on entry into the Penhoët economizer to prevent corrosion by sulphurous soots.
Permanent lenghts of piping sectioned off and bolted shut under normal circumstances allow either one of the economizers to be by-passed in case of a burst (see page 39 for instructions regarding these emergency steps).
Each economizer is protected by a Cocard Crosby safety valve set to 95 Kg/cm^2.

STEAM AIR HEATER

On expulsion from the boiler fans, air is directed into an SICC air heater divided into two symetrical sections. The air, compressed, mid-way along the boiler's length, is distributed into two circuits which have their exits at the front and rear faces of the boiler respectively, each passing through one of the two sections. Each section consists of 3 elements, each of which may be dismantled with cupro-nickel tubes ringed with fins of 3/10 mm thick red copper. These tubes are brased on to vertical steam and water headers.
The air heaters are fed with steam by the HP bleeder and the six elements exhaust in parallel into a bottle fitted with a Masoneilan water level regulator (see diagram n° 3640-2).
The elements are fitted with individual air vents open permanently to the drain tank ; this tank is fitted with an air vent pipe which must be permanently open when the boiler is in service.

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BOILER FANS

Each boiler is served by two Neu rotary distributor boiler fans (see Neu instructions). They have the following characteristics for an air temperature of 55°C :

a) 2 fans in parallel

- output	55 700 m^3/h
- static output pressure	620 mm WG
- total output pressure	644 mm WG
- fan shaft power	170 HP
- speed of rotation	1 770 RPM

b) 1 fan only in operation

- output	83 000 m^3/h
- static output pressure	398 mm WG
- total output pressure	425 mm WG
- fan shaft power	200 HP
- speed of rotation	1 770 RPM

The fans are driven by 250 HP single-polarity motors.

The impeller and the motor drive shaft are mounted at their coupling on smooth sea water cooled bearings : at their two ends, they are mounted on conical ball bearings acting as stops. Output is regulated by a ring of dampers fitted in the intake and operated by a MECI Type T.12 servo motor.

A counterbalanced lid is fitted in the fan delivery divergent nozzle. Finally, a control valve allows one fan to be isolated at rest ; it is operated by remote control from the boiler-room watchkeeping position by means of a Teleflex cable.

A contactor prevents a fan being started up if its dampers are not completely closed ; their closure is indicated by a green signal light on the boiler room control console. It is impossible to start up if the green light is not on.

It is possible to operate on one fan per boiler up to a fuel-oil consumption of 4 000 to 4 500 Kg/h per boiler ; beyond this point, two fans in parallel are necessary.

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Operation on two fans in parallel is possible down to the lowest rates of consumption. However, at rates below 4 000 Kg/h, it is less economical than operation on a single fan, and at very low speed, it renders boiler air regulation a more delicate matter.

INTERIOR ASSEMBLY

The interior assembly is limited to the steam drum which contains :

- a feed pipe slotted on the upper side
- a steam inlet pipe
- a pre-heater
- a service desuperheater consisting of an immersed tubular element fed by steam drawn off at the secondary superheater outlet. The desuperheater consists of two elements in series, with straight steel tubes.

EXTERIOR ASSEMBLY (see diagram n° 1130.3)

1) Cockburn's - A.B.C. automatic rapid closure valve (see A.B.C. instructions)

This valve acts as a non-return valve on the superheated steam outlet, and can be closed by remote control by means of two relay valves, one situated at the boiler face, the other on the control console in the engine room.

2) Desuperheated steam inlet valve

This valve can be remotely controlled from C. desk gangway by means of a Telektron pneumatic control system (see special instructions).

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3) Safety valves

- For saturated steam, two Cocard Crosby valves mounted directly on top of the boiler drum (see Cocard instructions for description and adjustment). They are set respectively at 71.5 and 71.3 Kg/cm^2.
- For superheated steam, one Forster-Vapor valve set at 66 Kg/cm^2 (see special instructions for description and adjustment). This valve can either function spontaneously or have its action initiated by a saturated steam pilot valve set at 71 Kg/cm^2 ; the back pressure of this latter moves the piston of a jack (see figure n° 3).

4 - Levels

The "Pétrole service" transparent level gauges consist of three offset glasses ; in addition, the two mountings are themselves offset by the height of one glass in relation to one another, so that the normal level corresponds approximately to the top of the middle glass of the mounting nearer the ship's centre-line, and to the bottom of the middle glass of the mounting on the outboard side (see sketch n° 4).

The normal level is marked on the mountings by a red line on a small scale A white band represents the limits of admissible variation. To replace the level glasses, follow the "Pétrole Service" instructions contained in the annexe to page 49 of this guide. The nuts must be tightened using a dynamometric spanner which forms part of the ship's tool kit.

In addition, each boiler is fitted with a Bailey-Jerguson remote indicator with an electric repeater on the engine-room control console (see Bailey instructions)

5 - Soot blowers

Each boiler is fitted with 12 Forest soot-blowers with electric remote control (see special instructions). The soot-blower are controlled automatically by push-buttons in the soot-blower console, situated in the boiler-room gangway. Control is effected by a semi-automatic sequence, i.e. if a certain number of buttons in the console have been pressed beforehand, the corresponding soot-blowers will start up automatically one after the other in numerical order. The number of ./.

passes made by the soot-blowers can be adjusted : when new, the machines are adjusted for 3 blowing operations.

The allocation of the soot-blowers is shown in sketch n° 5.

- Blowers 1 - 3 (front face) and 2 - 4 (back face) are retractible machines placed in the gap above the secondary superheater.
- Blowers 5 and 6 are fixed-head machines, which blow through the back of the primary superheater and underneath part of the Penhoët economizer,
- Blowers 7 and 8 serve the lower units of the Penhoët economizer,
- Blowers 9 and 10 operate on the upper units of the Penhoët economizer,
- Blowers 11 and 12 serve the Green economizer.

An individual air inflow on each soot-blower prevents combustion gases surging back into the piping and causing corrosion there.

MECI AUTOMATIC REGULATION

All details concerning this equipment will be found in the MECI operating instructions. This guide will limit itself to providing a reminder of data of which knowledge is essential for the operation of the boiler rooms.

1) Steam pressure regulation

The control gauges (2 in each boiler room) measure the pressure of the superheated steam in the bulkhead piping of heater I to port and to starboard. They control the oil pressure at the distributor by adjusting the openings of the valves which discharge into the fuel line.

A 3- way tap, placed in the centre of the control console, provides the following choices :

- separate operation in which the two fuel lines, port and starboard, operate individually, regulated by the two control gauges, it is imperative that this mode of operation be used when the live steam main cross-connection is not open.

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- joint operation in which a single control gauge (either port or starboard) controls all the boilers. This mode of operation is recommended wherever the main steam line cross-connection is open. When 3 boilers in each boiler room are being used, control should generally be given to the control gauge on the side on which 2 boilers are lit.

Note 1 - Good care should be taken to avoid incorrect procedure resulting in the admission of impulsion to isolated steam piping, or in impulsion operation on one side only if the main steam line cross-connection is closed.

Note 2 - It should not be forgotten that whilst a boiler is on line through desuperheated steam only, its pressure is not under the control of the automatic regulating system.

2) Regulation of the fuel/air mixture

Smoke flow is measured by the combined pressure drop in the economizers. The rate of flow of oil for each boiler is measured by the pressure drop of a diaphragm situated above the burner register. In fact, two diaphragms are fitted in series, each one associated with a control gauge type S.200. The first covers its whole movement between 210 and 1050 g/cm^2 . The second moves from 0 up to the maximum rate of oil flow of 6 500 kg/h. An inversion relay gives priority to"low flow"impulsion below 2 500 kg/h and to "high flow" above this figure. The object of this device is to improve the precision with which the rate of oil-flow is measured at low consumption figures.

A relay compares smoke flow with oil-flow in order to maintain a constantly balances fuel/air mixture.

The quantitative differentiation made by this regulation system is such that a rigidly constant fuel.air ratio should generally be obtained, regardless of the number of burners in operation and of the type of nozzles being used. In practice, a surplus of air is experienced, which is greater at low rates of consumption. The air flow can be adjusted by means of a pressure transformer. Normal adjustment corresponds to the first mark on the transformer. To increase air-flow, reduce the transformation ratio (0.8 - 0.6 etc...) ; to reduce air-flow, increase the transformation ratio (1.2 1.4 etc...)

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The oil flowmeters are fitted with a steam heating device which [illegible] be switched on approximately 2 hours before using the regulation sy[illegible]

The smoke flowmeter should be set to zero when the smoke ducts a[illegible]e warm, with the boiler stopped and the boiler fans isolated. Under these conditions, the zero takes accoung of natural draught. If the zero were set when the ducts were cold, an abnormally large excess of air would be obtained at low operating levels.

Since oil flow is measured at entry into the registers, care must be taken to ensure that the header return is well isolated and airtight ; any leak in the header return upsets the operation of the regulation system by increasing the excess of air.

3 - Feed regulation

The system comprises 3 elements : 3 S.200 differential gauges measuring respectively :

- level variations (amplitude ± 375 mm in relation to standard level)
- feed water flow (diaphragm at drum water inlet)
- steam flow (pressure drop in first pass of primary superheater).

A substraction relay compares feed water and steam flow and corrects the impulsions of the level measuring device.

For the regulation system to function correctly, the output pressure of the turbo-feed pumps at zero rate of flow should be slightly higher than working pressure, and under way this should be increased by the value of the pressure drop in the economizers, which reaches approximately 9 kg/cm^2 for maximum steam generation (6 500 kg/h of oil) . A satisfactory adjustment corresponds to 75 kg/cm^2 at anchor and to between 80 and 85 kg/cm^2 under way.

Note : Rigorous care should be taken to maintain complete airtightness at the differential gauge impulsion inlets : a blow-hole or joint leak, or leak of any king would cause the differential gauges to give false readings.

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4) Regulation of superheat temperature

This is effected by two water-injection elements. A control pyrometer records the final temperature (on the face of the control console). A second pyrometer within the console receives a derivative action ; it measures the temperature between the primary and secondary superheaters after the injection of water. This post-injection is repeated on a series 15 display on the face of the console.

Water injection is carried out selectively by one of two nozzles. The upper nozzle, type R.35 60-6-47 is capable of a greater output than the lower nozzle, type R.35 41-6-32. The nozzle to be selected is that which allows injection on to the MECI valve with the least opening adjustment. This will in addition, ensure optimum spray quality.

In commencing water injection, avoid hiccoughs. It is recommended that manual control be used initially before passing over to automatic control.

Peaks of superheat should be avoided. A superheat temperature alarm is given by the "Pyrométrie Industrielle" recording pyrometers, and another alarm signals loss of tension on the MECI superheat control pyrometers. Avoid leaving sections of the nozzle covers open when injection is not being carried out. A leak in the injection valve or its by-pass could reduce superheating to an abnormal level.

5 - Membrane rupture warning signal

The different servo-motors of the MECI regulating devices are built with double membranes. Rupture of a membrane is signaled by a pressure contactor Continued operation is possible temporarily on the second membrane until the defective one can be repaired.

6 - Compressed air feed (see Operating Instructions Volume I page 77)

A supply of dry, oil-free air is essential. A watch should be kept on the oil consumption of the compressors and on the working order of the Gohin Poulenc dehumidifying and oil-scrubbing equipment. The control devices are fed through 3 batteries of filters and pressure-reducers situated within the control console.

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These batteries comprise :

- 1 filter with felt and porcelaine elements,
- 1 pressure-reducer,
- 1 second paper filter below the pressure-reducer.

One pressure-reducer feeds two boilers ; there is therefore one set of filters and pressure-reducer permanently in reserve.

The filters should be maintained in a state of cleanliness, the elements being replaced as often as necessary.

7) Loss of compressed air

On loss of compressed air :

- the feed control valves close automatically,
- the oil valves open automatically, lowering the oil pressure to a minimum,
- the desuperheating water injection ports close automatically,
- the boiler fan servo-motors have an automatic tendency to shut down, but the aerodynamic pressure acting on the dampers maintains these latter in an intermediate position (see page 77 for action to take in the event of a compressed air breakdown).

DUST COLLECTORS

Each boiler is equipped with two "Ventil Cyclogalax" dust collectors (see special instructions) :

- 1 Cyclogalax VA.5 (small dust collector)
- 1 Cyclogalax VA.8 (large dust collector)

These pieces of equipment are built of stainless steel and work by aerodynamic centrifugation fo dust particles.

The small dust collector, alone, should be used at low levels of operation (at anchor) in order to achieve effective removal of dust. Under way, the two dust collectors should be used in parallel.

A shutter with two positions is fitted in the inlet of the large dust collector ; it can be operated by remote control from the boiler room control console by means of an automatic jack (see diagram n° 6).

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Before moving the "Pilotair" operating handle, press is to its full extent the unlocking button which must be held in this position until the operation is completed (completion of movement shown by an indicator light) : the green light indicates that the shutter is open and the red that it is closed.
A second shutter allows the small dust collector to be isolated ; it is operated directly and locks in the open position. It has a tendency to open under the action of the gas flow ; a red indicator bulb lights up on the control console if it is closed.

Important note -

Never light a boiler without having checked beforehand that the shutter of the small dust collector is locked open.

Soot evacuation is carried out hydraulically through linkage with the firing commutator. The interior of the evacuation commutators is vulcanite-protected. This evacuation must be in permanent operation on all 8 dust collectors as long as a boiler is lit in the boiler room.
Overflow pipes, connected to the water inlet, empty into the bilge pressing through an eye-piece in the boiler face.
The overflow pipes end in a pot with a water reserve : these pots must be supplied with water in order to avoid any discharge of soot or gas into the boiler rooms.
Above the isolating shutters of the dust collectors, each smoke duct is fitted with a shutter ; the space between the two series of shutters can be supplied with air by a special gastightness fan (1 in operation and 1 in reserve in each boiler room). This fan must be in operation at sea when one or several boilers in the boiler room are closed down, in order to prevent block-back of gases into the boiler(s) in question. Open the air shutter allowing the fan to supply the closed down boilers. Keep closed the eclipse gasket situated on the delivery side of the fan not in use.

FUNNELS

Each funnel is fitted with two fins for lateral smoke evacuation.

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The smoke ducts below the dust collectors meet in a single drum built of light alloy. A 3-position sector balanced shutter allows the smoke to be evacuated either through both fins at once, or on one side only. In a cross-wind in order to avoid the smoke being blown back down, it is advisable to close up the leeward fin and to allow the gases to escape through the windward one, the smoke then passes above the funnel and is blown down far from the ship.

The shutter is operated from the boiler room gangway by means of a pneumatic jack (see diagram n° 7) ; a bolt holds the shutter in position.

To operate the shutter, first throw the unlocking lever. The lug which locks the 3-position selector knob is withdrawn when the unlocking is effective. Then, move the knob to the desired position. Release the unlocking lever when the corresponding indicator bulb is lit.

Do not shift the shutter from port to starboard in a single movement. Operate the controls so as to stop the shutter in its mid-position before changing sides.

When one of the fins is closed, the pressure drop in the smoke ducts is increased (50 mm approximately at cruising speed). It is therefore advisable to operate with the shutter in its mid-position whenever the direction of the relative wind permits.

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II - PENHOET OIL FUEL BURNING EQUIPMENT

BURNERS AND AIR DISTRIBUTORS

The oil fuel burning equipment mounted on the boilers consists of Penhoët Type 1100-6.C air distributors, fitted to operate with fixed-flow burners, variation being obtained by altering the delivery pressure of the fuel. Each boiler possesses six distributors, five controlled pneumatically and one manually. The burners are fed with oil by a distribution register. The central burner can be fed with light fuel by special detachable piping to allow starting from cold. The five burners and air distributors are operated from the boiler room control console by pneumatic control.

BURNERS (Plate 1)

Penhoët burners use mechanical atomization.

A burner comprises a single-block body (1), at the front end of which is mounted a nozzle (2) secured to the body by a nut (3). The rear end, fitted with an isolating handle (4), contains the fuel inlet, and fixes the burner to its support. A circular asbestos joint ensures gastightness on the firebox side and prevents combustion gas blow-back into the boiler room.

The burner is held in place on its support by a single screw fitted with an operating wheel and mounted on a tipping stirrup. At the front it is centred in the guide-tube by two guides and by fins welded to the body. Screwing down the burner removes at the same time the ball from the safety valve.

The mounting and dismantling of a burner can be carried out in a very short time.

The burner nozzle (2), fixed to the front end of the body, provides mechanical atomization. The fuel is led from outside the nozzle into a whirling chamber through tangential cylindrical passages set at a determined angle to the horizontal This ensures rotation of the fluid in the chamber prior to its projection, in very fine droplets, through the sprayer orifice centred on the chamber.

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The whirling chamber is closed on the side opposite the outlet by a jointless gastight plug (5).

The nozzle is mounted on the burner support on ground bearings and without the use of a joint.

The nozzles of Penhoët burners are mounted in the following manner : R.35, which denotes the common type of all the nozzles, and three numbers. The first of these gives the diameter, in tenths of a millimetre, of the sprayer orifice ; the second gives the number of tangential passages ; and the third gives the diameter, also in tenths of a millimetre, of these passages.

The ship's equipment includes the 5 following nozzles :

R.35 : 41-6-32 ; 36-6-28 ; 32-6-25 ; 30-5-25 ; 25-5-21

Graph n° 8 shows the output of these nozzles plotted as a function of fuel-oil pressure.

PNEUMATICALLY CONTROLLED AIR DISTRIBUTORS (Plates II and III)

In case of damage to the air circuit, these can be operated manually. Detachable handles can be mounted to facilitate this operation.

The actual distributor is fixed permanently by means of four cross-pieces (7) to a circular door (6) of which it forms part. It is situated in the air duct which feeds it and the door, bolted on to the front of the caisson, ensures closur of this latter. An asbestos joint ensures gastightness towards the combustion chamber. Also fixed to the door, are the boiler fuel-oil inlet and compressed air control system mountings.

The distributor consists of :

a) a converging-diverging nozzle in two parts. The converging part is of pressed sheet steel, but the diverging part, more exposed to heat, is, in fact, formed by the refractory wall of the boiler face moulded into suitable shape.

b) an air control cone (9) surrounding the burner and situated to the rear of and within the converging part of the nozzle, so as to control flow through the cylindrical air inlet hole. Convergent nozzle and control cone are made integral with one another by welded fins situated at their edges. Aerodynamic

vanes (10) are welded on to the central control cone at the front, angled so as to swirl the combustion air sufficiently.

c) an obturator (1) which closes the air inlet cylinder when the burner is not in use. The movements of the obturator are externally controlled by a system of rods which passes through the door by means of stuffing boxes. The movements of the obturator are limited by fixed stops. The opening action is from back to front.

d) a junction piece (12) of refractory steel, fitted at the front of the control cone. This junction piece, placed in the orifice of the air outlet to the firebox, can move longitudinally. Operation is external and can be carried out whilst the equipment is stopped or working. Optimum adjustment is made by trial and error and the rods are then locked in position. No further adjustment is required unless the burner position is changed.

e) a tubular casing (13), fixed permanently to the door and centred at the front in the central cone. The movable burner guide tube (14) moves within this tube. Towards the front, a clack-box protects against the flare back and blow back of hot gases on to the boiler room gangway during manoeuvring. The burner opens the clack box flap in its pre-lighting movement. On shut-down, its closure protects it from radiation from the firebox. The tubular casing is provided with a cooling orifice and contains in its lower part drains, for the evacuation of fuel should this be necessary.

EXTERNAL FITTINGS

The burner, fitted in line with the air distributor, is mounted externally on a support (16) which is integral with the movable guide tube. The alignment of the support is maintained during its movement by two rods (17) screwed into the door.

Fixed to the movable support, are the following :

1) the fuel inlet

This works from a manually controlled secondary cock described below. The

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outlet hole from the support is obturated by a ball valve when there is no burner in position.

2) the tipping stirrup mounting of the burner (19) with its wheel-operated screw.

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3) beneath, a toothed rack (20) sliding in a guide with longitudinal position adjustment by means of a screw (21). The function of this toothed rack is to open mechanically the primary fuel inlet cock (22) at the end of the burner's forward movement. It is necessary to readjust the setting of the toothed rack if the position of the burner is changed.

4) horizontally, and in line with the burner, a cross-connection which drives the obturator of the air distributor when the support moves.

5) between the two guide rods, the coupling (23) of the pneumatic remote control servo-motor.

6) beneath the support, a drip-tray (24) to catch fuel drips which may occur when a burner is withdrawn, and a drain cock (25) to drain the burner before it is removed.

On the burner door, apart from the guide rods and the guide tube gastightness mechanism, the following fittings are to be found :

- above the burner, an opening viewing port (26) allowing observation of the flames and used to introduce the ignition torch. The port can be covered by a shutter,
- on an adapted mounting, the primary fuel inlet cock (22),
- the stuffing boxes of the obturator and junction-piece rods.

PNEUMATIC REMOTE CONTROL

This includes :

a) a servo-motor clamped to the door immediately above the burner and enclosed in an insulated casing,

b) on the control console, a "Westinghouse Pilotair" control. The "Pilotair" returns to neutral as soon as pressure on the lever in either direction is released,

c) connecting piping between servo-motor and "Pilotair".

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The servo-motor comprises a cylinder (28), closed at the front by a screw-plug (29) and at the rear, by a second plug, which is integral with the cylinder. The front plug carries the air inlet, connected to the mounting clamp on the door, for the backward movement of the burner. At the rear, the plug welded to the cylinder has an air inlet for the reverse operation.
A single-block piston and its rod (30) move within the cylinder. The rod passes through the back and gastightness is ensured, as too for the piston in the cylinder, by self-lubricating cast-iron packing segments.
The servo-motor rod is coupled to the burner mounting by a rod (31) fitted with a ball-and-socket joint hinged on one of the socles of the mounting.
The two rods are connected by a stanchion nut (32) locked by two counter-nuts.
The "Pilotair" possesses an inlet for air regulated to a suitable pressure, and two outlets, one leading to each of the two servo-motor feed inlets. A piston, operated by a hand lever, distributes the air under pressure, and at the same time ensures its escape from the other side of the servo-motor.
The piping connecting Pilotair and servo-motor (diagram plate V) is of copper and is connected by K.S.A. joints. Decompression cocks are situated in the circuit to allow manual operation, as are diaphragms to ensure satisfactory working of the equipment.

