Technology Exchange of Swirling-cutting Drill Bit and Other Downhole Tools

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2012.02

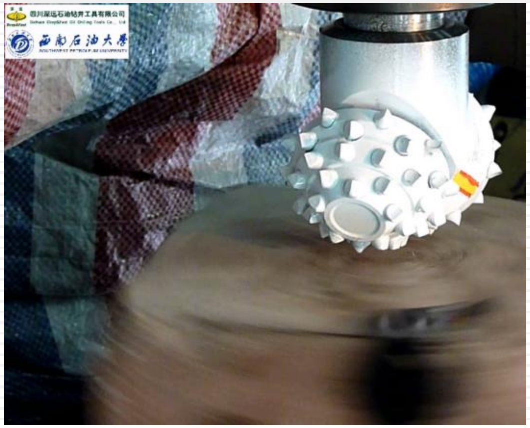
1、旋切钻头

结合前期研究成果，主要说明旋切钻头关键参数轮体速比、轮体夹角 β 轴颈偏移量 s ，对井底模型的影响。

2.1 井底模型关键参数影响分析

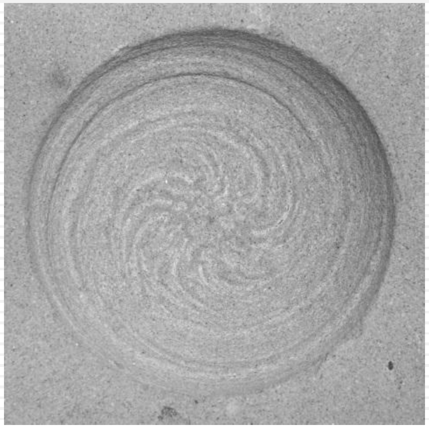
2.1.1 研究基础

（一）建立旋切钻头前期研究成果总结，完成相关研究



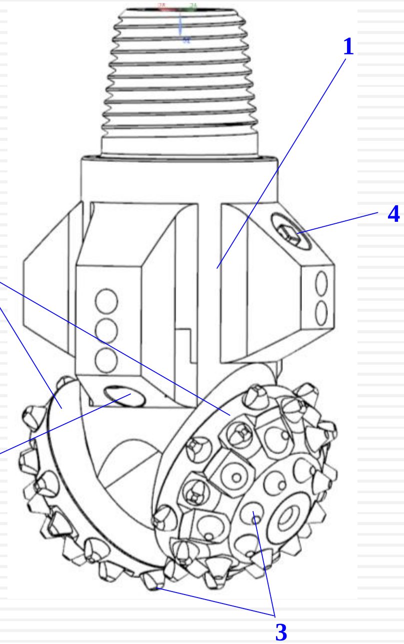
实验钻进

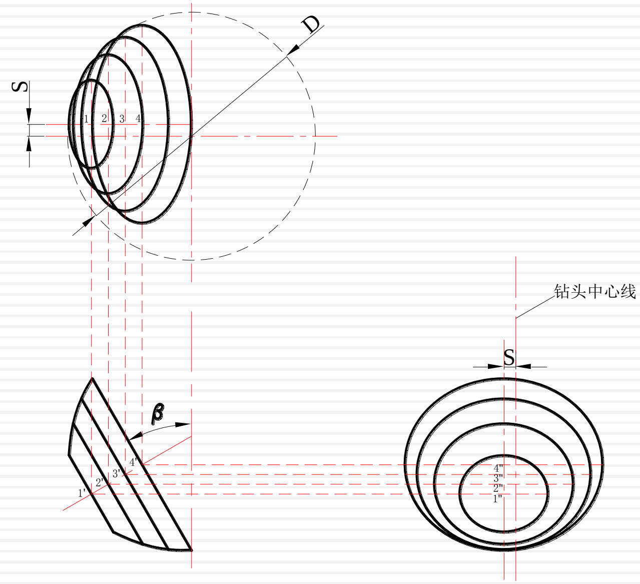
反转（S 为负值，顺时针旋风）

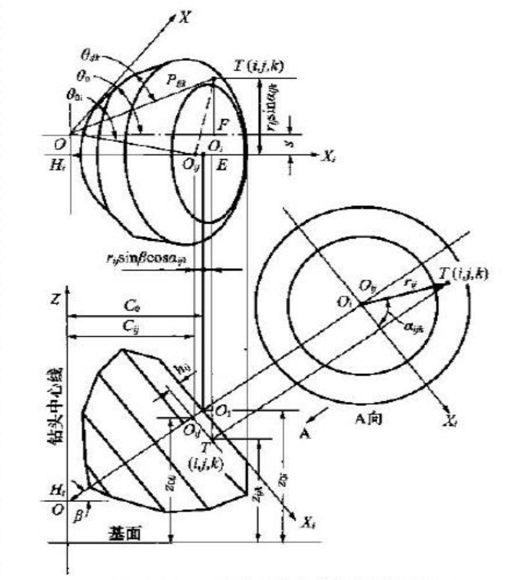


正转（S 为正值，逆时针旋风）

（二）、建立旋切钻头几何学（结构）、运动学方程。







运动轨迹方程

$$\rho_Q = \sqrt{(C_0 - h_Q\cos\beta + r_Q\sin\beta\cos\alpha_Q)^2 + (r_Q\sin\alpha_Q - s)^2}$$

$$\theta_Q = \theta_0 - \frac{2\pi(i-1)}{3} - tan^{-1}\left(\frac{r_Q\sin\alpha_Q - s}{C_0 - h_Q\cos\beta + r_Q\sin\beta\cos\alpha_Q}\right)$$

$$z_Q = z_Q - h_Q\sin\beta - r_Q\cos\beta\cos\alpha_Q$$

速度方程

$$v_{Q\rho} = \frac{d\rho Q}{dt} = \lambda_{Q\rho} r_Q \omega_i$$

$$v_{Qt} = \rho_Q \frac{d\theta_Q}{dt} = \rho_Q \omega_b - \lambda_{Qt} r_Q \omega_i$$

