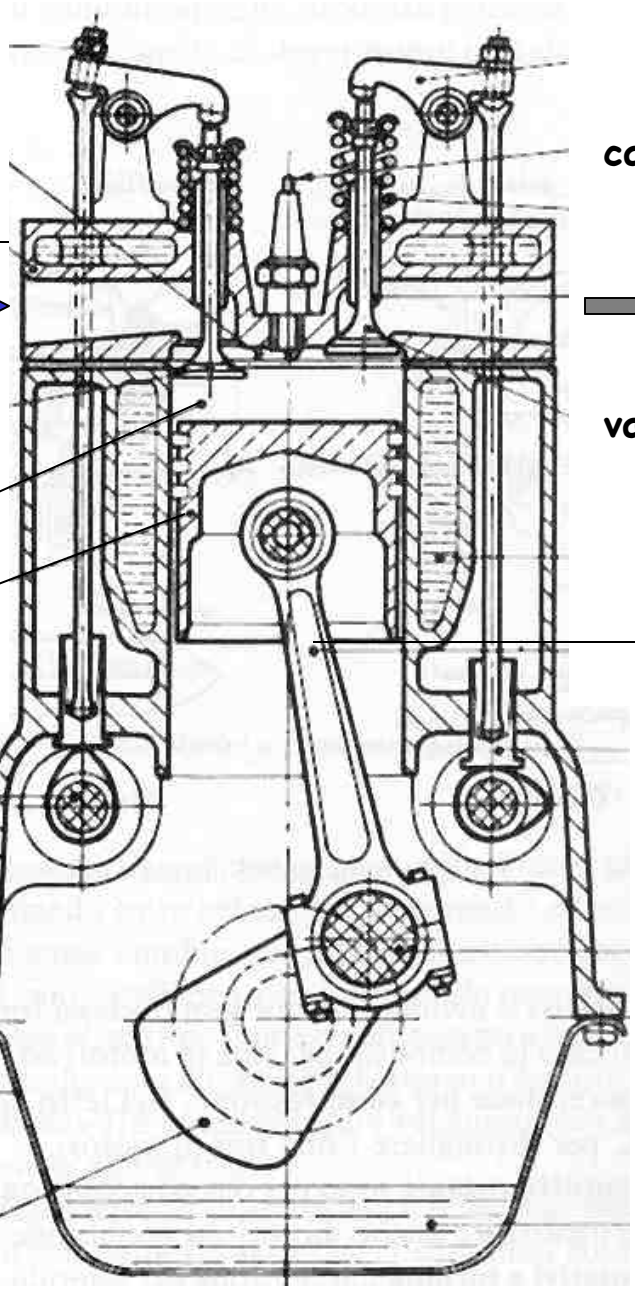
Programma

Motori a pistoni

- generalità
- cicli termodinamici teorici e reali
- prestazioni
- carburazione, iniezione e sovralimentazione


camera di combustione
candela
testa
(dal carburatore)
(gas di scarico)
valvola di aspirazione
valvola di scarico
cilindro
biella
pistone o stantuffo
basamento
albero a gomiti
coppa
contrappeso
lubrificante

Classificazione dei motori alternativi

Accensione del combustibile:
-ad accensione per scintilla (AS)
-ad accensione per compressione (AC)

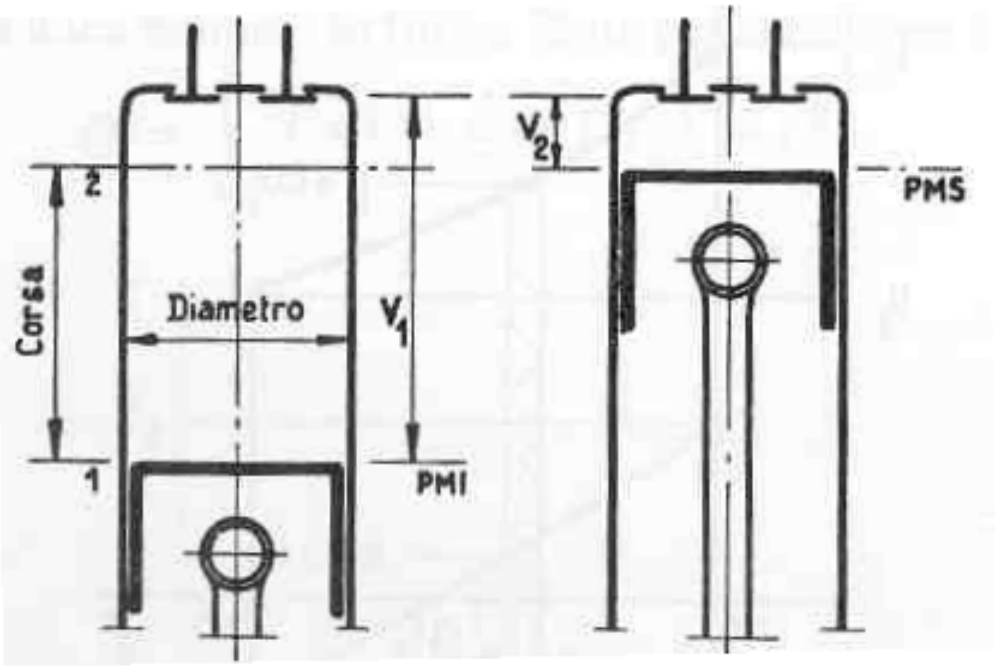
Ciclo operativo:
-a quattro tempi
-a due tempi

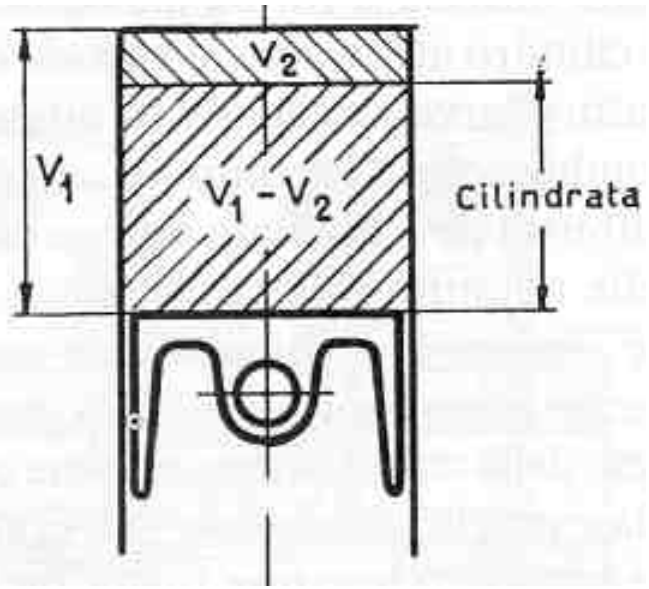
Immissione del combustibile:
-a carburazione
-ad iniezione

Sistema di alimentazione:
-ad aspirazione naturale
-sovralimentati

Sistema di raffreddamento:
-ad acqua
-ad aria
-a liquido speciale
……

Nomenclatura

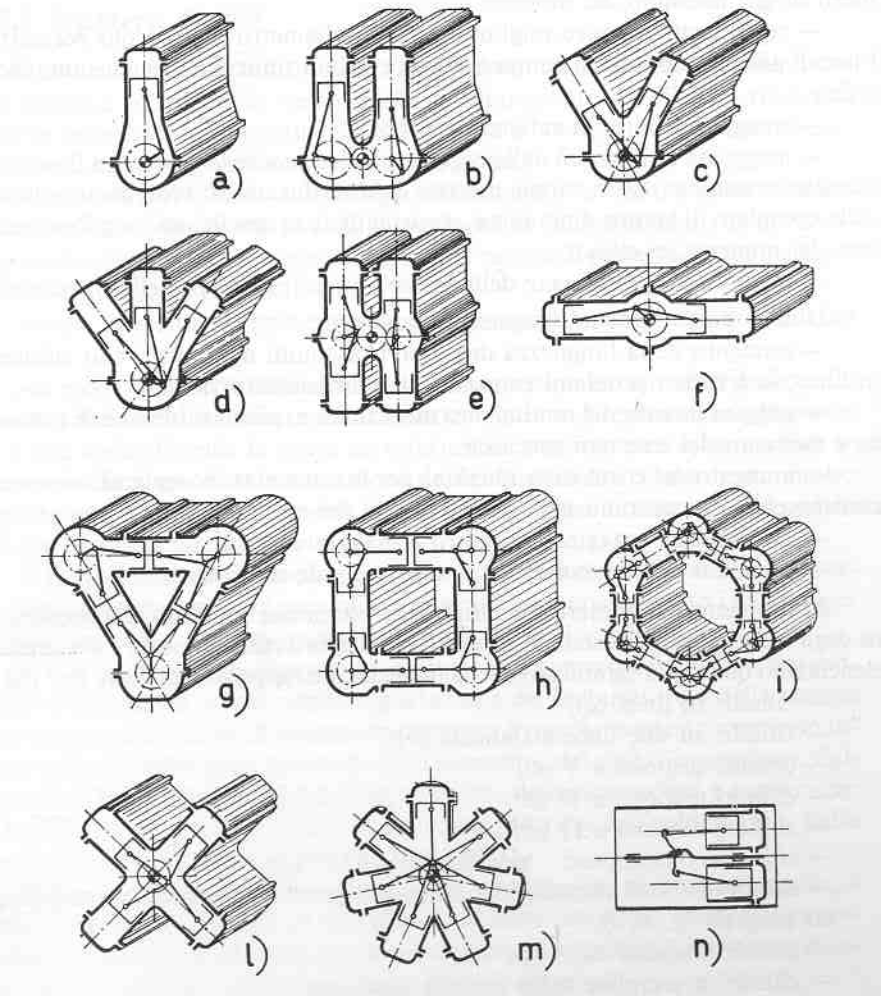




- Diametro od Alesaggio (Bore)
- Corsa (Stroke)
- Punto morto superiore (PMS)
- Punto morto inferiore (PMI)