FUEL COCKS - Plate IV

Each distributor possesses two fuel inlet cocks. Both are safety cocks consisting of a conical steel chest and a steel plug pressed firmly into the chest by a spring device. The rod is fitted with a safety gland, tightness being achieved in the main by the adjustment of the plug in the chest.
These cocks are of rapid operation type, opening or closing requiring a rotation of only about 90°.

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On the rod of the primary (inverted chest) cock (22) is fitted a fixed pinion which engages with the toothed rack on the support to cause the cock to open. An index integral with the pinion provides accurate indication of the position of closure. The primary cock is fixed permanently to a door support.
The secondary cock (18) is operated by a specially shaped handle, and includes a device to prevent the burner being dismounted while the cock is open. Its opening and closing are strictly limited by stops.
Beneath the secondary cock, a small, hand-operated cock (25) allows the burner to be drained into the drip-tray with the main cock closed.

FUEL PIPING

The fuel is led to the primary cock by a fixed system of steel piping. Precautions are taken to permit its free expansion and the connection between the primary and secondary cocks is with the help of rustproof flexible piping.
The installation as a whole is completed by an electric device for indicating the positions of the burner. Two contactors (35), one fixed to the door, the other to the movable mounting, illuminate corresponding indicator lights on the boiler room control console next to the "Pilotairs". To hold the burner in its two alternative positions, an adjustable locking mechanism has been fitted (36).

- orange indicator light illuminated : burner in operating position
- green indicator light illuminated : burner extinguished and in withdrawn position
- neither light illuminated : burner in motion, or not correctly in position in either direction.

In this latter case, action should be taken at once to bring the burner to completion of its movement. If necessary, open the pneumatic circuit decompression cocks to facilitate this operation.

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OPERATION

The placing of a burner in position is always carried out with the guide tube-mounting assembly in its rear position (green bulb illuminated). The burner in position is thus protected by the non-return flap in front of it. The locking screw should be well tightened to ensure gastightness and to allow passage of the secondary cock safety feather. Once the burner is fixed in position, open the secondary cock. Note that in the rear position of the mounting, the primary cock is closed : this cock shoudl never be manually operated except during adjustment (infrequent).

Since the burners are protected from the flames, they can quite safely be left in position, fitted with pre-selected nozzles, ready to be lit. The lighting of the first burner is carried out with the aid of a torch introduced through the viewing port. It is preferable, in this instance only, to have the secondary cork closed, to move the burner into its operating position manually or by pneumatic control, and then, having introduced the torch, to open the secondary cork, at the same time keeping the ignition under observation. Close the viewing port as soon as the torch is withdrawn.

When a pneumatically controlled burner is brought into operation, the compressed air, chanelled by the "Pilotair" on to the back face of the servo-motor piston, pushes this forward, causing the mounting and the burner itself to move with it. Total movement equals 240 mm. In the first part of this, the burner opens the flap in the guide-tube ;then, the front stops of the obturator rods enter into contact with the cross-piece, and the obturator begins to open. Finally the toothe rack engages the pinion of the primary cock and causes this in turn to open. On completion of the movement, the air and fuel inlets are fully open and the burner lights.

To extinguish the burner, the "Pilotair" lever is brought forward and the servo-motor piston moves the equipment backwards. The rack, still engaged with the pinion of the primary cork, causes the cork to close. Thr cross-piece entering into contact with the back stops of the obturator rods, causes the

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obturator in turn to close, and the burner withdraws behind the protective flap. If the burner is extinguished for what is to be a prolonged halt, or in order for it to be replaced, close the secondary cork and drain the burner before dismantling.

ADJUSTMENTS

The situation may arise, in the event of use of a fuel different from that used at the time of adjustment, in which it becomes necessary to alter the position of the burner within the converging-deverging nozzle in order to achieve good combustion. For this purpose, the burner is provided with a capacity of movement up to 50 mm maximum. The adjustment requires care, in order to avoid working unsatisfactory operation, which could lead to damage.
Adjustment is possible whilst the burner is alight, but it is preferable in order to avoid disturbing the operation of the boiler, to carry it out with the burner extinguished.
Proceed in the following manner - Instance in whith the initial position of the burner is at the extreme rear of its movement, burner to be moved forward :
Extinguish the burner (pneumatic control), close the secondary cock (18), drain the burner and dismount it. Place the dummy burner in position.
Using pneumatic control (do not decompress the air circuits), send the moving equipment into its forward position. The rack (20) is then engaged with the pinion (34) of the primary cock (22), and the obturator (11) is open. Air pressure on the servo-motor piston (30) holds the equipment in this position.
Free the lock-nut of the front contactor screw and slacken the screw (the indicator light is then extinguihed).
Push forward the front nuts of the obturator rods.
Slacken the front and rear locking nuts (33) of the servo-motor piston coupling stanchion (32).
The moving equipment is then free to move, supported by the rack-and-pinion assembly of the primary cock.
Simultaneously turn the rack screw and the servo-motor coupling stanchion (32) in the appropriate direction. With the rack (20) acting as a fixed point, the burner mounting will move forward the desired amount.
Check the new points of adjustment in relation to the initial points given at the end of the chapter.

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Tighten the locking counter-nuts on the stanchion nut. Note that whilst carrying out any adjustment, or work on the servo-motor, the rotation of the piston in the cylinder must be prevented. A flat piece on the visible section of the rod is provided for this purpose.

Reconnect the front nuts of the obturator rods on the cross-piece, and tighten the rods cross-connecting tubes by means of the rear nuts.

Adjust the screw of the front contactor so as to illuminate the corresponding indicator light, and lock it.

Open the decompression cocks and move the equipment back manually. Adjust the screw of the rear contactor and lock it.

Carry out several manual movements to verify that the equipment is working correctly, paying particular attention to the meshing of the primary cock rack and pinion, and to the illumination of the indicator lights. On closing the decompression cocks, check the correct working of the equipment under pneumatic control before mounting and lighting a burner.

Since the junction piece is operated manually only and has no connection at all with the pneumatic system, its adjustment must always be carried out separately. Its capacity of movement is likewise 50 mm. If it is necessary, adjustment of the position of the junction piece should be made, after adjustment of the burner. The operation is carried out with the burner alight, after slackening of the locking screws on the rods passing through the stuffing boxes in the door.

All the adjustments made from whatever starting point, are carried out in the same way, acting in either one direction or the other.

a) The distance between the front heel of the toothed rack and the door is always equal to 59 mm when the burner is in its operating position, whatever the adjustment of the latter.

b) In this same operating position, there must always be 7 mm of polished servo-motor cylinder rod visible, in order to ensure the necessary play in the cylinder at the limit of the movement.

c) When the burner is in its rear position, the distance between the front face of the mobile mounting and the central strenghtening piece of the door is 113 mm. This corresponds to a burner position 320 mm behind the brick wall of the combustion chamber. The front face of the junction piece should then be 70 mm in front of the burner.

The above figure (113 mm) is the datum from which all adjustments should be calculated.

The tools necessary for carrying out an adjustment are as follows :

- 4 x size 35 spanners for the obturator rod nuts,
- 4 x size 26 spanners for the stanchion and the servo-motors rod locking nuts,
- 2 x size 17 spanners to hold the servo-motor rod and to adjust the contactor rods,
- 4 x size 9 Allen spanners for the rack screw,
- 1 x size 59 gauging rod for checking the position of the rack-heel.

III - OPERATION

A - STARTING UP

BOILER STATES WHEN SHUT DOWN

Three different situations may be envisaged :

a) the boiler is still warm, having been shut down within the previsous 48 hours
   - water in the drum at the normal level
   - superheaters empty

b) the boiler is cold, having been shut down more than 48 hours previously
   - water in the drum at the normal level,
   - superheaters full of water to minimize corrosion

c) the boiler has been placed in a state of preservation for a prolonged shut-down
   - upper drum full up to the air release
   - superheaters full of water

The lighting-up process described below is applicable to situation b). In situation a), as soon as lighting begins, open the superheater drain cock; in situation c), in addition, bring the water down to its normal level in the drum before lighting up.

The situation of a shut-down boiler is additionally defined as follows :

- all sections closed to water and steam, in particular those covering the feed regulators and the water injection valves,
- shutters closed on large and small dust collectors.

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- ventilation flaps closed on the delivery side of the two boiler fans
- air distributors closed,
- burner fuel-cocks closed and burner registers isolated.

LIGHTING UP AND RAISING STEAM

1) Ensure that the plating of the boiler casing is in good condition and that all inspection doors are shut, particularly those of the inner casing which may have been removed during the shut-down.
2) Open the shutter of the small dust collector
3) Open the register of the boiler fan which is to be started up
4) Start cooling-water circulation to the boiler fan bearings
5) Open the Cockburn's - A.C.B. automatic stop valve
6) Set up the feed system so as to have only the head valve upstream of the feed regulator left to open (I.54).
7) Open the steam inlet and the drain cock of the steam air heater
8) Start oil circulation in the register, opening the drain slightly until a high enough temperature is reached (100 - 110° approximately)
9) Open the air releases on the drum, connecting pipes and superheaters
10) Ensure that the boiler fan flaps are completely closed : green light on the control console.

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11) Start up a boiler fan, open all the air distributors, open the flaps wide, ventilate the boiler thoroughly for 2 minutes, and then close the air distributor and the dampers again

12) Light up on R.35 25.5.21 nozzle on the central air distributor, with an oil pressure of 10-15 Kg/cm^2. Using successive 10 minutes burns interspersed with periods of 10 minutes extinction, heat up the boiler until steam begins to form. Lighting up may also be carried out in a continuous manner using an R.35 20.4.19 nozzle.

13) As soon as steam begins to form, close the air release and open the drain cocks of the superheaters ; drain the superheaters into the bilge until a pressure of 8 Kg/cm^2 is reached.

14) At 8 Kg/cm^2, open the superheater exhausts to atmosphere and close their drains to the bilge. Drain the desuperheater and continue to raise pressure using a continuously lit 25 burner until pressure equalization with the other burners is achieved. About 3 hours are required to reach a pressure of 60 Kg/cm^2. It is nevertheless advisable not to accelerate the procedure, and to allow the temperature to rise gradually.

CONNECTING UP

1) As soon as steam is raised, open wide the drain cock (Z.75) upstream of the main steam line bulkhead valve, and Z.72 either to the bilge, or to the drain tank to heat the main line.

2) When pressure is equalized, drain the desuperheater in use (to the drum), and drain also at Z.90 upstream of the desuperheated steam inlet valve and Z.87, either to the bilge or to the drain tank ; then, connect up to the desuperheated steam main.

3) Drain at Z.71 downstream of the A.C.B. stop valve, and at Z.70, either to the bilge or to the drain tank. Check by means of a bilge drain sample that the steam is perfectly dry upstream of the main steam line bulkhead valve, then open very gradually the by-pass to this valve.

4) Open the main steam line cock very gradually.

5) Switch oil pressure regulation over to automatic control if this has not already been done

6) Switch air regulation to automatic control after checking that the oil flowmeters are being heated to a suitable temperature.

7) Switch feed regulation to automatic after releasing air from the impulsion inlet pots of the differential gauges

SPECIAL CASE OF THE FIRST BOILER OF A BOILER ROOM

Lighting up is carried out with diesel oil, using the lighting-up pump and hose which are provided for this purpose, to feed the central burner. Immediately, connect up the desuperheated steam line to heat the oil in the settling tanks and in the oil headers.

Switch over to oil when the register temperature exceeds 100°.

In the case of this first boiler, the main steam line cock may be opened at a lower pressure ; the by-pass to this cock may even be opened before lighting up (see Operating Instructions Volume I page 2).

B - NORMAL OPERATION

STEAM PRESSURE

Superheated steam pressure should be regulated to between 60 and 64 Kg/cm^2. It is necessary to exceed 60 Kg/cm^2 during manoeuvring. At anchor, operation at reduced pressure, 45 Kg/cm^2, for example, is possible without difficulty.

OIL HEATING

1) Oil temperature at the register should be regulated so as to obtain a viscosity of 2.5° E (115 - 130°C for present oil fuels).
2) As far as possible, all the distributors shoudl be in use during operation under way. This will result in better flame distribution, the air distributors will all be cooled by air from the fans, and the pressure drop in the air will be reduced. The oil flow to the burners, however, must not drop so low as to jexpodize the stability of the flame. In particular, the pressure drop in the distributors should remain sufficient to ensure that the pressure waves in the combustion chamber produce no adverse effects.
3) Nozzles should be selected to provide an oil pressure between about 14 and 21 Kg/cm^2 : this provides considerable latitude for varying the oil pressure either above or below its average valve. Prolonged operation at pressure below 12 Kg/cm^2 is not recommended, as atomization tends to become coarser at this level. However, temporarily, during manoeuvring, pressure may fall to 7 Kg/cm^2, but this figure constitutes a minimum.

On the other hand,though,there is no obstacle at all to the raising of oil pressure up to the maximum valve allowed by the pumps, equivalent to 28 Kg/cm^2 at the register.

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4) Regulation of the fuel/air mixture can be carried out correctly only if all the burners in use are fitted with the same nozzle type. Different nozzles should only be used temporarily during burner changeovers. Even during manoeuvring, efforts should be made by manipulating the number of burners in use, to ensure that as far as possible, all nozzles fitted are the same.

5) Air regulation is carried out by ON/OFF action on the pneumatically controlled distributors. It is likewise carried out by ON/OFF action on the manually controlled central distributor : it is not advisable to regulate the air on this distributor by adjusting the obturator, particularly when other distributors are in use.

6) The central burner should as a rule be kept permanently alight. It functions as a pilot burner, its flame being used to light the outer burners.

7) Under way, change the burners at least once every 24 hours in order to steam-clean them.

8) Use only nozzles in perfect condition ; these nozzles should be periodically examined ; if possible with a magnifying glass, and an atomization test should be carried out using water.

SAFETY INSTRUCTIONS

The following safety instructions must be posted in the boiler rooms and brought to the knowledge of all personnel.

1) Before lighting up a boiler, ensure that the shutter of the small dust collector is properly open

2) Before using the pneumatically controlled distributors, ensure that all the rack-controlled stopcocks are in the closed position, and carry out a dummy control operation of the distributors

3) Danger of an explosion exists if the combustion chamber contains unburned gases at the moment of lighting up. Ventilate the chamber well before introducing the torch, and check that no accumulation of oil has built up in the air duct by opening the blow-off cock of the double casing if necessary.

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4) The torch used for lighting up should be extinguished immediately afterwards in the tube provided for this purpose.

5) The fireman carrying out the lighting up operation should stand to the side of the air distributor and not in front of it.

6) Light up only when the oil has been heated to a high enough temperature to ignite immediately, so as to avoid spreading any on the sole.
In the event of the flame going out after lighting up, immediately close the fuel cock and recommence the lighting-up operation taking the same precautions.

7) Check that the burner is tightly screwed on to its mounting before opening the fuel cock on the distributor. Check that the register feed cock is open ; outside periods of manoeuvring the register feed cocks on all burners not in use should be closed.

8) Always maintain the nozzles in a condition of perfect cleanliness, using the steam-cleansing device. After cleansing, rinse the nozzles with diesel oil and grease them thoroughly before stowing them. Never use steel wire to unblock the nozzle holes ; use of copper wire is permitted.

9) For the central air distributor, open the air inlet before opening the fuel cock, and close the fuel cock before closing the air inlet. Never leave an extinguished burner in position in the distributor ; its end would be in danger of becoming red-hot.

10) In the event of fire or explosion, shut the rapid closure cock situated on the oil register at the level of the boiler room control position grating.

11) Repair without delay leaks in the oil piping ; only use electric arc or oxyacetylene equipment when the pipes have been cleaned completely and there is no further trace of oil.

12) Rigorous cleanliness is essential for safety. Avoid build-ups of oil in drain-traps, drip-trays, etc...

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14) If a burner is badly lit and oil runs on to the sole, there is a danger that it may spread into the double casing and catch alight.

In the event of fire, extinguish the burners, stop the boiler fan and operate the steam drench system. If there is a build up of oil in the double casing without fire, allow to cool, ventilate and then open the inspection doors to clean up. Do not open whilst the boiler is warm ; the inflammable gases would cause an explosion.

REGULATION OF EXCESS AIR AND COMBUSTION

When combustion is well regulated, the smoke glasses should be perfectly clear. If, even before the glasses darken distinctly, faint shadows are seen, than the smoke is grey and clearly visible outside.

If proceeding at a steady speed, regulate the excess air so as to obtain a percentage of CO2 in the smoke betwen 13 and 14 %, equivalent to 2.7 - 4 % of oxygen.

If manoeuvring, increase the excess air by a significant amount to between 11 and 13 %.

If at steady speed, it is impossible to exceed 13 % CO2 without producing smoke, seek the cause :

- dirty or damaged burners,
- maladjustment of burner or junction piece positions,
- coke on the junction piece : in this case, shake the piece, or if necessary withdraw it slightly,
- coke on the furnace throut : in this case, extinguish the burner momentarily to enable the coke to be consumed and if necessary give a blast of air by opening the distributor for a few seconds without opening the oil.

If coke forms systematically on the furnace throut, check the dimension figures of the throut together with the centering and the longitudinal position of the burner at the first opportunity.

Observe the flame through the eye-pieces in the lateral wall.

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Note 1 - It may happen, with an abnormally high excess of air at low pressure that the flame may leave the burner and that the oil may burn in a sheet on the back wall of the combustion chamber, producing large quantities of white smoke. Act immediately to remedy such a situation by reducing excess of air and if necessary, extinguish the burner in question in order to relight its flame.

Note 2 - Vibration of the boiler face may start to occur if the excess of air is insufficient : take action immediately to stop this by increasing the excess of air, assuming manual control for example if the automatic regulation system has failed, or extinguishing some burners.

THE FEED SYSTEM

Boiler levels should be checked constantly. Despite the accuracy of the Bailey-Jerguson remote gauges and the MECI level recorders, it should not be forgotten that the only check which is practically immune to failure is that provided by the level glasses. Check that they are in good condition and keep a constant watch on them. The normal level should remain between the two red bands on the scale ; if, it enters above or below either of them, take steps to remedy the situation without delay, but without undue haste.

If the level is no longer visible, having passed beyond the limits of the glasses, shut down the boiler immediately. Try to establish by draining the columns whether the level has disapperared above or below, and return it to normal by extracting or feeding as necessary.

Do not forget, however, that it can be extremely dangerous to feed a boiler which has lacked water long enough for the tubes to become red-hot : the immediate vaporisation of the water on contact with red-hot tubes could cause a serious accident.

The feed system is normally controlled by the MECI automatic regulator. Two courses of action are available in the event if its failure :

1) Assume manual pneumatic control of the feed regulation.

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2) Bring into operation the by-pass and overhead sections of the MECI regulator ; their mechanical remote control is led to the boiler-room control position . Manual operation should be carried out smoothly, avoiding jerks.

It has been stated above, on page 9, that the delivery pressure of the turbo-feed pumps should be maintained between approximately 75 and 85 Kg/cm^2.

OPERATION OF THE BOILER FANS

It has been stated, on page 4, that a single boiler fan is all that is required up to an oil consumption of 4 000 to 4 500 kg/h per boiler, and that beyond this level, it is necessary to use two fans in parallel.

a) Switching into parallel :

- open the delivery register of the second fan (Teleflex control)
- check that the flaps are properly shut (green light on the control console) : for this, it is necessary for pneumatic control to be switched by means of the 3-way cock on to the first fan only,
- start up the second fan,
- when the signal light indicating completion of the starting sequence is illuminated, switch the 3-way cock to control of both fans (H + B);

under automatic control, the new balance position of the flaps will be established automatically : under manual control, the flaps should be closed, to maintain at a constant the pressure in the air duct.

b) Changing over fans :

- initiate parallel operation and then stop one of the fans,
- switch the 3-way cock to the desired position and then close the register of the stopped fan,
- adjust the position of the flaps if under manual control ; under automatic control, the new flap position will be assumed automatically.

Note : The register of a stopped fan may be left open if quick starting capability is required : the non-return valve on the delivery side of the fans provides sufficient airtightness . However, it is preferable to close it for a

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prolonged period of inoperation in order to avoid any unnecessary air leak. It is in any use necessary to close the registers of both fans when the boiler is shut down, in order to avoid gas blow-back into the boiler room.

OPERATION OF THE DESUPERHEATING WATER INJECTION SYSTEM

The water injection piping will be isolated, all sections closed off, as long as the oil flow rate remains below 4 400 Kg/h, per boiler room. Above 4 400 Kg/h, the following steps should be taken :

- switch the water injection control system to manual and close the valves,
- open up the sections to pressurize the injection piping and establish water flow to one or other of the nozzles. Remember that the lower nozzle gives a higher output than the upper one.
- gradually commence manual injection when the temperature almost touches 500°C avoiding any abrupt action,
- adjust the automatic controls to obtain on aperture equivalent to that obtained under manual control.
- then, switch to automatic control.

Peaks of superheat should always be avoided, a temperature of 500° being considered a maximum. However, isolated, irregular peaks of up to 510° can be tolerated for several minutes. The water injection system should not be made subject to brusque control action, as the abrupt temperature changes caused by a massive and uncoordinated injection have a harmful effect.

Very important note - Before manoeuvring water injection, chech the engine room salinometers and then, if necessary, proceed to a check on the chloride content of the feed water. It is dangerous for the superheaters to inject water containing an abnormal amount of salt. If salt is detected in the condensers or in the drain tank, take immediate steps to facilitate the stopping of water injection should this be necessary : reduce air excess, reduce speed, change number of boilers.

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SOOT BLOWING

Soot should be blown once every 24 hours, proceeding in the following manner :

1) Open the two valves in series on the soot-blower steam inlets and leave the soot-blower piping under pressure for 10 minutes, drain cock closed, so that it may warm up.
2) Close the downstream steam inlet and depressurize the piping using the drain cock.
3) Repeat heating process for another 10 minutes and drain again.
4) Actual blowing of soot : run all the soot-blowers once in the order 1-12 If necessary, carry out a second blowing of the elements which appear dirtiest preferably, operating the soot-blowers in numerical order (direction of steam flow).
5) After soot-blowing, close the two head valves again, open the drain cock to depressurize and dry out the piping, and close on completion.

Note - It is recommended that soot be blown after each crossing in order that the boilers should not be left shut down with an accumulation of soot in them.