$$v_{Qz} = \frac{dzQ}{dt} = v_{bz} + \lambda_{QZ} r_Q \omega_i$$

$$\lambda_{Q\rho} = \frac{\left[\frac{r_Q}{2}\cos^2\beta \sin 2\alpha_Q - (C_0 - h_Q \cos\beta)\sin\beta \sin\alpha_Q - s\cos\alpha_Q\right]}{\sqrt{(C_0 - h_Q\cos\beta + r_Q \sin\beta \cos\alpha_Q)^2 + (r_Q \sin\alpha_Q - s)^2}}$$

$$\lambda_{Qt} = \frac{(C_0 - h_Q \cos\beta)\cos\alpha_Q + r_Q \sin\beta - s\sin\beta \sin\alpha_Q}{\rho^2{}_Q}$$

$$\lambda_{Qz} = \cos\beta \sin\alpha_Q$$

加速度方程

$$a_{Q\rho}=\frac{r_Q}{\rho_Q}\left[\frac{r_Q}{2}\cos^2\beta\sin 2\alpha_Q-\left(C_0-h_Q\cos\beta\right)\sin\beta\sin\alpha_Q-s\cos\alpha_Q\right]\varepsilon_c$$

$$+\frac{r_Q}{\rho_Q}\left[r_Q\cos^2\beta\cos 2\alpha_Q-\left(C_0-h_Q\cos\beta\right)\sin\beta\sin\alpha_Q+s\sin\alpha_Q\right]\omega^2{}_c$$

$$-\frac{r_Q}{\rho^3{}_Q}\left[\frac{r_Q}{2}\cos^2\beta\sin 2\alpha_Q-\left(C_0-h_Q\cos\beta\right)\sin\beta\sin\alpha_Q-s\sin\alpha_Q\right]^2\omega^2{}_c$$

$$-\rho_Q(\omega_b-\lambda_{Qt}r_Q\omega_i)^2$$

$$a_{Qt}=\rho_Q\left[\varepsilon_b-m\varepsilon_c-\left(m\right)'\omega^2{}_c\right]+2(\omega_b-\lambda_{Qt}r_Q\omega_i)r_Q\lambda_{Q\rho}\omega_i$$

$$a_{Qz}=a_{oz}+r_Q\cos\beta\cos\alpha_Q\,\varepsilon_c+r_Q\cos\beta\cos\alpha_Q\,\omega^2{}_c$$

$$\mathrm{m}=r_Q\left[\left(C_0-h_Q\cos\beta\right)\cos\alpha_Q+r_Q\sin\beta-s\sin\beta\sin\alpha_Q\right]/[(C_0-h_Q\cos\beta+r_Q\sin\beta\cos\alpha_Q)^2+(r_Q\sin\alpha_Q-s)^2]$$

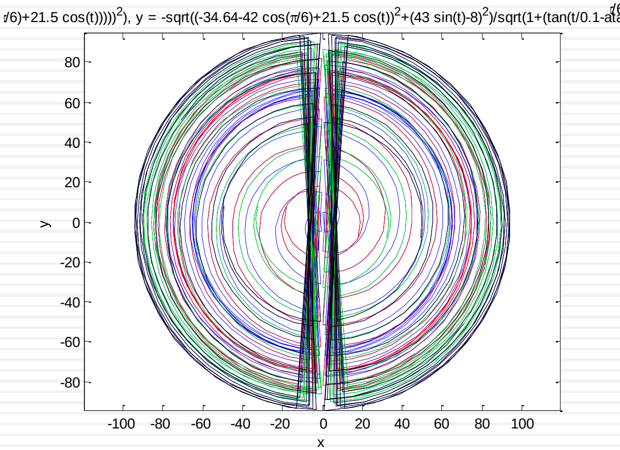
$$(\mathrm{m})'=\frac{-r_Q\left[\left(C_0-h_Q\cos\beta\right)\cos\alpha_Q\sin\alpha_Q-s\sin\beta\cos\alpha_Q\right]}{(C_0-h_Q\cos\beta+r_Q\sin\beta\cos\alpha_Q)^2+(r_Q\sin\alpha-s)^2}$$

$$-\left\{r^2{}_Q\left[\left(C_0-h_Q\cos\beta\right)\cos\alpha_Q-s\sin\beta\sin\alpha_Q+r_Q\sin\beta\right][r_Q\cos^2\beta\sin 2\alpha_Q\right.$$

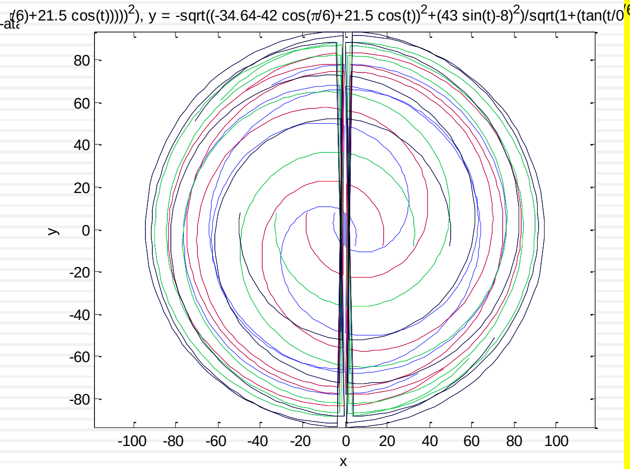
$$\left.-2\left(C_0-h_Q\cos\beta\right)\sin\beta\sin\alpha_Q-2s\cos\alpha_Q]\right\}/[(C_0-h_Q\cos\beta$$

