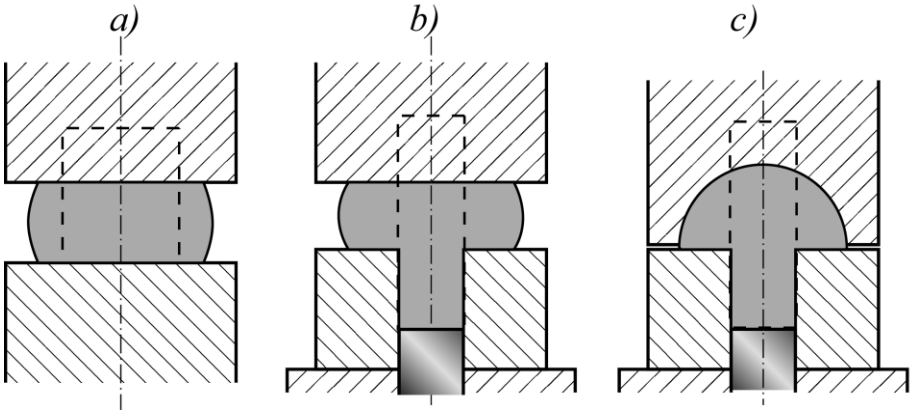
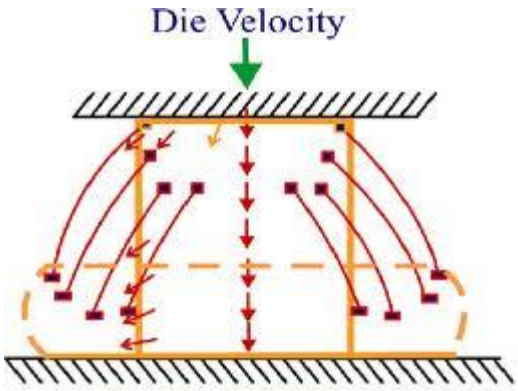
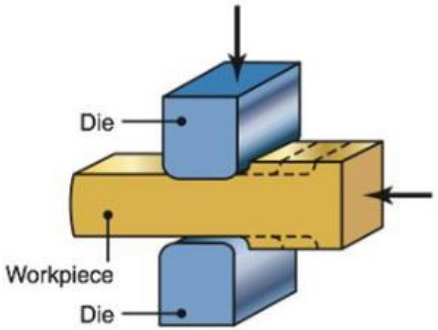
Sabijanje valjka

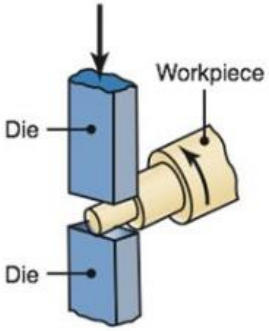
Sabijanje valjka predstavlja elementarnu operaciju zapreminskog oblikovanja koja se vrlo često pojavljuje kao samostalna operacija ili operacija predoblikovanja pri izradi složenih delova. se kao

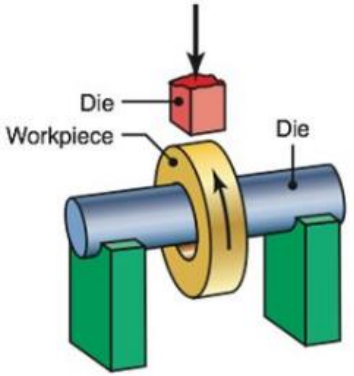
- slobodno sabijanje
- sabijanje u kalupu

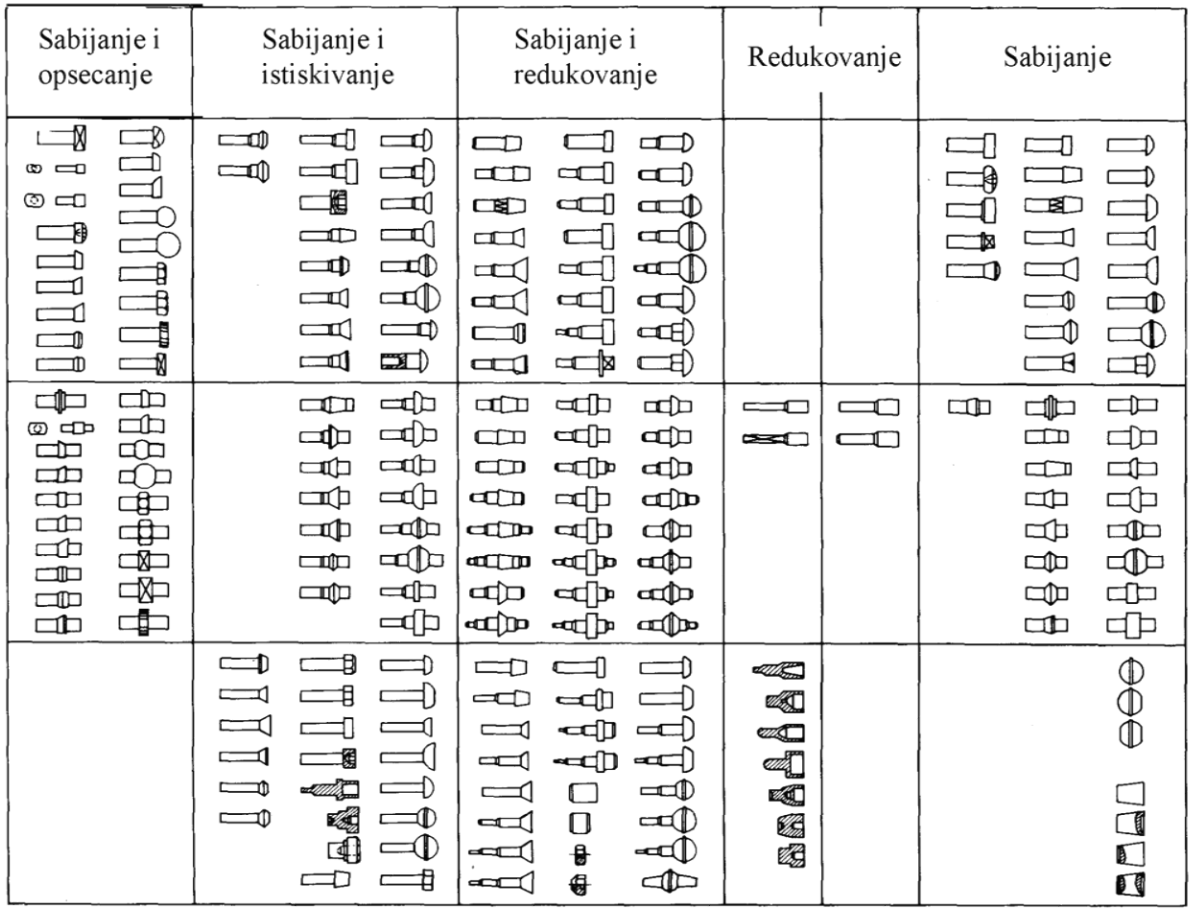


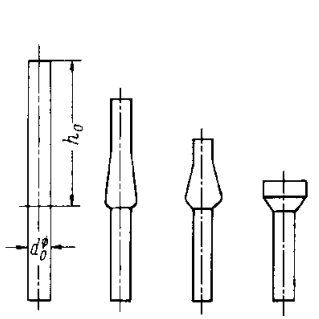


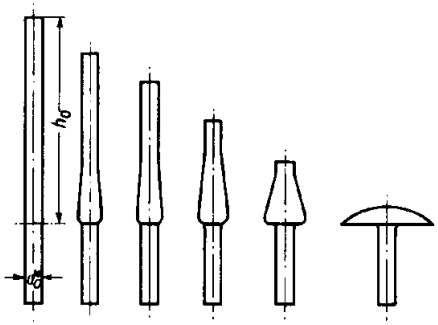


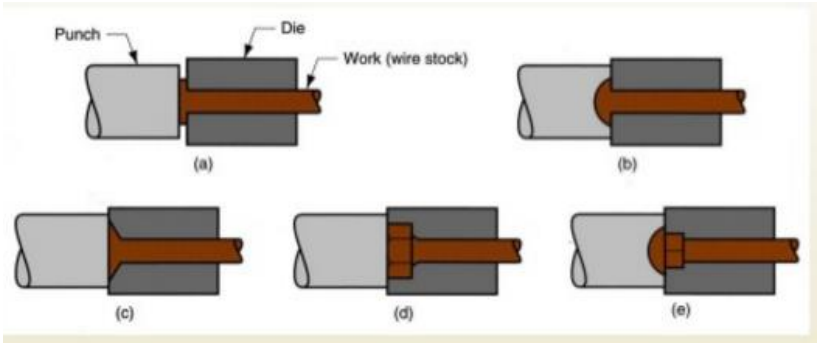





Sabijanje i opsecanje
Sabijanje i istiskivanje
Sabijanje i redukovanje
Redukovanje
Sabijanje






