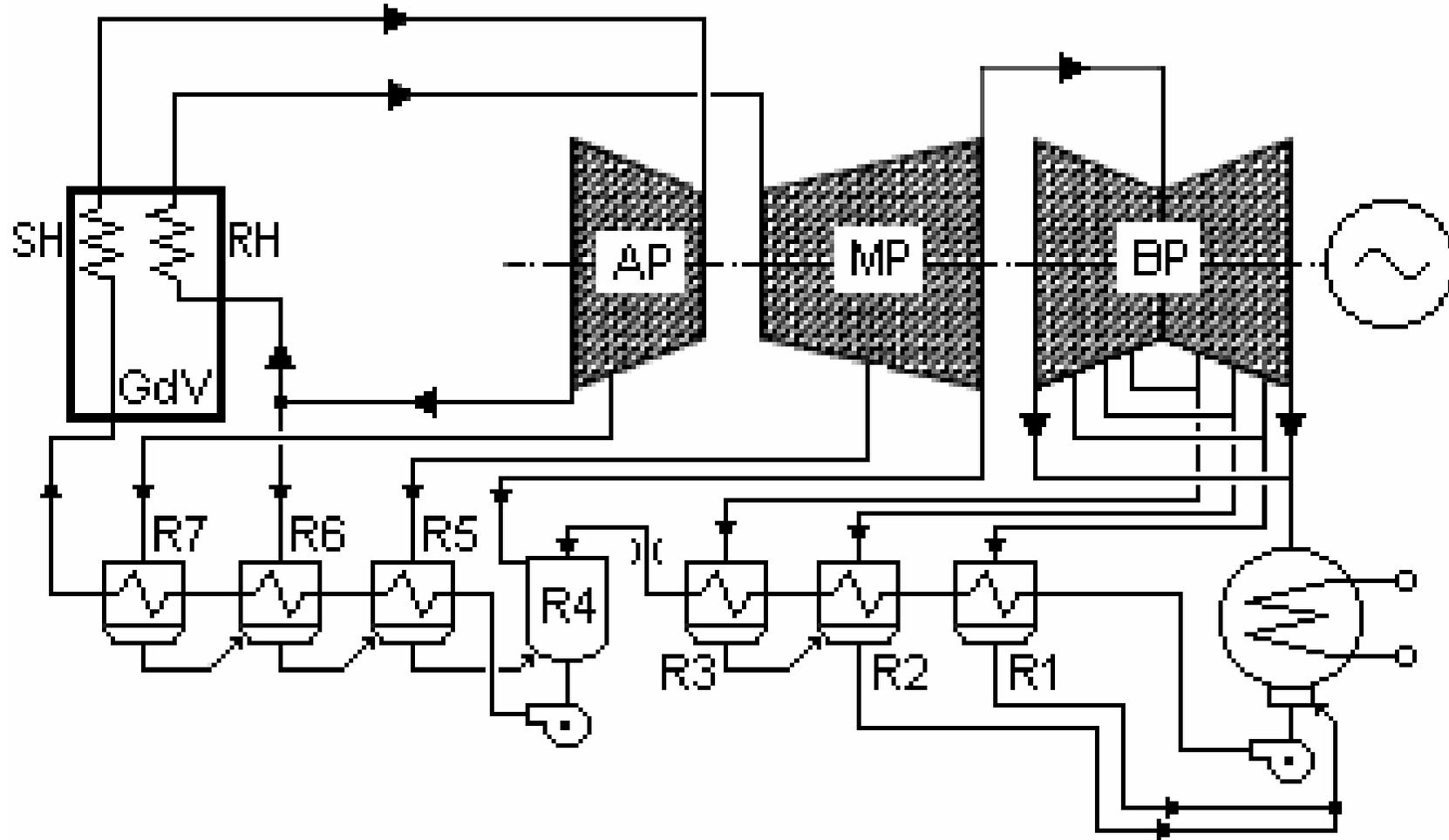
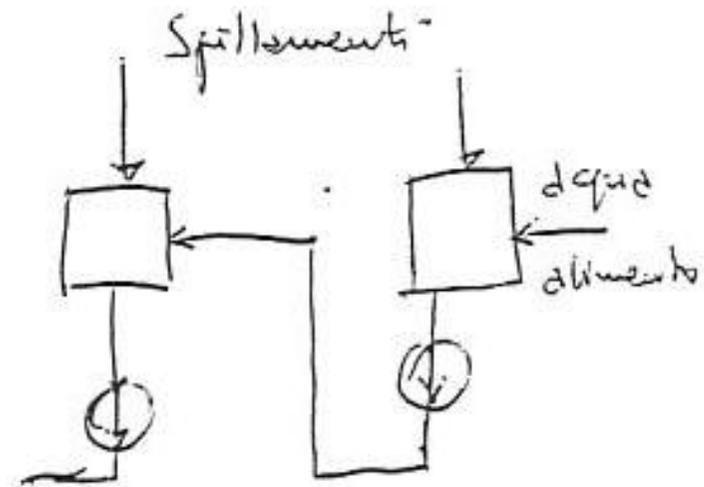
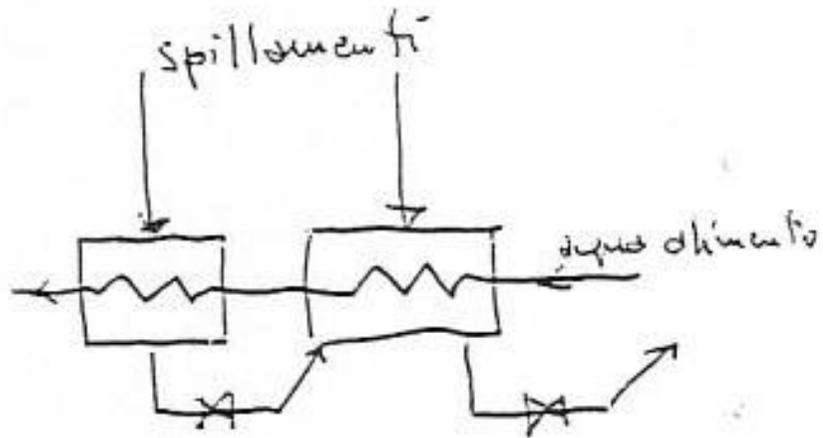


# Impianti a vapore

# Impianti a vapore



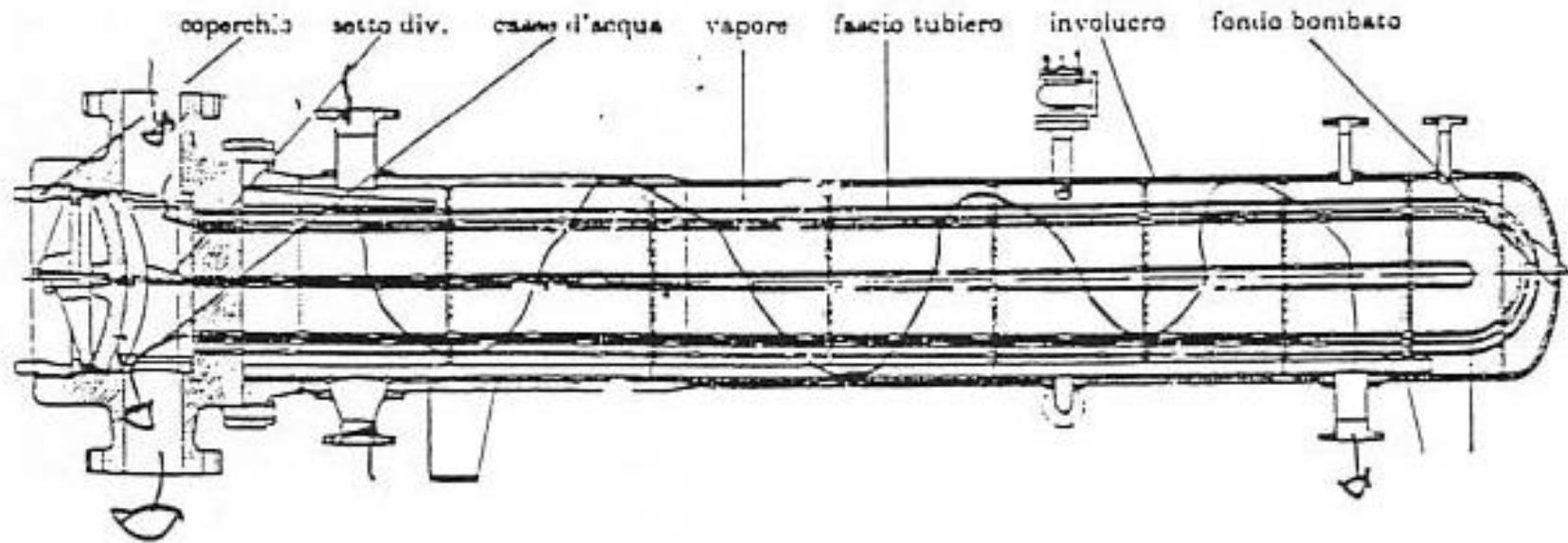
# Rigeneratori



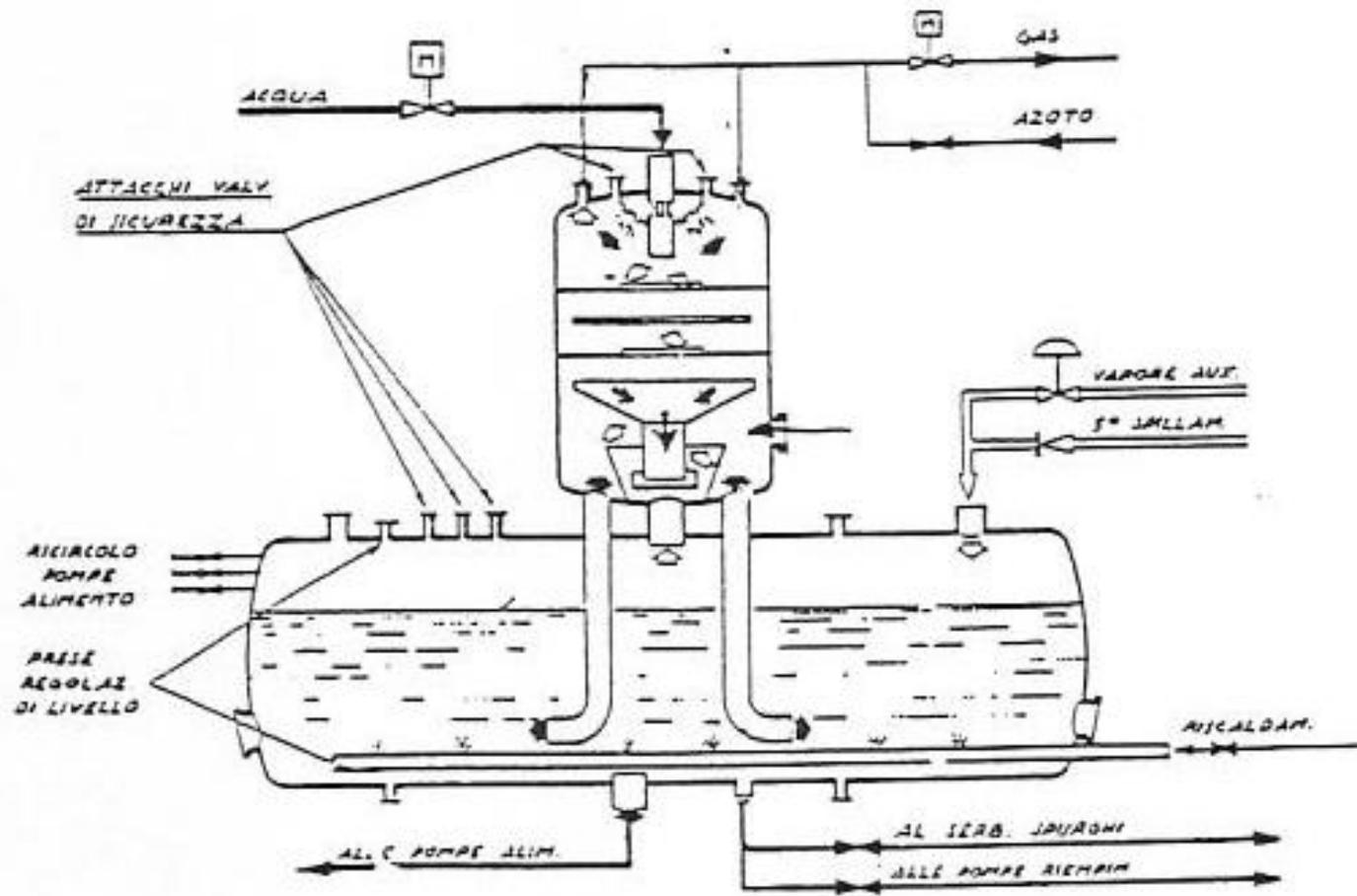
# Rigeneratori

	Scambiatori a miscela	Scambiatori a superficie
Vantaggi	<ul style="list-style-type: none"><li>- Scambio termico molto efficace con raggiungimento della stessa temperatura finale dei due fluidi</li><li>- Configurazione molto semplice dello scambiatore</li></ul>	<ul style="list-style-type: none"><li>- Maggiore affidabilità perché non sono necessarie pompe, poiché il condensato defluisce spontaneamente dai rigeneratori a valle a quelli a monte fino al condensatore</li><li>- Maggiore libertà nella scelta delle pressioni di spillamento</li></ul>
Svantaggi	<ul style="list-style-type: none"><li>- Per ogni scambiatore è necessaria una pompa per aumentare la pressione lungo la linea di alimento</li><li>- Minore affidabilità del sistema perché ci sono più organi meccanici in movimento</li></ul>	<ul style="list-style-type: none"><li>- Minore efficienza dello scambio termico</li><li>- Maggiore costo degli scambiatori di calore</li></ul>

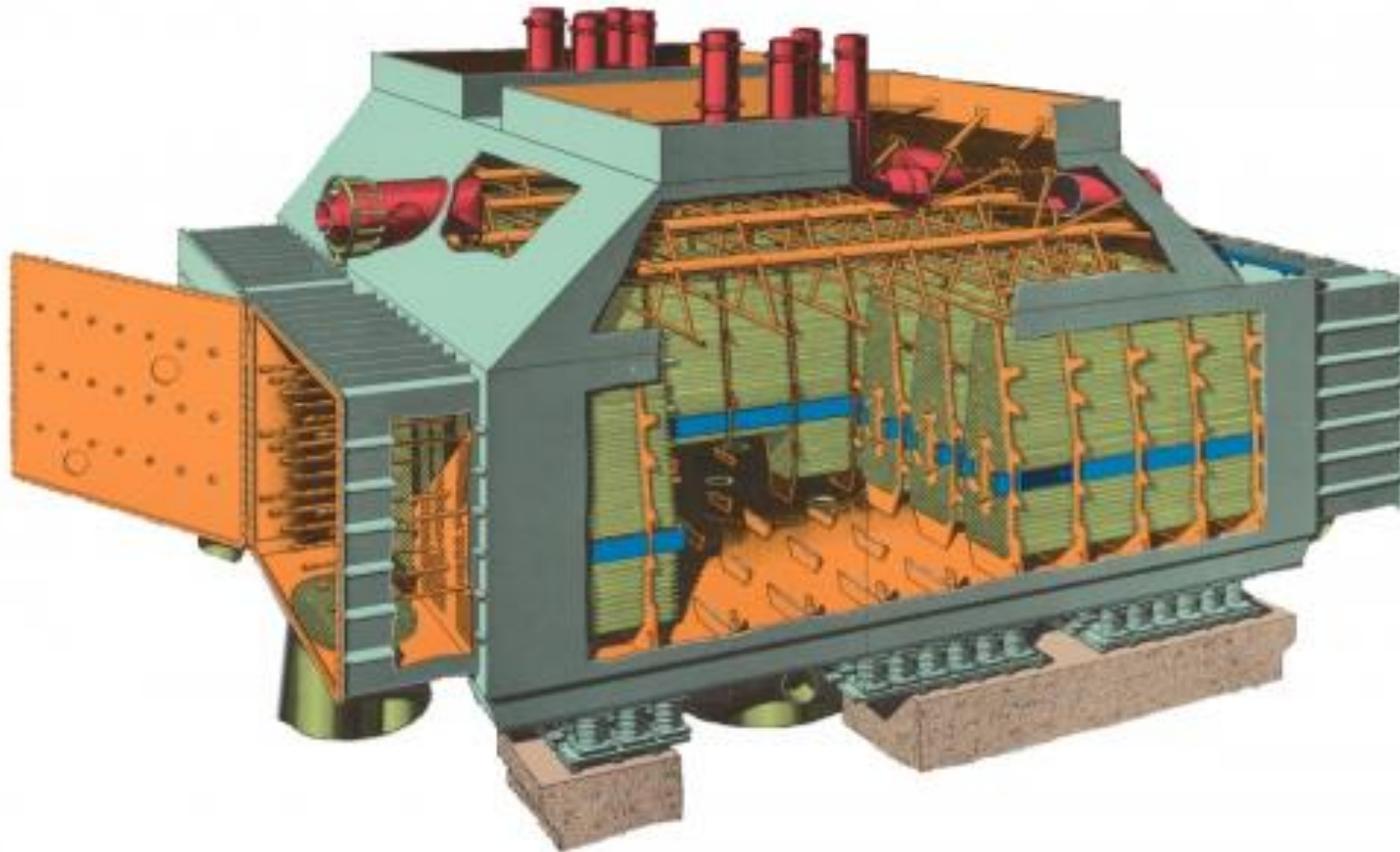
# Rigeneratore



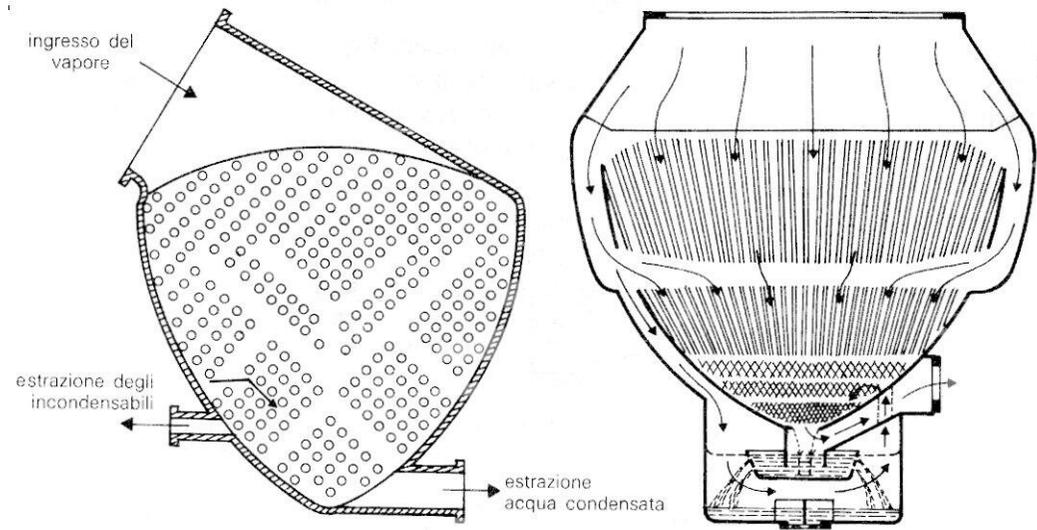
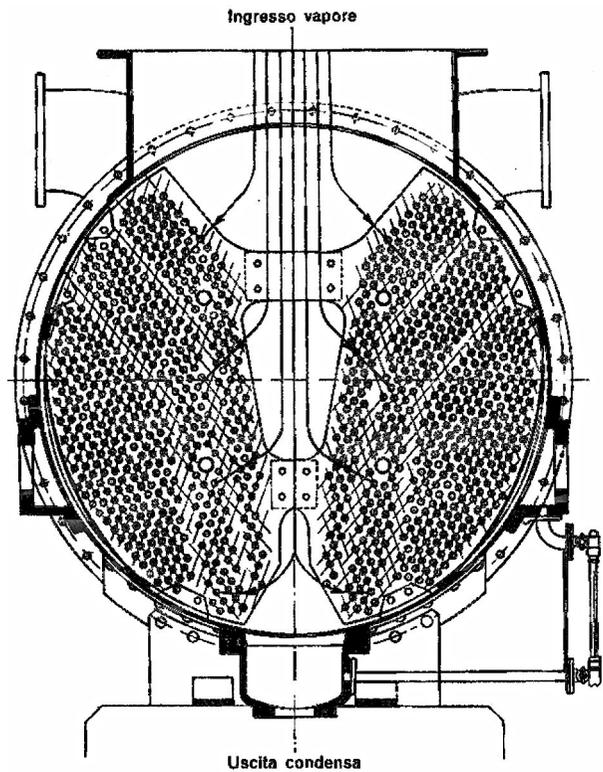
# Degasatore