WATER TREATMENT

The quality of the water used in the boilers should be subject to constant check. Refer to chapter 5 of this guide which deals fully with this aspect of operation.

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C - SHUTTING DOWN A BOILER

After extinguishing a boiler :

- isolate the main steam line at the bulkhead and at the A.B.C. stop valve,
- isolate the desuperheated steam line,
- leave the water at a level sufficient to allow subsequent filling of the superheater from it, and inject hydrazine via the phosphate pump,
- close the MECI feed regulator head valve,
- close the boiler fan registers,
- close the dust collector shutters,
- isolate the air heater from the steam line and drain.

When the boiler has cooled down, about 48 hours after extinction, fill the superheater.

If the boiler is to be shut down for a prolonged period (5 days or more), completely fill the upper drums up to the air releases, injecting hydrazine.

It is recommended that shut-down boilers be kept luke-warm in order to avoid external corrosion of the tube bundles. It is possible to :

1) Apply a burst of heat periodically using diesel oil, which has the advantage of eliminating the risk of corrosion by dissolved oxygen ;
2) Heat the boiler by starting up one boiler fan and the steam air heater, with a single air distributor open. Start up also the gastight integrity fan, in order to avoid blow-back of gas into the extinguished boiler (see page 12).

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D - OPERATIONAL INCIDENTS

CUT-OUT OF A BOILER FAN

a) If one fan remains in operation, immediately extinguish enough burners to bring the rate of oil flow down to 4 500 Kg/h per burner and check that there is no more black smoke.

b) If there is no fan in operation, immediately extinguish all the burners. As soon as one fan has been started up, give a blast of air to ventilate the combustion chamber and the double casing. Check that no drips of unburned oil have collected before relighting.

COMPRESSED AIR BREAKDOWN (see page 11 above)

- Stop the main engines.
- Ensure the feeding of the boilers by means of the automatic regulator by-passes ; oil pressure will fall to a minimum (approximately 5 kg/cm^2) and the boiler fan flaps will remain in an intermediate position.
- Keep a watch on the flames, extinguishing the burners if pressure falls below 3 kg/cm^2, or if the flames become detached from the distributors.

OBSTRUCTION OF THE FUEL-OIL DISCHARGE

It may happen that the oil discharge of the MECI valves to the sedimentation tanks may become partially or totally blocked by a plug of cold oil ; this is particularly likely when the position of the 3-way cock has just been changed to direct the discharge into another tank. If this is the case, the oil pressure will not drop, despite the opening wide of the MECI valve, and the steam pressure will rise.

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Immediately extinguish enough boilers to avoid blowing the safety valves. Then, select the same discharge route as was in in use before the incident and attempt to blow out the oil plug.

FIRE IN THE AIR DUCT

See safety instructions to be posted in the boiler-room gangway (page 31).

LEAKS

1) Generator tube burst

If the tube concerned is in the combustion chamber, the flames will probably be blown out :

- shut the rapide-closure cock on the burner register, or , failing that, the individual fuel cocks of the different burners,
- close the main steam line Cockburn's - A.B.C. valve by means of the emergency valve,
- switch feed regulation to manual, leaving the MECI valve cracked just enough to allow a limited feed for as long as the brick faces are still red-hot, then isolate the boiler.

2) Leak from a generator tube expansion fitting

This type of leak is difficult to detect during operation. An increase in feed rate without apparent cause may be noted on the gauges. In the long run, it will be observed that the percentage of salt in the boiler drops or ceases to rise in the absence of extraction. On extinction, seek out the leak by listening through a viewing port or a dismantled air distributor. Do not be deceived, however, by the air noise, caused by natural draught through the viewing ports. When the boiler has cooled down, inspect the tube bundles and look for traces of salt.

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3) Superheater leak

The sympton of this is a slight increase in feed rate ; however, it is hardly detectable except by hydraulic test, by traces of salt if it occurs at a tube fitting or as a result of a blockage, or by sound in the boiler once it is shut down.

4) Economizer leak

- abrupt increase in feed rate without effect on salinity within the boiler,
- external leaks through joints in the casing.

Intervene quickly, as the jet of water under pressure will attack any obstacle in its path, particularly neighbouring tubes ; there is thus a risk of chain-reaction bursts.

The Green and Penhoët economizers can be individually isolated by means of valves provided for this purpose and locked open.

Test the Green economizer first, and then the Penhoët economizer in series with it. As part of the emergency measures, open the economizer air release and drain cock, and by-pass. Do not exceed a steam temperature of 350°C at the inlet of the Green economizer if it is isolated.

Keep watch on the superheat temperature, which will be higher than during normal operation.

5) Leak in the desuperheater whilst in operation

Symptoms of this are a drop in boiler salinity and, in the long term, traces of salt on the spindles of the desuperheated steam cocks (pressure reducer, turbo-feed pump, obturator, etc...) ; analysis of the desuperheater drain product may also provide an indication. Isolate the suspect boiler as soon as possible.

6) Leak in the preheater

Unexplained increase in the heating of the water in the bare-tube economizer.

It should be noted that this heating variesin inverse proportion,to the CO2 percentage of the smoke for a set speed.

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IV - MAINTENANCE AND REPAIRS

WASHING OF THE BOILER ELEMENTS

a) General points

Combustion of fuel oil n° 2 causes the formation of deposits on the tubes exposed to the hot gases :

- cinders on the generator tubes, particularly in the combustion chamber,
- sulphate and vanadium derivative deposits on the superheater tubes,
- sulphate and soot deposits in the economizers, particularly in the low-temperature Green economizer.

The deposits on the superheater tubes can be removed by washing with hot water. The soot in the economizers can be recovered in part by vacuum cleaning or removed by washing.

b) Fregency of cleaning

The frequency of cleaning to be recommended cannot be laid down in any precise manner ; it depends on the percentage of impurities in the fuel, on the quality of combustion, on the effectiveness of fuel additives, etc...
It is recommended that washes be spaced out as much as possible, being carried out at the earliest after 3 000 hours of operation, but perhaps occurring only every 6 000 hours, provided that intermediate inspections of the elements prove satisfactory.

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It is possible to limit washing to one part of the boiler only, for example the superheater or the economizers. To wash the economizers, without wetting the superheater, stretch a plastickover over the rear of the primary superheater.

c) Washing procedure

The sulphuric and sulphuretted deposits become particularly corrosive when thereis humidity present. It is therefore important to remove the acidity, and to do so in such a way that after washing, the surfaces dry rapidly.
Before washing, open the inspection doors and the soot pockets, and set up the spouts allowing the water to be evacuated to the drain tank.
For washing, hot (50-60°) fresh water should be used, rendered alkaline (ph. 8-8.5) by the addition of phosphate and soda. In each boiler room, there is provided for this purpose, a special tank on which a hydro-ejector draws (see diagram n° 1132.6) . If required, this tank may be used to add Teepol to the washing water in order to soak the deposits more easily.
The washing material should be used as shown in plan n° 1180-1 : flat nozzles, round nozzles, hoses, etc...
During the washing of the economizers, it is advisable to protect the thin cement of the boiler casing behind the superheaters with a plastic sheet.
At the time of washing, the boiler should be as warm as possible taking into account the necessity for personel to enter the tube-wall gaps (40 - 50° approximately).
Wash the tube bundles until all traces of deposit have disappeared, and until the water issuing from the soot pockets is no longer acidic and turns litmus paper blue.
The washing must be complete : any deposit remaining impregnated with water in a spot not easily accessible, on top of the tubes and cross-connectors of the superheater, for example, will have a harmful corrosive effect. Open all the inspection doors to allow complete access, and remove the superheater

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brick layers and the piles of bricks which screen the superheater supports.

It is important that the washing be carried out by conscientious personel and that a responsible petty officer should inspect the tube bundles on completion of the operation.

After washing, light up the boiler immediately to dry it out ; failing this, warm it up using one boiler fan and the steam air-heater with a single air distributor open.

Under no circumstances, leave a boiler wet and cold, as this risks serious corrosion of the casing plates, the tube feet, etc...

IMPORTANT RECOMMENDATIONS

During cleaning, attention should be paid to the following points :

a) On the front and rear faces, remove all soot which could eventually be deposited on the loops of the Green economizer in the air duct. These deposits may be removed with a vacuum cleaner. Repaint the bends and the headers with Apexior n° 1.

b) On the front face, clean the connecting bends of the Penhoët economizers in the air duct. If the deposits are large, examine and, if necessary, repair the cement seals at the tube outlets.

c) Inspect the superheater tube feet through the inspection plugs provided for this purpose. Blow out the deposits with compressed air, or if necessary, remove by washing with alkaline water.

CLEANING OF THE INTERNAL PARTS

If the treatment of the boiler water is correct, then as a rule no significant deposit should occur within the boiler tubes. A descaling device with flexible lead and serrated wheel driven by compressed air forms part of the ship's tool kit. However, it is not advisable to use this frequently or regularly, unless large deposits are detected, as the mechanical descaling of the tubes destroys the protective coating formed by the phosphates.

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The drums should be cleaned at every inspection : remove mud deposits by washing with fresh water through hose and nozzle ; take care to remove all mud deposits which might build up around the tubes of the internal desuperheater, particularly in the vicinity of the tube sheets and supports. Such deposits may have a rapid corrosive effect on the desuperheater tubes.

TUBE INSPECTION

After internal cleaning of the steam header or after any work at all carried out within it, a check must be made to ensure that no tube remains obstructed by a foreigh body.

Passing a steel ball through the tubes is the simplest method of carrying out this test. On completion, an inspection will ensure that no tool or other object has been left in the drum, and the sealing plug will immediately be replaced.

HYDRAULIC TESTS

It is STRICTLY FORBIDDEN to carry out any hydraulic test of the boilers with cold water. Before any test, give enough bursts of heat to raise the water temperature to 50 - 60°C.

Avoid frequent raising of the boiler pressure for test purposes to a level higher than working pressure : most leaks can be detected at medium pressures (30 - 40 kg/cm^2 for example).

EXPANSION OF THE BOILER FEET

The free movement of the boiler feet should be checked periodically. If necessary, introduce grease through the oval holes.

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VARIOUS REPAIRS

1) Boiler tubes

In the event of damage, boiler tubes may be plugged following the instructions given below, but this is essentially a temporary measure and a new tube should be fitted as soon as possible, particularly in the case of tubes which screen bricked sections (lateral wall tubes and combustion chamber rear wall tubes). The brickwork, the insulation, and even the casing plates risk deterioration. Superheater support tubes should not be plugged. In the event of damage to one of these tubes, stop the boiler until the tube can be replaced.

Boiler tube plugs should be inserted with the aid of a mallet. Perfect tightness will be achieved by turning the plug through at least one revolution with a spanner applied to its squared end.

Do not forget to drill a small hole in the plugged tube to prevent an accidental rise in pressure, which would blow out the plugs. The plugs are depicted in plan 1180-3.

If it is necessary to cut a tube using oxy-acetylene equipment, ensure that the cut is at least 50 mm from the tube plates.

The expanded end of the tube should be filed down so that there remains no projection which could damage the tube plate on extraction of the tube.

When it is necessary to work in a header through a hand hole plug, take the precaution of protecting the machined surfaces of the header with a light copper plate.

To extract a tube-end, cut with an oxy-acetylene torch a jack inside the header pushing on a round-form cold chisel can be used to free the part fitted into the tube plate. However, care should be taken to avoid damaging the mounting hole.

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Before fitting a new tube, the mounting in the plate should be cleaned with emery paper. All sharp edges should be eliminated and no furrows or protuberances should be tolerated.

Check that the replacement tube is clear, and as far as possible, polish both its inside and outside with emery paper up to a distance from the end about 25 - 30 mm greater than the thickness of the tube sheet. Round off the ends during expanding and bell-mouthing operations. The ends of the tubes and the corresponding mounting holes in the tube sheet should be perfectly cleaned with a rag soaked in a trichloroethylene type solvent. The tubes inserted in their correct positions are expanded using external bell-mouthing tube expanders provided in the tool kit. Use of these tools should be made as follows :

<u>In the top header</u> :

Having regard for the thickness of the tube-sheet (106 mm), the operation should be carried out in two stages, first expansion and then bell-mouthing.

<u>1st stage</u>

Expansion	tube	69 x 89	tool n° 52.466
	tube	58 x 70	tool n° 52.468
	tube	45 x 57	tool n° 52.471

<u>2nd stage</u>

Expansion	tube	69 x 89	tool n° 52.465
Bell-mouthing	tube	58 x 70	tool n° 52.467
	tube	45 x 57	tool n° 52.470

<u>Middle header - Bottom header</u> :

For these tube plates, which have a maximum thickness of 70 mm, the operation can be carried out with a single tool

Expansion Bell-mouthing	tube	69 x 89	tool n° 52.465
	tube	58 x 70	tool n° 52.467 and 52.469
(superheater front element)	tube	47 x 57	tool n° 52.470

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As a general rule, the tubes should be expanded slowly so that the ends are not forced too widely apart during the operation. It is better to expand a tube too

little than too much. A tube which has not been expanded enough and which leaks during the hydraulic test can be expanded further. However, a tube which leaks after excessive expansion may have to be removed and replaced. Moreover, excessive expansion can lead to a flaking of the metal of the tubes by the rollers. Excessive greasing of the part to be expanded should be avoided ; moist soap can usefully replace grease for this purpose.
Do not forget to clean the end of the tube to remove surplus grease after the operation.

BOILER CASING AND BRICKWORK

The boiler brickwork must be maintained in good condition, and repairs should be effected using the same materials employed in the construction of the boiler.
When replastering only is necessary, the old material should be dug out to from a dove-tril and to ensure that the repair cement or filler holds.
As a general rule, never add water to the putly to be used on the surface of the front or back faces of the combustion chamber.
For large repairs, specialists should be called upon.
Throats which have been repaired should be carefully moulded on to the template centred in the guide tube (plan n° 1520.291).
Check the gastightness of both inner and on to casings.

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SUPERHEATERS

The plugs of the superheater headers are of a special type consisting of an expanded tube and a plug welded inside this tube (plan n° 1180.2). To gain access to the tubes, break the sealing weld with a fire grinding wheel or with the cutting tool (plan PT 1180.1).

To extract the inner plug, use the set of tools (plan PT 1180.3).

To fit a replacement plug, adjust the external diameter so that it can be inserted with ease and carry out the weld (plan 1180.2).

It is not necessary to fit the welded plug immediately.

A temporary plug, referred to as the repair plug, is provided for this eventuality (primary superheater plan 1141.3).

The fitting of this plug requires the height of the expanded sleeve to be reduced by 25 mm using either the cutting tool (plan n° PT 1180.2 A) or preferably a grinding wheel.

The plug marked 26 is introduced into the header through the oval hand hole.

The gasket marked30 is fitted after checking that the mounting is in perfect condition, and the stirrup marked 27 is applied, held in place by the nut marked 28. Tightness is then assured by gasket 31, tightened by nut 29.

For the secondary superheater, plan 1141.4, repair plug numbers 23 - 28.

Through the tube expanding hole or the hand hole, it is possible to plug the tubes of the superheater (plan 1180.3).

Do not omit (forget) to drill the plugged tube in order to avoid any internal pressure excess which could blow out the plugs.

At each annual inspection, check the position and security of the perforated plates which protect the superheater headers from the steam line. Also check the free dilation of superheater headers.

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For the replacement of the expanded sleeve, use tool n° 52.474 for expanding and bell-mouthing.

For the expanding and bell-mouthing of the superheater tubes, use tools n° 52.475 and 52.476.

PENHOET ECONOMIZERS

The plugs of the Penhoët economizer headers are of the same type as those used in the superheater headers.

Repair operations are of the same type. Similarly, a temporary repair plug is provided. (Plan 1151.1).

Plug number 12 is introduced into the headers through the oval hand hole.

Then, gasket n° 15, stirrup clip n° 13 and gasket n° 16 are fitted, all being held in place by nut n° 14.

For the replacement of the expanded sleeves, use tool n° 52.472 for both expanding and bell-mouthing.

For the expanding and bell-mouthing of the tubes of the Penhoët economizer, use tool n° 52.473.

GREEN ECONOMIZERS

See special FOSTER GREEN instructions.

LINER "FRANCE"

INSTRUCTIONS FOR THE REMOVAL AND THE REFITTING OF

THE STEAM LEVEL GAUGE GLASSES

930.381.1155.18

INSTRUCTIONS FOR THE REMOVAL AND THE REFITTING OF THE STEAM LEVEL GAUGE GLASSES

1 - GENERAL POINTS

1) The level gauge should be removed when :

   a) soiling of the mica prevents the level of the liquid being seen

   b) the glass becomes opaque as a result of the deterioration of the mica

   c) a leak has occured which has not been stopped quickly.

2) To effect glass (or mica) replacement, it is advisable, wherever possible, to stop the chamber of its cocks (4 bolts to unscrew). This avoids any false alignment of the constituent pieces on refitting. (*)

3) Below 40 kg/cm^2, the bolts are simply inserted in the body (A is what follows). Above 40 kg/cm^2, they are screwed into the body (B in what follows!.

4) It is necessary to provide the following replacement parts :

   - transparent glasses of the appropriate number,
   - washers (internal and external) for each glass
   - mica pieces of the same number as the glasses
   - packing pieces for glass fitting, thickness 0.4 mm, length 45, height 5

(*) the advantage of having <u>always ready</u> one or two replacement chambers, which may be exchanged with those already in position simply by removal and refitting of the 4 bolts referred to above, is clear. The saving of time is considerable, and the glasses can be replaced without haste in the best possible conditions.

II - REMOVAL OF A GLASS

A/ Below 40 kg/cm^2

1) - unscrew the nuts of the securing bolts, remove the cover, and then the glass (or its fragments) and the mica.

2) - remove the inner washer, taking great care not to damage the bed of the washer in the body if a tool is used to prise it loose. Note that the removal of the glasses, immediately after the removal of the gauge itself, still warm, reduces the adhesion of the washer.

3) carefully clean the bed of this washer.

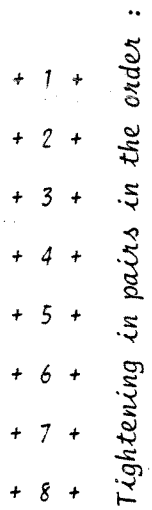
4) - remove the lid washer and clean its bed in the lid.

B/ Above 40 kg/cm^2

The operation is the same, but since the bolts are screwed into the body, all that needs to be done is to take off the nuts on the same side as the glass which is to be replaced, positioning the chamber horizontally with the glass in question on top.

III - FITTING IN A GLASS

A/ Below 40 kg/cm^2



1) - place the chamber body flat on a bench, the mounting of the glass to be replaced facing upward, and press the inner washer (new) into its bed, followed by the mica

4.5
3.6
2.7
1.8

2) - fit the glass, positioning at each end and along the edges 4/10 packing pieces of klingerite or similar, and then the external washer.

3) - place the cover on top of this washer, and then the nuts on their bolts ; having checked that the glass is suitably centred and that the washers and the mica are correctly positioned, tighten the nuts by hand.

4) - Using a torque wrench on an initial setting of 0.7 mkg, tighten the nuts in the order shown on fig. 2., i.e. beginning in the centre. Increase the torque by steps of about 1.4 mkg, recommencing the

tightening of the nuts after each adjustment. Always in the same order, and finishing on a torque of 7 mkg (initial tightening).

Important : To avoid too great a torque on the bolts, it is necessary to grease the nuts before refitting them.

5) - when the gauge is back in service, the washers are permanently hot, and tightly compressed as a result, which leads to a virtual slackening off, with the torque falling from 7 mkg to about 4.8 mkg. However, this torque is still sufficient to prevent any leak.
Refit the chamber between its cocks, and gently open the cocks to bring the gauge up to working temperature.
To complete the operation, a final tightening up of the nuts should be carried out. First, as a safety measure, close the stop cocks and open the drain cock. Then, with the torque wrench set at 48 mkg, carry out a general tightening in the order indicated in fig. 2.

6) - when the gauge is back in service, check carefully that these are no leaks. If there are, repeat operation (5). The slightest continued seepage of steam may attack the surface of the bed of the inner washer, and will necessitate the re-machining of the chamber.

B/ Above 40 kg/cm^2

As stated in I (3), the bolts are screwed into the body of the chamber. This results in a reduction of the torque necessary for tightening up.

1) - 2) - 3) - as for III A

4) - initial torque wrench setting 0.7 mkg, progressive increase in steps of approximately 1.4 mkg, as in III A, but finish on a setting of 5.5. mkg.

5) - the initial torque of 5.5.mkg falls, after entry into service of the gauge, to approximately 3.5 mkg.
Proceed as indicated in III A (5) and after carrying out a general tightening up at 3.5 mkg (sufficient to prevent any leak at 105 kg/cm^2 carry out the check described in III A (6).

IMPORTANT NOTE : Never lose sight of the safety aspect, and reduce pressure in the gauge in service before any tightening up operation on the nuts.

WATER TREATMENT

I - GENERAL POINTS

OBJECT OF THE TREATMENT

The boiler water and the feed water must be regularly analysed and treated. The object of this treatment is :

- to prevent salt being deposited in the steam generating tubes of the boilers
- to prevent priming
- to prevent internal corrosion of the boilers and the feed piping

Deposits are guarded against by limiting the total salinity of the boiler water, and in particular its chloride content.

A fairly high percentage of P_2O_5 ions is necessary to precipitate the alkaline earth chlorides progressively as they enter the boilers.

Priming is similarly guarded against by limiting the total salinity of the boiler water.

To combat corrosion :

a) oxygen is eliminated as completely as possible from the feed water and the boiler water. In the deaerator, a very high degree of physical gas separation is obtained ; this separation is completed by the chemical destruction of the residual oxygen (hydroxine injections).

b) the water in the circuit is given a fairly high alkalinity. Additions to the boiler water are of caustic soda and phosphates. In the case of the feed water, the partial break down of the hydrasine into ammoniac contributed to the raising of the pH. It may be necessary though to add very small doses of volatile amino products.

ANALYSIS EQUIPMENT

1) In each boiler room, a PROSIM analysis cabinet contains material allowing the levels of the following to be checked :

- alkalinity : degrees of alkalinity (DA), total alkalinity (DTA) and basicity (DB)
- high concentration chlorides (boiler water)
- low concentration chlorides (evaporator production and feed water).