Punch
Die
Work (wire stock)
(a)
(b)
(c)
(d)
(e)

Custom heading parts
Material: Aluminium,Copper,Steel,etc.
Shape & Size: Customized

Custom heading parts
Material: Aluminium,Copper,Steel,etc.
Shape & Size: Customized

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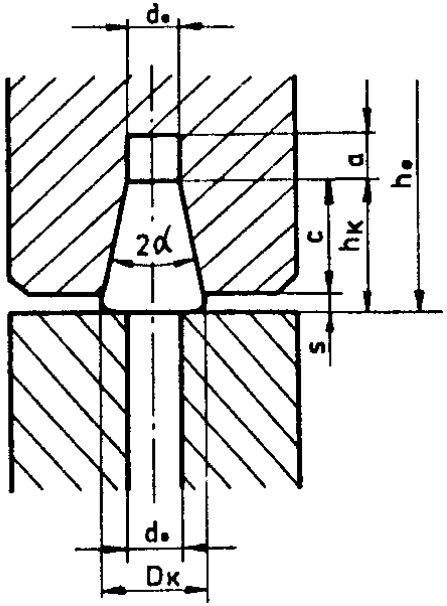
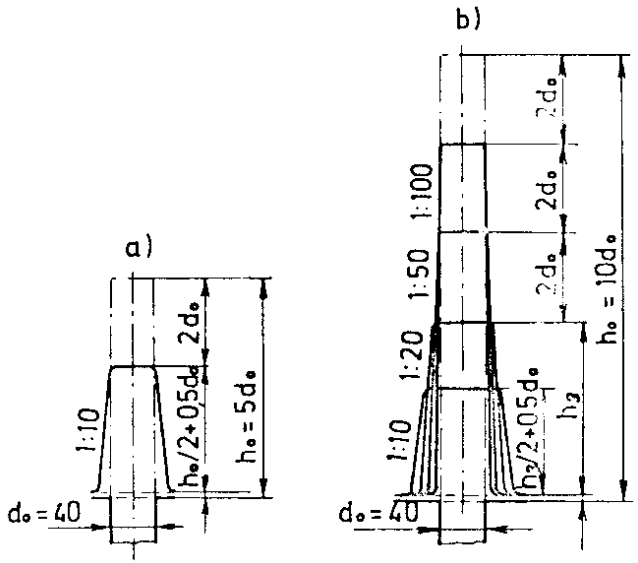
Granični odnosi sabijanja



$15^o < 2\alpha < 25^o$

Broj operacija	$(h_o/d_o)_g$	$(d_1/h_1)_g$	$(d_1/d_o)_g$
1	2,4	4,5	2,2
2	2,4÷4,5	4,5÷8,5	2,2÷2,6
3	4,5÷8	8,5÷10	2,6÷4
>3	>8		

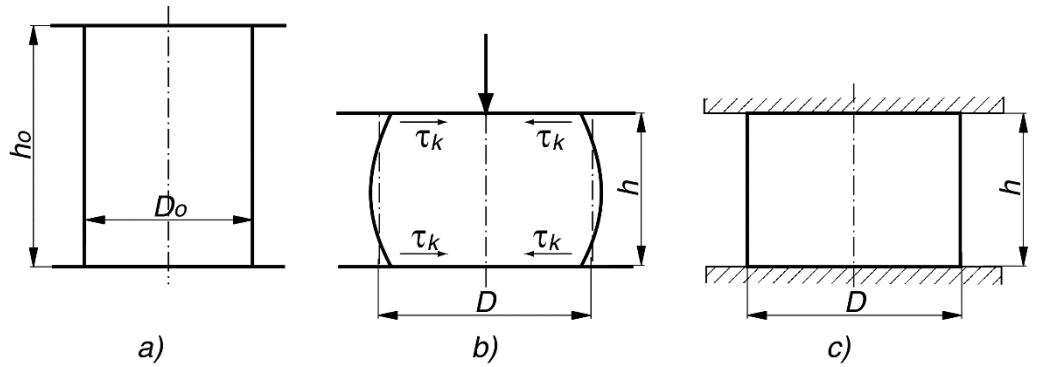
Hladna obrada



Topla obrada

$h_o/d_o \approx 2,3$

Slobodno sabijanje valjka ravnim pločama



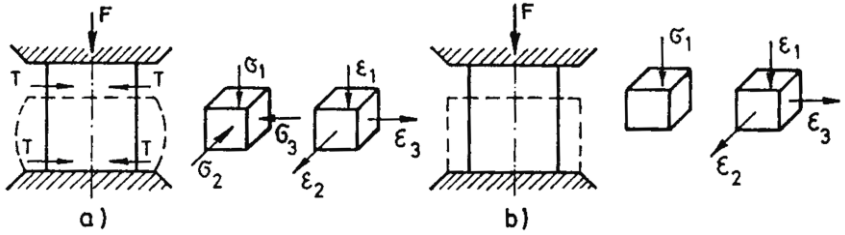
$$\left(h_0 / d_0\right)_{\max} \leq 2{,}5 \div 3{,}5$$

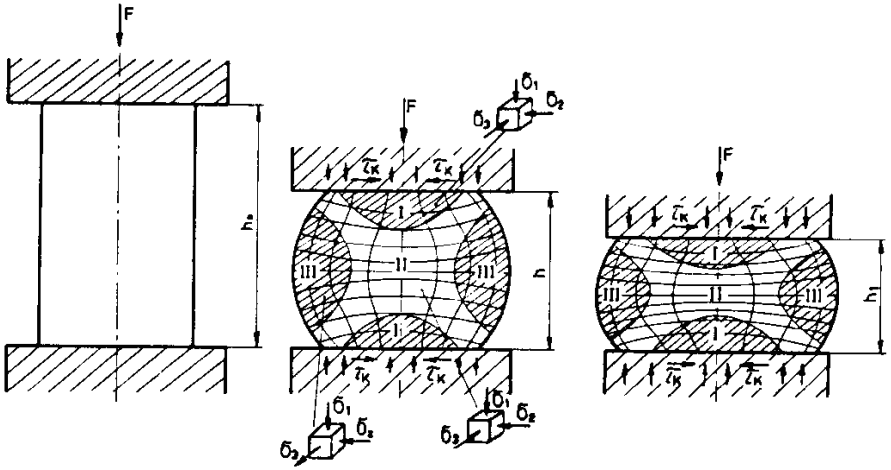
Teorijska analiza slobodnog sabijanja obuhvata
- analizu deformacija
- analizu naponskog stanja
- određivanje parametara procesa

Pretpostavke i uprošćenja:

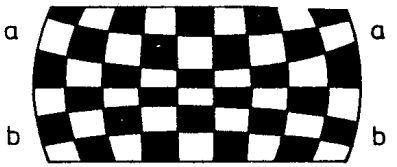
1. *Smatra se da valjak tokom obrade zadržava prvobitni cilindrični oblik (izvodnice ostaju paralelne iako u realnom procesu zbog delovanja kontaktnog trenja nastaje ometanje tečenja i pojava buričastog oblika.*
2. *Tangencijalni kontaktni napon proporcionalan je normalnom kontaktnom naponu (σ_n) i koeficijentu trenja (μ): $\tau_k = \mu\ \sigma_n$*
3. *Radijalni napon (σ_r) ne menja se po visini obratka*