$$+r_Q\sin\beta\cos\alpha_Q)^2+(r_Q\sin\alpha_Q-s)^2]^2$$

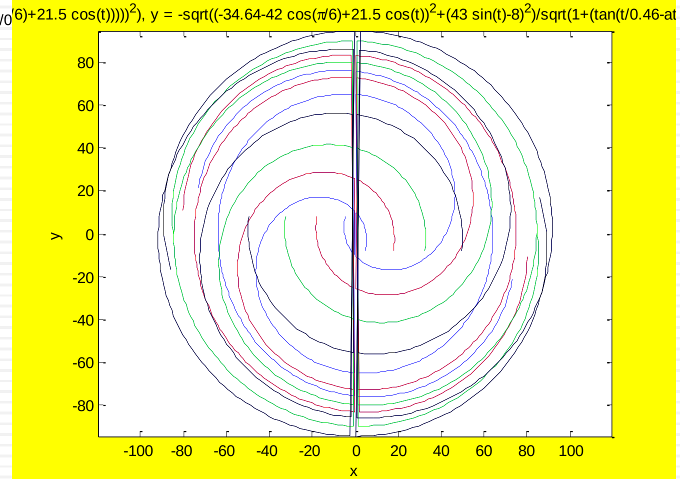
2.1.2 轮体速比对井底模型的影响



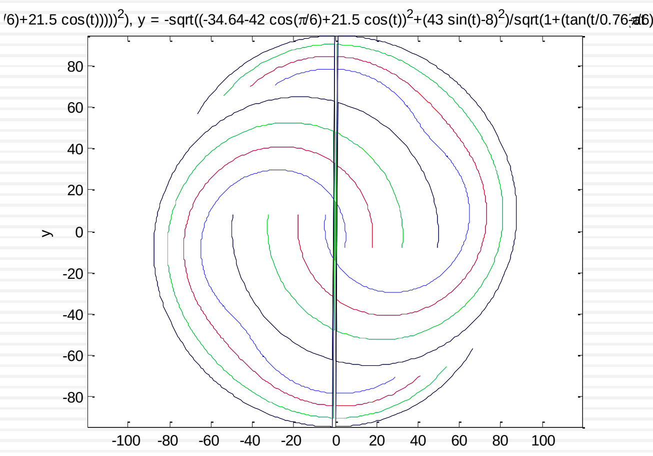
轮体速比=0.1



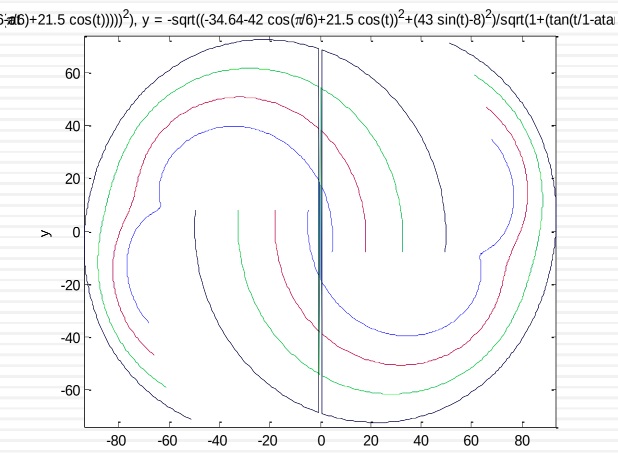
轮体速比=0.3



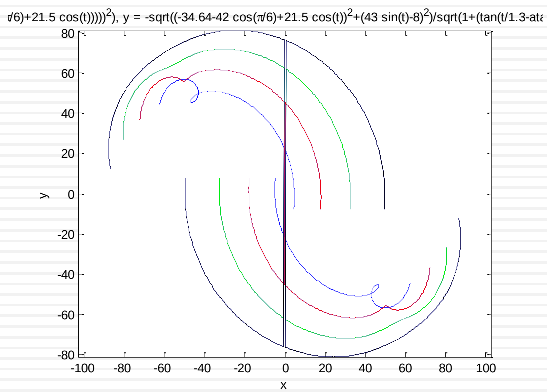
轮体速比=0.46



轮体速比=0.76

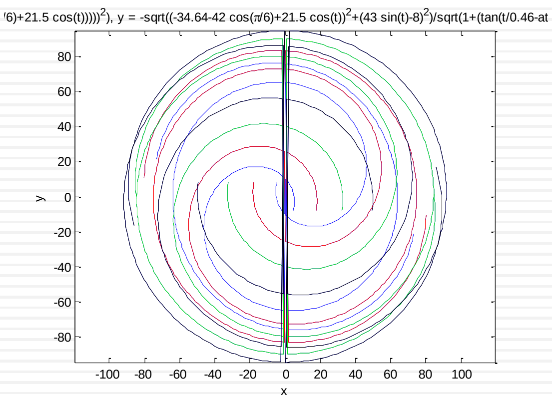


轮体速比=1

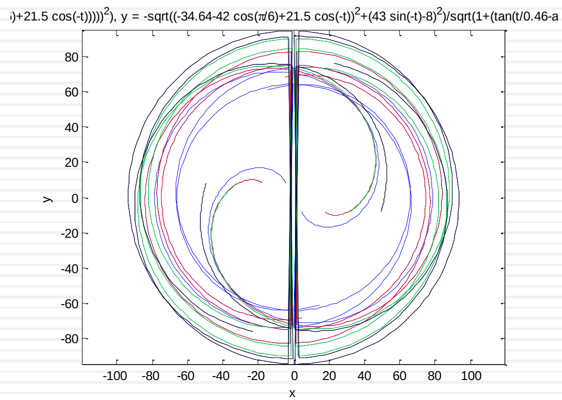


轮体速比=1.3

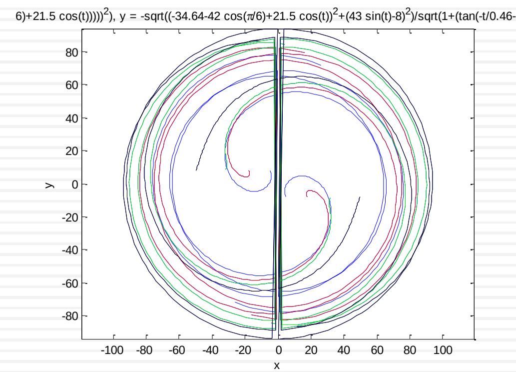