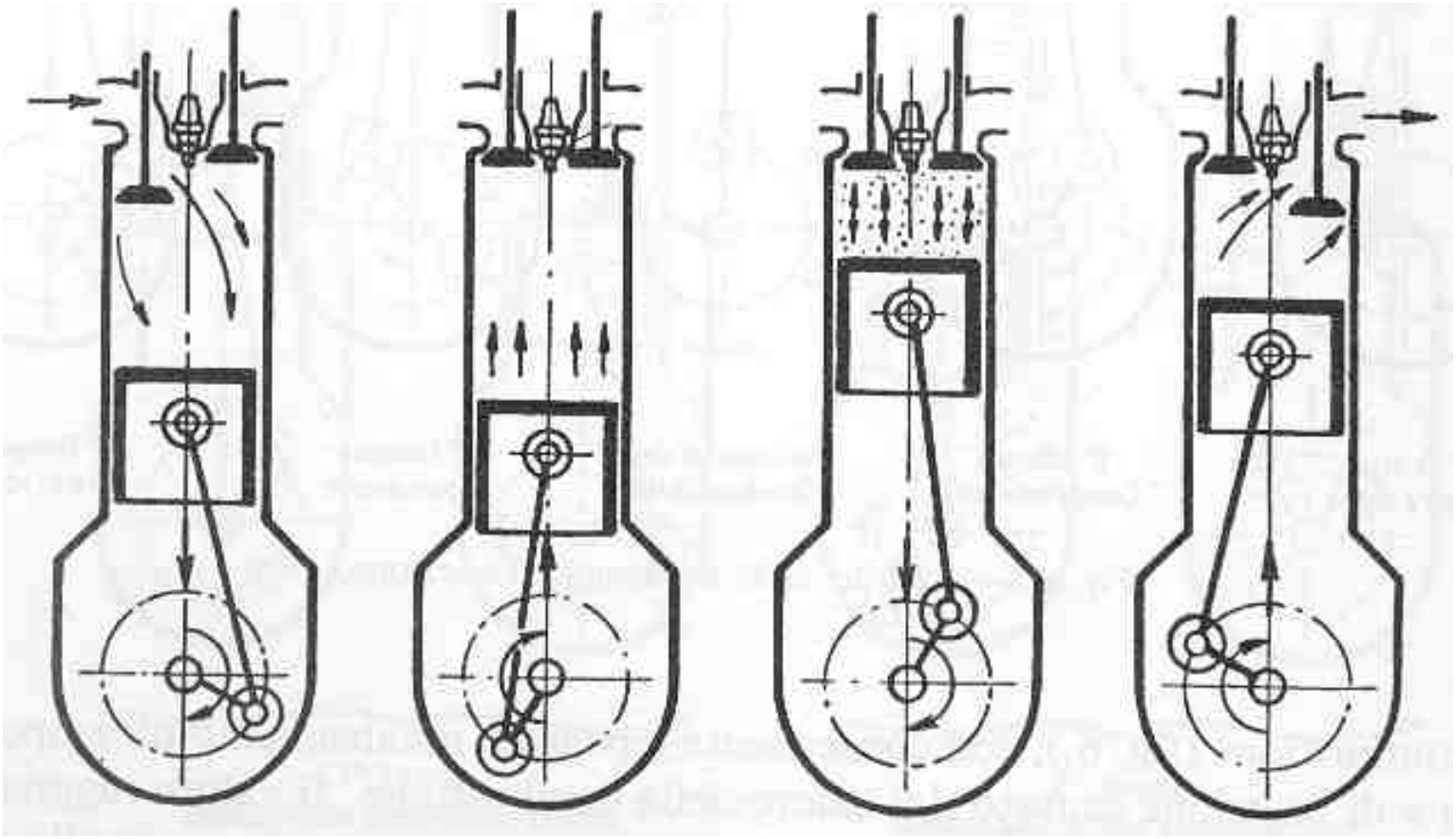
- Volume totale del cilindro, V_1
- Volume della camera di combustione, V_2
- Cilindrata, $V_1 - V_2$
- Rapporto volumetrico di compressione $\rho = V_1 / V_2$

Numero e disposizione dei cilindri



a) **Cilindri in linea**
b) **Cilindri su due linee affiancate**
c) **Cilindri a V**
d) **Cilindri a W**
e) **Cilindri ad H**
f) **Cilindri contrapposti**
g) **Cilindri a triangolo**
h) **Cilindri a quadrato**
i) **Cilindri ad esagono**
j) **Cilindri ad X**
k) **Cilindri a stella (o più stelle)**
l) **Cilindri in fascio paralleli**