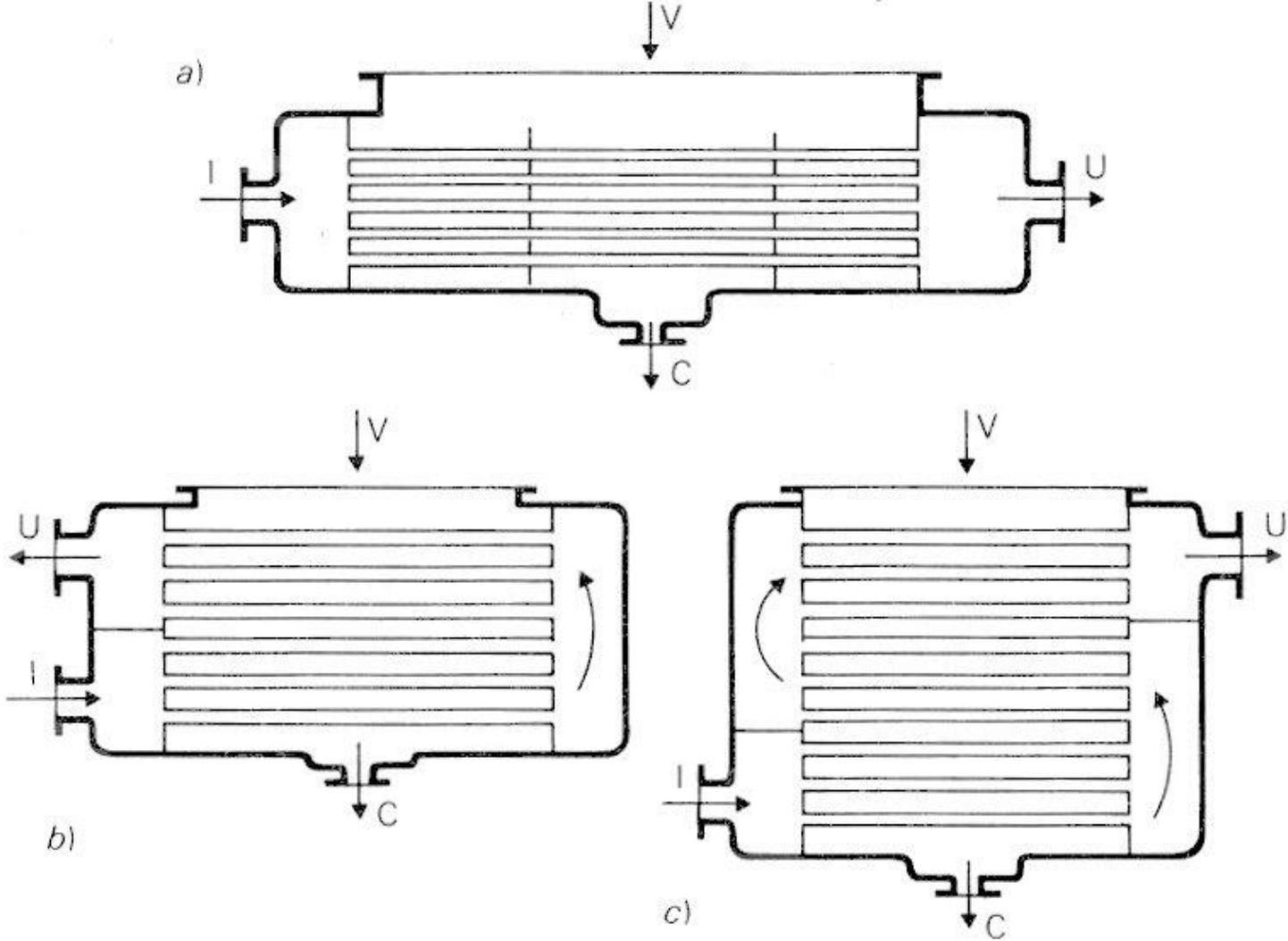
# Condensatore



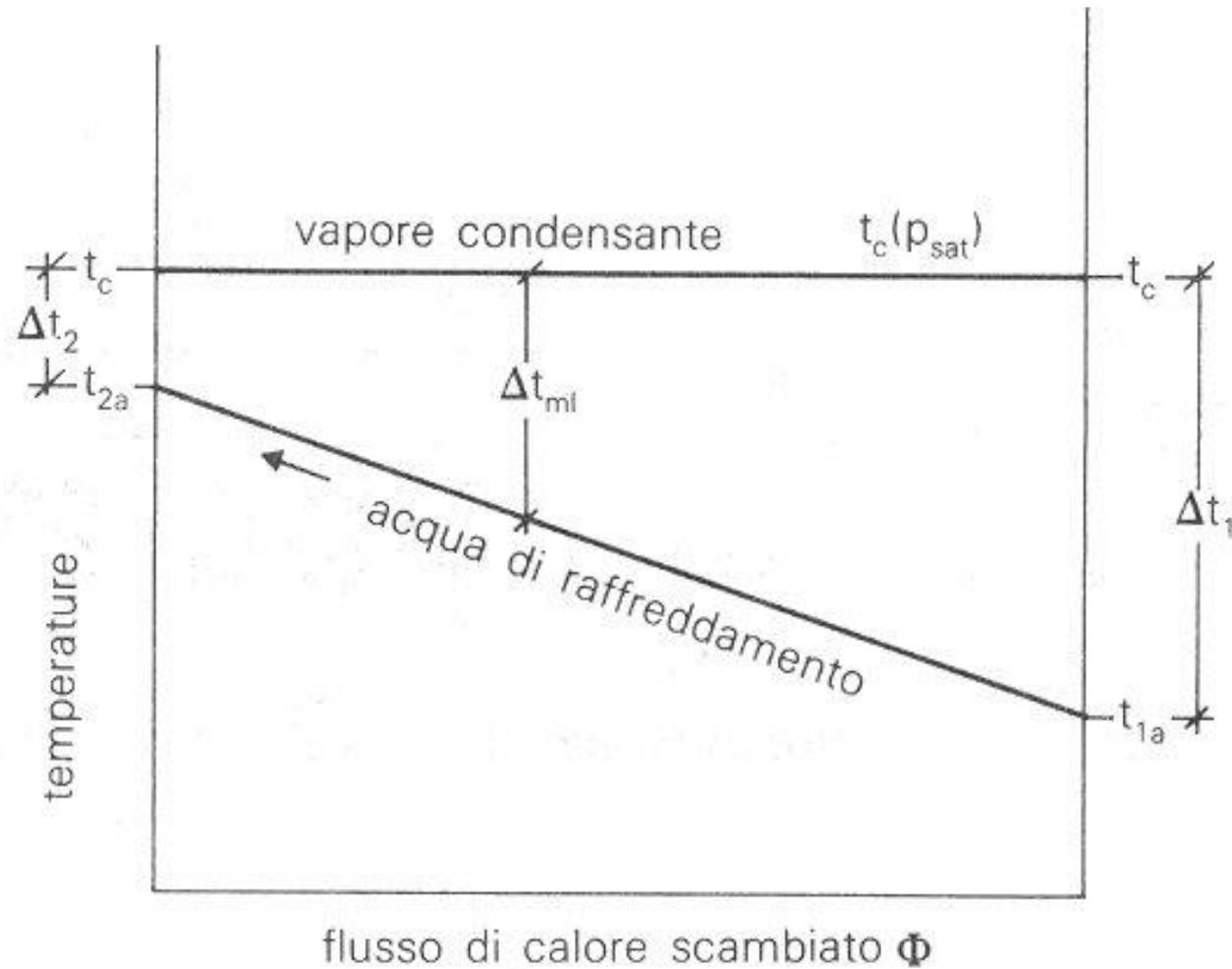
# Condensatore



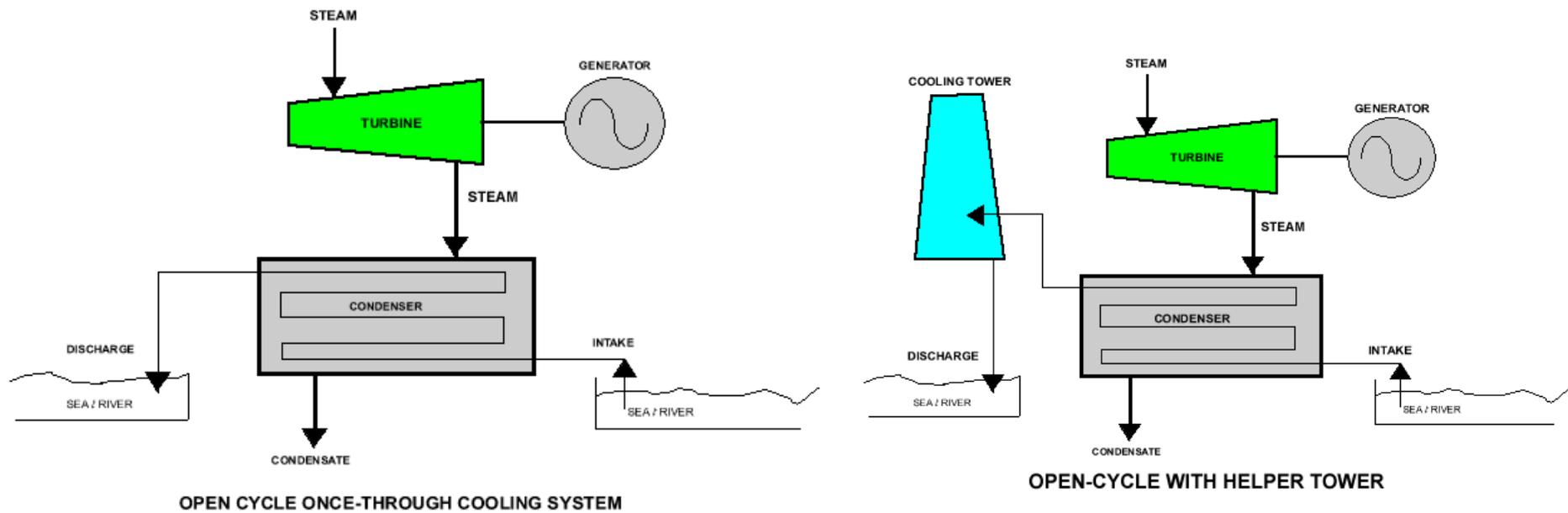
# Condensatore



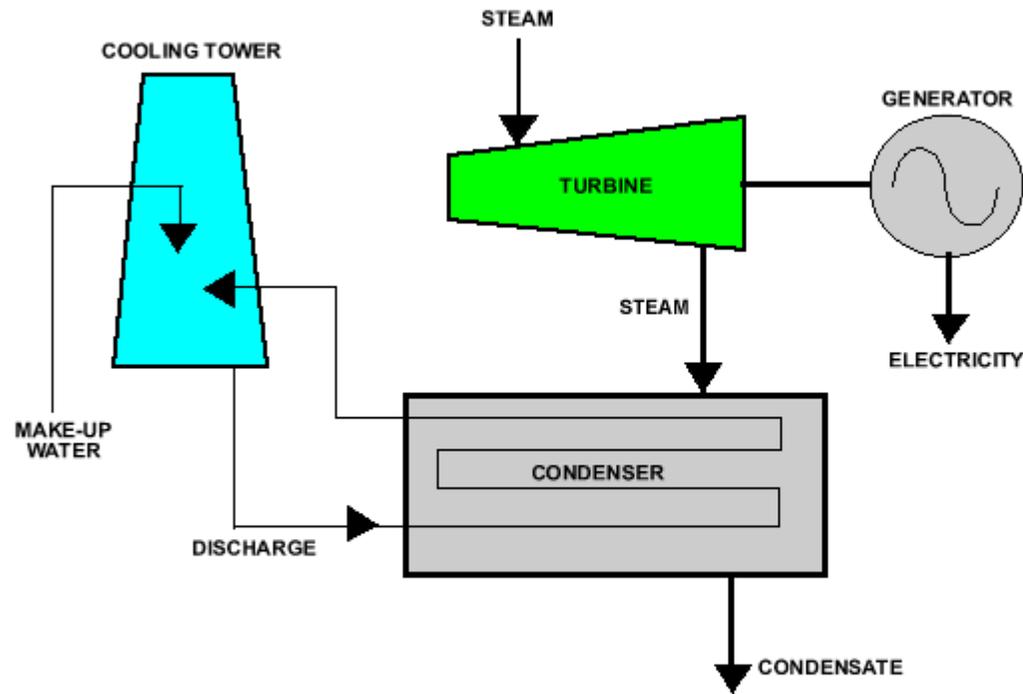
# Condensatore



# Refrigerazione in circuito aperto

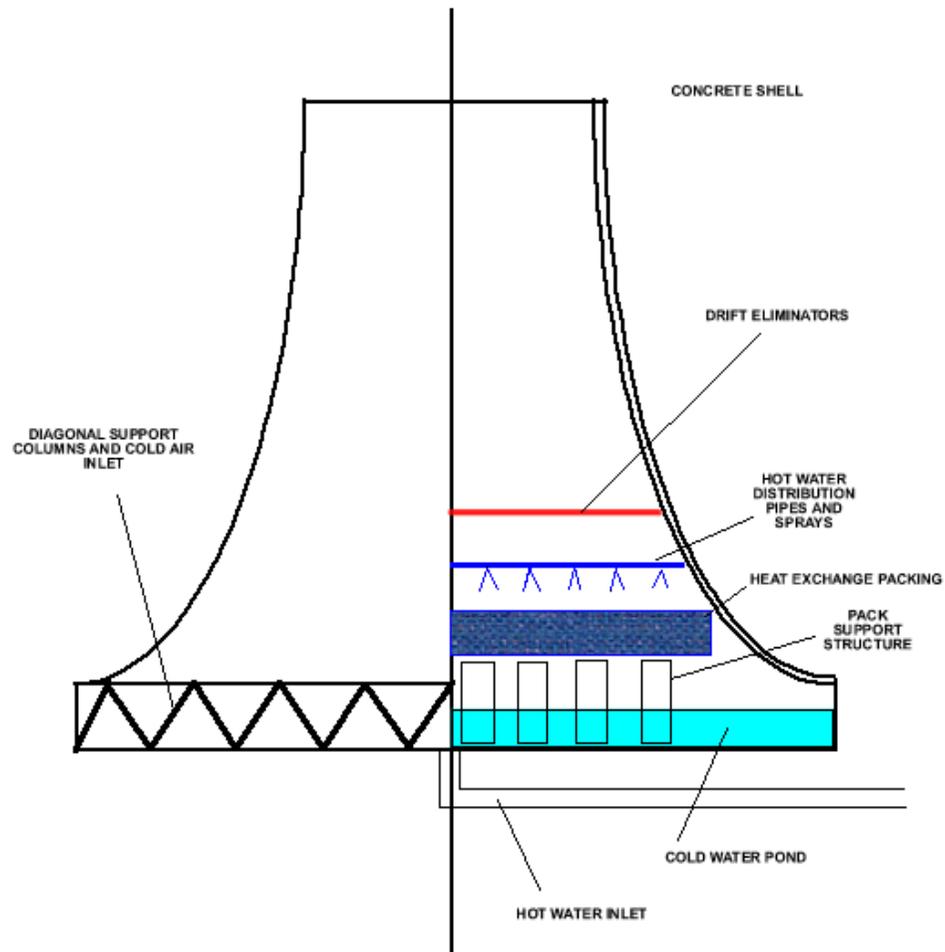


# Torre evaporativa



TYPICAL CLOSED-CYCLE COOLING SYSTEM

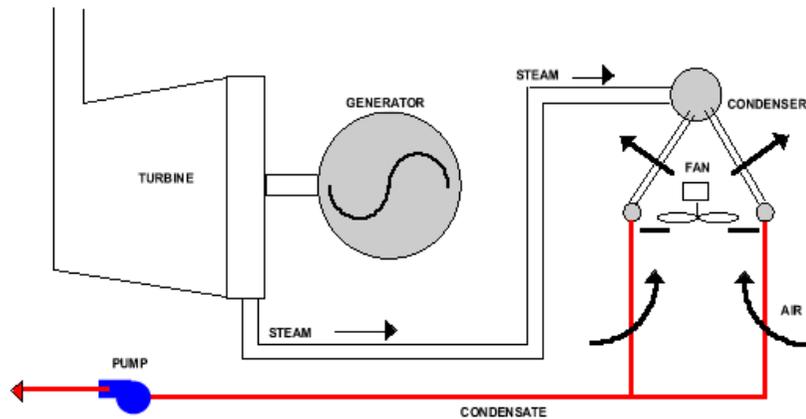
# Torre evaporativa



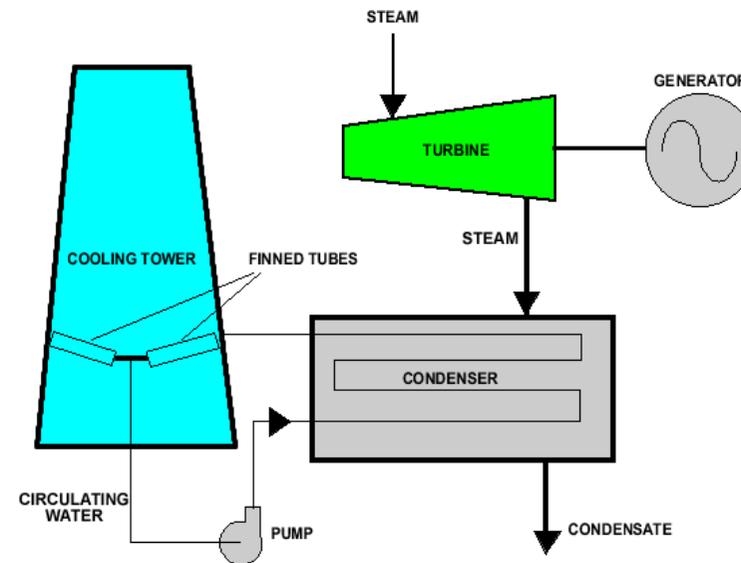
PART SECTION OF A NATURAL DRAUGHT COOLING TOWER - COUNTER FLOW



# Torre a secco



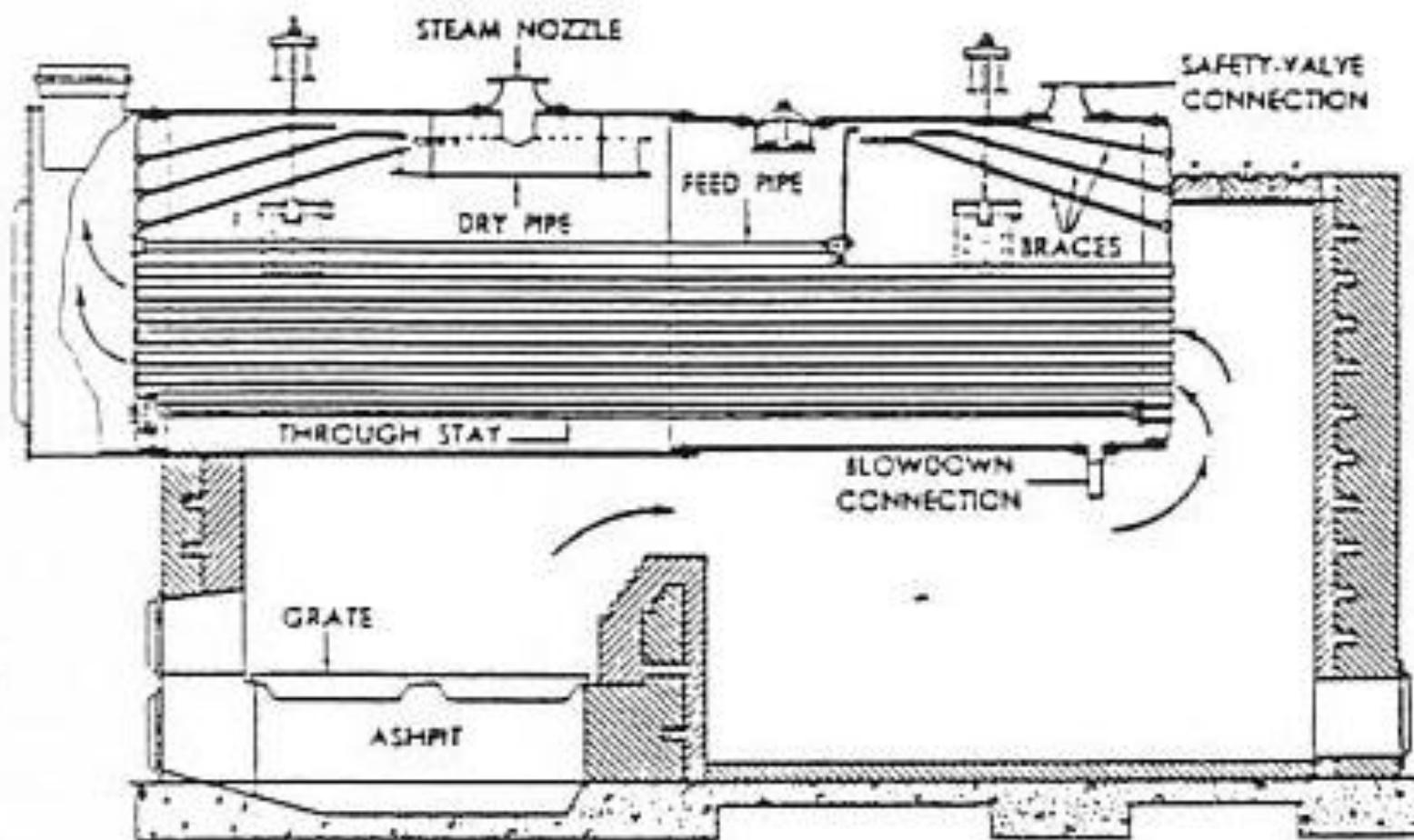
**DIRECT AIR-COOLED SYSTEM**



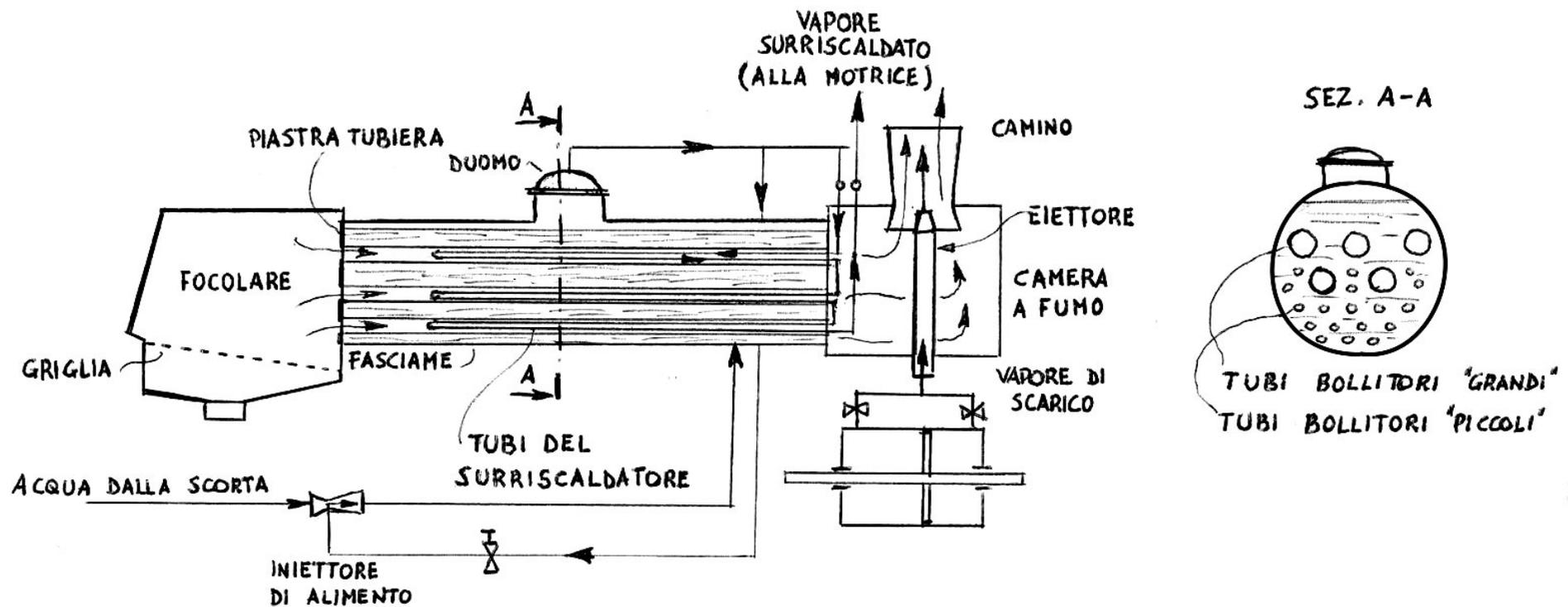
