熔模铸造浇注补缩系统

一、组成

浇口杯　直浇道　横浇道　内浇道

冒　口　缓冲坑　出气口　集渣包

过滤网

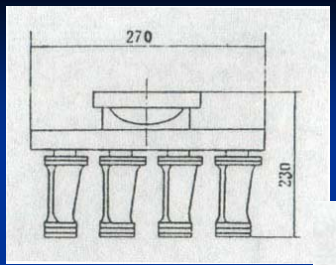
二、功能

1 充填
2 补缩
3 排蜡
4 配热
5 辅具

三、分类

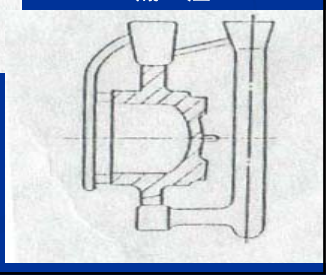
1.按注入方式分

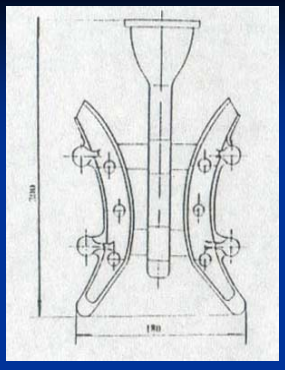
顶注、底注、侧注、联合注入



顶　注

底　注





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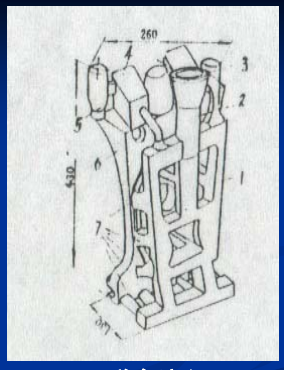
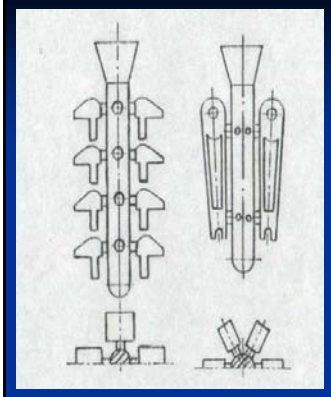


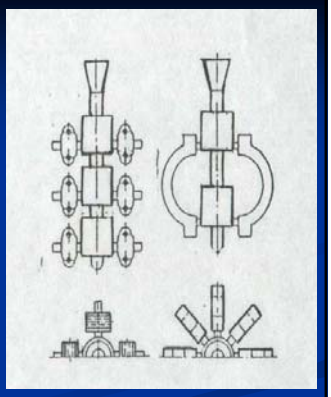
联合注入

2.按结构组成分

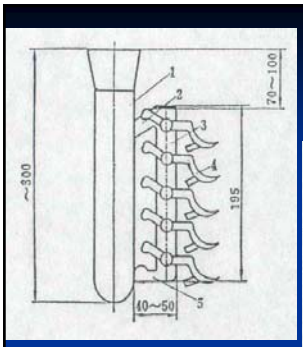
- 直浇道式：单一直浇道、直浇道+补缩节、多道直浇道、过渡直浇道、空心直浇道
- 横浇道式：单一横浇道、多道横浇道、圆板、圆环、多层、多层多道
- 冒口式
- 组合式



