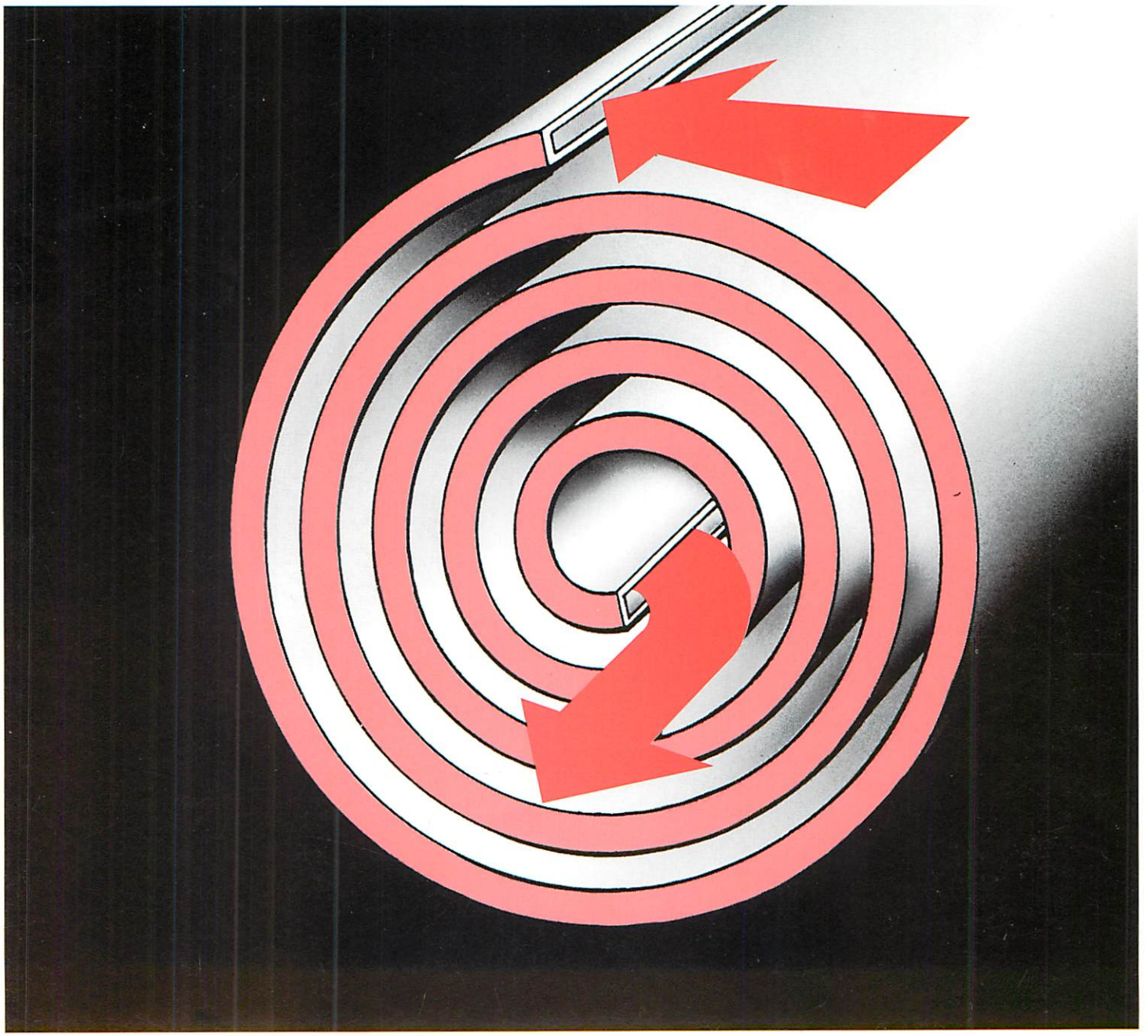
M-987

Alfa Laval

Alfa Laval Thermal

Spiral Heat Exchanger
INSTRUCTION BOOK

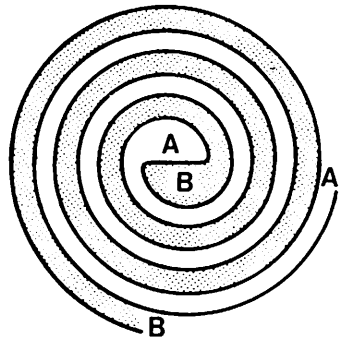


CONTENTS

MFG # 22077

INTRODUCTION

The Spiral heat exchanger (SHE) consists in principle of a strip of metal wound around a central core, to form two concentric spiral channels - one for each of the fluids between which heat is to be transferred.

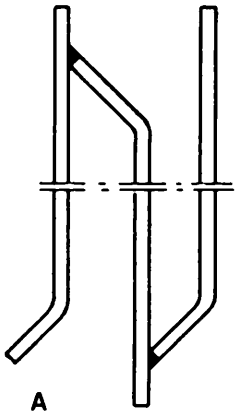


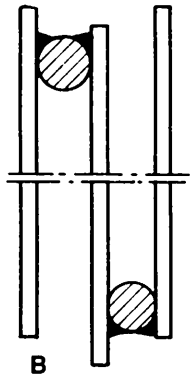
TYPE I OR II

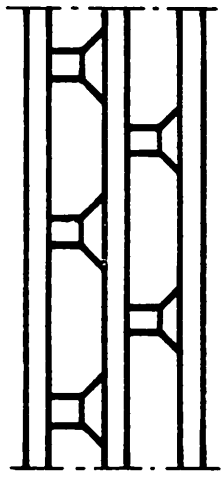
The edges of the strips may be sealed in a variety of ways, depending on the type and function of the SHE. Two channel sealing methods are used:

a) the edge of the strip is rolled and welded to the adjacent strip.