**INDIRECT DRY-COOLING SYSTEM**



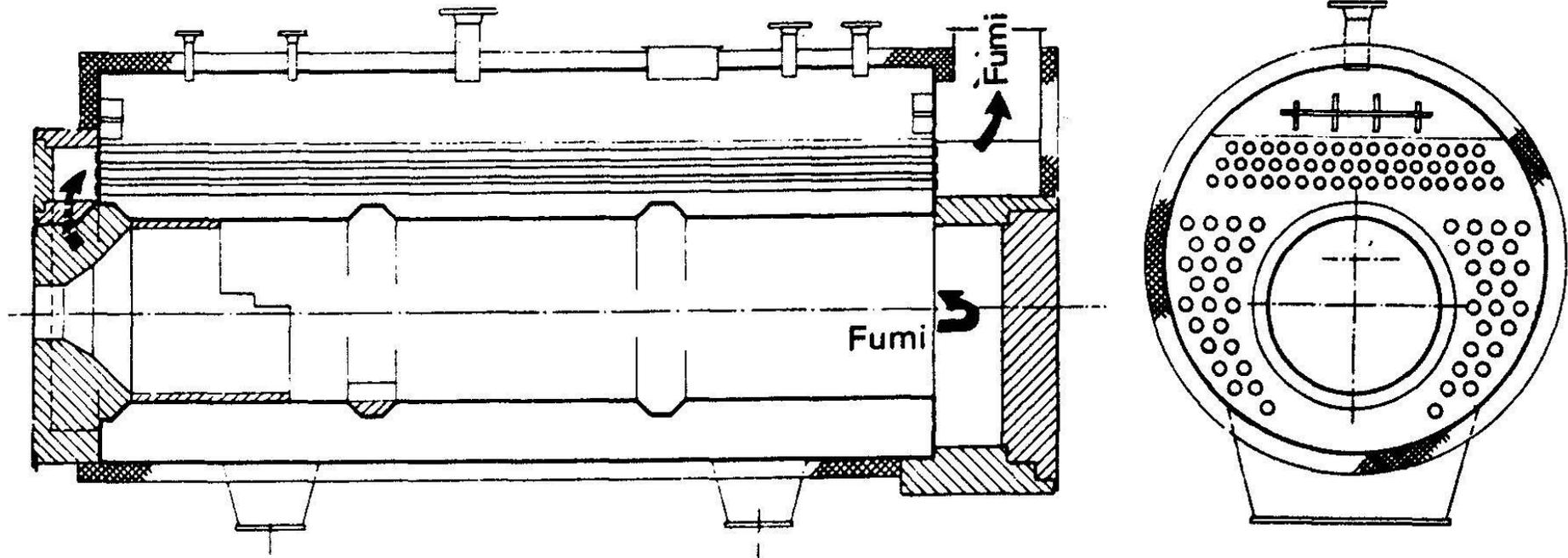
# Caldia a tubi di fumo a semplice passaggio



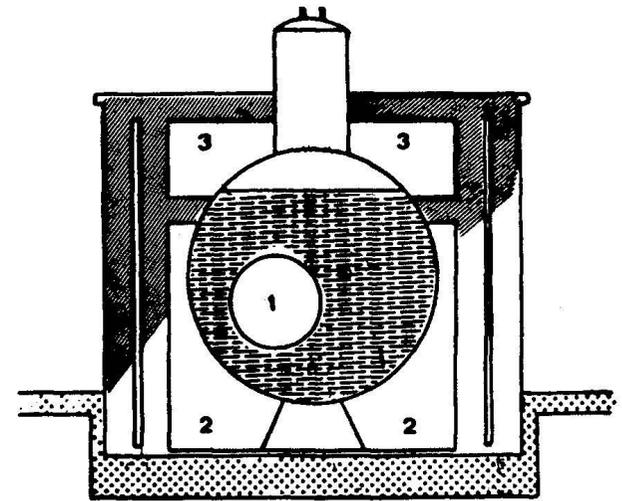
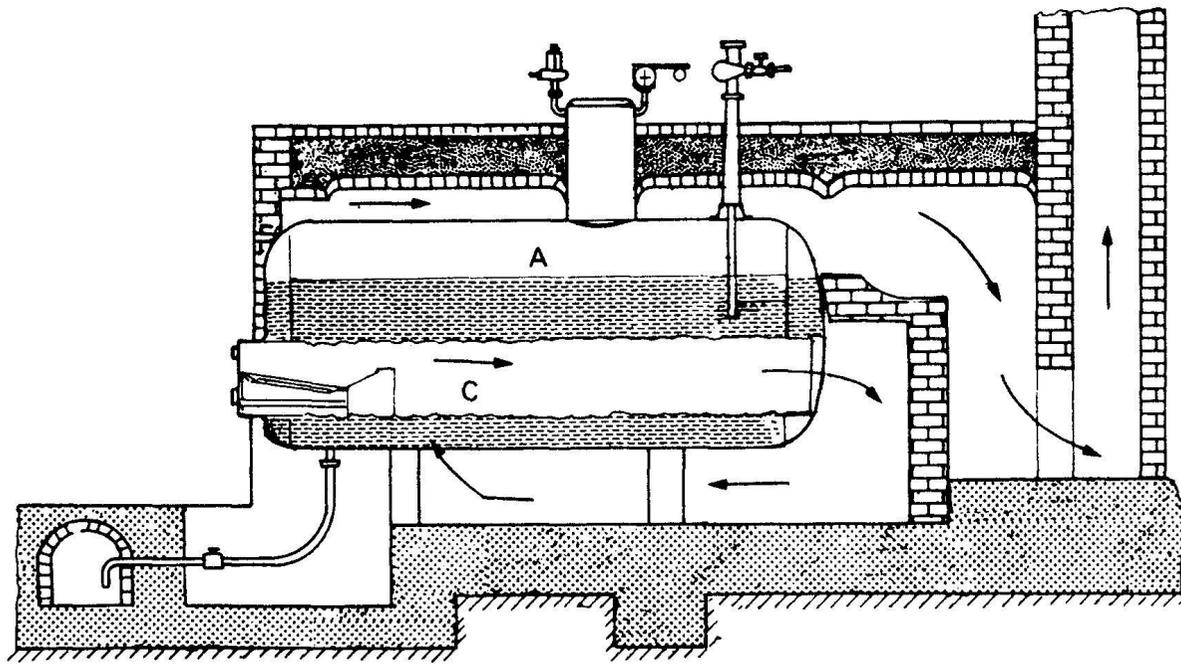
# Caldaia a tubi di fumo a semplice passaggio



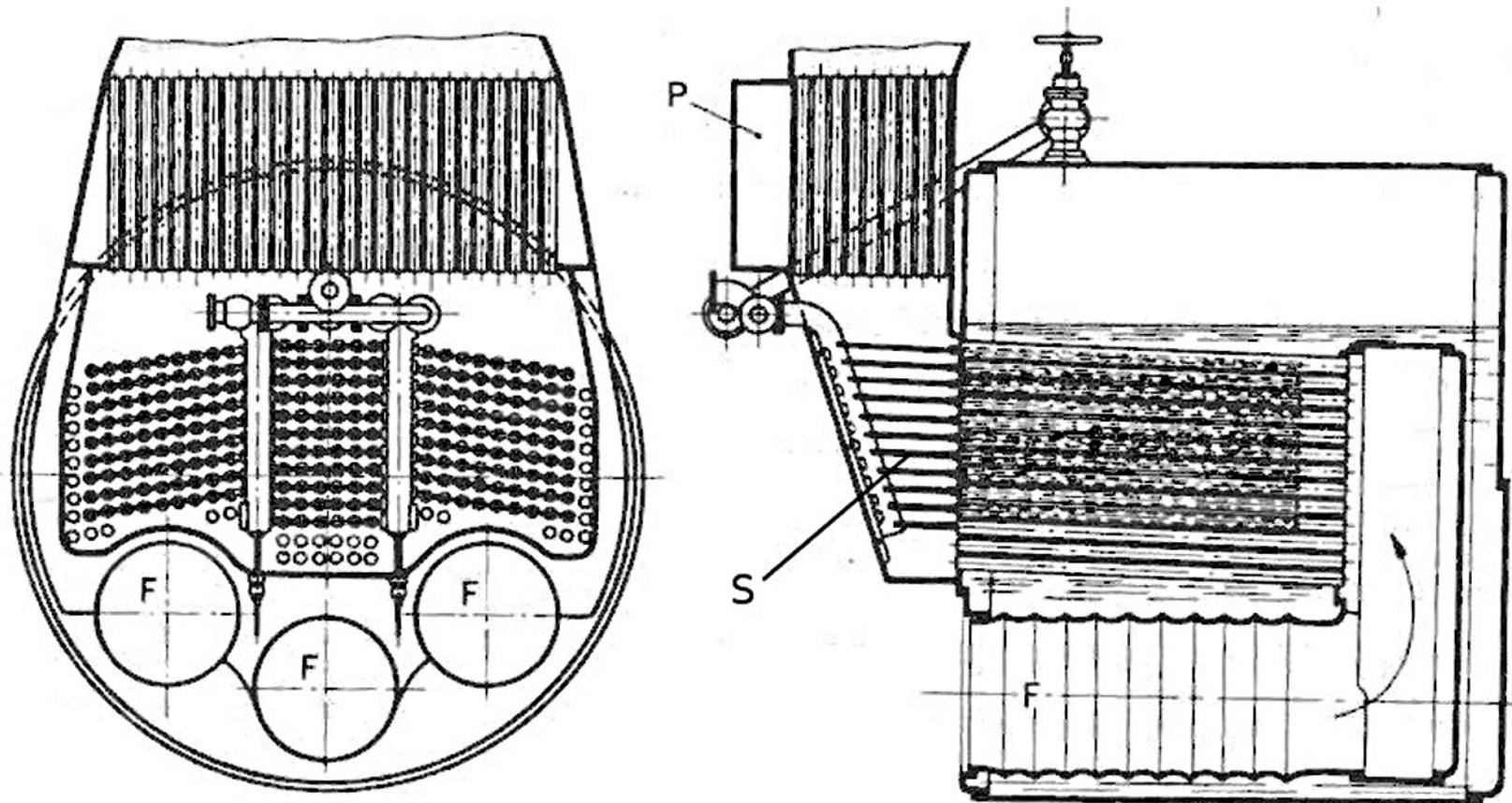
# Caldaia a tubi di fumo a semplice passaggio



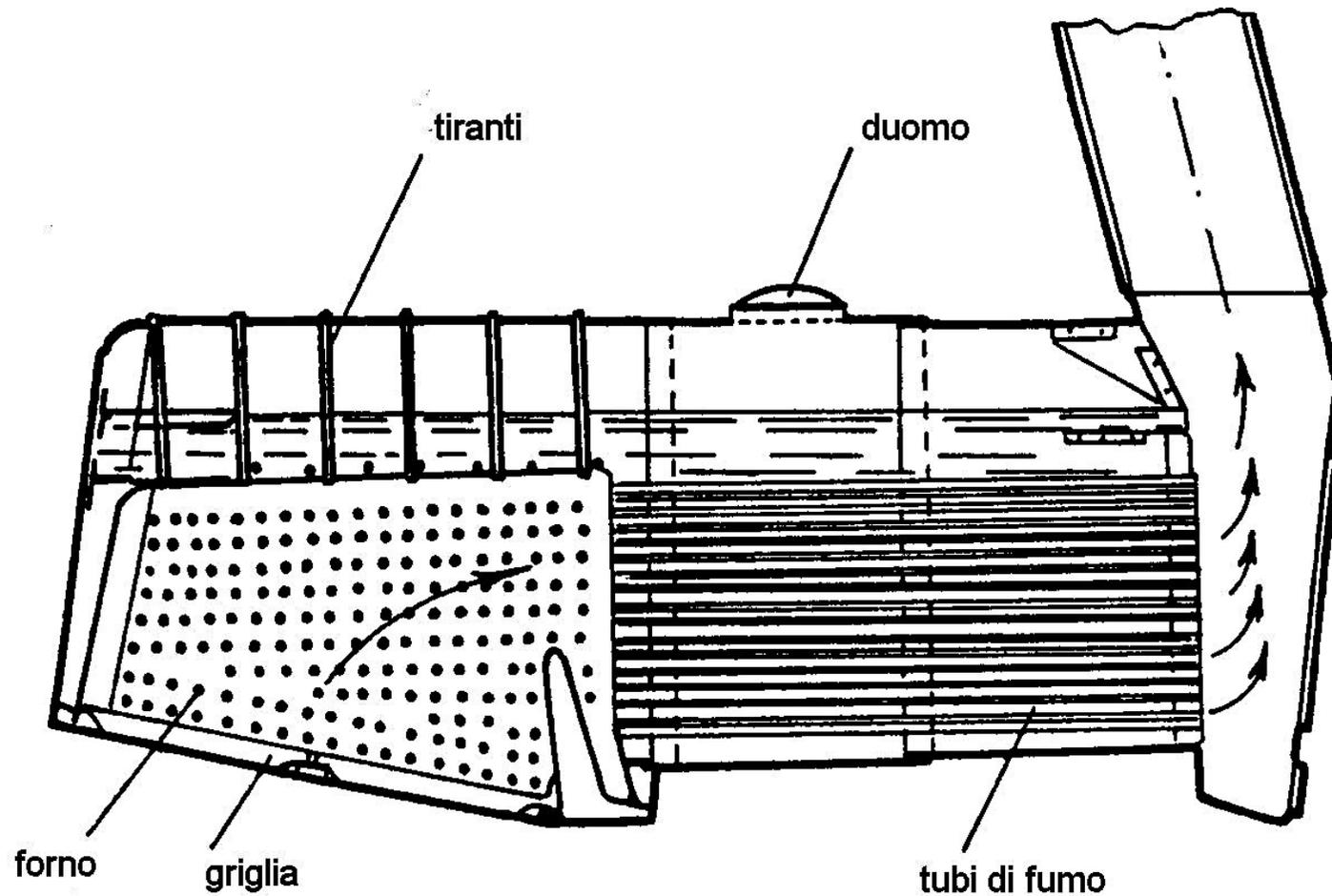
# Caldaia a tubi di fumo a tre giri di fumo



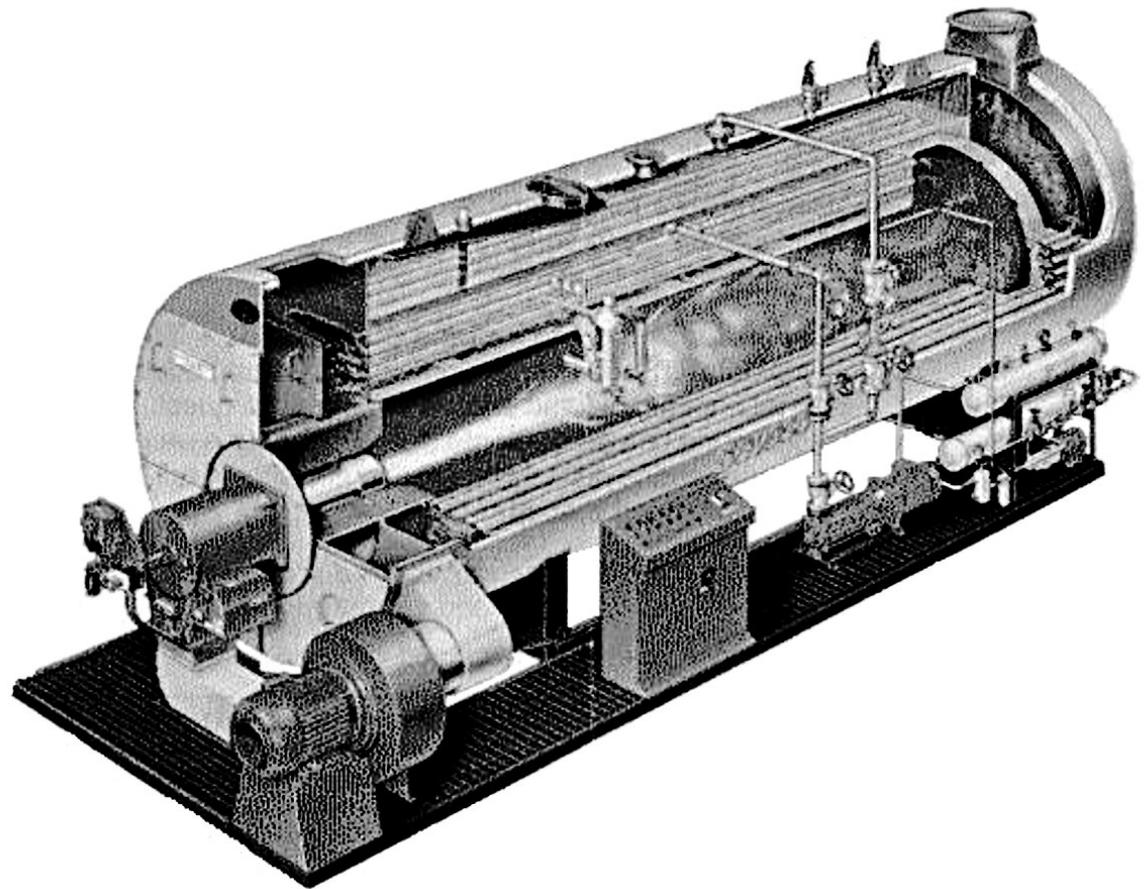
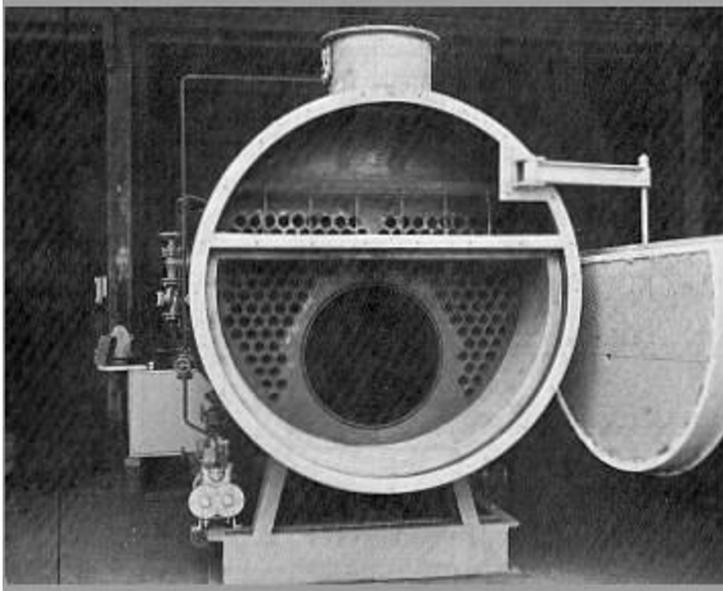
# Caldaia a tubi di fumo di tipo scozzese



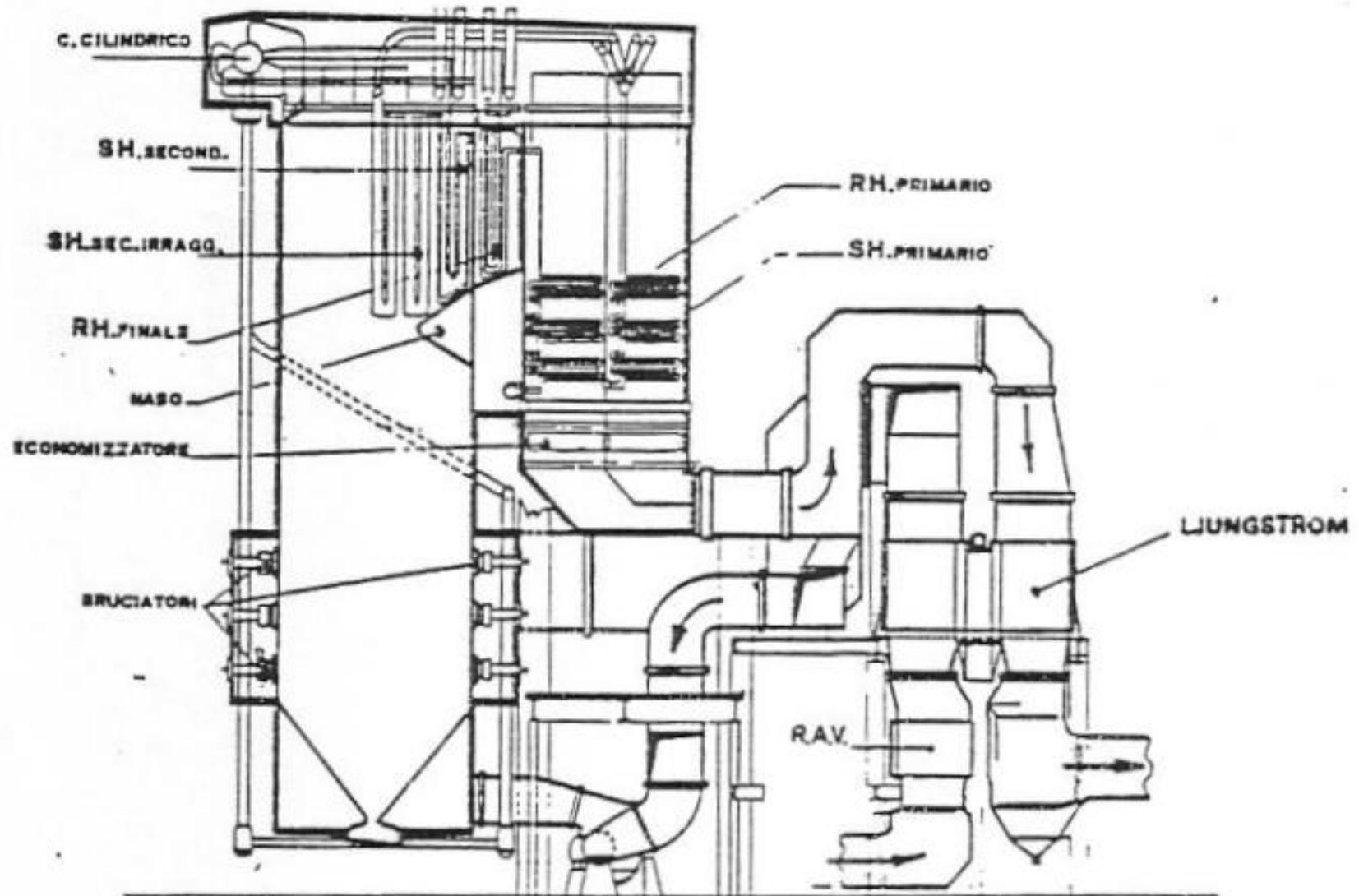
# Caldaia a tubi di fumo a fiamma diretta