2.1.3 轴颈偏移量（含牙轮转向布置）对井底模型的影响



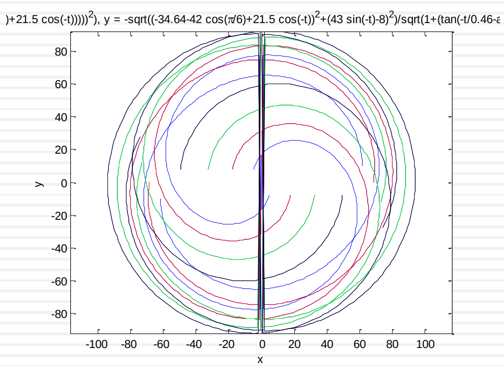
钻头正向，牙轮正向



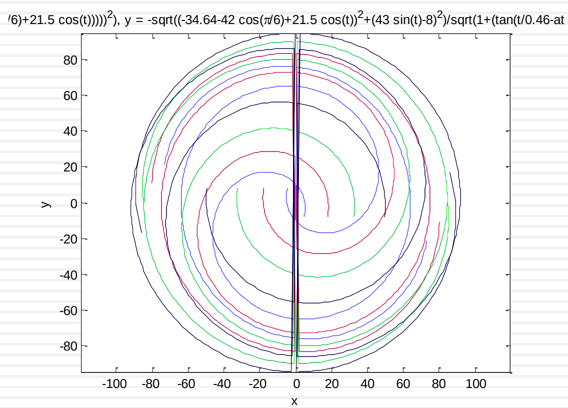
钻头正向，牙轮负向



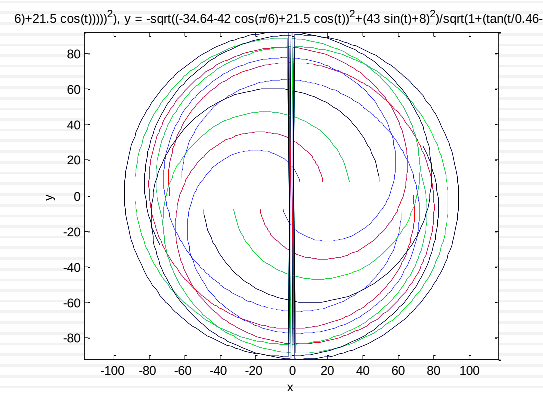
钻头负向，牙轮正向



钻头负向，牙轮负向



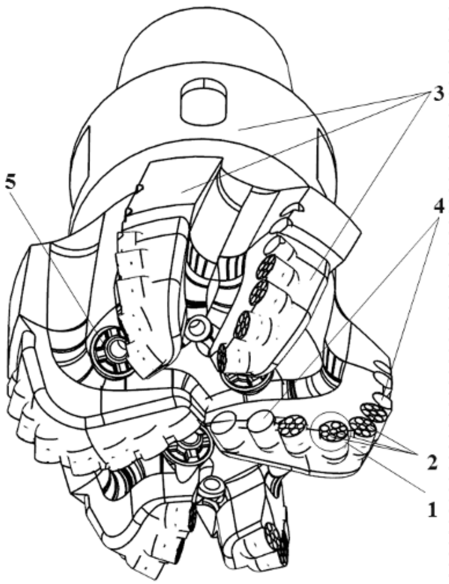
S=+8MM

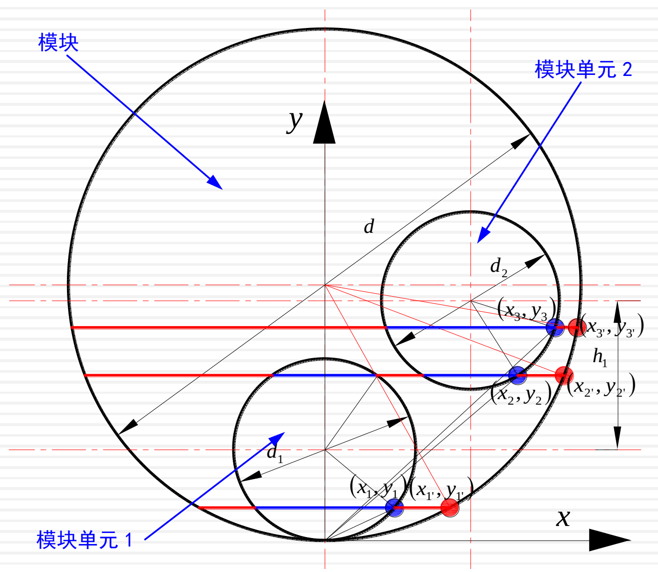


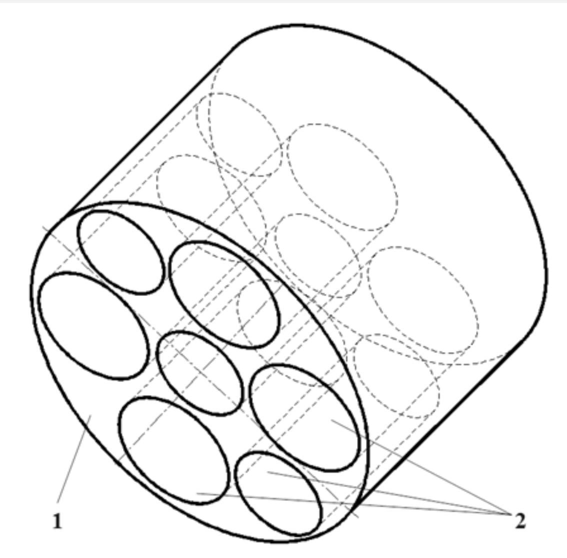
S=-8MM

2.2 模块PDC

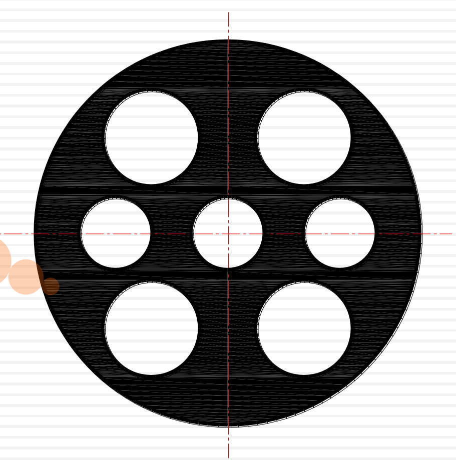
根据前期研究结果，对后期的思考

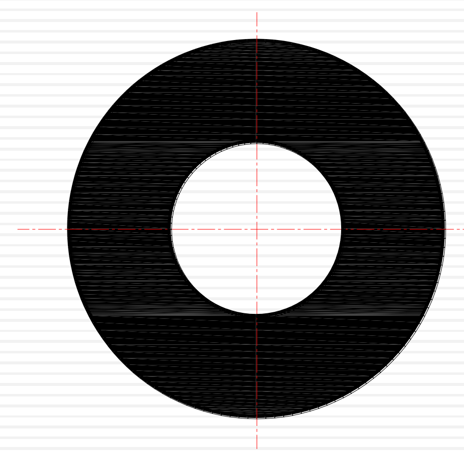






