

BRODSKI RASHLADNI UREĐAJI

BS 3

Ostale primjene na brodu

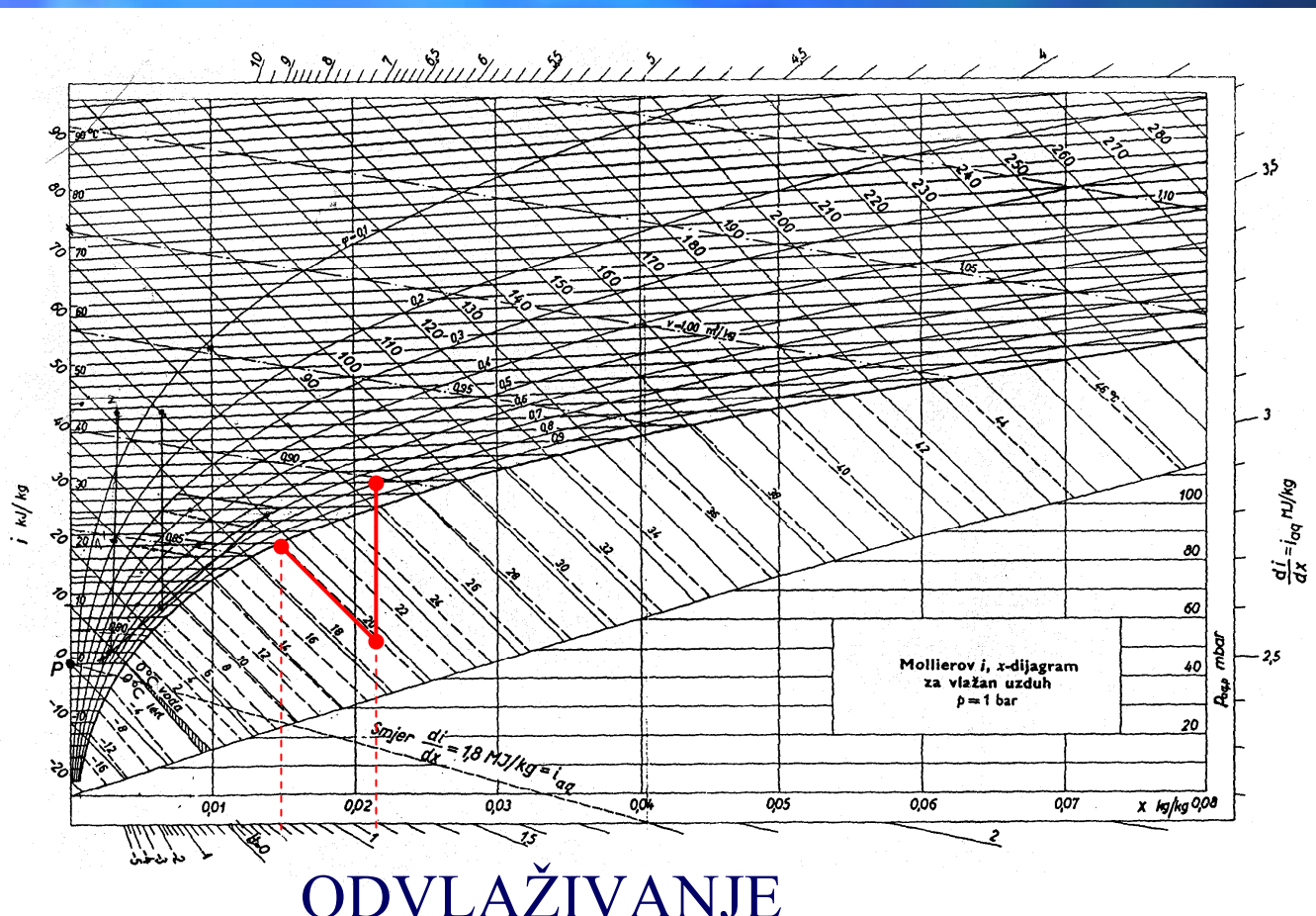
Ostale primjene

- sustav klimatizacije
- sustav hlađenja na brodovima za prijevoz ukapljenog plina (LPG, LNG)
- sustav hlađenja skladišta
- rashladni sustav kontejnera
- rashladni sustav za pothlađivanje i zamrzavanje ribe
- rashladni sustav niskotlačnog CO₂

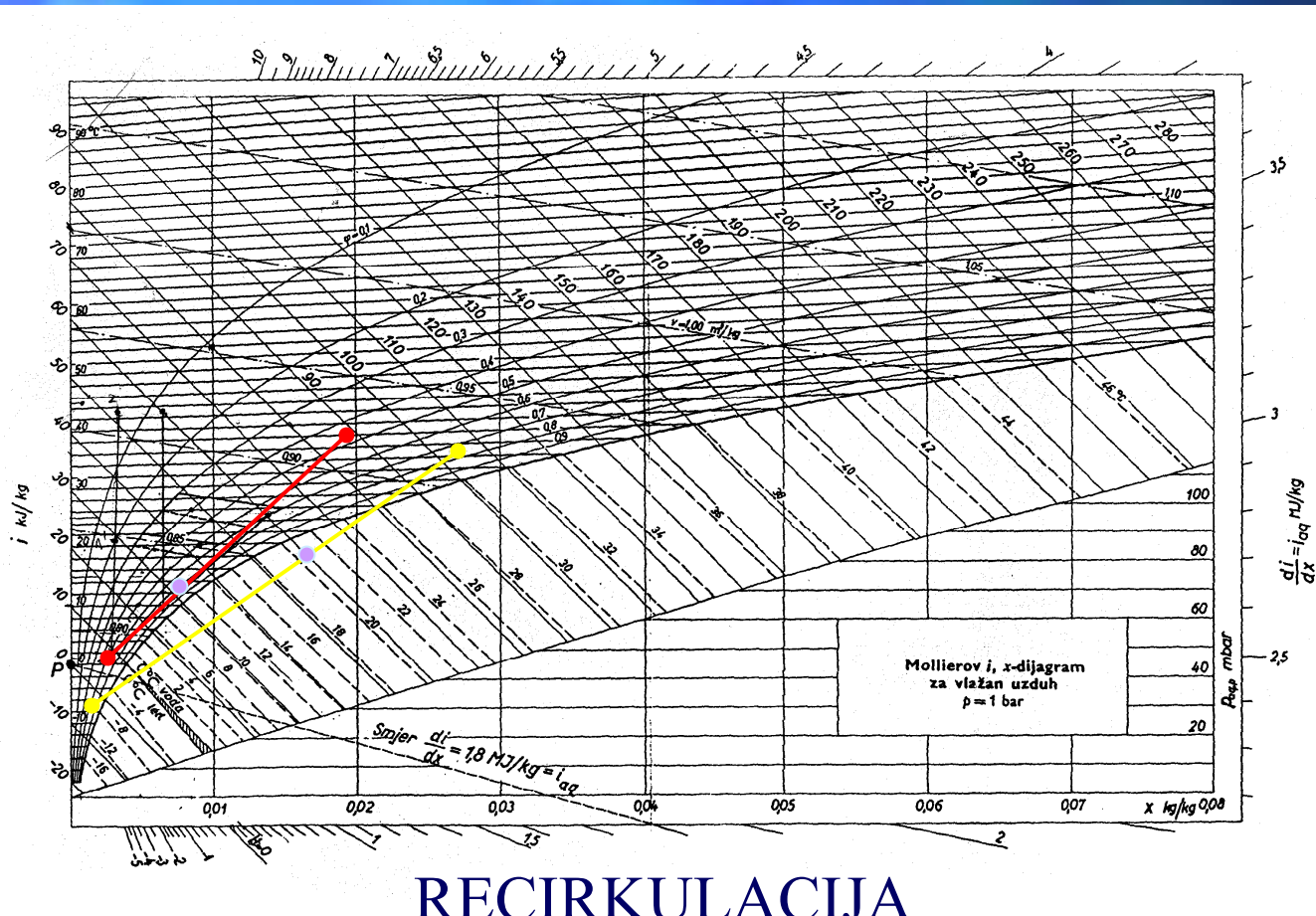
Klimatizacija

- nadgrađa
- kontrolne prostorije strojarnice
- drugih prostora

Vlažni zrak - hlađenje

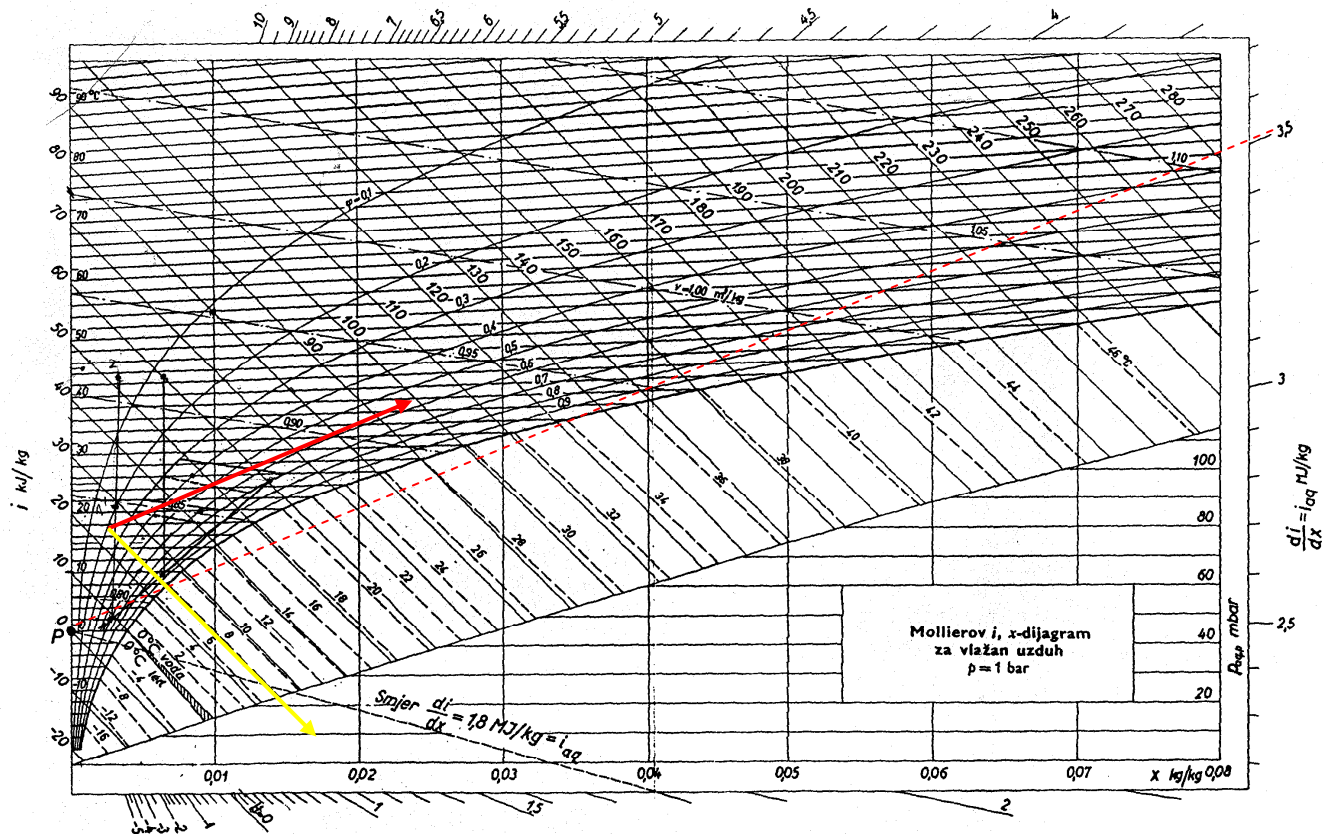


Vlažni zrak - miješanje



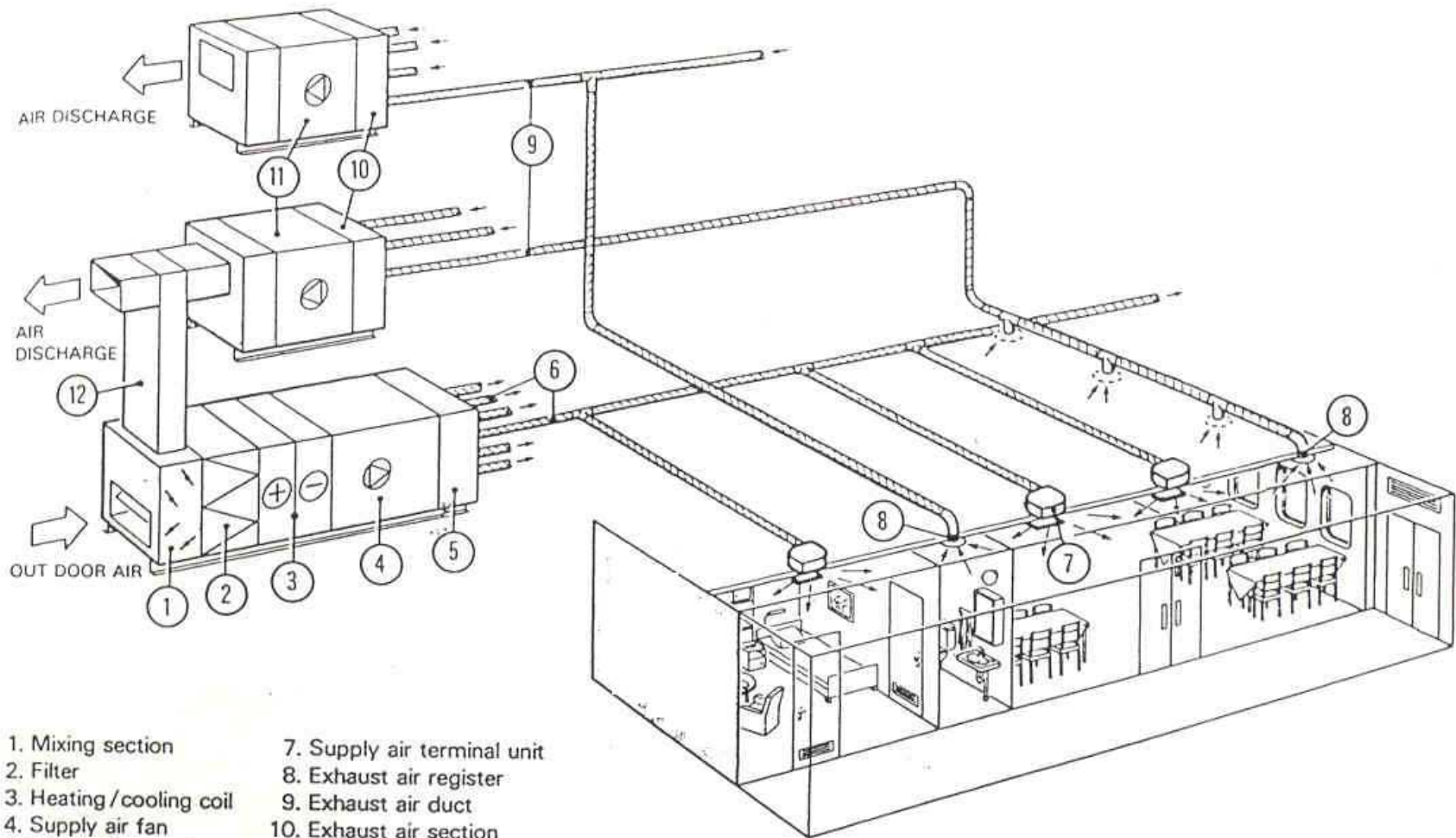
RECIRKULACIJA

Vlažni zrak–vodena para, voda

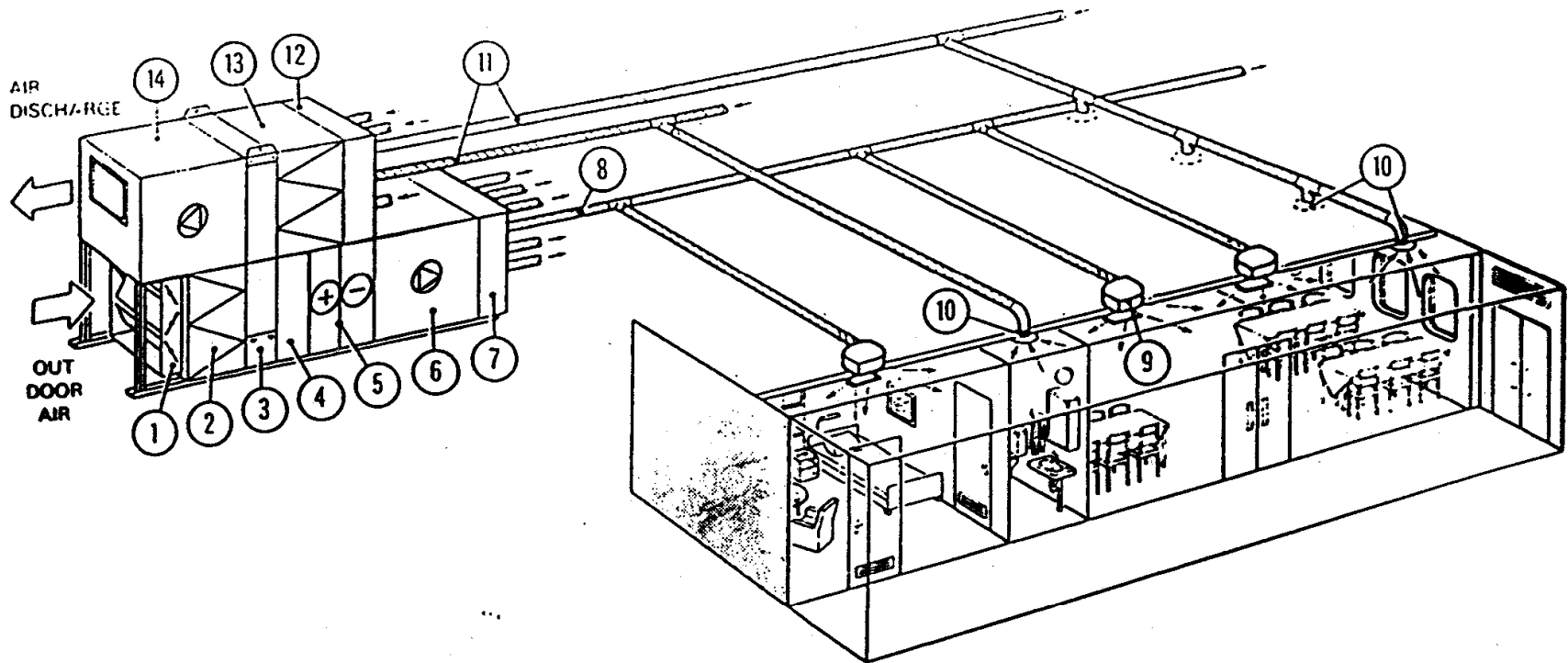


Centralna klima jedinica - sustavi

- Jednocijevni sustav
 - jedno-, dvo- ili višezonski
 - recirkulacija ili regeneracija
 - s elektr. dogrijavanjem
- Dvocijevni
 - recirkulacija ili regeneracija
- Skladišta, kuhinje, ECR