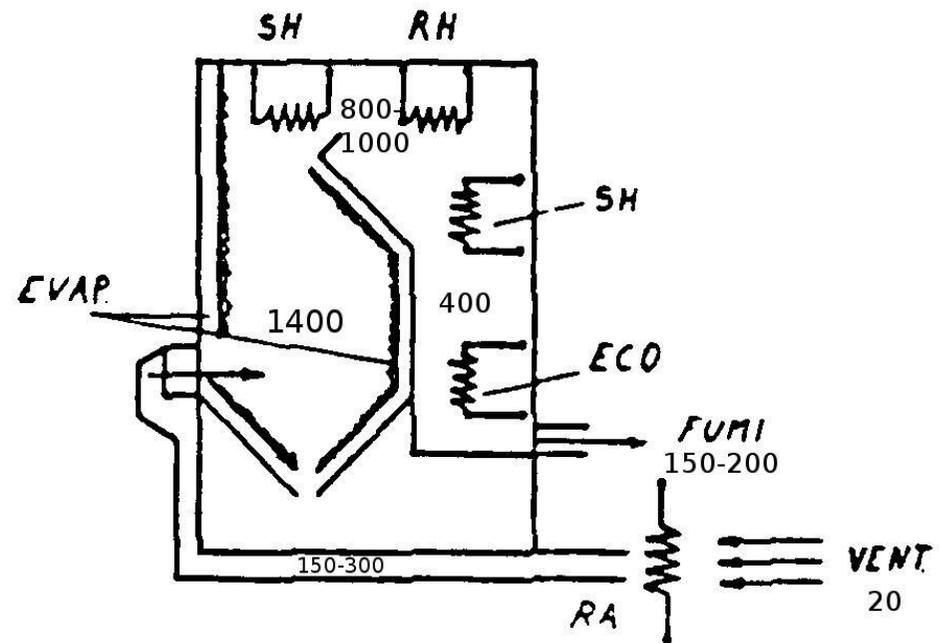
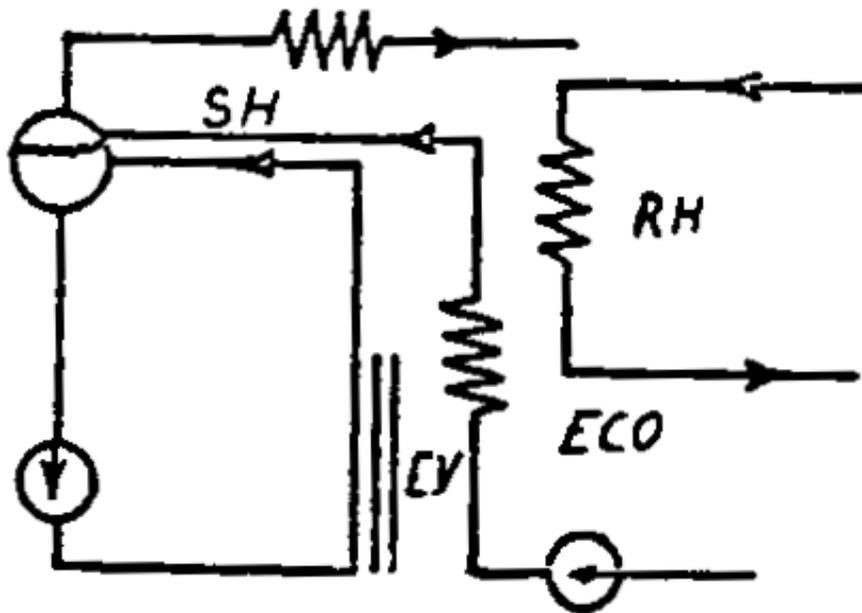
# Caldaia a tubi di fumo



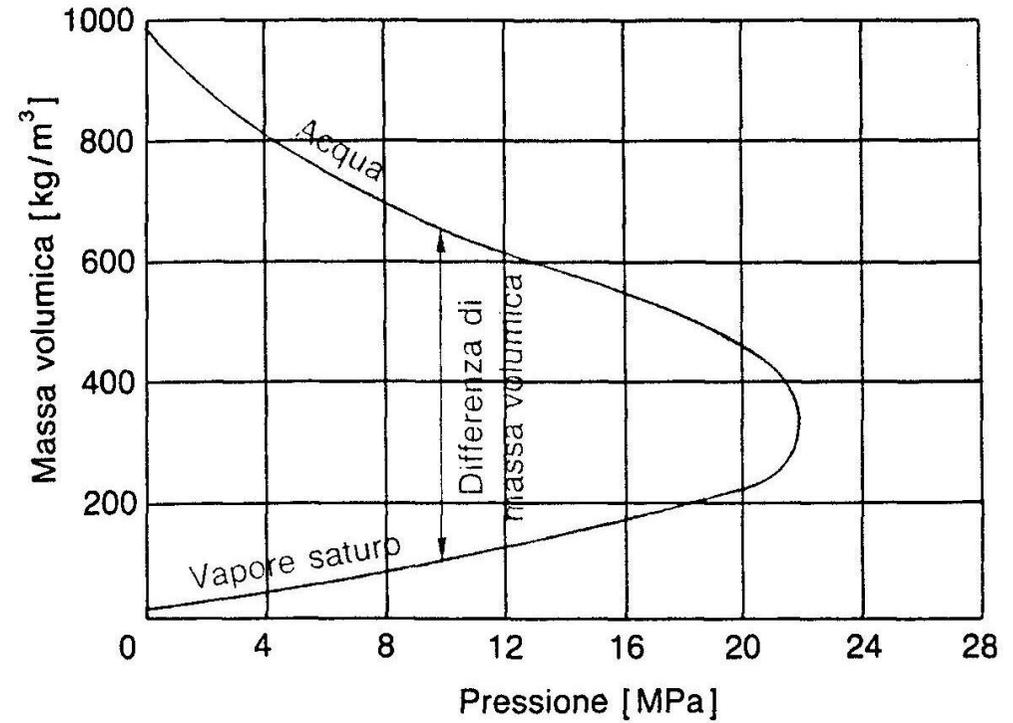
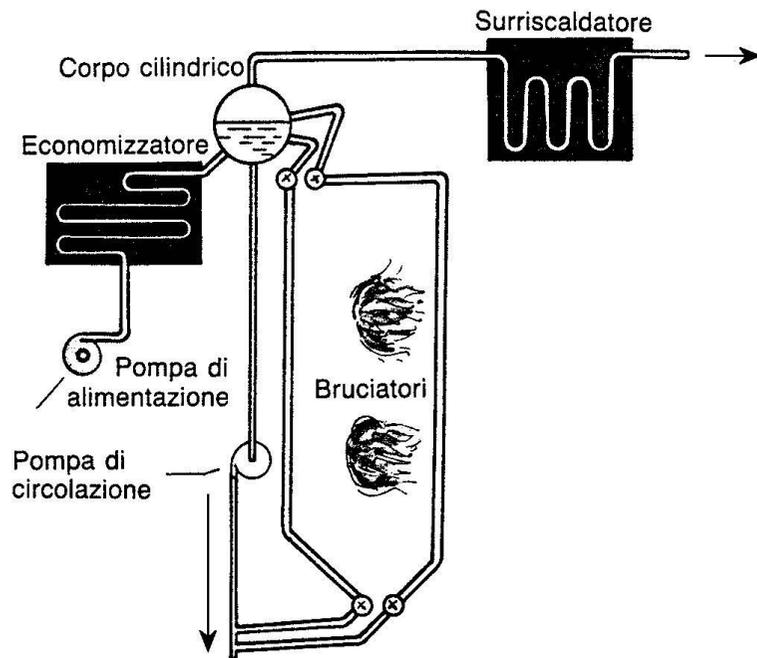
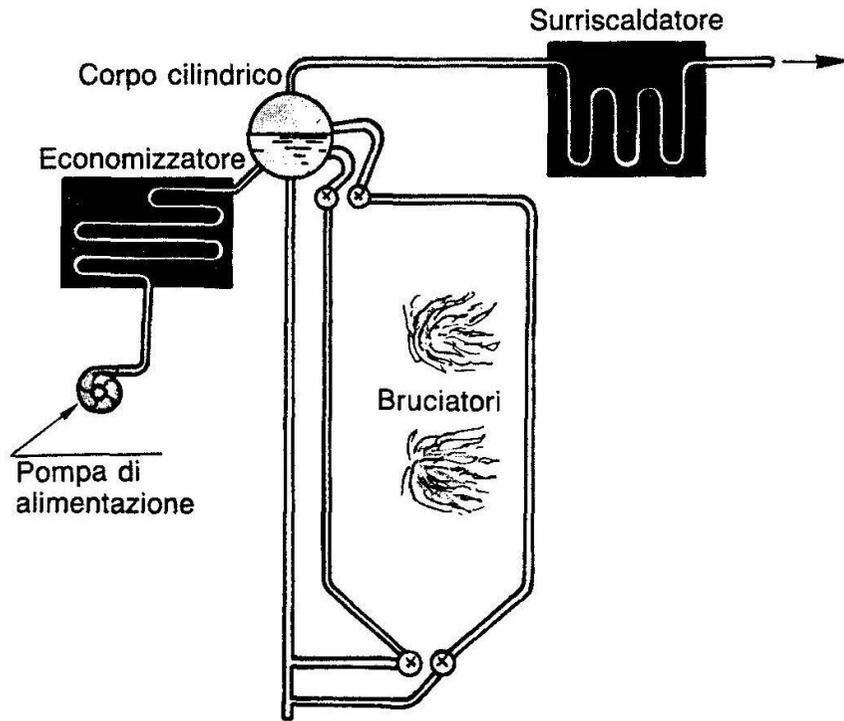
# Caldaia a tubi d'acqua



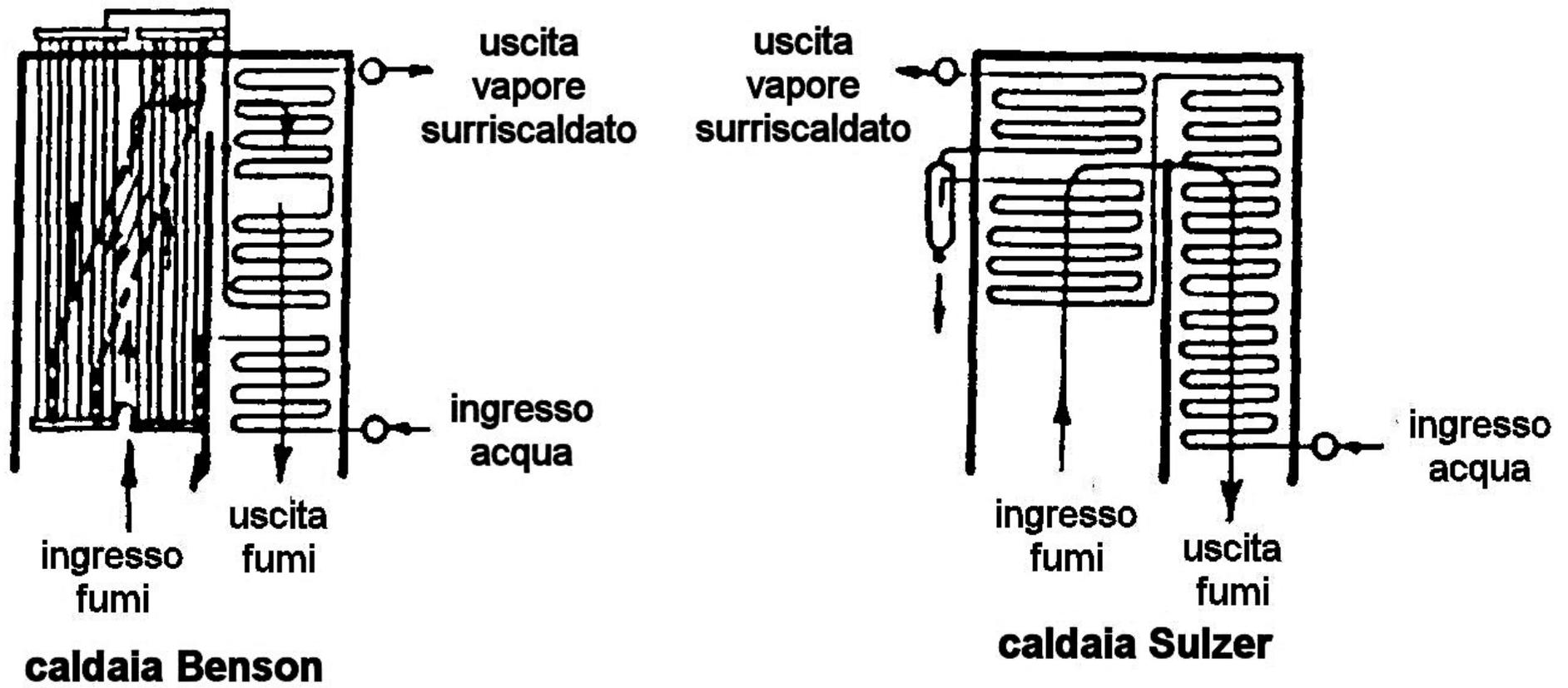
# Circuito acqua vapore



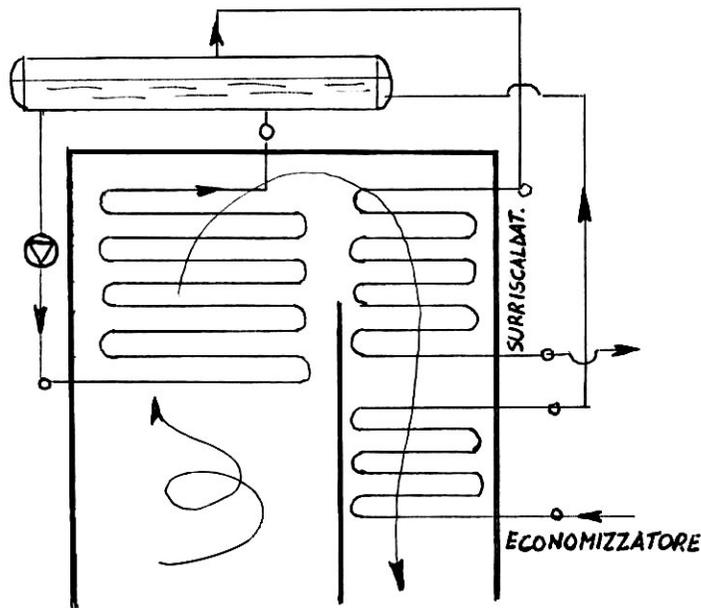
# Circuito acqua-vapore



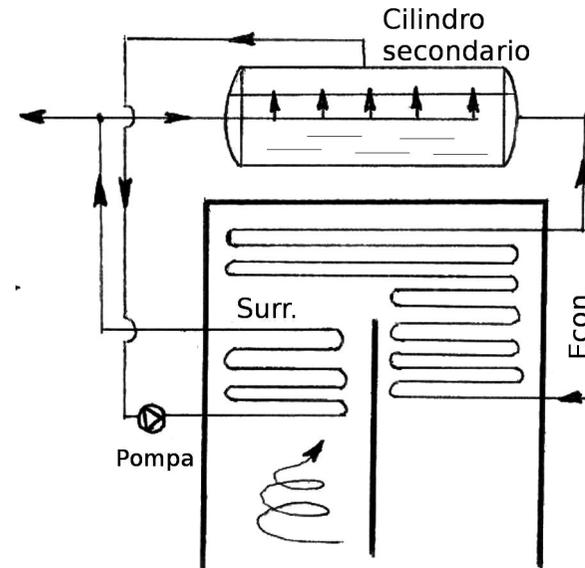
# Circuito acqua-vapore supercritico



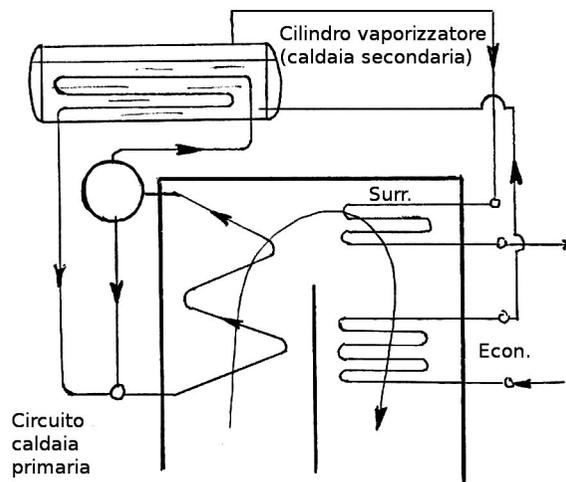
# Diversi tipi di circolazione



Caldaia La Mont

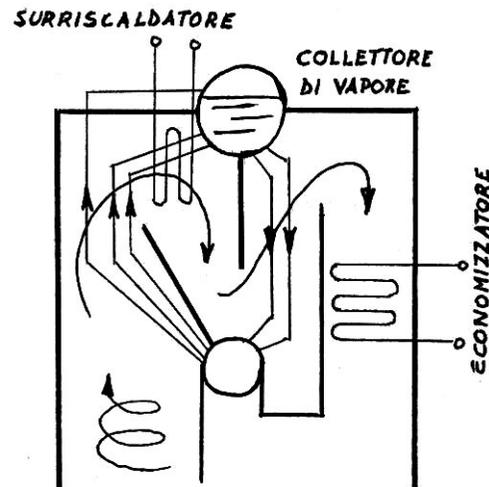
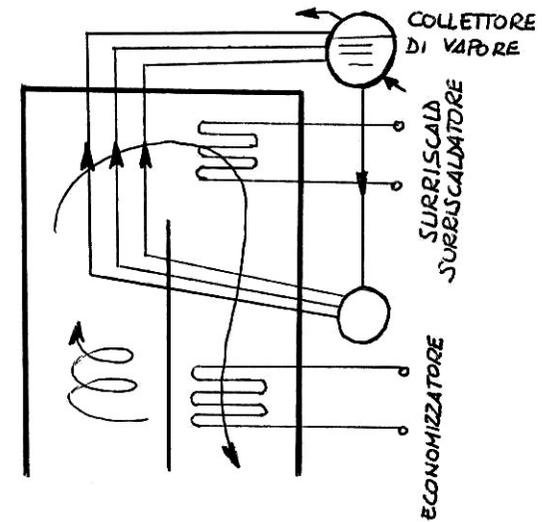
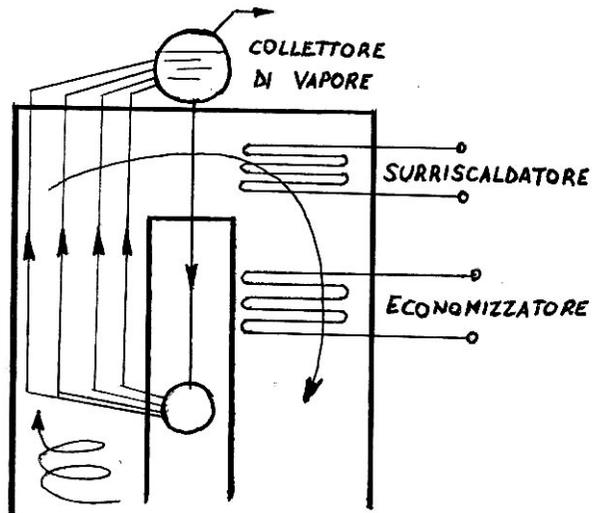