另一种补充
（挖空）？

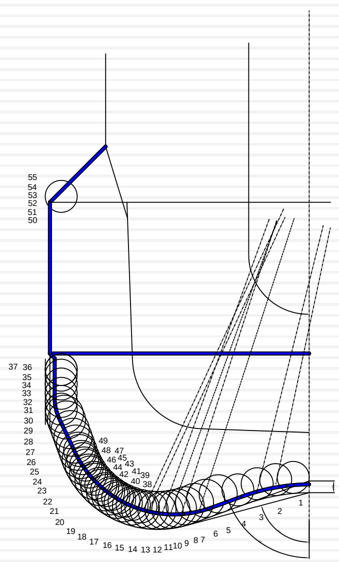


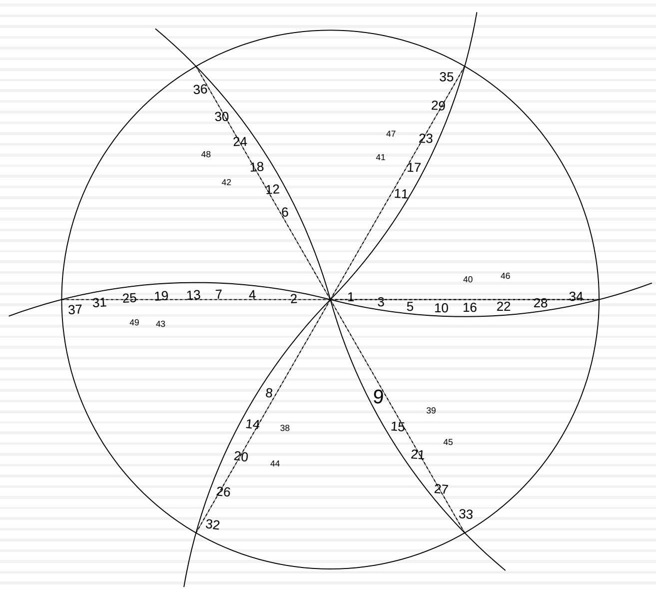


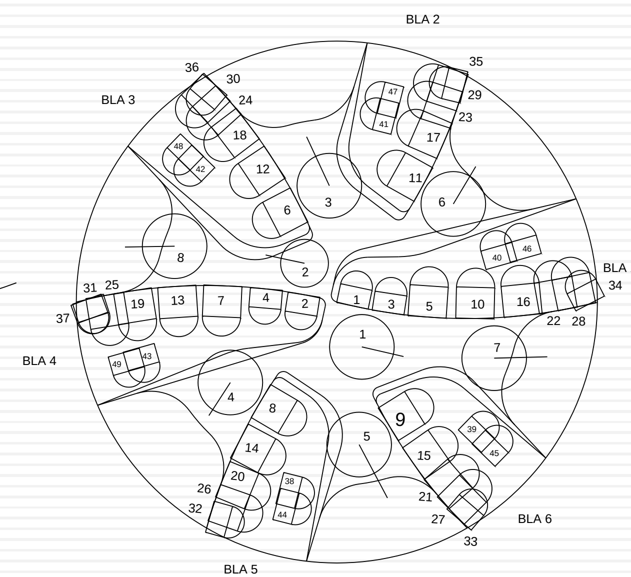
2.3 PDC布齿基础研究

现场反馈问题：（供参考）PDC中心齿的倾斜角，对齿的覆盖率、干涉、破岩率的影响，PDC的基础问题。编软件进行科学设计？

失效部位(中心、外围、保径)、失效形式（磨损、冲击、磨损）？



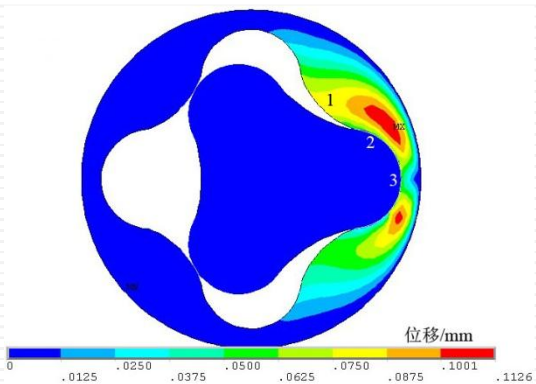




2、螺杆钻具（PDM）

橡胶性能、温度等基本参数对橡胶配合过盈量、钻具寿命的影响？

（一）、常规衬套与等壁厚衬套计算结果



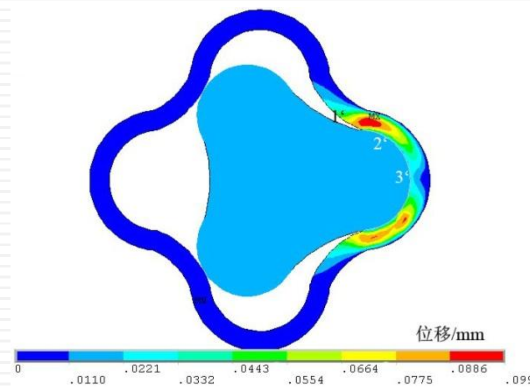
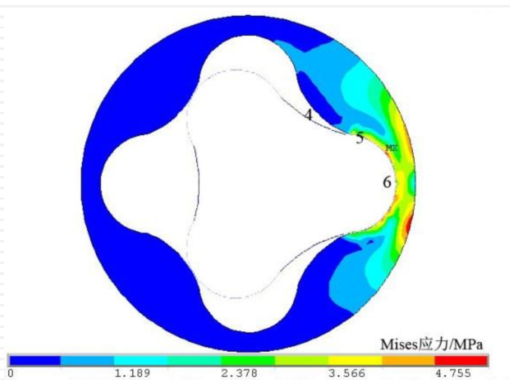