Analiza naponsko-deformacionog stanja

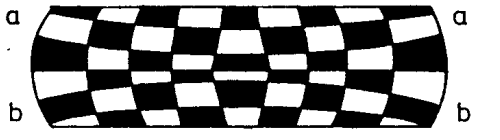


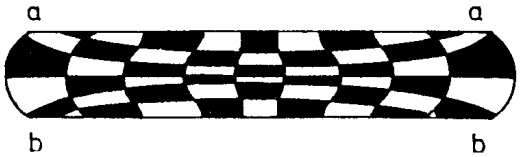


a) Slobodno sabijanje sa trenjem
b) Slobodno sabijanje bez trenja

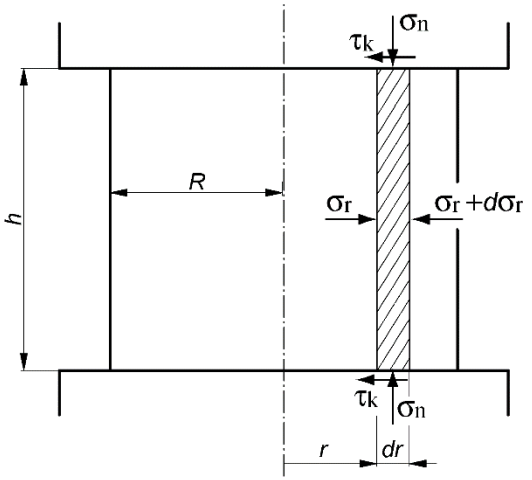


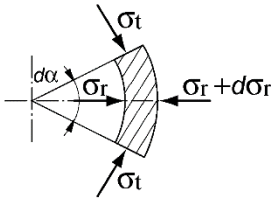
- deformacija visine: $\varphi_z = \varphi_h = \ln\frac{h}{h_0} < 0$
- radijalna deformacija: $\varphi_r = \ln\frac{R}{R_0} > 0$
- tengencijalna deformacija: $\varphi_t = \ln\frac{2\pi R}{2\pi R_0} = \ln\frac{R}{R_0} = \varphi_r \qquad \varphi_r = \varphi_t = -\frac{\varphi_z}{2}$
- efektivna deformacija: $\varphi_e = \frac{\sqrt{2}}{3}\sqrt{(\varphi_r-\varphi_t)^2+(\varphi_t-\varphi_z)^2+(\varphi_z-\varphi_r)^2} = |\varphi_z| = \ln\frac{h_0}{h}$

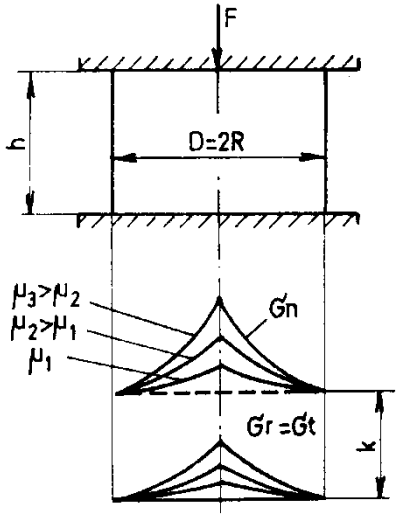




Proračun napona pri slobodnom sabijanju valjka ravnim alatima







$$\sigma_r\, r\cdot d\alpha\cdot h-(\sigma_r+d\sigma_r)(r+dr)d\alpha\cdot h-2\tau_k\, r\cdot d\alpha\, dr+2\sigma_t\, dr\cdot h\cdot\sin\frac{d\alpha}{2}=0$$

$$\tau_k=\mu\cdot\sigma_n$$

$$\sigma_r\cdot dr\cdot h+d\sigma_r\cdot r\cdot h+2\mu\cdot\sigma_n\cdot r\cdot dr-\sigma_t\cdot dr\cdot h=0$$

$$\varphi_r=\varphi_t\Leftrightarrow\sigma_r=\sigma_t$$

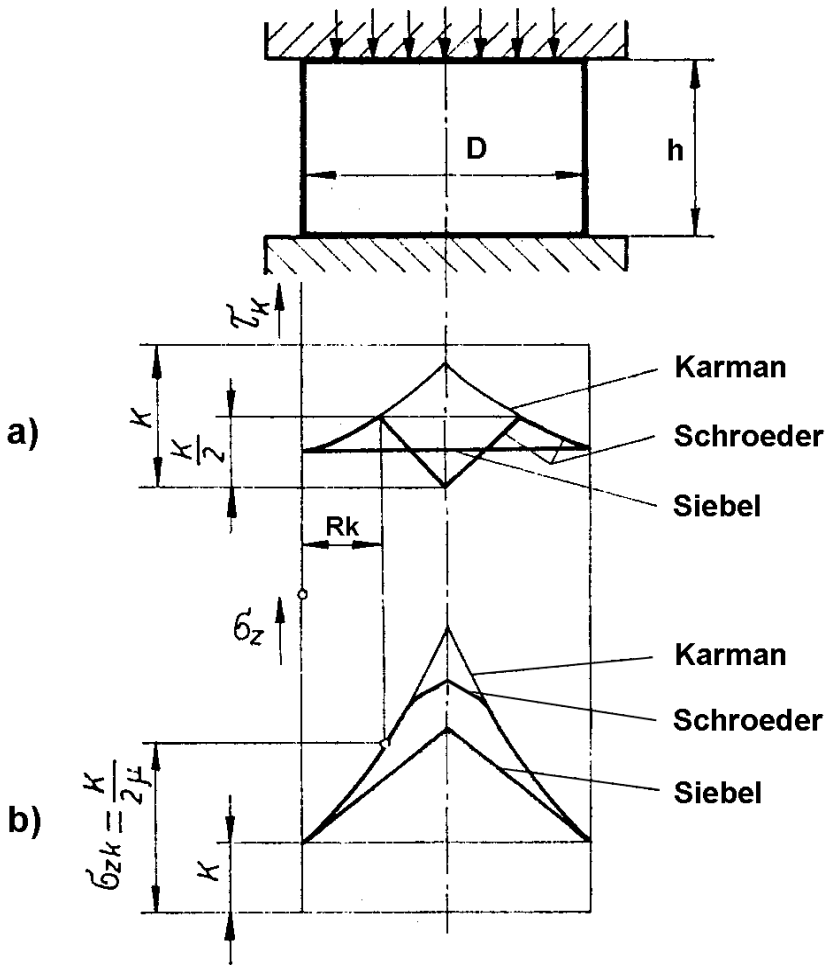
$$d\sigma_r\cdot r\cdot h+2\mu\cdot\sigma_n\cdot r\cdot dr=0$$

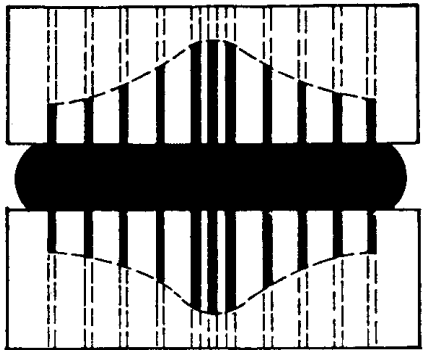
$$\sigma_n-\sigma_r=K\Rightarrow d\sigma_n=d\sigma_r$$

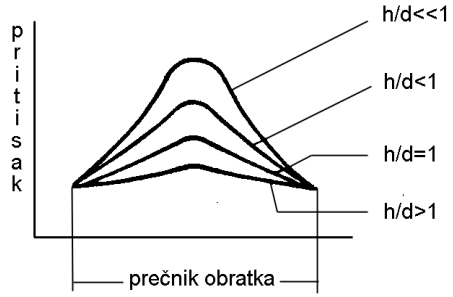
$$\frac{d\sigma_n}{\sigma_n}=-2\mu\frac{dr}{h}\Rightarrow\ln\sigma_n=-\frac{2\mu}{h}r+C_1$$

za $r=R\rightarrow\sigma_r=0$, tj. $\sigma_n=K$ $\Rightarrow$ $C_1=\ln K+\frac{2\mu}{h}R$