Caldaia Loeffler

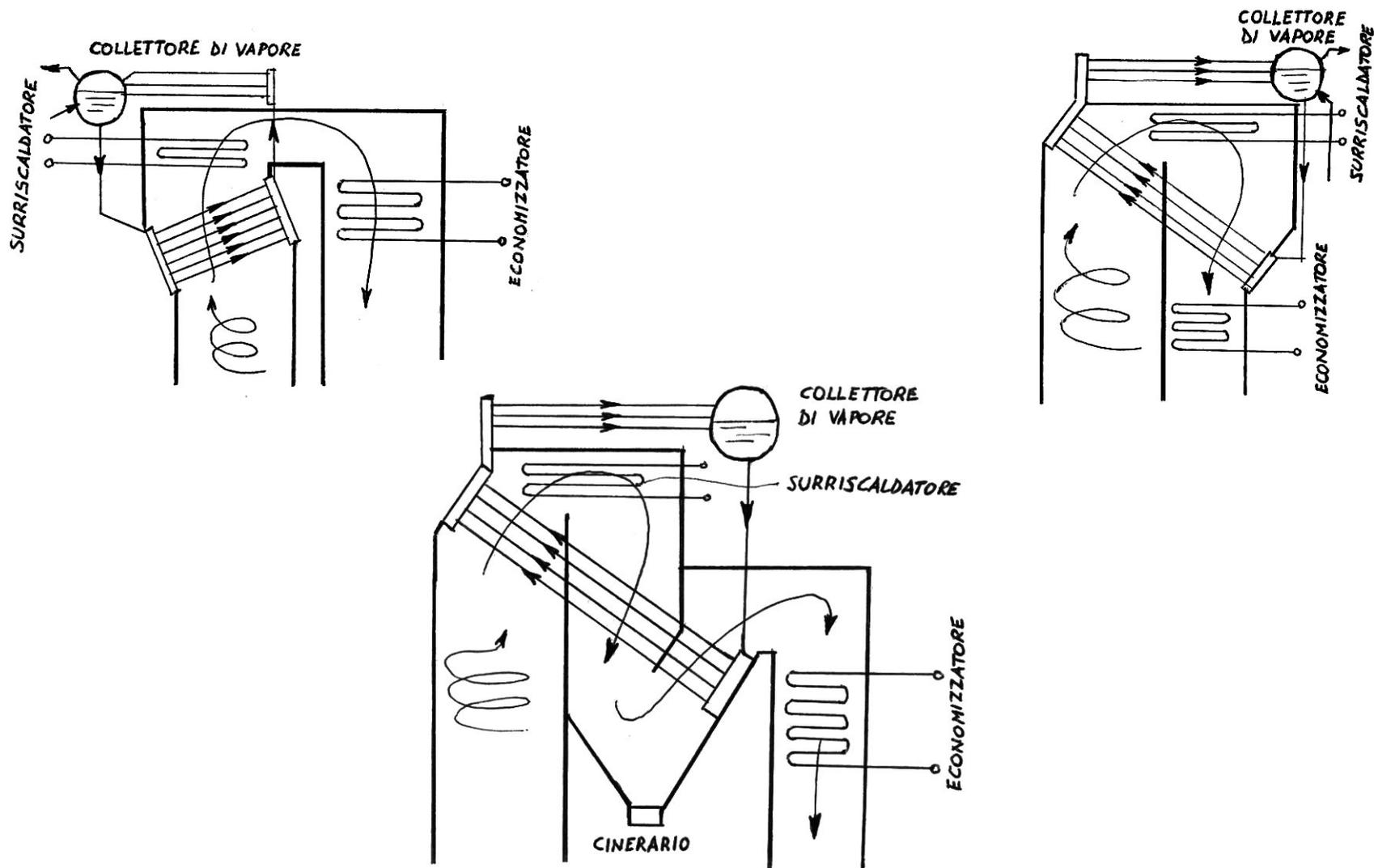


Caldaia Schmidt

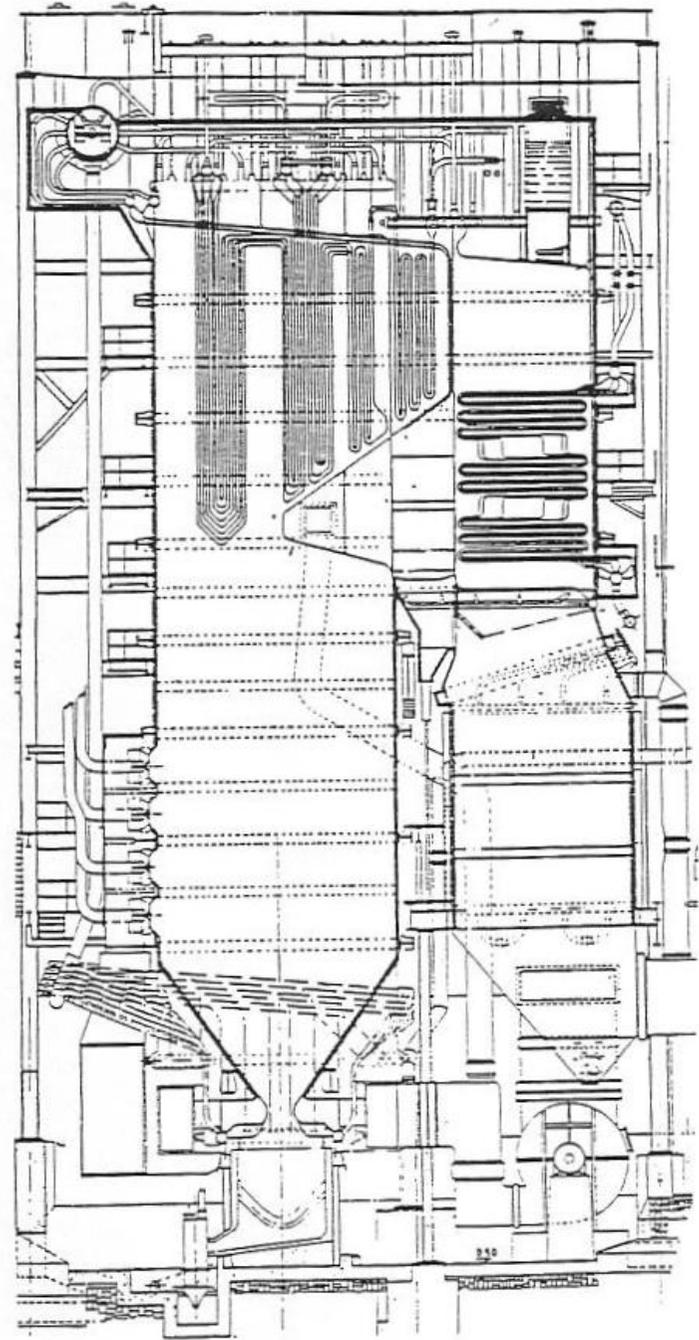
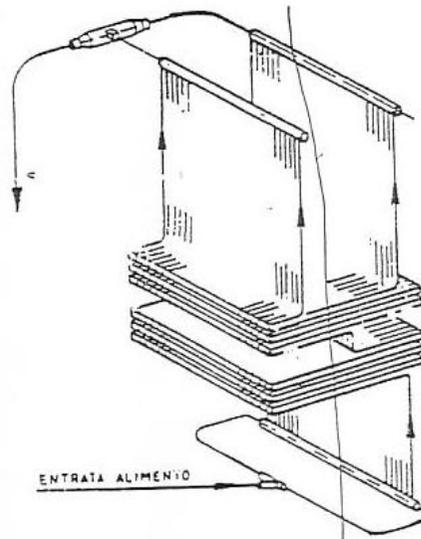
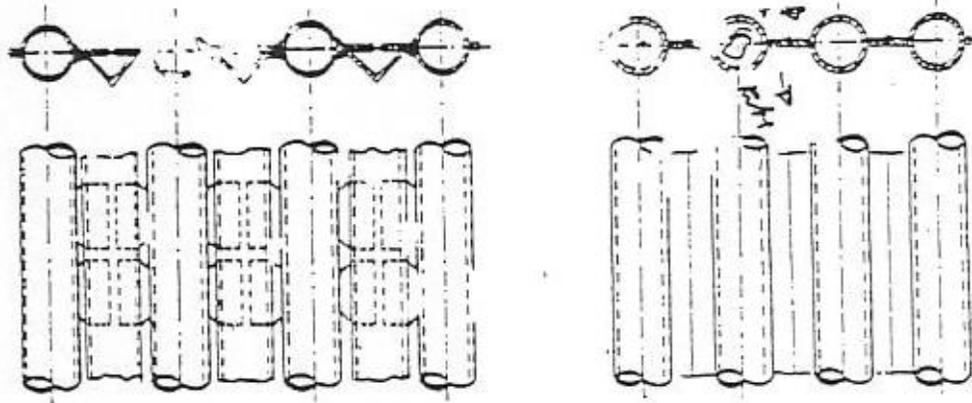
# Posizione corpi scambio Tubi ripidi – 1,2,3 giri



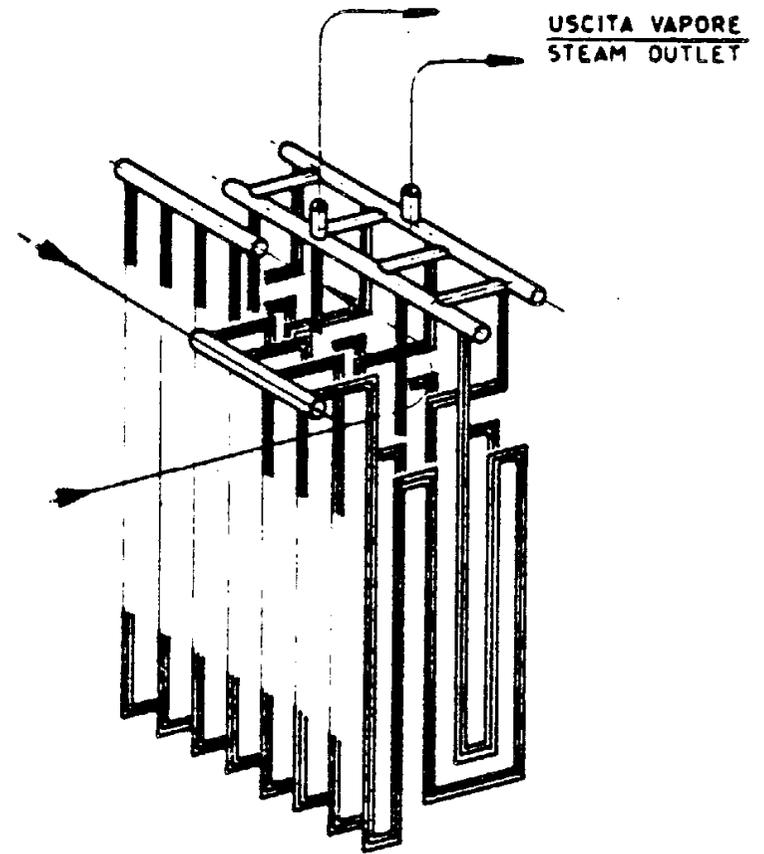
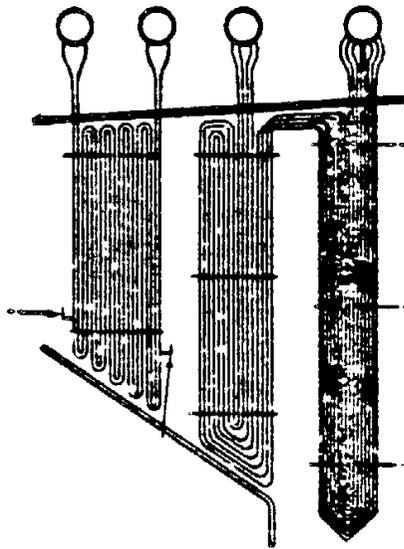
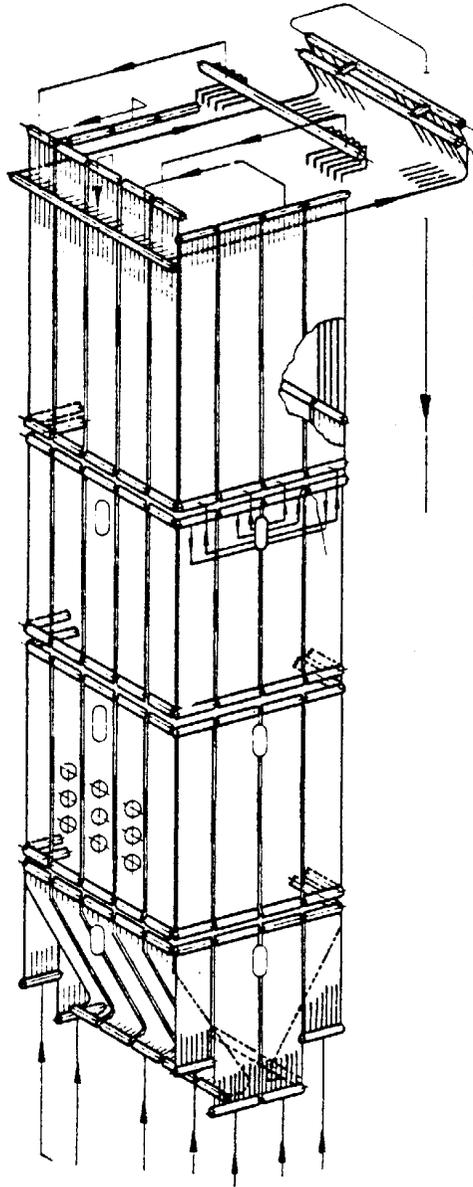
# Posizione corpi scambio Tubi suborizzontali – 1,2,3 giri



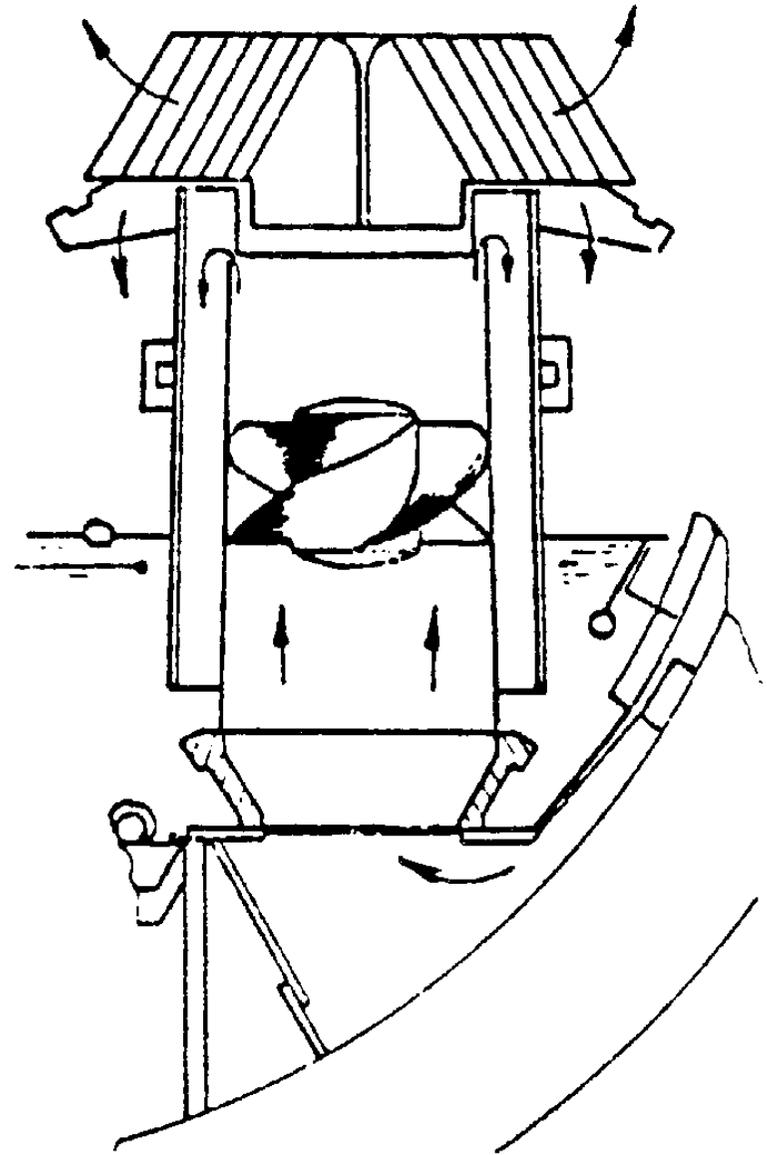
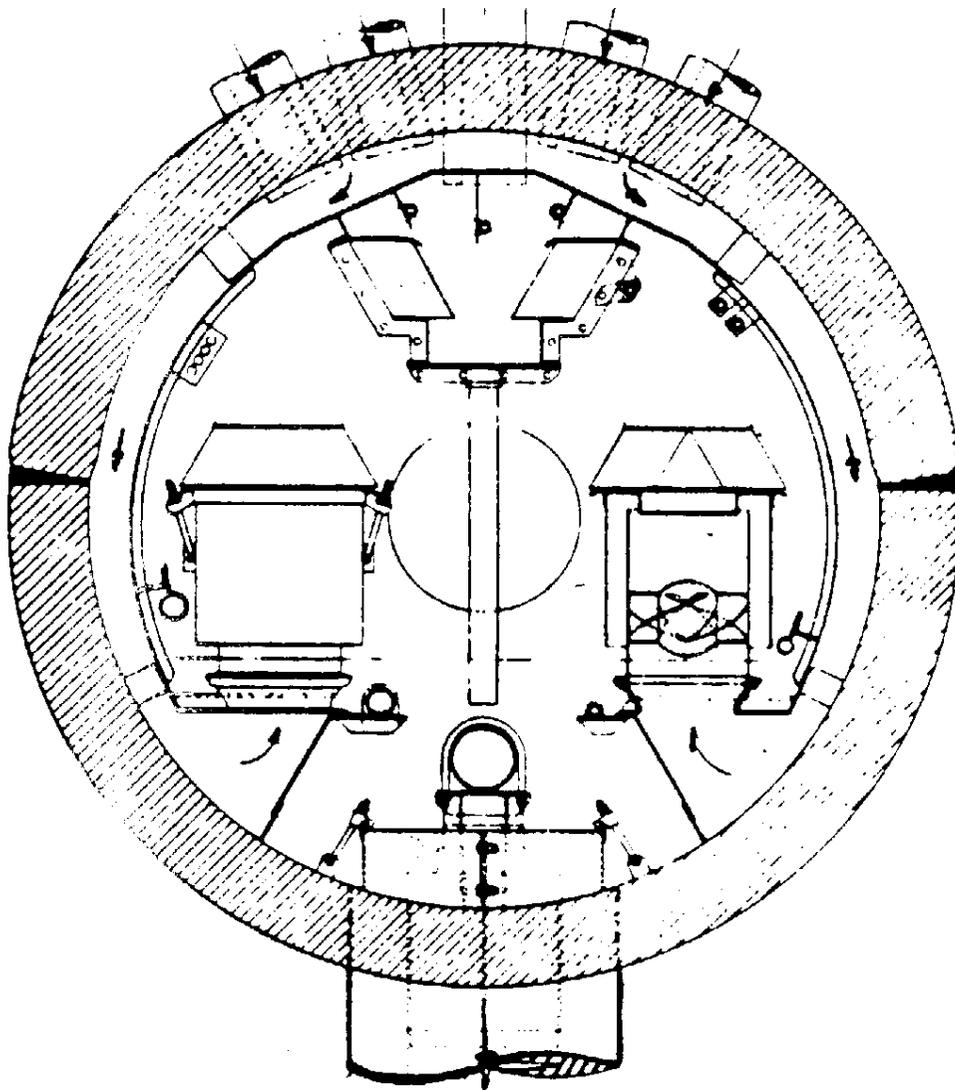
# Generatore di vapore



# Generatore di vapore



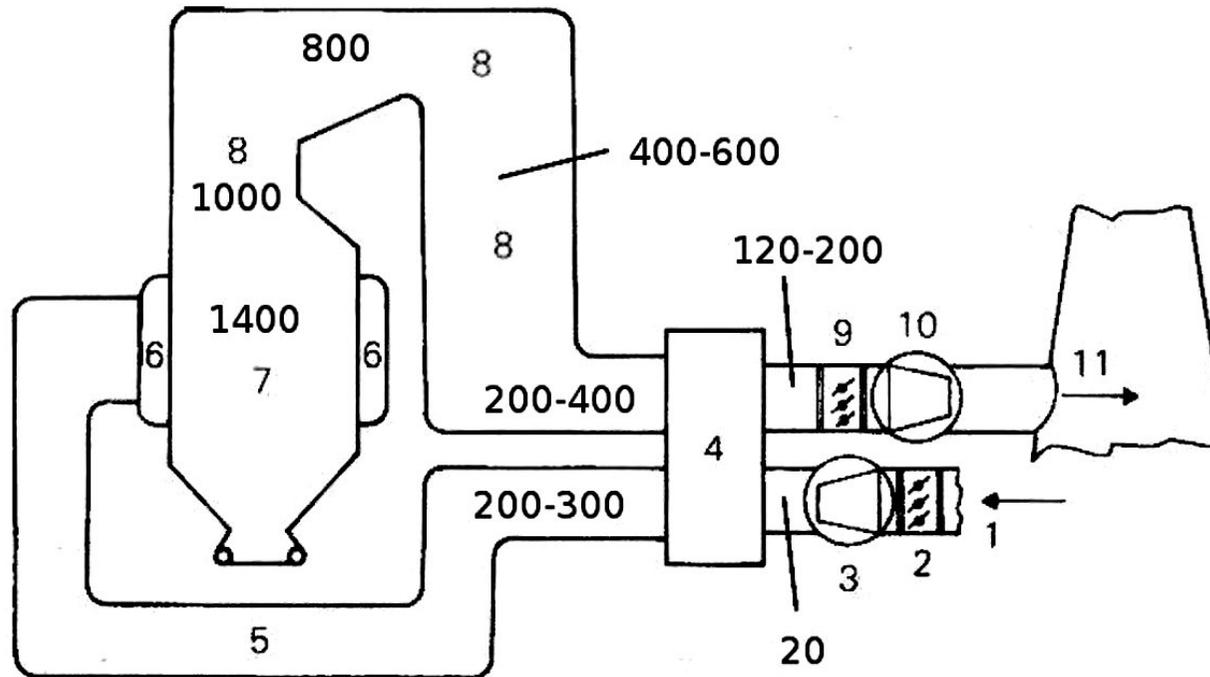
# Corpo cilindrico



# Parametri caldaie

		TIPI DI CALDAIE					
		A tubi di fumo	A corpo cilindrico a tubi d'acqua suborizzontali	A corpo cilindrico a tubi d'acqua subverticali	A corpo cilindrico a tubi d'acqua verticali con c. di c. a parete schermata	A corpo cilindrico a circolazione forzata	Monotubolari ad attraversamento forzato
potenzialità assoluta	t/h	< 50	100-300	200-600	300-2000	200-600	fino a 2000
pressione di esercizio	MPa	< 3,0	2,0-6,0	4,0-10,0	6,0-18,0	10-20	12,0-25,0
temperatura di esercizio	°C	200-300	300-400	300-500	400-550	500-550	500-550
rendimento termico	%	70-80	80-90	85-92	85-92	85-92	85-92
sup. totale di riscaldamento	m <sup>2</sup>	60-150	400-800	500-1500	500-3000	500-1500	fino a 2000
potenzialità specifica	kg/hm <sup>2</sup>	10-20	50-100	80-150	> 200	> 200	> 200
carico termico superf. c. di c.	kW/m <sup>2</sup>	10-20	50-150	150-250	250-350	50-350	250-350
carico termico volumetrico tot.	kW/m <sup>3</sup>	120-250	300-500	500-700	700-1000	700-1200	1000-1500
contenuto d'acqua	min	> 60	30-40	20-30	10-20	5-10	3-6
cifra di circolazione	—	—	10-20	8-15	5-10	8-3	1