2) In the engine room laboratory, on B deck are 3 PROSIM cabinets containing respectively the material necessary for checks on the levels of the following :

a) - alkalinity (DA,DTA,DB)
   - high concentration chlorides
   - low concentration chlorides

b) - phosphates
   - oxygen
   - PH (by calorimetry)
   - hydrasine
   - silica (high concentrations of 2.5 - 25 milligrammes per litre)

c) - silica (low concentration of 0.2 - 2.5 milligrammes per litre)
   - hardness

Methods of analysis are described in detail in the PROSIM instructions.
In addition, the laboratory is equipped with a SEPI Electrofact PH-meter type 52 A, and with a Philips Philoscope conductometer (refer to the operating instructions of these two pieces of apparatus).

SAMPLE COCKS

Sample cocks with coolers are provided :

1) in the boiler rooms, on the central distributor of each boiler (see diagrams n° 1650.6 and n° 1130.3)

2) in the engine rooms (diagram n° 1650.6) :

- on the delivery side of the drain-tank pumps
- on the suction side of the turbo-feed pumps
- on the delivery side of the turbo-feed pumps.

Finally, sample taps without coolers are provided on the delivery sides of the main and auxiliary condensate pumps.

METHODS OF TREATMENT

1) In each boiler room, a 220 litre tank is provided for addivites (plan n°1557.2). An Emidecau piston pump, capable of an output of 350 litres per hour, at a pressure of 110 kg/cm^2, pumps into each boiler, either through the economizer or directly into the upper drum. (see diagrams n° 1650.1 and 1130.3). The treatment additives are normally pumped into the water through the economizer.
Pumping directly into the drum should, as a rule, be used only for treatment of a boiler which is shut down, or for treatment of a boiler on which the economizer is out of action.
The Emidecau pump can, if necessary, be used as a test pump.

2) In both the forward and after engine rooms, a 250 litre tank allows a dilute solution of hydrasine to be introduced, drop by drop, by gravity into the atmospheric drain tank.

WEIGHT OF WATER CONTAINED IN A BOILER

	Boiler under pressure		
	Boiler cold	shut down	in operation
- Green economizer	900 kg	800 kg	800 kg
- Penhoët economizer	3 000 kg	2 600 kg	2 600 kg
- Superheaters	3 400 kg		
- Boiler itself at normal level	21 800 kg	16 400 kg	14 000 kg
- Level variation of 100 mm from normal level	1 100 kg	825 kg	715 kg

The doses of additives for the boilers should be calculated for the weight of water contained in the boiler itself, without taking account of the economizers.

II - TREATMENT

1° FEED WATER

A - Salinity

The salinity of the feed water should be as low as possible : keep a watch on the condenser and drain tank salinometers, and intervene without delay as soon as any rise in salinity is detected.

It is difficult to evaluate precisely, using the salinometer, any penetration of salt leading to a salinity of the order of one milligramme per litre is the condenser. It is more practical to observe the variation in the salinity of the boiler water over a period of several hours when no extraction is carried out.

Example : let us suppose that the fuel-oil consumption of one boiler room is 17 tons per hour with 3 boilers in operation, and that the salinity rises 50 milligrammes in 24 hours. The introduction of salt is then :

$$\frac{3 \times 50 \times 14\,000}{24 \times 1\,000} = 87.5 \text{ g/h}$$

Vapourisation is approximately :

$$13.6 \times 17\,000 = 230 \text{ kg/h}$$

The introduction of salt corresponds to a salinity of :

$$\frac{87.5}{230} = 0.38 \text{ mg/l}$$

Note : if the steam dryness function is 0.995 and if the boiler water contains 50 milligrammes per litre of chlorides, the quantity of salt carried away by the steam corresponds to a salinity of $0.005 \times 50 = 0.25$

It can be seen that with an excellent dryness function of 0.995, the salt removed by the steam gives the condensate a salinity of the same order as that calculated in the preceding example.

On the other hand, the pressure of ammoniac, or ever of volatile amino products in the water, in the circuit, increases the salinometer readings slightly.

B - Oxygen content

The deaerator receives :

- water from the main condensers, of which the oxygen content can reach as much as 20 - 25 gammas (1 gamma equals 10^{-3} milligrammes per litre),
- water from the atmospheric drain tank of which the oxygen content during normal operation is of the order of 400 - 600 gammas.

The oxygen content at the deaerator outlet sould not exceed the minimum detectable by the orthotolidine dosage method, i.e. 7 gammas.

At anchor, the feed water may be partially aerated on the delivery side of the turbo-feed pumps by mixing with the non-deaerated water used for cooling stuffing box linings.

To guard against penetrations of oxygen, it is sufficient to maintain a hydrasine concentration of 50 gammas in the feed-water during operation. This extremely low level corresponds to the minimum which may be detected by chemical analysis.

C - Alkalinity and PH

The alkalinity of the feed water must be maintained within quite narrow limits.

Water with a low PH corrodes steel (piping, economizers, etc...).

Water with too high a PH will attack the alloys of copper (condensers, heaters, etc...

The PH of the condensate should be maintained between 8 and 8.5, and preferably between 8.3 and 8.4.

In the absence of hydrasine treatment, or if they are necessary, of volatile amino product additives, the condensate would be slightly acid (PH = 6.5 approx.).

Hydrasine treatment, carried out with the aim of eliminating oxygen, contributes through a second reaction, to the raising of the PH of the condensate (see page 69).

Normally, the addition of hydrasine in the dose recommended above is sufficient to obtain the desired PH both in the condenser and in the deaerator outlet.

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2° BOILER WATER

A - Phosphates

The concentration, expressed as P_2O_5, should be between 20 and 40 milligrams per litre

B - Chlorides

The chloride concentration should not exceed 100 milligrammes per litre. It should be endeavoured, as far as possible, not to allow it to exceed 80 milligrammes per litre.

A chloride concentration of 350 milligrammes per litre can be tolerated temporarily for a few hours following accidental pollution of the circuit ; however, in this case, the phosphate concentration should be increased to 80 milligrammes per litre of P_2O_5. Boiler pressure should be reduced until a normal situation can be regained.

C - Total salinity

The total salinity of the boiler water should normally remain below 300 milligrammes per litre, which corresponds to a resistivity of 1 200 ohms/cm/cm^2.

D - Alkalinity

The alkalinity of the boiler water is defined by the degree of alkalinity (DA) and the degree of total alkalinity (DTA).

Realisation of the following conditions should be attempted :

$$5 \leq DA \leq 8$$

$$1.5\ DA \leq DTA \leq 2\ DA$$

If this result is obtained, a check will show that the PH is between 10.5 and 11.5 If the DA is between 10 and 15, or if the DTA is between 13.5 and 20, an extraction will probably have to be carried out in the very near future.

If the DA exceeds 15, or if the DTA exceeds 20, undertake an extraction immediately. If the DA and the DTA are too low, trisodium phosphate and soda and, in certain circumstances, disodium phosphate, should be added.

The graph on the following page shows the relationship between DA, DTA and the levels of soda and P_2O_5 . On this graph :

- the addition of soda moves the reference point in a direction parallel to the straight line DA = DTA
- the addition of trisodium phosphate moves the reference point in a direction parallel to the straight line TAC = 2 TA
- the addition of disodium phosphate moves the reference point in a direction parallel to the y-axis.

Tables 1 and 2, established from the graph, show the doses of treatment products to add in order to arrive at a situation approximately P_2O_5 = 40 and DA = 6.

E - Hydrasine and oxygen

The dose of hydrasine added to the feed water (50 gammas) leads to a hydrasine concentration of 50 - 80 gammas in the boiler water. There should thus be no taxe of oxygen to be found in this water.

F - Silica

The silica concentration should not exceed 6 milligrammes per litre. The size of the silica dose for such low concentrations in the presence of phosphates is a particularly delicate matter. Such a dose should be added only rarely and it is advisable to engage a specialist laboratory to do the job.

TREATMENT OF AN ISOLATED BOILER

30 minutes before isolating a boiler, commence a hydrazine injection using the Emidecau pump. The hydrazine concentration should be raised to 1 000 gammas, which corresponds to an injection of about 15 gammas of hydrazine per boiler.

TREATMENT OPERATIONS

1° Extraction

Rapid extraction may be carried out from the surface or from the bottom of the water in the boiler, or a continuous extraction may be carried out via the sample cock. The latter procedure is recommended, as it allows the volume of water being extracted to be conveniently measured, and also allows a check to be maintained on the results by means of analyses carried out at intervals as the operation progresses.

2° Addition of soda and phosphates

Since the tank for additives has a useful capacity of 200 litres and the Emidecau pump an output of 350 litres/hour, the tank is emptied in approximately 35 minutes. The abrupt introduction into the system of large doses of soda or of phosphates must be avoided, however, as the result would be a temporary increase in the concentration in the upper drum of the boiler which could lead to priming and the choking of turbines. The dose of chemical added to the tank at one time whilst the boiler is in operation, is therefore limited to 250 grammes. If the dose required exceeds 250 grammes, fill the tank several times in order to effect a gradual injection of the chemical.

The Emidecau pump can pump in either upstream of the economizer, or directly into the water drum.

When the boiler is in operation, pump in via the economizer.

When the boiler is shut down, pump directly into the drum.

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3° Addition of hydrazine

Hydrazine is generally supplied in a dilute solution of 10 % N_2H_4.

For addition to the drain tank, dilute this solution further so as to introduce the hydrazine in a 1 or 2 % solution.

For addition to the boilers, a dose of the order of 15 grammes diluted in the 200 litres of the additive tank corresponds to a dilution in the region of 1 / 10 000.

Note : The handling of hydrazine requires precautions : personnel should wear gloves and protective glasses to handle the solutions.

FREQUENCY OF ANALYSES

1) Main condensate water

once a day :

- PH test
- measure of resistivity with Philoscope
- ammoniac level

2) Feed water

a) once a day :

- PH test
- measure of resistivity with Philoscope
- oxygen level

b) once a crossing :

- oxygen level

./.

3) Boiler water

a) twice a day :

- DA
- DTA
- chlorides

b) once a day :

- phosphates
- PH
- resistivity
- hydrazine

c) on shut-down boilers :

- oxygen and hydrazine levels every 5 days.

DOCUMENTATION

UNITS

The unit most widely used to designate levels of concentration is the milligramme per litre. 1 milligramme per litre is the equivalent of 1 gramme per tonne. This unit is designated by the abbreviation ppm (part per million) in English and American publications.

Very low concentrations are reckoned an gammas, i.e. in thousandths of a milligramme per litre.

Levels of alkalinity (see next paragraph) are expressed in French degrees. The French degree corresponds to one five-thousandth of a gramme molecula per litre :

$$1° F = \frac{N}{5\,000}$$

Example : For caustic soda Na OH, a gramme molecule is 40 grammes, and 1°F therefore represents 8 milligrammes per litre.

ALKALINITY - DA, DTA, DB

1) The measure of alkalinity DA corresponds to the indicator effect of phenolphtalene (PH = 8.4). It titrates compounds dissolved in water which give the solution a PH higher than 8.4. This is the case of free soda or of the first valence of trisodium phosphate : $PO_4\,Na_3 \longrightarrow PO_4Na_3\,H$

2) The measure of total alkalinity DTA corresponds to the indicator effect of helianthine or methylorange (PH = 4). It titrates compounds dissolved in water which give the solution a PH higher than 4.

In addition to the compounds titrated by the DA, those compounds which give their solutions a PH of between 8.4 and 4 are thus also titrated : this is the case of the second valence of trisodium phosphate or of the first valence of disodium phosphate

$$PO_4\ Na_2\ H \longrightarrow PO_4\ Na\ H_2$$

3) The measure of basicity DB indicates the level of free alkali after precipitation of the phosphates and carbonates by the addition of barium chloride. The three valences of trisodium phosphate are titrated thus.

Only the measures DA and DTA are used for boiler water.

For solutions of caustic soda : DA = DTA = DB

For solutions of trisodium phosphate $PO_4\ Na_3$: DTA = 2DA

For solutions of disodium phosphate $PO_4\ Na_2\ H$: DA = 0

The graphical representation of DA, DTA and its interpretation are shown above (page 60 annexe A , graph n° 1).

PH

The PH of a solution is the cologarithm of its concentration of H ions. It expresses the degree of acidity or alkalinity of the solution.

For water at 22°C :

$(H^+)\ (OH^-) = 10^{-14}$

$(H^+) = (OH^-)$

$(H^+) = 10^{-7}$

$PH = 7$

For an acidic solution PH $<$ 7

For an alkaline solution PH $>$ 7

The PH of a solution is related to the temperature of the latter. When it is stated that the PH of the boiler water should be in a region of 11, it is understood that this is the PH of the water at ambient temperature. In fact, at the saturation temperature of 280°C, corresponding to a pressure of 65 kg/cm^2 the PH is not more than 9.

The table below gives the PH for varying concentrations of the solutions of soda and trisodium phosphate.

Concentration mmg/ℓ	PH of a solution of soda NaOH	PH of a solution of phosphate $PO_4 Na_3$	Ammoniac $N H_3$
For 1 milligramme/litre	9.5	7.3	
2 "	9.8	7.9	8.5.
3 "	10.0	7.95	8.65
5 "	10.3	8.0	9.1
10 "	10.5	8.25	9.6
20 "	10.8	8.65	10.1
30 "	11.0	8.9	10.25
40 "	11.1	9.1	10.45
50 "	11.2	9.2	10.47
60 "	11.3	9.3	10.48
70 "	11.37	9.35	10.49
80 "	11.45	9.4	10.5
90 "	11.48	9.45	10.5
100 "	11.5	9.5	10.51

CONDUCTIVITY OF A SOLUTION

The conductivity of a solution is proportioned to its concentration of salts. It is also related to the temperature of the solution.

$$C = CO \times \frac{(20 \times t)}{45}$$

where CO is the conductivity at 25°C

and C is the conductivity at t° C

Conductivity is expressed in micromhos /cm^2/cm ; its inverse, resistivity, is expressed in ohms/cm^2/cm.

Graph n° 2 shows the resistivity of different solutions as a function of their concentration.

SOLUBILITY OF OXYGEN IN WATER

The solubility of a gas in water is a function of the partial pressure of the gas and of temperature.

If water and air are placed in contact in an enclosed space at atmosphere pressure, the pressure of the water vapour increases with temperature, and the partial pressure of the oxygen in the space consequently decreases : the solubility of oxygen is thus inversely proportional to temperature.

PHOSPHATES

This guide advocates the use of trisodium phosphate and disodium phosphate. However, it also refers to the concentration levels of phosphates expressed as $P_2 O_5$.

The relationship between the gramme molecules of these different compounds are as follows :

$P_2 O_5$ = 142 grammes

1/2 $P_2 O_5$ = 71 grammes

$PO_4 Na_3$ = 164 grammes

$PO_4 Na_2 H$ = 142 grammes

1 gramme of P_2O_5 thus corresponds to 2.31 grammes of $PO_4 Na_3$ and 2 grammes of $PO_4 Na_2 H$.

These relationship apply to the industrial anhydrous products, which have a tendency to hydrate in a humid atmosphere, forming di- and trisodium phosphates crystallised with 12 molecules of water

$PO_4 Na_3$ 12 $H_2 O$ = 380

$PO_4 Na_2$ 12 $H_2 O$ = 358

It is advisable to check periodically the phosphate content of the products held on board ; if these products are partially hydrated, their doses should be adjusted accordingly.

Certain additive products will sold under trade names contain, in addition to disodium phosphate and trisodium phosphate, polyphosphates such as hexametaphosphate $(PO_3 Na)^6$.

HYDRAZINE

Hydrazine $N_2 H_4$ is a liquid with a boiling point of 113.5°C .

The commercial product is hydrazine hydrate $N_2 H_4 H_2O$ which contains 64 % pure hydrazine.

Concentrated hydrazine explodes on contact with violent oxydizers such as $Mn O_4 K$ or $H_2 O_2$.

For safety, only hydrazine hydrate diluted to 10 % of $N_2 H_4$ should be used on board.

Hydrazine is moreover toxic and should be handled only with care.

Hydrazine reacts with oxygen according to the formula :

$$N_2 H_4 + O_2 \longrightarrow N_2 + H_2O$$

The reaction in fact is more complex and the oxides of iron also play a part in it. It is fast at high temperatures, but slow at low temperatures. Hydrazine and oxygen can co-exist for quite a long time at temperatures below 90°C, but at 140°C, 90 % of the oxygen is destroyed in three minutes. In this reaction, a given weight of hydrazine theoretically destroys an equal weight of oxygen (hydrazine excess 100 %).

Hydrazine has a tendency, however, to decompose at high temperatures :

$$3\ N_2 H_4 \xrightarrow{\text{Heat}} 4\ NH_3 + N_2$$

This forming of ammoniac explains why the addition of hydrazine increases significantly the PH of the condensate, a result which would not otherwise be expected from the pressure of hydrazine alone. Solutions of hydrazine are in fact only very slightly alkaline :

Concentration in mmg/ℓ	PH
32	9.3
3.2	8.8
0.32	8.3
0.032	7.8

VOLATILE AMINO PRODUCTS

These are liquids of which the solutions are basic and which tend to evaporate in the boiler : their presence in the steam and in the condensate increases the PH of the extraction water.

Their use is not indispensable and is not included in the instructions given above for the treatment of boiler and feed water.

Purely, for information, the following may be quoted :

1° morpholine - formula $C_4 H_9 NO$

- molecular weight : 87
- boiling point : 129°C

2° cyclohexylamine - formula $C_6 N_{11} NH_2$

- molecular weight : 97
- boiling point : 129 - 138°C

3° dimethyl - ethanol - amine - formula $N (C_2 H_5)_2 CH_2 CH_2 OH$

- molecular weight : 117.5
- boiling point : 162°C

Annexe A

GRAPHIQUE N° 1

GRAPH

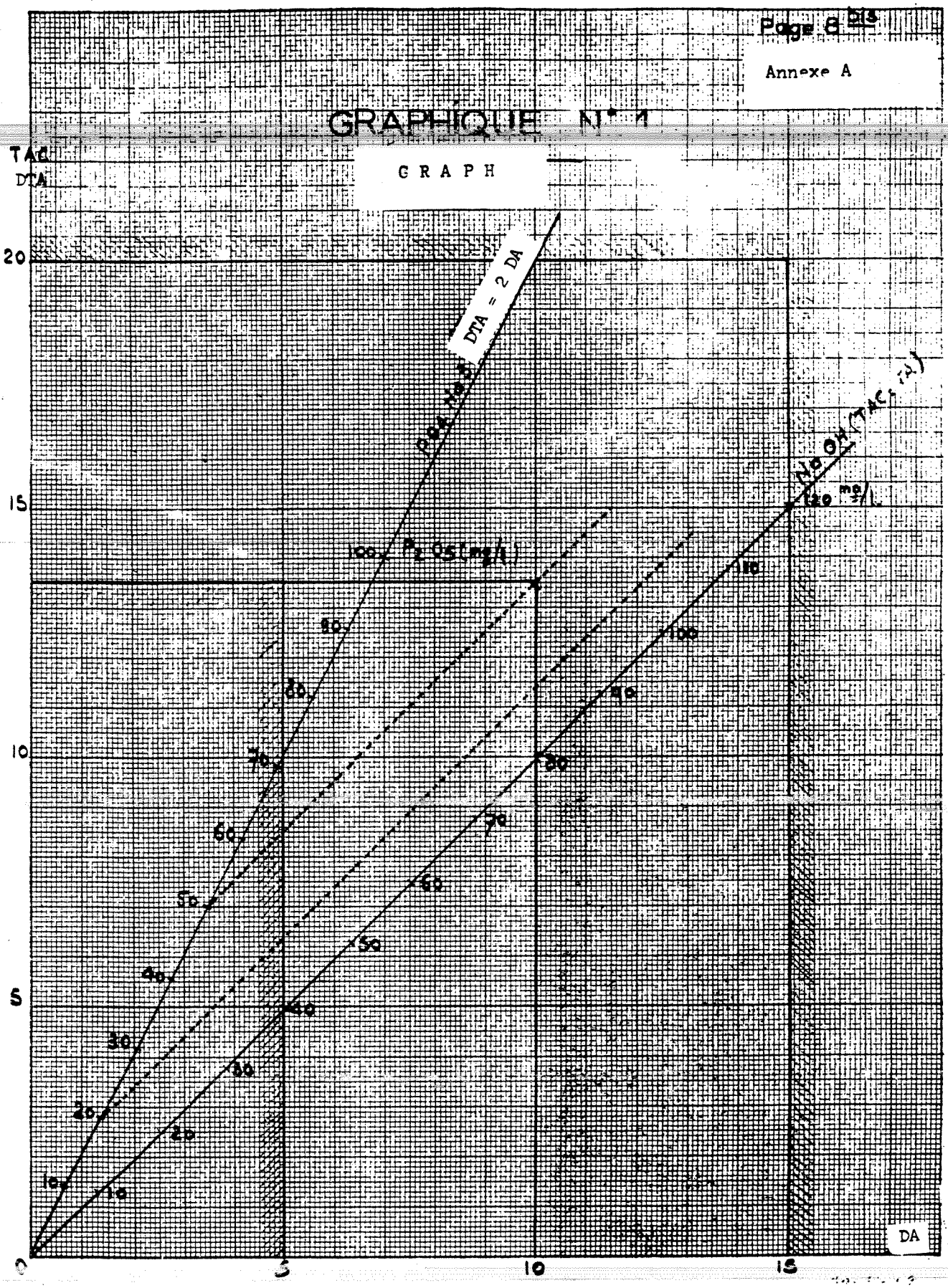


TABLEAU I. PAQUEBOT FRANCE. TRAITEMENT DES EAUX DE CHAUDIÈRES.

Table I. Treatment of boiler water ADDITION DE PHOSPHATE TRISODIQUE ET DE SOUDE CAUSTIQUE (DOSES EXPRIMÉES EN GRAMMES PAR TONNE D'EAU)

Addition of trisodium phosphate and causting soda (doses expressed in grammes per tonnes of water.