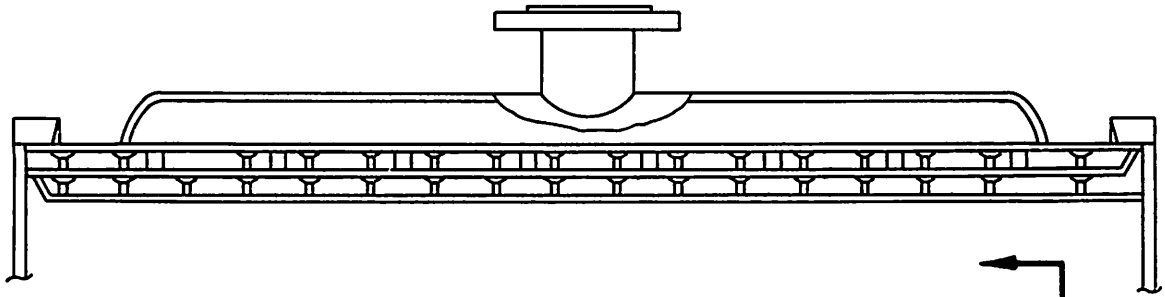
b) a bar is inserted and welded to each strip.

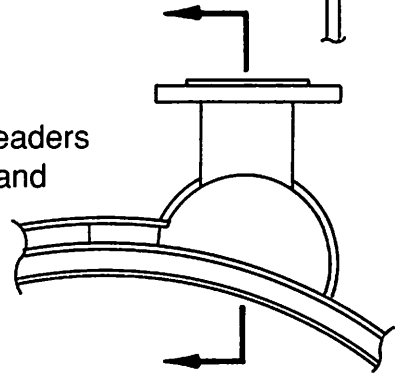






The strip is normally provided with spacer studs to maintain the desired channel spacings for the two channels.





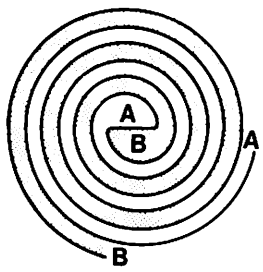
The spiral body thus formed is provided with peripheral headers and covers incorporating fluid connections. The number and location of these connections is dependent on the type of function of the SHE.

SPIRAL TYPES

Type I

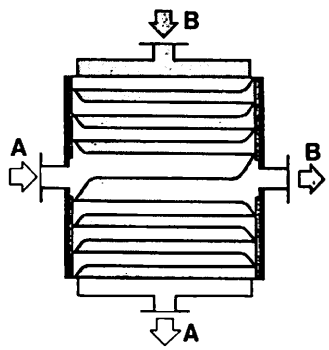
Normally intended for liquid/liquid services, the horizontally mounted Type IH spiral has alternate channels welded, i.e. one channel sealed at one face of the spiral body and the other channel sealed at the other face. Flat covers on each face.

Channel A is thus accessible from the left hand face of the body, channel B from the right hand face.

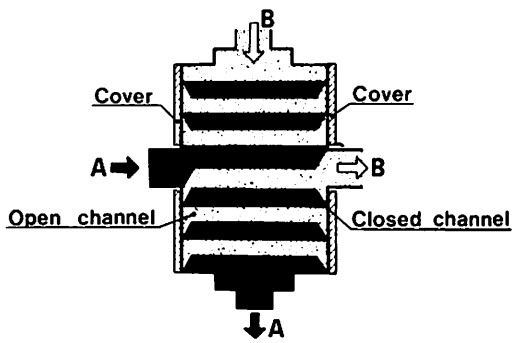


For gas phase or two phase gas/liquid services, the Type I spiral is mounted vertically—Type IV—for improved venting or phase separation.

For some duties, one channel may be completely welded and the other completely open. The closed channel is not accessible for inspection or mechanical cleaning, but the open channel is accessible from both faces. This construction is therefore used when one of the fluids is very dirty, or when one of the fluids presents severe gasketing problems.



Flows are normally counter-current. If fluid A enters at the periphery and exists at the central cover connection, fluid B enters the other central cover connection and exits at the periphery. Co-current operation is sometimes used, here both fluids enter at the periphery or at the central cover connections.



