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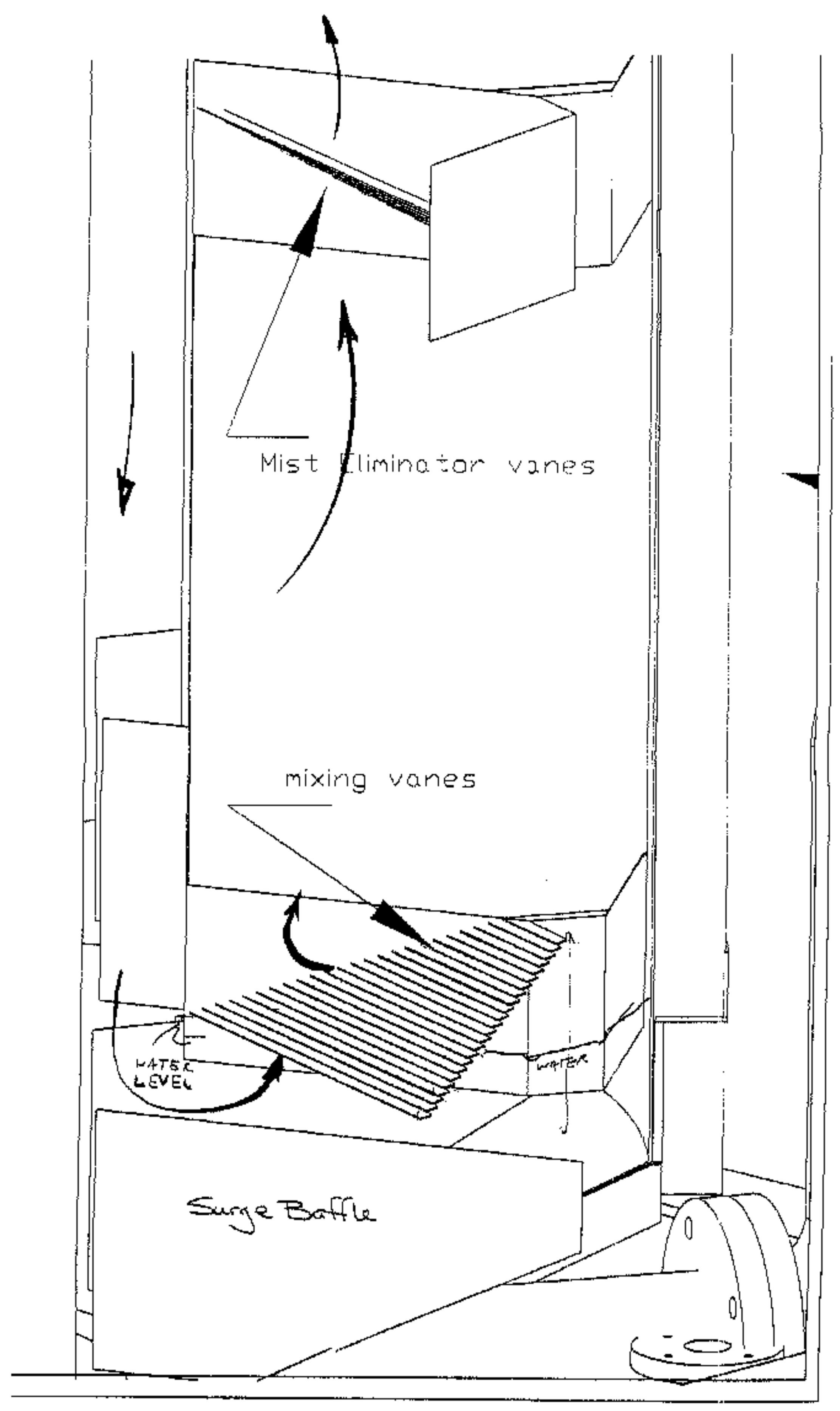
(54) Titre : METHODE ET APPAREIL POUR LAVER DES GAZ A L'AIDE D'AILETTES D'AGITATION

(54) Title: METHOD AND APPARATUS FOR SCRUBBING GASES, USING MIXING VANES



METHOD AND APPARATUS FOR SCRUBBING GASES, USING MIXING VANES

Exhaust gases are generated in many industrial and transportation applications. Environmental concerns as well as industrial consequences of release of pollutants or contaminants require their elimination or reduction. Sulfur dioxide is a particular component of many processes involving combustion, ranging from thermoelectric generation, waste incineration, industrial processes, and exhaust gases of prime movers, including diesel engines.

The present invention comprises a gas scrubbing apparatus and the related method wherein the exhaust gases from industrial activity, called exhaust gases hereafter, are scrubbed to remove particulate and gaseous contaminants.

The scrubber comprises an exhaust pipe, an inner or hot plenum, and an outlet plenum. Preferably, these components are arranged concentrically, and the gases flow in counter directions through each plenum. The inner or hot plenum is of a convoluted or star shape, providing increased surface area for gas contact. In the inner plenum, water pre-spray jets wet the exhaust gases as they move between the inner exhaust pipe and the star-shaped wall.

A liquid bath, which may be oils, solvents, water or even seawater, obstructs the flow of the exhaust gases as they pass from the inner hot plenum, passing below the lower lip of the star-shaped wall to enter the outer exhaust plenum. Consequently, the exhaust gases must pass through the liquid bath. The liquid bath, in its static conditions, seals off the passage between the inner and outer plena. In a preferred embodiment illustrated in the attached Figures, at the conjunction of the inner star plenum with the outlet plenum, a series of mixing vanes is interposed across the outlet plenum. In the static state, mixing vanes may be above mean water level, and become immersed as inlet gas flow rises. Depending on the application, the mixing vanes may also be partially immersed in a liquid bath. The vanes comprise horizontal members arranged in an overlapping stepped configuration to provide a convoluted flow path for exhaust gases while the exhaust gases are percolating through the liquid bath. The flow of the gases through the liquid bath and through the mixing vanes causes turbulence, and results in generation of fine bubbles in a liquid/gas mixture which promotes the absorption of contaminants and particulate matter into the liquid. The choice of liquid may be determinative of the degree of absorption of contaminant gases, but the fine dispersion of tiny bubbles of exhaust gases is a principal factor in dissolving contaminant gases in the liquid bath. The mixing vanes act to enhance contact between gas/liquid, and lengthen the route of gas passage to increase the time in which the gas is resident in the mixture.

After passing through the mixing vanes, a saturated mixture of bubbles, liquid and gases, in the nature of a foam or thin mist, ascends upwardly in the lower reaches of the outlet plenum. Additional water jets may be located in this region for additional scrubbing and to supply liquid water to the system. Separation and removal of the liquid from the scrubbed exhaust gases is achieved by contact on the walls of the outlet plenum, including the star plenum wall and the external wall.

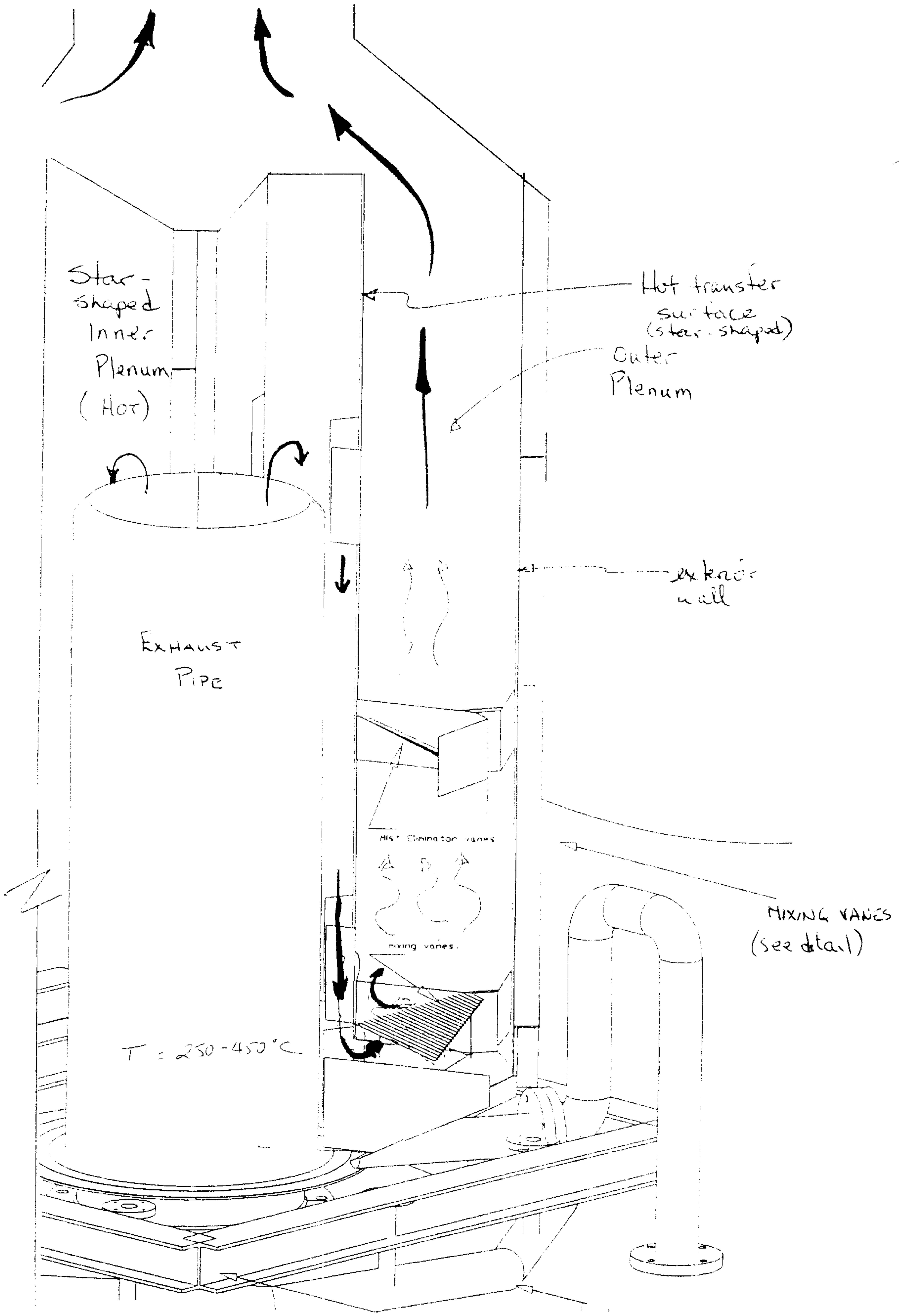
Further separation and removal of the liquid content is achieved by mist eliminator vanes spaced above the mixing vanes. The mist eliminator vanes are similar to the mixing vanes, and remove moisture by contact as the gases pass through the convoluted arrangement of vanes. Downstream (above in the example) of the mist elimination vanes, the saturated exhaust gases pass adjacent the hot surface of the star plenum, thereby reheating and raising the temperature of the exhaust gases above the moist saturation point. Consequently, the exhaust gases when exiting the exhaust plenum, will be below the saturation point, thus eliminating or substantially reducing condensation of liquids on downstream piping, and preventing/reducing visible fogging in the atmosphere. Consequently, condensation plumes and infra-red radiation is considerably reduced.