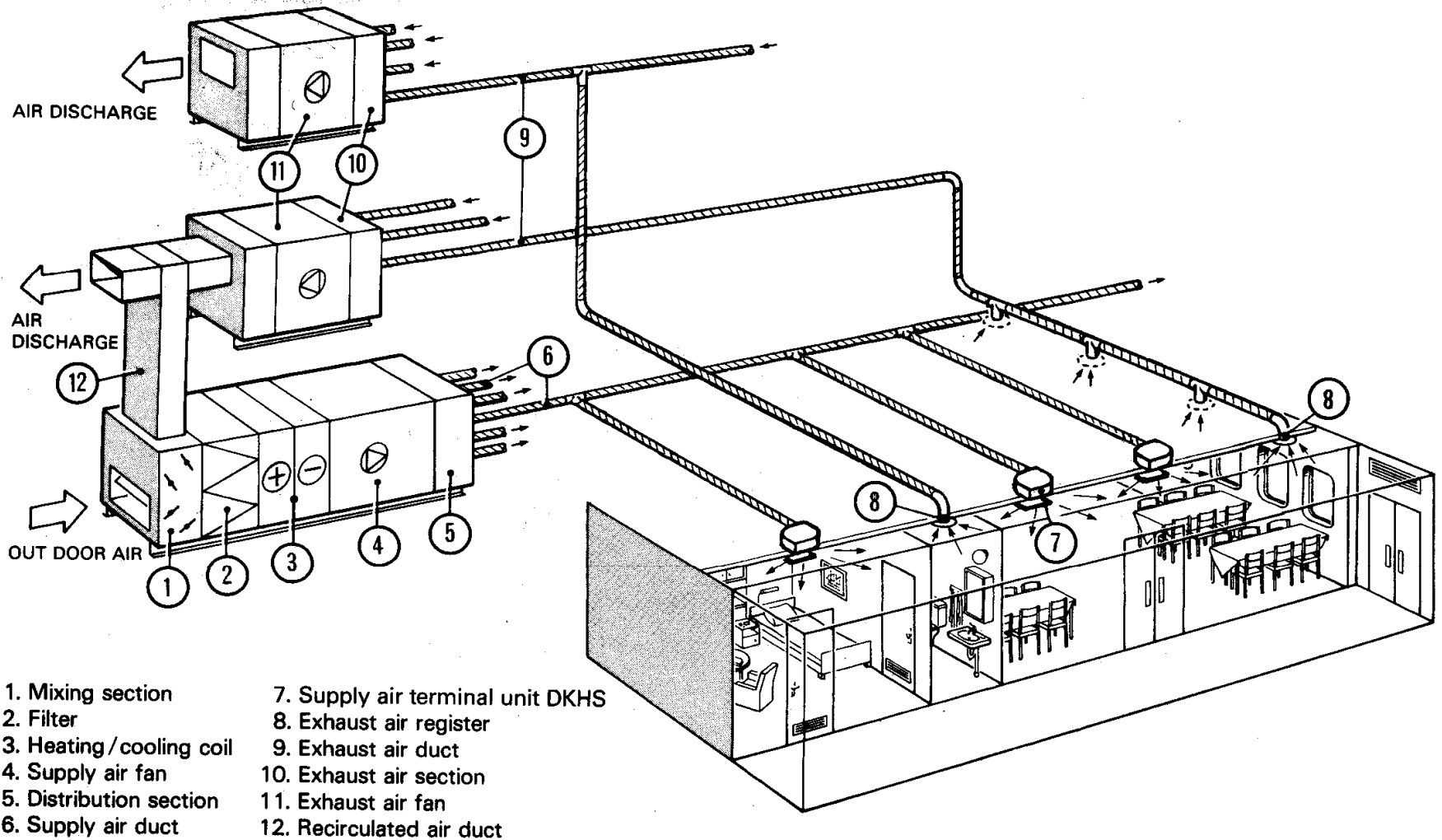


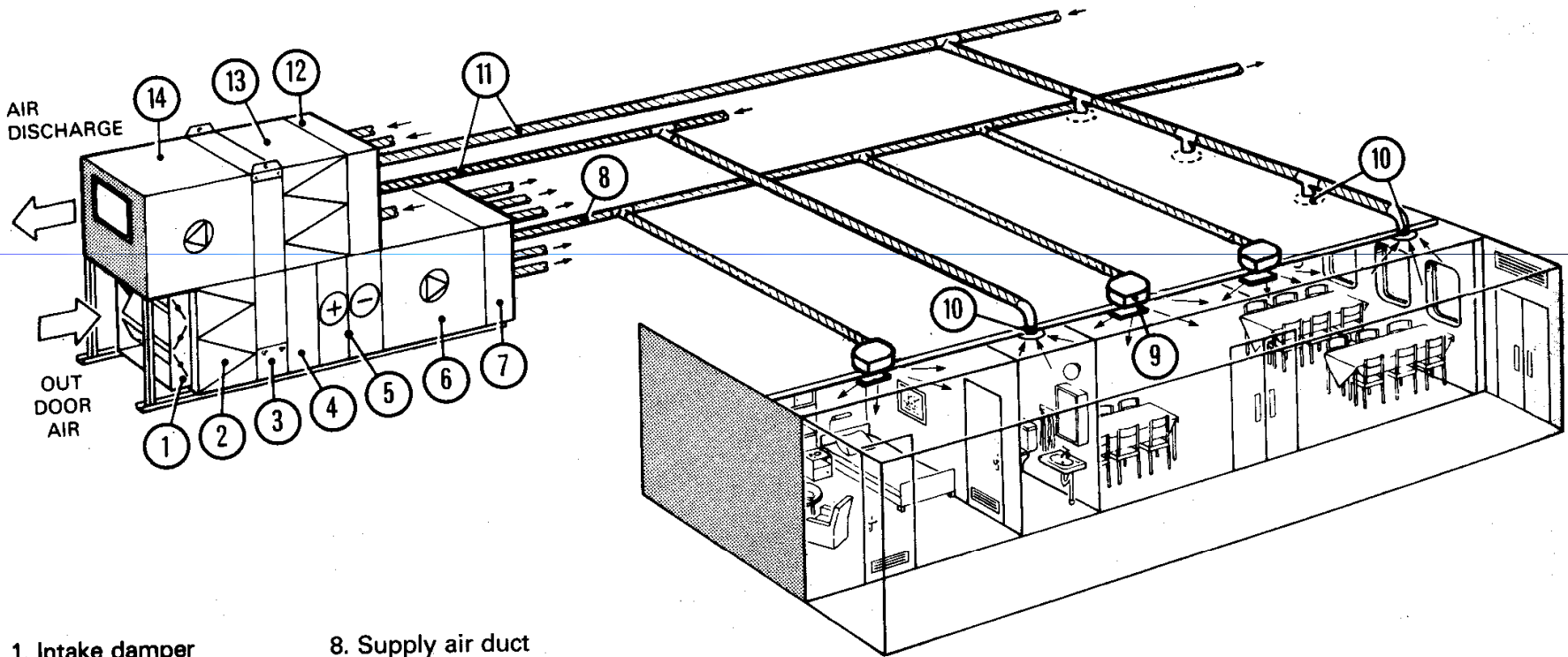
- | | |
|--------------------------|-----------------------------|
| 1. Mixing section | 7. Supply air terminal unit |
| 2. Filter | 8. Exhaust air register |
| 3. Heating /cooling coil | 9. Exhaust air duct |
| 4. Supply air fan | 10. Exhaust air section |
| 5. Distribution section | 11. Exhaust air fan |
| 6. Supply air duct | 12. Recirculated air duct |



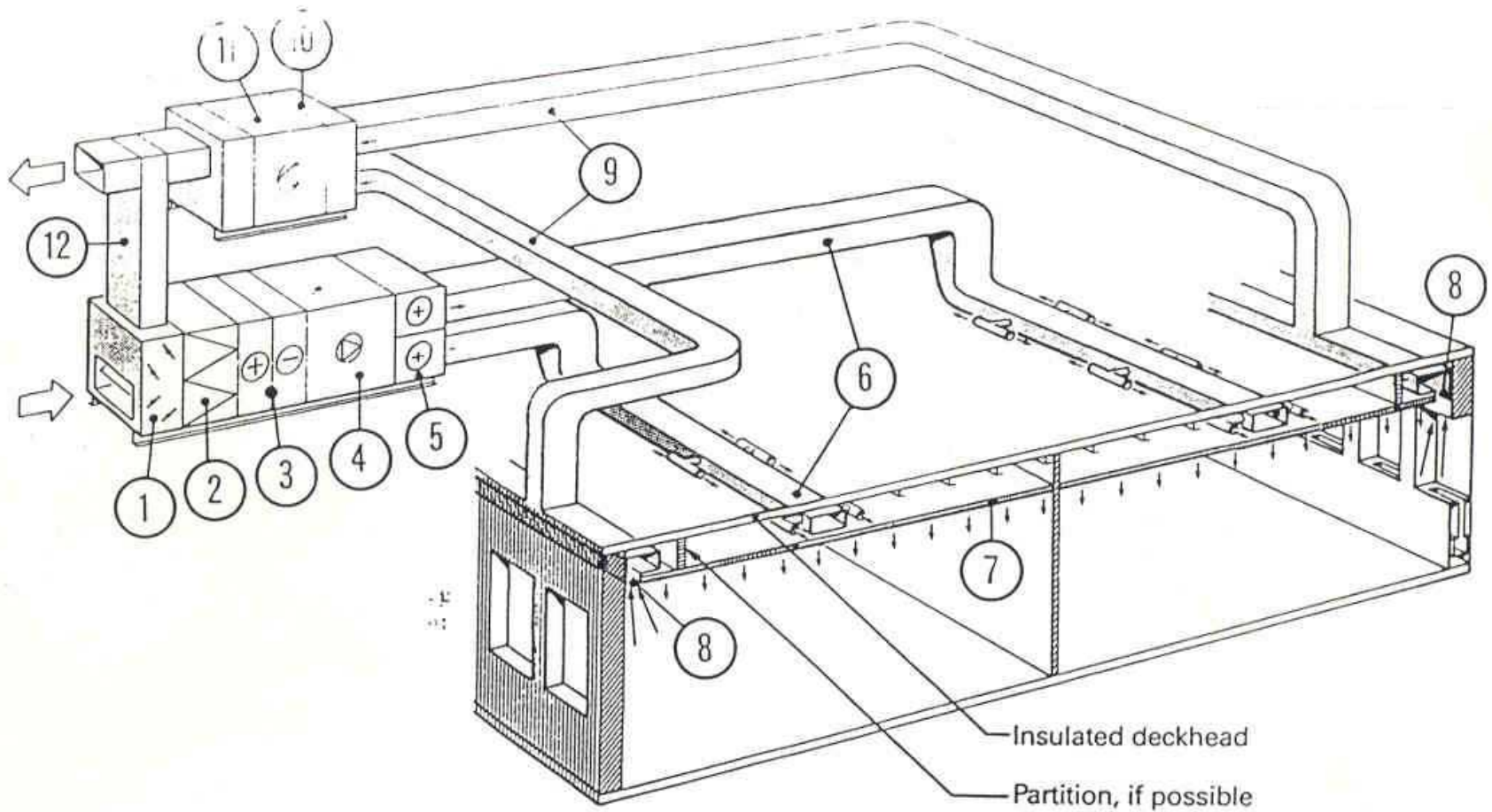
1. Intake damper
2. Filter
3. Recovery unit
4. Empty section
5. Heating / cooling coil
6. Supply air fan
7. Distribution section

8. Supply air duct
9. Supply air terminal unit
10. Exhaust air register
11. Exhaust air duct
12. Exhaust air section
13. Filter
14. Exhaust air fan



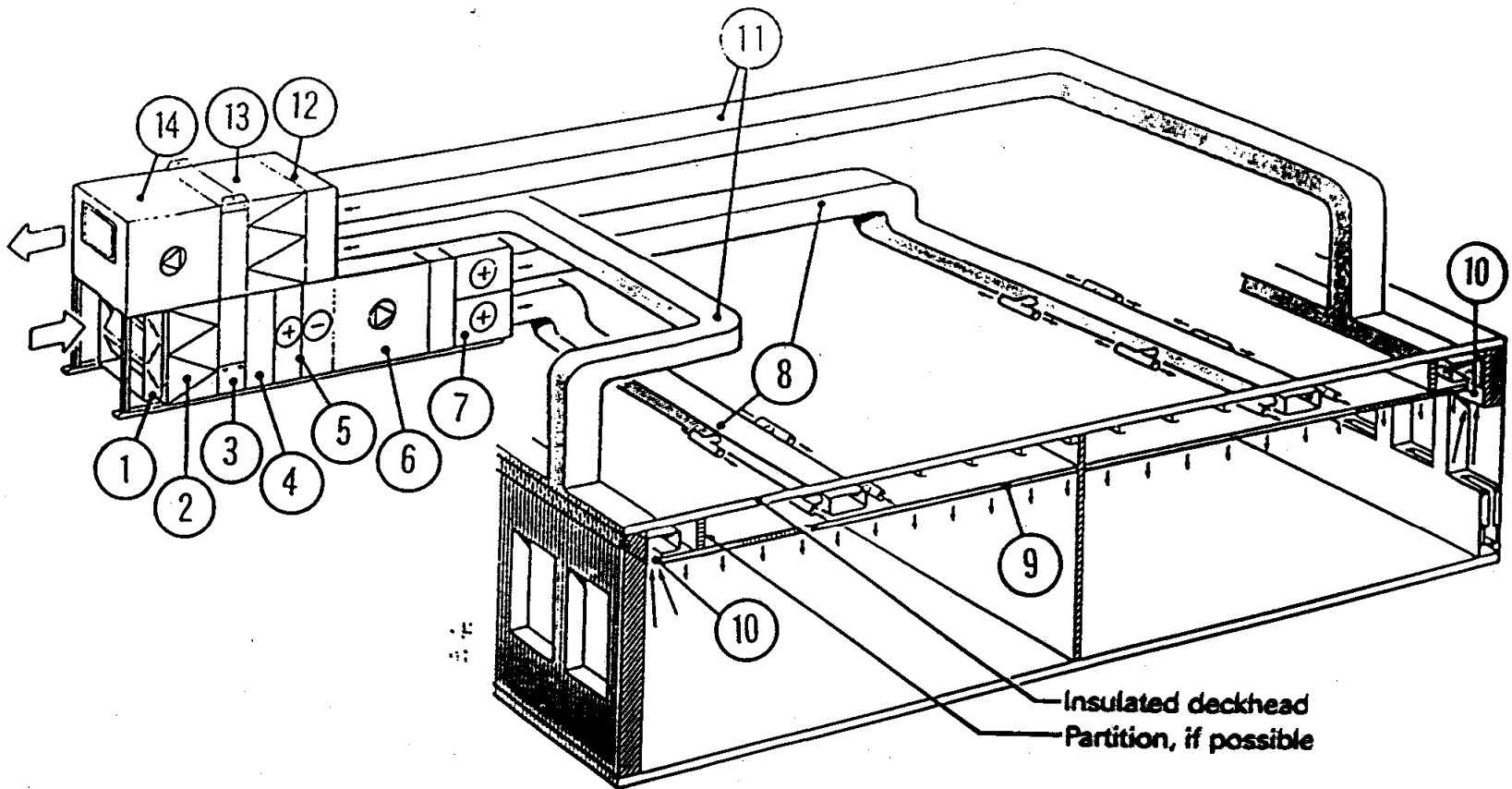


- | | |
|---------------------------|----------------------------------|
| 1. Intake damper | 8. Supply air duct |
| 2. Filter | 9. Supply air terminal unit DKHS |
| 3. Recovery unit | 10. Exhaust air register |
| 4. Empty section | 11. Exhaust air duct |
| 5. Heating / cooling coil | 12. Exhaust air section |
| 6. Supply air fan | 13. Filter |
| 7. Distribution section | 14. Exhaust air fan |