Ciclo operativo a 4 tempi



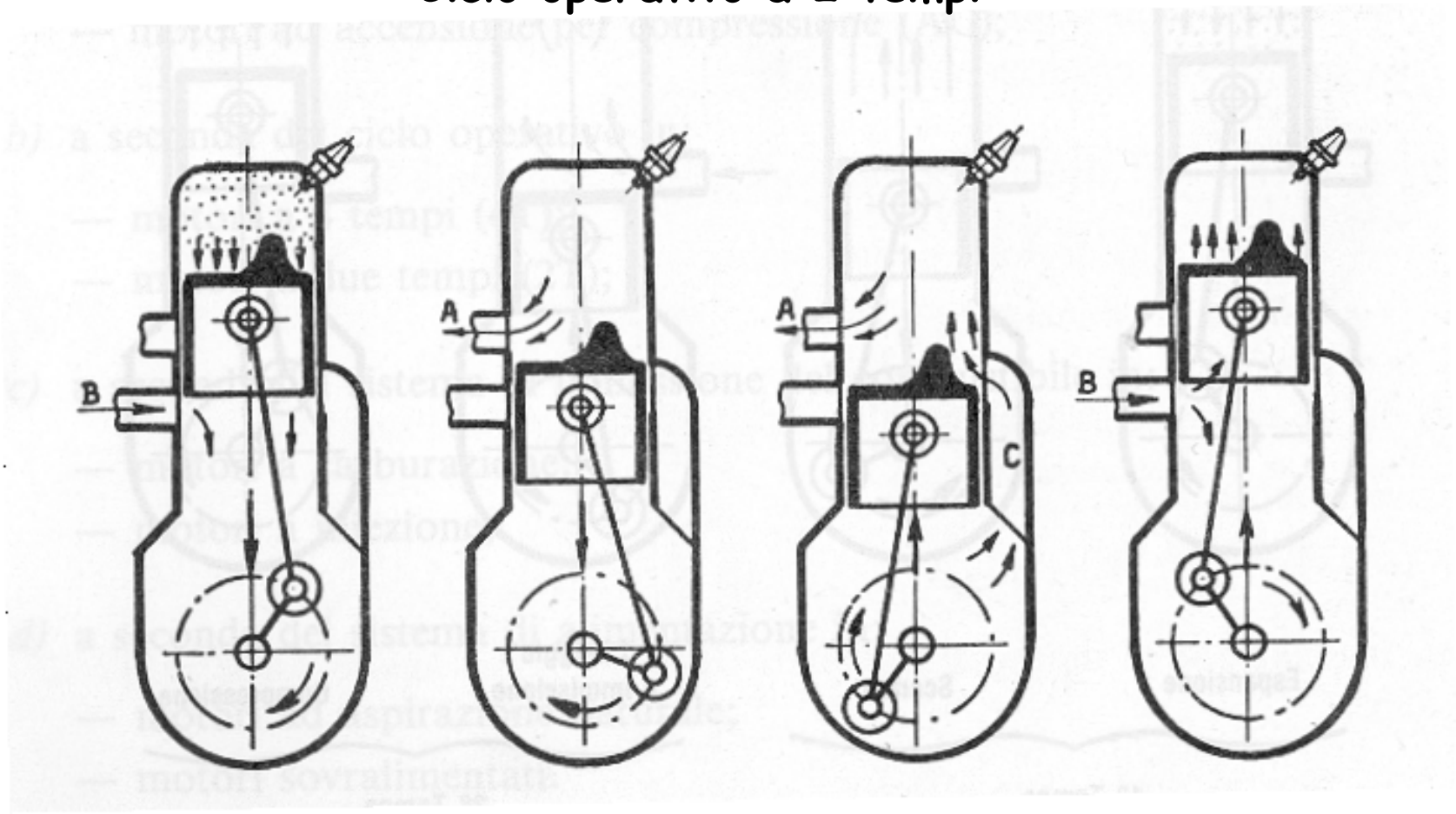
1° tempo:
Immissione

2° tempo:
Compressione

3° tempo:
Combustione

4° tempo:
Scarico

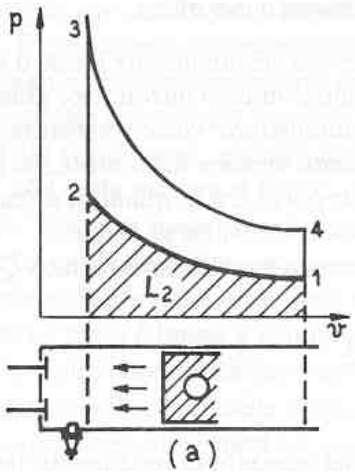
Ciclo operativo a 2 tempi

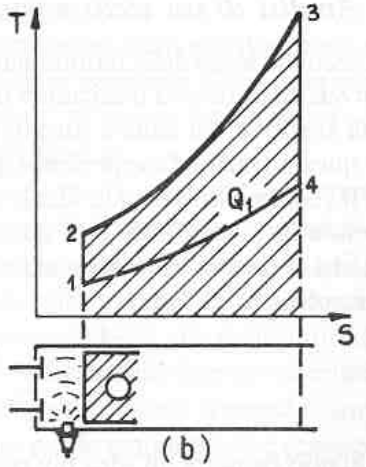


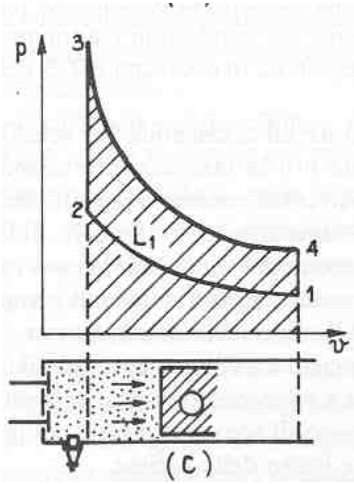
Espansione — Scarico — Lavaggio ed immissione — Compressione

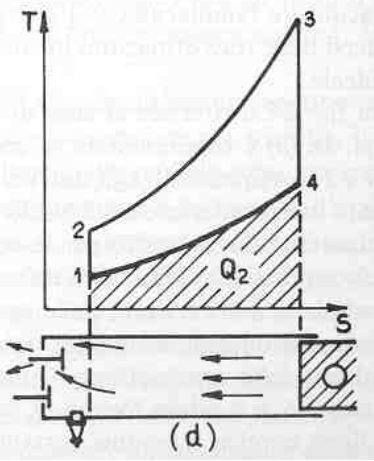
1° tempo — 2° tempo

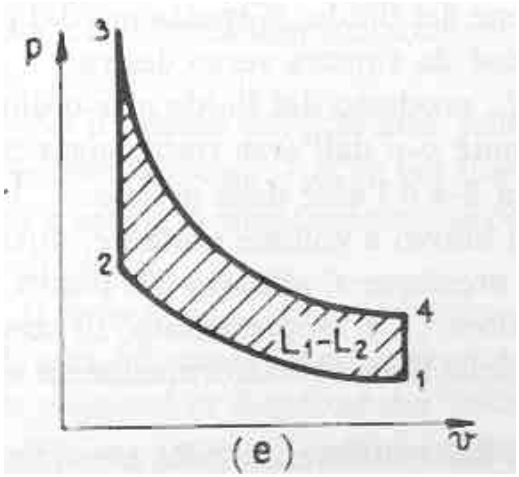
Il ciclo Otto teorico

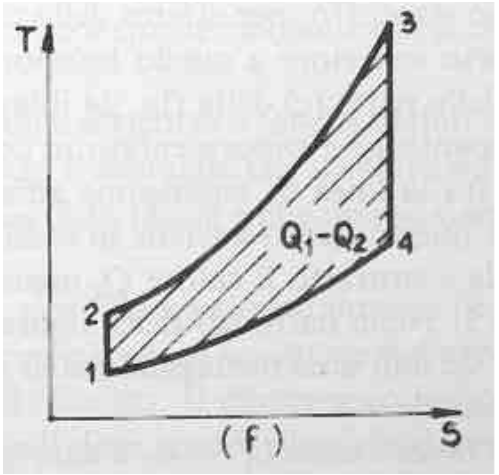












Il ciclo Otto teorico

1-2: Compressione isoentropica (lavoro L_1)

2-3: Introduzione (istantanea) di calore a volume costante (calore Q_1)

3-4: Espansione isoentropica (lavoro L_2)

4-1: Sottrazione (istantanea) del calore a volume costante (calore Q_2)

Il ciclo Otto teorico

Dal primo principio della termodinamica (sistema chiuso):

$Q_1 = U_3 - U_2$

$Q_2 = U_4 - U_1$

$L_u = L_2 - L_1 = Q_1 - Q_2$

cioè:

$L_u = (U_3 - U_2) - (U_4 - U_1)$

e quindi: $\eta_T = \frac{L_u}{Q_1} = \frac{(U_3 - U_2) - (U_4 - U_1)}{U_3 - U_2} = 1 - \frac{U_4 - U_1}{U_3 - U_2}$

Il ciclo Otto teorico

Ipotesi: gas caloricamente perfetto:

$$U_3 - U_2 = c_v(T_3 - T_2)$$

$$U_4 - U_1 = c_v(T_4 - T_1)$$

Per le trasformazioni isoentropiche:

$$\frac{T_1}{T_2} = \left(\frac{v_1}{v_2}\right)^{(1-\gamma)} = \rho^{(1-\gamma)}$$

$$\frac{T_4}{T_3} = \left(\frac{v_4}{v_3}\right)^{(1-\gamma)}$$

Il ciclo Otto teorico

Quindi:

$$\eta_T = 1 - \frac{U_4 - U_1}{U_3 - U_2} = 1 - \frac{T_4 - T_1}{T_3 - T_2} = 1 - \frac{T_1}{T_2}\left(\frac{\frac{T_4}{T_1} - 1}{\frac{T_3}{T_2} - 1}\right)$$

Ma $v_1 = v_4$ e $v_2 = v_3$ e quindi:

$$\frac{T_2}{T_1} = \frac{T_3}{T_4} \Rightarrow \frac{T_4}{T_1} = \frac{T_3}{T_2}$$

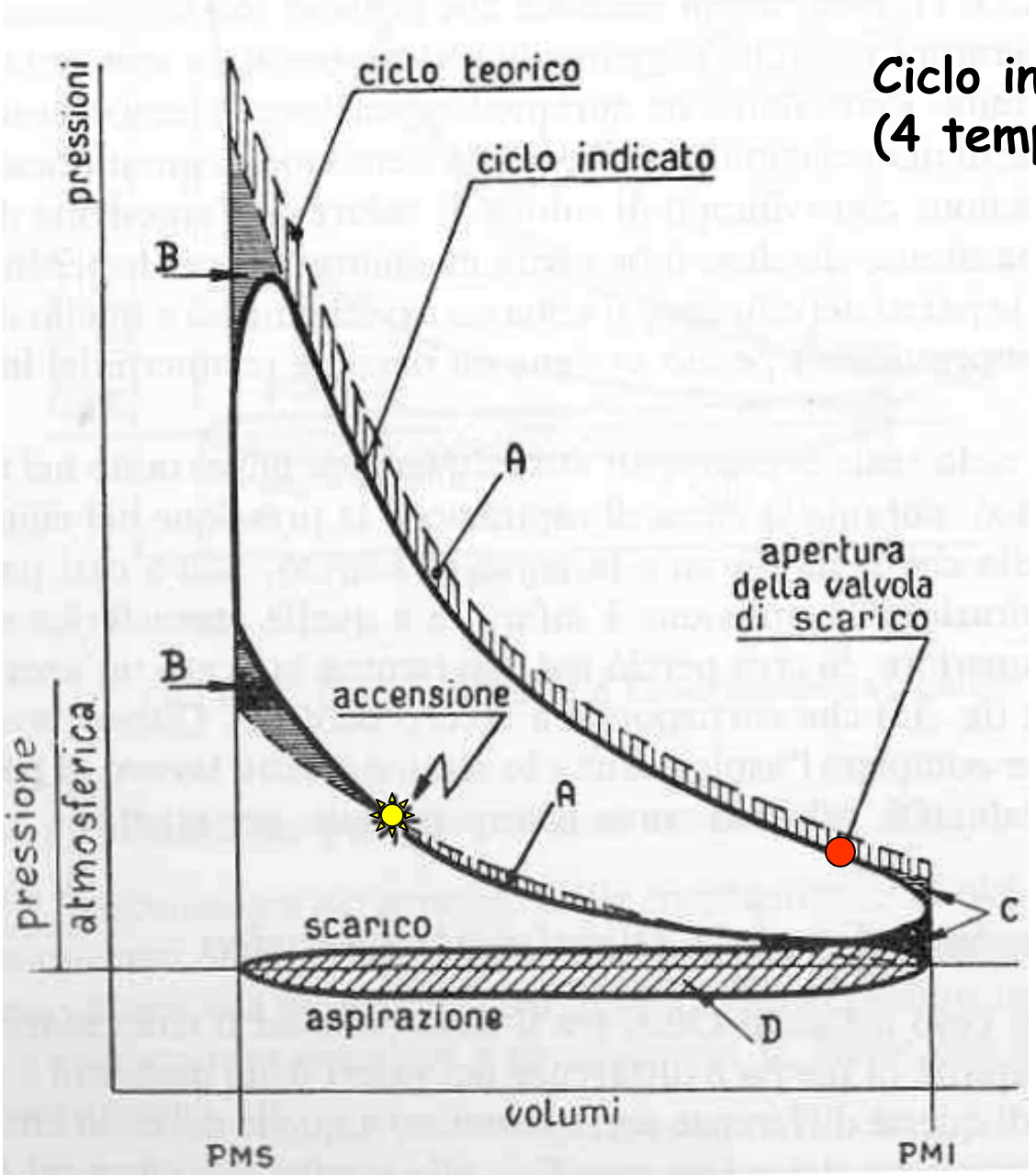
E quindi:

$$\boxed{\eta_T = 1 - \rho^{(1-\gamma)}}$$

$\rho \uparrow \Rightarrow \eta_T \uparrow$

$\gamma \uparrow \Rightarrow \eta_T \uparrow$

Ciclo indicato (4 tempi)