The treating liquid (i.e. water, etc.) removed by the mist eliminators and wall contact drips into the bottom of the tank, where radial surge or wave baffles inhibit agitation and allow settlement of particulate matter. Such particulate matter and excess treating liquid may be removed from the conical bottom of the tank. The liquid may then be cooled, treated and reintroduced into the system.

A further feature of the scrubber design is a cylindrical circumferential baffle at the perimeter of the mixing vanes. The baffle defines an annular passage spaced inwardly of the exterior wall of the outer plenum, at the level of the mixing vanes. In the event of a rapid increase in gas flow into the unit, this feature permits water from the bottom of the tank to surge, upwardly through the passage and over the mixing vanes. This increases the water supply to the vanes, while simultaneously allowing an expansion of inlet gas volume due to the downward pressure on the water surface n the tank. The net effect is to make the scrubber more reliable in varying flow situations, a common problem for other wet scrubber designs.

The present design operates with a small liquid head of one to six inches of liquid such as water, and results in a dramatically reduced back pressure in the exhaust system. The overall pressure drop of the system is less than six inches of water, principally from the hydrostatic pressure of the liquid bath level.

The scrubber is an effective means for removal of SO_2 and particulate matter resulting from combustion of fuels, such as diesel fuel. Levels of 80% particulate removal and 95% SO_2 removal have been achieved by this apparatus and method.



Star-shaped Inner Plenum (Hot)
Hot transfer surface (star-shaped)
Outer Plenum
exterior wall
Exhaust Pipe
Mist Eliminator vanes
mixing vanes
MIXING VANES (see detail)
T = 250-450°C

Fig 1

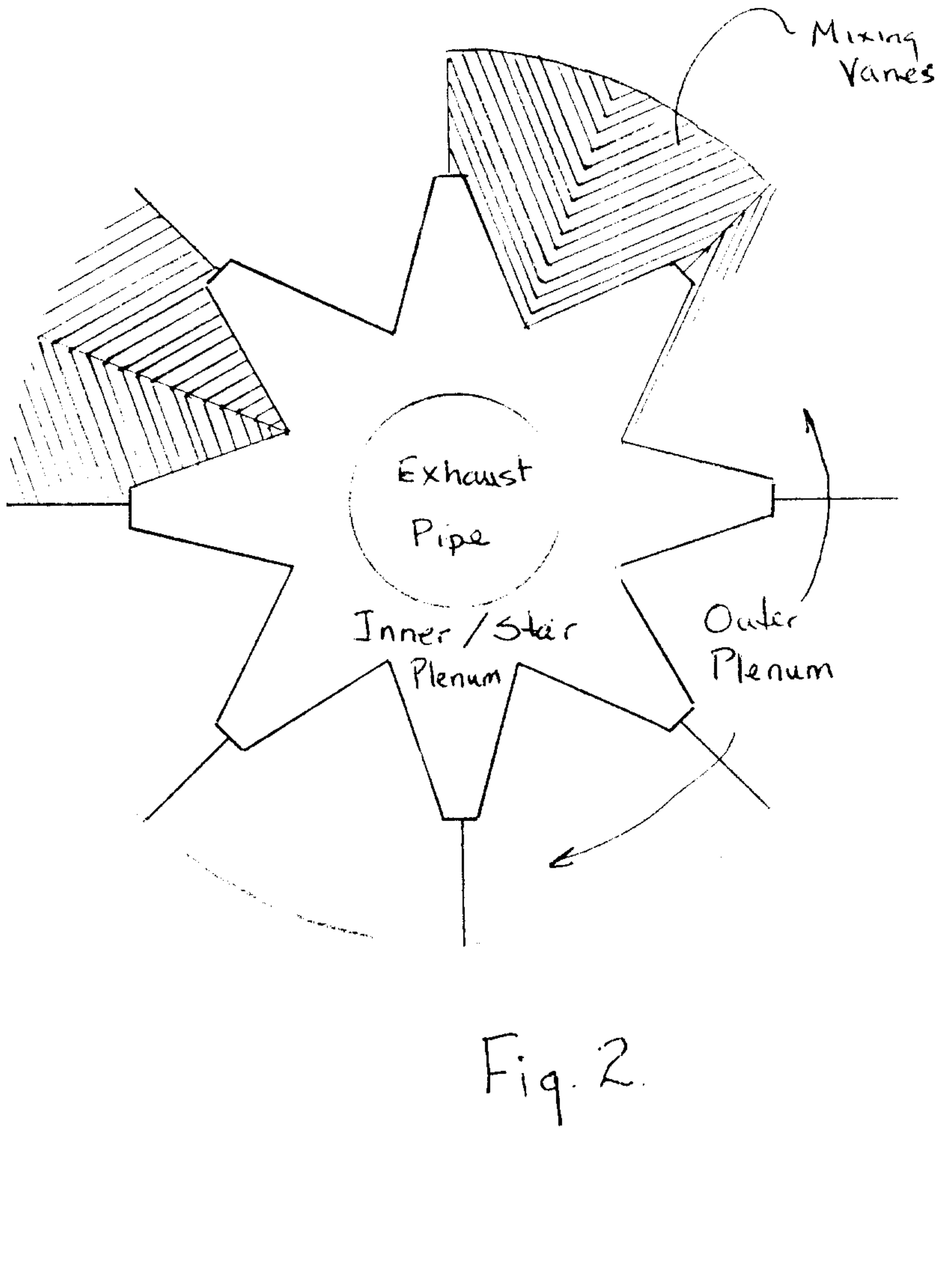


Fig. 2.