P: Phosphate

N: Soude (soda)

P_2O_5		TA (DA) 0	1	2	3	4	5	6	7	8	9	10
0	P	92	92	92	92	92	ADDITION DE PHOSPHATE DISODIQUE. Addition of disodium phosphate.					
	N	32	24	16	8	0						
5	P		81	81	81	81						
	N		24	16	8	0						
10	P		69	69	69	69						
	N		24	16	8	0						
15	P		58	58	58	58	58					
	N		32	24	16	8	0					
20	P			46	46	46	46					
	N			24	16	8	0					
25	P			35	35	35	35					
	N			24	16	8	0					
30	P				23	23	23	23				
	N				24	16	8	0				
35	P				0	0	0	PAS D'ADDITION No addition				
	N				24	16	8					
40	P				0	0	0					
	N				24	16	8					
45	P					0	0					
	N					16	8					
50	P					0	0					
	N					16	8					

PHOTOGAY LYON

TABLEAU II. PAQUEBOT FRANCE. TRAITEMENT DES EAUX DE CHAUDIÈRES. ADDITION DE PHOSPHATE DISODIQUE ANHYDRE ET DE SOUDE CAUSTIQUE

Table : II. Treatment of boiler water (DOSES EXPRIMÉES EN GRAMMES PAR TONNE D'EAU).

Addition of anhydrous disodium phosphate and caustic soda (doses expressed in gramme per tonne of water)

P_2O_5		T.A. (D.A.) 0	1	2	3	4	5	6	7	8	9	10
0	P	80	80	80	80	80	80	80	80	80	80	80
	N	48	40	32	24	16	8	0	0	0	0	0
5	P		70	70	70	70	70	70	70	70	70	70
	N		40	32	24	16	8	0	0	0	0	0
10	P		60	60	60	60	60	60	60	60	60	60
	N		40	32	24	16	8	0	0	0	0	0
15	P		50	50	50	50	50	50	50	50	50	50
	N		40	32	24	16	8	0	0	0	0	0
20	P			40	40	40	40	40	40	40	40	40
	N			32	24	16	8	0	0	0	0	0
25	P			30	30	30	30	30	30	30	30	30
	N			32	24	16	8	0	0	0	0	0
30	P				20	20	20	20	20	20	20	20
	N				24	16	8	0	0	0	0	0
35	P				0	0	0					
	N				24	16	8					
40	P				0	0	0					
	N				24	16	8					
45	P					0	0					
	N					16	8					
50	P					0	0					
	N					16	8					

P : Phosphate.
N : Soude. (soda)

PAS D'ADDITION.
No addition

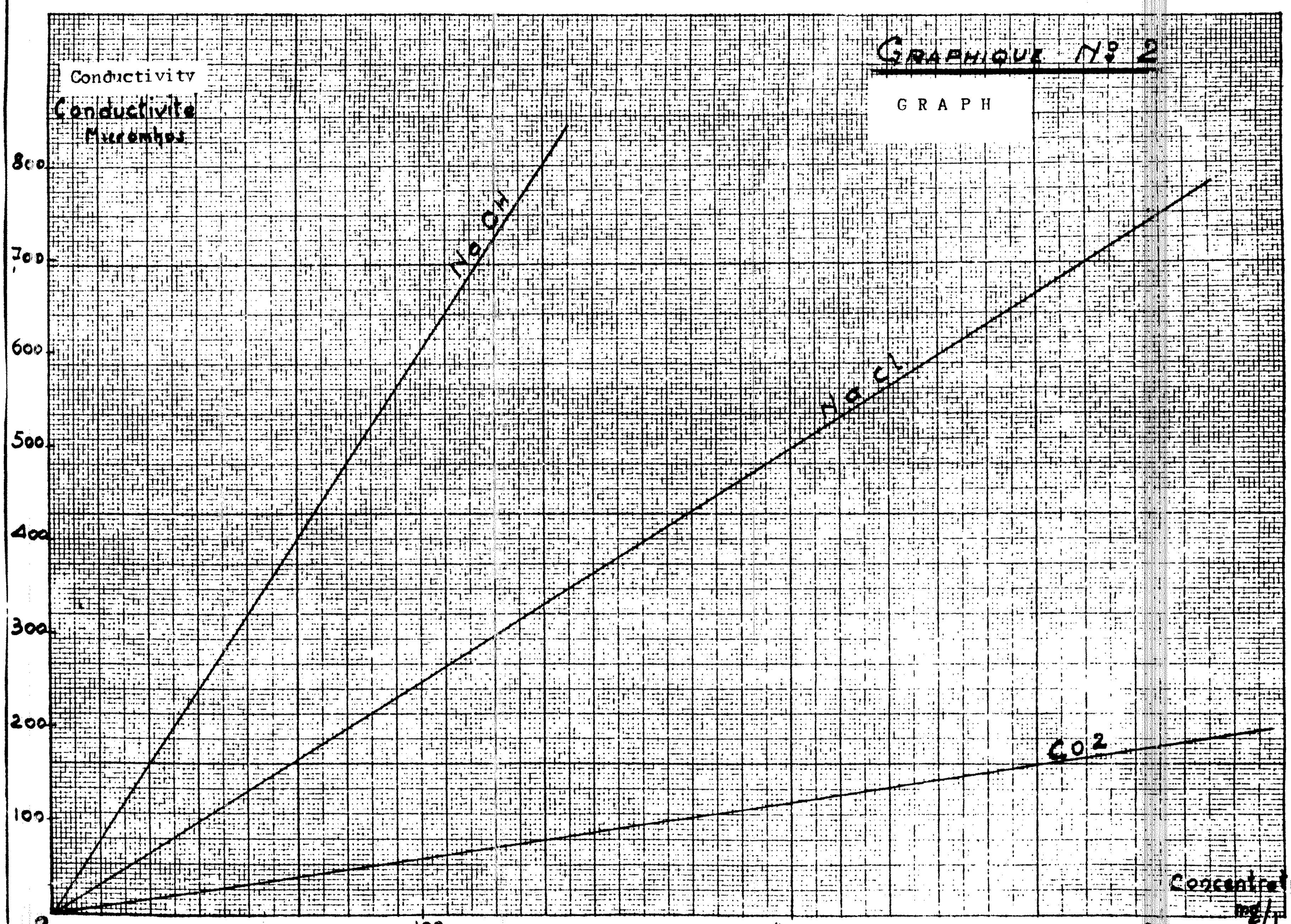
TABLEAU III

TABLE III

Résumé des Consignes pour traitement d'eau

Summary of water - treatment instructions

	Lower limit **Limite inférieure**		Upper limit **Limite supérieure**
EAU ALIMENTAIRE Feed water	8 ≤	**Na Cl**	≤ 1 mg/L.
		PH	≤ 8,5
		O_2	≤ 7 grammes
		Hydrazine : 50 gammas	
EAU DE CHAUDIERE Boiler water		Na Cl	≤ 80 à 100 mg/L.
	5 ≤	TA (DA)	≤ 8
	1,5 TA (DA) ≤	TAC (DTA)	≤ 2 TA (DA)
	20 mg/L. ≤	$P_2 O_5$	≤ 40 mg/L.
	10,5 ≤	PH	≤ 11
	50 gammas ≤	Hydrazine	≤ 80 gammas
		$S_i O_2$	≤ 6 mg/L.


GRAPHIQUE N° 2
GRAPH
Conductivity
Conductivite
Micromhos
800
700
600
500
400
300
200
100
0
NaOH
NaCl
CO2
Concentration
mg/l

GRAPH N° 3

SOLUBILITY OF OXYGEN
IN WATER
AT ATMOSPHERE PRESSURE

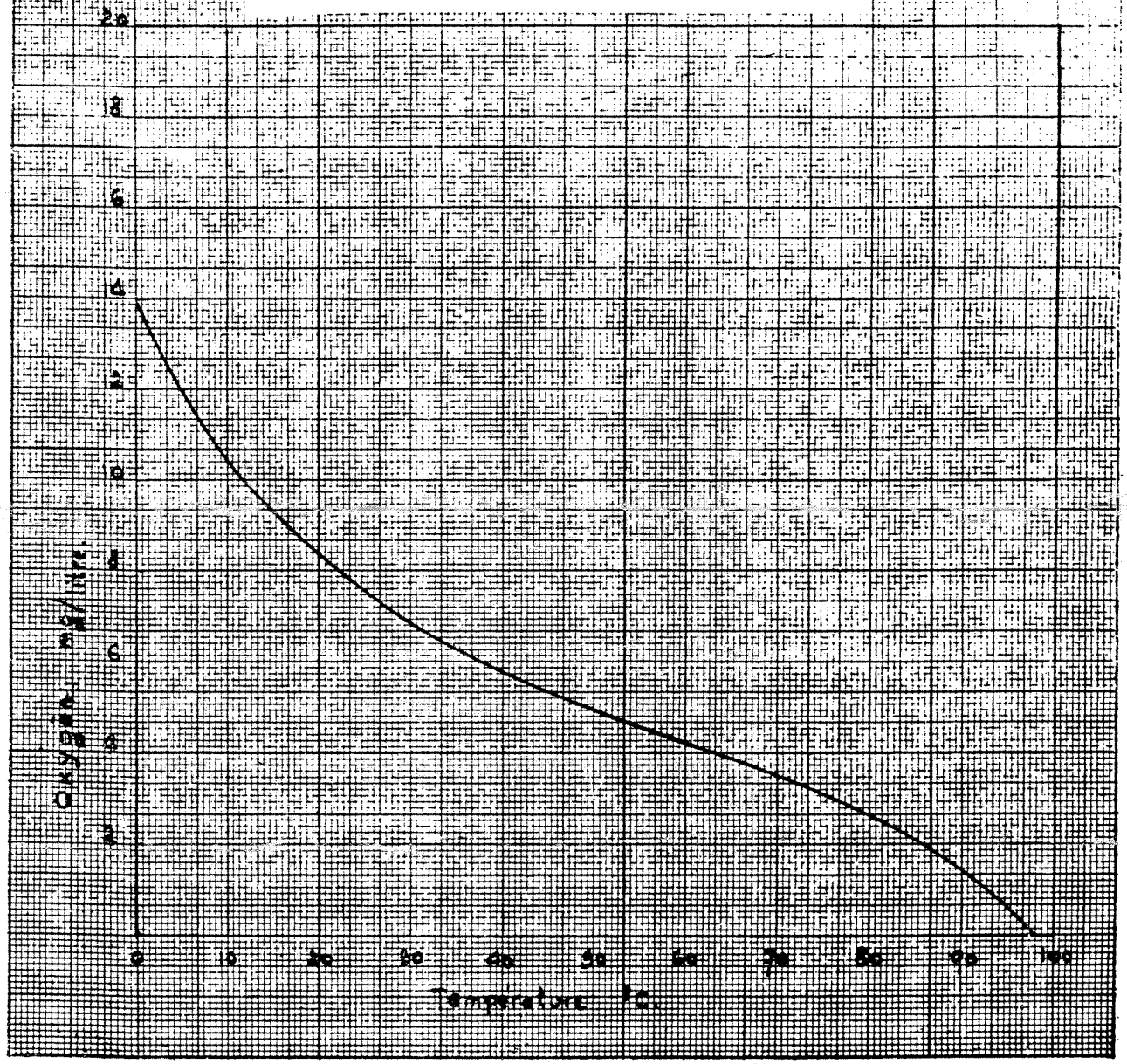
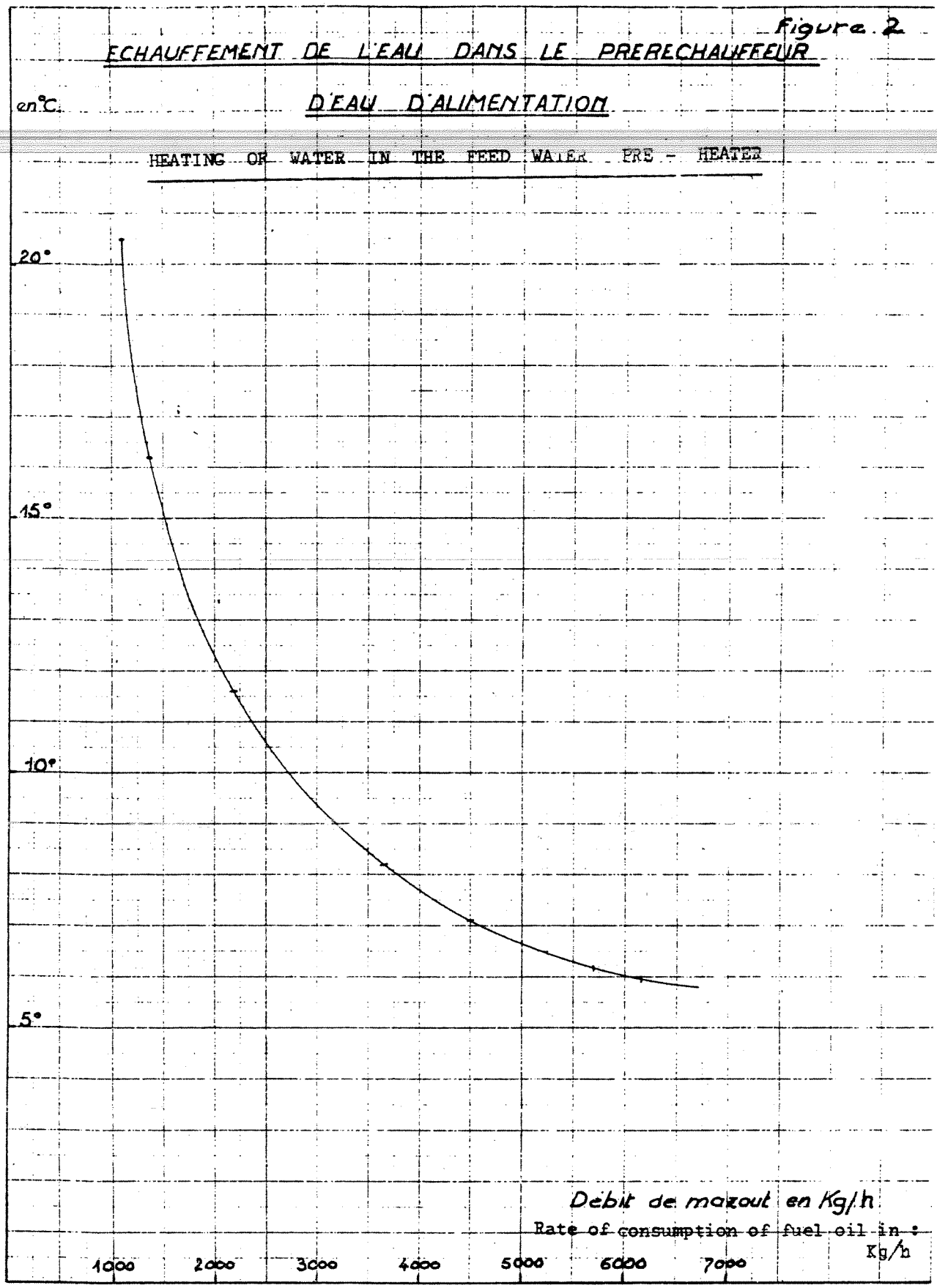
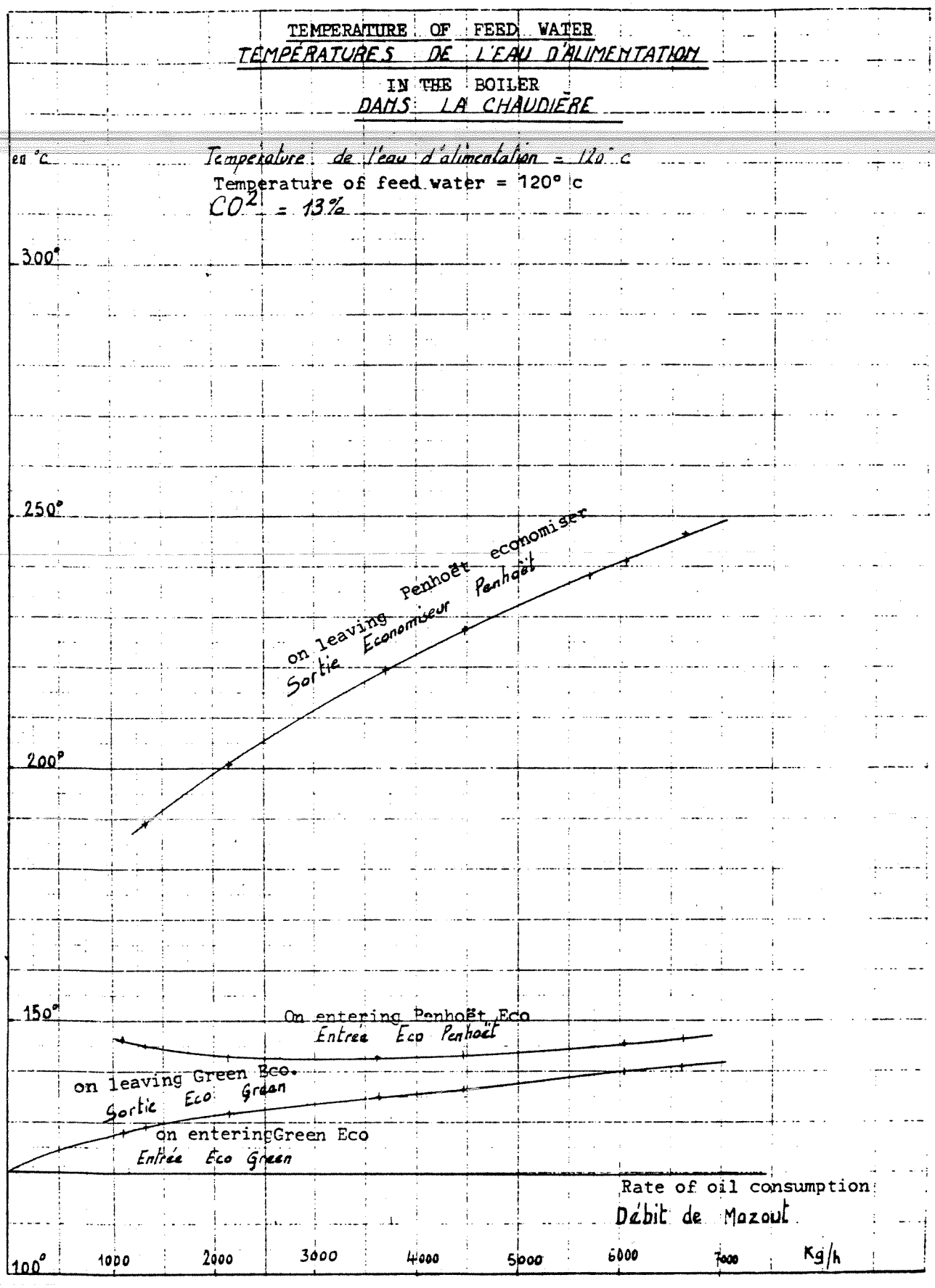


Figure 2

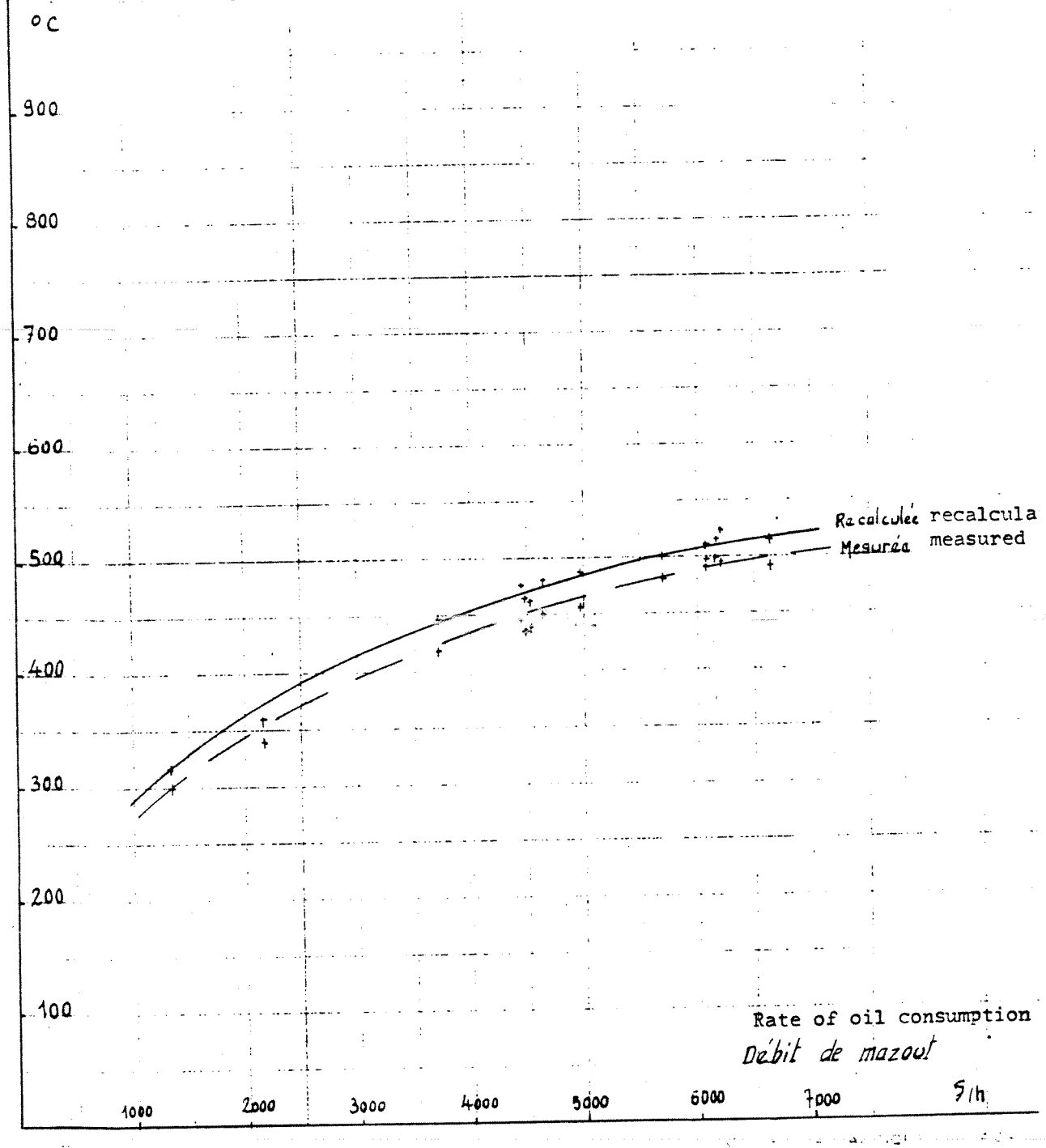
ECHAUFFEMENT DE L'EAU DANS LE PREREHAUFFEUR D'EAU D'ALIMENTATION

HEATING OR WATER IN THE FEED WATER PRE - HEATER




TEMPERATURE OF FEED WATER
TEMPÉRATURES DE L'EAU D'ALIMENTATION
IN THE BOILER
DANS LA CHAUDIÈRE
en °c
Temperature de l'eau d'alimentation = 120° c
Temperature of feed water = 120° c
CO2 = 13%
300°
250°
200°
150°
100°
on leaving Penhoët economiser
Sortie Economiseur Penhoët
On entering Penhoët Eco
Entrée Eco Penhoët
on leaving Green Eco.
Sortie Eco Green
on enteringGreen Eco
Entrée Eco Green
Rate of oil consumption
Débit de Mazout
1000
2000
3000
4000
5000
6000
7000
Kg/h