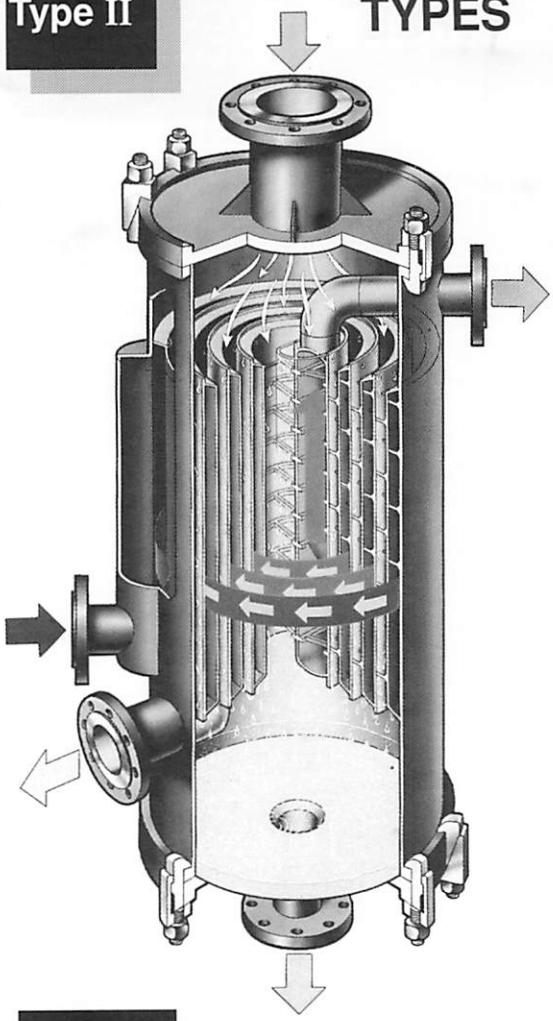
SPIRAL TYPES

Type II

The Type II SHE operates in cross flow, one fluid passing from face to face of the body. The channel for this cross-flow fluid must therefore be open at both faces.

The other fluid is in spiral flow and the channel is welded at both faces. The central entry or exit for the spiral flow fluid is taken through an extension of the outer "shell" of the body, which incorporates the connections for the cross-flow fluid.

The Type II spiral is normally used for condensation or vaporization duties, where a channel of larger cross-section than in a Type I can be obtained. Additional connections (e.g. vent or drain connections) can be provided in the top and the bottom covers on the cross flow side. The central core of a Type II is normally closed to prevent bypassing of the cross flow fluid.In vaporizers operating with internal recirculation or in overhead condensers the central core may be open.



Type III

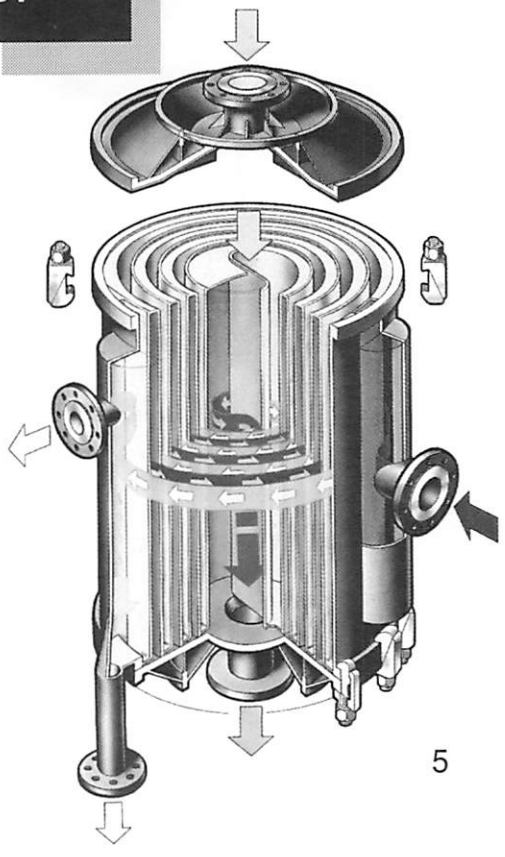
The Type III is a combination of Types I and II usually used as a condenser which can combine both subcooling of condensate and desuperheating of non-condensables.

The top cover feeds the vapor in cross-flow to the main part of the spiral body. At the periphery, channels are closed over the outer turns of the spiral body, forcing the vapor into spiral flow in the outer turns.

The cooling water enters at the periphery of the body and leaves via a central pipe exiting through the periphery.

Condensate flows in the lower part of the channel from center to periphery and is removed via a header which also incorporates a connection for noncondensables.

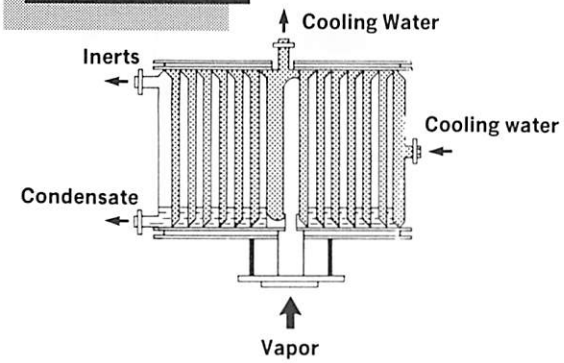
The channels in a Type III are normally alternately welded. In certain cases, the cooling medium channel is totally welded.



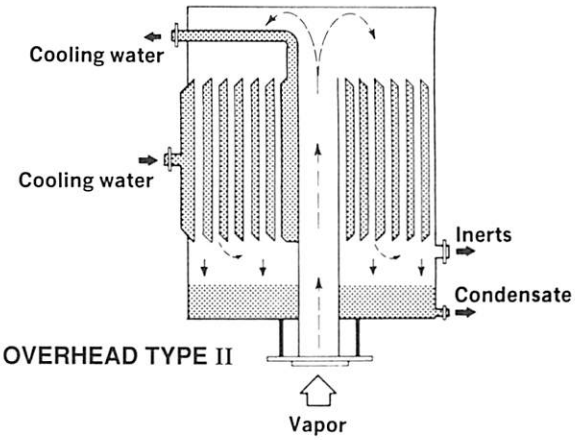
SPIRAL TYPES

Overhead Condensers

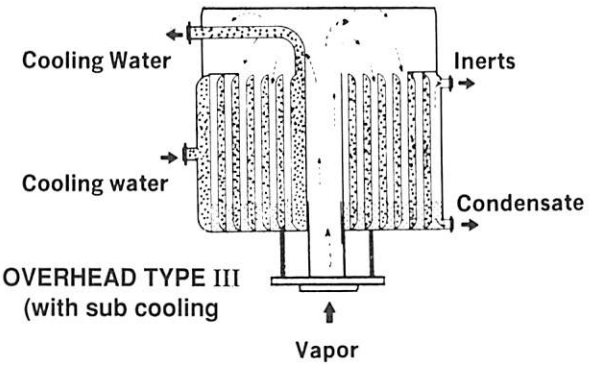
These are variants of the basic Types I, II and III. The construction is such that vapor is admitted to the SHE directly via the bottom cover, thus eliminating vapor pipework when the units are used as condensers on distillation columns or reactors.