单一直浇道

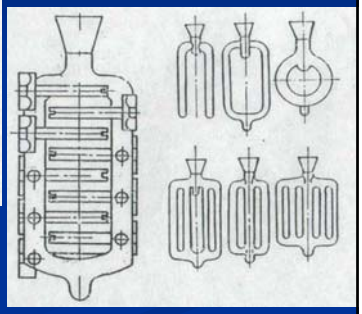


带补缩节的直浇道

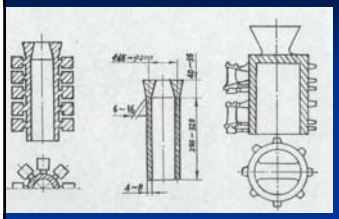


过渡直浇道

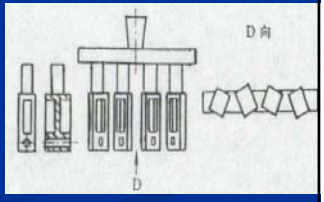
多道直浇道

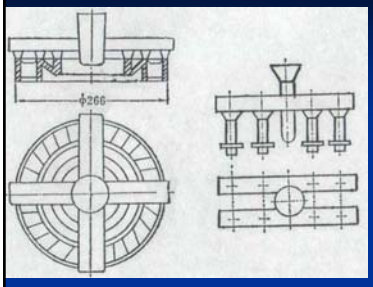


空心直浇道

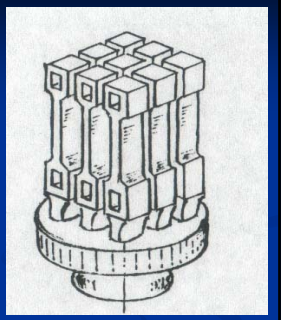


单一横浇道

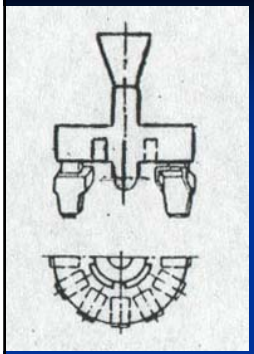




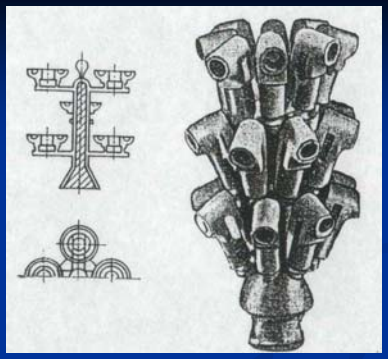
多道横浇道



圆板

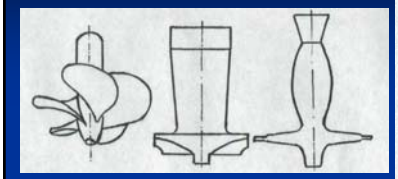


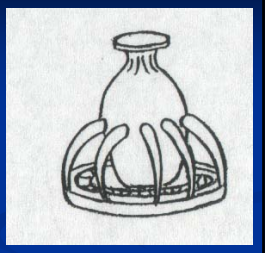
圆环



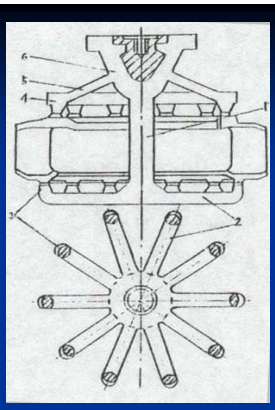
多层多道

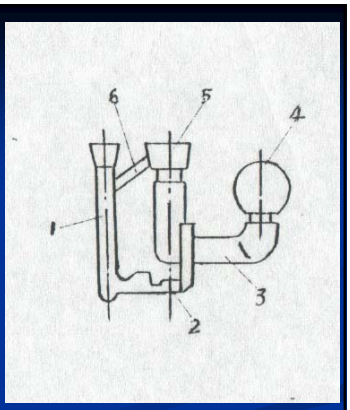
多层





冒口式





组合式

3、按补缩组元分

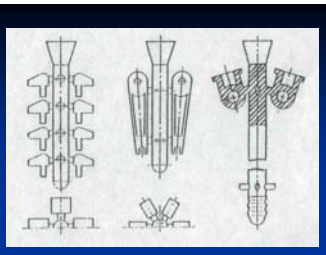
Ⅰ.中心直浇道　　Ⅱ.横浇道

Ⅲ.竖浇道　　Ⅳ.底注竖浇道+侧冒口

Ⅴ.侧冒口　　Ⅵ.顶冒口

Ⅶ.直浇道+局部冒口　　Ⅷ.局部冒口

Ⅰ



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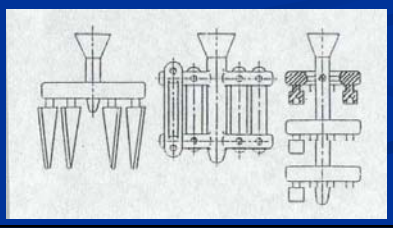

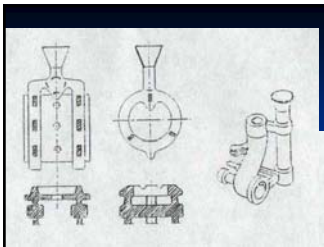

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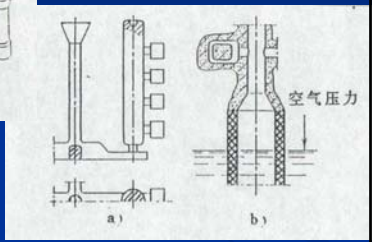

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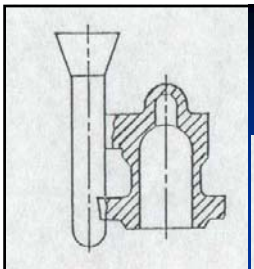

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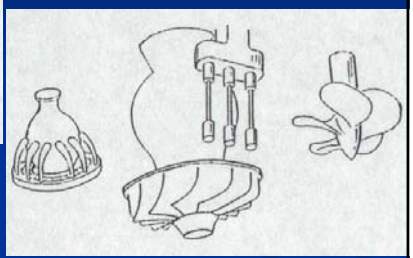

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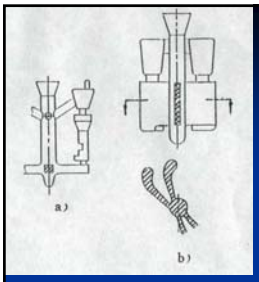

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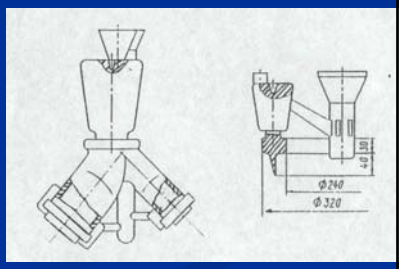