SMOKE TEMPERATURE UPSTREAM
TEMPERATURE DES FUMEES EN AMONT
OF THE PENHOET ECONOMISER.
DE L'ECONOMISEUR PENHOET

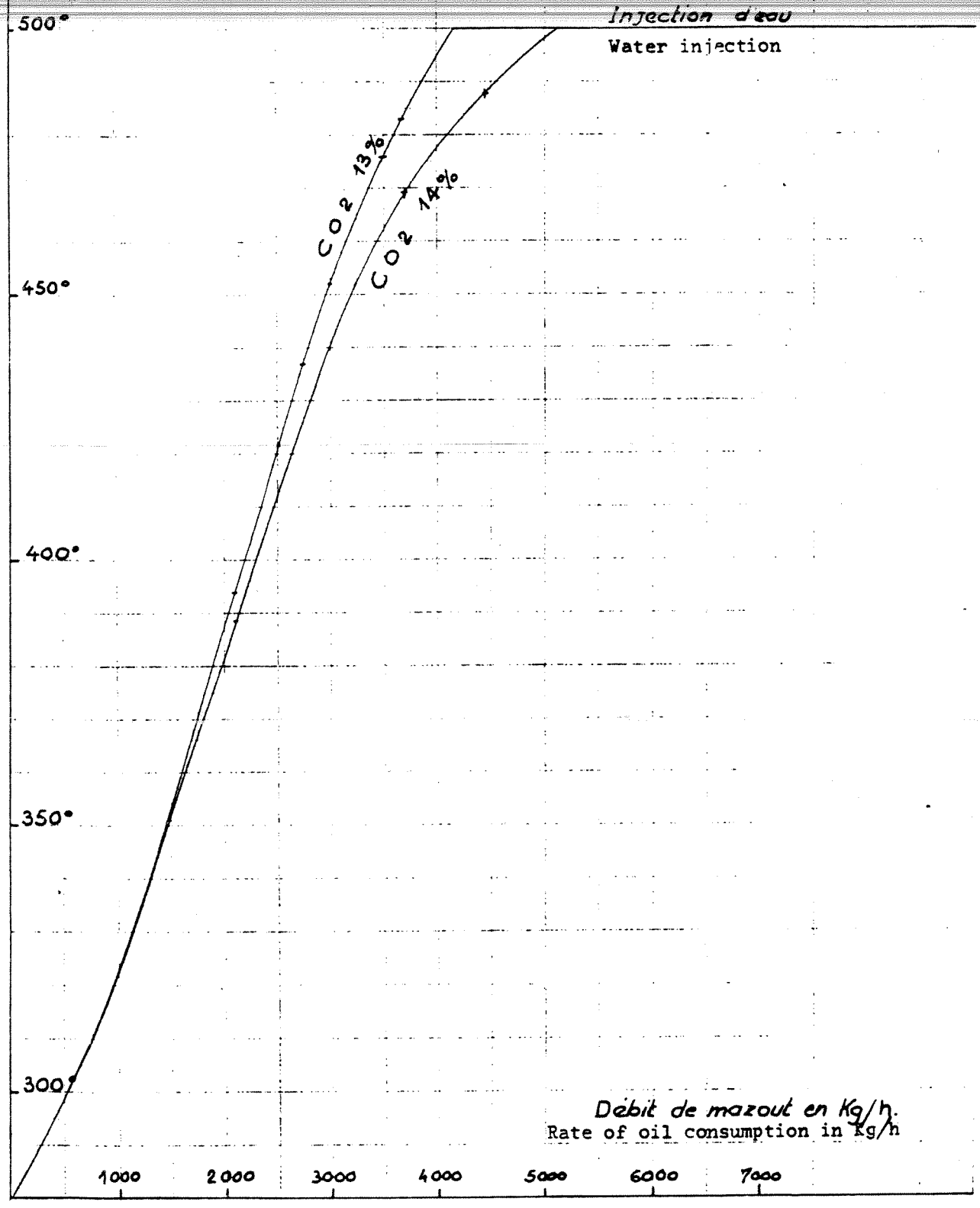


TEMPERATURE OF SUPERHEATED STEAM

TEMPERATURE DE LA VAPEUR SURCHAUFFEE

(on leaving the recordary superheater)

(a la sortie du surchauffeur secondaire)

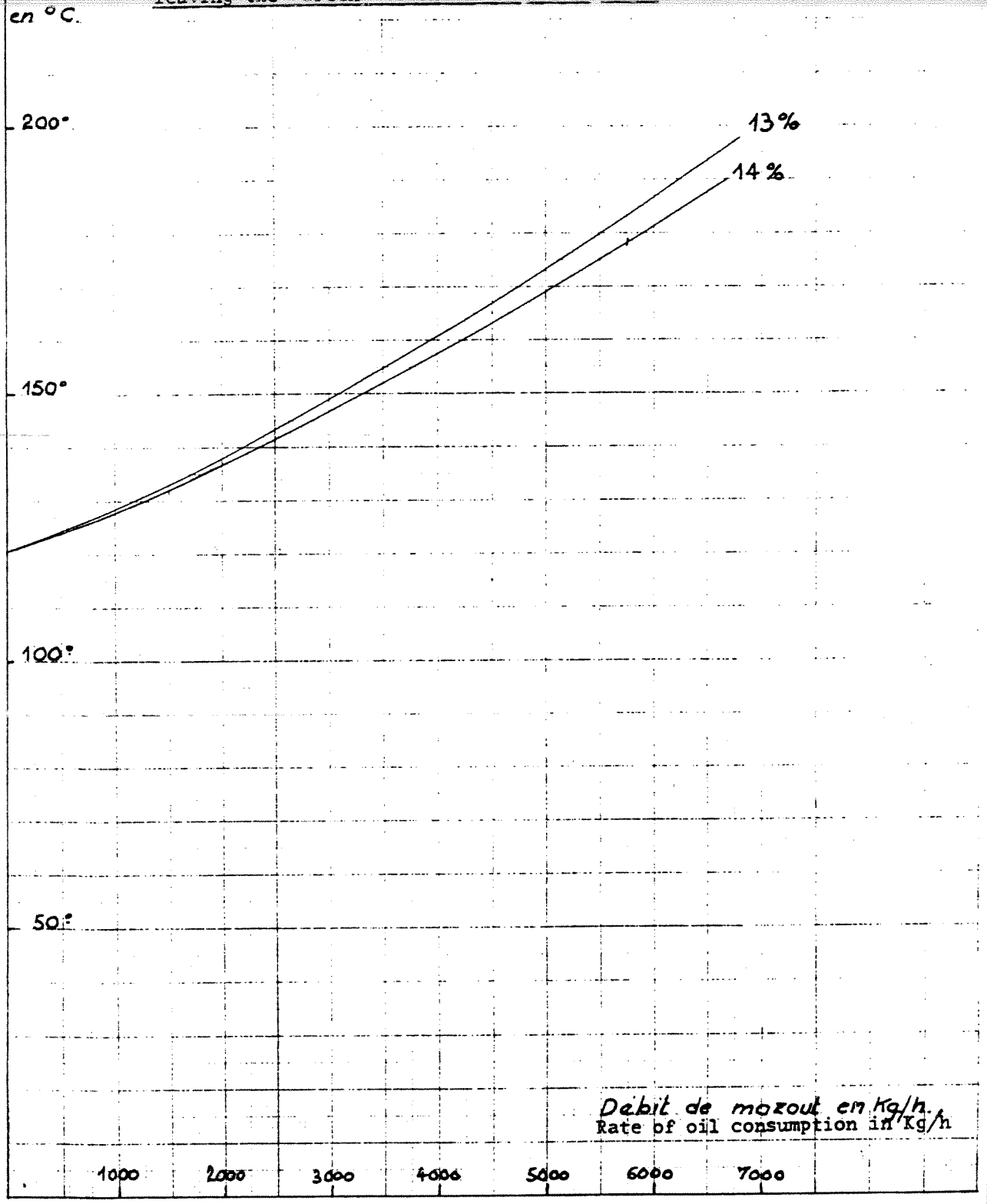


TEMPERATURE OF SMOKE

TEMPERATURE DES FUMEES

à la sortie de l'économiseur "GREEN" dans la cheminée

leaving the "Green" economised in the funnel

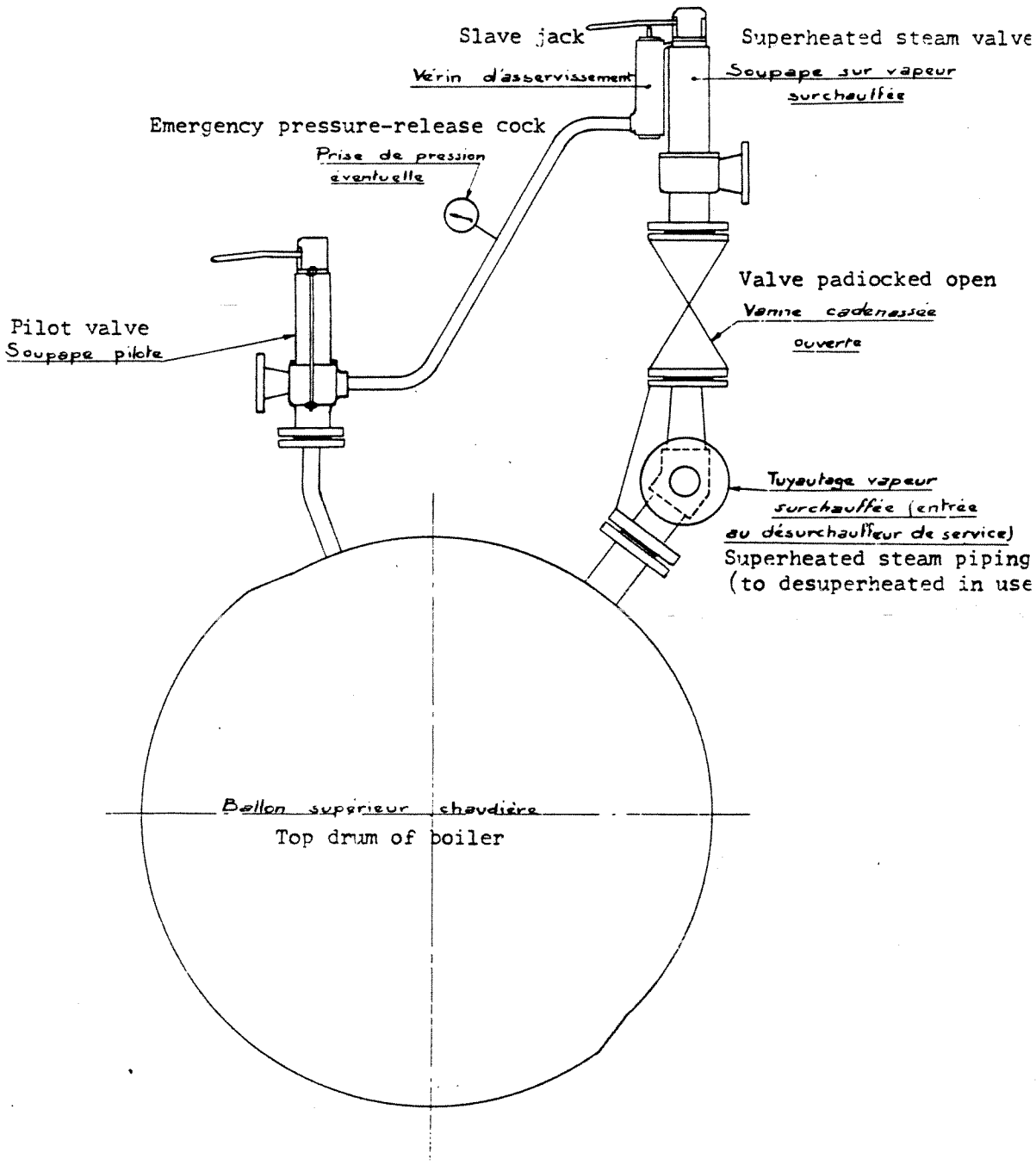


DIAGRAM

- SCHEMA -

Figure 3

Installation de la soupape de sureté sur vapeur surchauffée
Installation of the superheated steam safety valve
et de sa soupape pilote sur vapeur saturée
and its saturated steam pilot valve

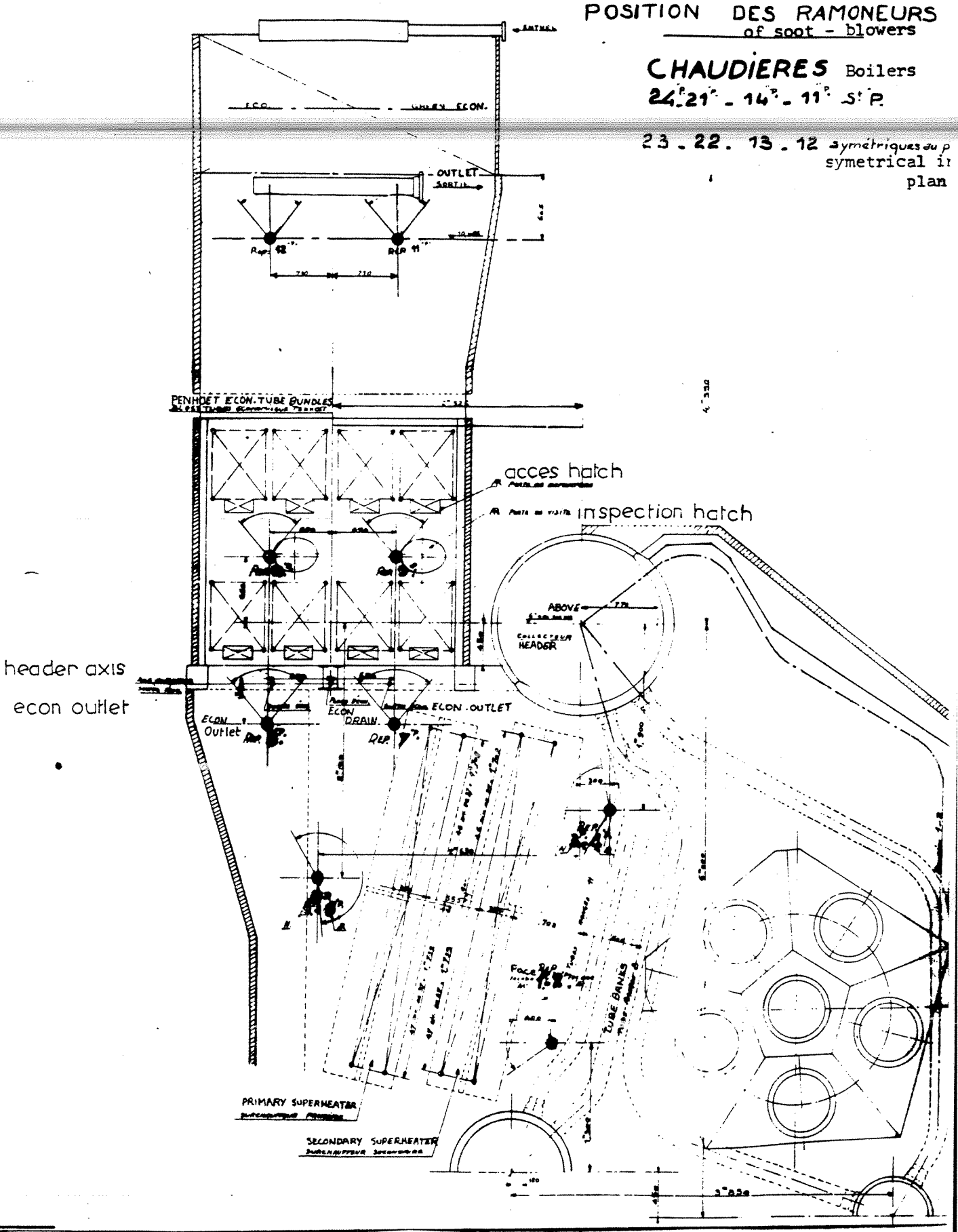


SKETCH Croquis

POSITION DES RAMONEURS
of soot - blowers

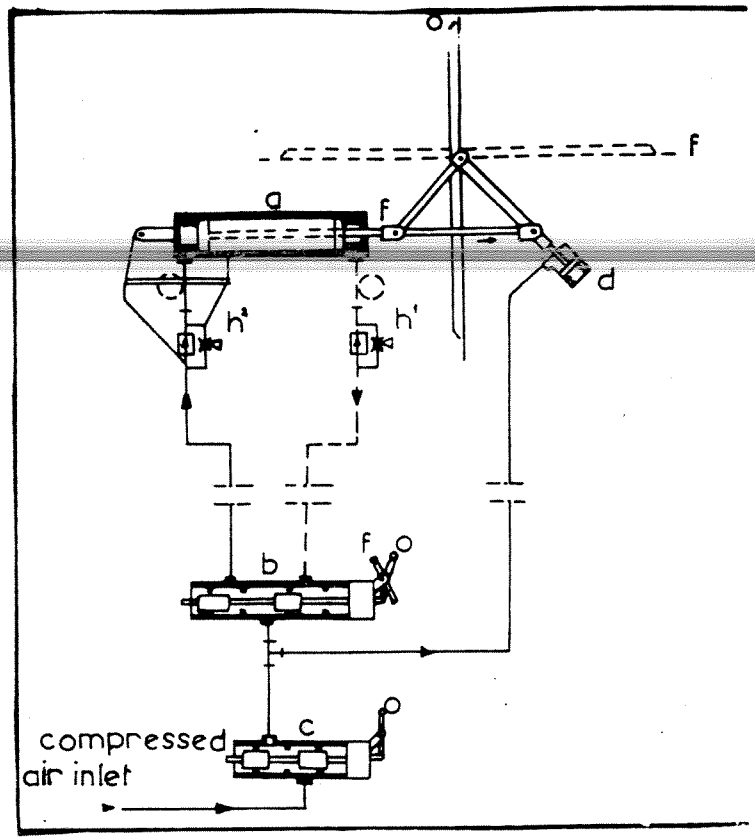
CHAUDIERES Boilers
24 - 21 - 14 - 11 St P.

23 - 22 - 13 - 12 symétriques au p
symetrical i
plan



PNEUMATIC CONTROL of the SHUTTERS of the LARGE DUST REMOVERS

COMMANDE PNEUMATIQUE des VOLETS des GROS DÉPOUSSIEREURS



Operation

Opening the shutter : Throw lever of valve C. Compressed air passes through this valve and acts on the cylinder of bolt D.

Place the lever of valve B in position O. This allows pressurisation of the left side of jack A.

Discharge, from the right-hand side of the jack occurs through valve B via the fixed delay duct of the non-return valve H_1

Release lever of valve C, stopping flow of compressed air. Repressuratic of bolt D is effected by this same valve C, allowing the shutter to be torked in the open position.

Closing the shutter : Throw the lever of valve C. Compressed air passes through this valve and acts on the cylinder of bolt D, which frees the shutter.

Place the lever of valve B in position F. This pressurises the right hand side F jack A.

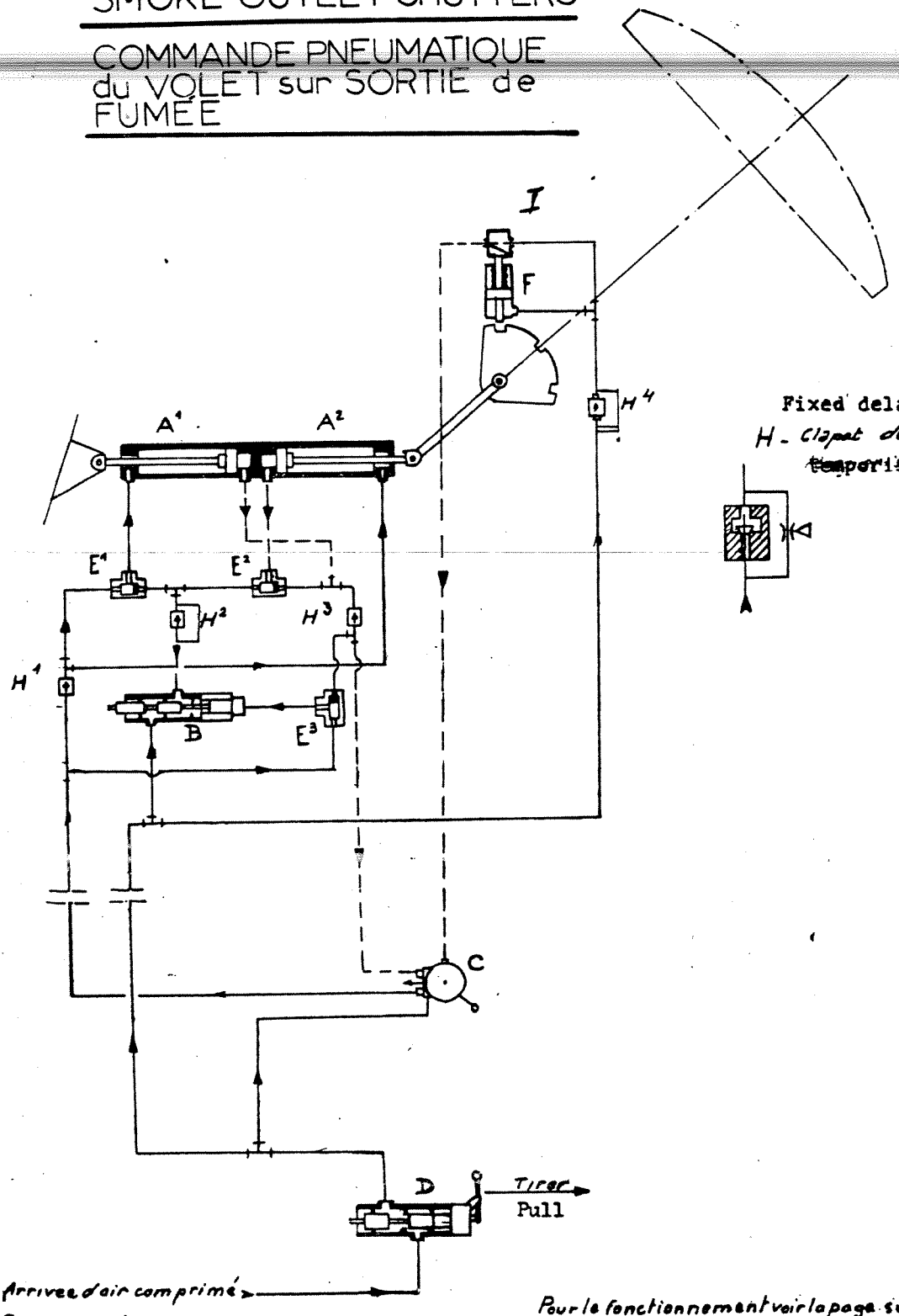
Discharge from the left hand side of the jack accuts through valve B, via the fixed delay duct of the non-return valve H_2.