图1 10Mpa内压常规衬套位移云图　　图2 10MPa内压等壁厚衬套位移云图



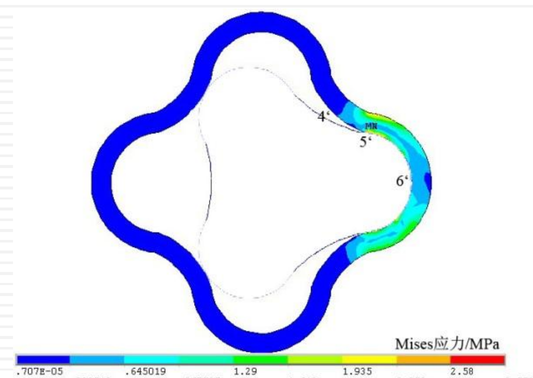
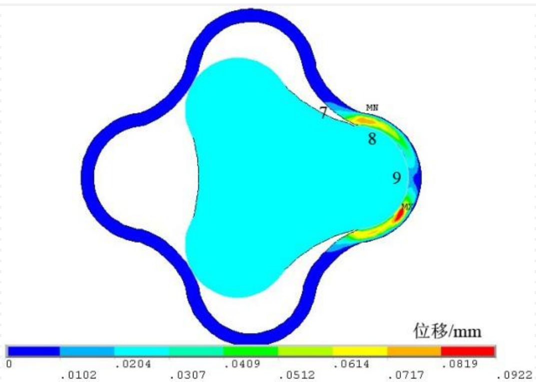
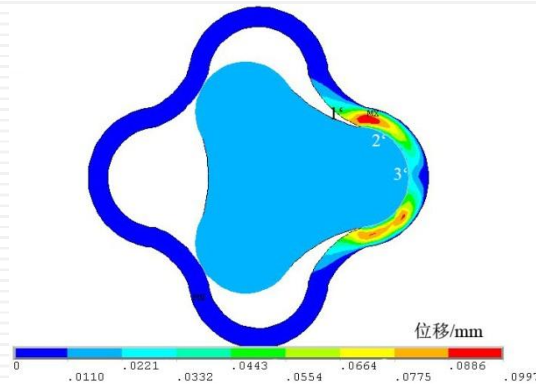