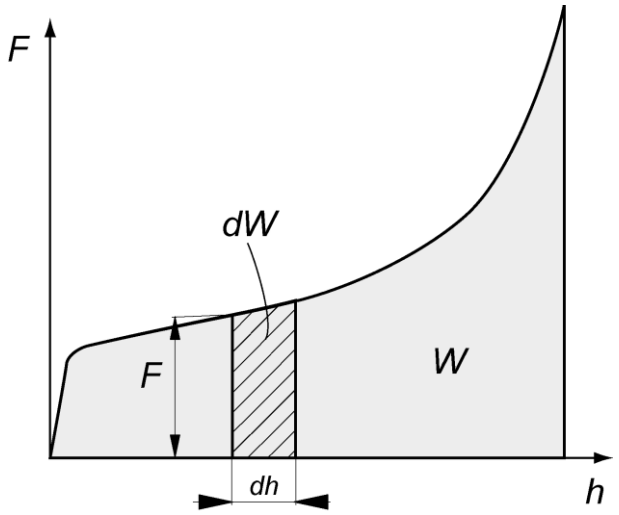
$$\sigma_n=K\,e^{\frac{2\mu}{h}(R-r)}$$


D
h
a)
Karman
Schroeder
Siebel
Rk
Karman
Schroeder
Siebel
b)




pritisak
h/d<<1
h/d<1
h/d=1
h/d>1
prečnik obratka

Deformaciona sila i deformacioni rad pri slobodnom sabijanju



$$F = \int \sigma_n dA = \int_0^R \sigma_n 2\pi r\, dr = 2\pi K \int e^{\frac{2\mu}{h}(R-r)} r dr$$

$$e^x = 1 + x + \frac{x^2}{2} + \frac{x^3}{6} + ...$$

$$F = K A \left(1 + \frac{\mu}{3}\frac{D}{h}\right)$$

$F = F_i = K \cdot A$ - idealna deformaciona sila

$$W = \int_{h_0}^{h} F \cdot dh = V K_{sr} \left[\ln\frac{h_0}{h} + \frac{2}{9}\mu\left(\frac{D}{h} - \frac{D_0}{h_0}\right)\right]$$

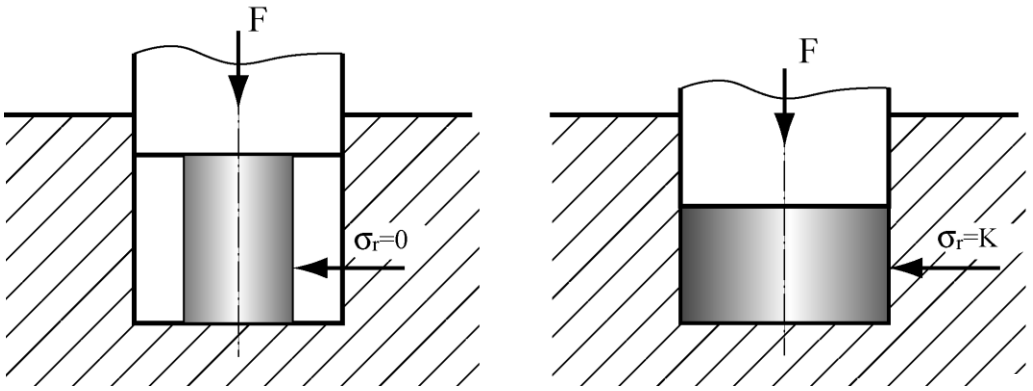
$$K_{sr} = \frac{1}{2}(K_0 + K_1)$$ -srednji napon tečenja

$$W_i = V k_{sr} \ln\frac{h_0}{h} = V k_{sr} \varphi$$ - idealni deformacioni rad

Stepen korisnog dejstva procesa sabijanja

$$\eta = \frac{W_i}{W}$$

Sabijanje valjka u kalupu

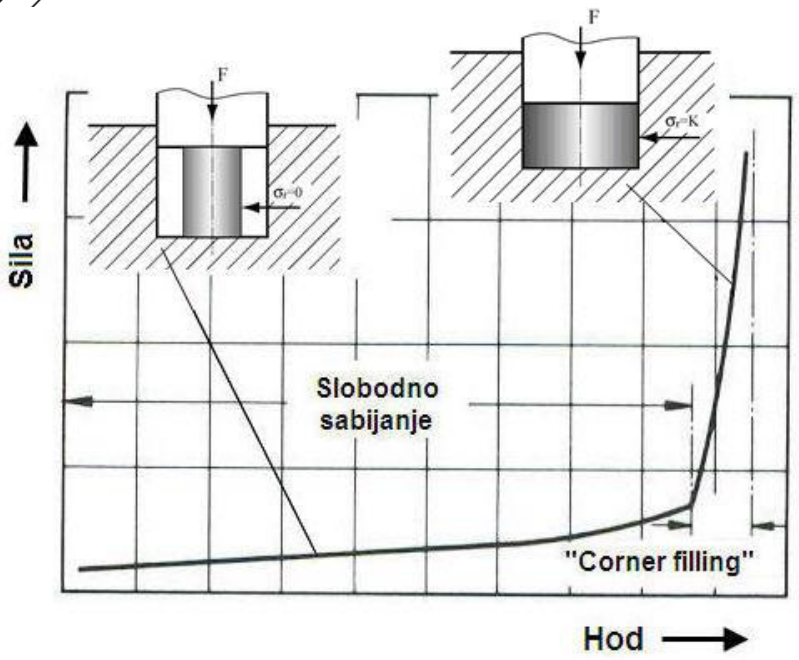


$$\frac{d\sigma_n}{\sigma_n} = -2\mu\frac{dr}{h} \Rightarrow \ln\sigma_n = -\frac{2\mu}{h}r + C_2$$

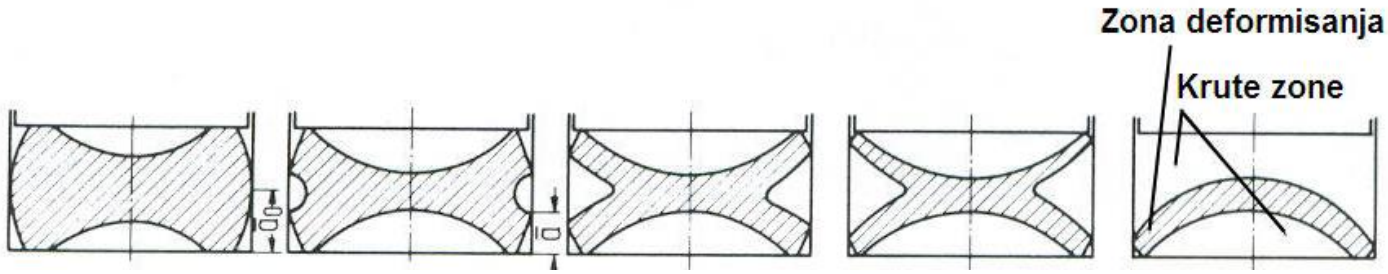
$$\sigma_n - \sigma_r = 2K \Rightarrow d\sigma_n = d\sigma_r$$

za $r = R \rightarrow \sigma_r = K$, tj. $\sigma_n = 2K$ ⇒ $C_2 = \ln 2K + \frac{2\mu}{h}R$

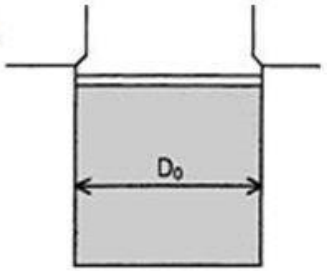
$$\sigma_n = 2K\, e^{\frac{2\mu}{h}(R-r)}$$



$$F = 2K\,A\left(1 + \frac{\mu}{3}\frac{D}{h}\right) \qquad W = 2V\,K_{sr}\left[\ln\frac{h_0}{h} + \frac{2}{9}\mu\left(\frac{D}{h} - \frac{D_0}{h_0}\right)\right]$$

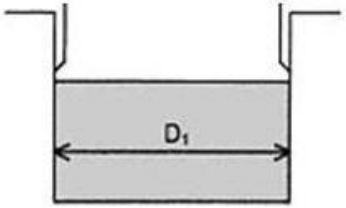


1.