Release the lever of valve C.

Schéma 7
Diagram 7

PNEUMATIC CONTROL of SMOKE OUTLET SHUTTERS

COMMANDE PNEUMATIQUE du VOLET sur SORTIE de FUMÉE



Fixed delay non-ret
H - Clapet de non-retour temporisé

Pour le fonctionnement voir la page suivante
For operation see following page

Diagram 7

PNEUMATIC CONTROL OF SMOKE OUTLET SHUTTERS

PRINCIPLE OF OPERATION

The positions of the lever of the rotary valve "C" are as follows :

- lever down - starboard closed
- lever horizontal - starboard and port open
- lever up - port closed

Never pass directly from one side to the other

The diagram opposite shows the starboard shutter closed. The lever of Pilotair D is in the neutral position, lever C is down, and bolt F, spring-loaded, immobilises the shutter.

To change the position of the shutter, pull lever D, allowing compressed air t enter the left-hand side of cylinder A^1, via C-H^1 and E^1, and the right-hand side of A^2 via C and H^1. Discharge from the right-hand side of A^1 occurs throu the air release at C by way of the fixed delay duct of H^3, and discharge from the left hand side of A^2 through E^2 via the delay mechanism of H^2, and through the air release of valve B controlled by double valve E^3. At the same time, air is admitted beneath piston of bolt F, passing through the fixed delay duct of H^4.

When bolt F has freed the shutter, if acts on valve I at the end of its moveme sending compressed air to the bolt of valve C, which in its turn frees the lever of the valve.

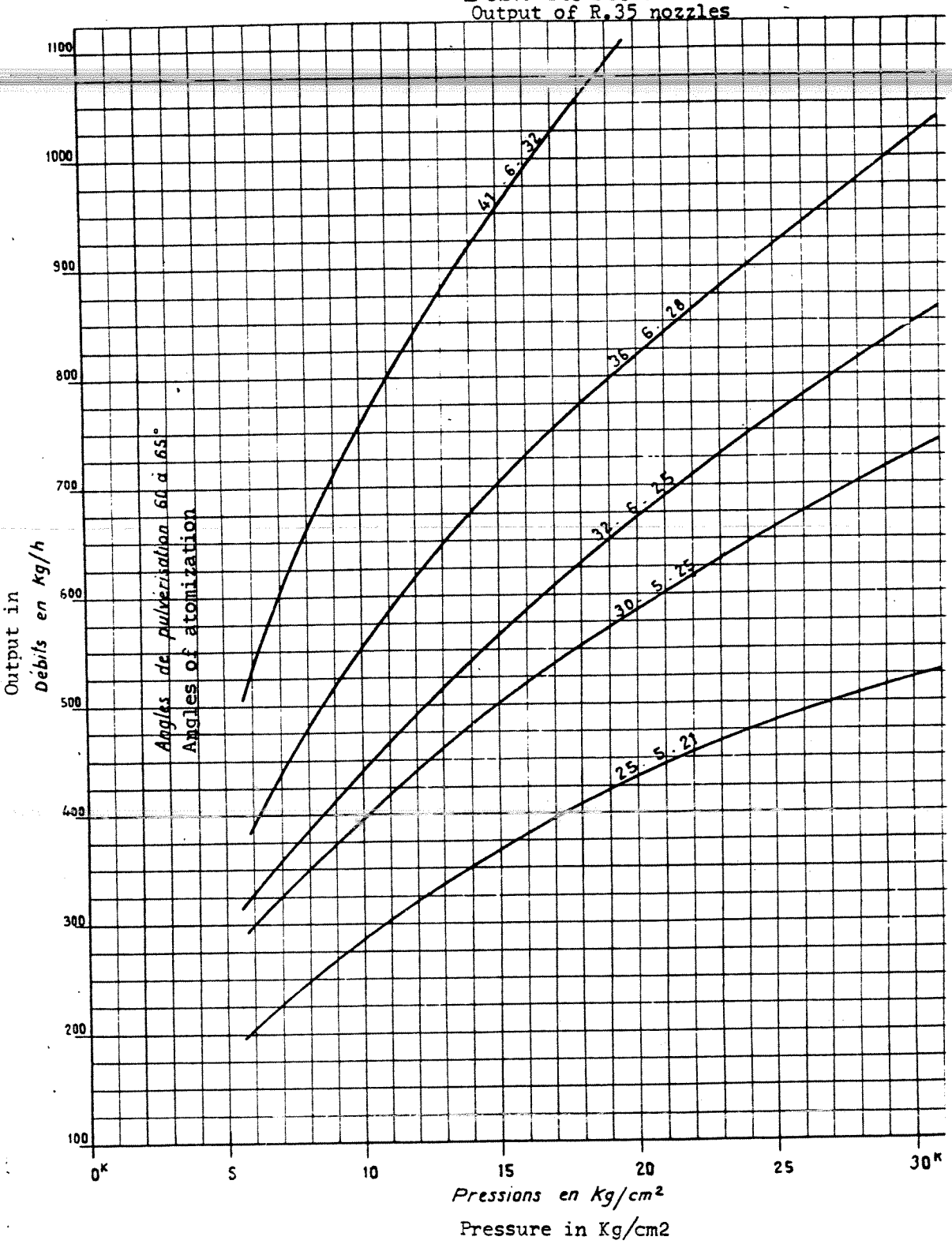
At this point, and whilst maintaining pressure on lever D, move lever C into the horizontal position to obtain "starboard and port open". Do not release le D until the indicator lamp corresponding to the position of lever C is illumin

Lever D is once more in the neutral position. Discharge from bolts C and F

Diagram 7 (bis)

occurs through the air release of valve C, the spring of bolt F immobilizes the shutter, valve I at the end of F' s movement closes, and the bolt of valve C, also spring-loaded, locks the lever.

Débit des buses R.35
Output of R.35 nozzles



Etablissements HIARD

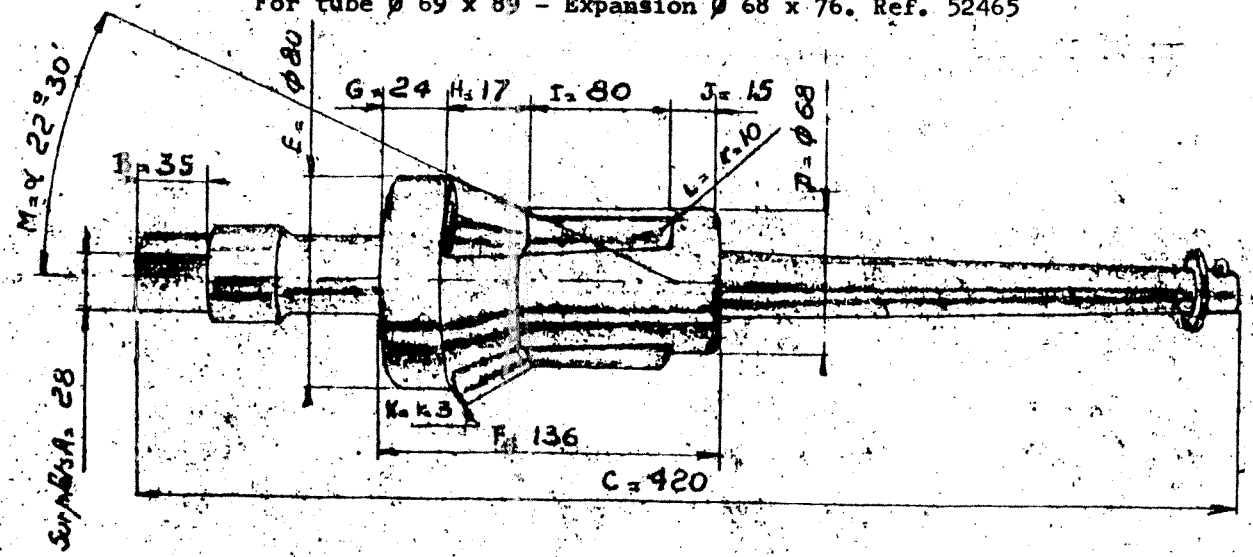
56 AVENUE de CHOISY . PARIS XIII° GOB. 37.51 – 03.61.

EXPANDING AND BELL - MOUTHING TOOLS

APPAREILS à MANDRINER et EVASER

Pour TUBE ϕ69x89 - Expansion ϕ68x76 Ref 52465

For tube ϕ 69 x 89 - Expansion ϕ 68 x 76. Ref. 52465



MODIFICATIONS

G.J. 1-62

DATE	Référence	A	B	C	D	E	F	G	H	I	J	K	L	M

Etablissements HIARD

56 AVENUE de CHOISY - PARIS XIII^{e} - GOB 37.51 - 03.61

DUDGEON SERTISSEUR SIMPLE SPECIAL à BUTEE à BILLES

SPECIAL TUBE EXPANDER WITH BALL THRUST BLOCK

FORMATION CYLINDRIQUE POUR TUBE 69×89 - Ref 52466

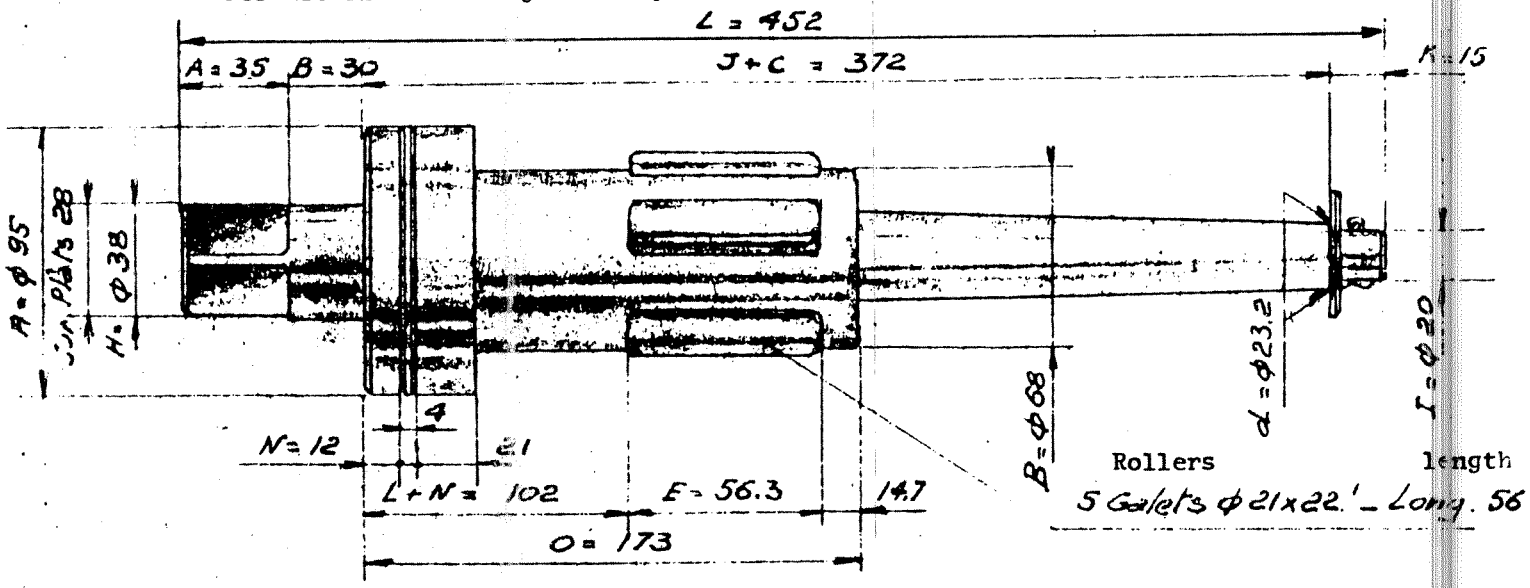
CYLINDRICAL TYPE FOR TUBE 69 x 89 - Ref 52466

PROFONDEUR EXTREME de SERTISSAGE 124 m/m

Maximum extent of expansion 124 m/m

à UTILISER en PREMIERE OPERATION SUR PLAQUE d'EPAISSEUR de 106 m/m

For use in first stage of operation on plate of 106 m/m Thickness



- 06 -

MODIFICATIONS

G.J 25-2-63

DATE	REFERENCE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V

Etablissements HIARD

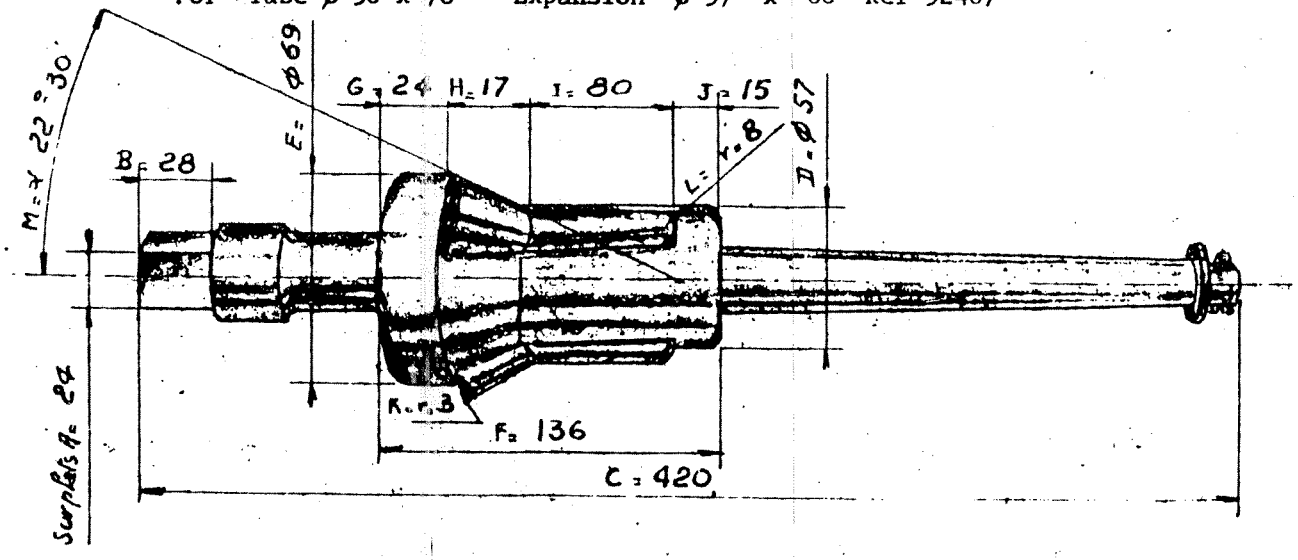
56 AVENUE de CHOISY PARIS XIII^{e} GOB. 37.51 - 03.61

EXPANDING AND BELL - MOUTHING TOOLS

APPAREILS à MANDRINER et EVASER

Pour TUBE ϕ 58 x 70 _ Expansion ϕ 57 x 66 Ref 52467

For Tube ϕ 58 x 70 - Expansion ϕ 57 x 66 Ref 52467



MODIFICATIONS

G.J. 1.62

DATE	Référence	A	B	C	D	E	F	G	H	I	J	K	L	M

Etablissements HIARD

56 AVENUE de CHOISY - PARIS XIII^e GOB 37.51 - 03.61

DUDGEON SERTISSEUR SIMPLE SPECIAL à BUTEE à BILLES

Special tube expander with ball thrust block

FORMATION CYLINDRIQUE POUR TUBE 58 x 70 - Ref 52468

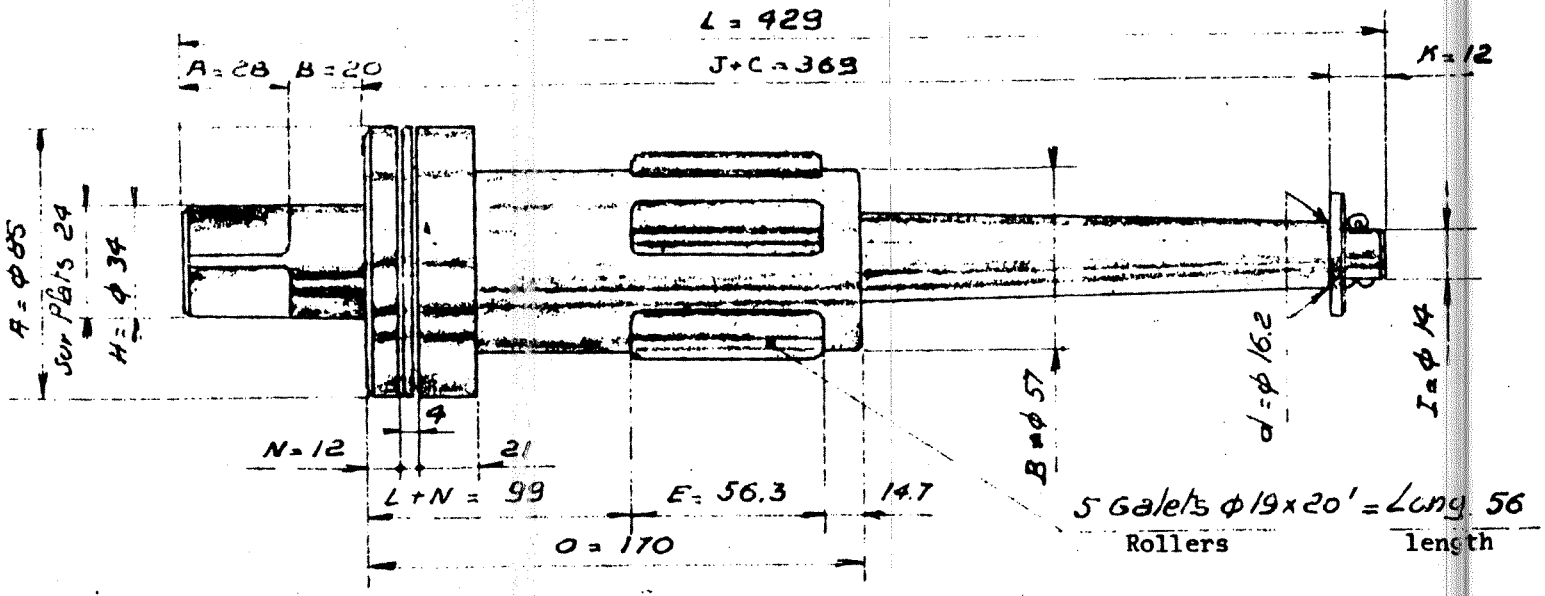
cylindrical type for tube 58 x 70 - Ref 52468

PROFONDEUR EXTREME de SERTISSAGE 121 m/m

Maximum extent of expansion 121 m/m

LA DEUXIEME OPERATION ETANT FAITE AVEC LE DUDGEON DU 3ème ~~POSTE~~

Second stage of operation being carried out with tube expander from position n° 3



MODIFICATIONS

GJ 25-2-62

DATE	REFERENCE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V

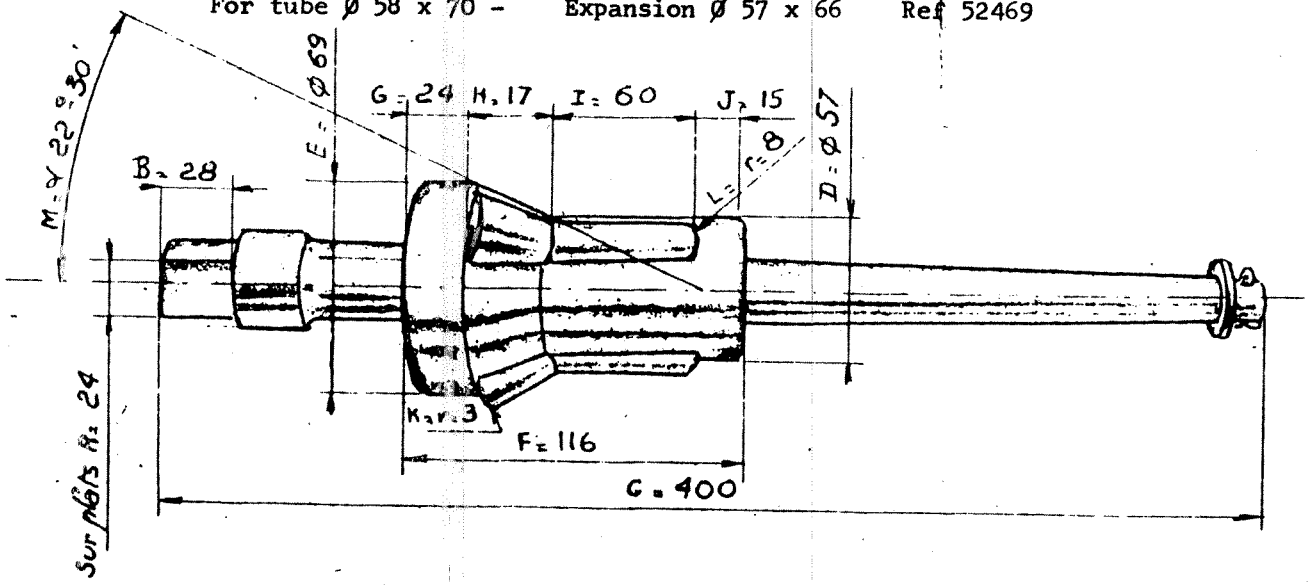
Etablissements HIARD
56 AVENUE de CHOISY . PARIS XIII° GOB. 37.51 – 03.61