Ⅷ

四、铸造设计方案

1.保证充填性

（1）充填完整性

①薄壁件保证充填速度

$Q = KL/\delta$　顶注k=0.05,侧注k=0.06　底注k=0.08

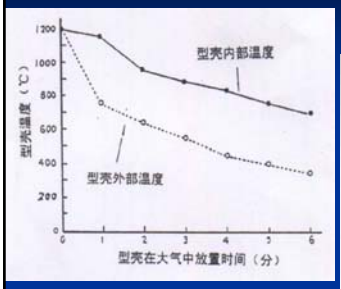
$f_O\sqrt{Hp} = Q/(\mu\rho\sqrt{2g})$　μ =0.7~0.9

$Hp = 2\sigma\cos\theta/(\delta\rho g)$　σ =1.5N/m

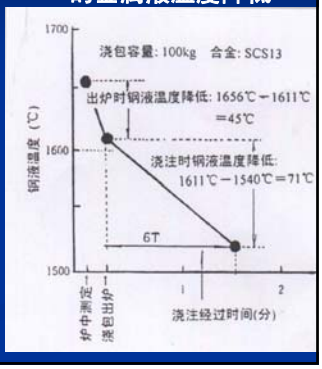
②浇注温度

过热度=130~160℃

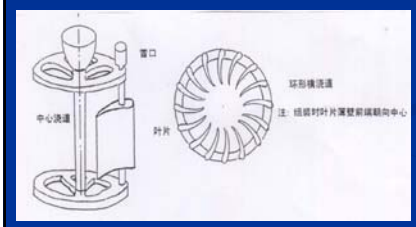
型壳焙烧后的炉外冷却特性



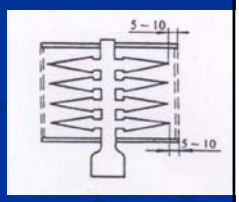
出炉过程和浇注过程的金属液温度降低



③薄壁部位缓慢冷却

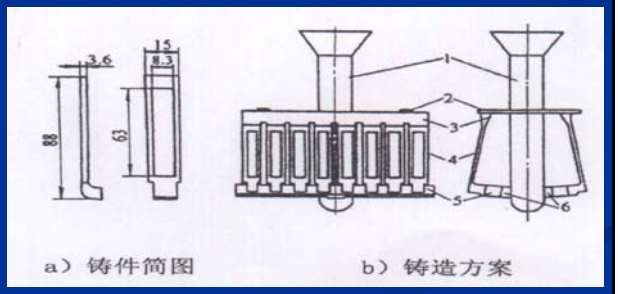


小型静翼叶片

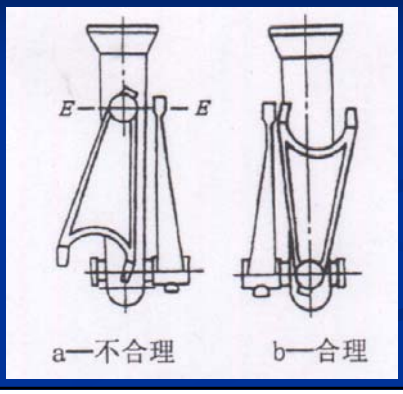


辅助浇道

④不能憋气

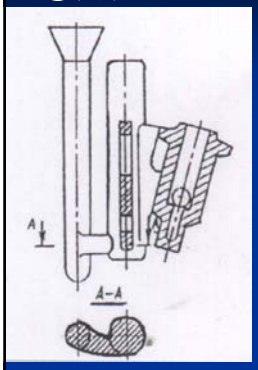


⑤浇注中途不能停顿

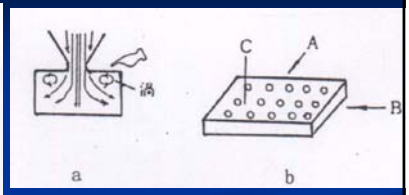


（2）充填的平稳性

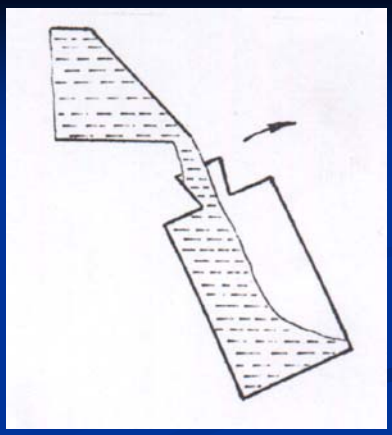
①底注



②流动状态



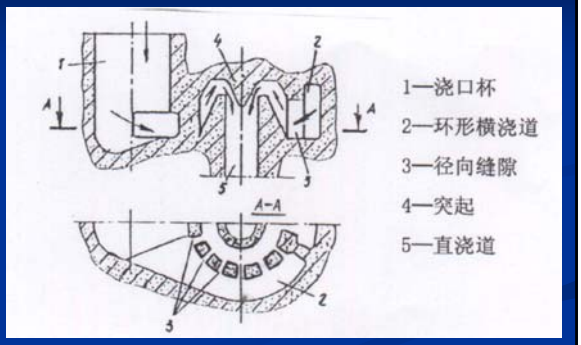
③倾斜浇注



④夹杂分布

⑤小直浇道

⑥过滤网



2.保证补缩

产生原因

体收缩率:

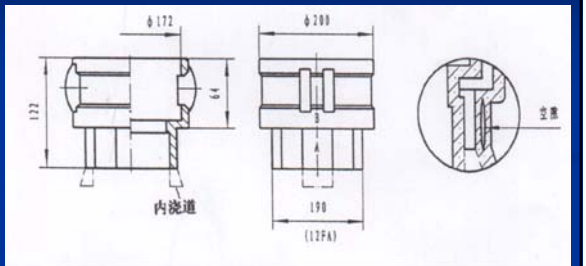
$$\varepsilon(\%) = 1.9943 + 7.459W_C - 4.73W_C^2 + \Sigma K_i W_i + K_T (T_p - T_L)$$

	W	Ni	Mn	Cr	Si	Al
Ki	-0.53	-0.0354	+0.0585	+0.12	+1.03	+1.07

体收缩率→凝固收缩流动（冷却慢处流向冷却快处）→冷却慢处流下孔 洞（缩孔）

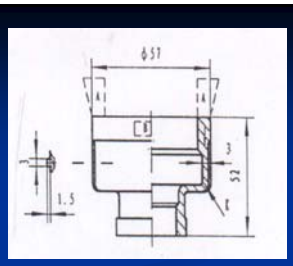
防止措施

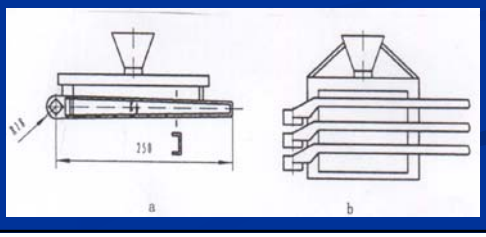
（1）转移（顺序凝固）



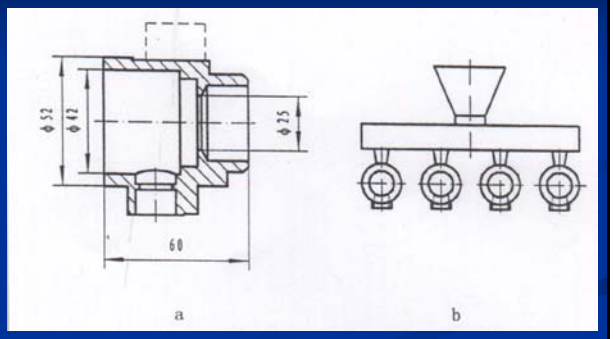
（2）分散（同时凝固）

①避免形成新的过热点





②孤立热节改善散热条件



3.避免铸件产生热裂

（1）原因

线收缩受阻→应力→应力>凝固时高温强度→裂纹

（2）时间

凝固阶段后期

（3）部位

铸件凝固时“弱点”部位→结壳最薄部位→“热点”

（4）防止措施

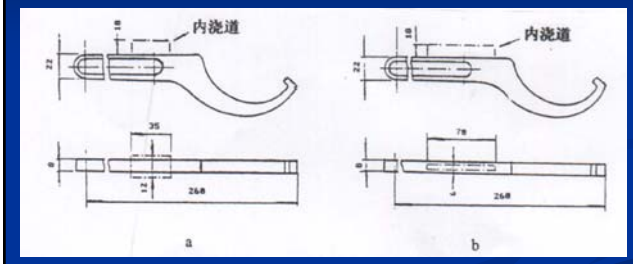
①选择热裂敏感性小的合金

凝固时收缩系数小，高温强度高的合金热裂敏感性小

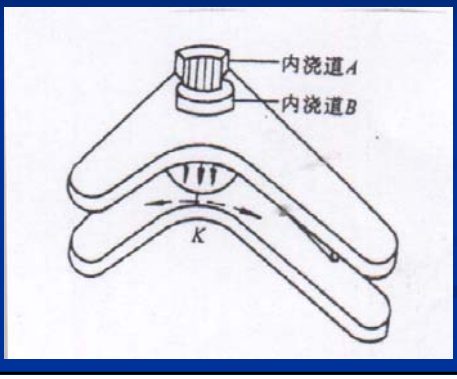
	Mn13	1Cr13	T10	ZG55	ZG35	30CrNiMo
高温强度（kg/cm³）	3	4	5	7	12	12
	工业纯铁	ZG20	1Cr18Ni9Ti			
高温强度（kg/cm³）	14	21	25			

②低温钢水红壳浇注

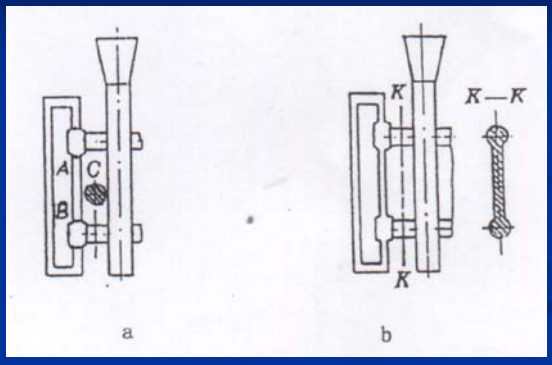
③薄壁铸件，扁宽浇口



④均匀充填型腔，避免浇注金属冲击固定点后形成“热点”