1. Mixing section
2. Filter
3. Heating/cooling coil
4. Supply air fan
5. Distribution section with heater
6. Supply air duct

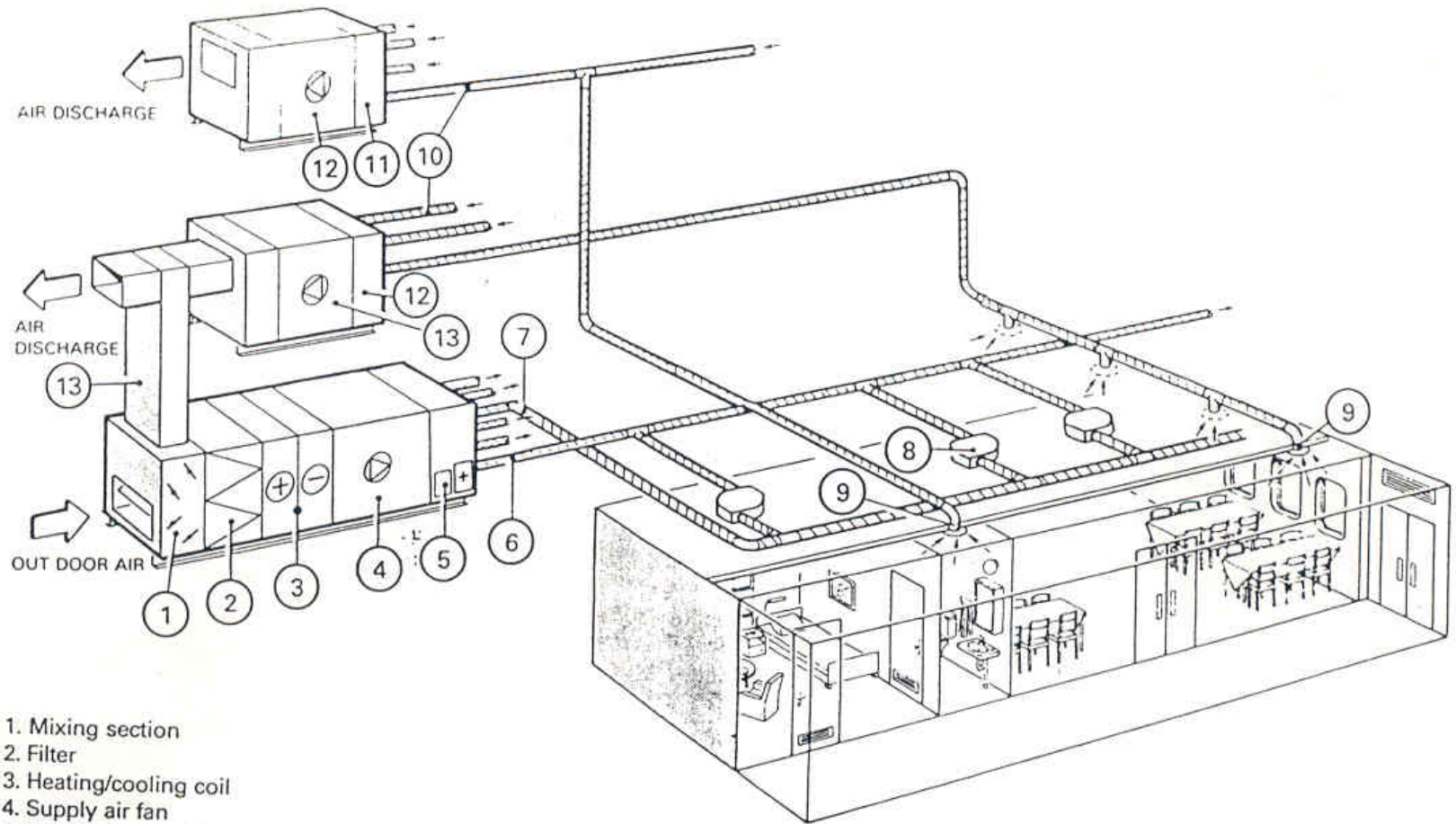
7. Perforated ceiling
8. Exhaust air grille
9. Exhaust air duct
10. Exhaust air section
11. Exhaust air fan
12. Recirculated air duct



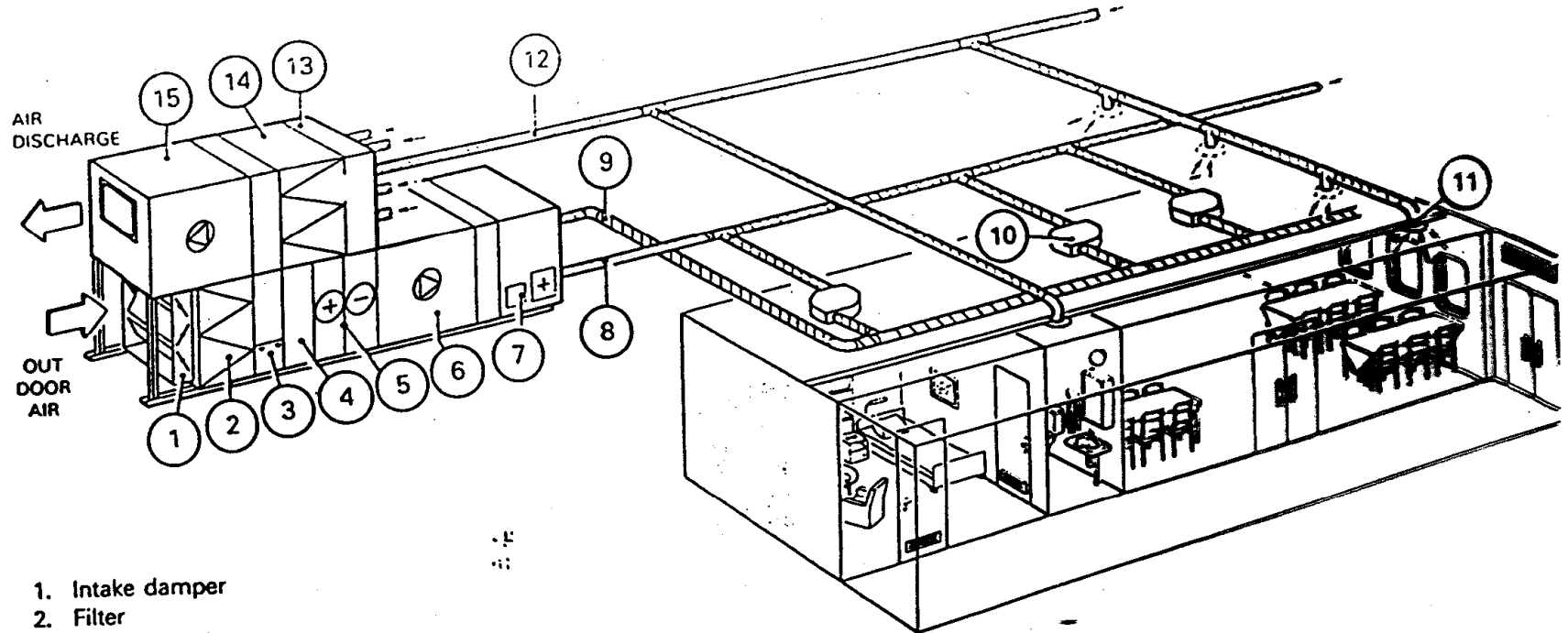
- 1. Intake damper
- 2. Filter
- 3. Recovery unit
- 4. Empty section
- 5. Heating/cooling coil
- 6. Supply air fan
- 7. Distribution section with heater

- 8. Supply air duct
- 9. Perforated ceiling
- 10. Exhaust air grille
- 11. Exhaust air duct
- 12. Exhaust air section
- 13. Filter
- 14. Exhaust air fan

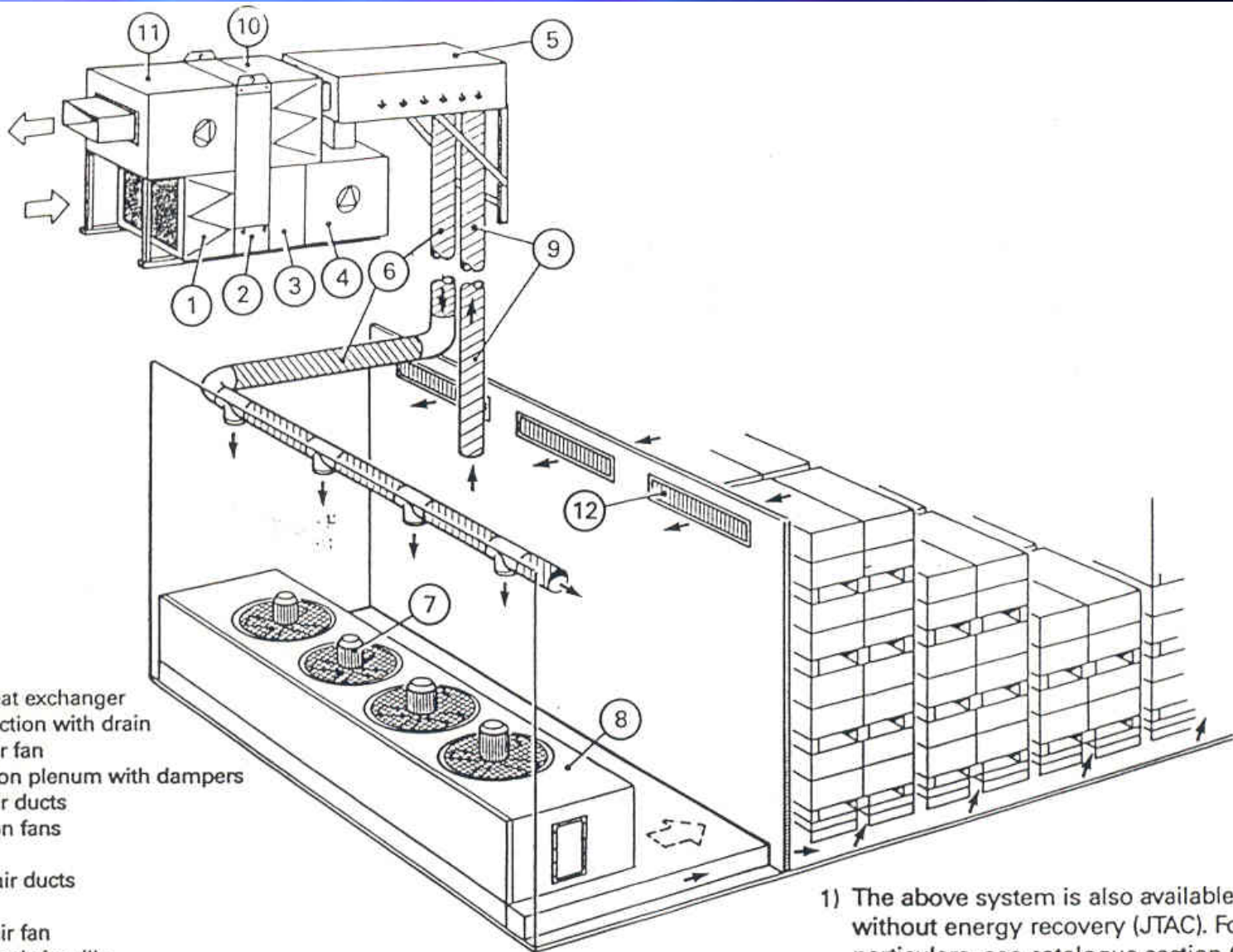
Insulated deckhead
 Partition, if possible



1. Mixing section
2. Filter
3. Heating/cooling coil
4. Supply air fan
5. Distribution section with reheating coil
6. Warm supply air
7. Cold supply air duct
8. Supply air terminal unit DKFS
9. Exhaust air register
10. Exhaust air duct
11. Exhaust air section
12. Exhaust air fan
13. Recirculated air duct

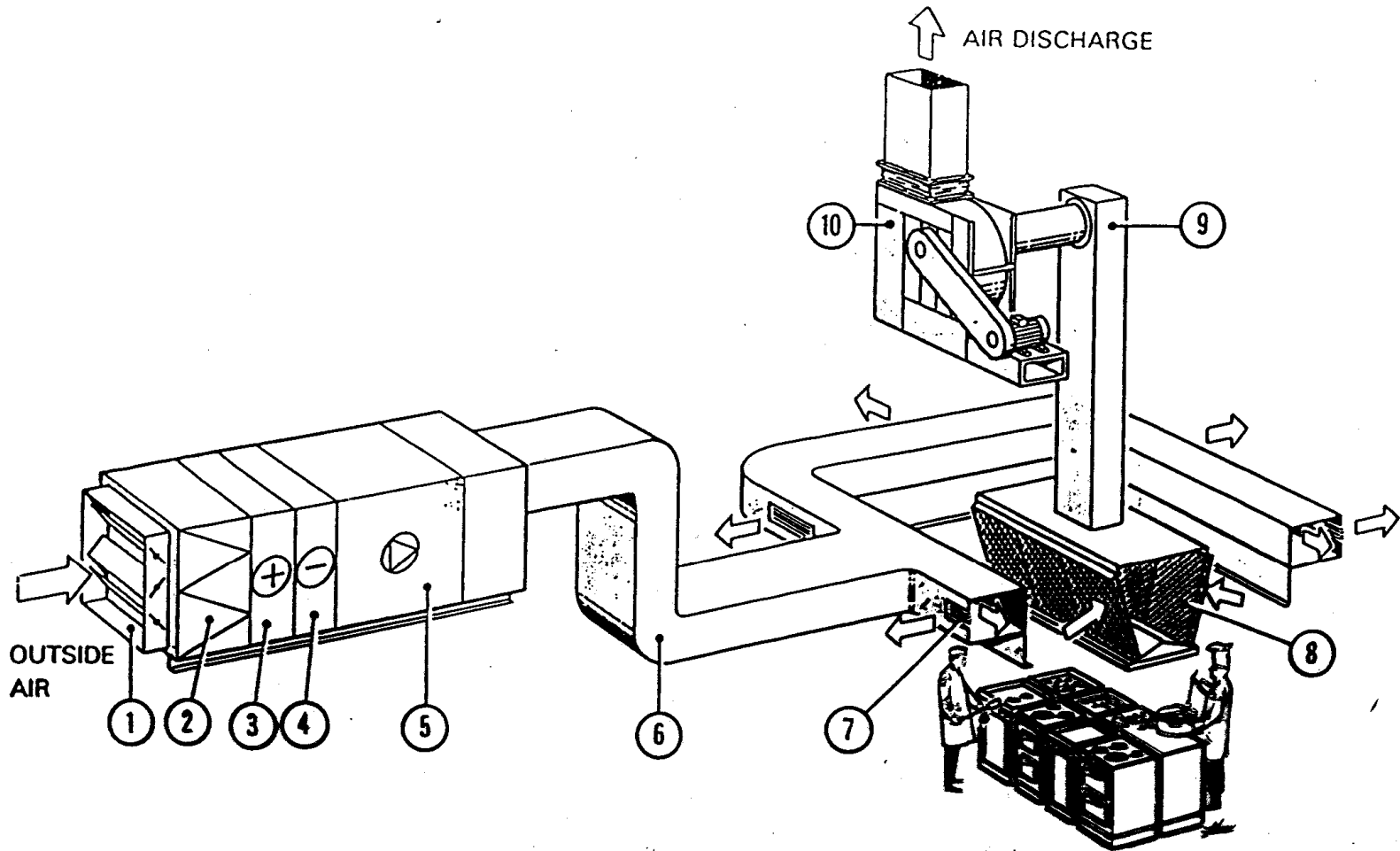


1. Intake damper
2. Filter
3. Recovery unit
4. Empty section
5. Heating/cooling coil
6. Supply air fan
7. Distribution section with reheating coil
8. Warm supply air duct
9. Cold supply air duct
10. Supply air terminal unit DKFS
11. Exhaust air register
12. Exhaust air duct
13. Exhaust air section
14. Filter
15. Exhaust air fan