Ciclo indicato (2 tempi)

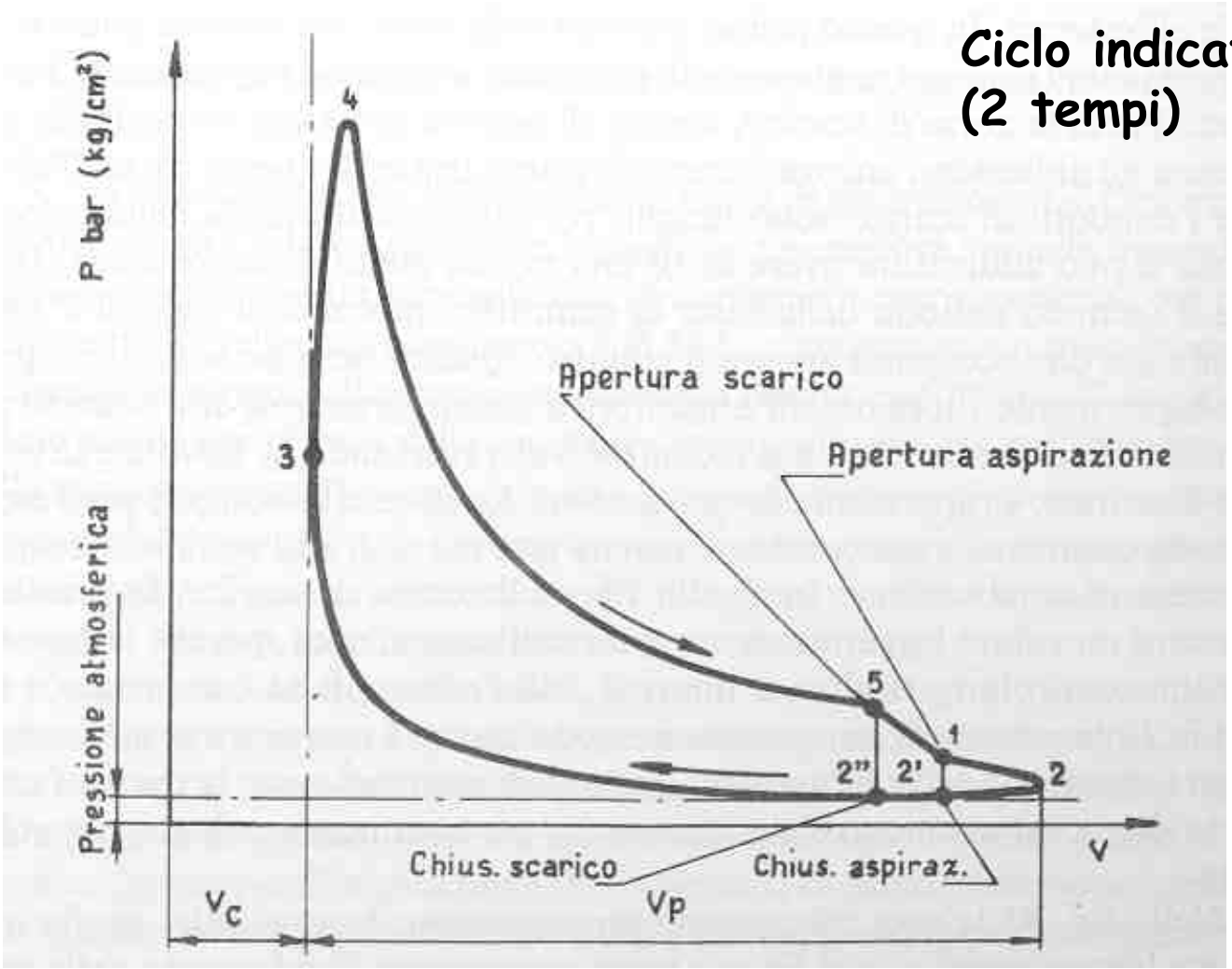


Diagramma delle pressioni (4 tempi)

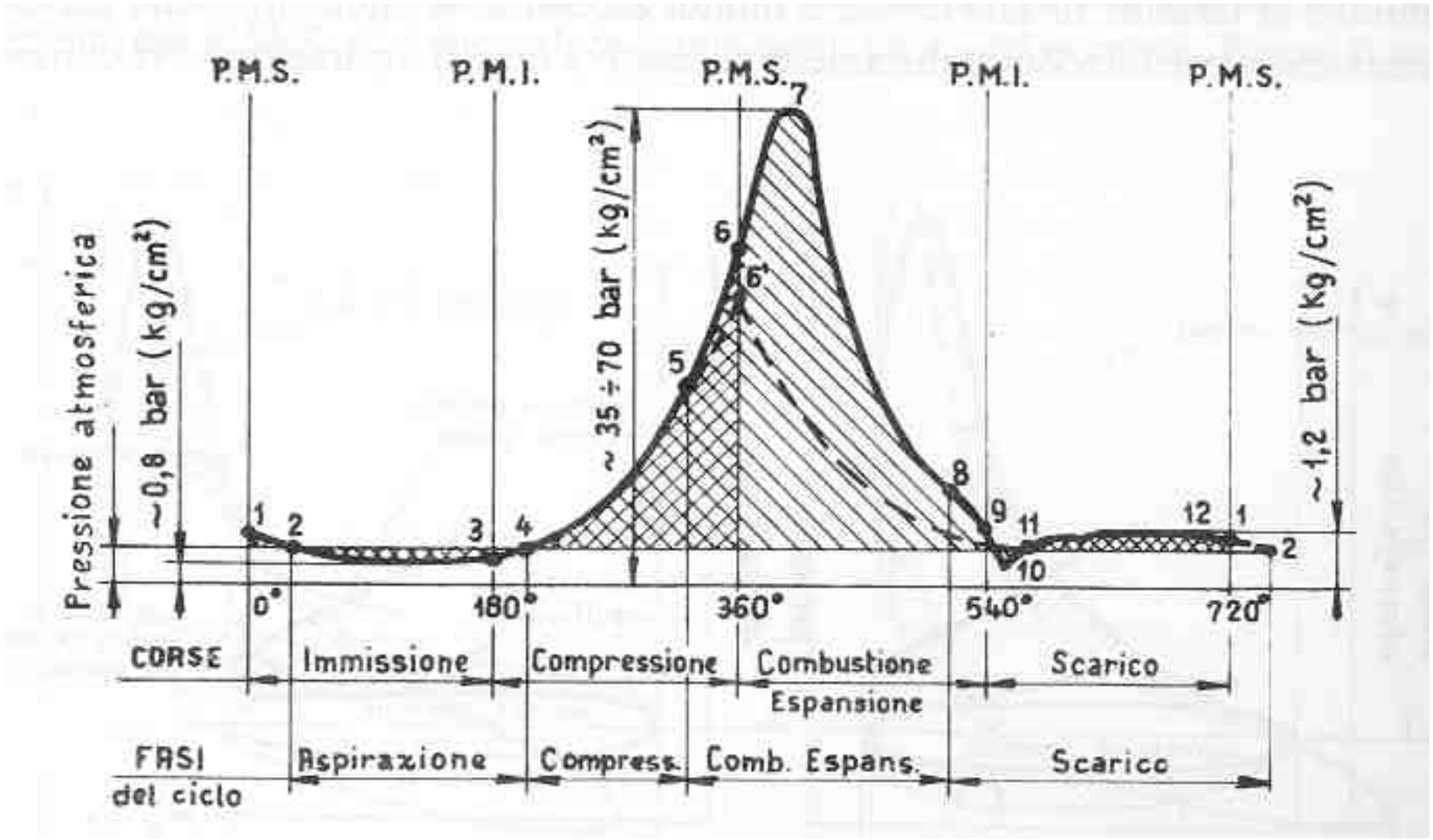


Diagramma delle pressioni (2 tempi)