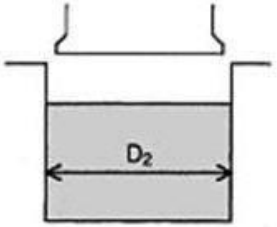
Početak procesa

2.



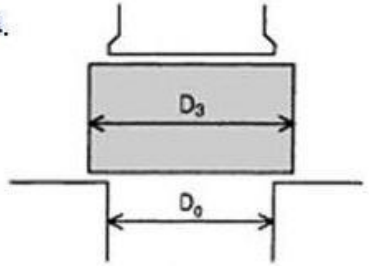
Faza opterećenja

3.



Faza rasterećenja
(sekundarno tečenje)

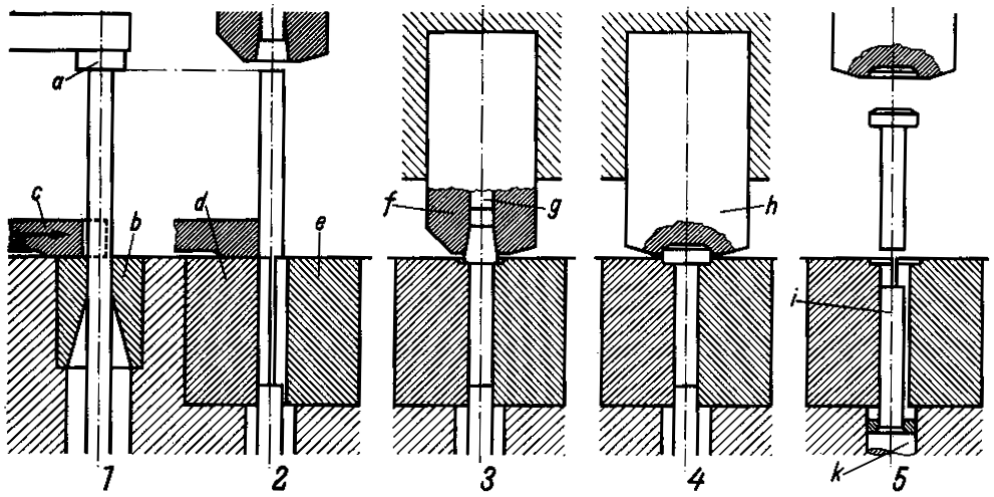
4.



Faza izbacivanja

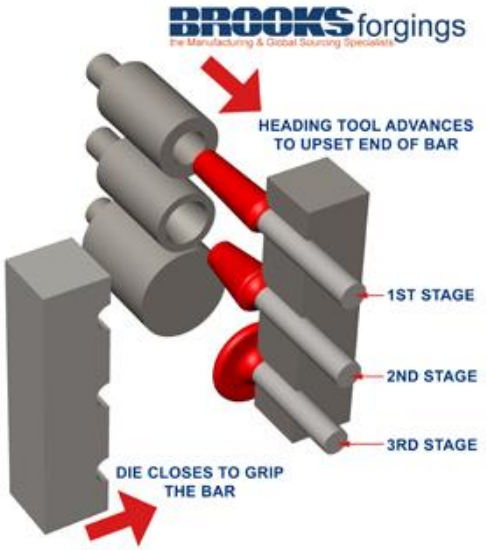
$D_o > D_2 > D_3 > D_1$

Alati za sabijanje



a – graničnik,
b – matrica za odsecanje,
c – nož za odsecanje pripremka,
d–nepokretan kalup,
e – pokretan kalup,
f – predoblikač,
g – izbacivač,
h – oblikač,
i – izbacivač,
k – pogon izbacivača.

Tvrdoća posle kaljenja i otpuštanja od 60 do 62 HRC



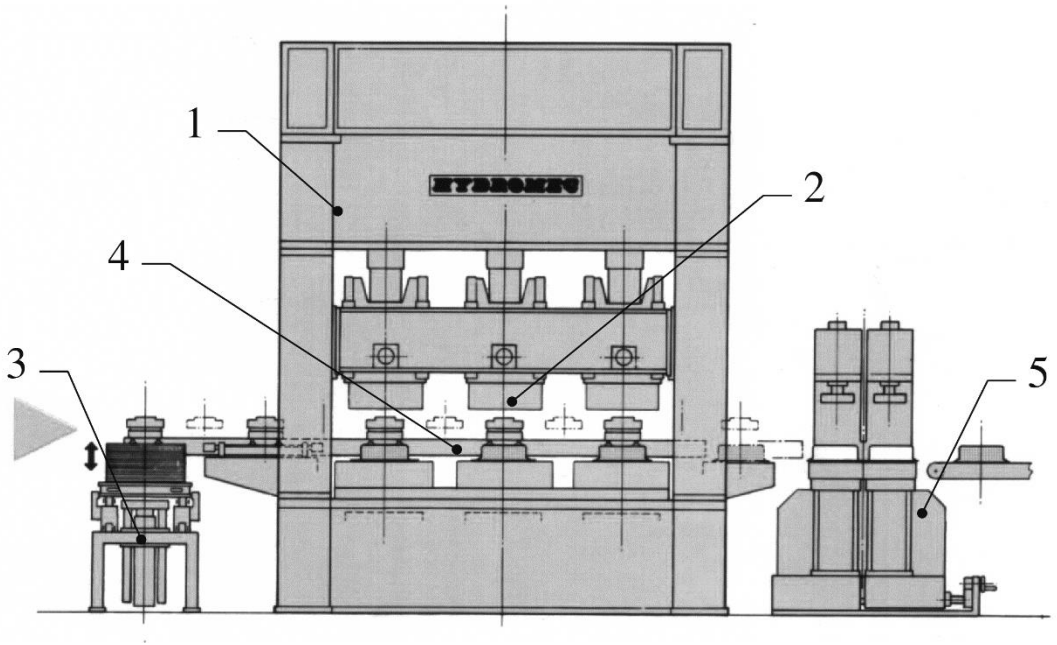
Mašine za sabijanje

Mašine za sabijanje biraju se na osnovu tehnoloških parametara procesa, od kojih su najvažniji:

- deformaciona sila
- deformacioni rad
- dimenzije alata
- hod alata
- veličina serije

Svaka mašina za obradu deformisanjem sastoji se iz:

- Pogonskog sistema
- Noseće strukture
- Sistema za upravljanje
- Sistema za podmazivanje
- Pomoćnih sistema



Klasifikacija mašina za OD

Mašine za obradu deformisanjem dele se prema različitim kriterijumima:

❖ Prema zakonu promene opterećenja, mašine se dele na mašine periodičnog i mašine kontinualnog dejstva

❖ Prema vrsti energije za deformisanje, mašine mogu biti statičkog i dinamičkog dejstva

❖Prema vrsti pogonskog sistema postoje:

a) mašine s mehaničkim pogonom,

b) hidraulične,

c) pneumatske itd.

❖Prema broju dejstava:

a) mašine jednostrukog (prostog) dejstva,

b) mašine višestrukog dejstva

❖Prema nameni:

a) mašine univerzalne namene,

b) mašine specijalne namene

❖Prema broju radnih pozicija, mašine se dele na jednopozicione i višepozicione

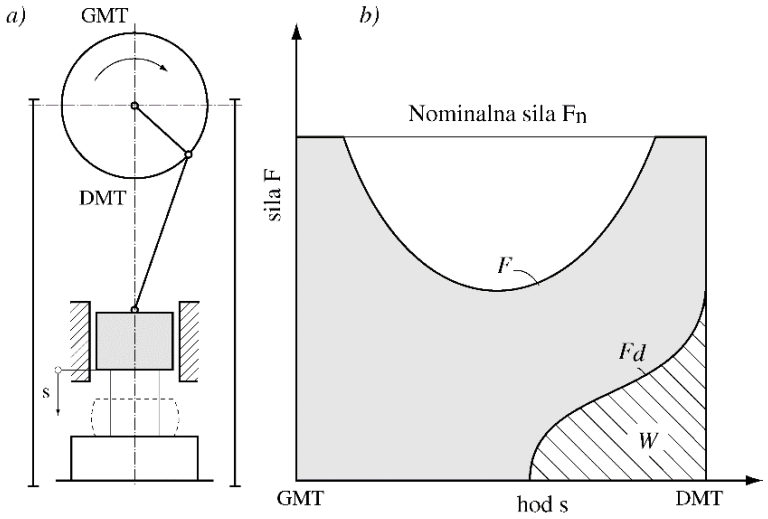
❖Prema glavnim karakteristikama (performansama)