⑤避免框形结构浇注系统



⑥改善工艺筋

⑦热裂转移

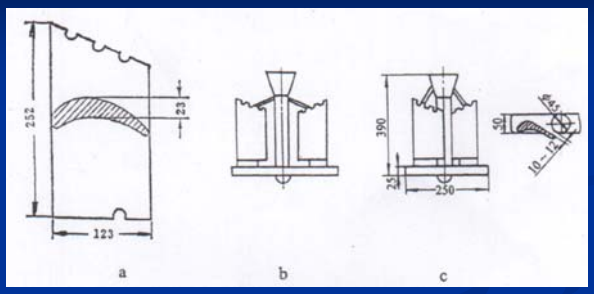
4.减少内应力和变形

（1）原因

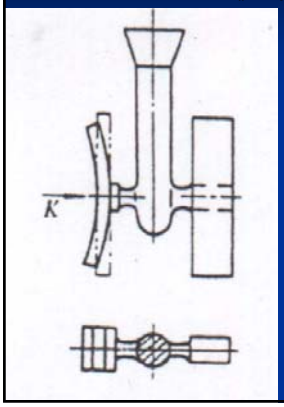
冷却过程不均匀→线收缩不一致→相互牵制→应力、变形

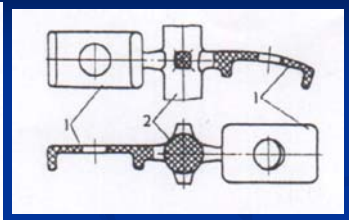
（2）防止措施

①缓慢铸件薄壁部位的冷却

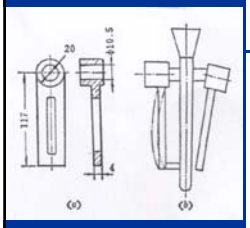


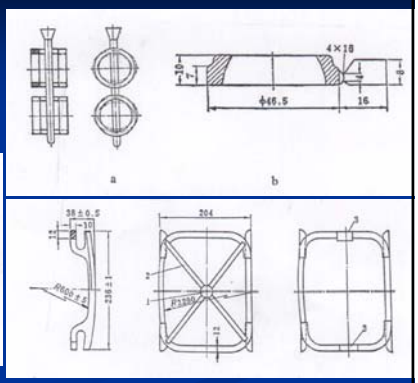
②收缩应力等作用力的作用断面，尽量是抗弯模量大的断面



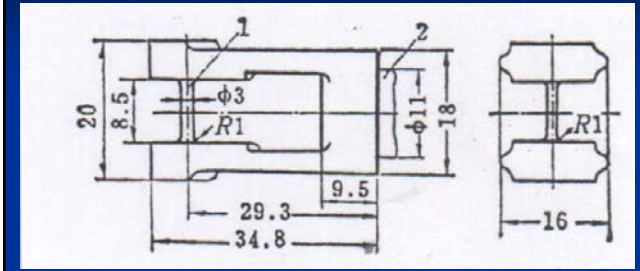


③尽可能设置单个内浇口

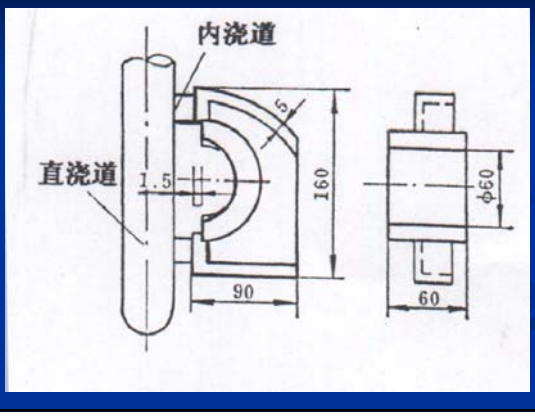




④设置工艺筋



⑤反变形



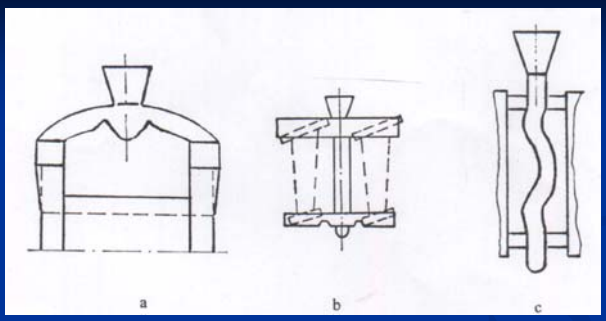
⑥变形转移