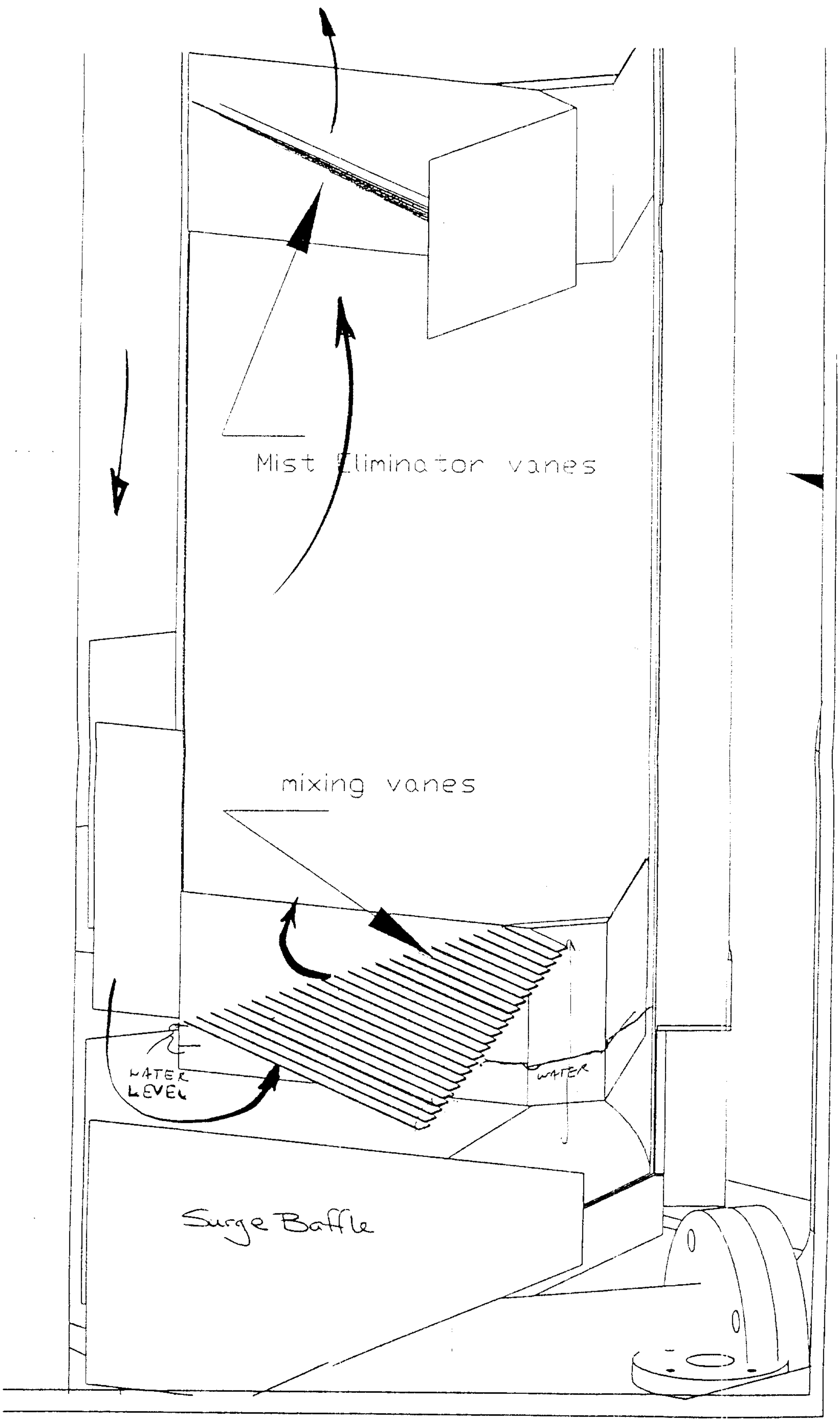

Mist Eliminator vanes
mixing vanes
WATER LEVEL
WATER
Surge Baffle

Fig.3

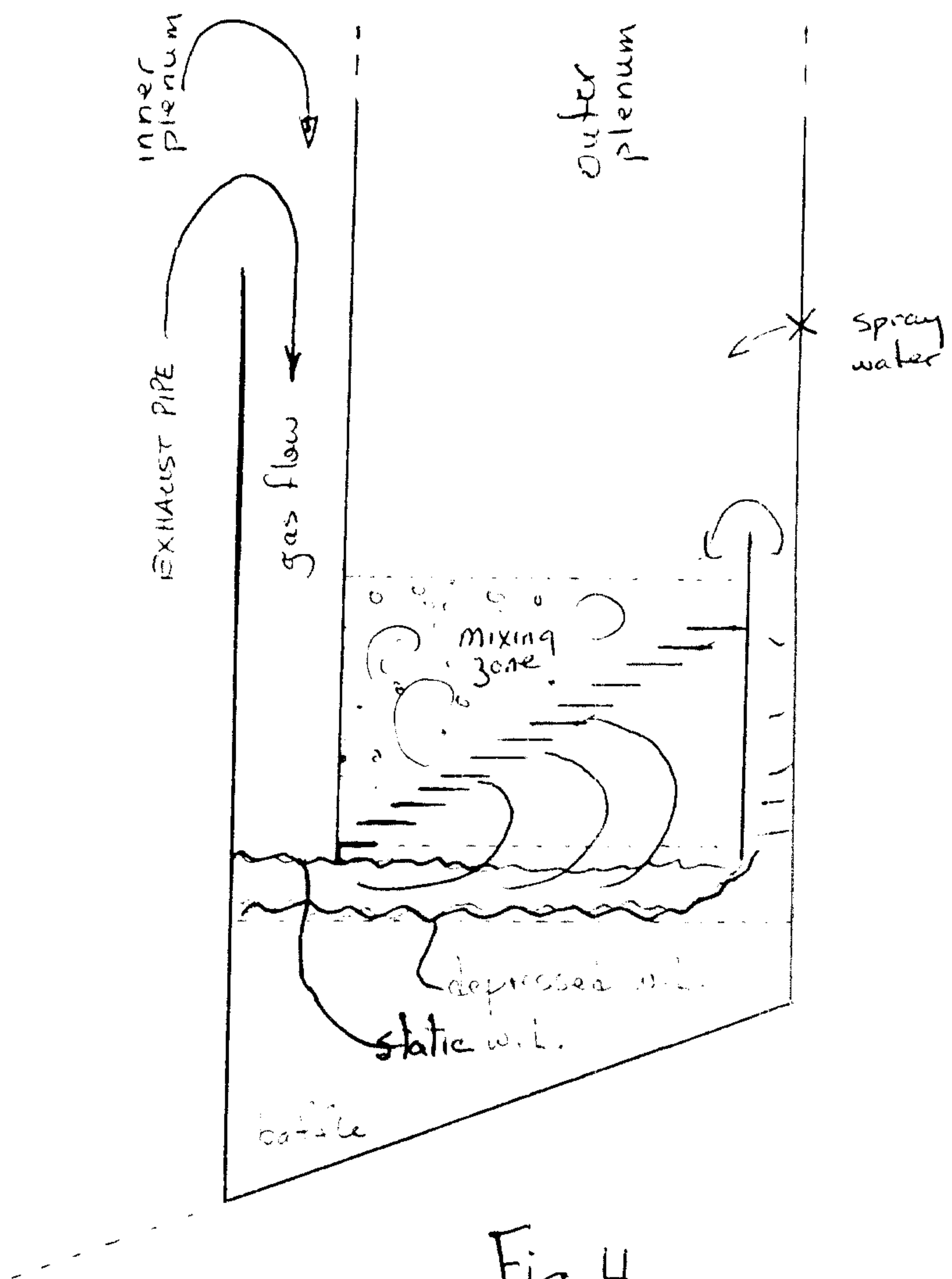

inner plenum
outer plenum
EXHAUST PIPE
gas flow
spray water
mixing zone
depressed w.L.
static w.L.
baffle