图3 10Mpa内压常规衬套Mises应力云图　图4 10Mpa内压等壁厚衬套Mises应力云图

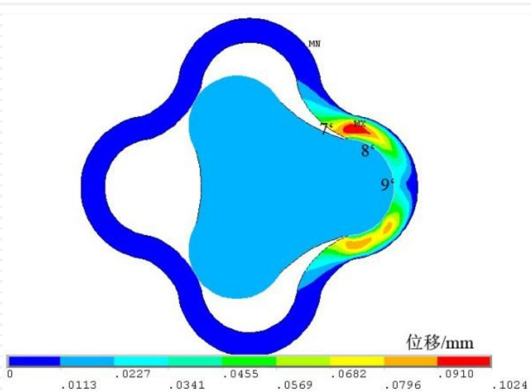
（二）、厚度变化对衬套性能影响



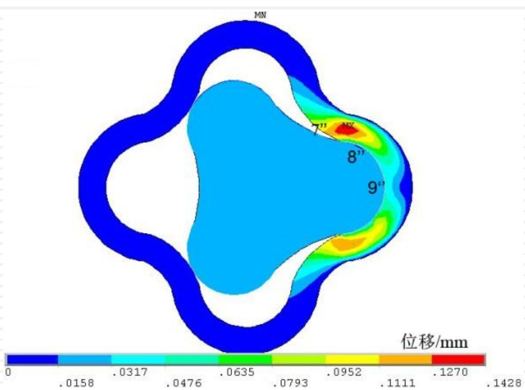
厚度5mm等壁厚衬套位移云图



厚度8mm等壁厚衬套位移云图



厚度10mm等壁厚衬套位移云图



厚度12mm等壁厚衬套位移云图

3、其他井下工具

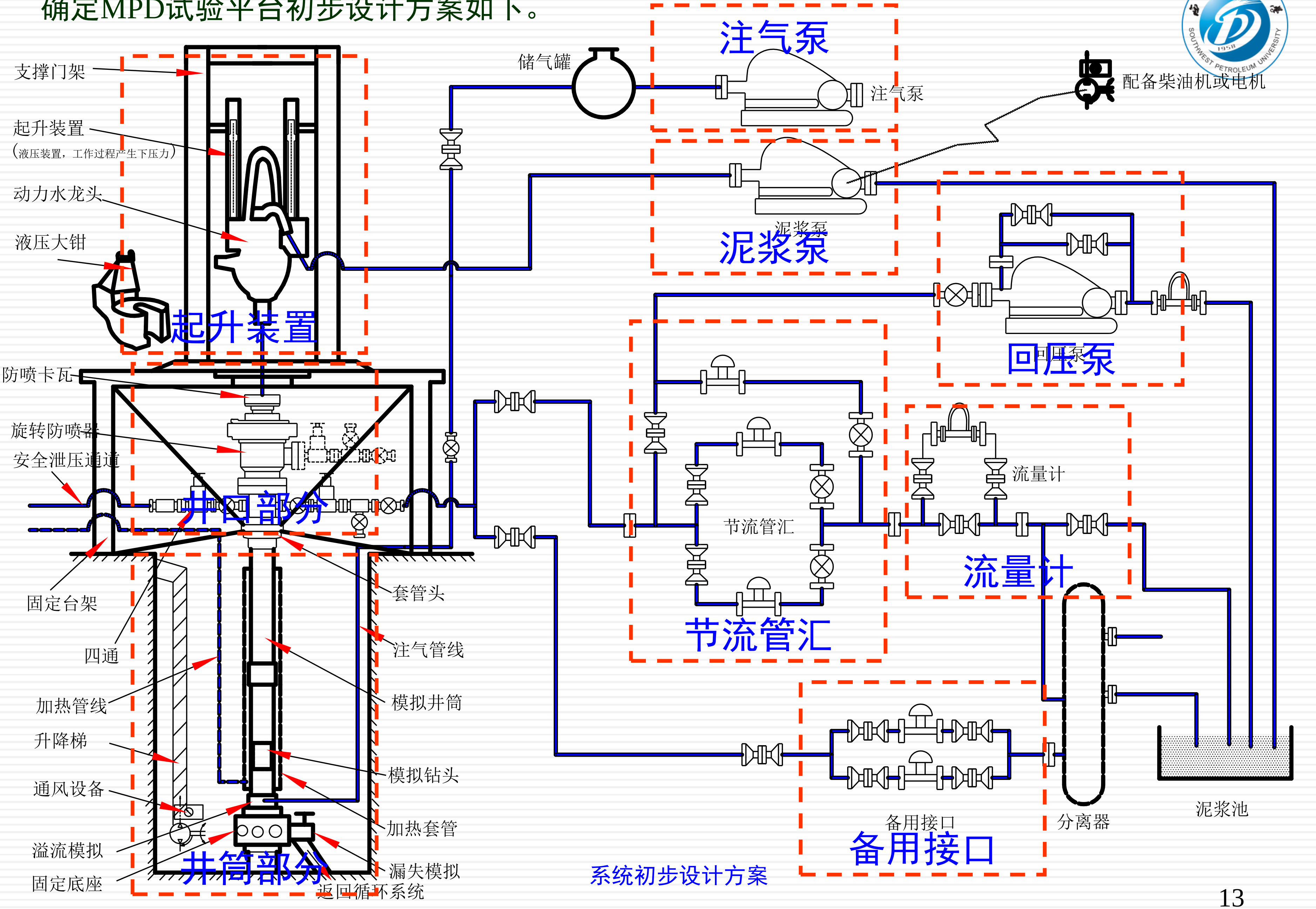
3.1 钻井新工艺

（1）连续循环钻井

（2）高温钻井在非开挖中的应用

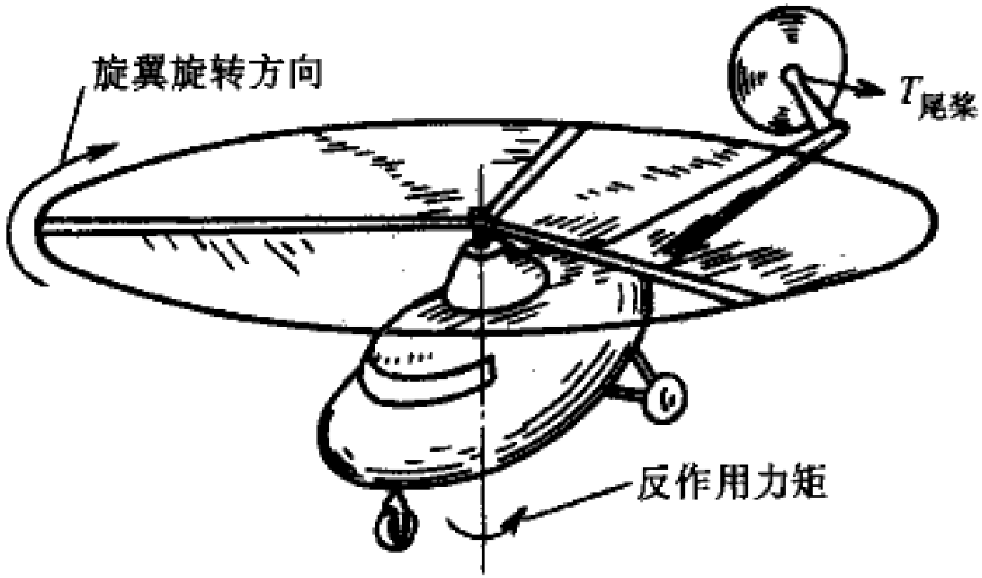
（3）MPD钻井？

确定MPD试验平台初步设计方案如下。