2个以上内浇口→框形结构→铸件与直

（横）浇道冷却不同步→产生变形

铸件刚度小，直（横）浇道刚度大→铸件变形大

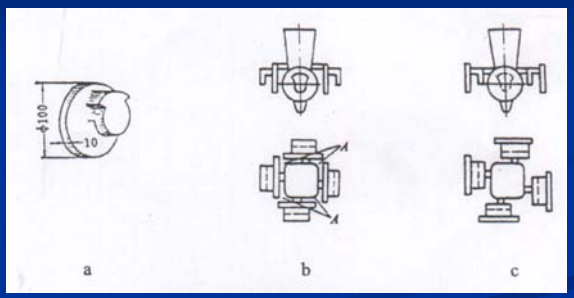
铸件刚度大，直（横）浇道刚度小→铸件变形小



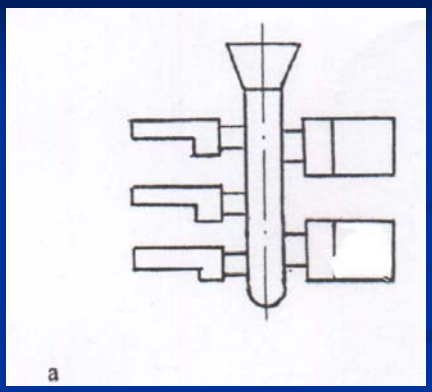
⑦校正变形

5.方便制壳

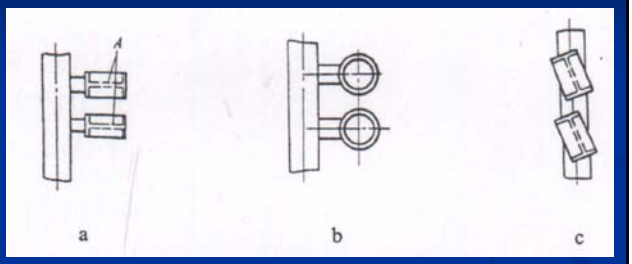
（1）方便涂料撒砂



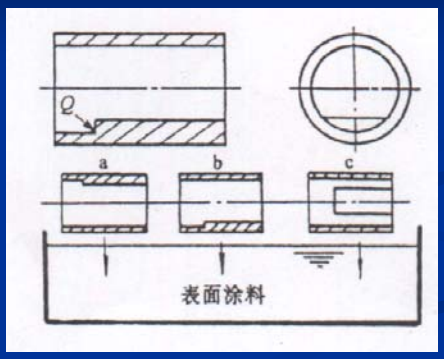
（2）大平面涂料时的多余涂料易流失、易刷料



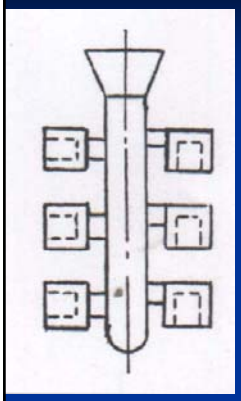
（3）保证硬化风干

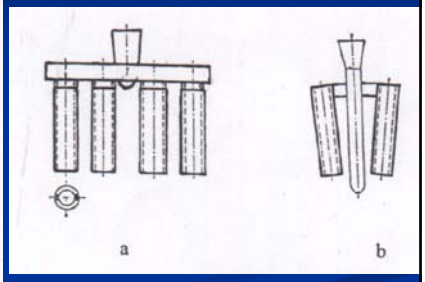


（4）方便涂料时蜡模的盲孔、凹槽、扬角处的气体排除，避免气泡豆

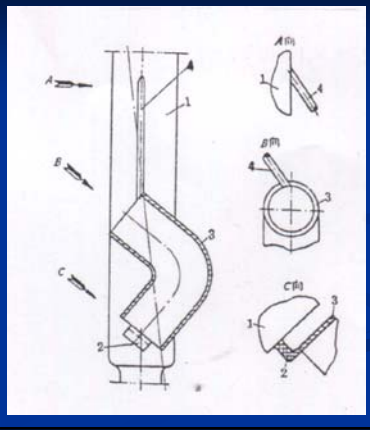


（5）方便盲孔、长孔的吹气、吹砂、刷料、堵砂处理