a) mašine čija je glavna karakteristika hod

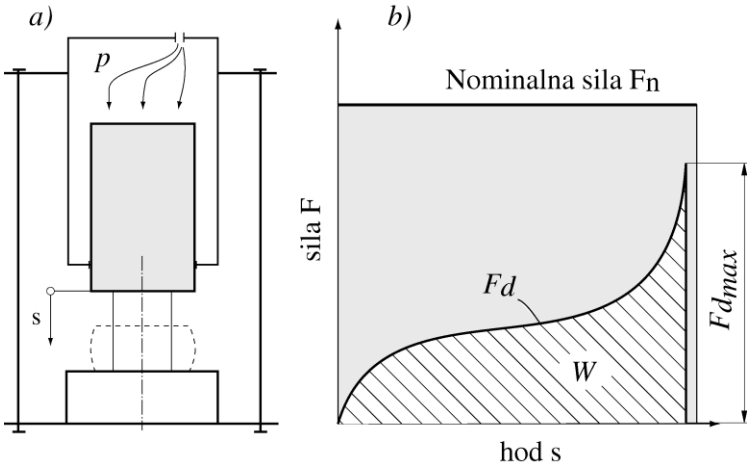
b) mašine čija je glavna karakteristika sila

c) mašine čija je glavna karakteritiska energija

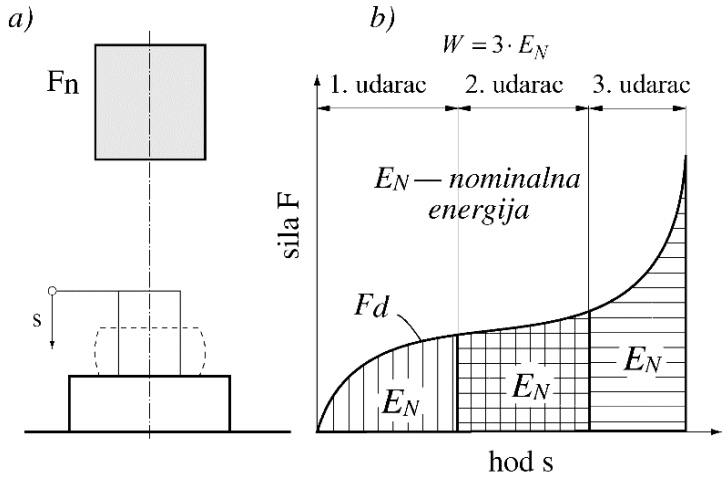
Mašine čija je glavna karakteristika hod imaju tu osobinu da se proces deformisanja završava u trenutku dostizanja maksimalnog hoda. U ovu gupu mašina spadaju sve krivajne prese u kojih se pritiskivač kreće od gornje do donje mrtve tačke i obrnuto.



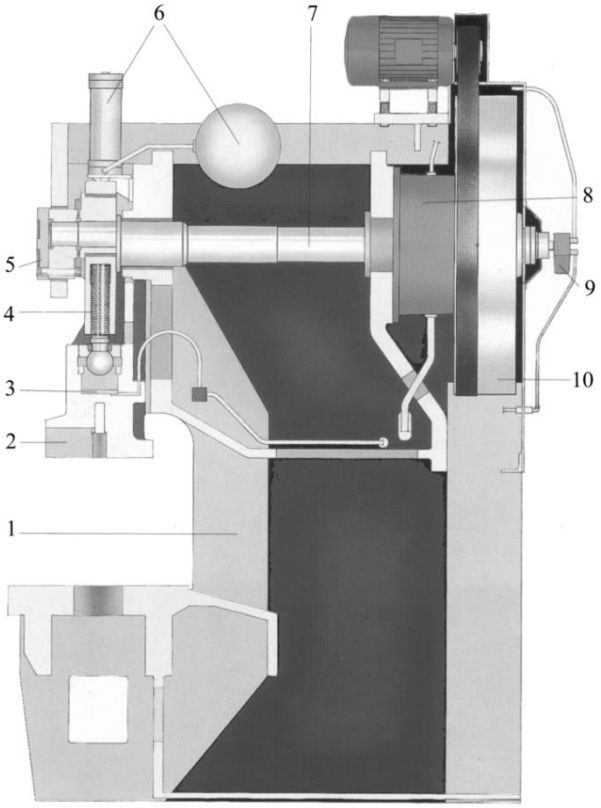
Mašine uslovljene silom karakterišu se time da se proces deformisanja zaustavlja dostizanjem maksimalne (nominalne) sile mašine. U ovu grupu mašina spadaju hidraulične prese.



Mašine čija je glavna karakteristika energija odlikuju se time što se proces deformisanja zaustavlja kada se utroši raspoloživa energija malja ili bata. U ovu grupu mašina spadaju čekići i zavojne prese.

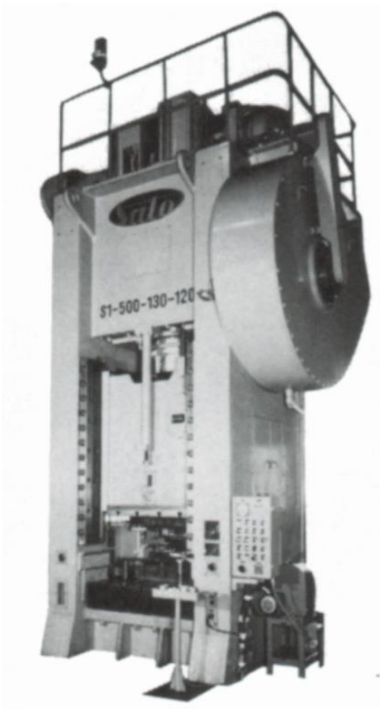


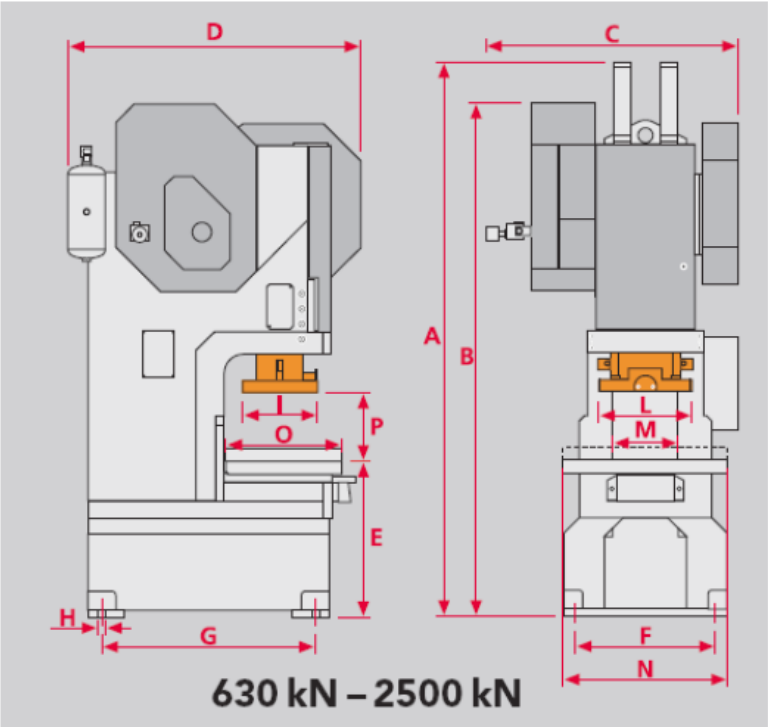
Mehaničke krivajne prese



1. otvorena noseća struktura
2. pritiskivač
3. hidraulični osigurač od preopterećenja prese
4. zavojno vreteno za regulaciju dužine krivaje
5. uređaj za primenu veličine ekscentriciteta
6. pneumatski balansni uređaj
7. ekscentar vratilo
8. spojnica s kočnicom
9. upravljački pneumatski ventil
10. zamajac