Expanding and bell - mouthing tools

APPAREILS à MANDRINER et EVASER

Pour TUBE ϕ 58 x 70 _ Expansion ϕ 57 x 66 Ref 52469

For tube ∅ 58 x 70 – Expansion ∅ 57 x 66 Ref 52469



MODIFICATIONS

G.J. 1.62

DATE	Référence	A	B	C	D	E	F	G	H	I	J	K	L	M	

Etablissements HIARD

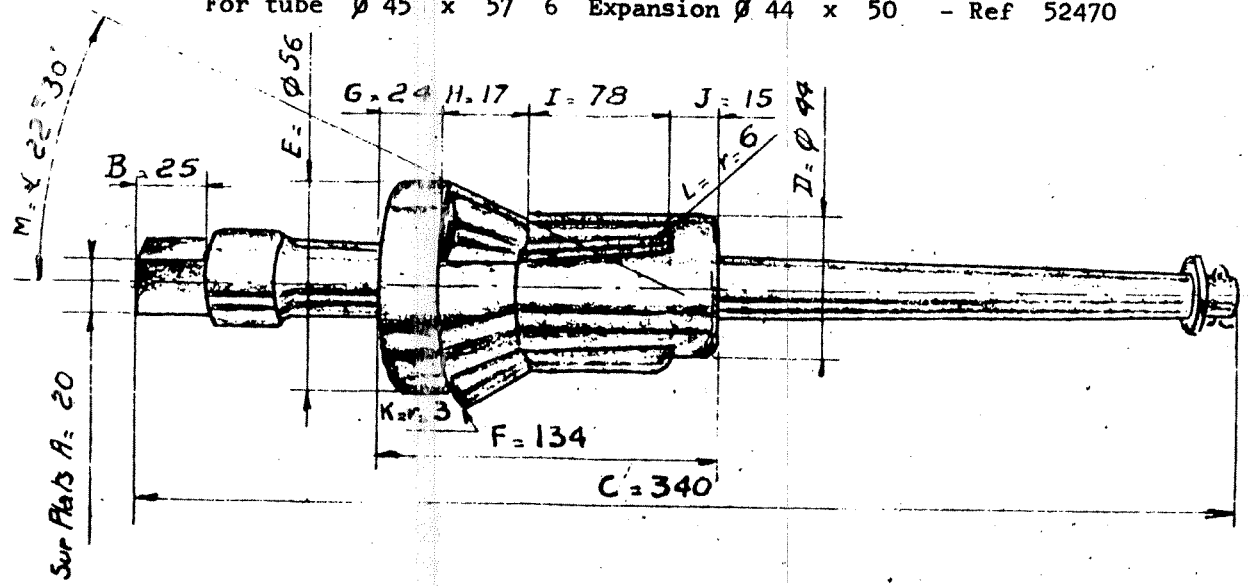
56 AVENUE de CHOISY - PARIS XIII° GOB. 37.51 - 03.61

EXPANDING AND BELL - MOUTHING TOOLS

APPAREILS à MANDRINER et EVASER

Pour TUBE ϕ 45 x 57 - EXPANSION ϕ 44 x 50 - Ref 52470

For tube ϕ 45 x 57 6 Expansion ϕ 44 x 50 - Ref 52470



MODIFICATIONS

GJ. 1-62

DATE	Références	A	B	C	D	E	F	G	H	I	J	K	L	M

Etablissements HIARD

56 AVENUE de CHOISY - PARIS XIII^e - GOB 37.51 - 03.61

Specail tube expanter with ball thrust - block

DUDGEON SERTISSEUR SIMPLE SPECIAL à BUTEE à BILLES

Cylindrical type for tube 45 x 57

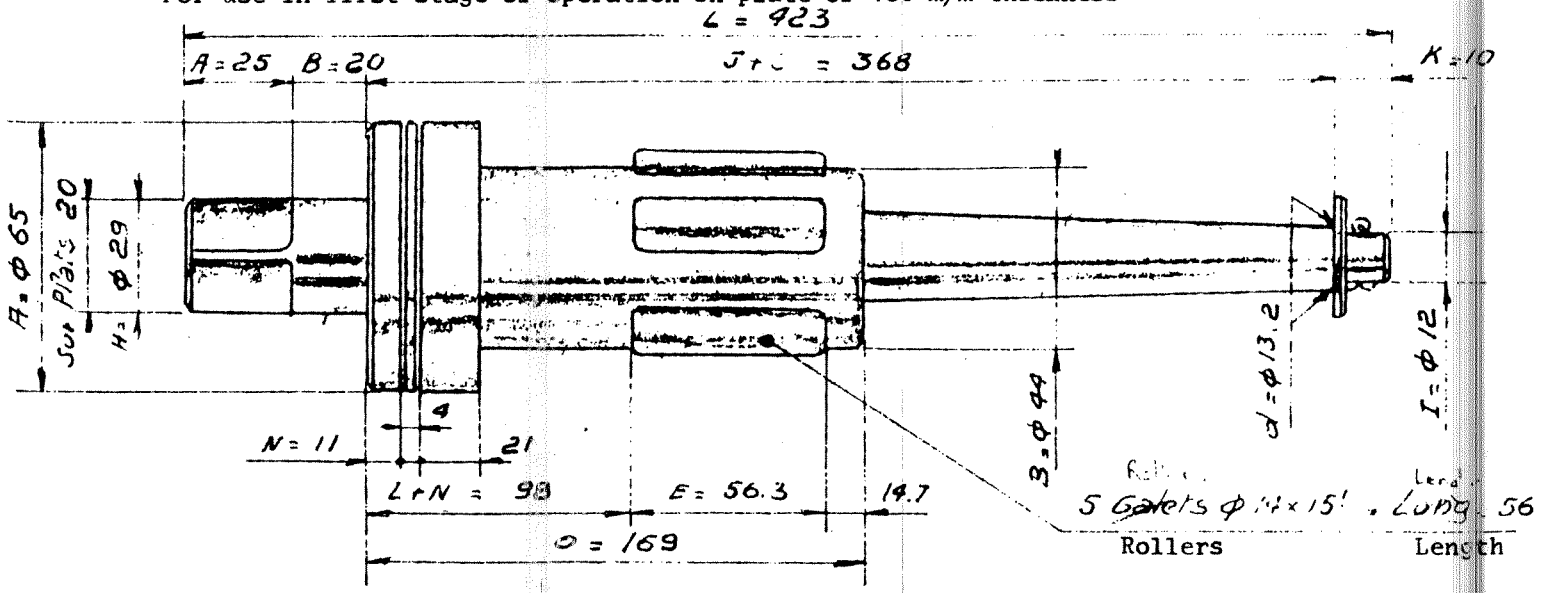
FORMATION CYLINDRIQUE POUR TUBE 45×57 - Ref. 52471

Maximum extent of expansion

PROFONDEUR EXTREME de SERTISSAGE 121 m/m

à UTILISER en PREMIERE OPERATION SUR PLAQUE d'EPAISSEUR de 106 m/m

For use in first stage of operation on plate of 106 m/m thickness



MODIFICATIONS

G J. 25-2-62

DATE	REFERENCE	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V

Etablissements HIARD

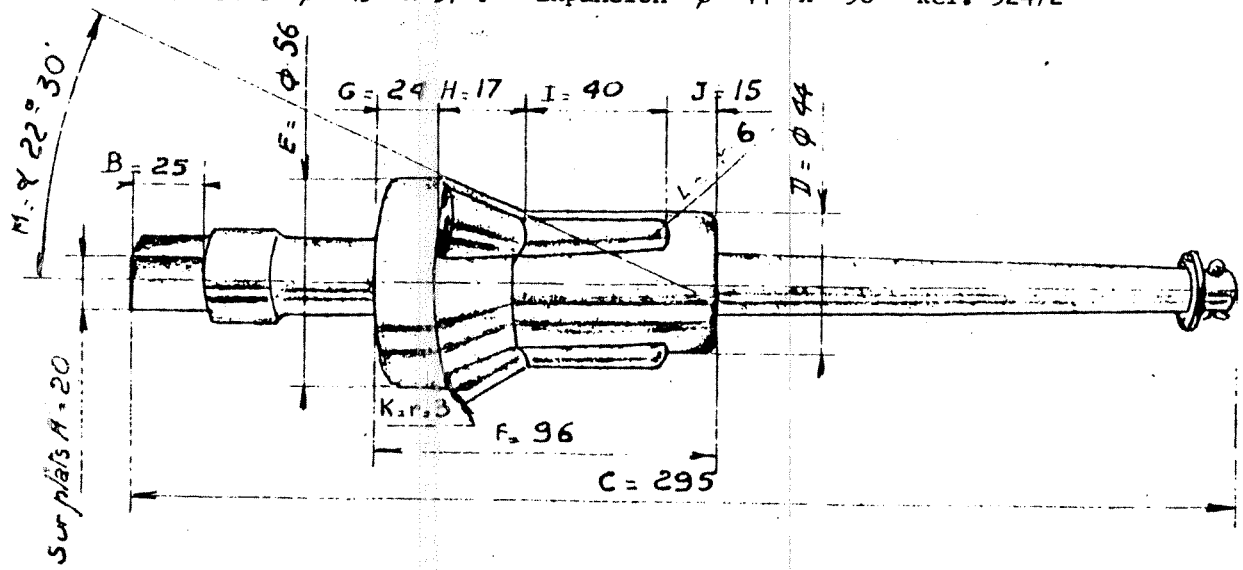
56 AVENUE de CHOISY . PARIS XIII° GOB. 37.51 - 03.61.

EXPANDING AND BELL - MOUTHING TOOLS

APPAREILS a MANDRINER et EVASER

Pour TUBE ϕ 45 x 57 . EXPANSION ϕ 44 x 50 Ref 52472

For tube ∅ 45 x 57 . Expansion ∅ 44 X 50 Ref. 52472



MODIFICATIONS

GJ. 1-62

DATE	Référence	A	B	C	D	E	F	G	H	I	J	K	L	M

Etablissements HIARD

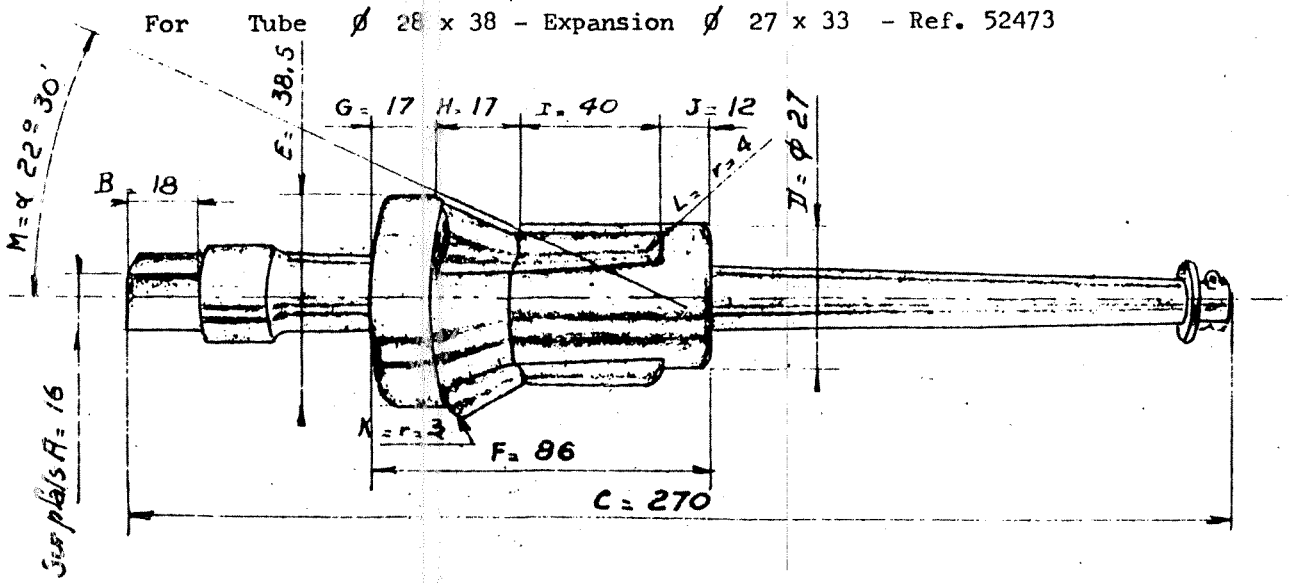
56 AVENUE de CHOISY . PARIS XIII^e^ GOB 37.51 - 03.61

EXPANDING AND BELL - MOUTHING TOOLS

APPAREILS a MANDRINER et EVASER

Pour TUBE ϕ 28 x 38 . EXPANSION ϕ 27 x 33 . Ref 52473

For Tube ∅ 28 x 38 - Expansion ∅ 27 x 33 - Ref. 52473



MODIFICATIONS

G.J. 1-62

DATE	Référence	A	B	C	D	E	F	G	H	I	J	K	L	M	

- 97 -

Etablissements HIARD

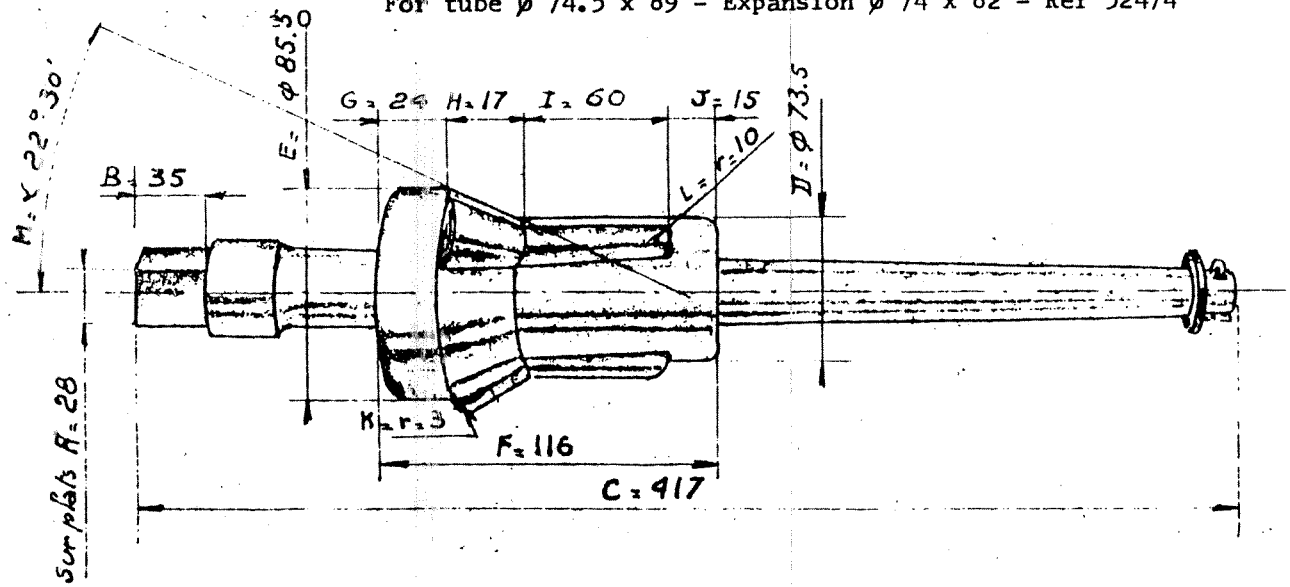
56 AVENUE de CHOISY . PARIS XIII^e. GOB. 37.51 - 03.61

EXPANDING AND BELL - MOUTHING TOOLS

APPAREILS a MANDRINER et EVASER

Pour TUBE ϕ 74.5 x 89 - EXPANSION ϕ 74 x 82 Ref 52474

For tube Ø 74.5 x 89 - Expansion Ø 74 x 82 - Ref 52474



MODIFICATIONS

G.J. 1.62

DATE	Reference	A	B	C	D	E	F	G	H	I	J	K	L	M	

Etablissements HIARD

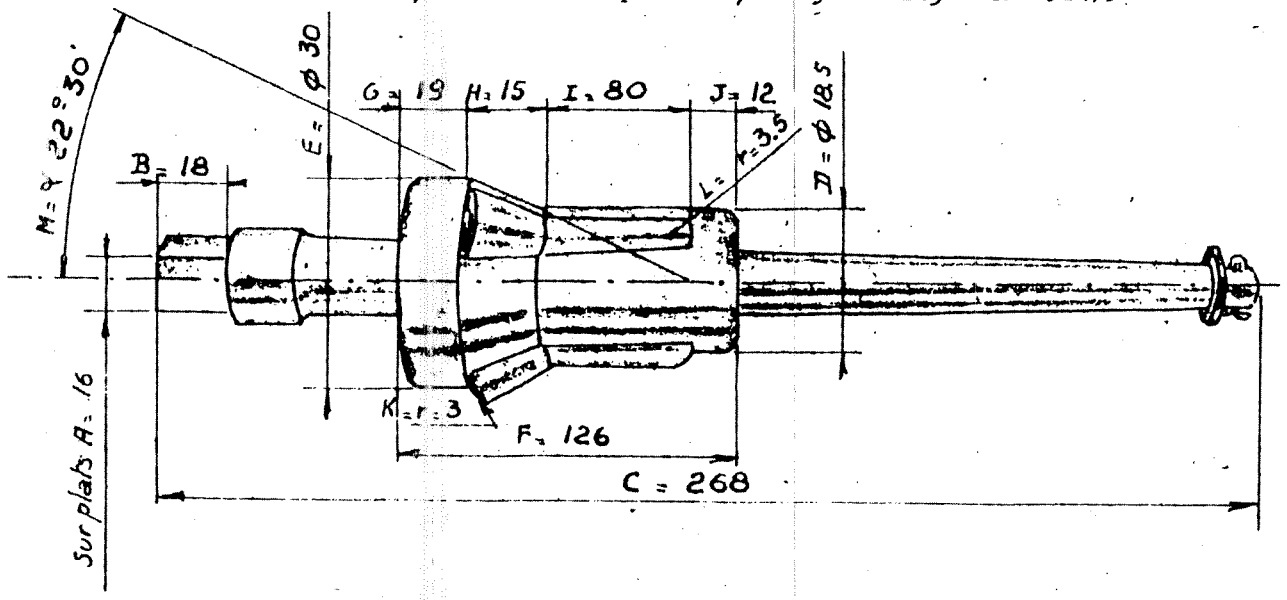
56 AVENUE de CHOISY . PARIS XIII^{e} GOB. 37.51 - 03.61

EXPANDING AND BELL - MOUTHING TOOLS

APPAREILS à MANDRINER et EVASER

Pour TUBE ϕ 19 x 25 _ EXPANSION ϕ 18^{5} x 22^{5} Ref 52475

For tube ϕ 19 x 25 - Expansion ϕ 18 5 x 225 Ref 52475



MODIFICATIONS

GI 1-62

DATE	Reference	A	B	C	D	E	F	G	H	I	J	K	L	M

Etablissements HIARD

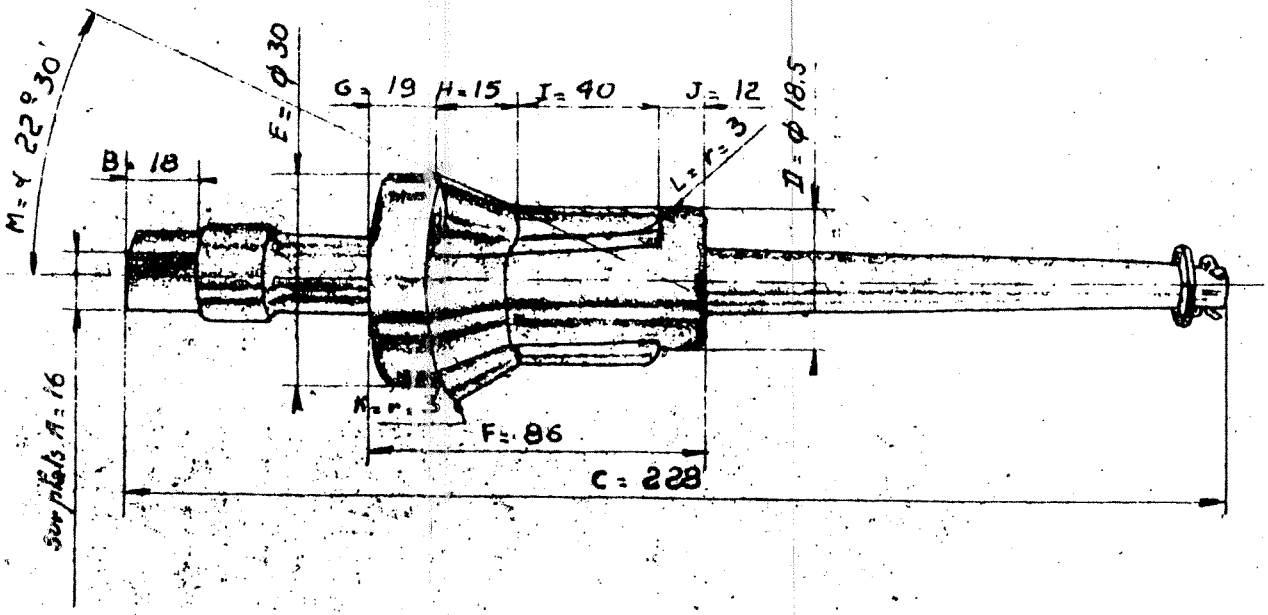
56 AVENUE de CHOISY - PARIS XIII° GOB. 37.51 - 03.61

EXPANDING AND BELL - MOUTHING TOOLS

APPAREILS a MANDRINER et EVASER

Pour TUBE ϕ 19 x 25 - EXPANSION ϕ 18^{5} x 22^{5} Ref 52476

For tube ~~ϕ 19 x 25~~ - Expansion ~~ϕ 18^{5} x 22^{5}~~ Ref. 52476



MODIFICATIONS

GJ. 1.62

DATE	Reference	A	B	C	D	E	F	G	H	I	J	K	L	M