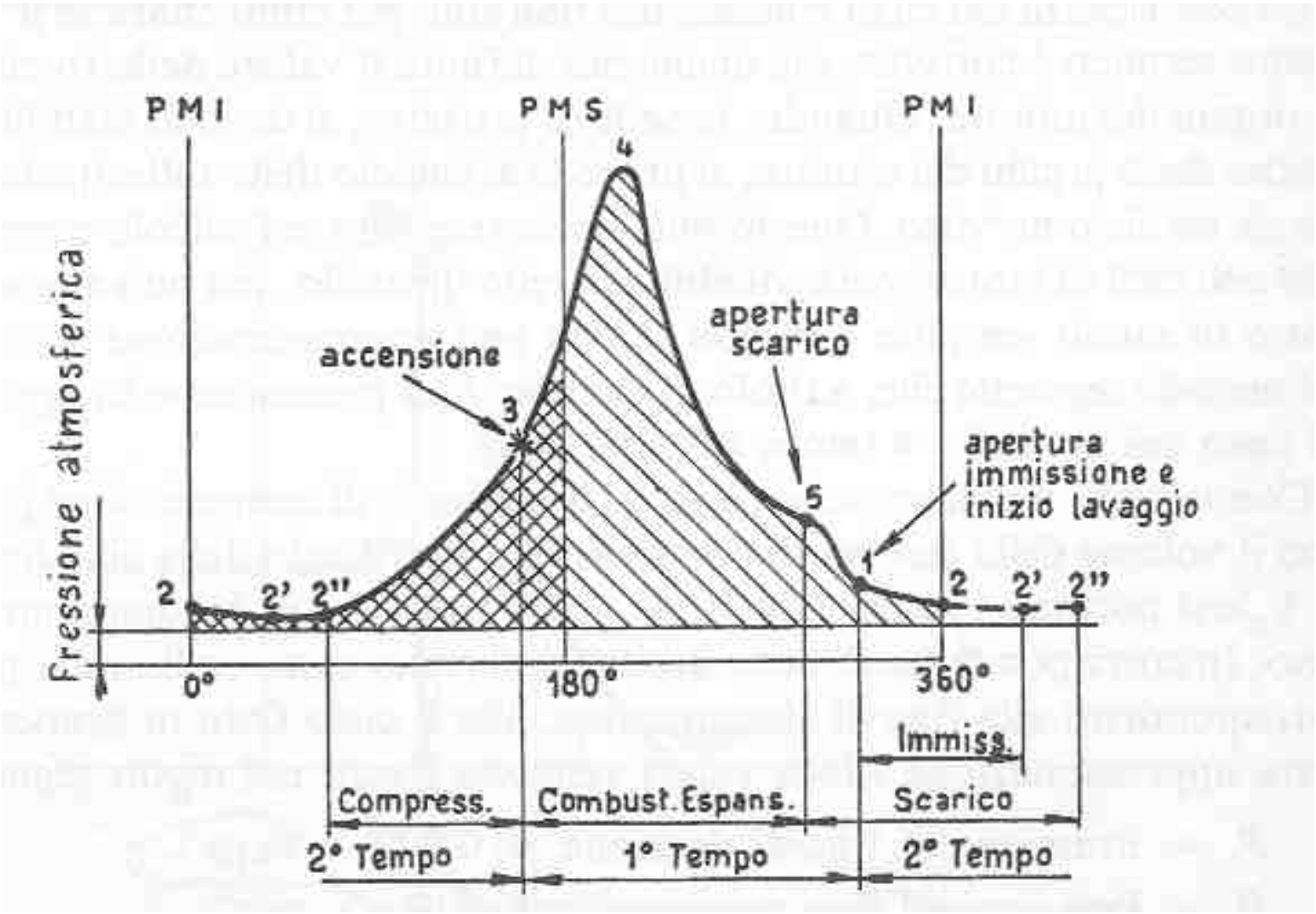


Diagramma della distribuzione (4 tempi)