Fig. 4

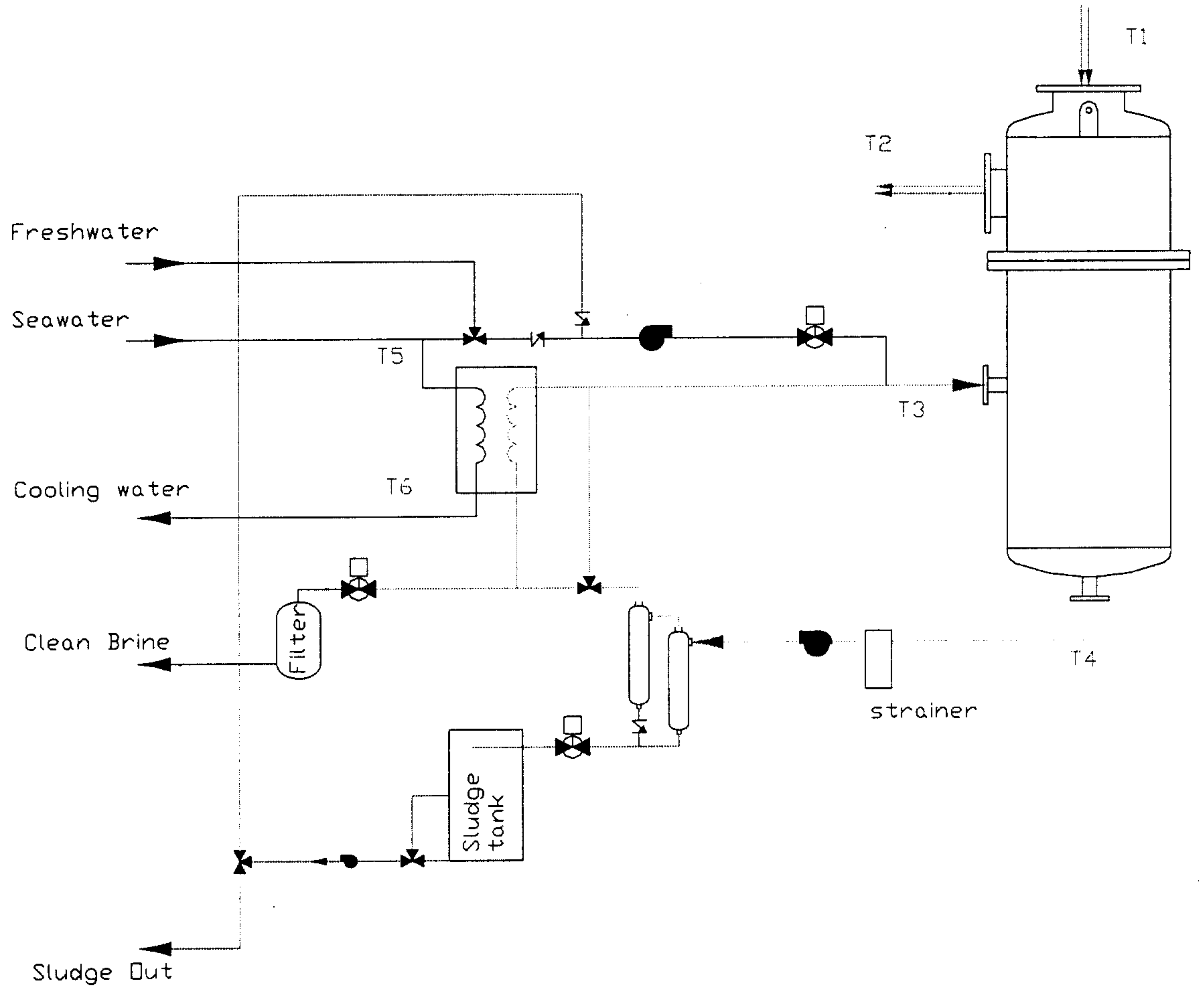


figure 1: schematic flow diagram for MAN B&W ecosilencer unit

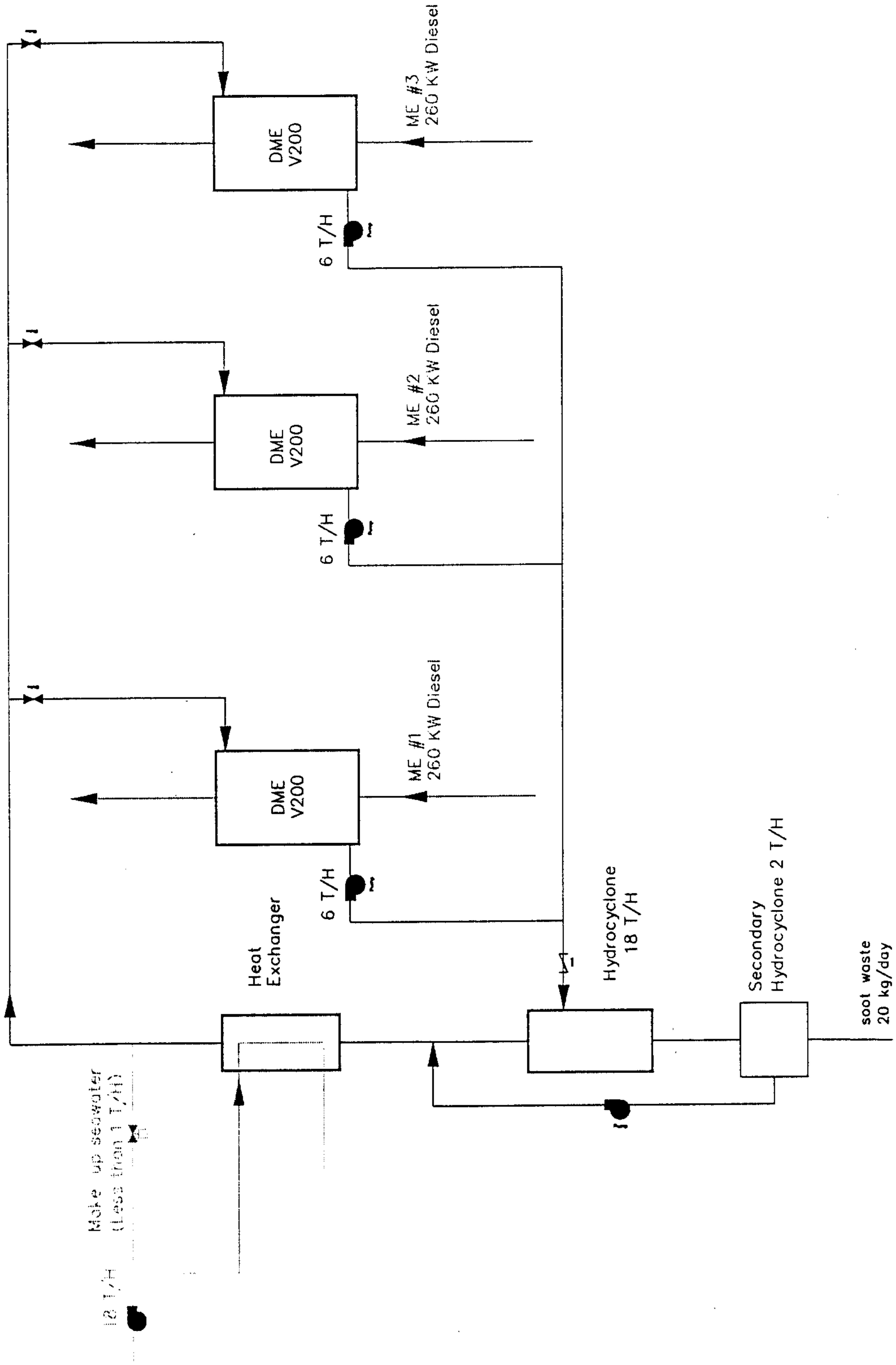


figure 2Schematic for ecosilencer system on ship , treating all engines