（6）防止蜡模破损、掉件



6.保证排蜡通畅

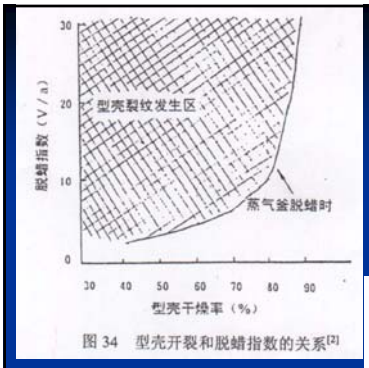
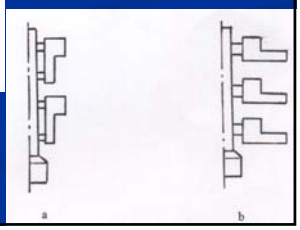
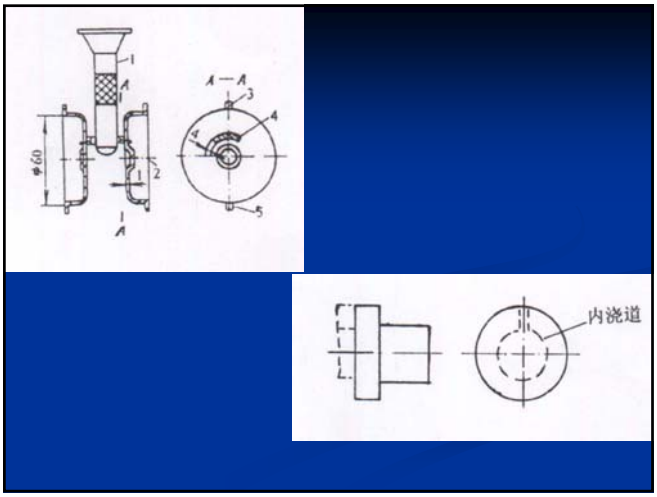
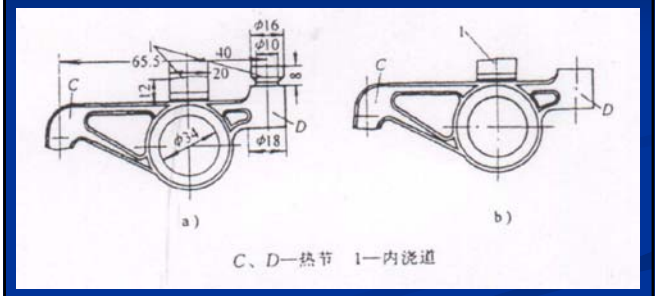


图 34　型壳开裂和脱蜡指数的关系[2]





7.提高工艺出品率

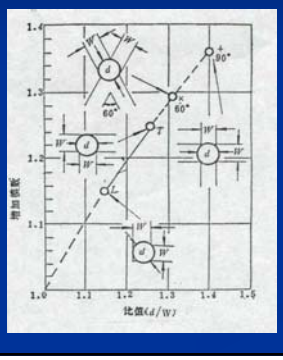


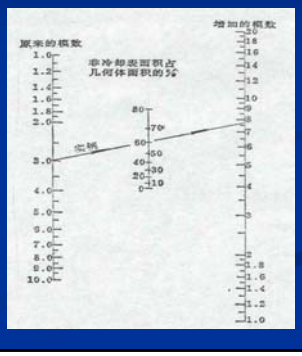
五、浇注补缩系统组元计算

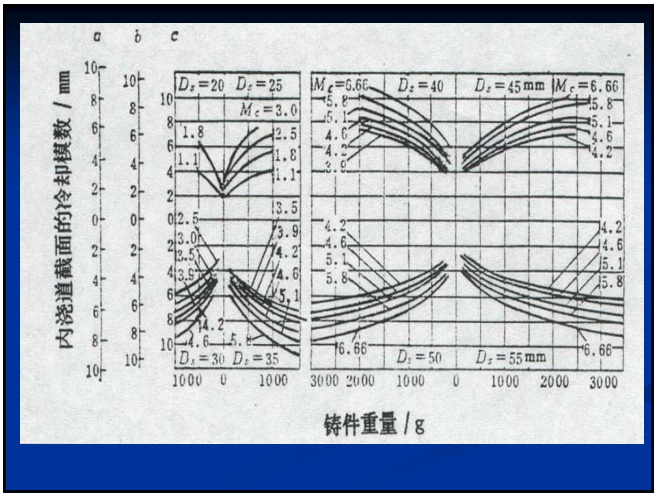
1.直、横、内浇道计算

①亨金法

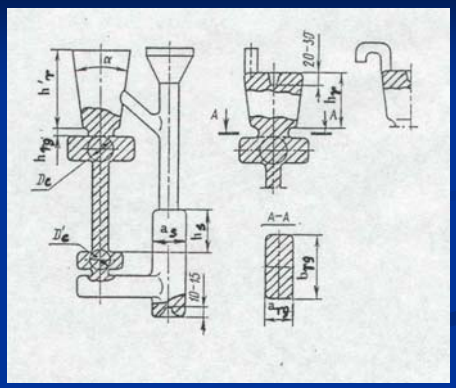
$$M_{内} = 11\sqrt[4]{M_{铸}^{3}}\,G\,\sqrt[3]{L_{内}}\,/\,M_{直}$$