OVERHEAD TYPE I



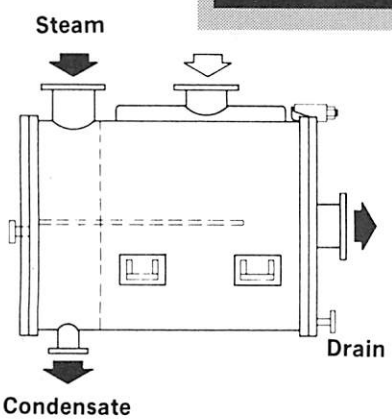
OVERHEAD TYPE II



OVERHEAD TYPE III
(with sub cooling

Horizontal Type III

Certain applications, for instance those involving fluids containing considerable solids, require an SHE with horizontal axis in order to reduce the risks for blockage. When heating such fluids,with steam, a special design is used (Type IIIH).



TYPE IIIH

The steam cover is provided with a baffle which extends about 2/3 of the way into the SHE body. Steam is thus caused to flow in the upper half of the body. The fluid being heated enters at the periphery and exits via the central connection on the flat cover at the opposite face.

Channels are alternately welded.

MOUNTING

Lift the SHE into position using the support feet or lifting lugs or, if fitted, the trunnions.

DO NOT LIFT THE UNIT USING THE CONNECTIONS, as mechanical damage can result.

With vertically mounted units Type I, II and III fitted with mounting pads, ensure that the body is correctly oriented and that the connection locations correspond with the connecting pipework and with those shown on the drawing. Type II and horizontally mounted Type I and III units have welded-on support feet and thus cannot be inadvertently mounted upside down.

CONNECTING

The connecting pipework should wherever possible be provided with valves in order to isolate the unit. Valves are essential between any pumps and the SHE. The use of piston-type pumps should be avoided, and all positive displacement pumps require a pressure relief bypass system.

The pipework should be arranged so that differential expansion/contraction effects cannot place undue strain on the SHE connections. Avoid long straight pipe-runs, by incorporating elbows and/or expansion loops or bellows.

Units using steam as the heating medium should be provided with a steam trap, preferably of the type which automatically vents noncondensables.

Good engineering practice should be observed when using control valves:

- Preferably not of "on-off" type, but if this is unavoidable, the valve action should be slow.

- Provided with manual bypass and isolation valves.

STARTING UP

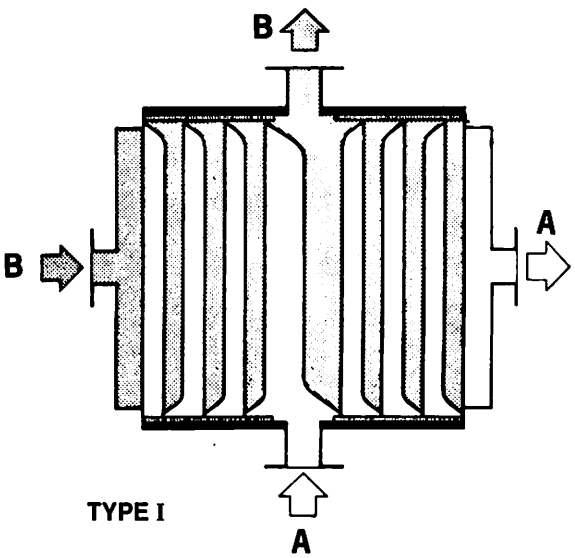
During normal shipment or prolonged periods of shutdown, relaxation of the cover gaskets and/or loosening of the hookbolt assemblies may have taken place. To help ensure a leak free cover, hookbolt assemblies should be retightened in a diagonally opposite sequence. Recommended torque values can be found in the reassembly section of this manual.

The cooler of the two media should normally be admitted to the SHE first. If one or both media are well below ambient temperature, the fluid nearest ambient should be admitted first.

If, for process reasons, it is not possible to follow this practice, start-up should be carried out as smoothly and as slowly as possible.

Pumps should always be started against closed valves, which are subsequently opened slowly, so as to avoid hydraulic shock. If the pump(s) is (are) remote from the SHE, ensure that all pipework and the SHE are filled before opening the valves fully.