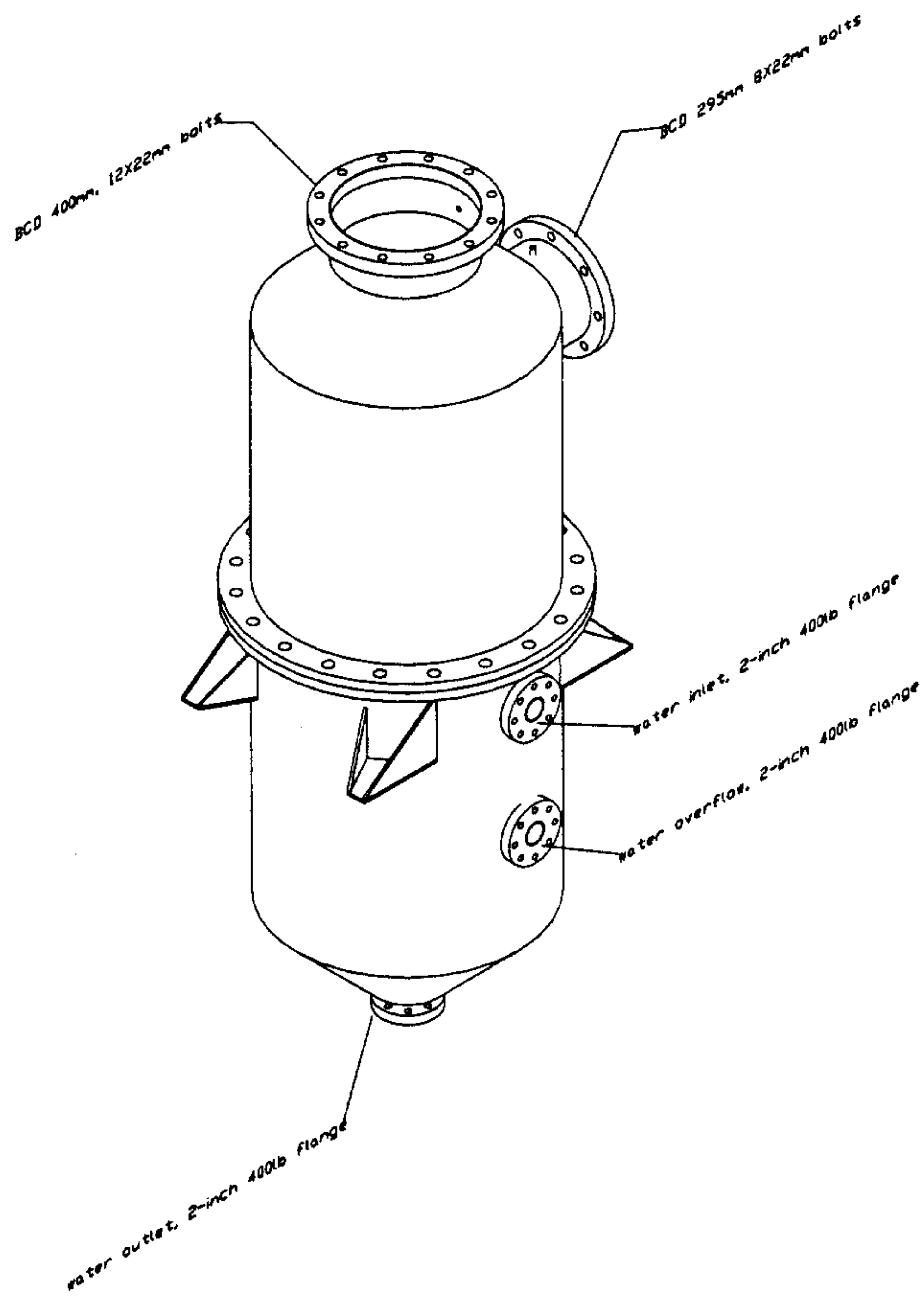
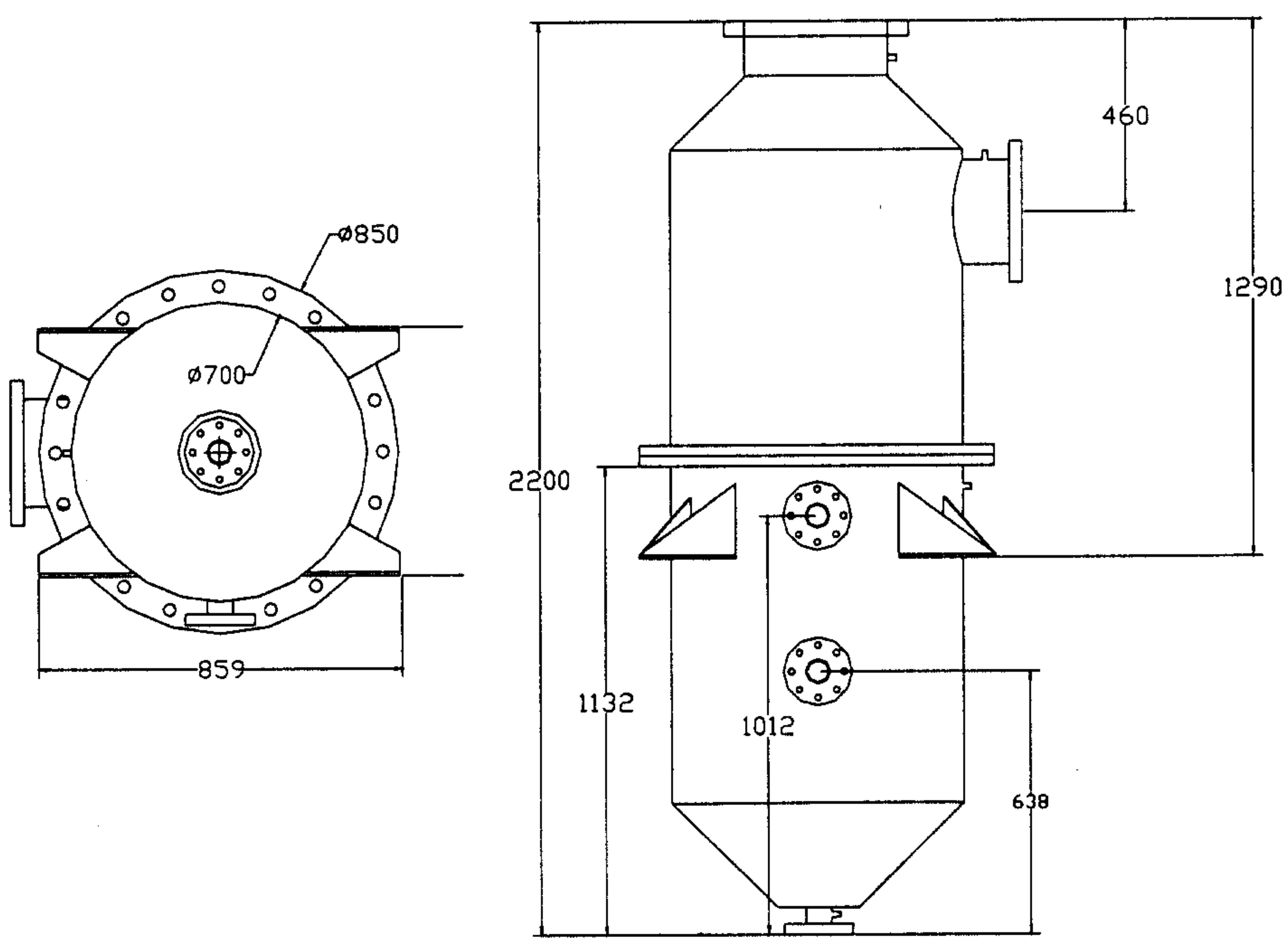


figure 3MAN B&W presurized Ecosilencer



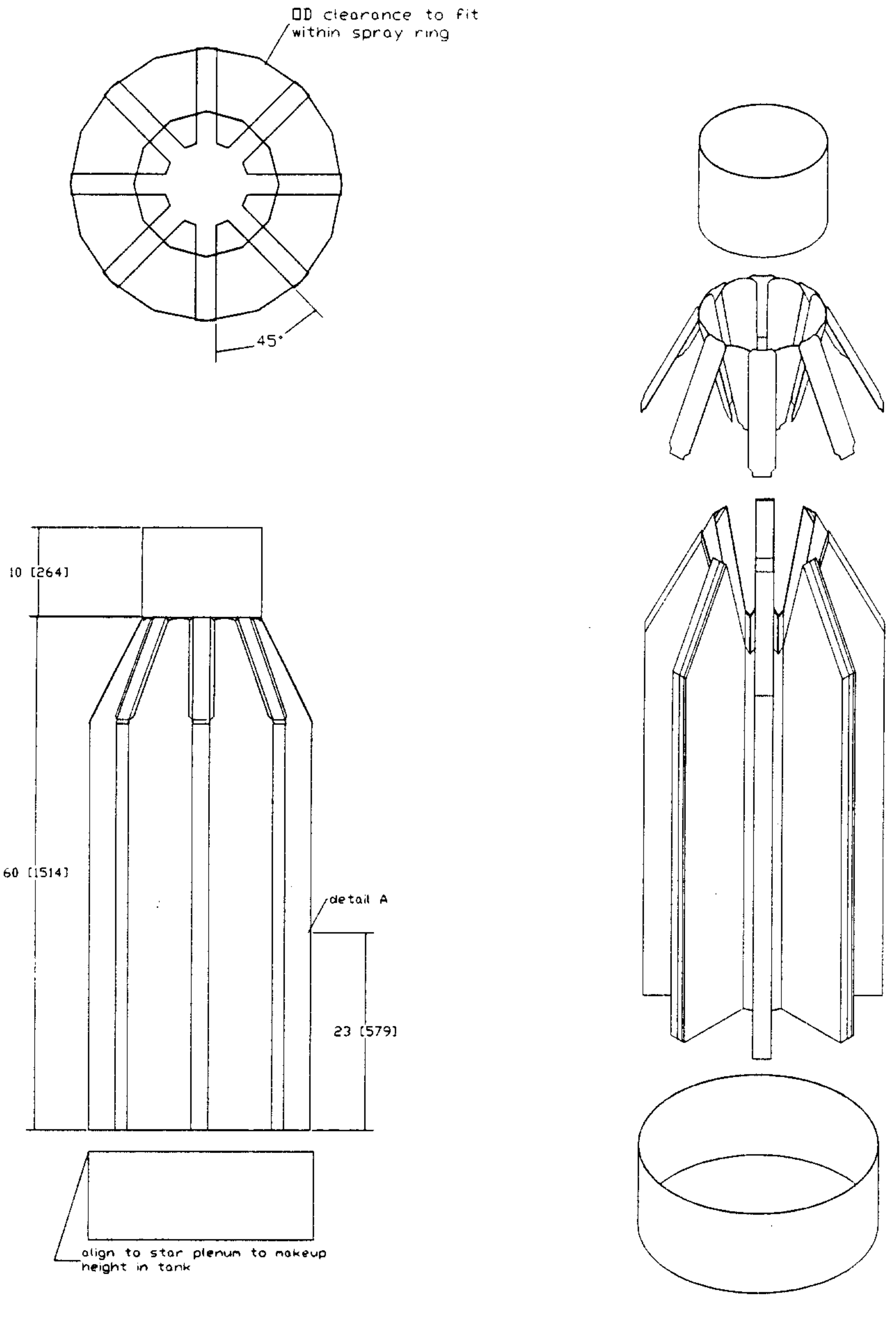
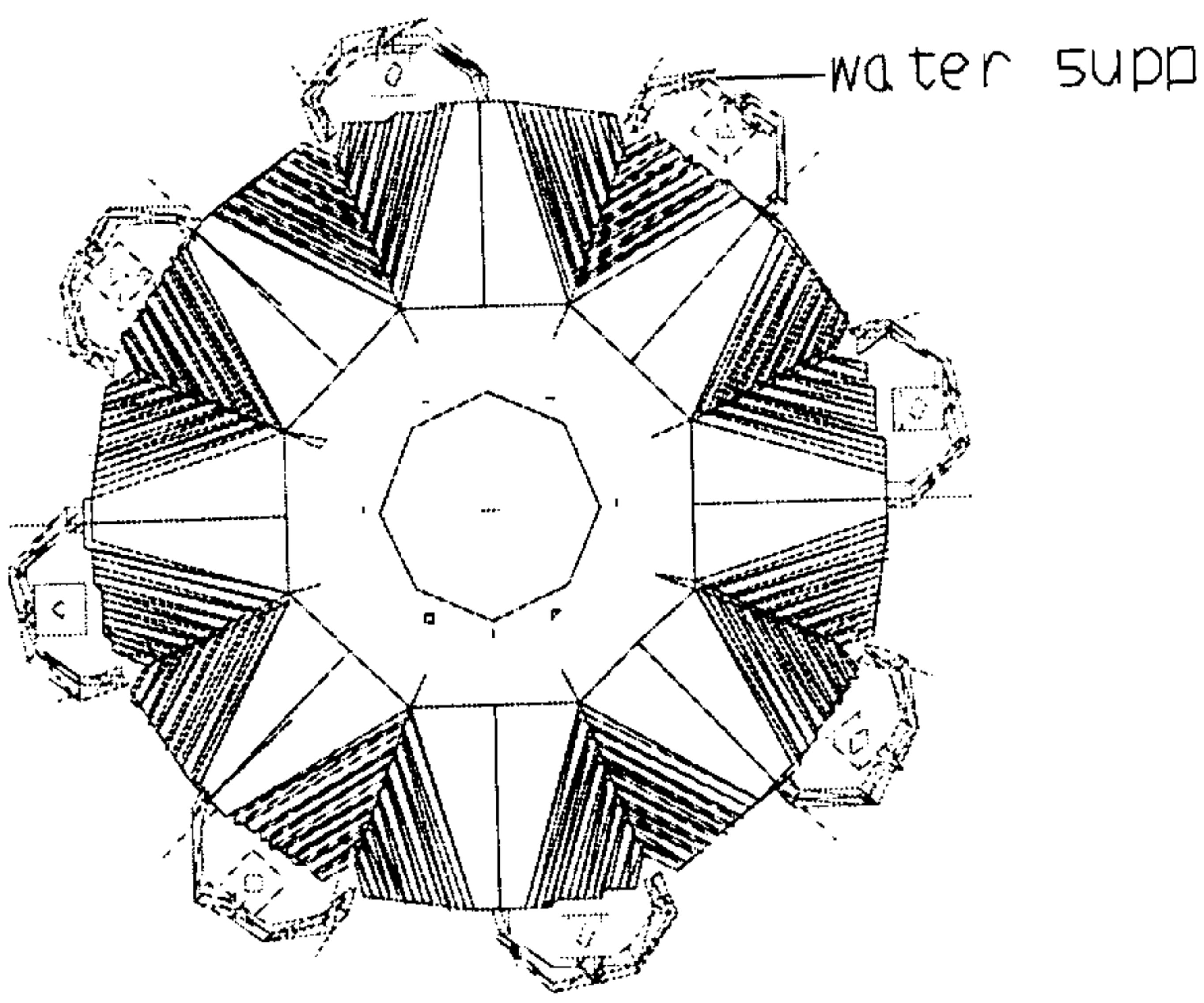