②内切圆法



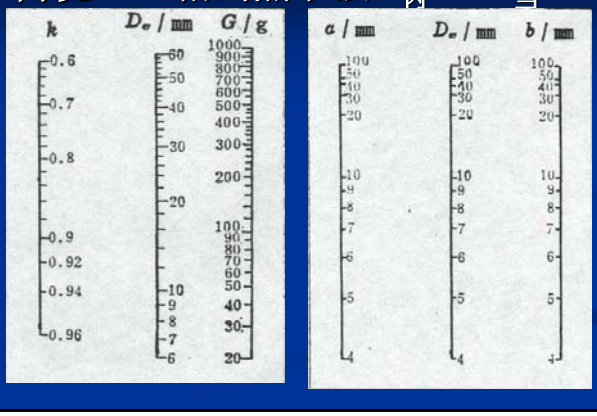
③比例系数法

$D_{内}$=（0.8~1)$D_{铸}$

$S_{内}$=（0.4~0.9)$S_{铸}$

④浇口杯补缩容量法

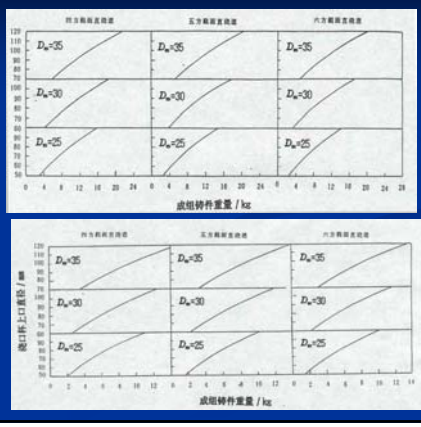
内浇口—相当热节法$D_{内}$=K$D_{当}$



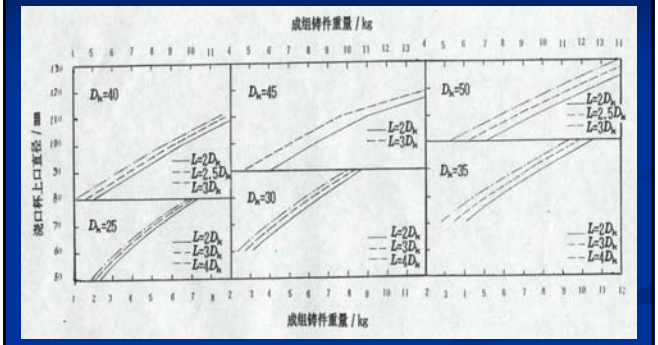
直浇道—$D_{直}$=(1.1~1.2)$D_{内}$

横浇道— $D_{横}$=(1.15~1.25)$D_{内}$

浇口杯—选用图



浇口杯—选用图



2.冒口计算

①冒口补缩范围

	作用区	端末区
900℃	8~10	8~10
1200 ℃	12~15	10~12

温度（℃）	<200	200~400	400~800
作用区	3~4	5~6	6~7

②冒口大小计算

Ⅰ热节圆法

Ⅱ模数法

$M_{铸}:M_{颈}:M_{冒}=1:(1.05\sim1.3):(1.2\sim1.5)$

$V_{冒}(k-\beta)=\beta V_{铸}$

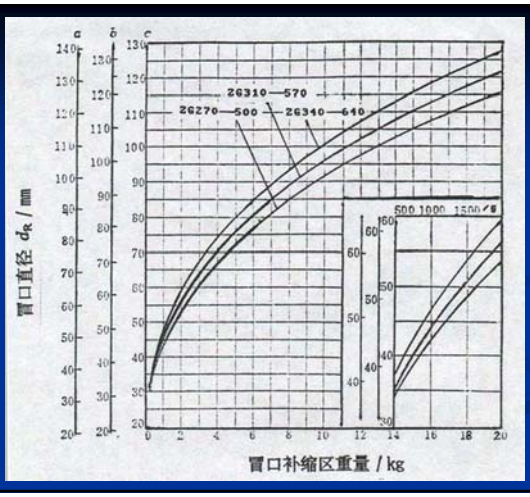
$V_{冒}=V_{铸}\times\beta/(k-\beta)$

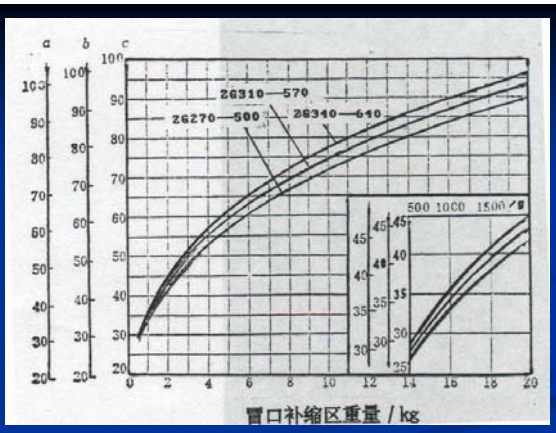
Ⅲ冒口计算图

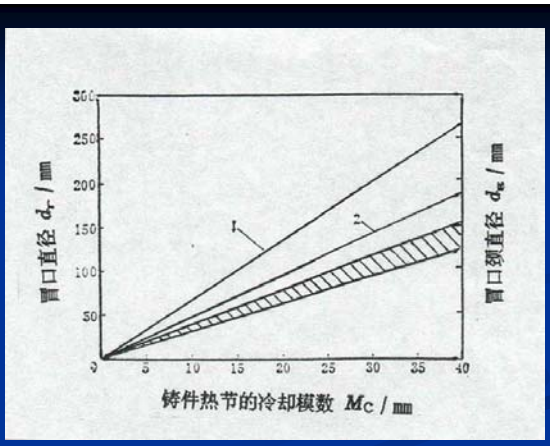
$D_{冒}=\max[d_r,d_R]$

dr—保证冒口比铸件冷却慢所需的冒口直径

d_R—保证冒口贮存足够金属液补缩铸件的冒口直径







The End