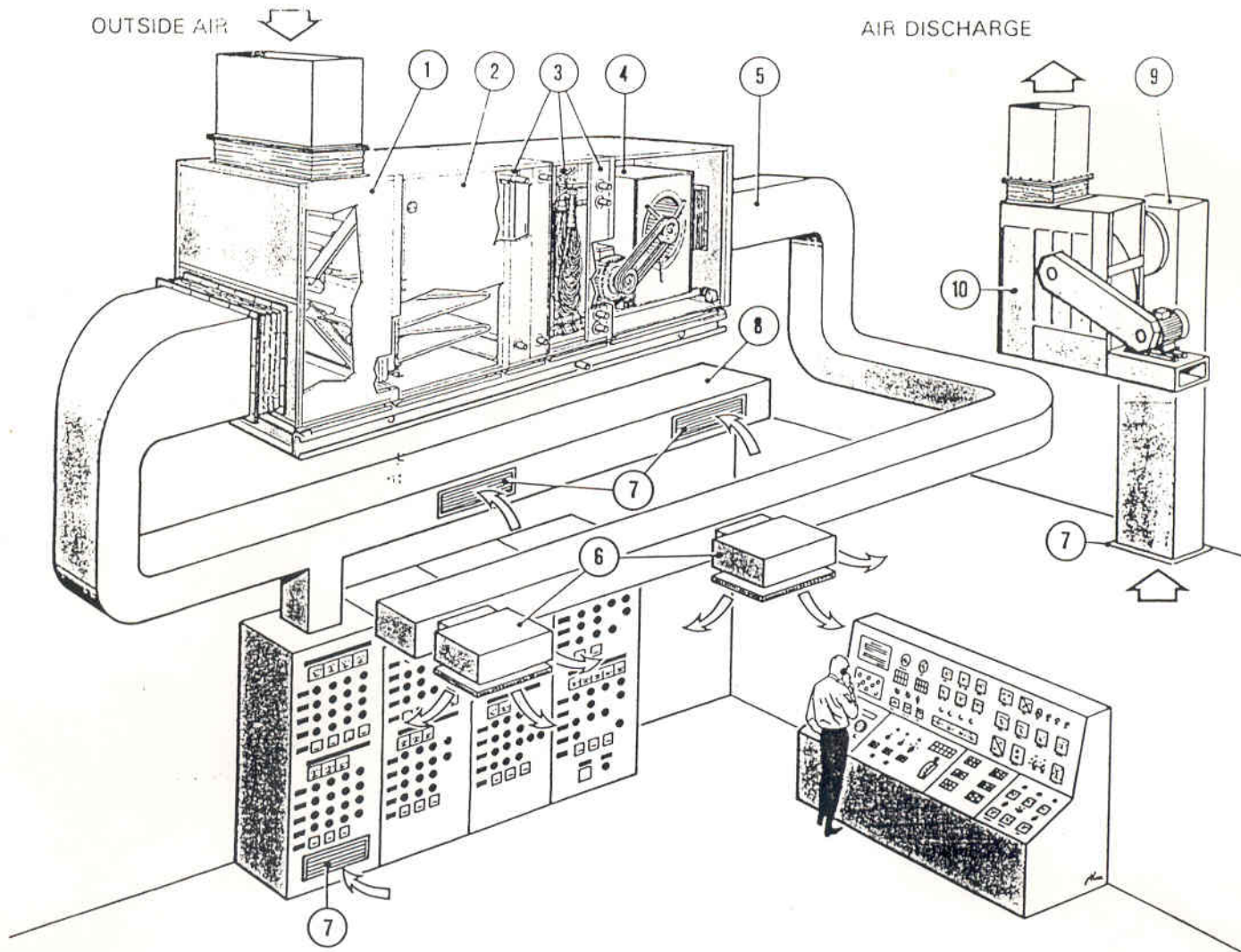
1. Filter
2. Rotary heat exchanger
3. Empty section with drain
4. Supply air fan
5. Distribution plenum with dampers
6. Supply air ducts
7. Circulation fans
8. Cooler
9. Exhaust air ducts
10. Filter
11. Exhaust air fan
12. Recirculated air grille

1) The above system is also available without energy recovery (JTAC). For particulars, see catalogue section G 80.



- 1. Intake damper
- 2. Filter
- 3. Heating coil
- 4. Cooling coil
- 5. Supply air fan

- 6. Supply air duct
- 7. Supply air device
- 8. Grease filter
- 9. Exhaust air duct
- 10. Exhaust air fan

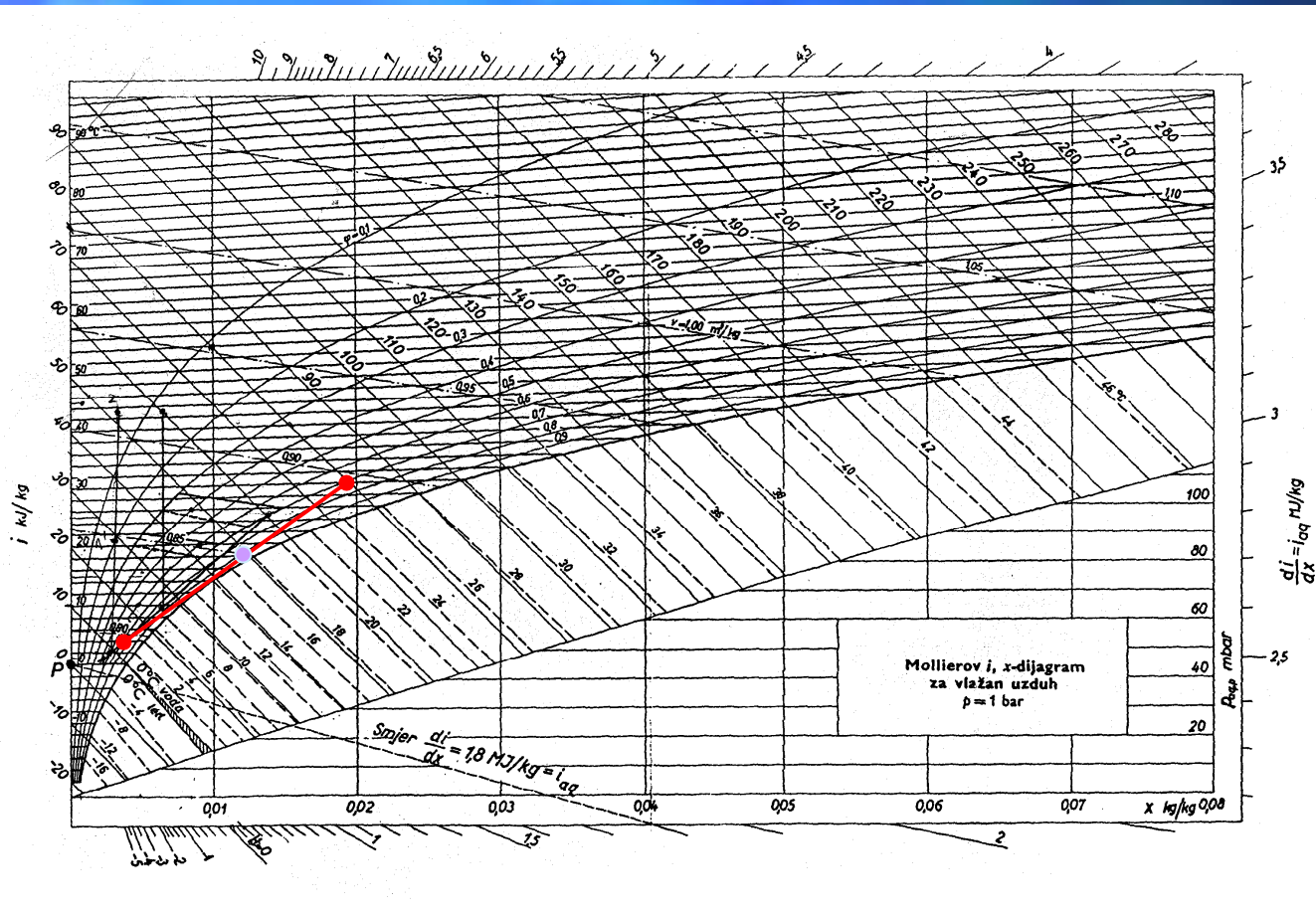


OUTSIDE AIR

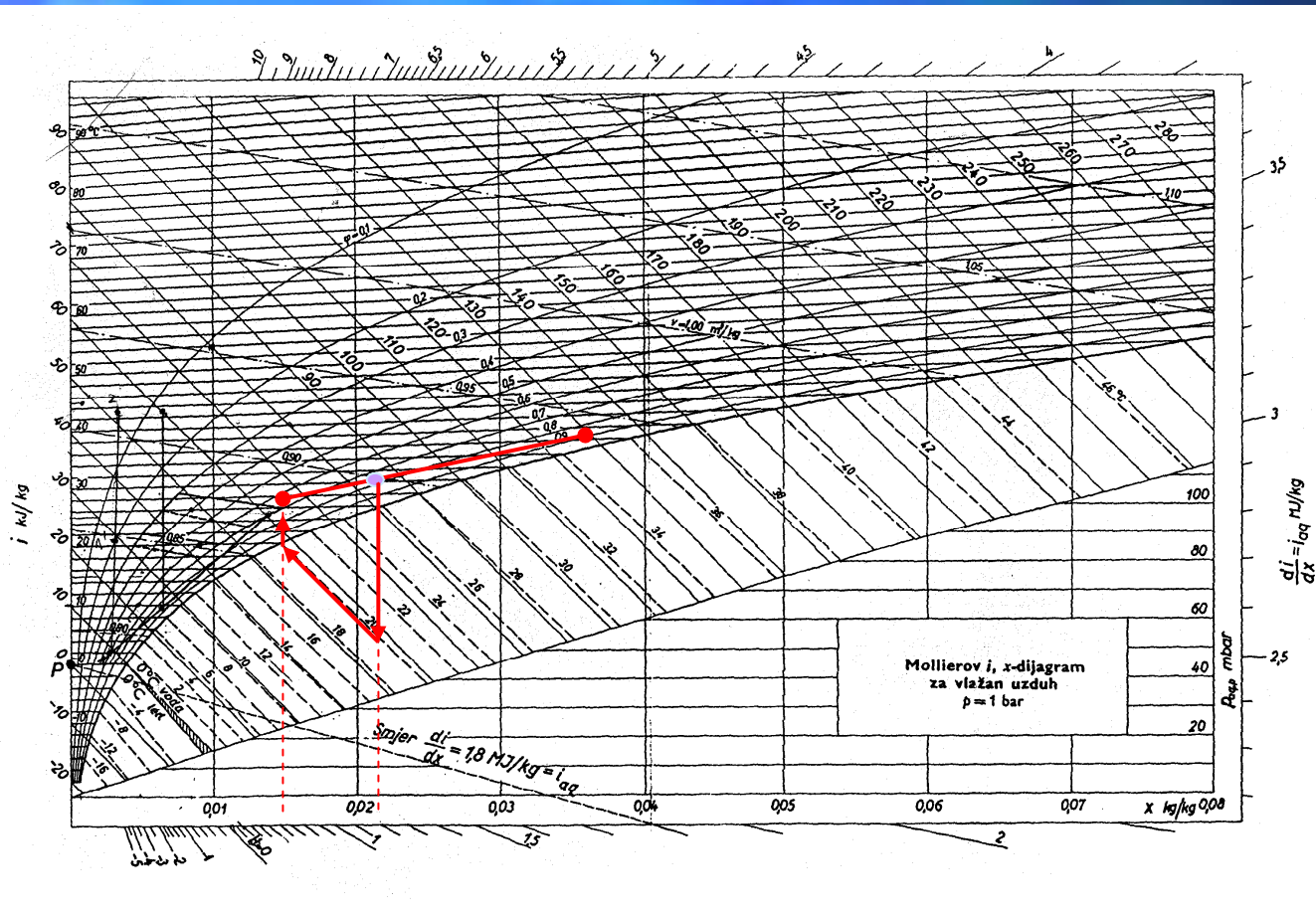
AIR DISCHARGE

- 1. Mixing section
- 2. Filter
- 3. Cooling / Heating coils
- 4. Supply fan
- 5. Supply air duct
- 6. Supply air device
- 7. Exhaust air device
- 8. Recirculated air duct
- 9. Exhaust air duct
- 10. Exhaust fan