figure 4Star plenum design for MAN B&W. Mixing trays not shown



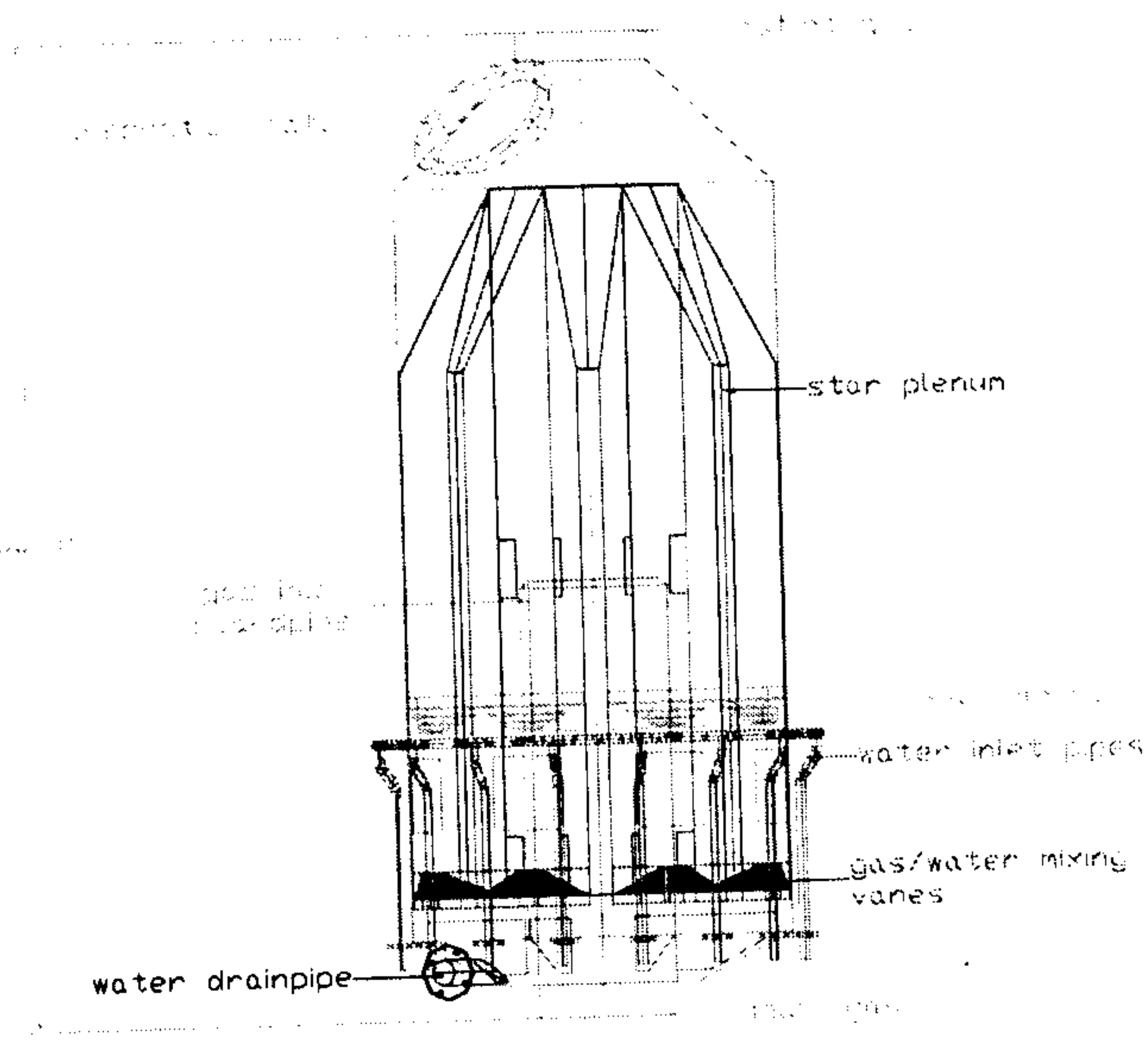
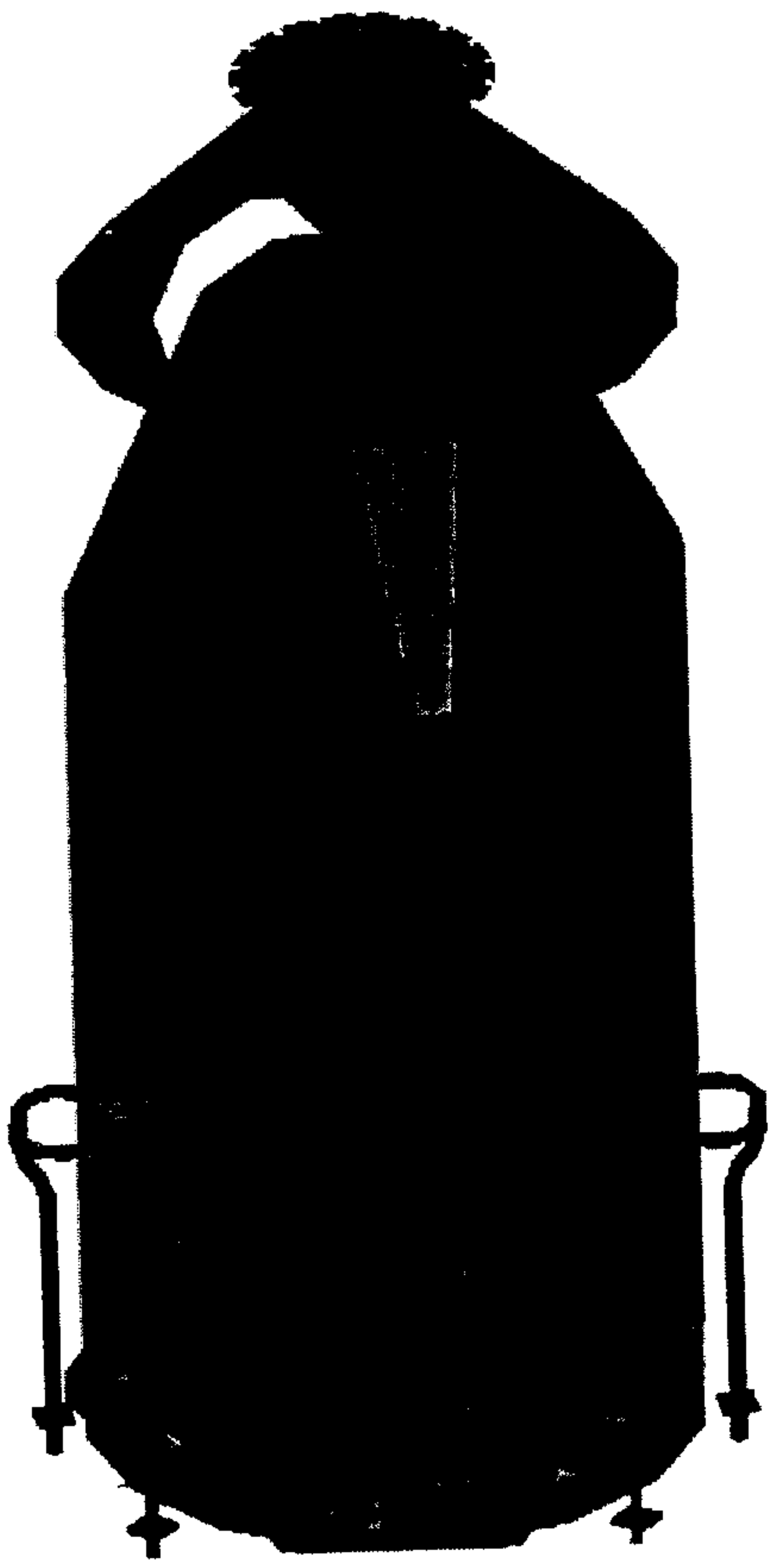
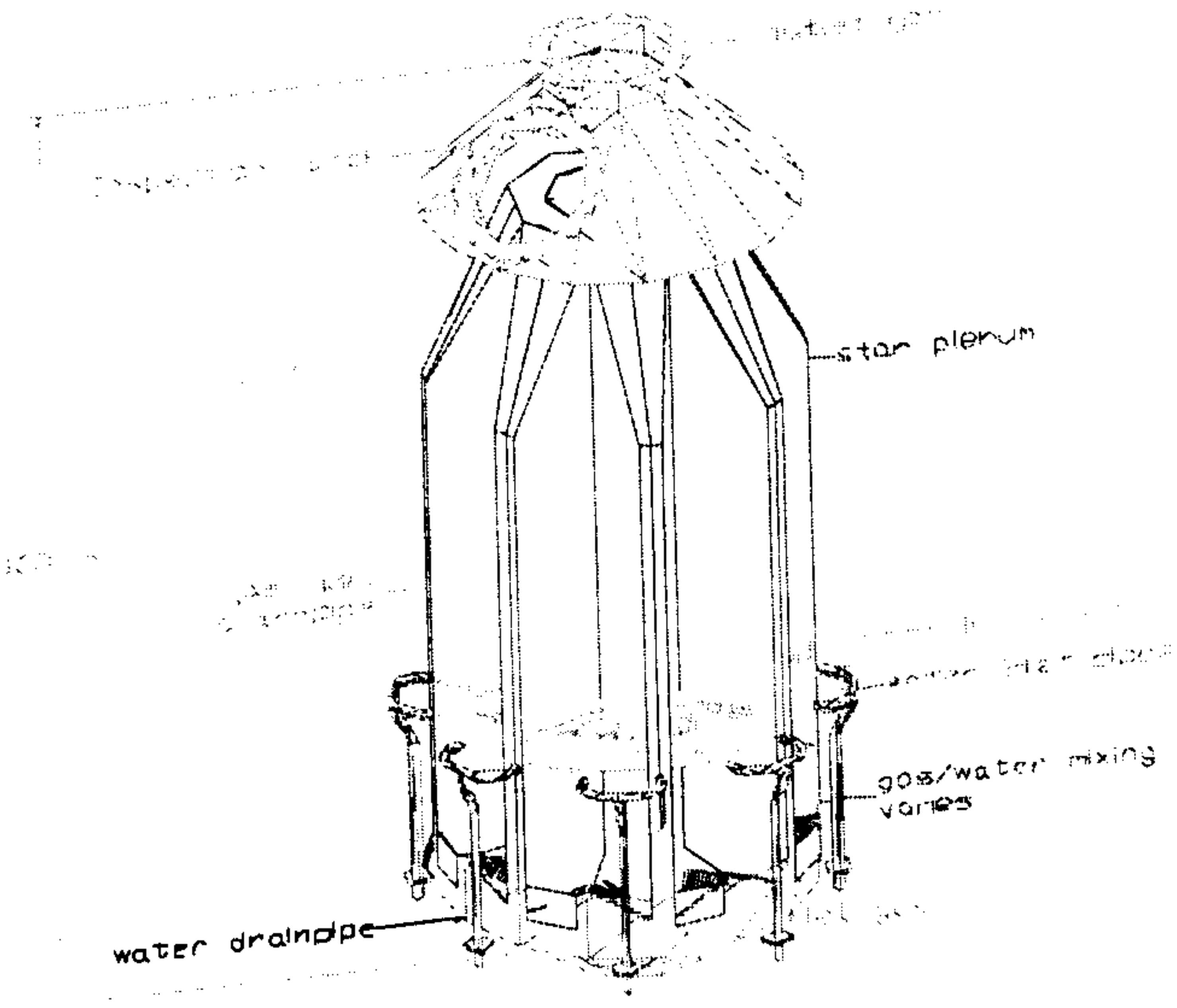