VENTING

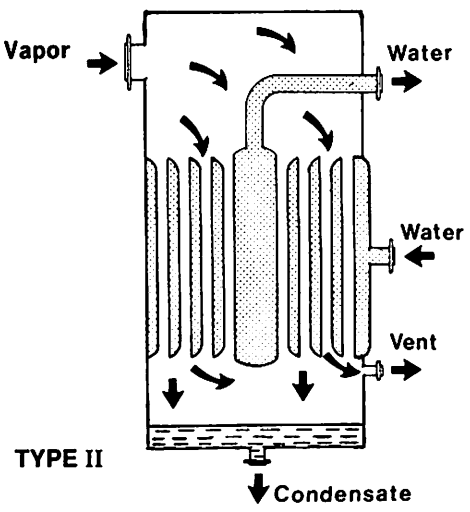


TYPE I

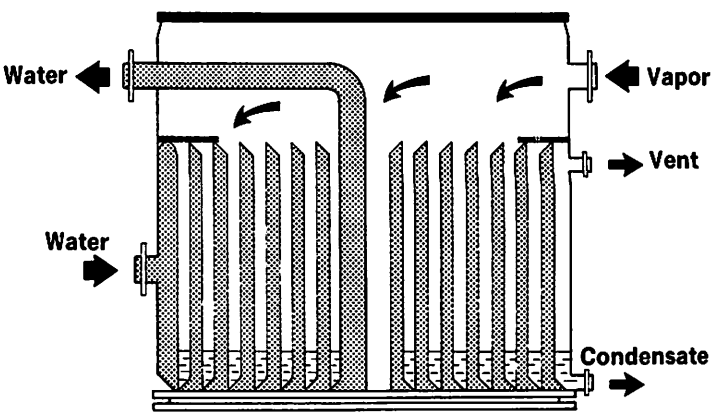
In order that the SHE shall operate according to specification, it is important that all residual air or entrained gas is removed. Vertically mounted Types I,II, and III are self-venting, in that noncondensables connections are always provided. The cooling medium (spiral flow) side is also self-venting due to the configuration of the unit.

The other channel is self-venting via the upper central connection in the cover (B channel).

Horizontally mounted units are self-venting via the fluid connections provided that the flows are maintained at tne specified values.



TYPE II



TYPE III

Good engineering practice should be observed:

- All SHEs should be operated in accordance with the ASME Section 8 Division I Pressure Vessel Codes to which all units are designed, fabricated and tested. Pressure relief devices MUST be installed as specified by the ASME Codes.

- Avoid sudden change in fluid flowrate, since hydraulic shock and fatigue effects caused by thermal expansion and contraction may otherwise occur.

- Avoid excessive turn-down ratios, since flowrates much less than design values may result in accelerated fouling. This applies particularly to duties involving fluids heavily loaded with solids.

In multiple installations, variations in capacity are best regulated by varying the number of units on line rather than by major variations in flow per unit.

SHUT-DOWN

Wherever possible allow the medium whose inlet temperature is nearest ambient temperature to circulate after the other medium has been turned off. All flow rates should be reduced slowly to avoid hydraulic and thermal shock.

Units containing fluids with normal boiling point well below ambient temperature (e.g. Freon, ammonia, etc.) should not be allowed to attain ambient temperature while containing the working fluid agalnst closed valves. The SHE is designed to withstand the pressures thus generated, but an obvious risk for personal injury exists if the unit is opened while still containing such fluid. The working fluid pipework system should be so arranged that continuous venting can be obtained.

If the shut-down period is short, and the SHE is not to be opened, the SHE should remain full—this renders subsequent start-up easier.

If leaving the SHE full of stationary liquid would involve a risk for corrosion, the unit should be flushed, cleaned, and drained.

If risk for freezing exists, or if the unit is to be opened, it should be flushed with water and drained.

If the unit is to be returned to the manufacturer for inspection, cleaning, or repair, it is important that it be drained of process fluids, flushed with either water or the proper cleaning agent, and redrained. This requirement is imposed by safety regulations for transport and upon arrival at the manufacturer.

When opening a unit which is mounted on trunnions, it is important to take steps to prevent the body from swinging round and causing damage or personal injury. This can happen if all pipework is disconnected and the bottom cover removed - the unit becomes top-heavy. The unit should thus be securely held in place and the top cover removed first.

Units provided with hinged covers should be securely fastened at piping connections and mounting brackets before opening to prevent tilting from the change in the SHE's center of gravity while the covers are open.

DRAINING

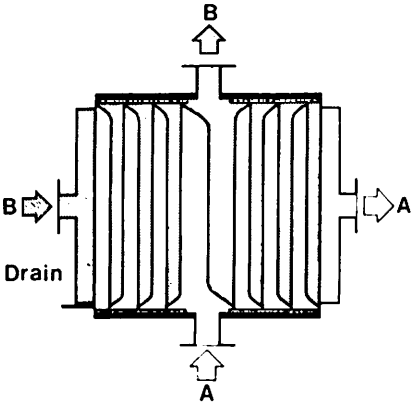
When the SHE is shut down and isolated from process and service streams, it can be drained. Vertical Type I SHE's have a drain fitted at the lowest point of the channel, whose exit connection is at the center of the upper cover (B channel).

The other channel is self-draining via the lower central connection in the cover (A channel).

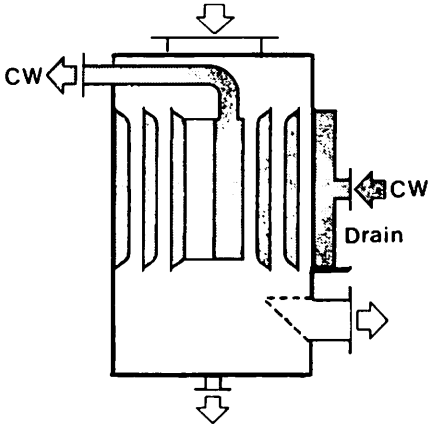
The spiral (normally cooling water) channel of Type II and vertical Type III units is drained in a similar manner.

The process (normally vapor) side of Types II and III are normally self-draining via the fluid connections.