# Circuito aria-fumi



## 1-6 percorso aria

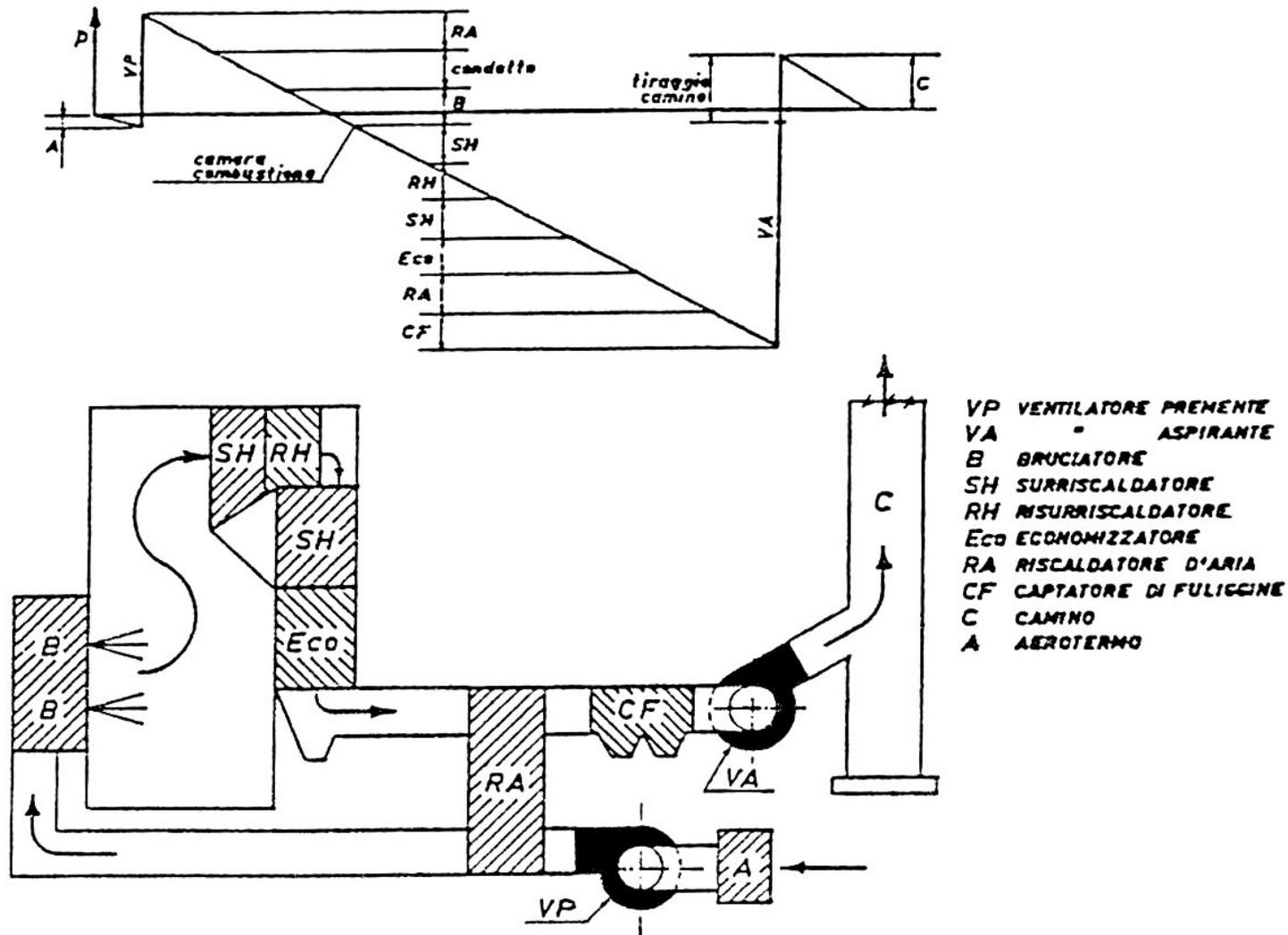
- 1 - aspirazione aria ambiente
- 2 - serrande di regolazione portata d'aria
- 3 - ventilatore premente
- 4 - preriscaldatore d'aria Ijungstrom
- 5 - condotti di distribuzione aria preriscaldata
- 6 - casse d'aria

## 7-11 percorso fumi

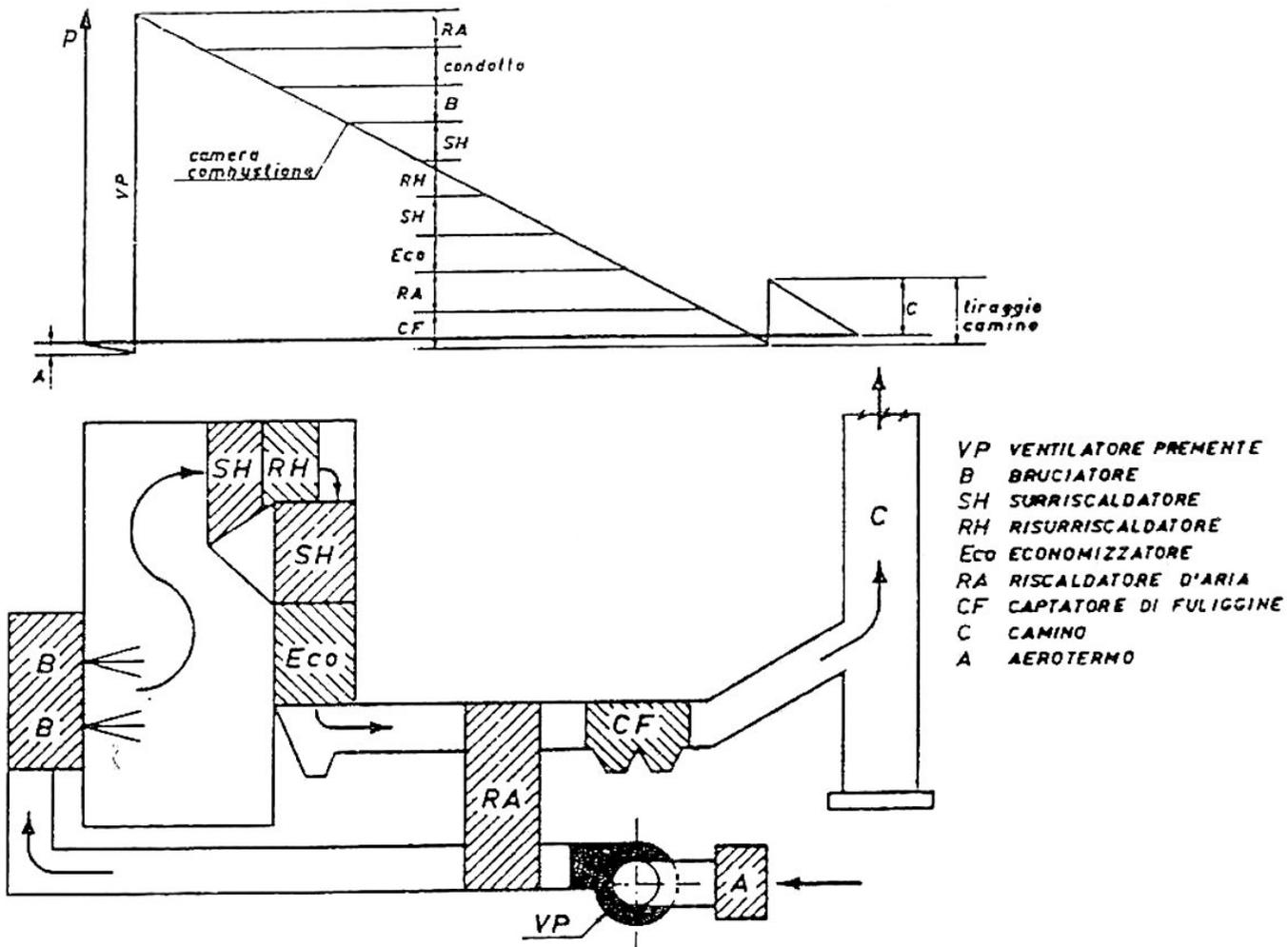
- 7 - camera di combustione
- 8 - condotti di scambio termico
- 9 - serrande di regolazione della depressione in c. di c.
- 10 - ventilatore aspirante
- 11 - camino