figure 1 Ecosilencer aborad Leif ericson





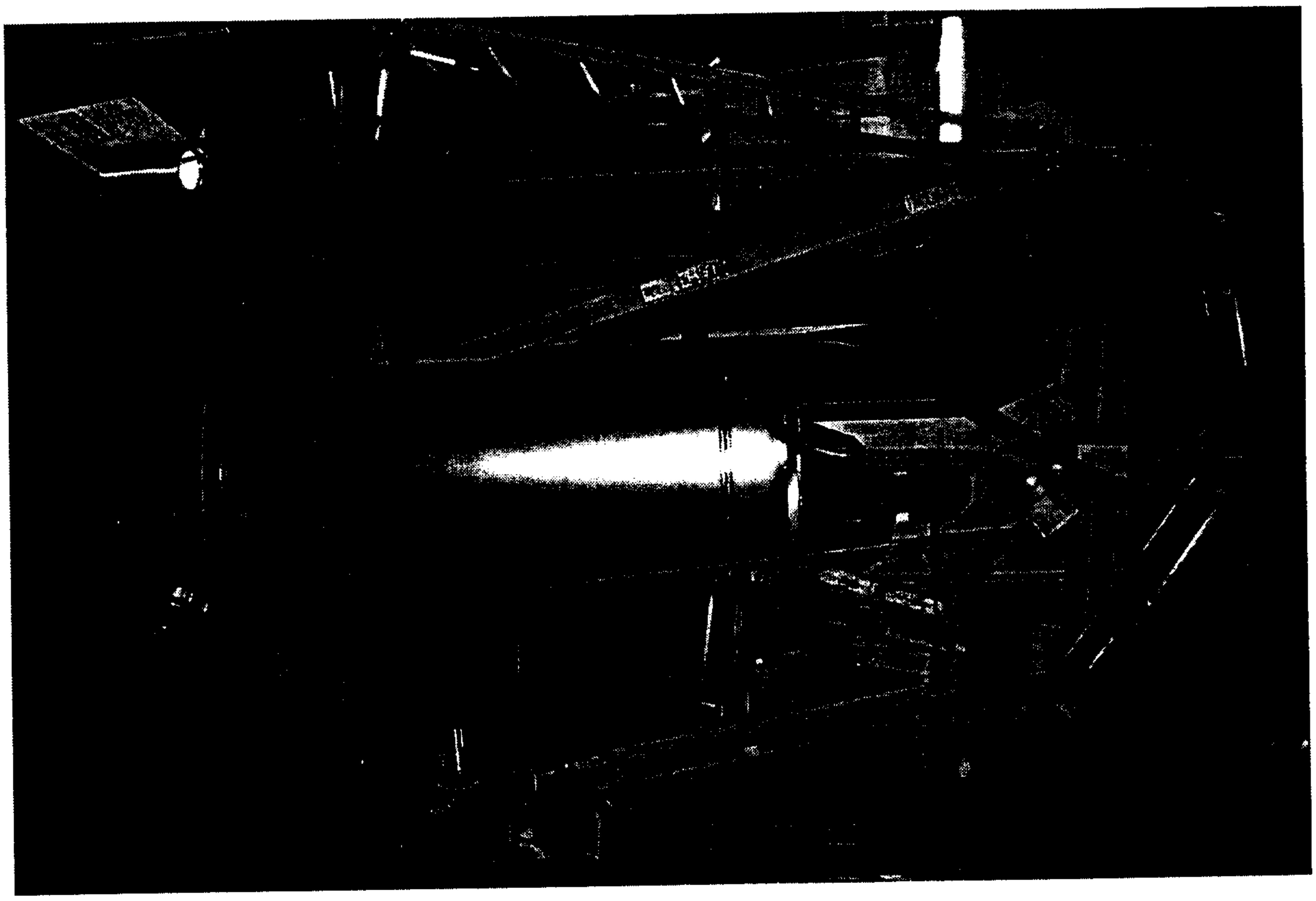


figure 1central standpipe during fabrication

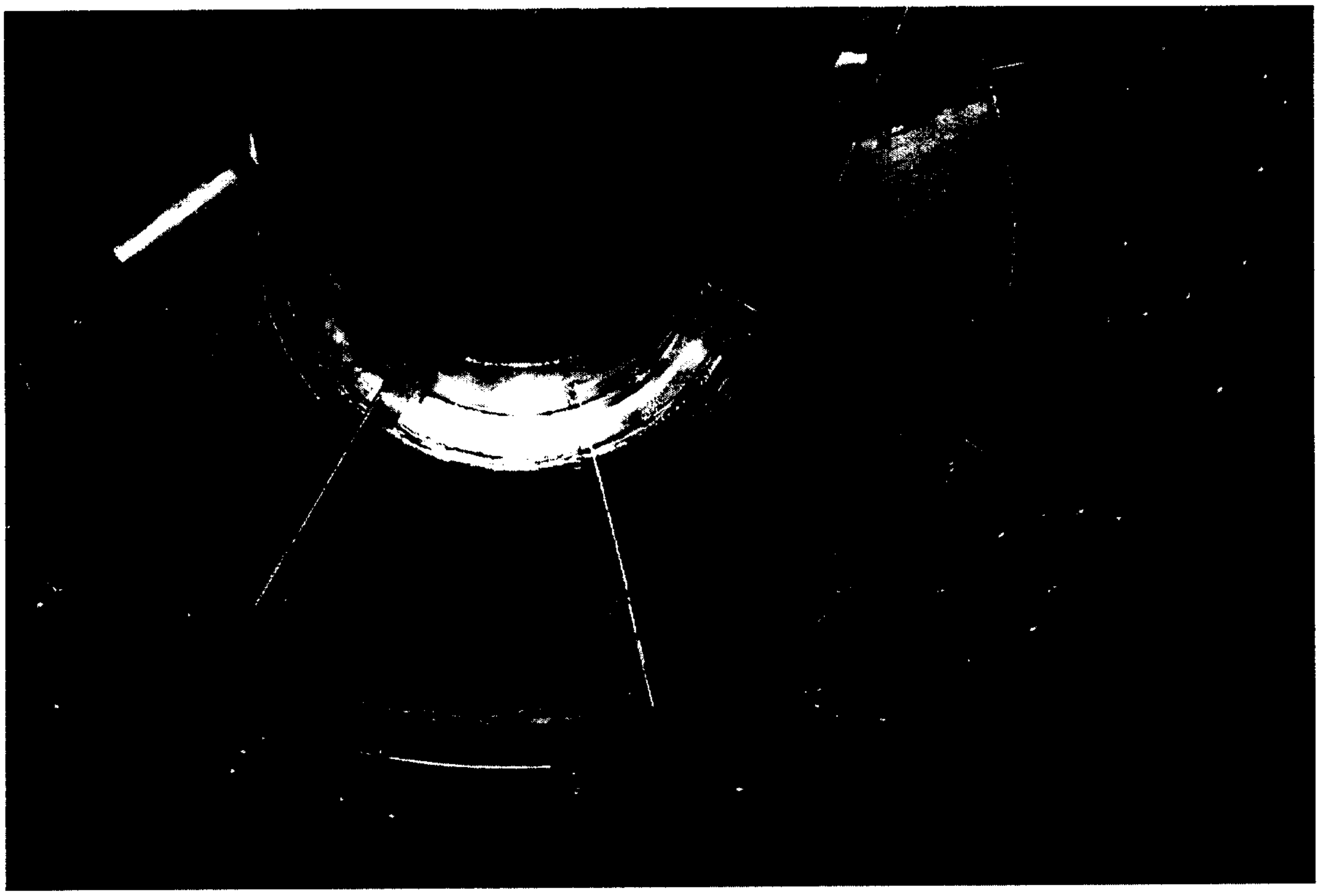


figure 1Picture inside Ecosilencer before star plenum installed

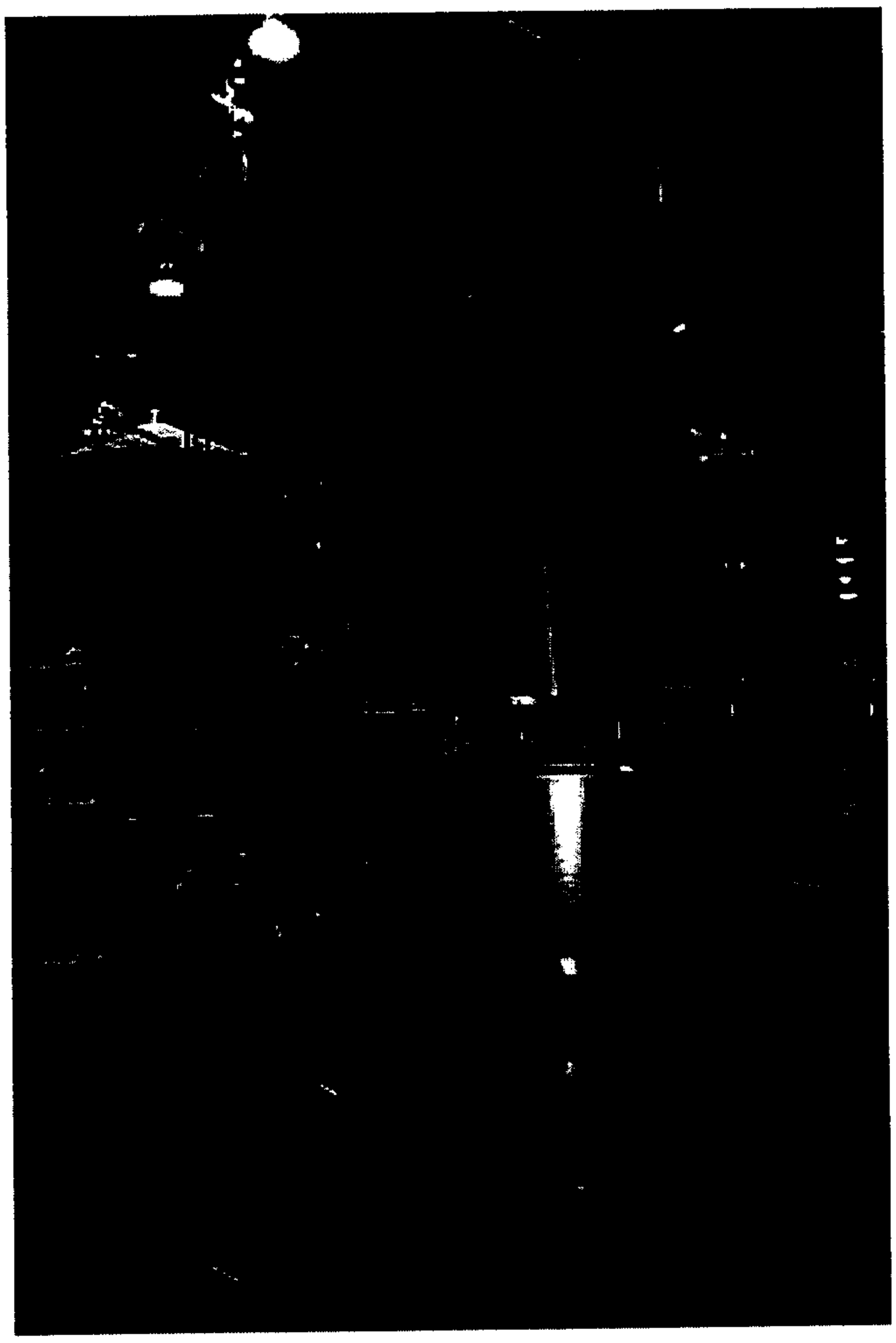


figure 2Assembley of Star Plenum into outer housing

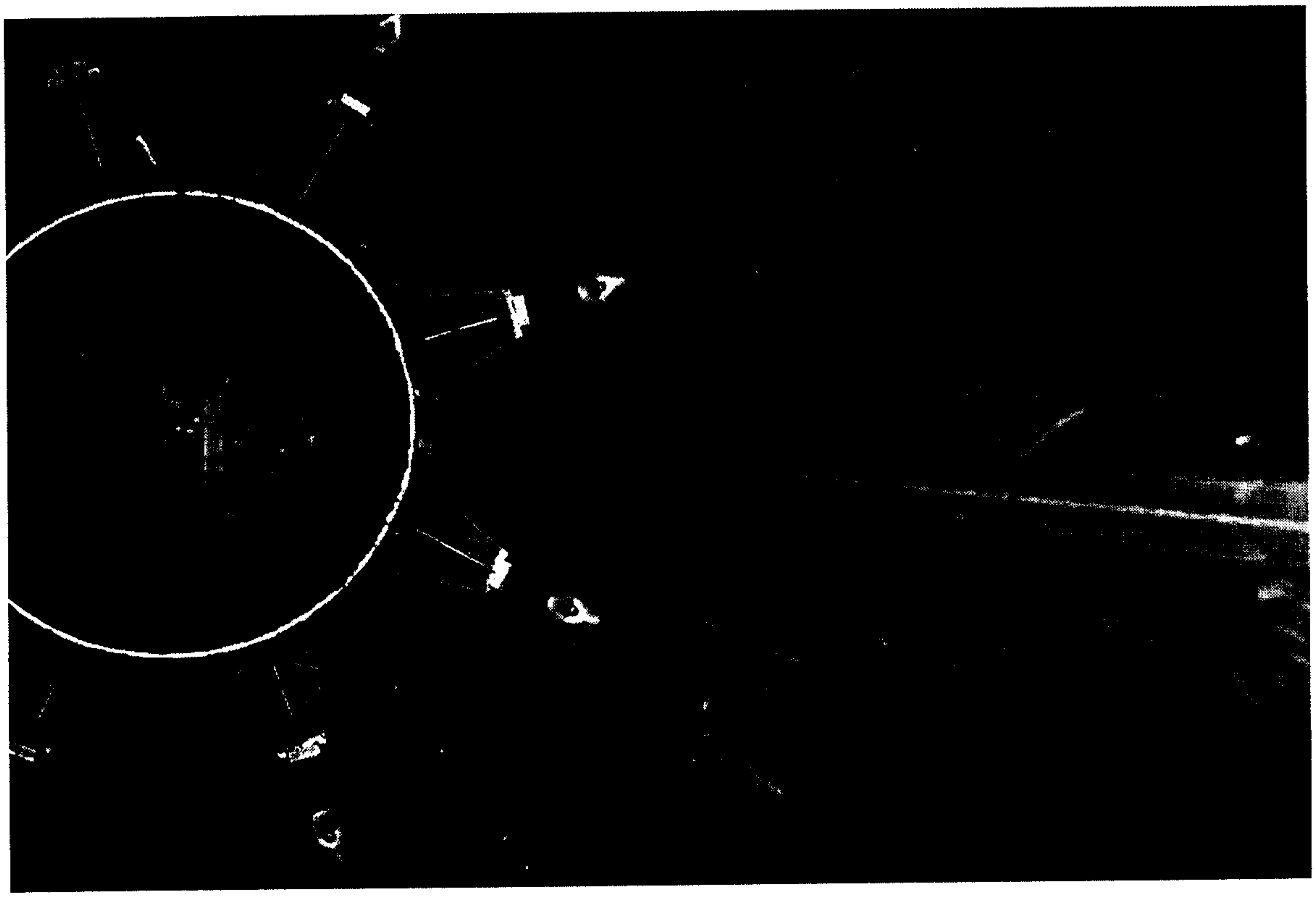


figure 1picture inside star plenum looking downward from top

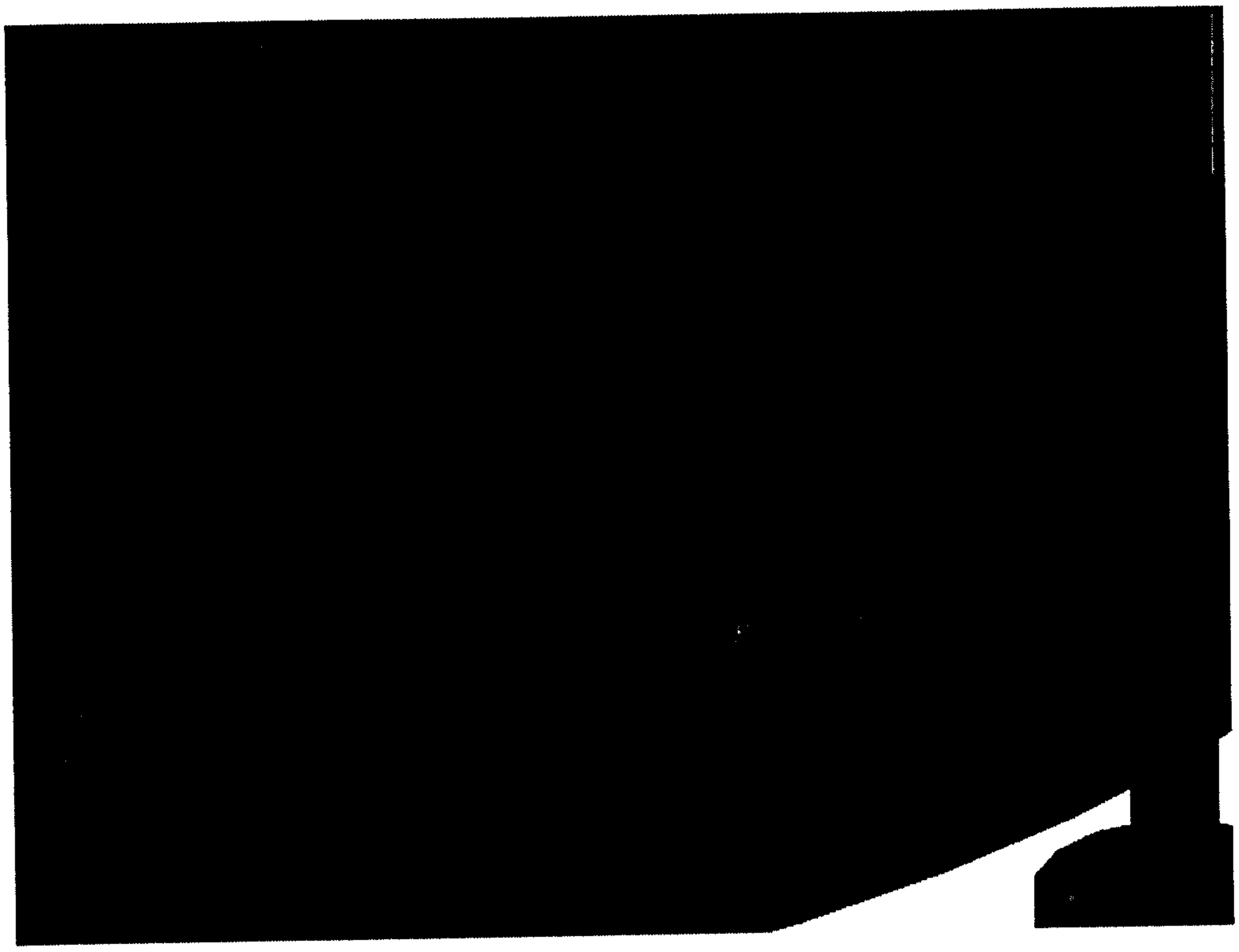