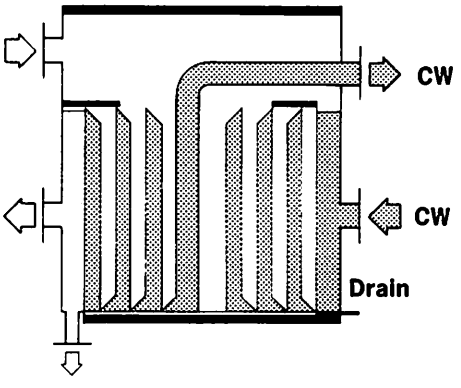
On horizontally mounted Type I and Type III units, a drain is located at the bottom of the cover.



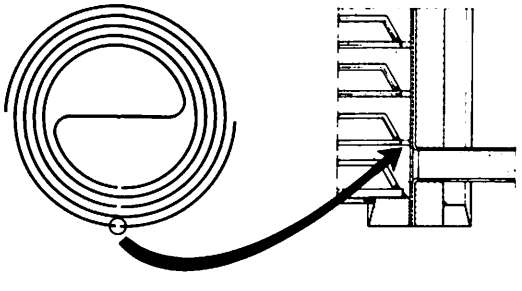
TYPE I



TYPE II



TYPE III



HORIZONTAL DRAIN

OPENING

A. Before opening a Type I or III unit,with alternately welded channels, make sure that:

1) Neither side of the unit is under pressure

2) Both sides are drained

An attempt to open the unit while under pressure, can obviously lead to injury and damage to the SHE or surrounding equipment.

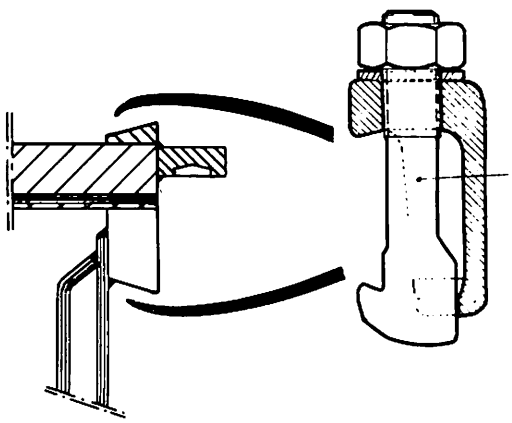
Units with one side completely welded may be pressurized on the welded channel side when open, but for reasons of safety, it is recommended to drain both sides even with such units.

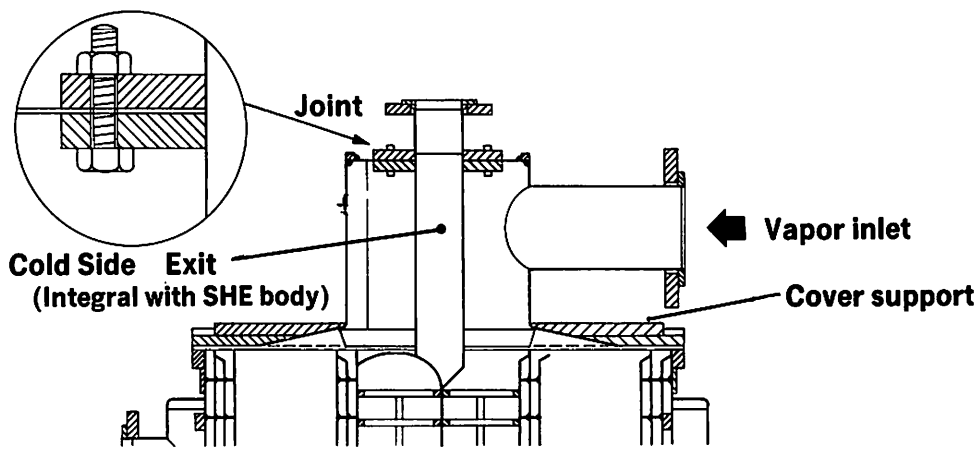
B. Disconnect the pipework.

C. SHE's are fitted with flat covers held down by hookbolts. After disassembly of hookbolts, the covers can be removed.

The lower cover of a Type IIIV is removed in the same way, but the upper cover incorporated a flanged joint for the cooling water outlet. This joint must be dismantled before the cover can be removed.

The gaskets (full face for Type I and the lower cover on Type III's, otherwise ring gaskets) may adhere either to the cover or to the faces of the SHE body, and thus will be damaged when removing the covers: when removing the residual gasket material, take care to avoid damaging the cover face, edges of the plate in the SHE body, or the tightening ring.





TYPE IIIV

On spirals with alternately welded channels (normally Types I and III), each channel can be visually examined from one of the SHE body faces. If the SHE has a large channel width and small spacings, it may be necessary to use some optical device such as an "introscope".

The channels should be examined for:

- Corrosion - often apparent adjacent to the channel seal welds near the body face and thus easy to detect.

- Erosion - often apparent in the center portion and/or in the area of the spacer studs and thus relatively easy to detect.

- Fouling - In vertical units, fouling may have a tendency to be most severe at the lower edge of the channels. Any fouling may be easily detected for the channel open to the bottom face, while any fouling in the other may only with difficulty be detected, since it is remote from the top SHE face.

- Mechanical damage - this will be immediately apparent in the form of distortion.

If massive corrosion or erosion is evident, or if mechanical damage is suspected, Alfa Laval should be contacted for advice regarding possible field repair.

CLEANING

Cleaning can be carried out by two methods:

- Mechanical, using for instance a high pressure water or steam/water jet on the opened SHE.