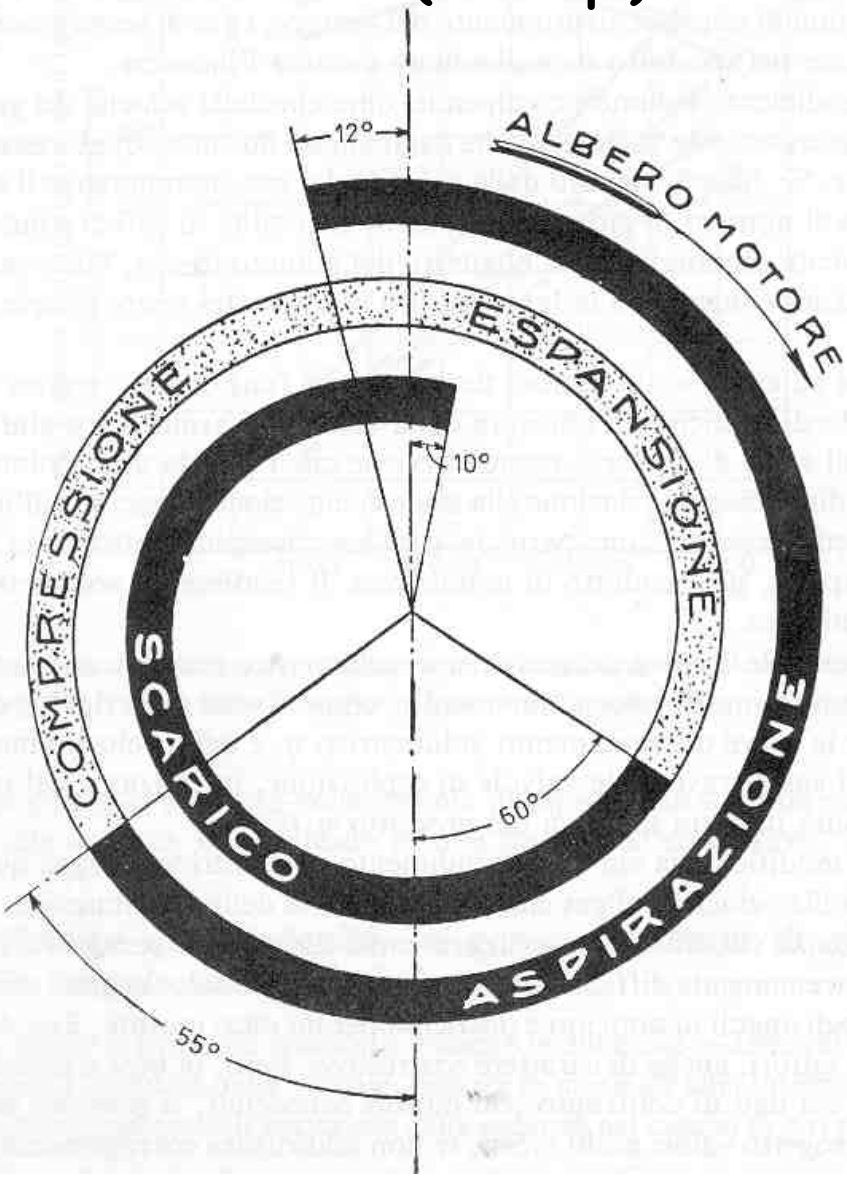
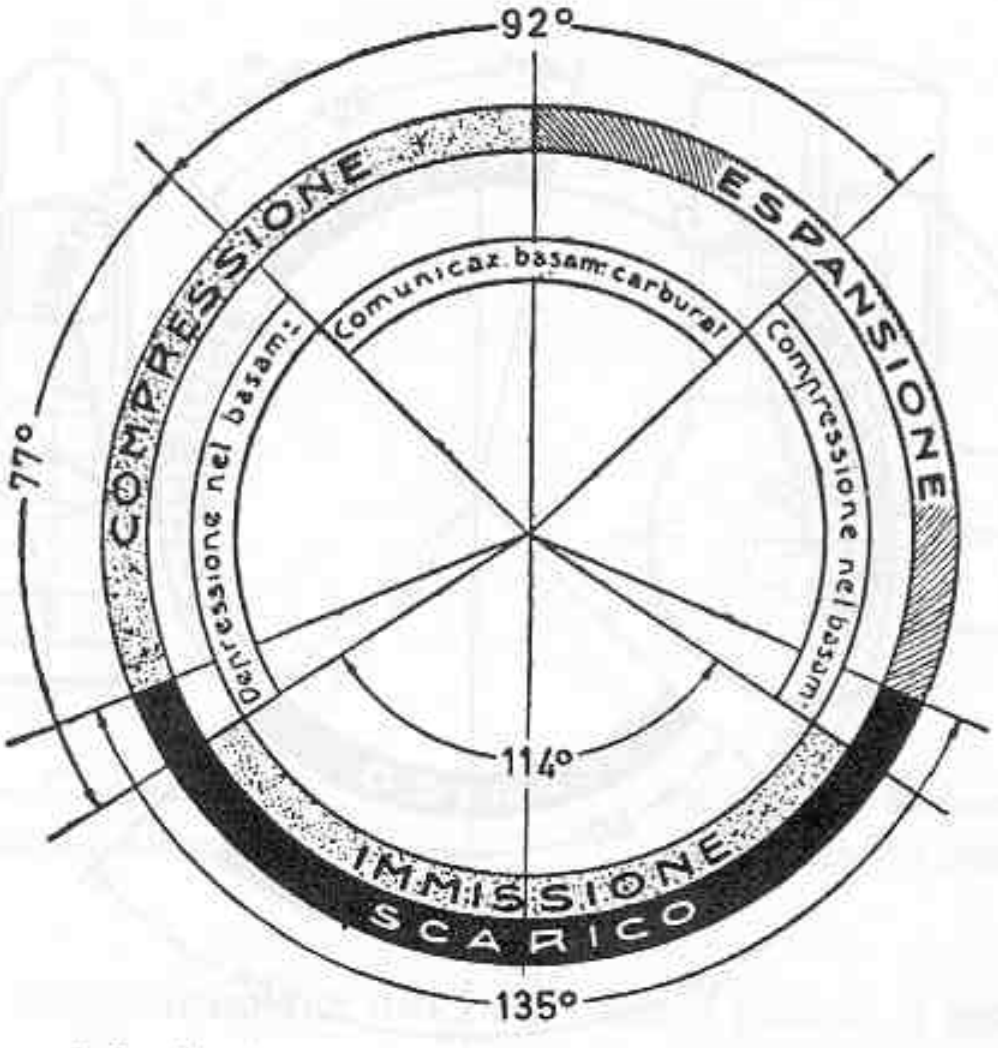
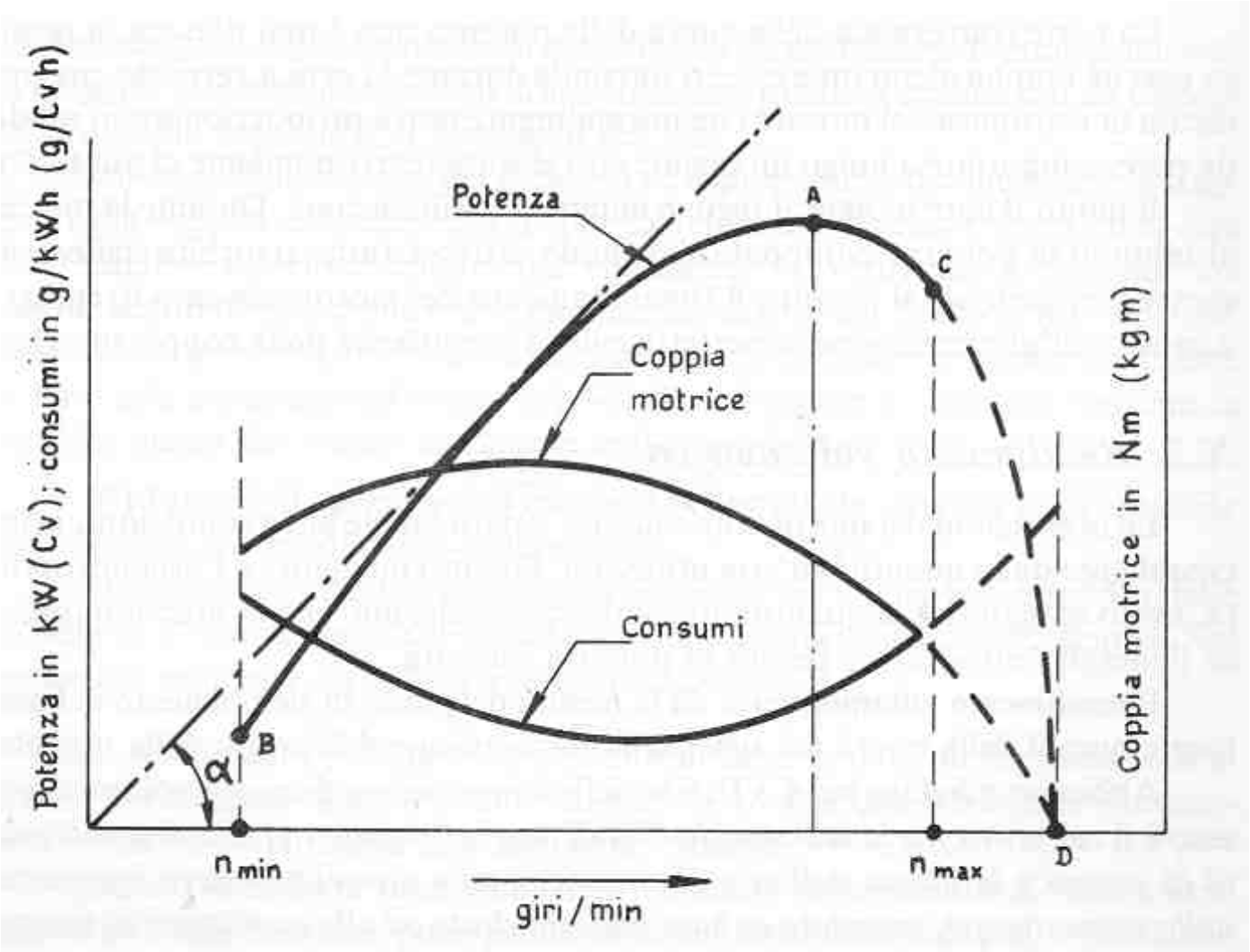