figure 3Rendered view of mixing tray with vanes in place. Water is shown

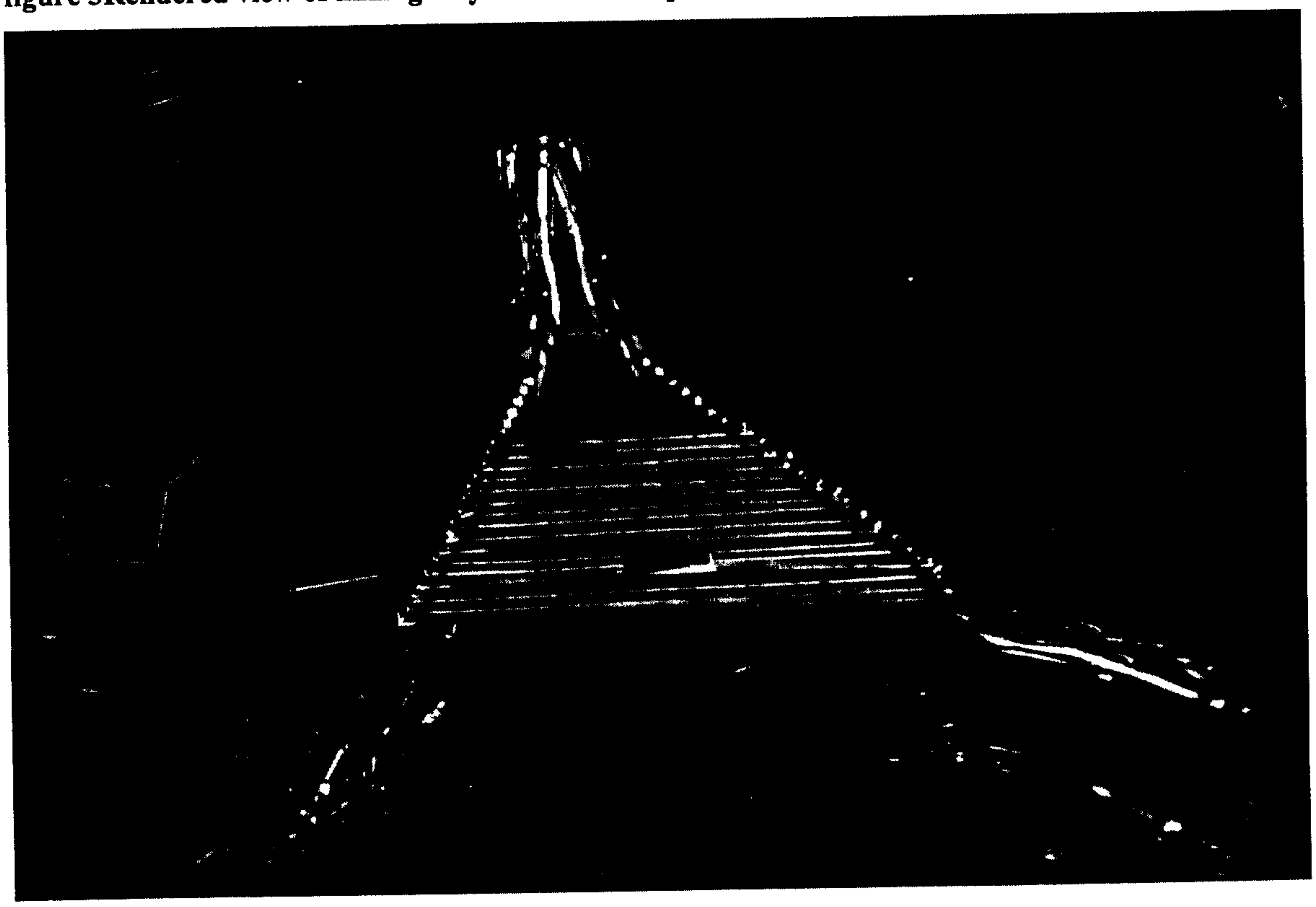


figure 4Mixing tray prototype being built

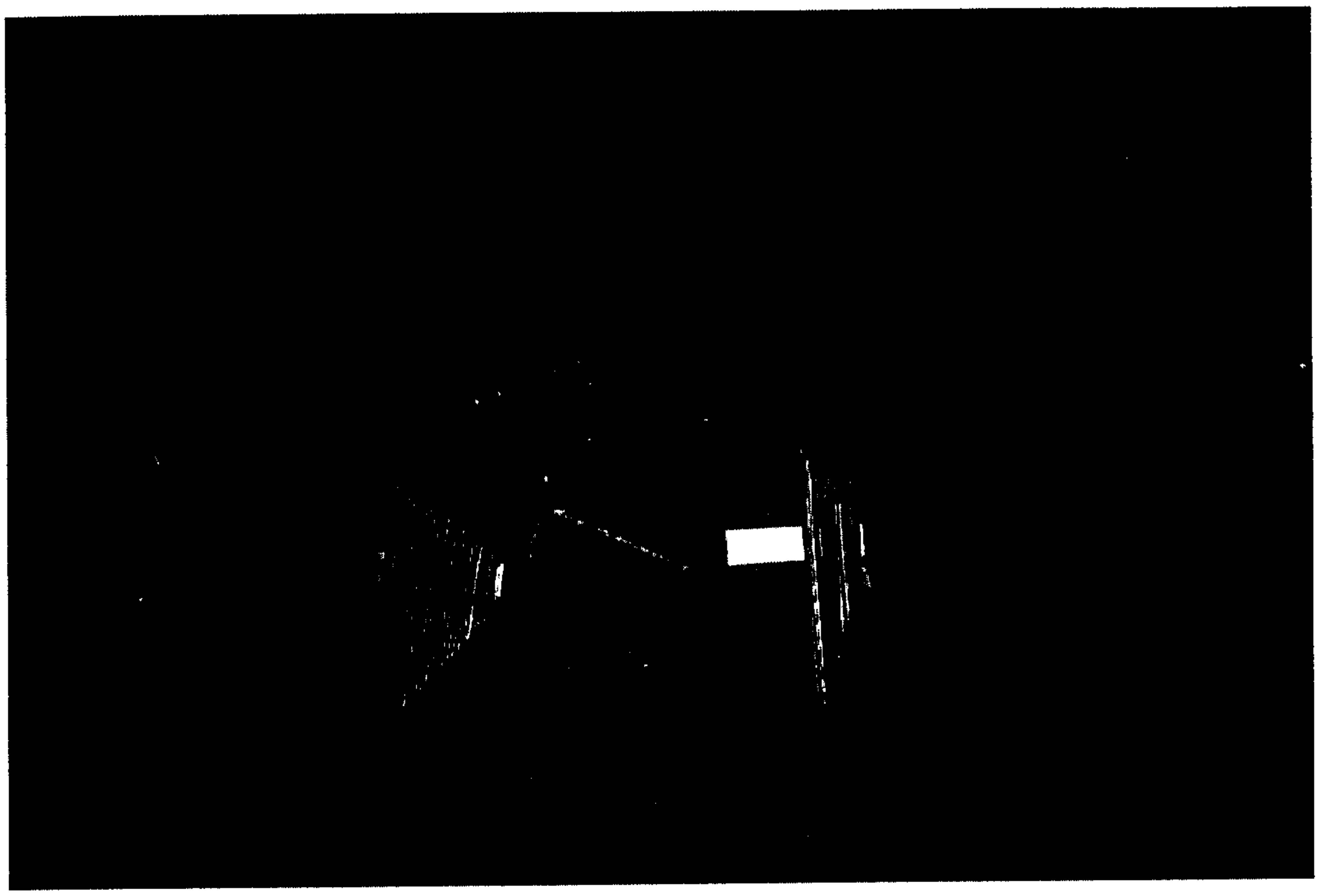


figure 5a set of finished mixing trays

Application number/ Numéro de demande : 2364100

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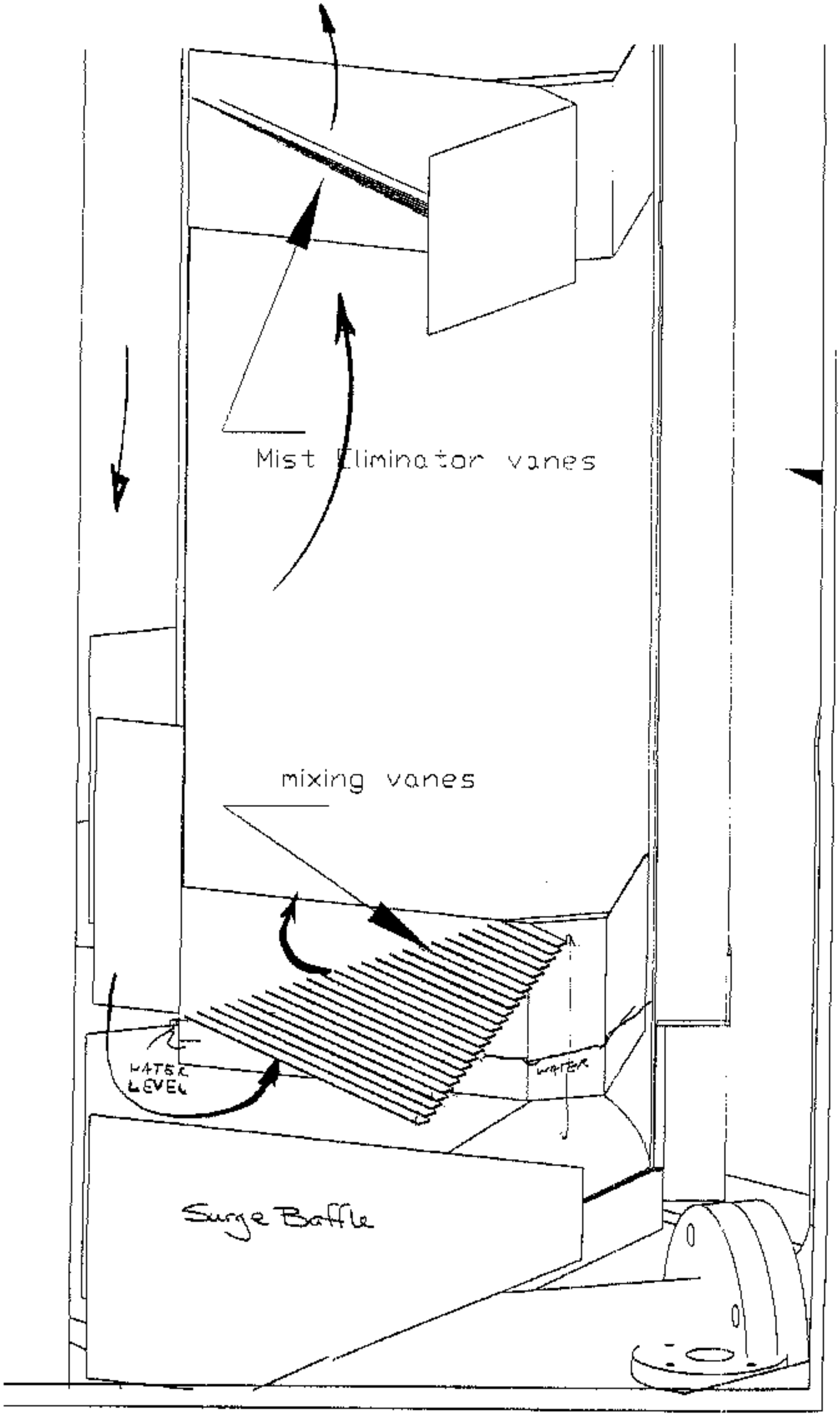
Mist Eliminator vanes
mixing vanes
WATER LEVEL
WATER
Surge Baffle