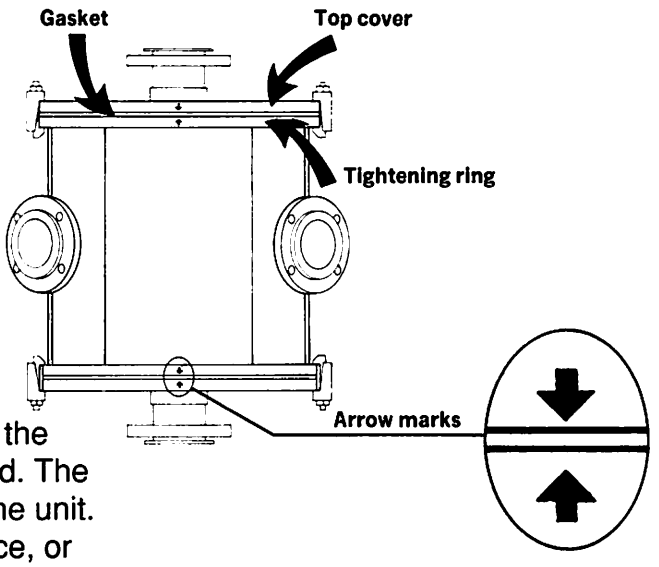
- Chemical cleaning in-place on the unit as installed.The pipework is then provided with valved branches to enable a suitable sequence of cleaning agents to be circulated. Any cleaning agents used should of course be compatible with the materials of construction. Proprietary cleaning agents should be used in accordance with the manufacturers' instructions.

Specific cleaning instructions can normally be supplied on request, if we are provided with detailed information on the nature of the fouling/scaling and on the serial number of the unit.

The unit should be completely flushed of all cleaning agents, and if not put back into operation immediately, drained.

REASSEMBLY

The body of a SHE is not perfectly circular. It is thus important that even if the covers are nominally identical, they are placed on the correct faces of the body and are correctly oriented. To assist in this respect, the edge of the cover and the tightening ring of the SHE body are marked. The arrow marks should correspond.

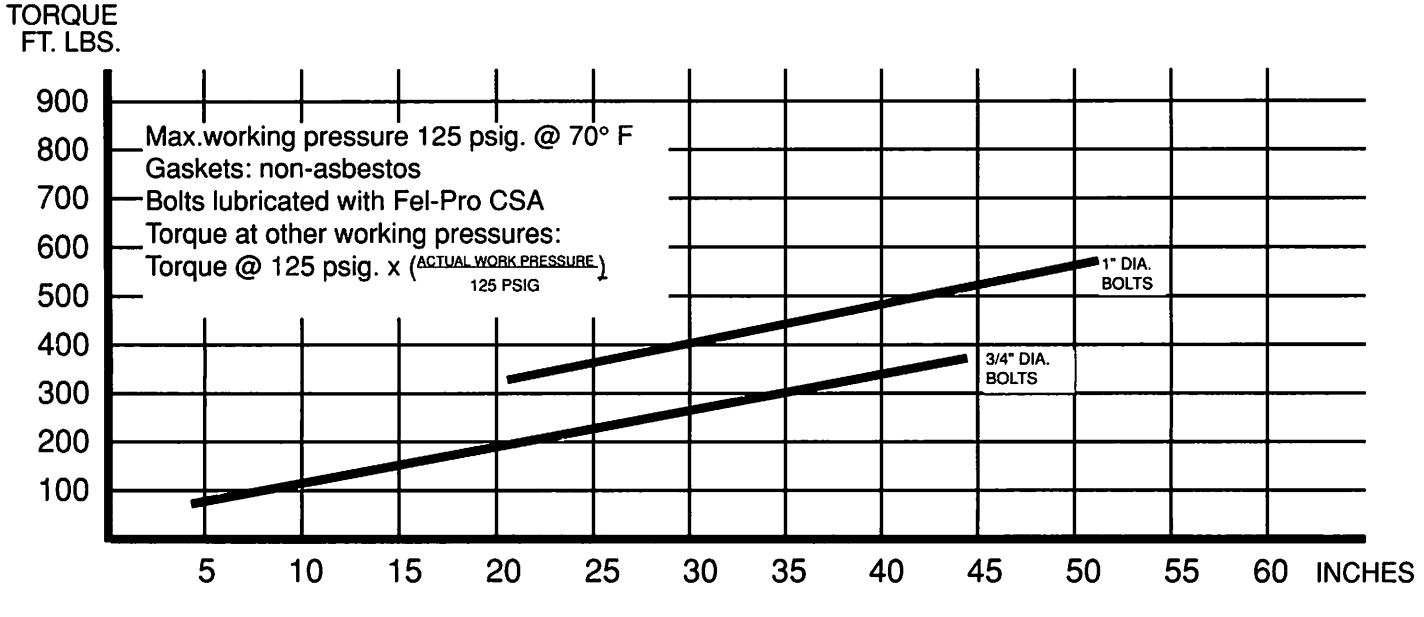


Covers are also normally stamped with the serial number of the SHE.

The gaskets between the covers and the SHE body are similarly not perfectly circular and should therefore be cut from a sheet of gasket material (normally non-asbestos) using the cover as a template. The gaskets on the top cover of Type IIIV and Type II SHE's are not full-faced. The fitting of a full-face gasket would destroy the function of the unit. Type I and bottom cover Type IIIV gasket must be full-face, or bypassing will occur. When replacing the gaskets on a Type IIIV, the cover gasket and the gasket for the water connection should be cut from the same sheet, as it is essential that these are of the same thickness.