# Circuito aria-fumi

## Tiraggio bilanciato

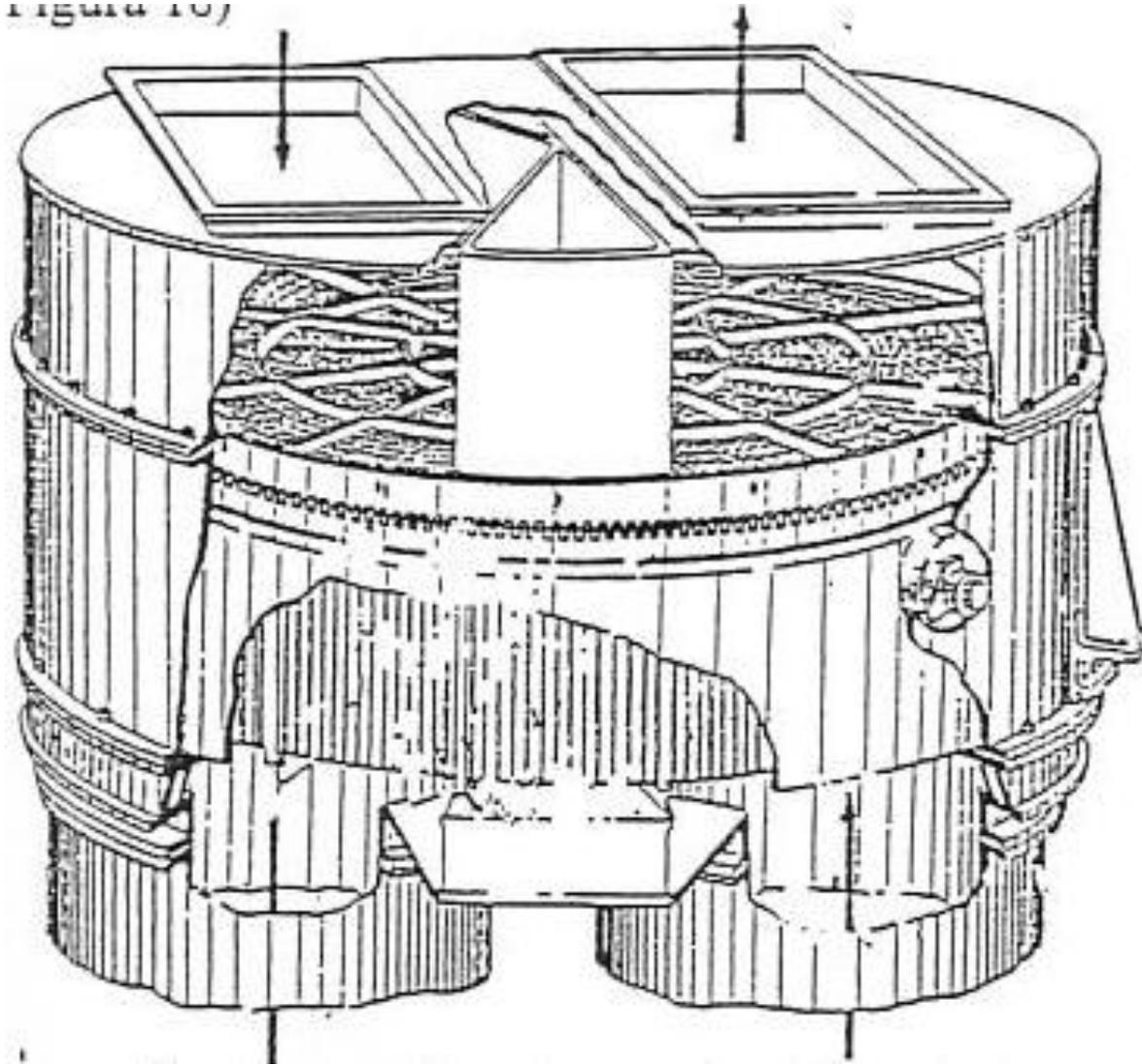


# Circuito aria-fumi Caldaia pressurizzata

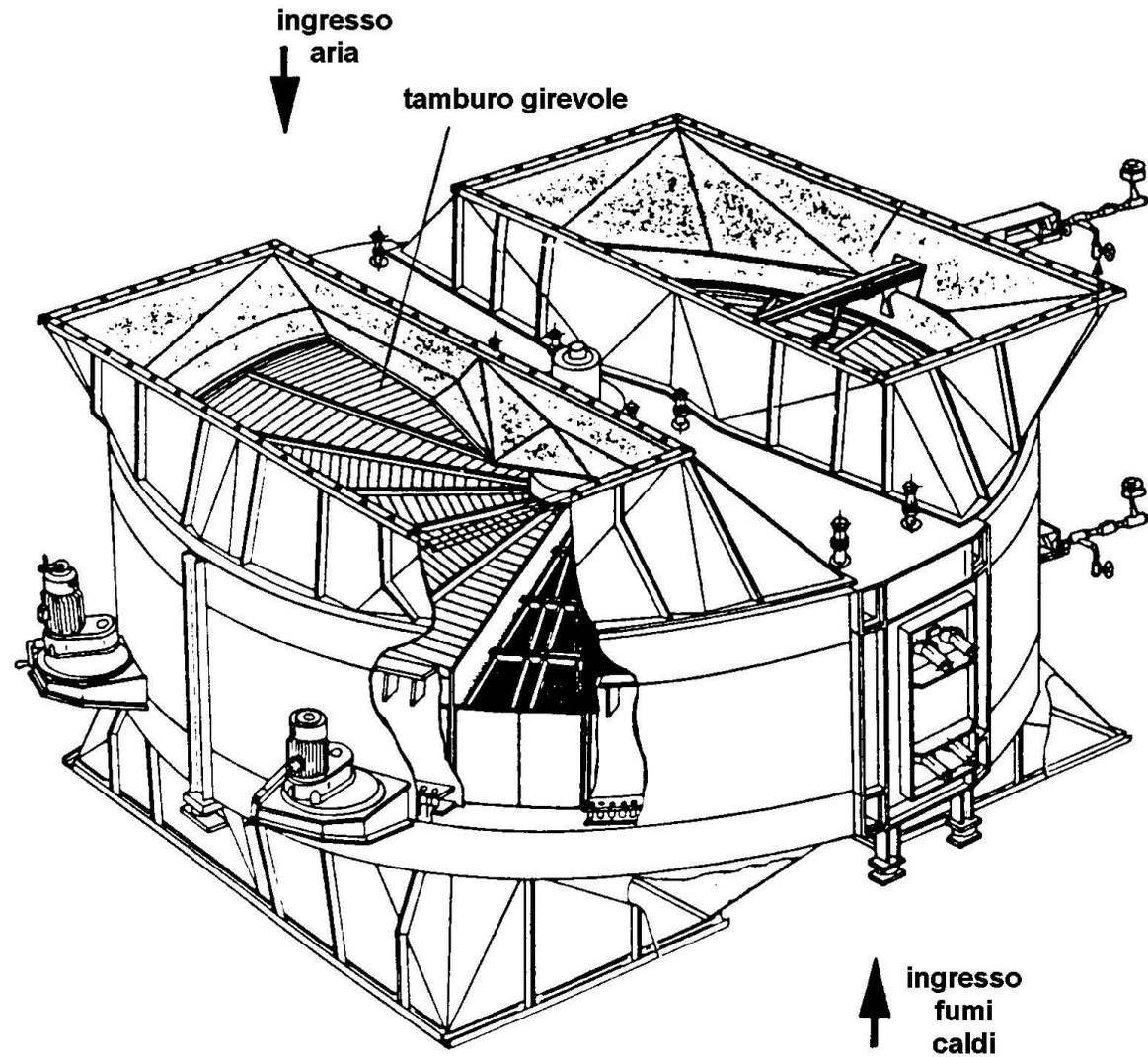


# Rigeneratore Ljungstrom

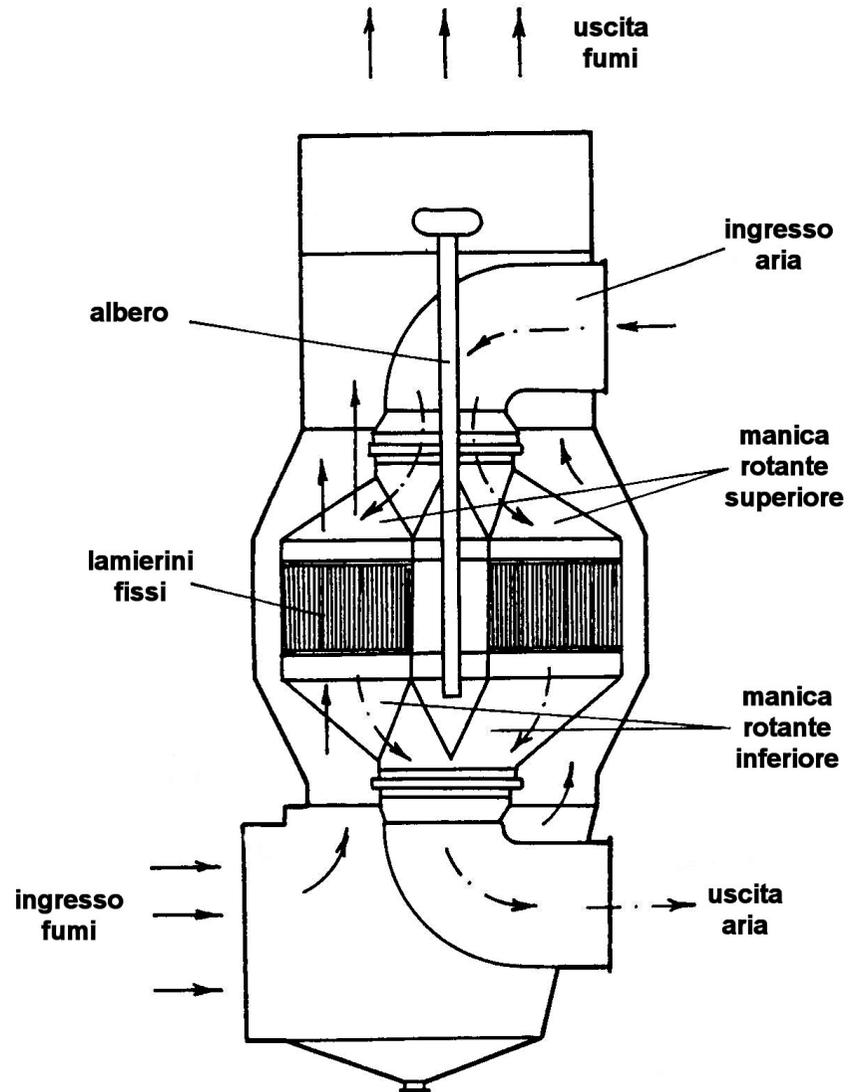
Figura 107



# Rigeneratore Ljungstrom



# Rigeneratore Rotemuhle



# Pulizia fumi

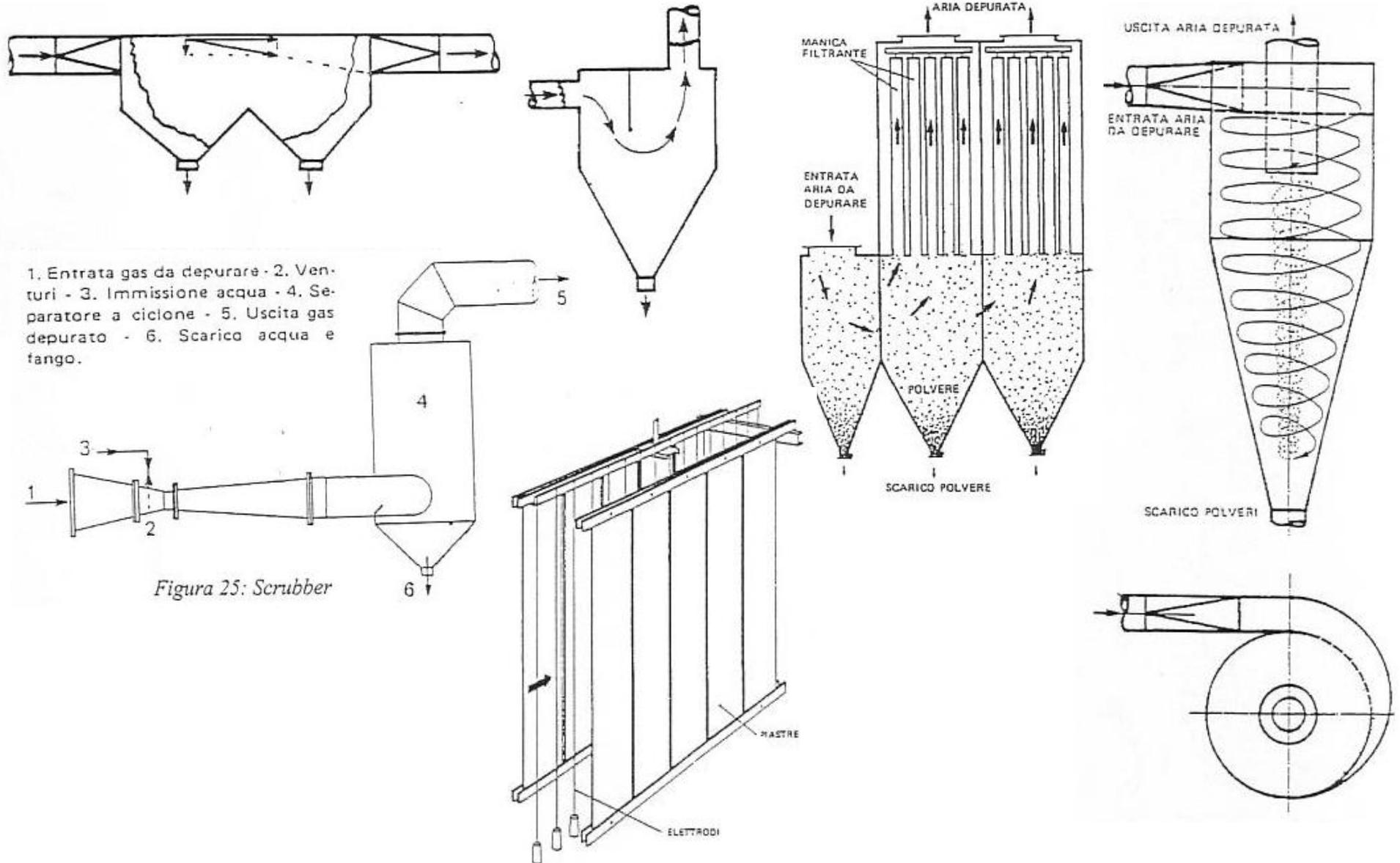
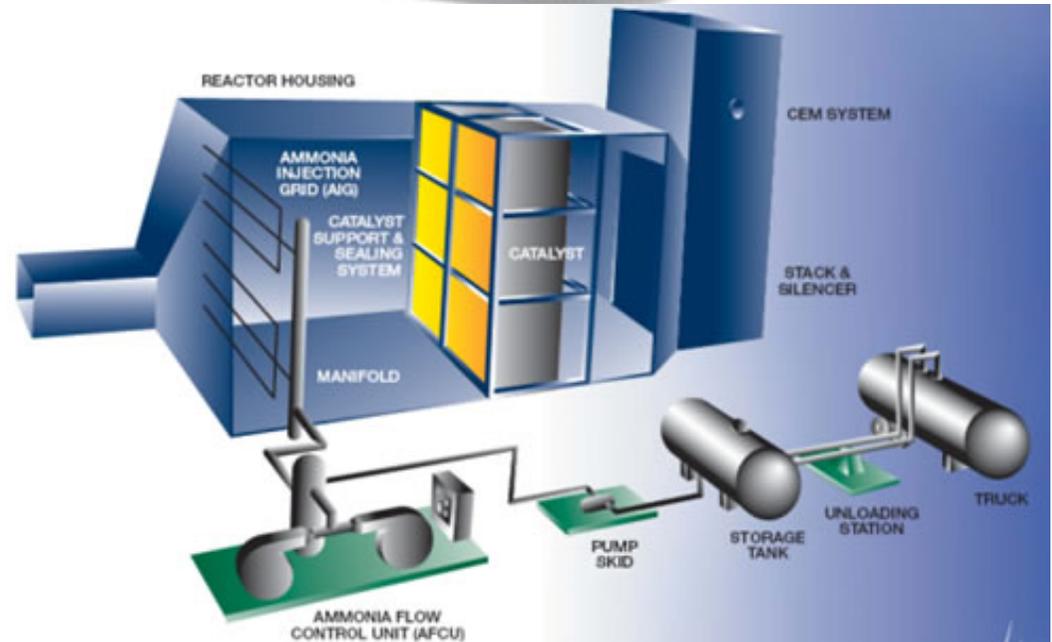
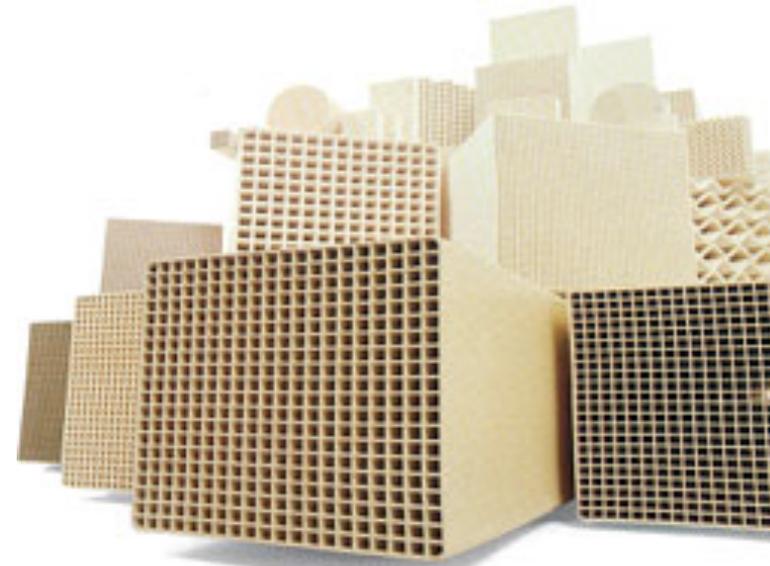
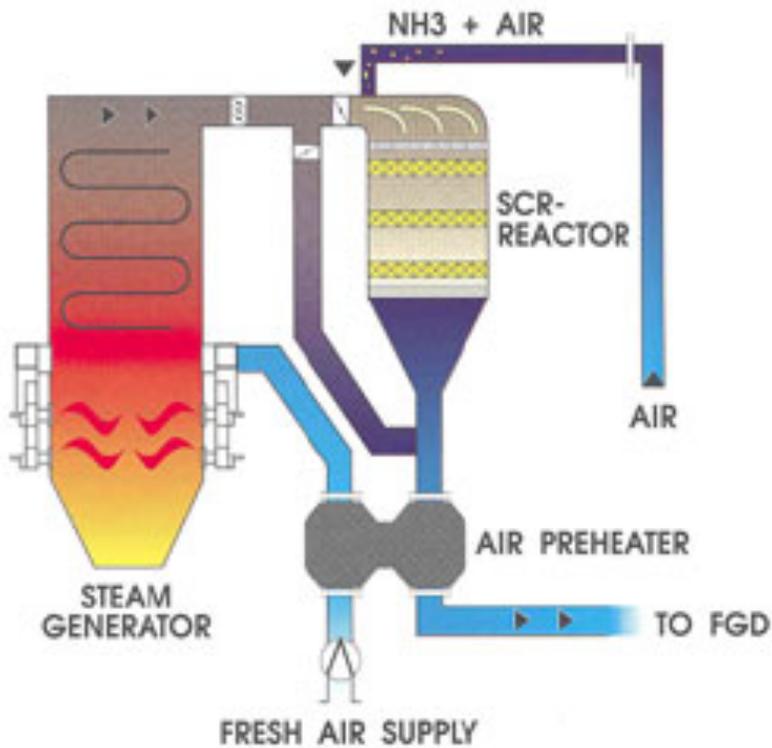
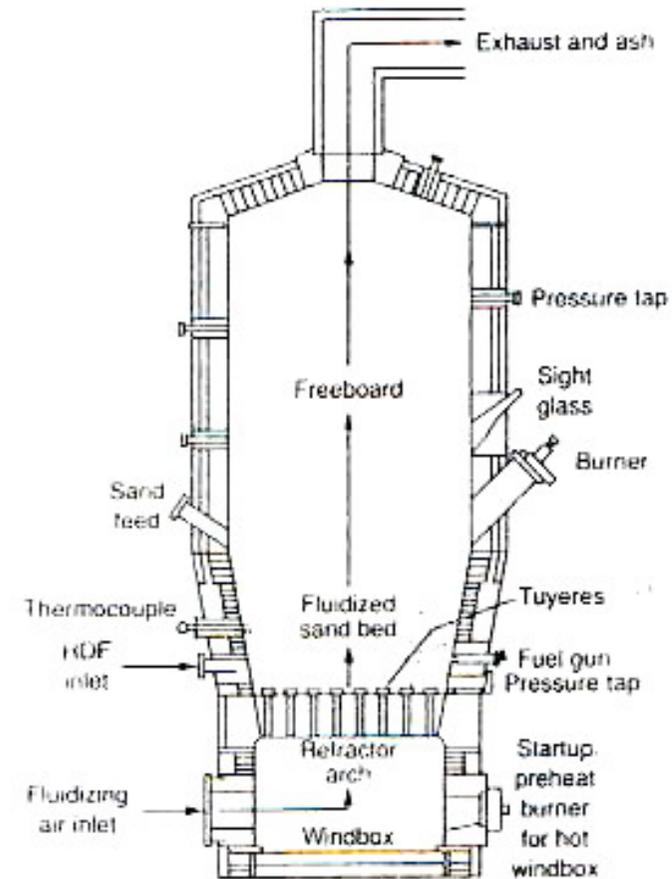
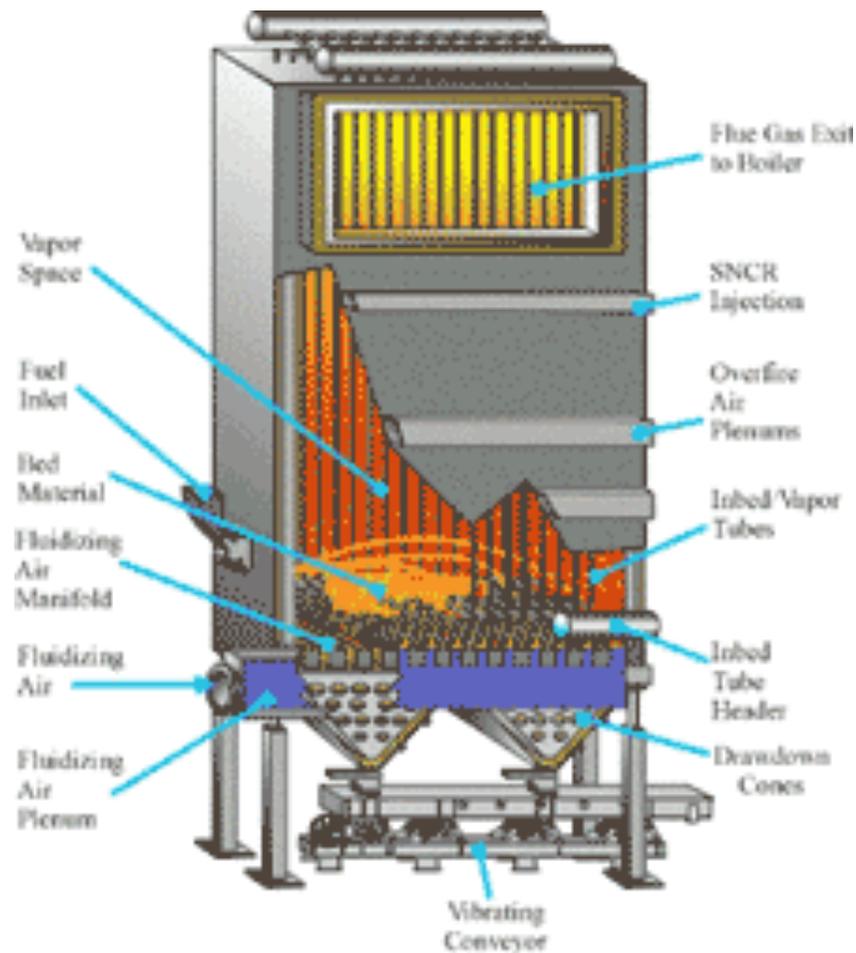


Figura 25: Scrubber

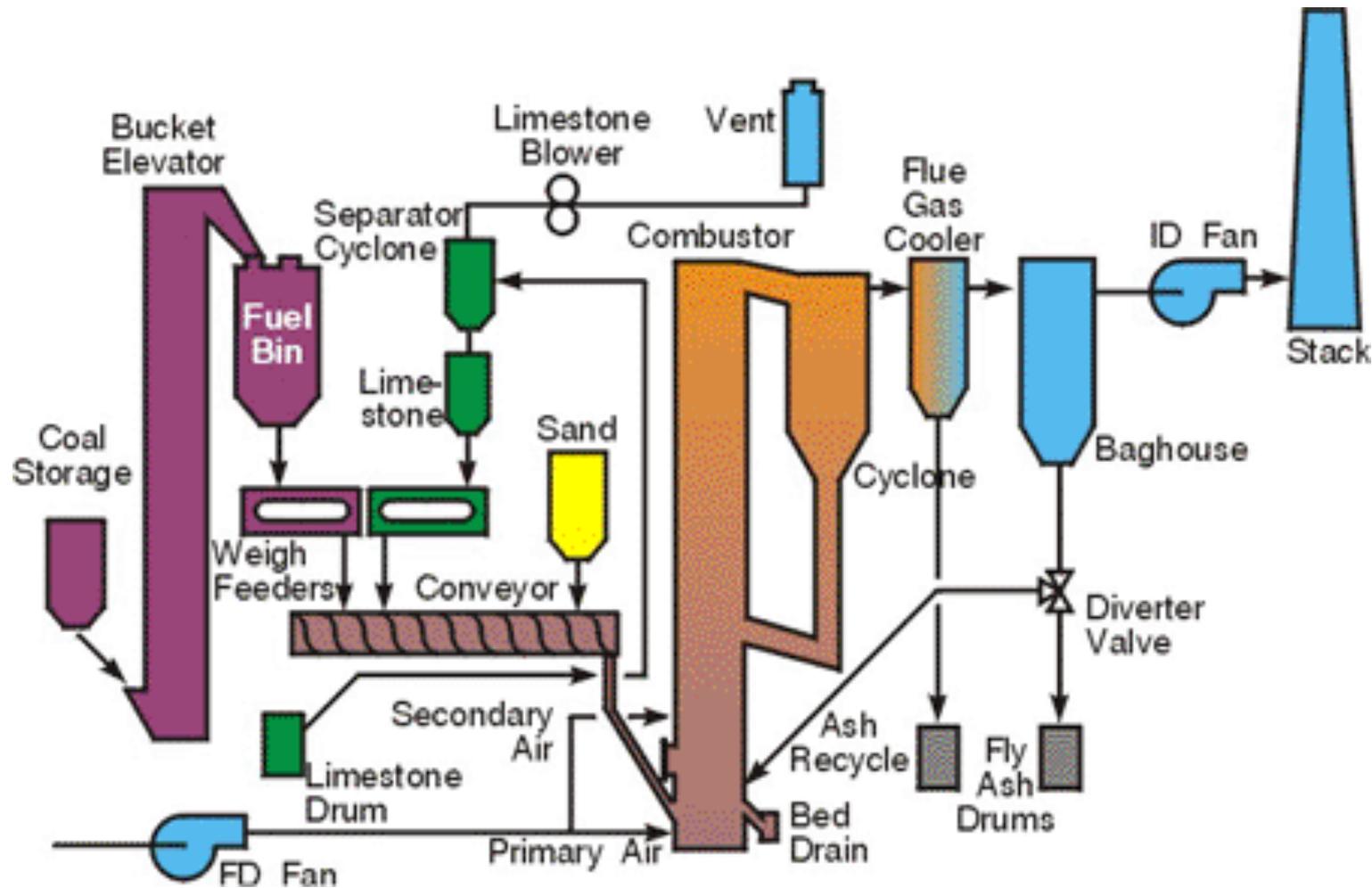
# Sistemi di riduzione NOx



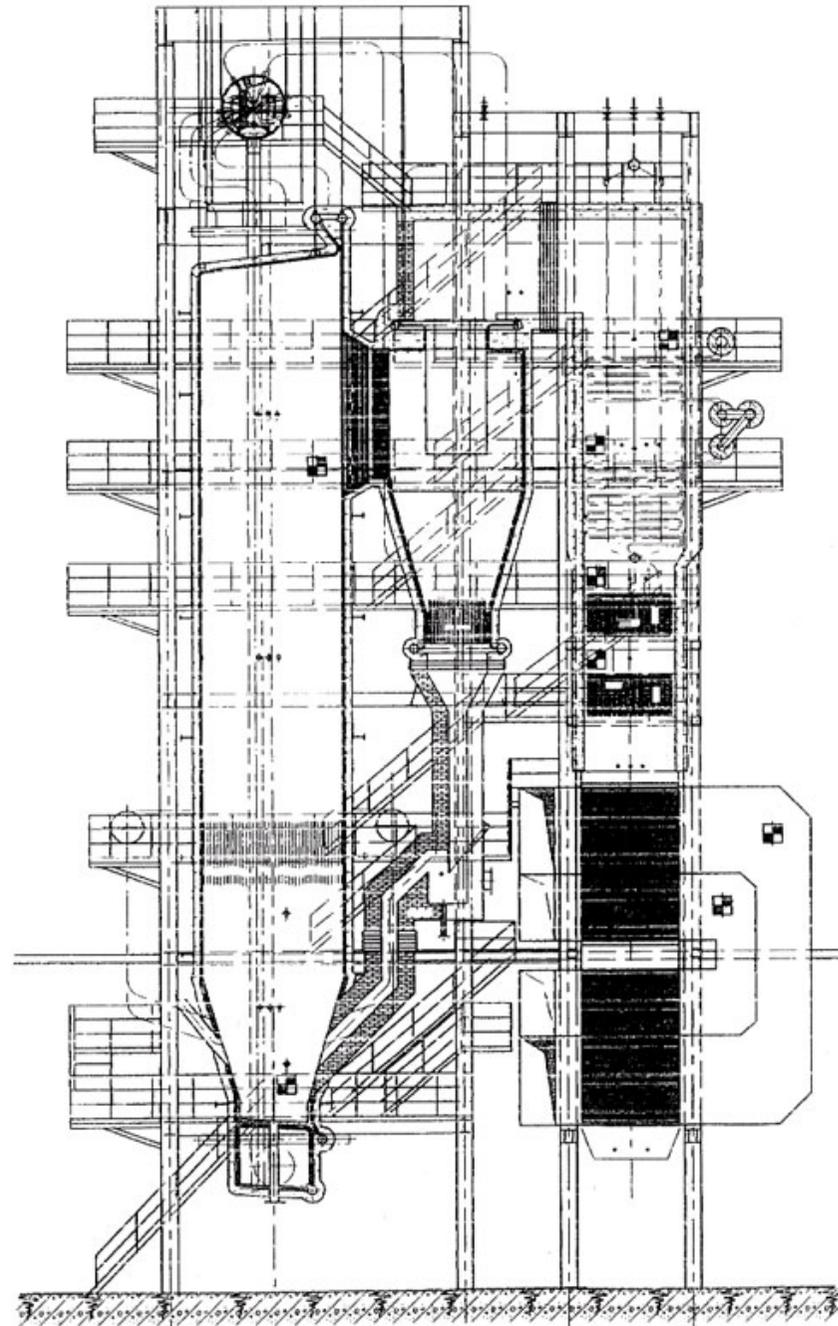
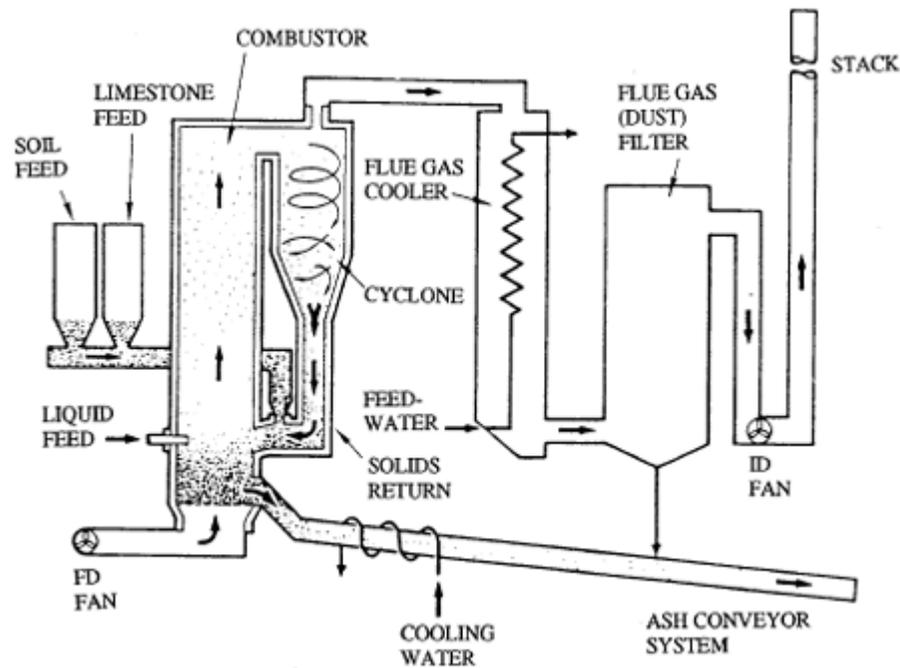
# Caldaia a letto fluido