Diagramma della distribuzione (2 tempi)



Curve caratteristiche



Piano quotato dei consumi

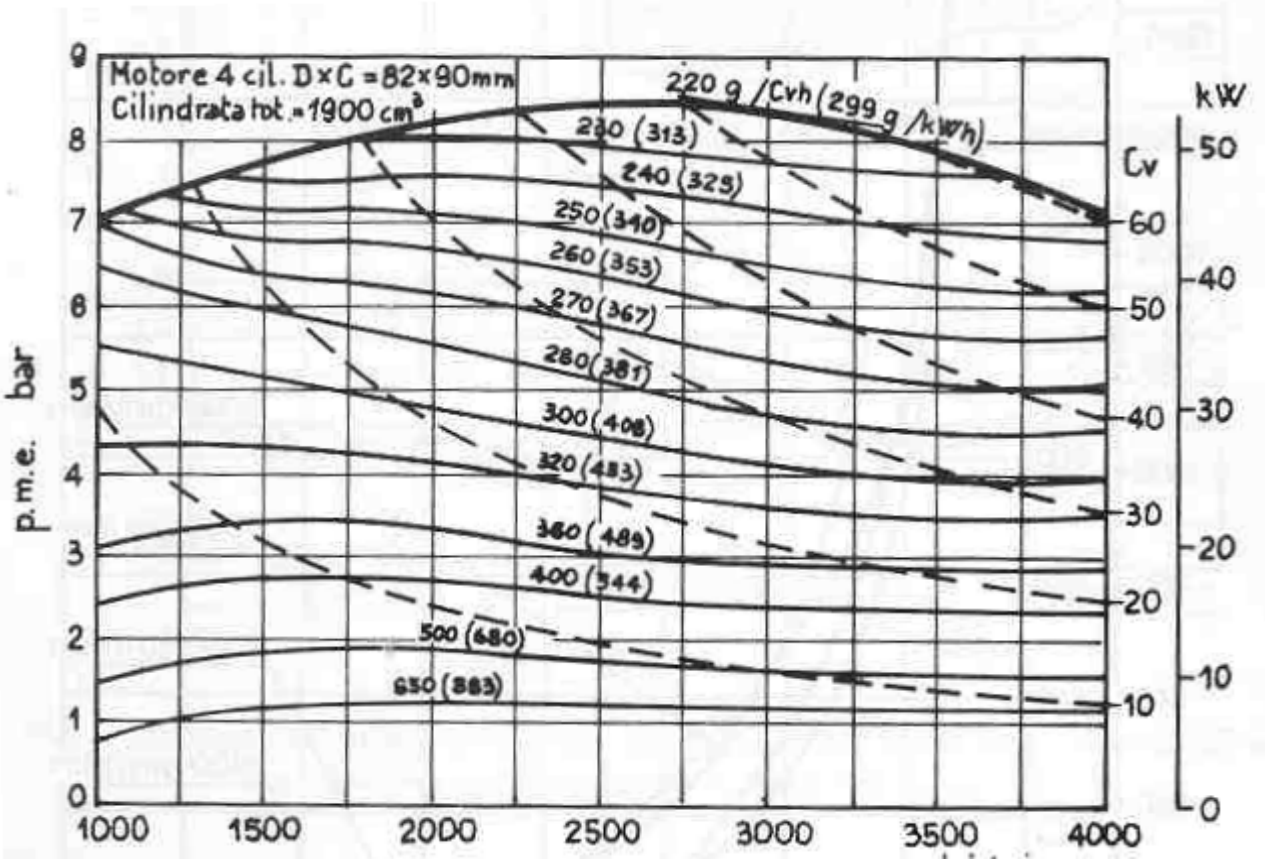
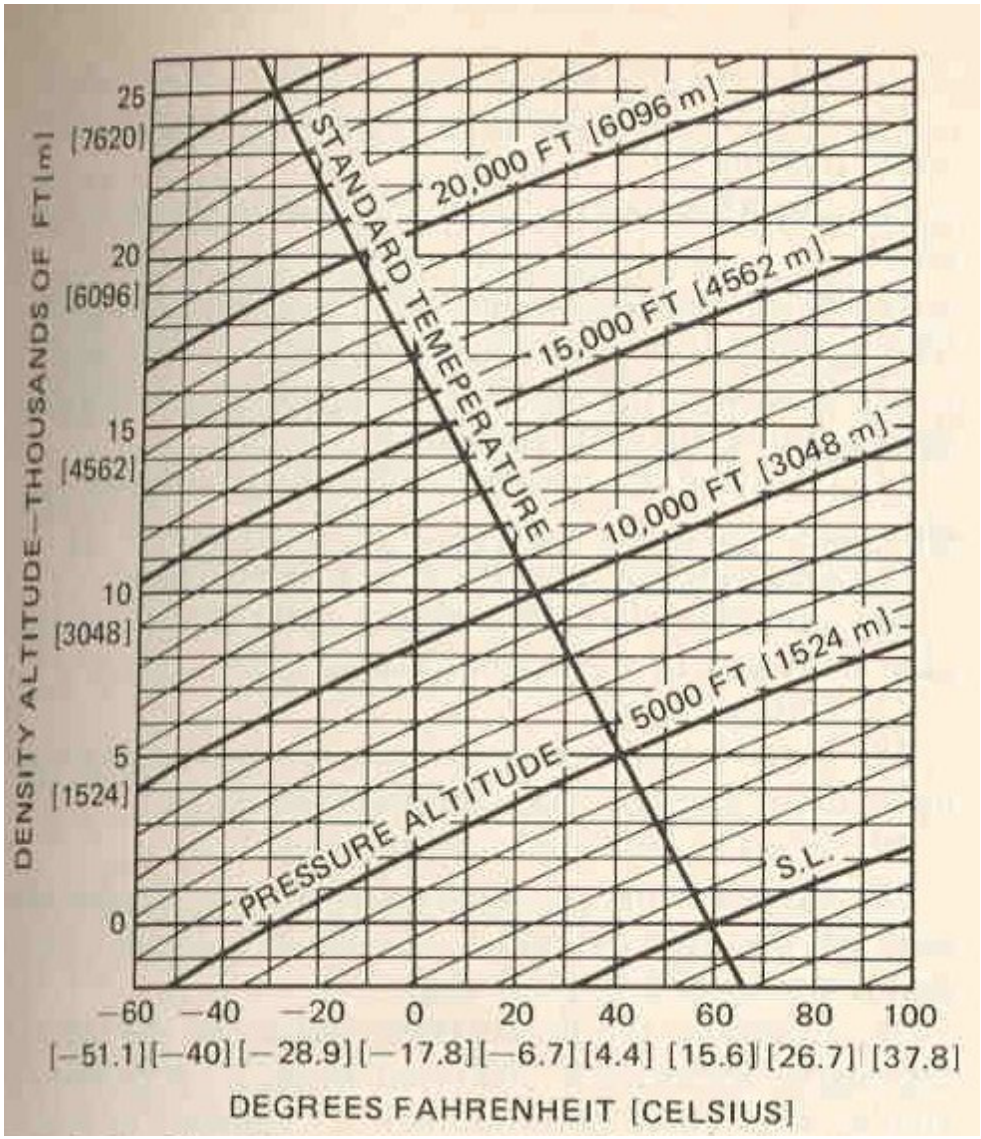
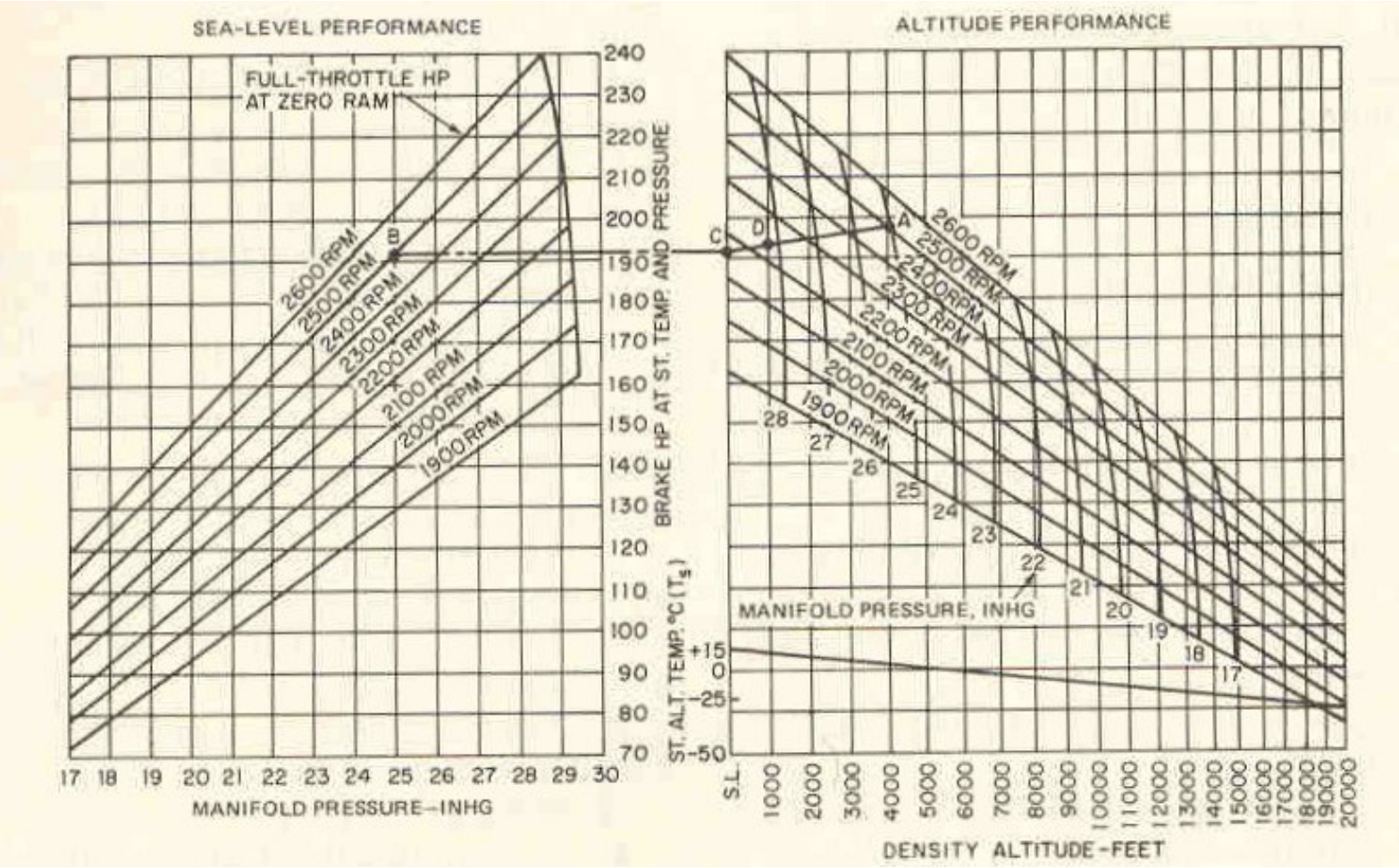