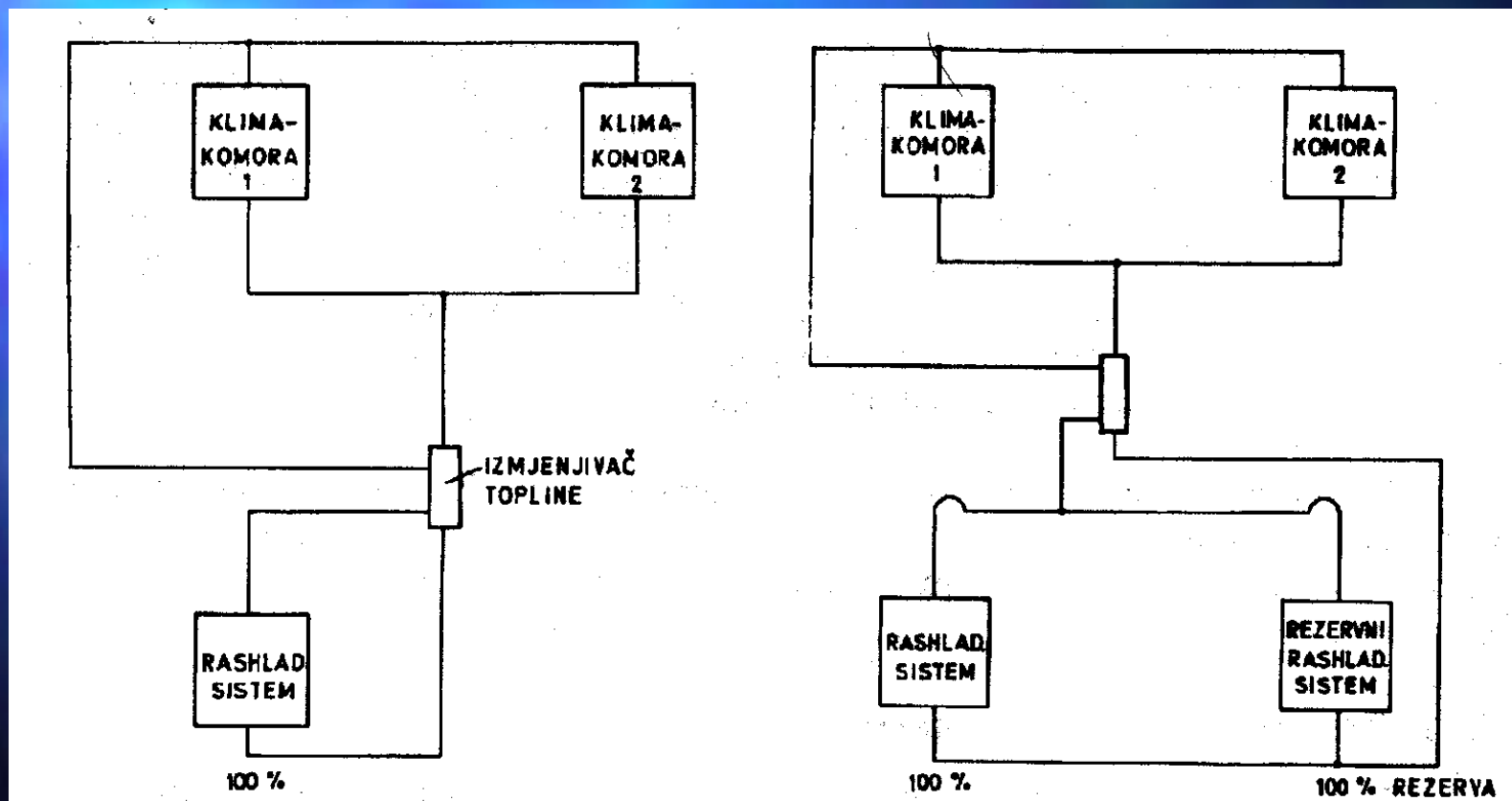
Primjer: zima, recirkulacija



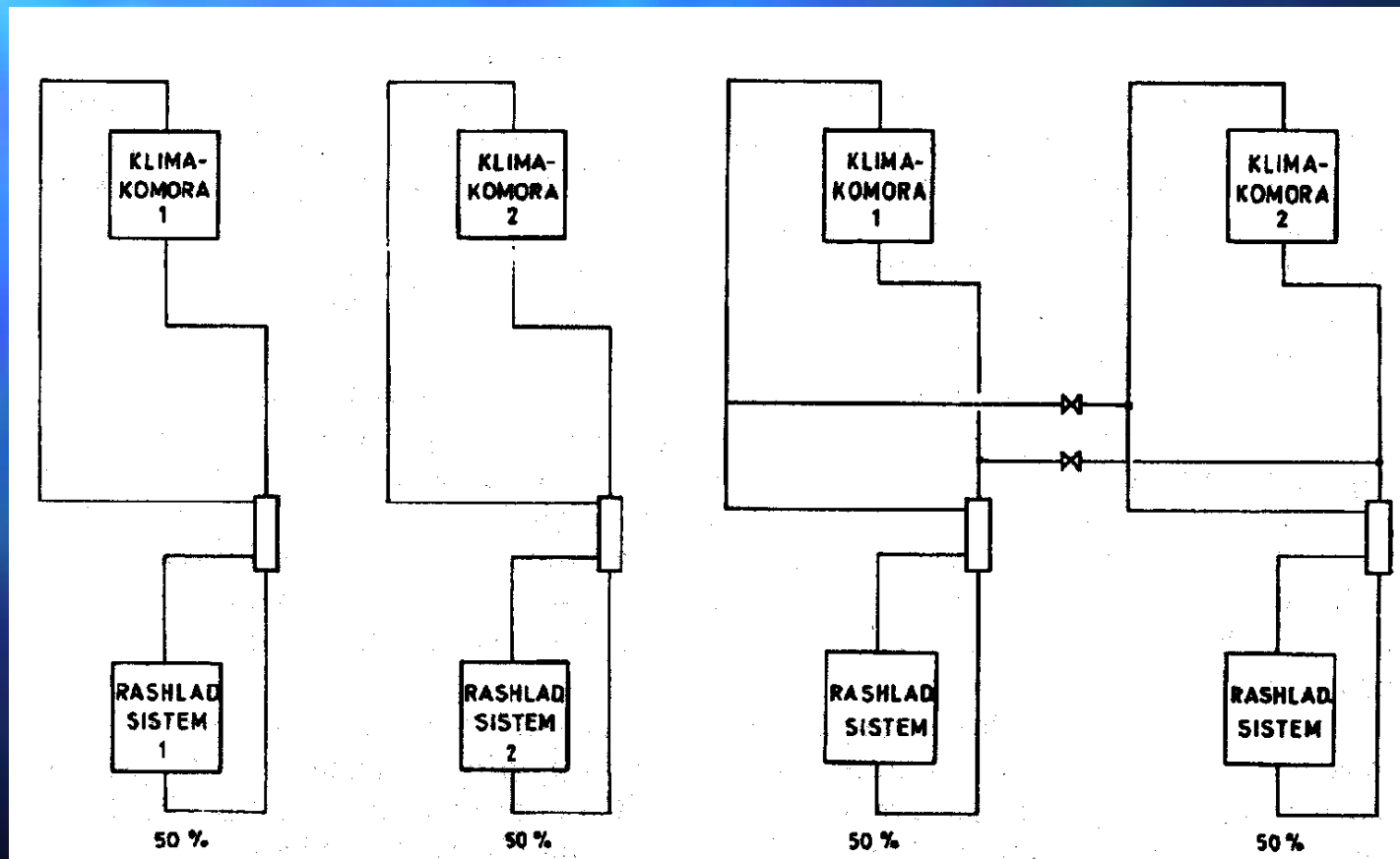
Primjer: ljetno, recirkulacija



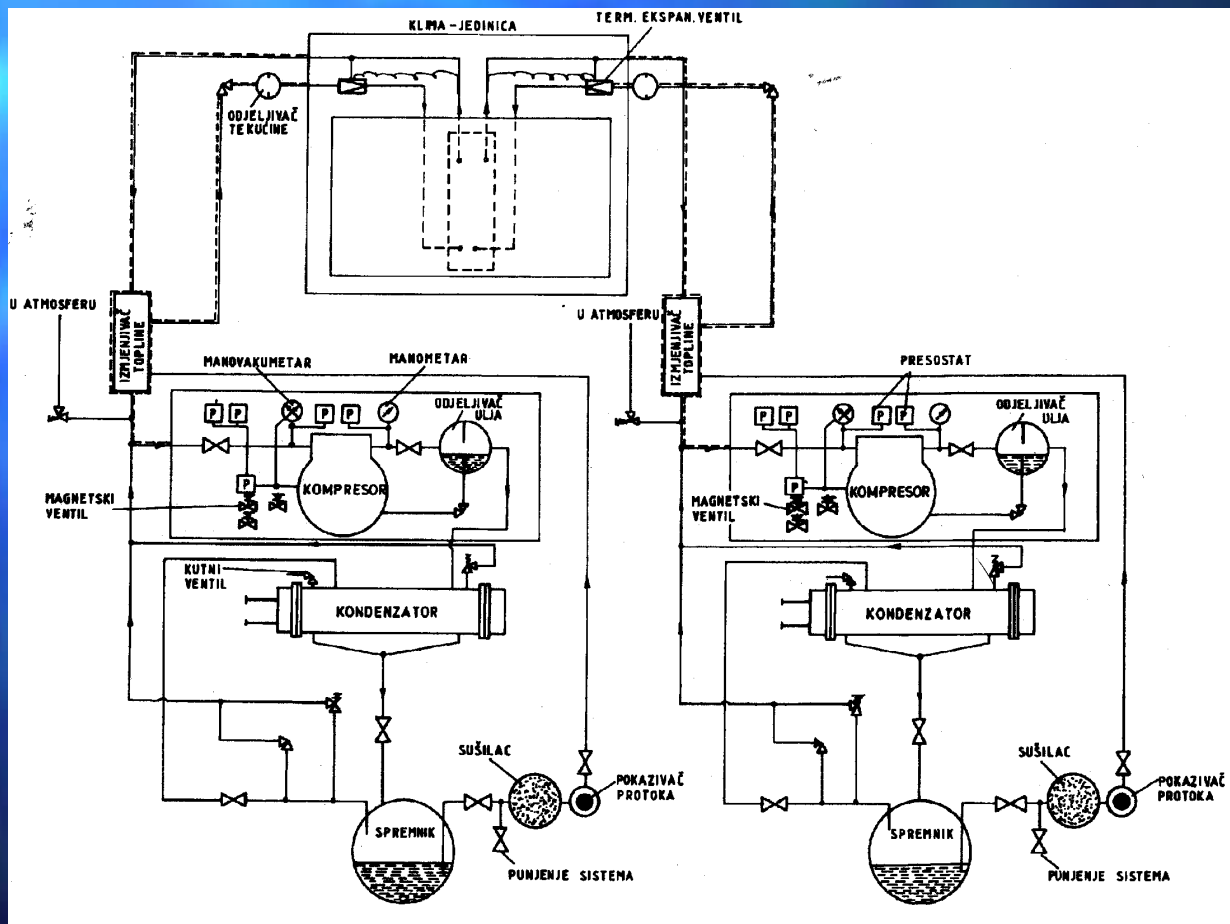
Izvedbe



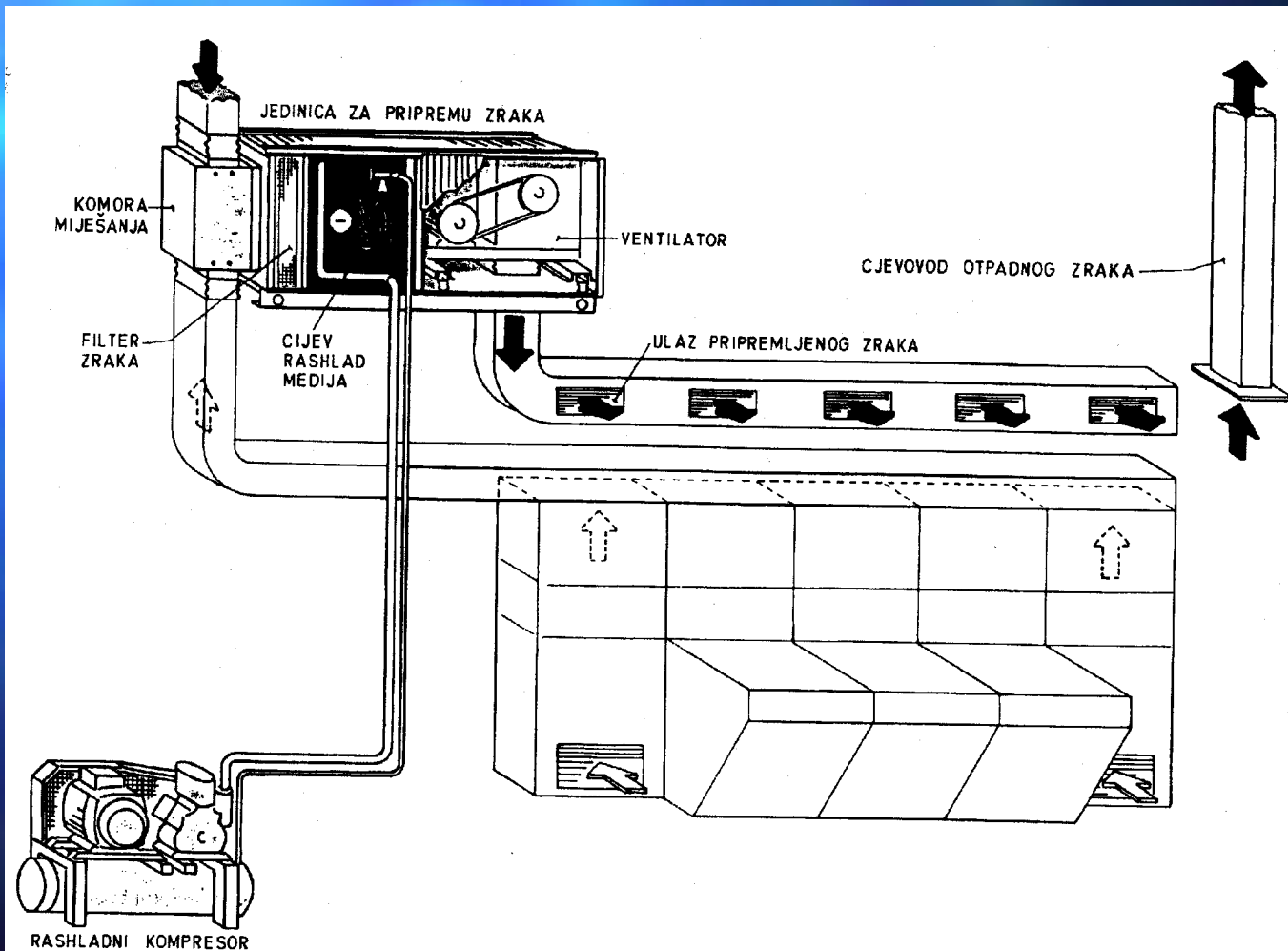
Izvedbe



Izvedbe



Izvedbe



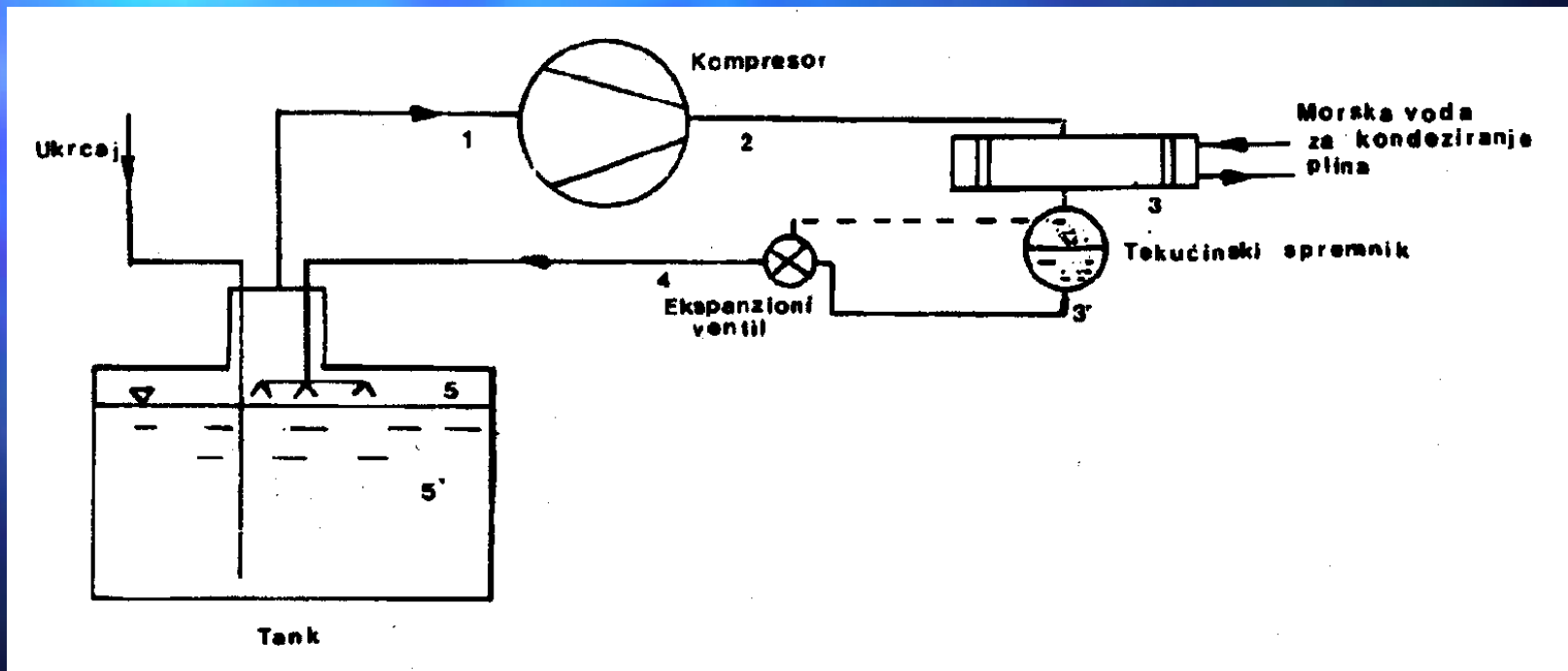
Ukapljeni plin

- LNG
- LPG
- smanjuje se volumen oko 600 puta

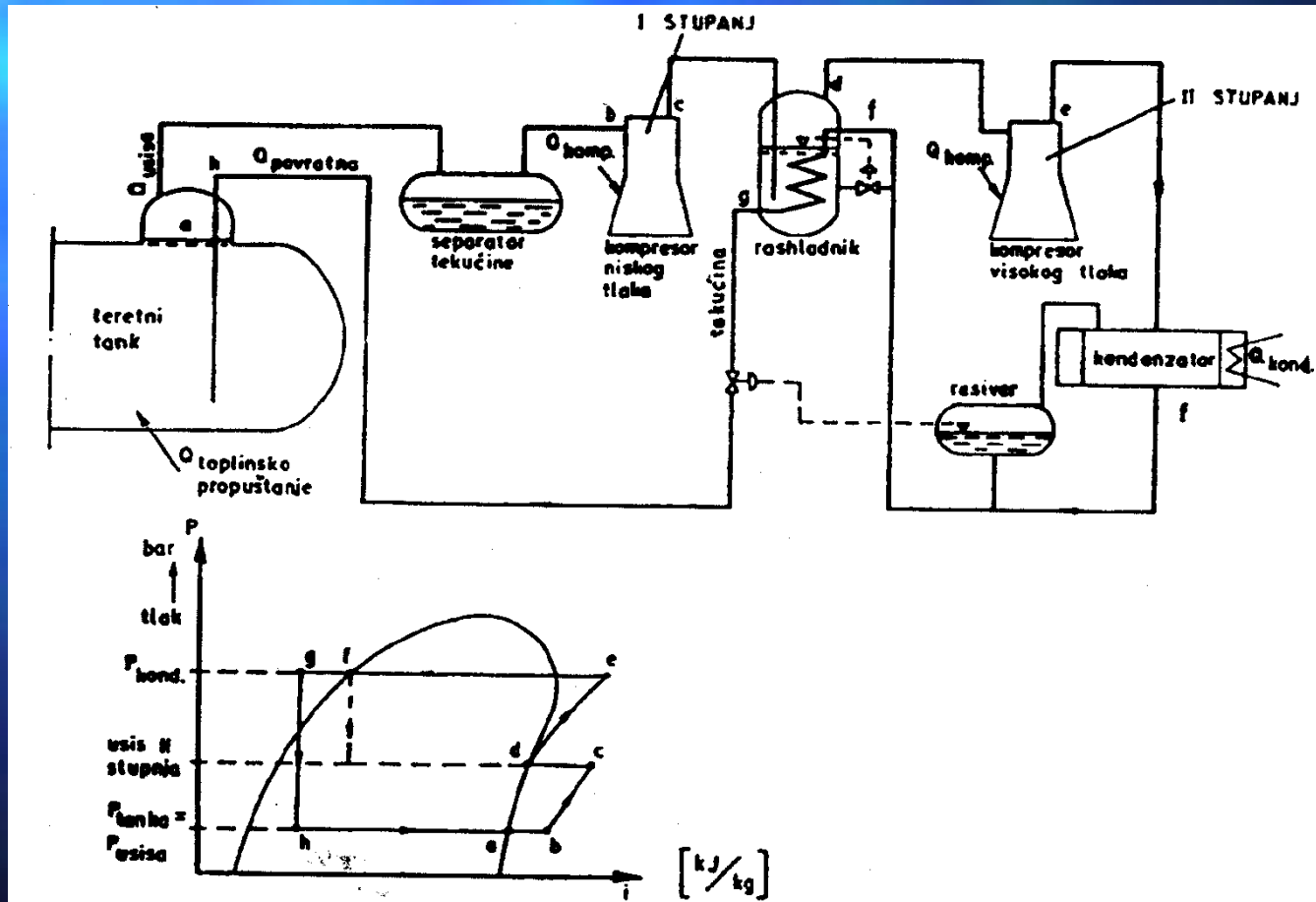
Ukapljeni plin

- $p = p_0, T \ll T_0$
- $p \gg p_0, T = T_0$
- $p > p_0, T < T_0$

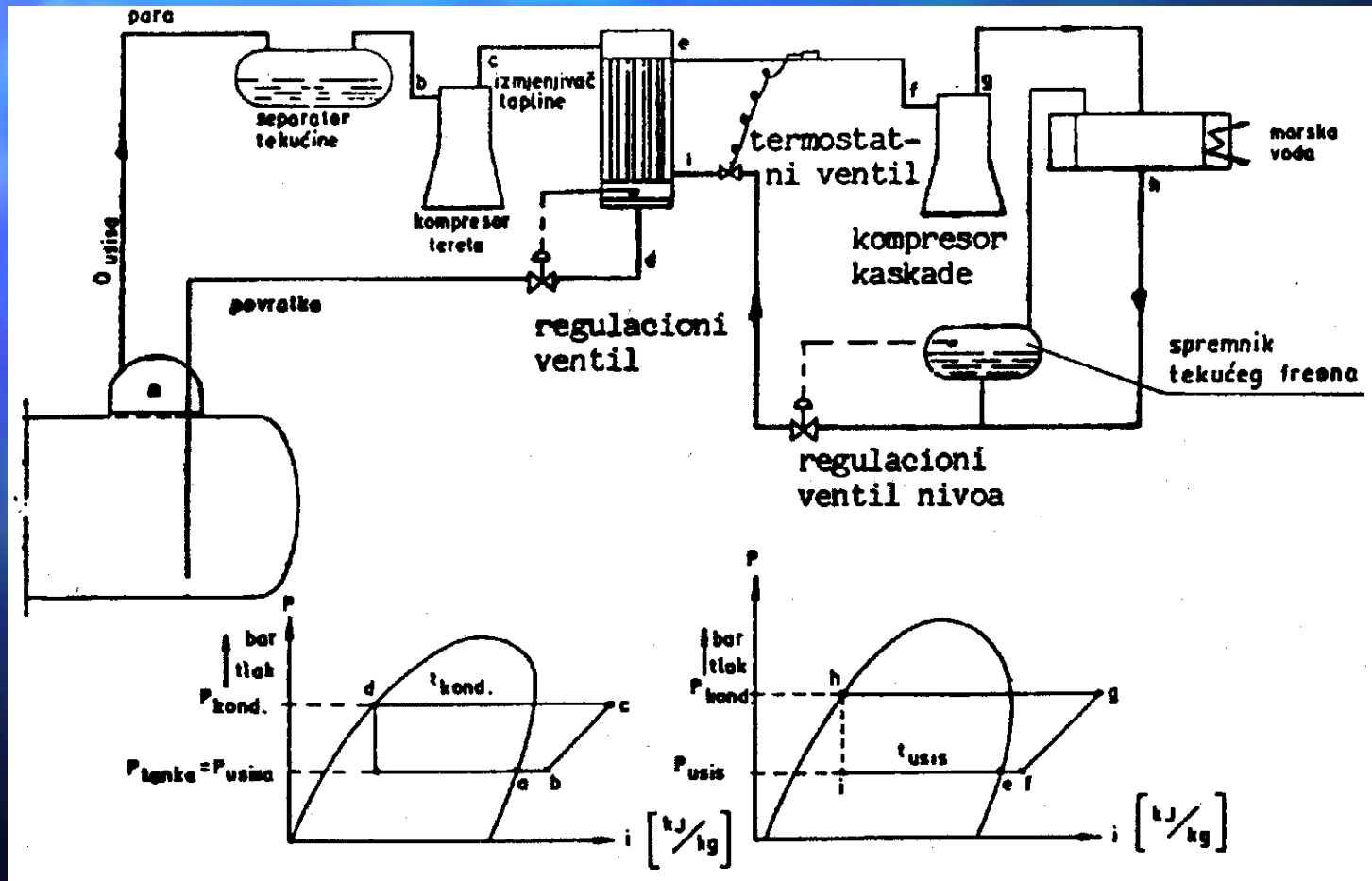
Jednostepena kompresija



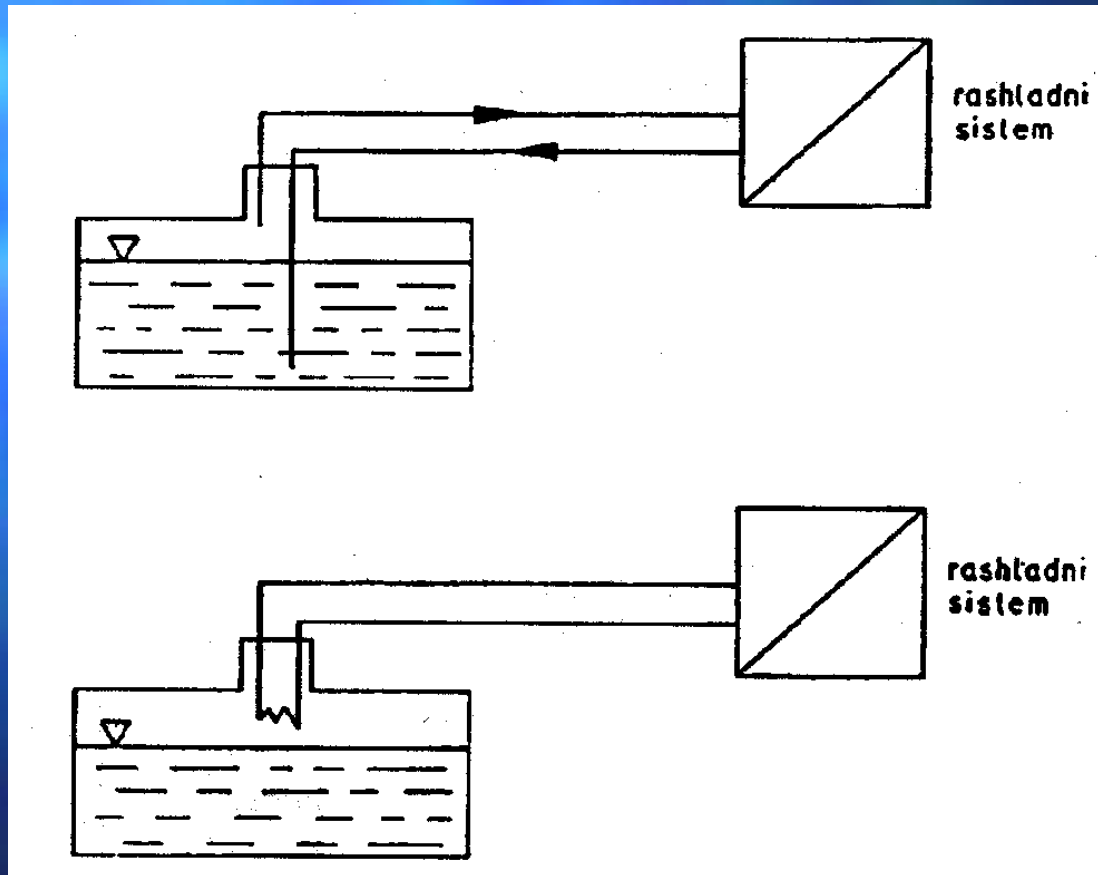
Dvostepena kompresija



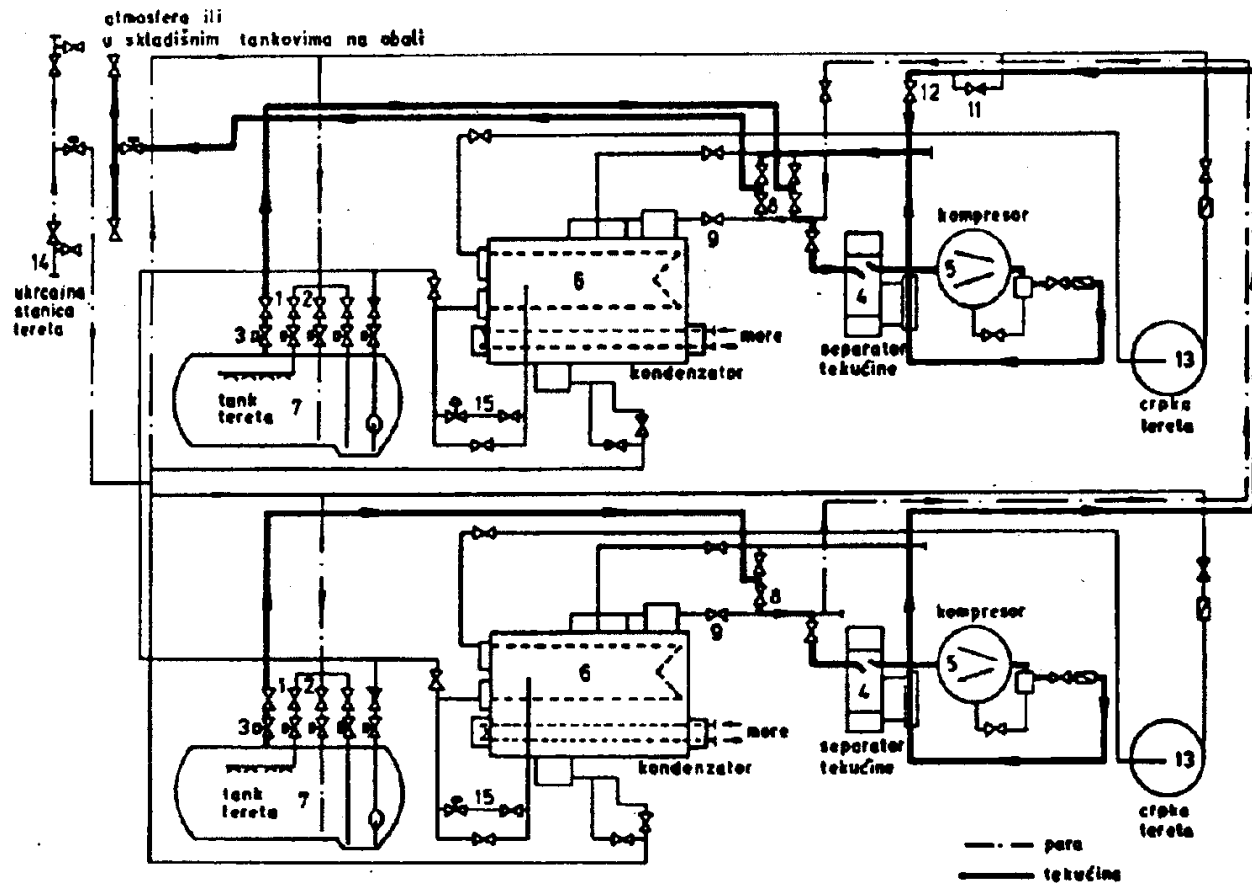
Kaskadni



Direktno i indirektno

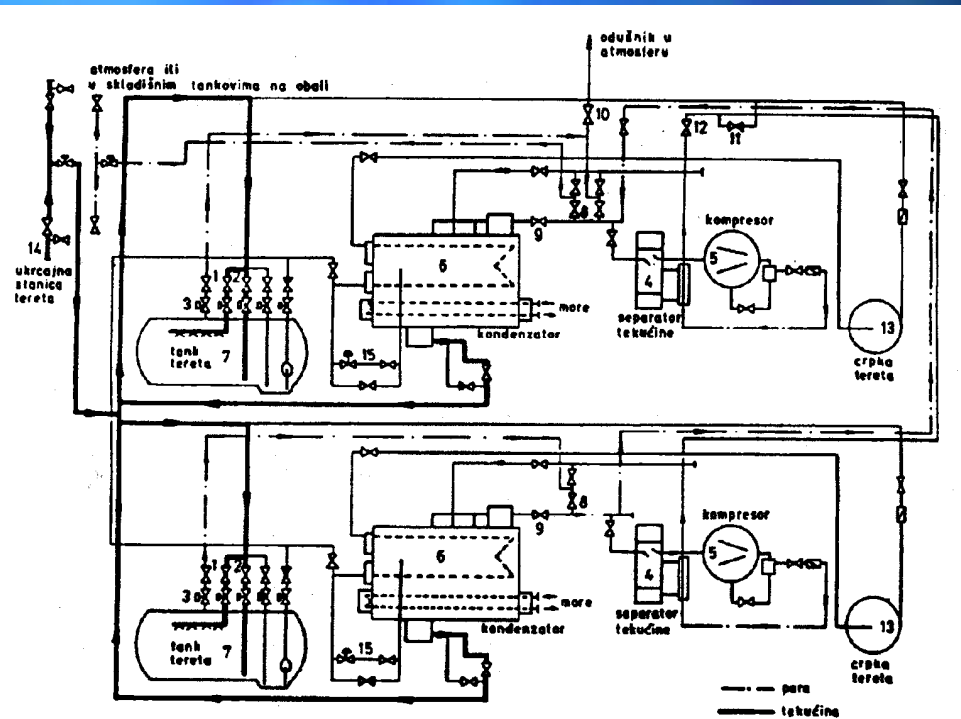


LPG-vakuumiranje



Vakuumiranje tankova i tereta