Osnovni tehnički podaci krivajne prese:
- nominalna sila (glavno dejstvo)
- nominalna energija
- nominalna sila ostalih dejstava
- hod pritiskivača
- broj hodova pritiskivača (u pojedinačnom i rafalnom režimu)
- dimenzije stola mašine
- dimenzije pritiskivača
- snaga elektromotora
- gabariti mašine
- masa mašine

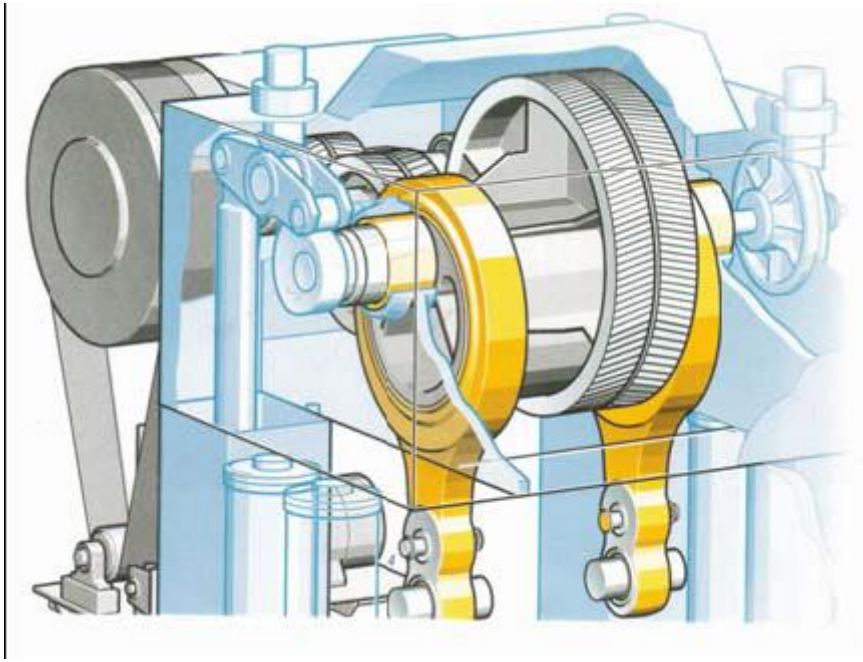


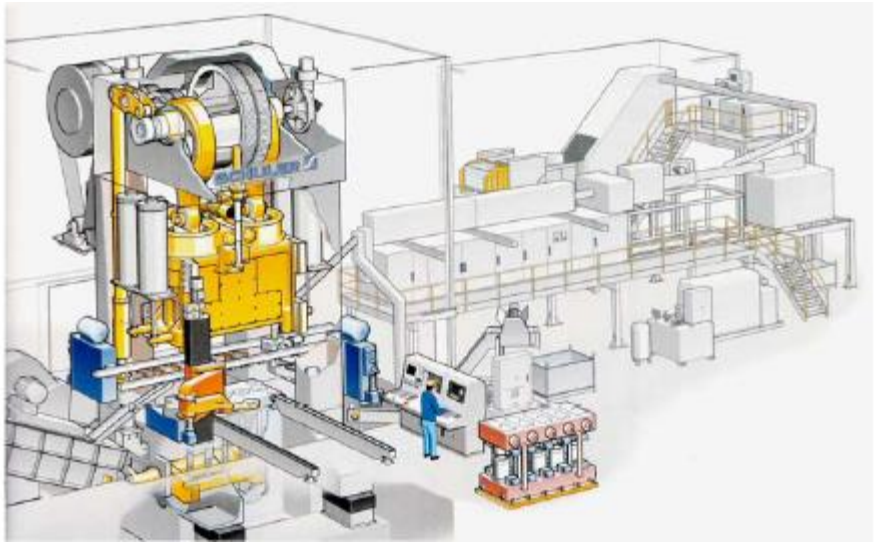


630 kN – 2500 kN

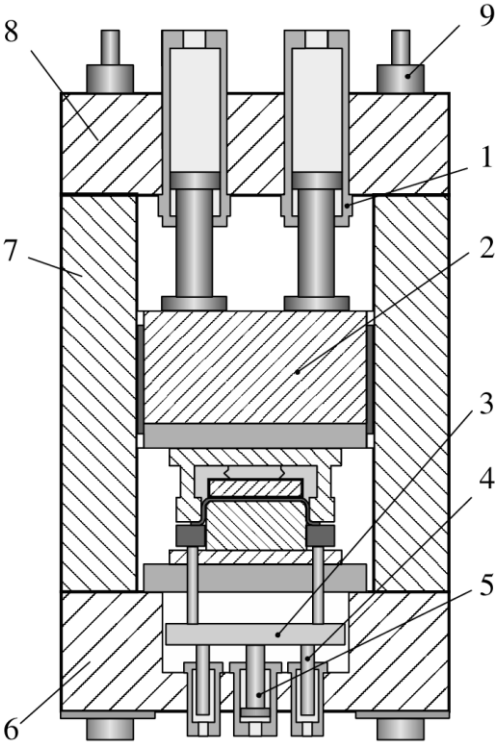
Maximum pressure		mm	400 kN	630 kN	1.000 kN	1.600 kN	2.500 kN
Table surface	N x O	mm	650 x 480	820 x 580	950 x 660	1250 x 750	1400 x 860
Hole in table		mm	120	165	165	165	200
Opening in the back	M	mm	270	330	370	510	630
Thickness of table		mm	53	68	68	78	128
Ram Surface	L x I	mm	350 x 300	470 x 340	450 x 450	850 x 600	100 x 700
Center bore in ram		mm	50	50	50	60	60
Ram adjustable		mm	70	100	100	110	1300
Stroke per min.		U/min	140	75	65	55	40
Drive power		kW	4	4	7.5	18.5	18.5
Stroke length adjustable		mm	12 - 100	8 - 120	10 - 130	12 - 180	19 - 150
Height of tool area	P	mm*	240	320	370	440	470
Depth of throat		mm	220	280	330	370	430
Weight with standard equipment		KG	3000	5000	7000	14000	276000
Dimensions of the press	A	mm	2410	3000	3200	3720	4400
	B	mm	2230	2750	3030	3440	4150
	C	mm	1170	1320	1440	1750	2150
	D	mm	1480	1570	1770	2380	2965
	E	mm	743	810	895	968	1075
	F	mm	610	690	810	1100	1420
	G	mm	915	1125	1205	1790	2335
	H	mm	45	40	40	60	60