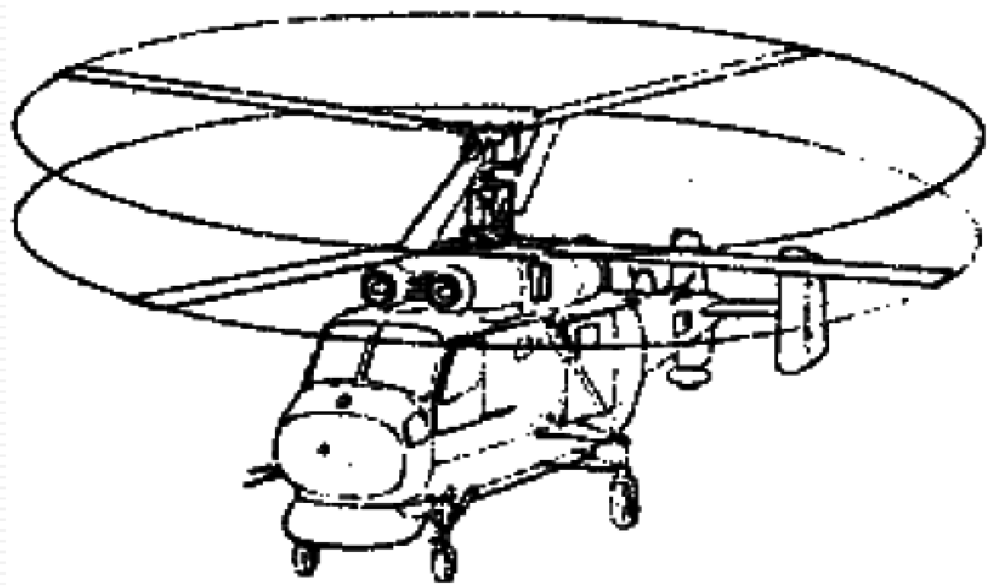


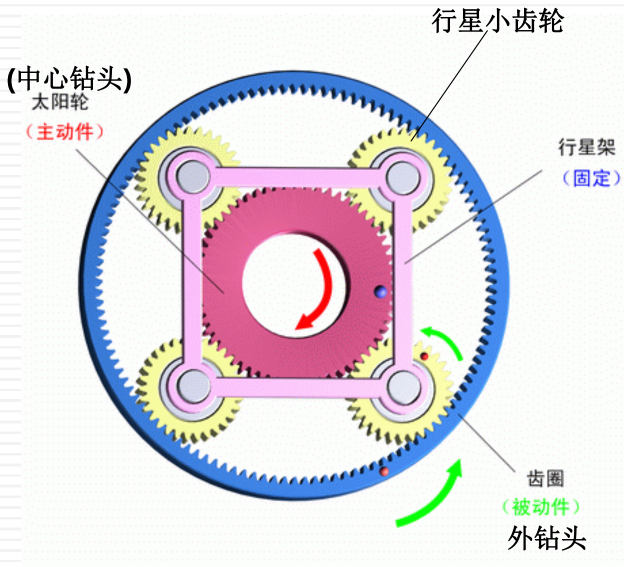
（3）一种新型无反扭矩的钻具

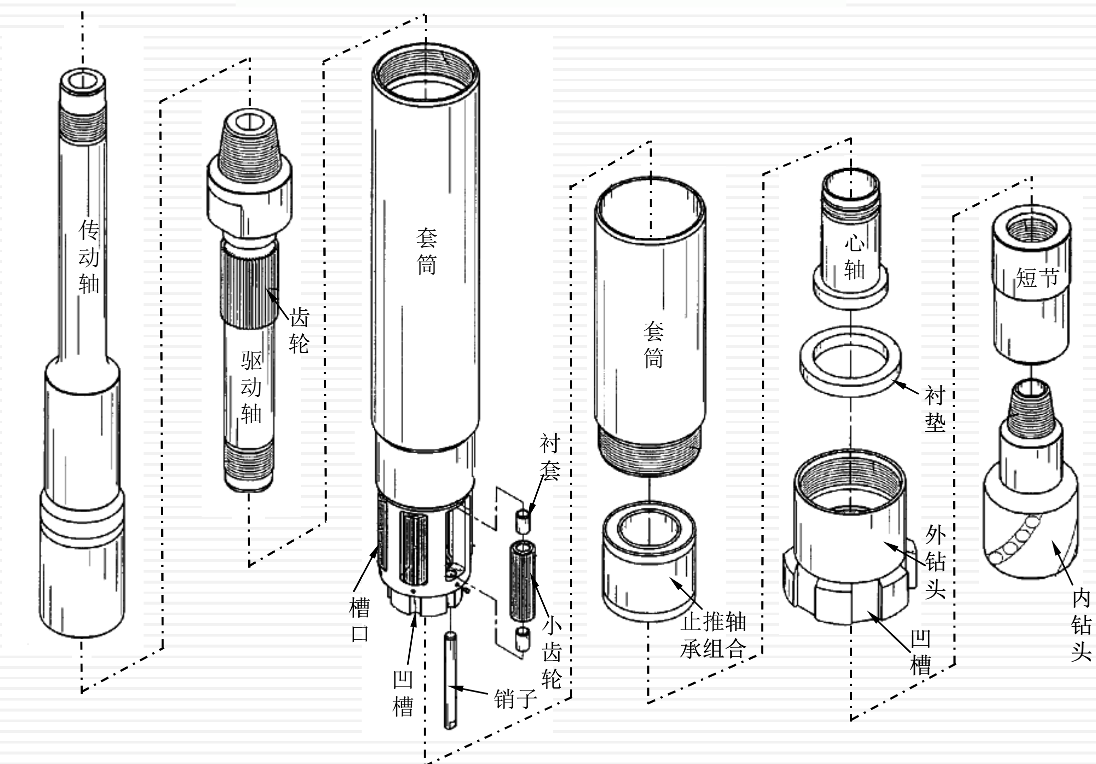
单旋翼直升机的反扭矩



共轴双旋翼直升机




行星小齿轮
(中心钻头)
太阳轮
（主动件）
行星架
（固定）
齿圈
（被动件）
外钻头


传动轴
齿轮
驱动轴
套筒
衬套
槽口
凹槽
小齿轮
销子
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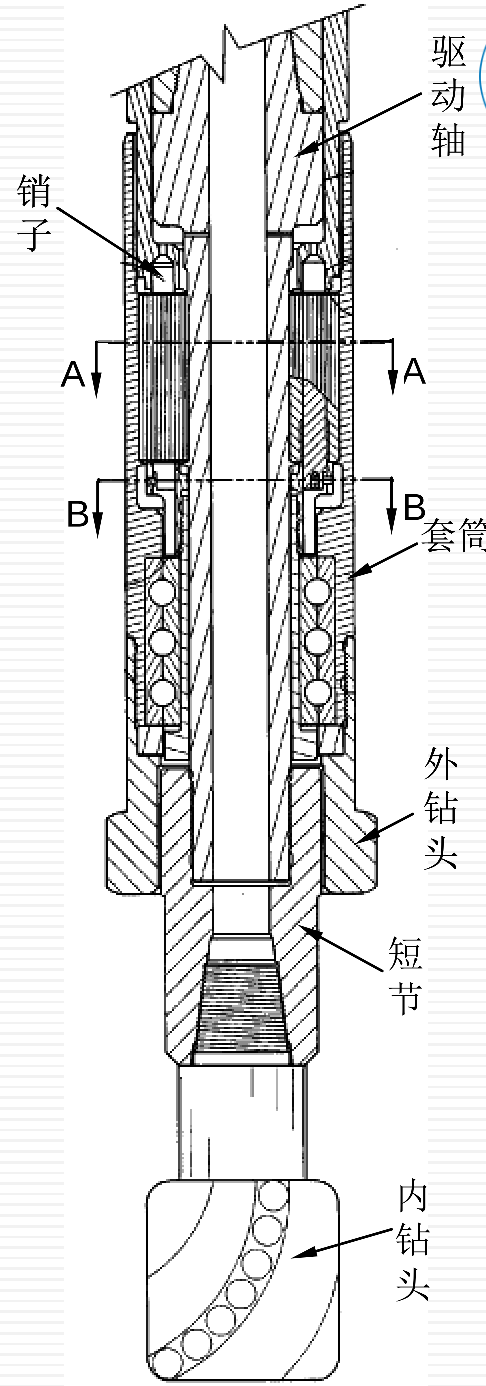
止推轴承组合
心轴
衬垫
外钻头
凹槽
短节
内钻头


驱动轴
销子
A
A
B
B
套筒
外钻头
短节
内钻头

谢谢！