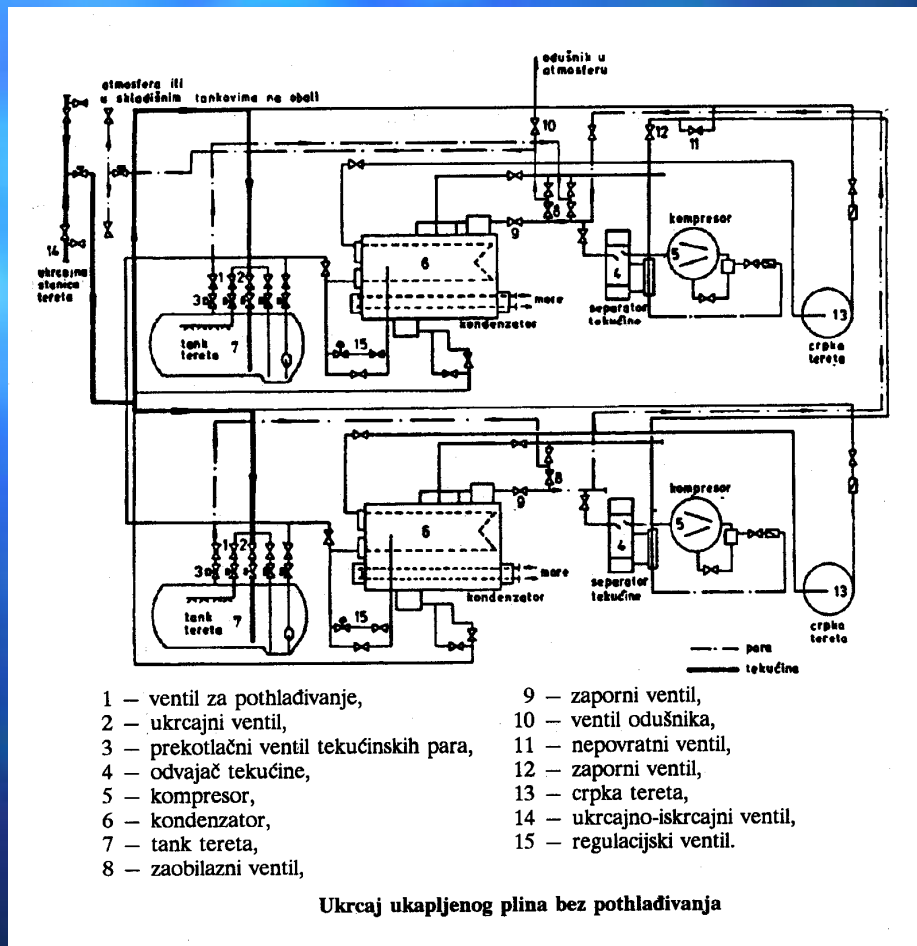
LPG-ukrcaj



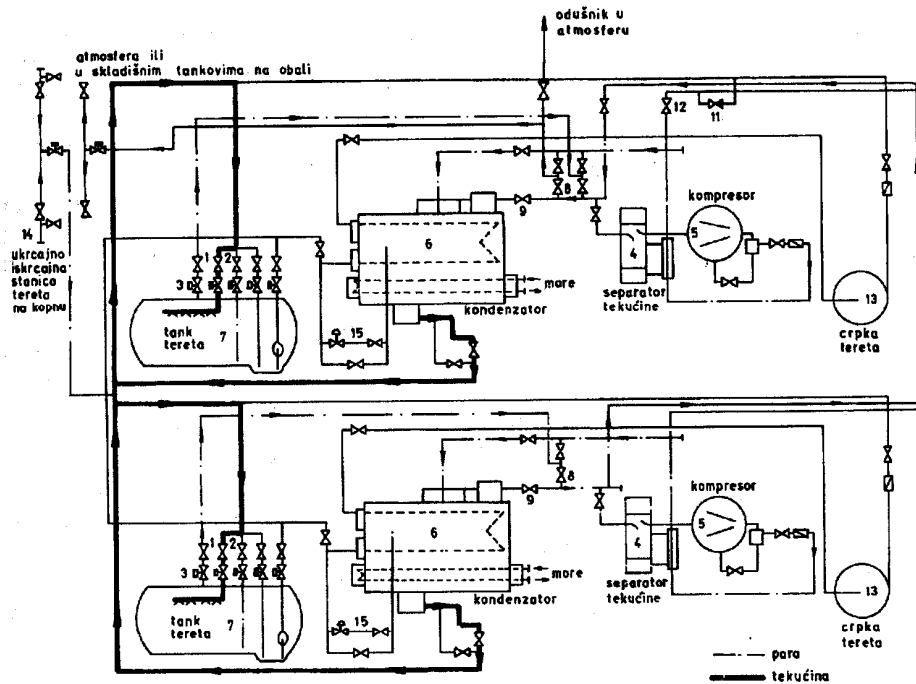
- | | |
|--|---------------------------------|
| 1 – ventil za pothlađivanje, | 9 – zaporni ventil, |
| 2 – ukrcajni ventil, | 10 – ventil odušnika, |
| 3 – prekotlačni ventil tekućinskih para, | 11 – nepovratni ventil, |
| 4 – odvajač tekućine, | 12 – zaporni ventil, |
| 5 – kompresor, | 13 – crpka tereta, |
| 6 – kondenzator, | 14 – ukrcajno-iskrcajni ventil, |
| 7 – tank tereta, | 15 – regulacijski ventil. |
| 8 – zaobilazni ventil, | |

Ukrcaj ukapljenog plina s pothlađivanjem

LPG-ukrcaj



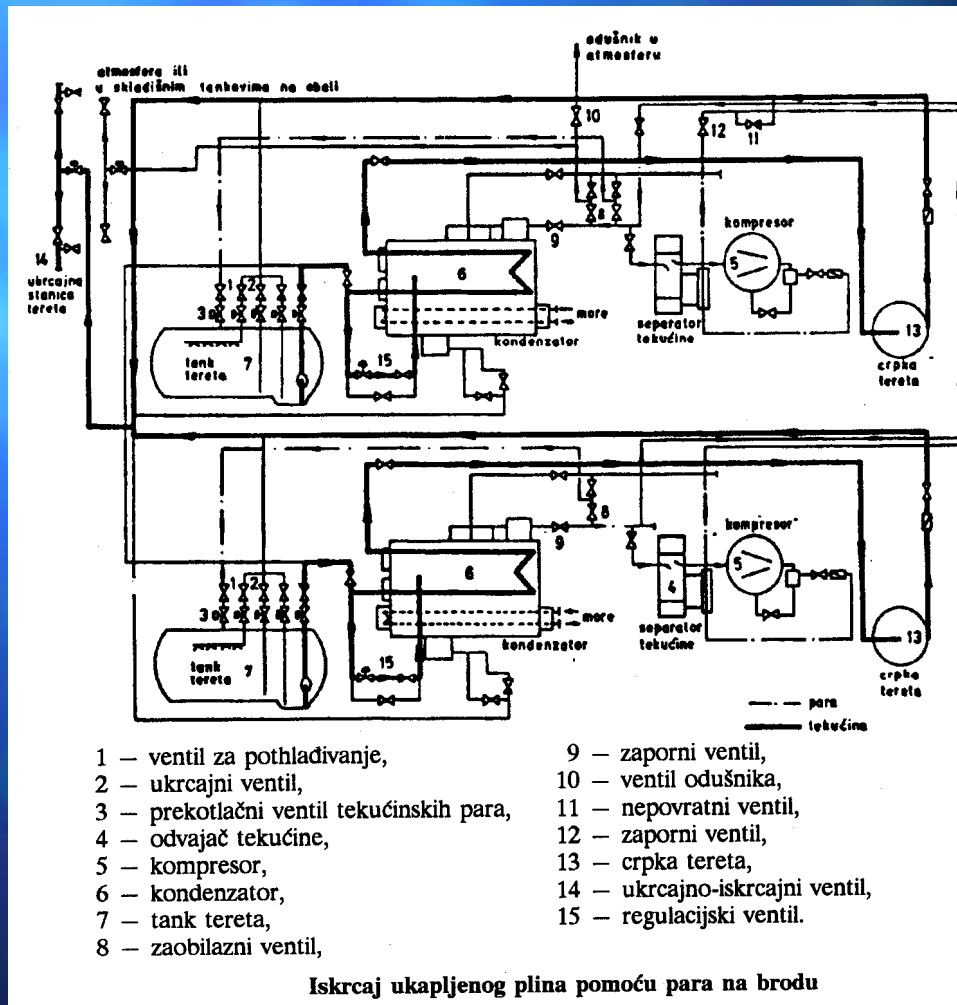
LPG-plovidba



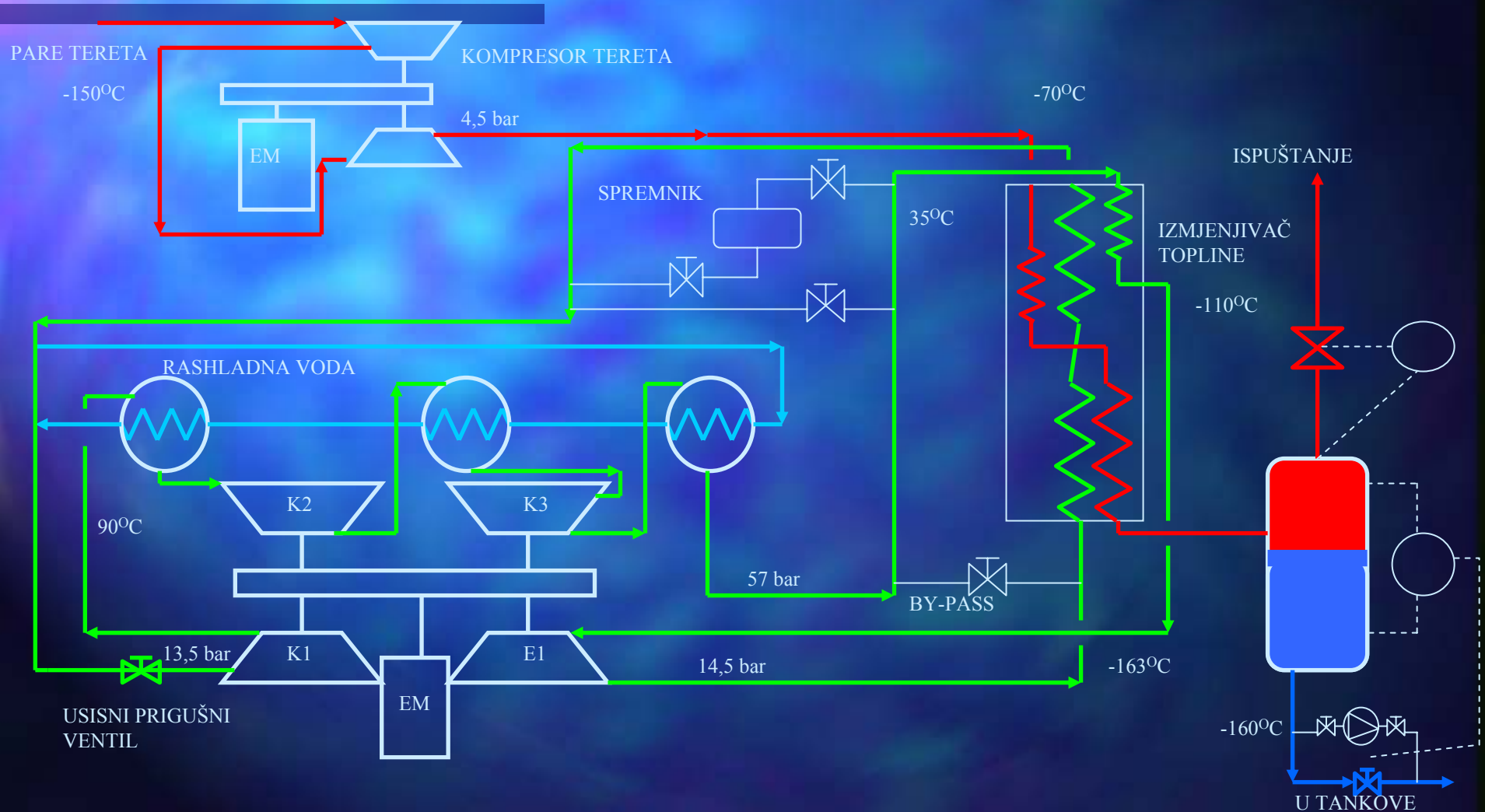
- | | |
|--|-------------------------------|
| 1 – ventil za pothlađivanje, | 9 – zaporni ventil, |