Certain applications demand the use of other gasket materials, such as synthetic rubber or reinforced PTFE.

Having put the gasket and cover in place, the hookbolts can then be applied and finger-tightened, making sure that the cover remains correctly located. The hookbolts can then be tightened down using the recommended torques in the graph below. To ensure that the hookbolts are applied at their proper locations and to avoid dislocating the cover during tightening, tighten diagonally opposite bolts.



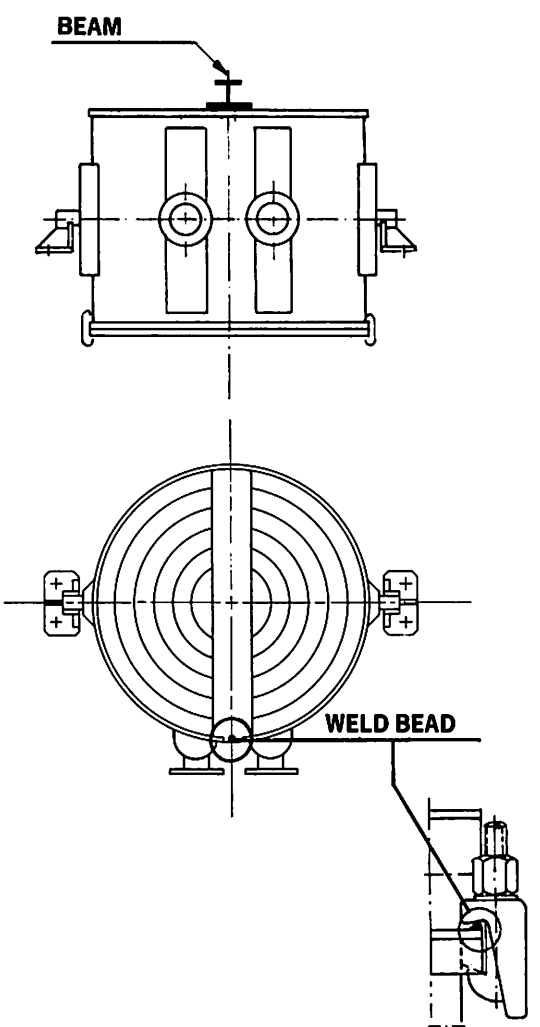
TESTING

Normal hydrostatic test procedures can be applied after complete reassembly of the SHE. It may, however, be desired to test one side of the unit before assembling the cover(s) on the other side.

If such testing is carried out on a unit with alternately welded channels, it is essential that the face of the SHE body which is exposed should be held down by a rigid beam or other device. The hydrostatic pressure on the side under test can otherwise distort the body and result in permanent and irrepairable damage. The beam can be held down by the hookbolts (place a weld bead as shown on the diagram below).

Maximum test pressure is one and one half (1 1/2) times maximum allowable working pressure (MAWP).

If hydrostatic testing is not practical, air testing should not be done without consulting Alfa Laval. *Air or gas testing can be very hazardous.*



PROBLEM SOLVING

SYMPTOM	POSSIBLE CAUSES	REMEDY
1.Inadequate thermal performance at start-up.	a) Air pockets. b) Insufficient service fluid (e.g. cooling water).	a) Vent. b) Check flowrates and temperatures.
2.Fall-off in thermal performance, possibly associated with a pressure drop increase or reduced flow.	Fouling on heat transfer surfaces.	Clean. Ensure flowrates as specified.
3.Fall-off in thermal performance with unchanged or reduced pressure drop.	Bypassing over face of SHE, caused by damaged Gasket or excessive pressure.	Replace cover gasket. Ensure operation at specified pressure.
4.Excessive pressure drop with approx. maintained thermal performance.	Blockage at inlet or outlet.	Clean, possibly most effectively by back - flushing.
5.External leakage.	a) Damaged cover Gasket. b) Insufficient pipe support. c) Relaxation of Gasket during shipment or shut-down. d) Thermal expansion during start-up.	a) Replace gasket. b) Rectify pipe support system. c) Tighten hook bolts. d) Check hook bolts. If leakage persists, check cover gaskets.
6.Internal leakage.	Heat transfer surface perforated by erosion, corrosion, or mechanical damage.	Contact Alfa-Laval for advice. Field repair may be possible.

Types I, II or III for Condensing or Steam Heating Duties

In addition to the symptoms, causes and remedies listed for liquid/liquid, the followinq can occur:

1.Rapid fall-off in thermal performance possibly with increasing vapor-side pressure drop.	Inadequate venting of non-condensables.	Modify gas removal system (enlarge or fit exhaust pump or fan).
2.Unstable performance-fluctuating condensate or product (cooling medium) outlet temperature and condensing.	a) Inadequate condensate removal. b) Underdimensioned steam supply system.	a) Modify condensate removal system (enlarge, fit removal pump or barometric leg). b) Check function of control valve and/ or pressure reducing valve. Change to larger size if necessary.

Types II or III for Vaporization Duties

The following additional phenomena can arise:

1.Inadequate or unstable thermal performance ("hunting").	a) Faulty conditions on heating medium side. b) Insufficient liquid feed on vaporizing side. c) Incorrect liquid level in thermosiphon system.	a) Adjust heating medium temp. and/or flow rate. If steam, adjust pressure. b) Modify inlet system. Increase in size, remove restrictions, or fit booster pump. c) Check liquid level is approx. the same as upper SHE.

NOTES

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