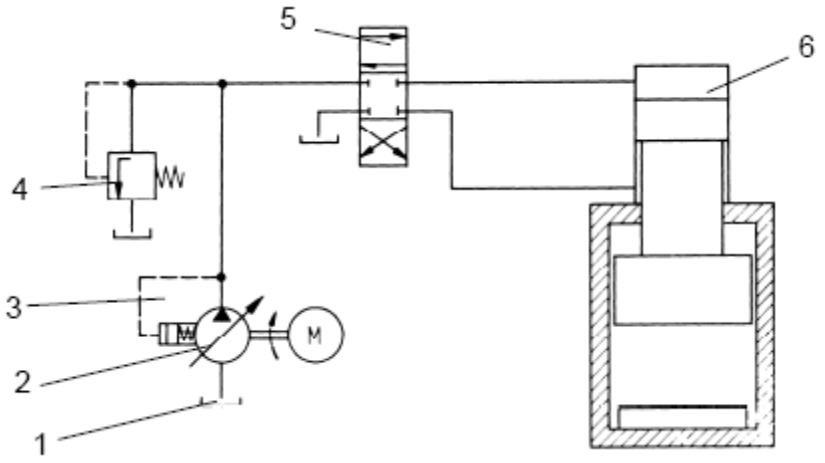

SCHULER

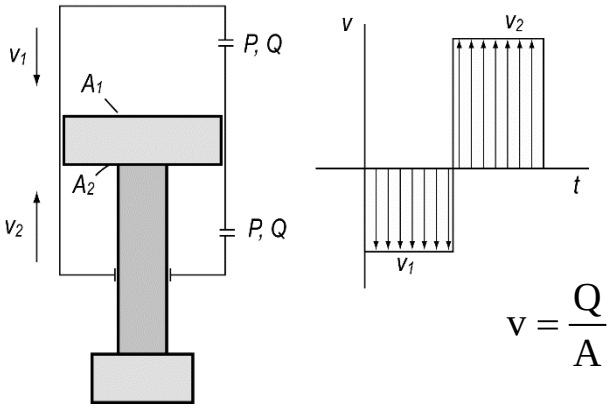




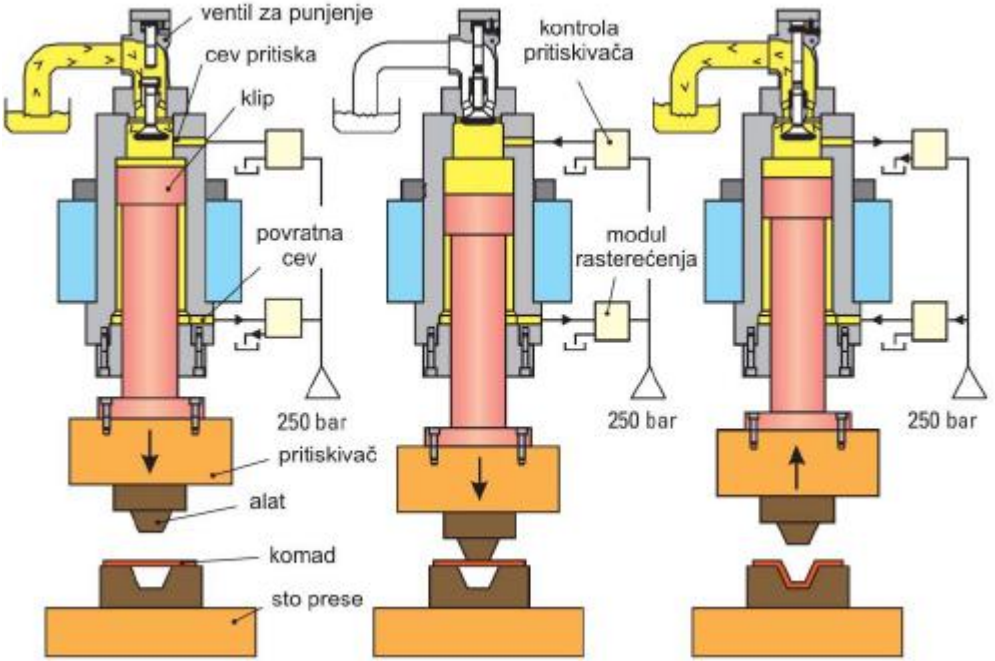
Hidraulične prese



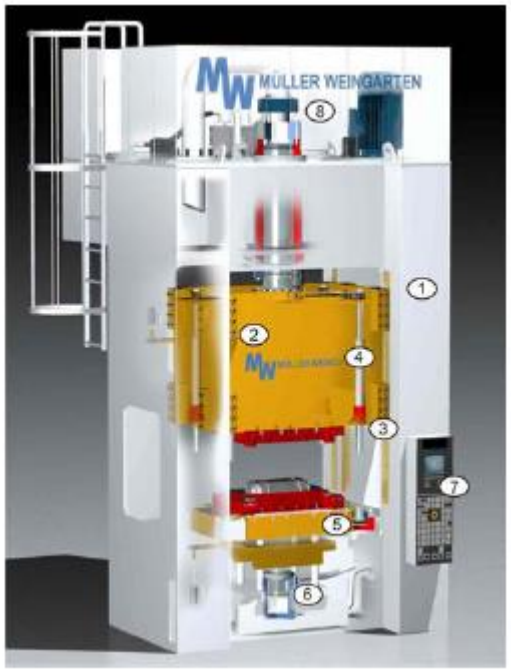


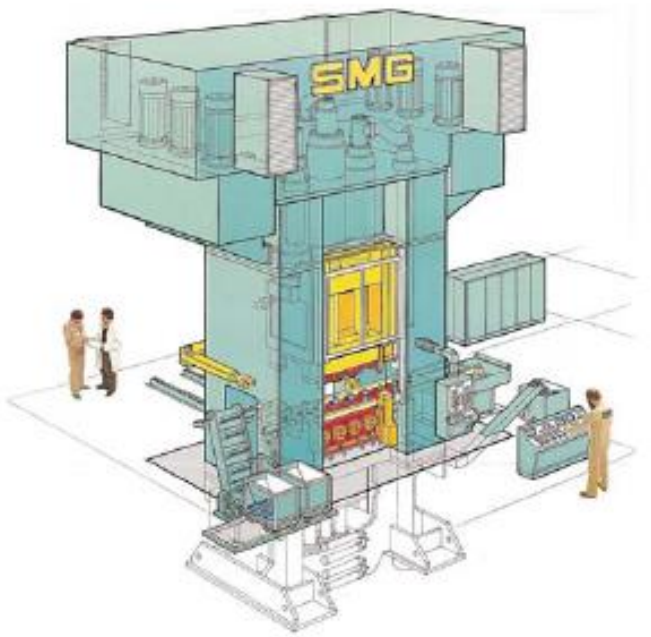


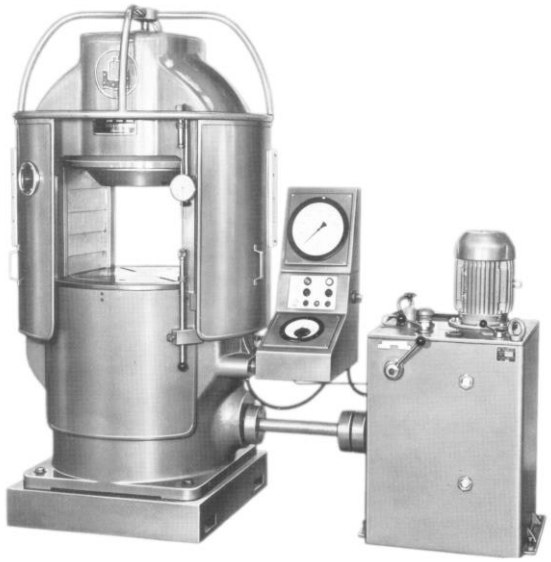
$$v = \frac{Q}{A}$$



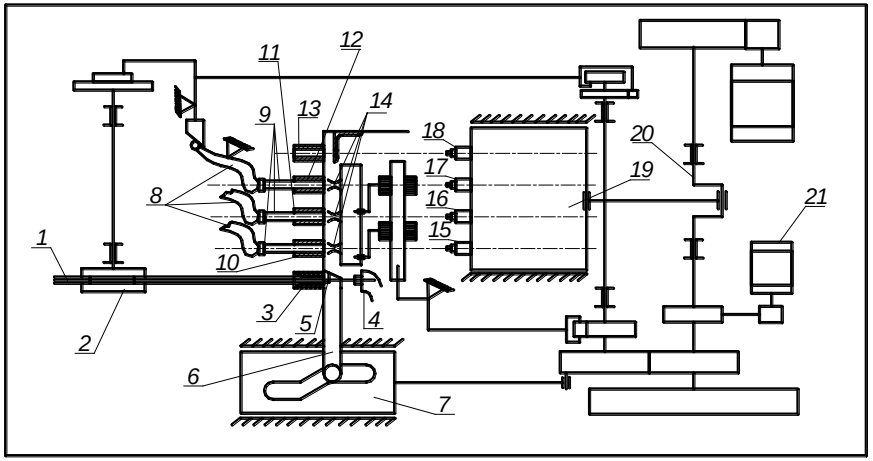
•nominalna sila glavnog dejstva prese
•nominalna sila ostalih dejstava
•brzina pritiskivača: a) približavanje, b) deformisanje, c) povratni hod
•brzine izvršnih elemenata pomoćnih dejstava mašine (držač lima i izbacivač, ako postoje)
•hod pritiskivača
•hod pomoćnih dejstava
•dimenzije pritiskivača
•dimenzije stola mašine
•karakteristike pumpe (*p, q*)
•snaga mašine
•gabariti mašine
masa prese







Automatske prese



Zavojne prese

Zavojne prese spadaju u grupu mašina čija je glavna karakteristika energija