Grafico della quota equivalente di densità

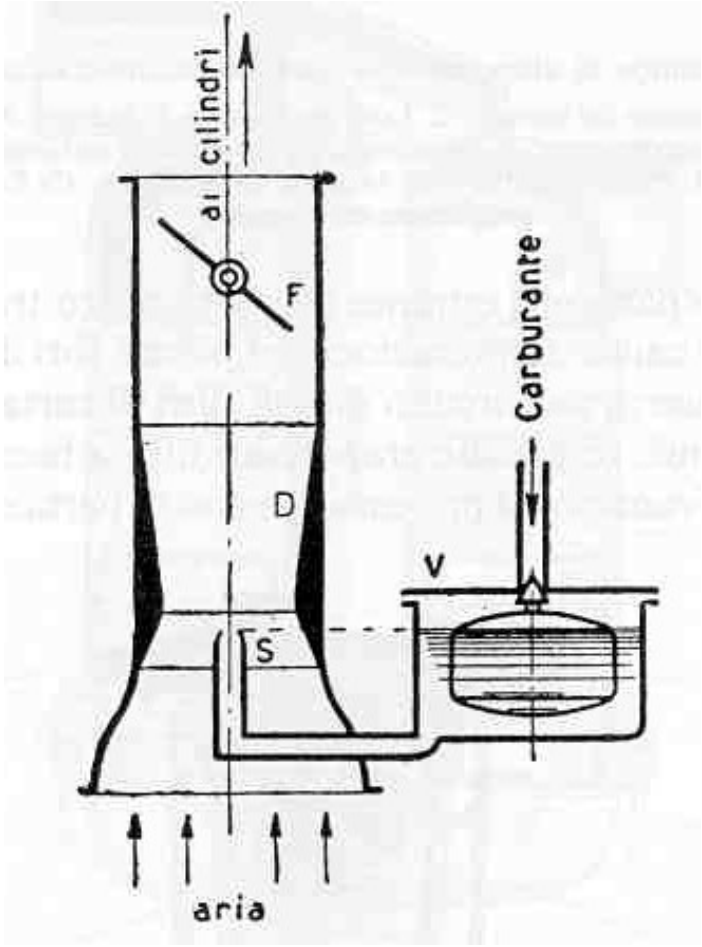


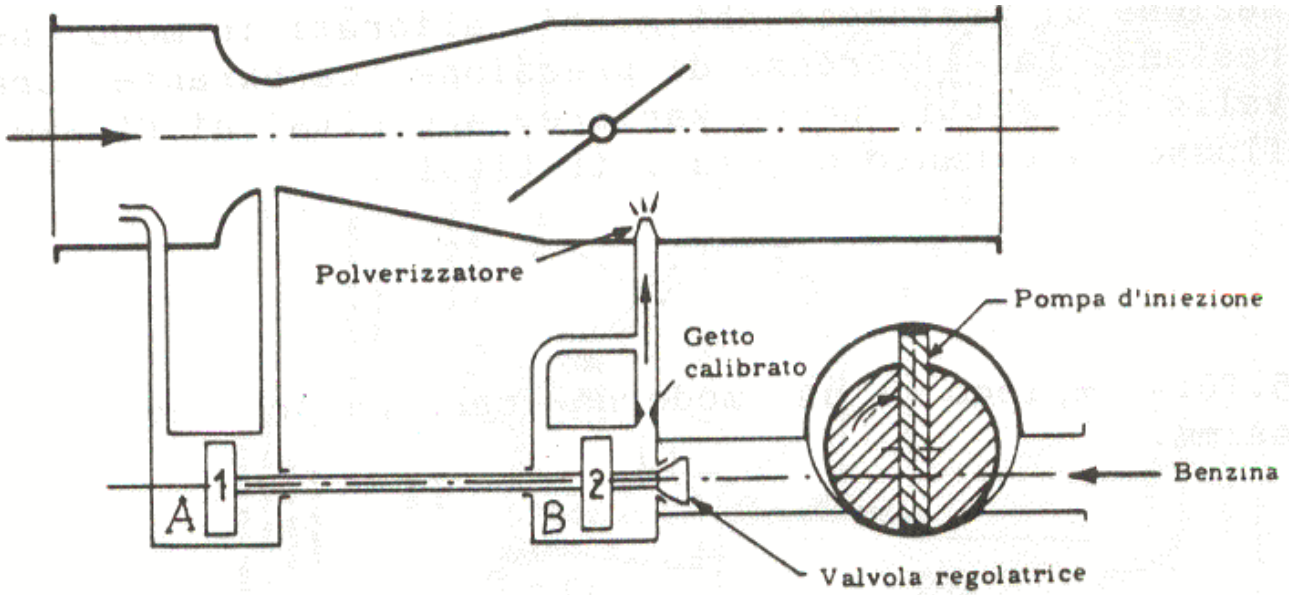
Curve di Calibratura



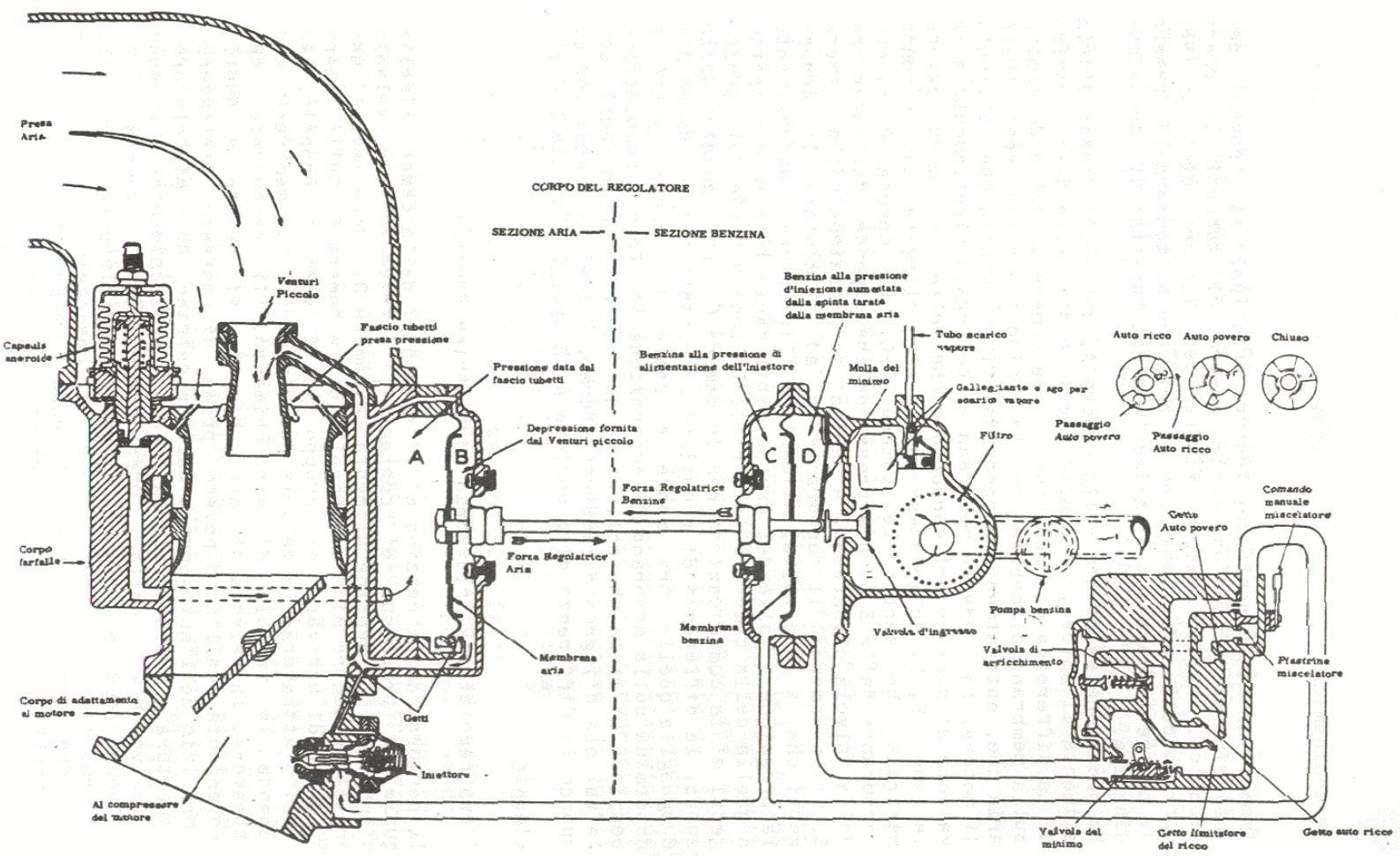
(Continental O-470-M)

Il carburatore semplice





Carburatore ad iniezione



Carburatore ad iniezione (sistema Bendix-Stromberg)

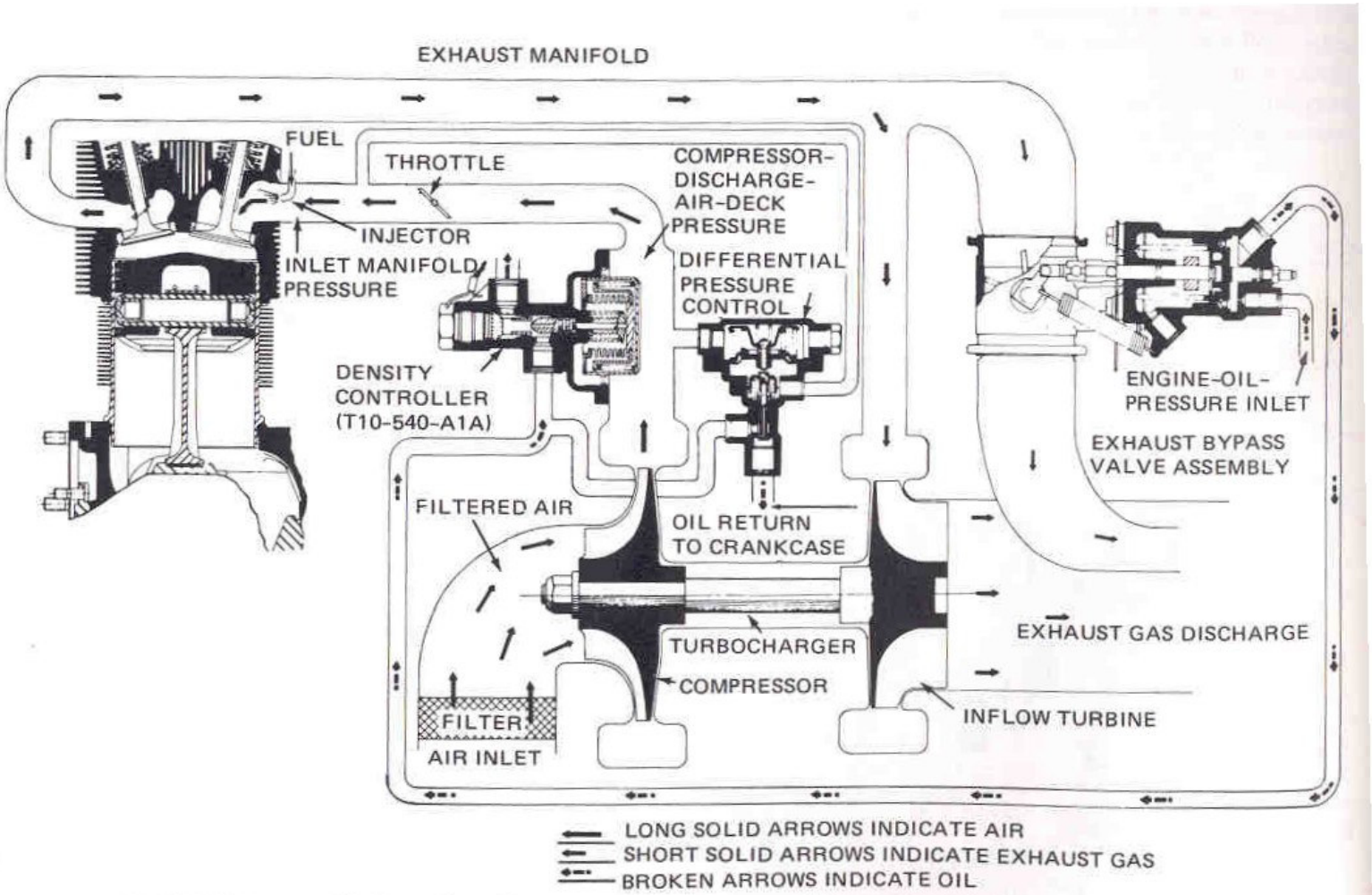


FIG. 5-25 Schematic diagram of automatic turbocharger control system. *(Textron Lycoming)*

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