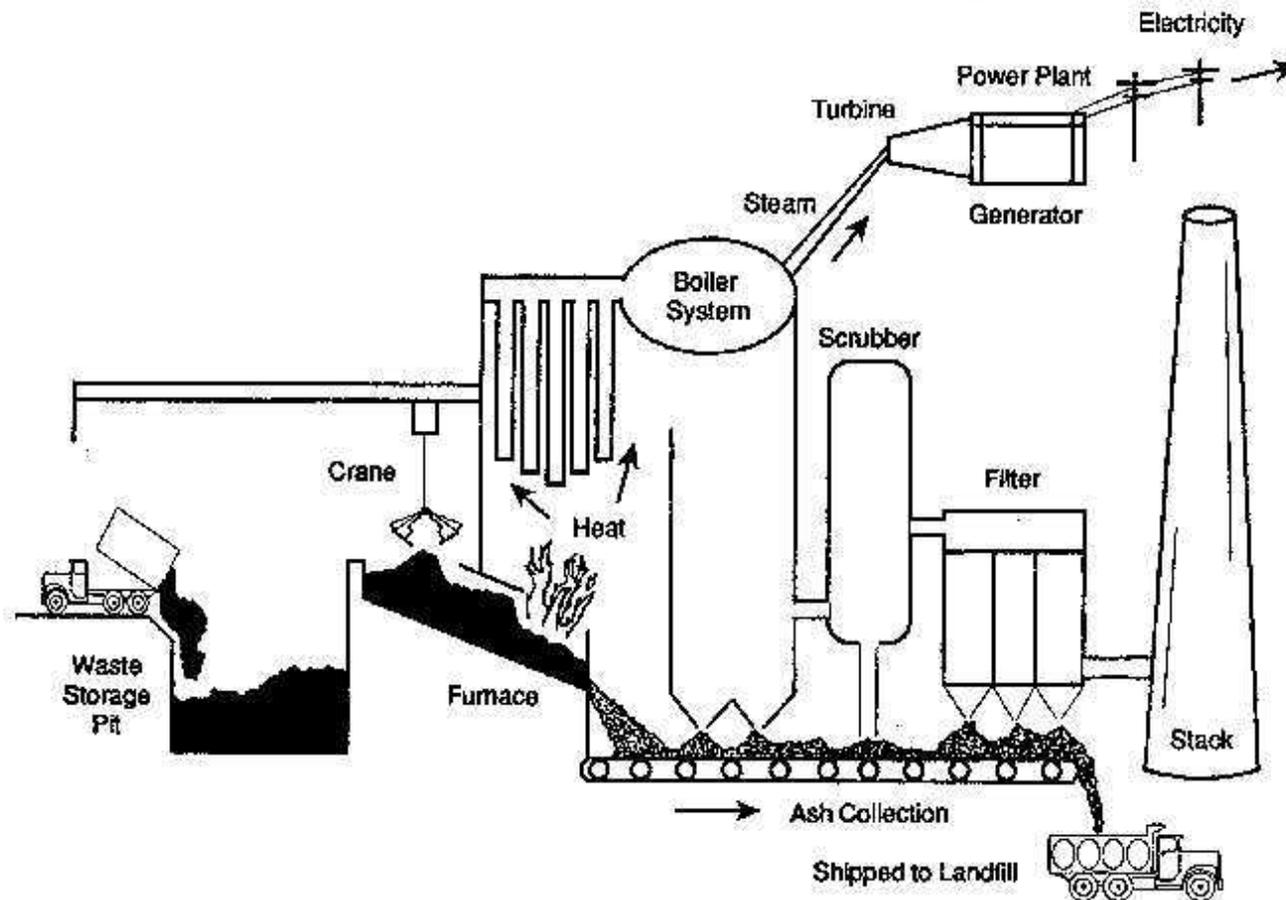
# Caldiaia a letto fluido circolante



# Letto fluido circolante



# Inceneritori

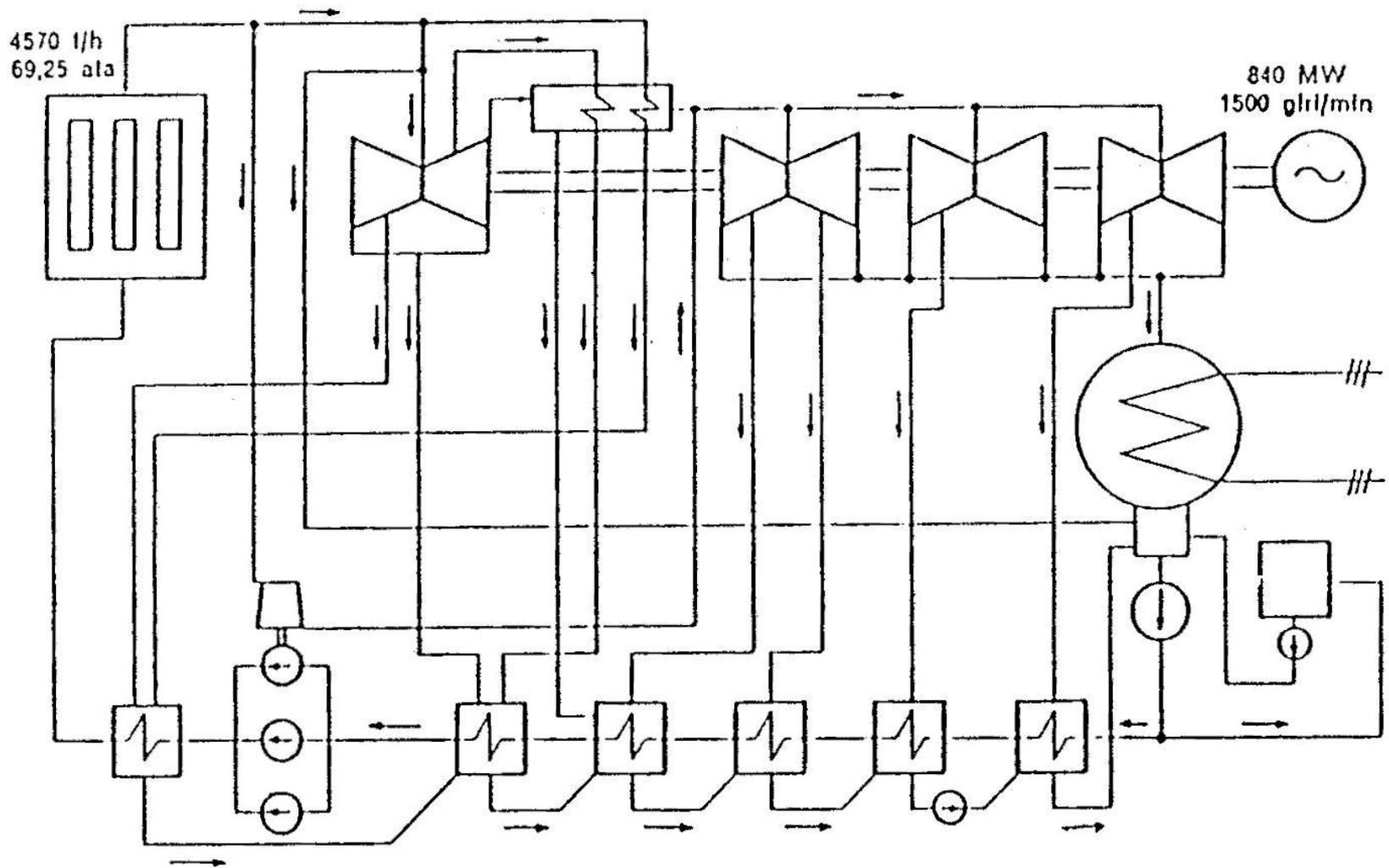


**Figure 13.** Mass burn waste-to-energy plant with pollution control system.  
*Source: EPA, Let's Reduce and Recycle.*

# Inceneritori

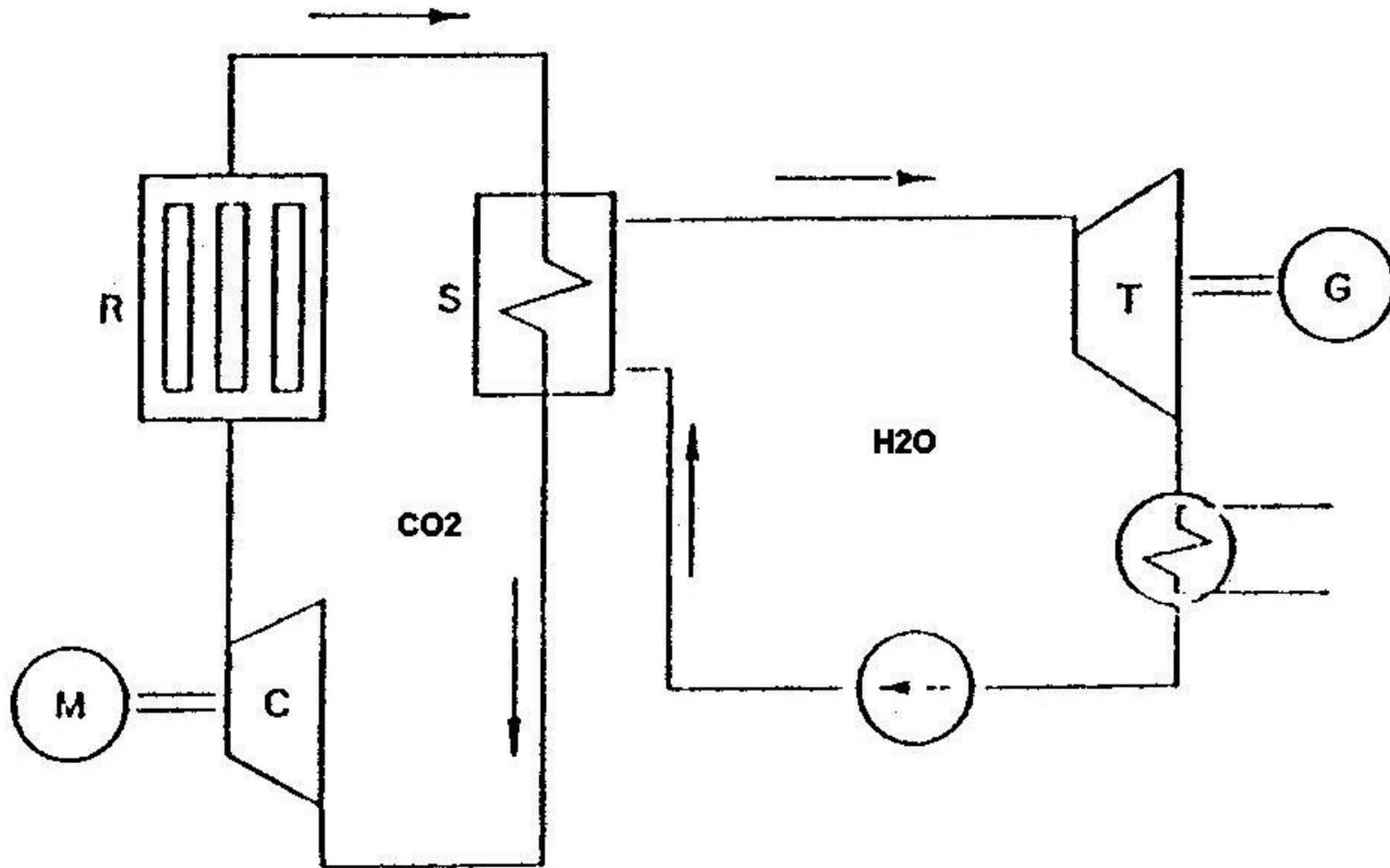


# Impianti Nucleari



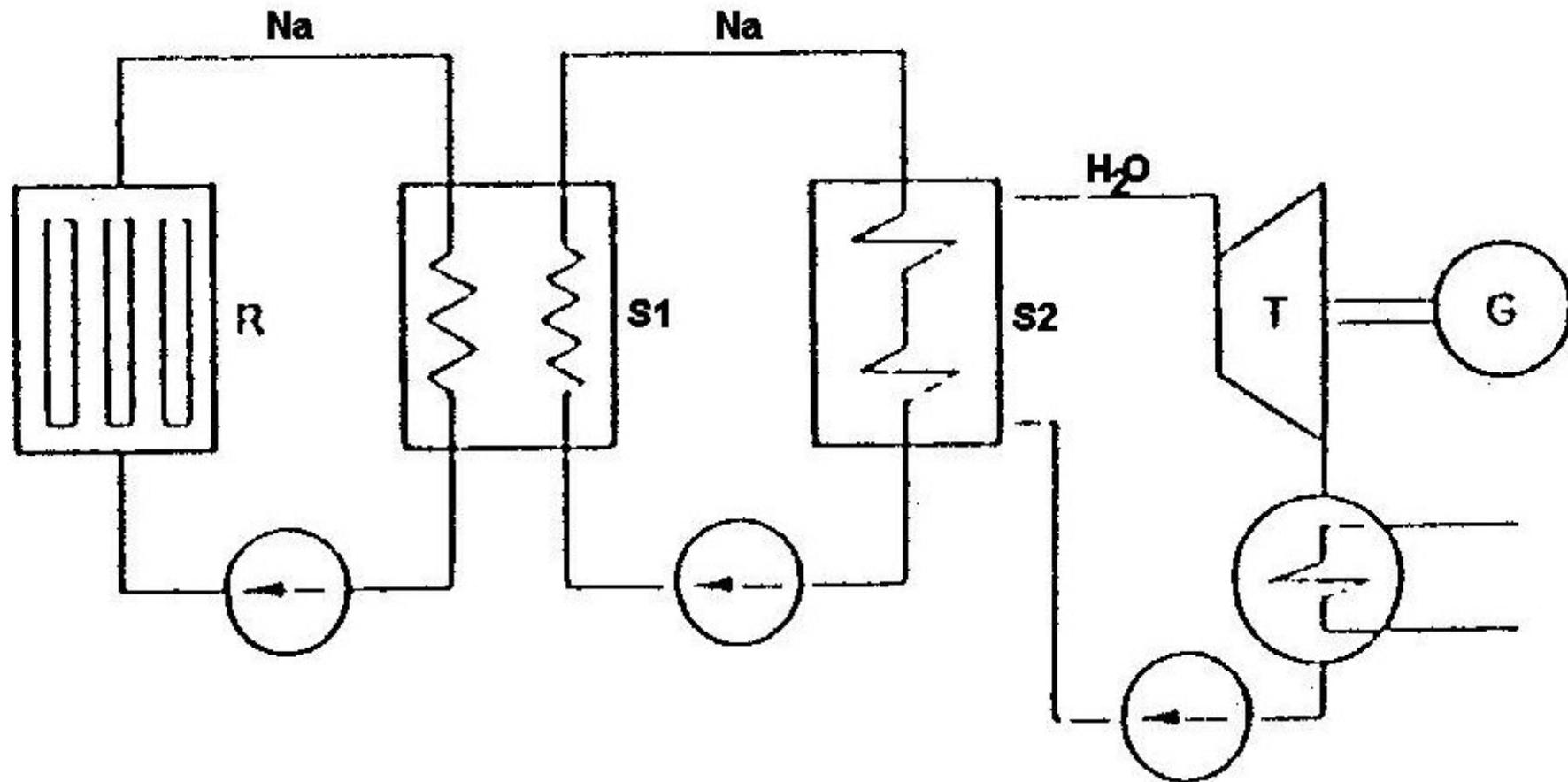
Centrale nucleotermoelettrica di Caorso

# Impianti nucleari



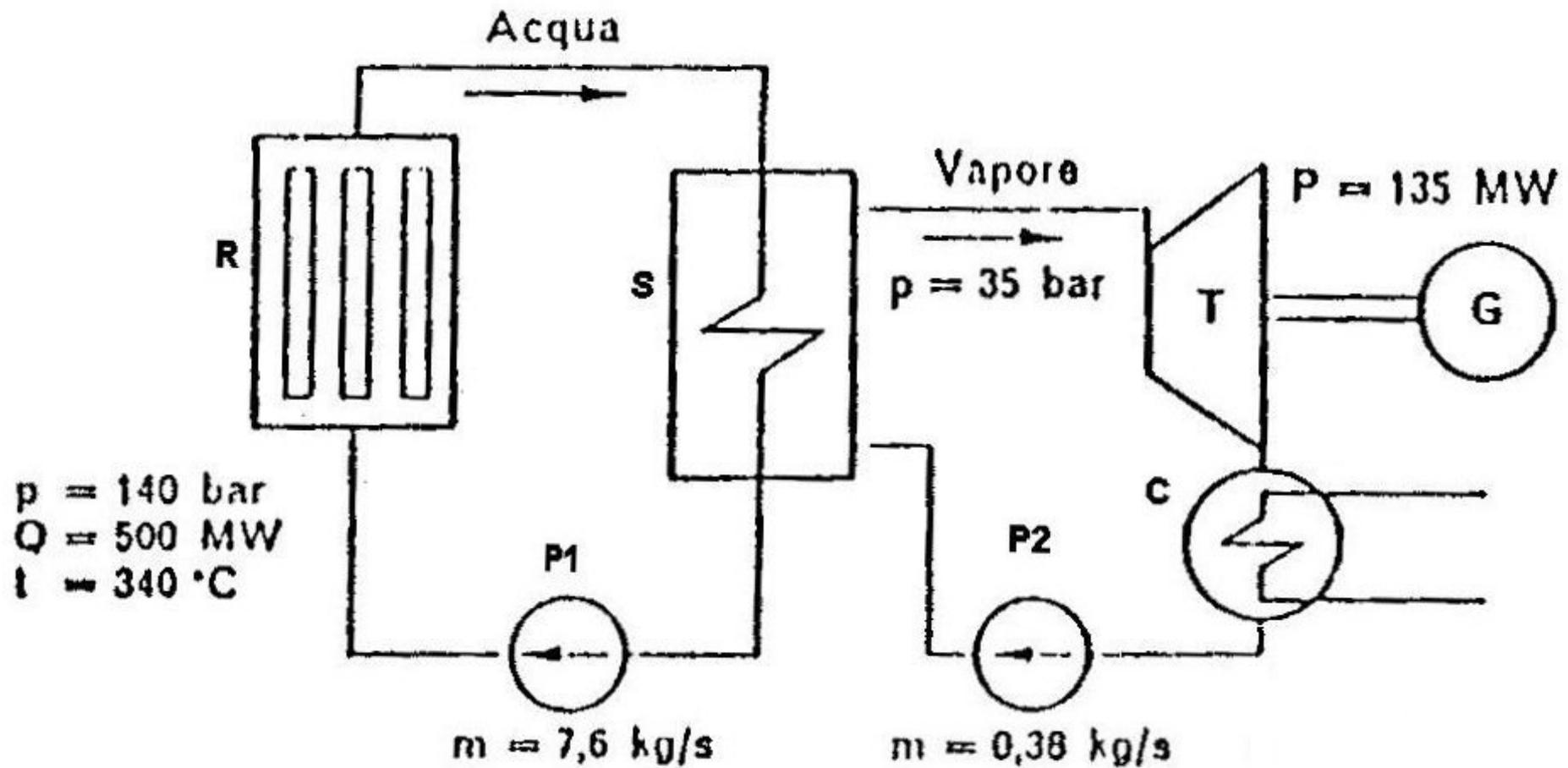
**R** reattore nucleare, **S** scambiatore generatore di vapore, **M** motore, **C** compressore circolatore per CO2  
**T** turbina a vapore, **G** generatore elettrico

# Impianti nucleari



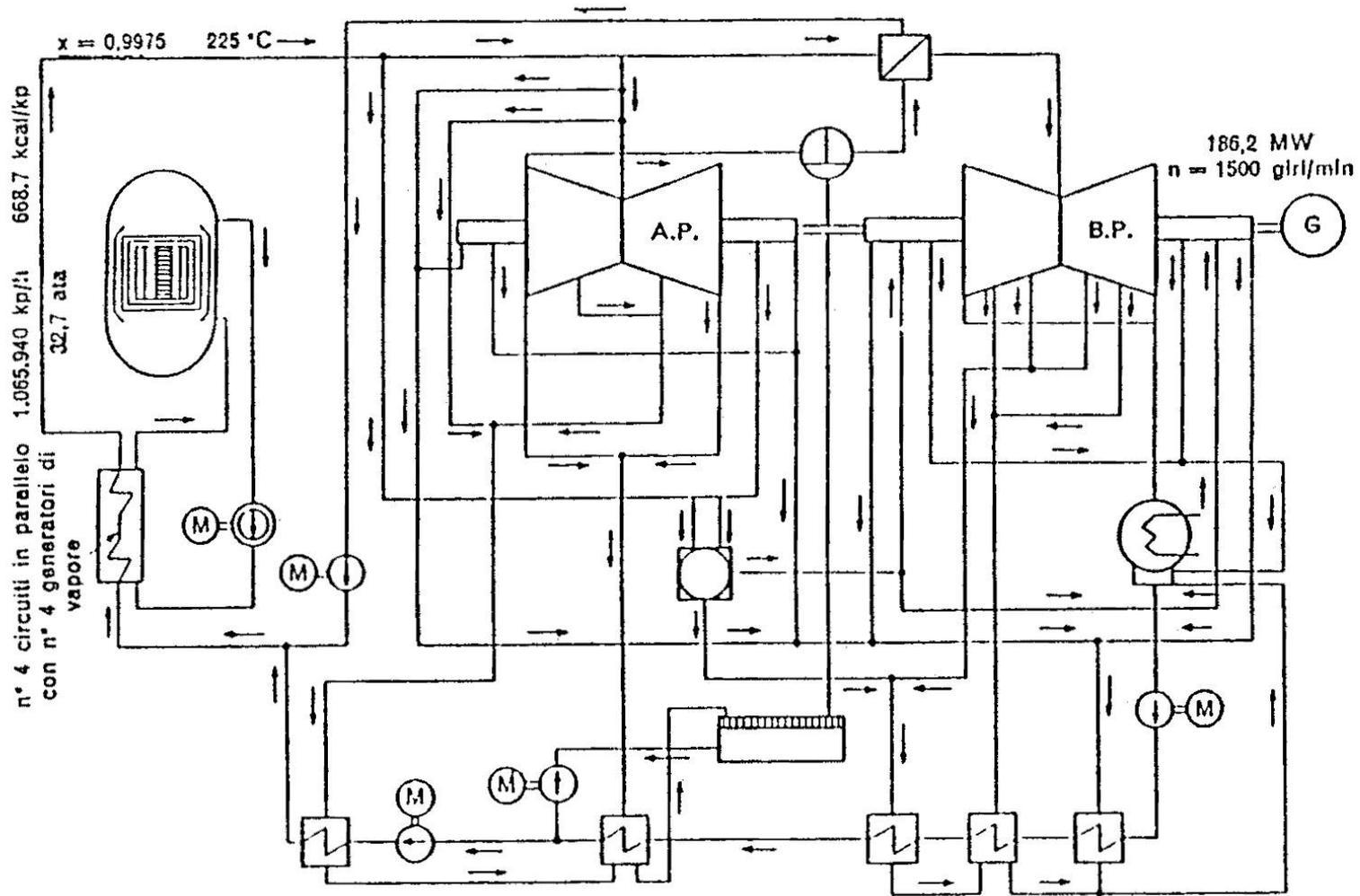
**R** reattore nucleare, **S1** scambiatore Na-Na, **S2** scambiatore Na-H<sub>2</sub>O generatore di vapore

# Impianti nucleari



**R** reattore nucleare, **S** scambiatore generatore di vapore, **P1** pompa del circuito primario  
**T** turbina, **G** generatore, **C** condensatore, **P2** pompa del circuito secondario

# Impianti nucleari



Centrale nucleotermoelettrica di Trino Vercellese

# Turbina a vapore