| 2 – ukrajni ventil, | 10 – ventil odušnika, |
| 3 – prekotlačni ventil tekućinskih para, | 11 – nepovratni ventil, |
| 4 – odvajač tekućine, | 12 – zaporni ventil, |
| 5 – kompresor, | 13 – crpka tereta, |
| 6 – kondenzator, | 14 – ukrajno-iskrajni ventil, |
| 7 – tank tereta, | 15 – regulacijski ventil. |
| 8 – zaobilazni ventil, | |

Pothlađivanje tijekom plovidbe

LPG-iskrcaj



Rashladni sustav za LNG



Hlađenje skladišta

- usporava kvarenje i razvoj mikroorganizama
- toplinsko opterećenje

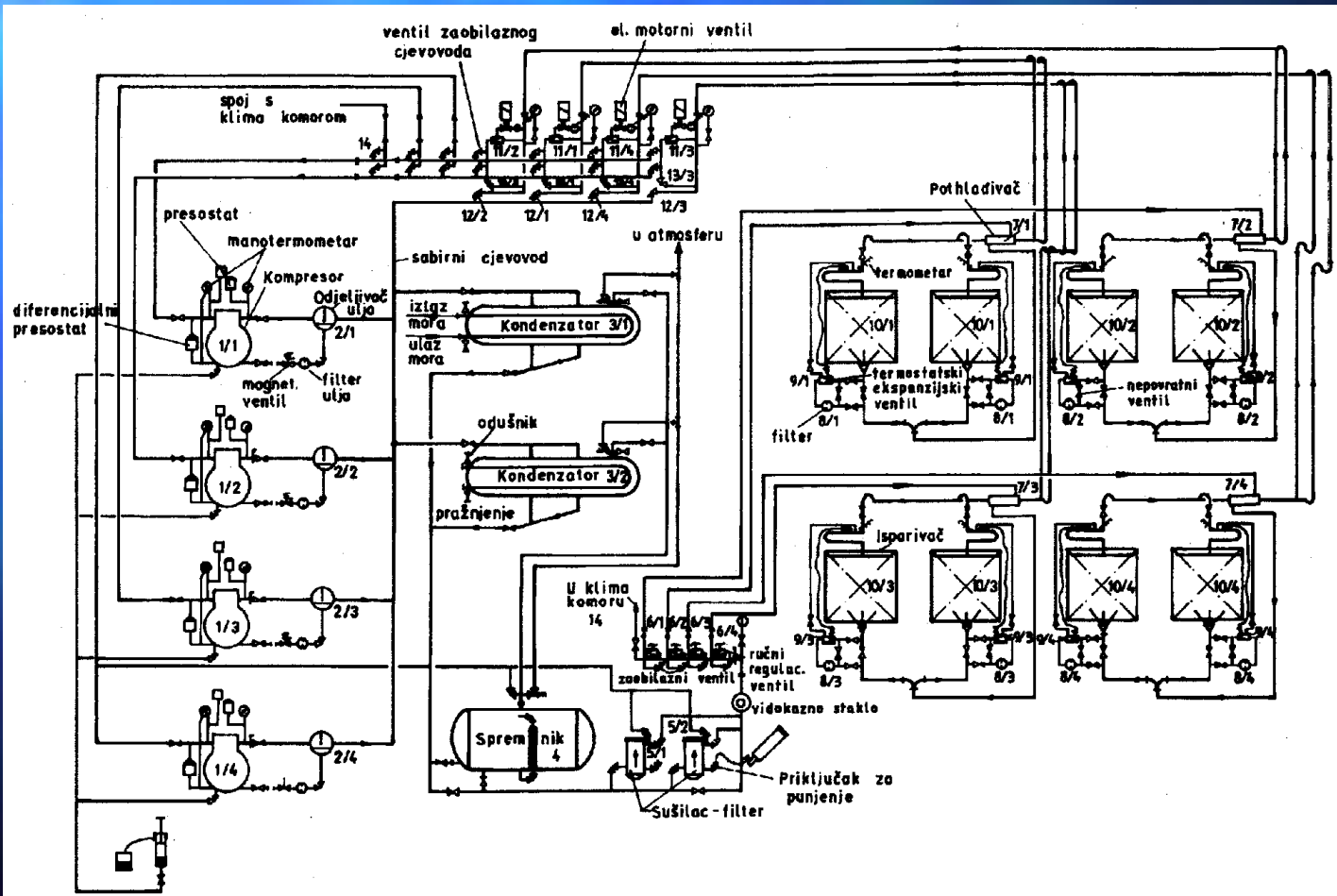
$$Q = Q_I + Q_V + Q_Z + Q_D$$

- mirno i burno ventiliranje
- sastav zraka?
- direktno i indirektno hlađenje

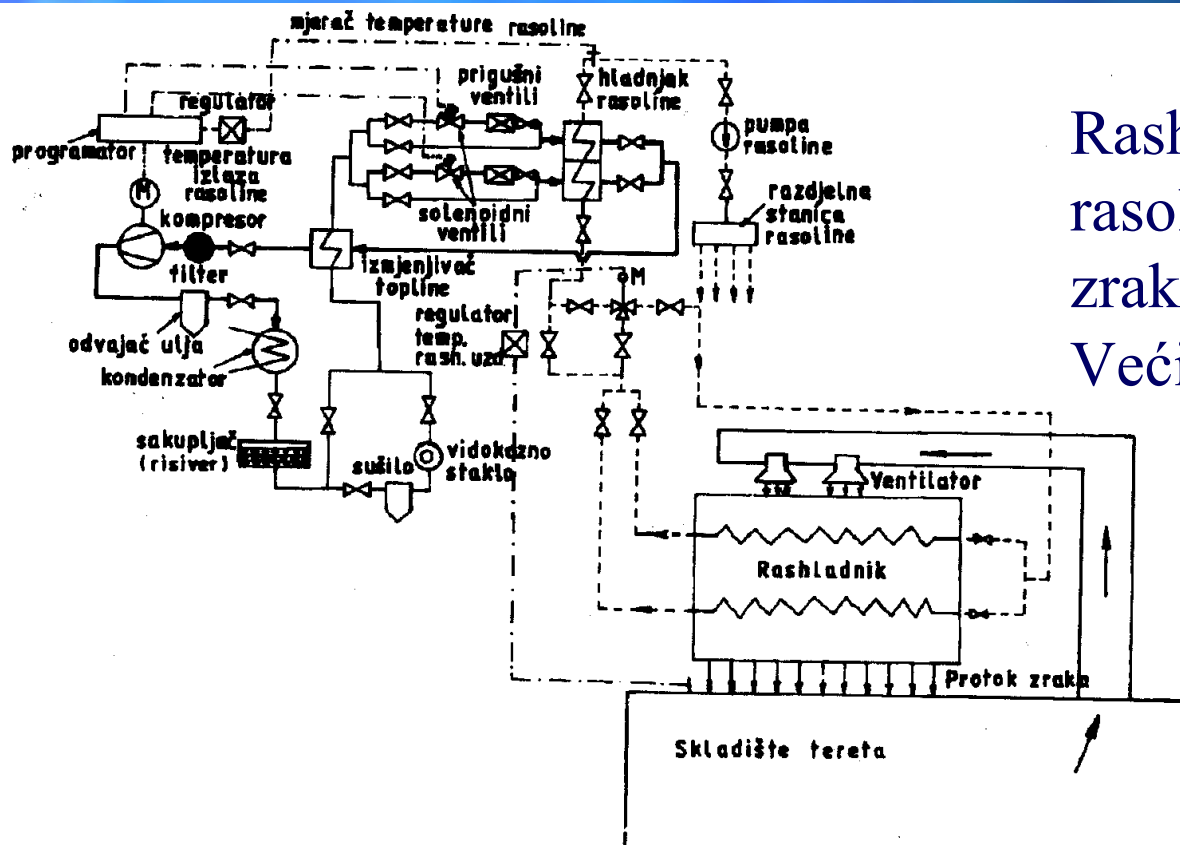
Teret

- konvencionalni prijevoz
- kontejneriziran
- hlađenje cijelog skladišta – debljina izolacije?

Direktno



Indirektno



Rashladni medij hladi rasolinu, a ova zrak u skladištu. Veći $\Delta t!!!$

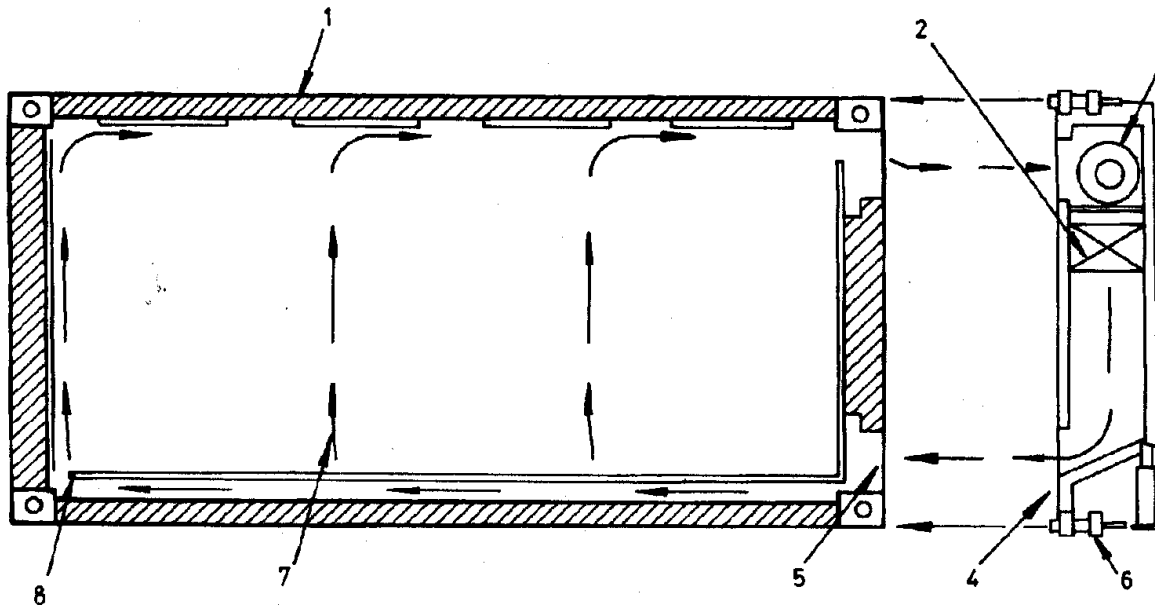
Shema indirektnog rashladnog sustava

Rasoline

- NaCl, CaCl₂, MgCl₂
- NaCl do -16°C
- CaCl₂ do -45°C (min. -55°C pri 30%)
- kapacitet dobavne pumpe

$$V = \frac{Q_o}{c(t_{1r} - t_{2r})\rho}$$

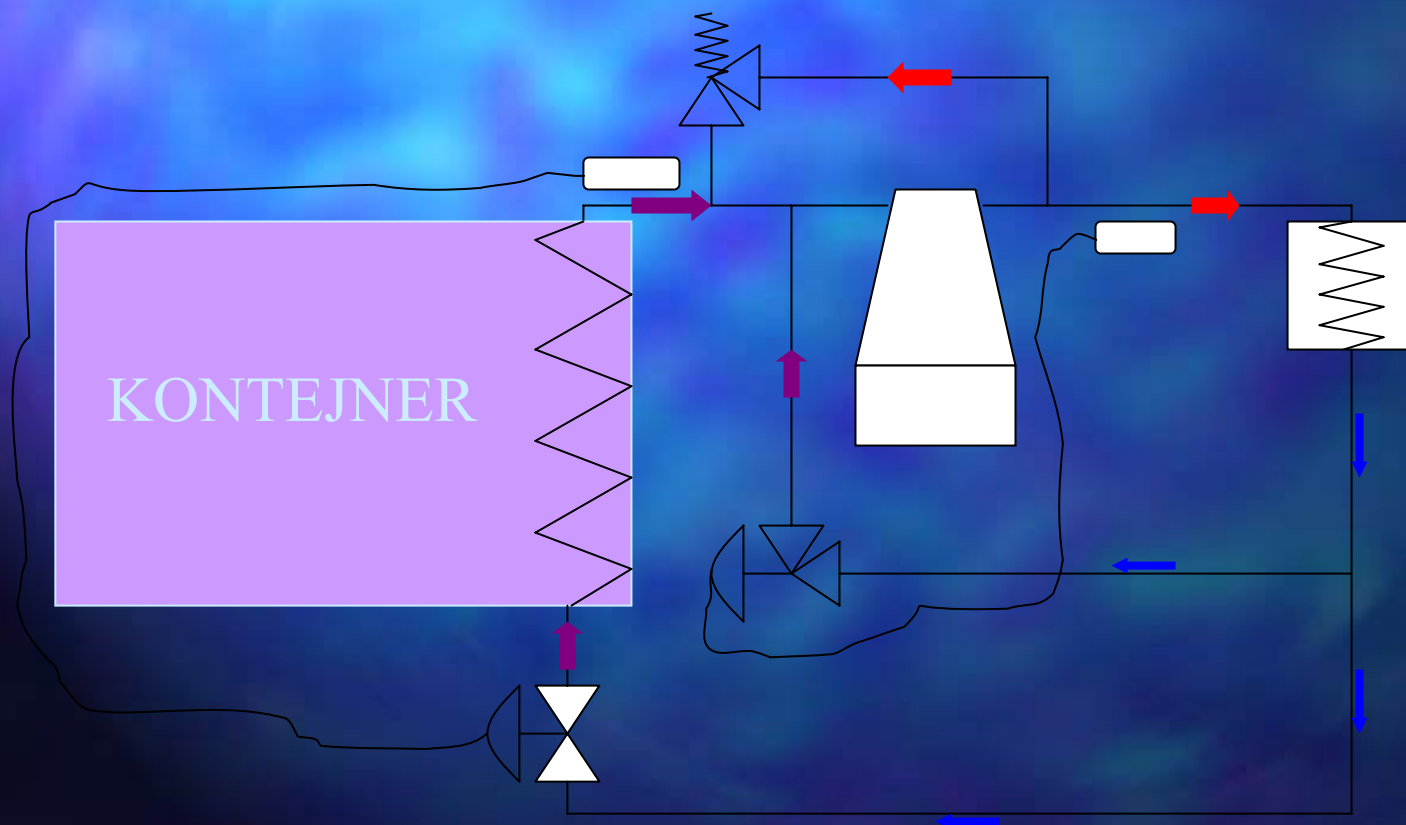
Kontejneri



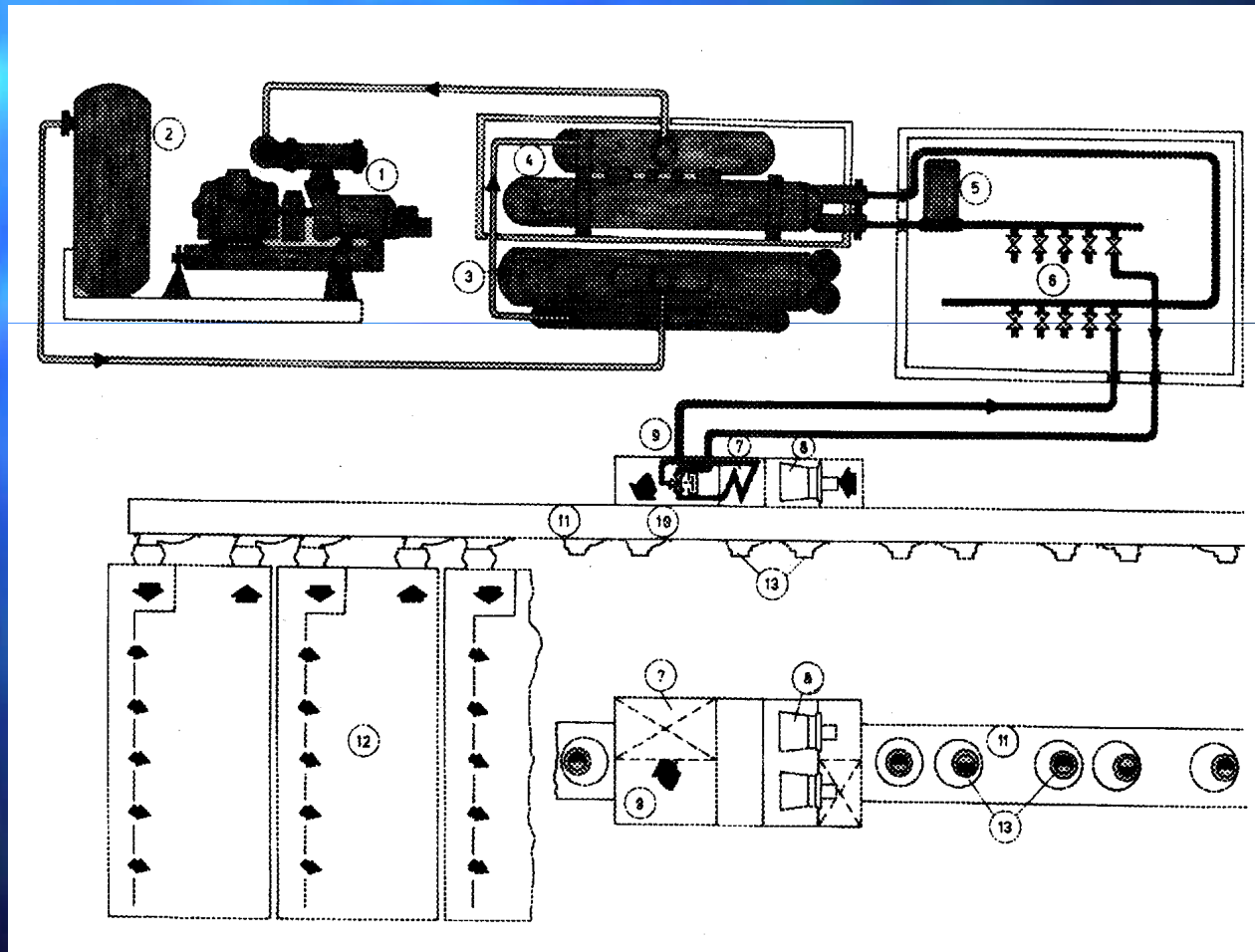
- | | |
|-----------------------|-----------------------------------|
| 1 – izolacija, | 5 – dva zračna otvora, |
| 2 – rashladno tijelo, | 6 – zatega na rashladnom uređaju, |
| 3 – ventilator, | 7 – protok zraka, |
| 4 – brtvila, | 8 – otvori za zrak. |

Rashladni kontejner sa skidljivim rashladnim agregatom

Shema uređaja

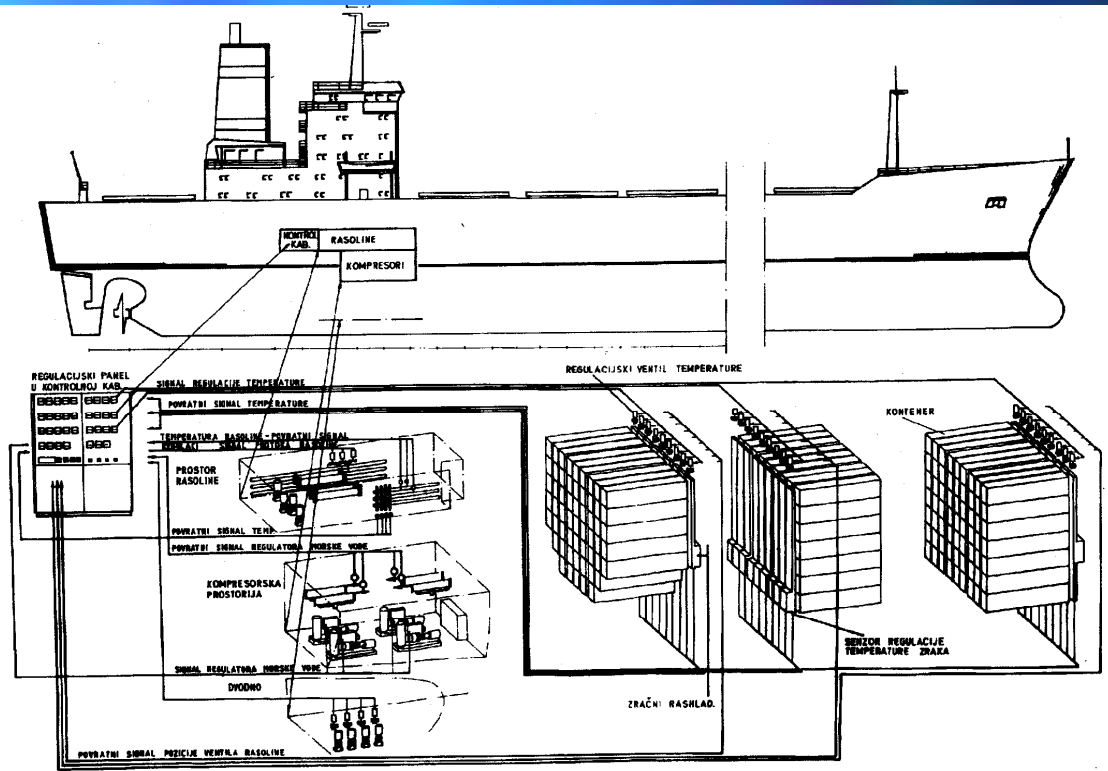


Kontejneriziran teret

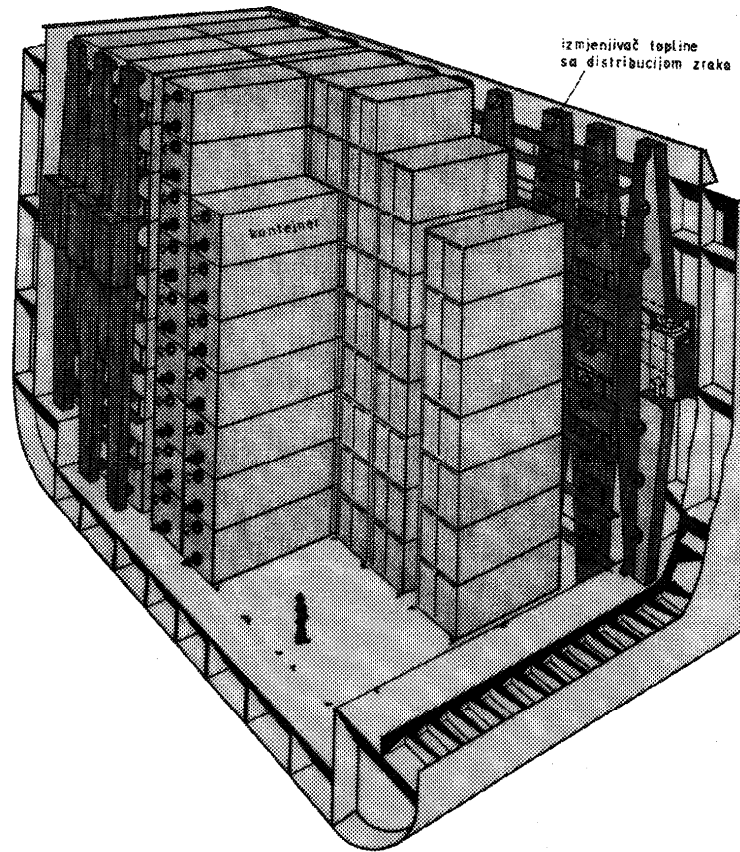


Kontejneri

Brod za prijevoz rashladnih kontejnera (Izvor: 41)



Kontejneri



Smještaj rashladnih kontejnera u skladištu broda (Izvor: 41)

Riba

- mlaz hladnog zraka (- 20-25°C)
- rasolina (- 12°C)
- isparivačke ploče
- pothlađivanje s morem (0°C)
- ekspanzija tekućeg dušika