一种新连铸机机型的诞生

传统的扁平坯一般都采用组合式结晶器，密排铜扇形段，柔性引锭杆 等。其机型都已经在生产上使用了几十年，但其工艺性、产品质量、设备制造、设备维修的弊端也不用多述。

今有一种采用钢管式结晶器，强冷密排足辊，刚性引锭杆等新技术设备的连铸机由北京中色建设机电设备有限公司研究制造，并在浙江衢州元立金属制品厂的50吨转炉，R8米，四机四流的多点弧的连铸机上生产120×360宽厚比等于3的扁平坯，一次拉坯成功，四流顺利拉出，坯型非常漂亮。

本机型有十大特点：

1. 工艺性好　带子母口的水冷铜法兰，上口不漏水，铜管不变形，弯月面锥度曲线保持好，而且不粘钢不挂钢。
2. 结晶器铜管锥度曲线精度高。
3. 窄水缝设计合理，精度高，水缝均匀，冷却均匀。
4. 密排强冷足辊替代密排的扇型段。
5. 刚性引锭杆，二冷简化，便于处理工艺事故。
6. 维护方便，简单。
7. 备品备件损耗少，成本低。
8. 事故处理快，作业率高。
9. 铜管结晶器寿命高，该断面的结晶器铜管过钢量＞12000t／支。
10. 坯型好，质量高。

本机型设备，工艺成熟，可靠性高，该机型可覆盖100～200×200～600mm的扁平坯，大矩型坯，大方坯的连铸机。

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中国冶金报

新型连铸机一次试车成功

本报讯（记者夏杰生　通讯员谢凤华）近日，由湖南海方冶金连铸设备制造有限公司研发、制造的，既可以生产方坯又可以生产板坯的新型4机4流连铸机，在浙江衢州元立金属制造有限公司一次试车成功。

新型连铸机具有如下特点：采用高效管式结晶器生产宽厚比大于3的矩形铸坯；用密排强冷足辊替代密排的扇形段，使二冷区简化；用刚性引锭杆代替柔性引锭杆，产品质量高、坯型好，产品规格可覆盖100~80mm×200~500mm的方坯、扁平坯、大矩形坯等。该设备通过工艺改进，可为企业降低设备制造费用，同时提高了连铸机作业率。

湖南海方冶金连铸设备制造有限公司自2002年开始，就如何采用管式结晶器来生产扁平坯、矩形坯课题进行了攻关，经过1年多的努力，在莱芜钢铁公司、唐山荣程钢铁公司，托顺钢铁公司的大力支持与配合下，宽厚比大于2、大于3、大于4的高效管式结晶器相继开发成功，并正式投入生产，为企业创造了良好的经济效益，与此同时，结晶器制造中的6项内容获得了国家专利，正是依靠高效管式结晶器的开发成果，才使得这种连铸机可以同时满足方坯和板坯的生产。

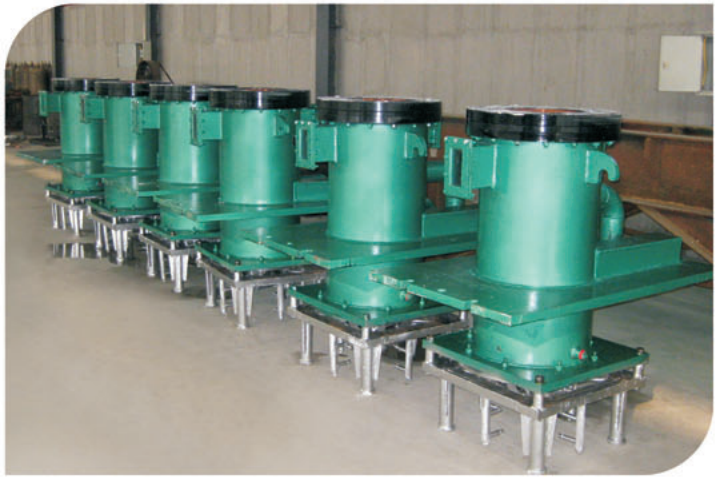
在国家重点发展热轧带钢的今天，如何提高中窄带钢的产品质量、生产效率，巩固市场占有率？湖南海方冶金连铸设备制造有限公司高效管式结晶器及连铸机的研发成功，将对我国的中窄带坯的生产起到积极的推动作用。

连铸采风

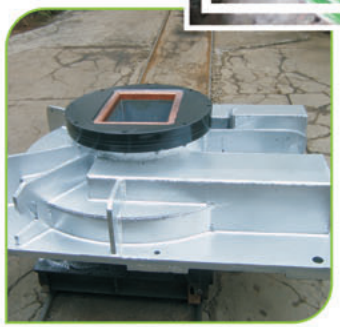
《中国冶金报》报道我公司产品
《China Metallurgical News》
reported that the company products

生产车间
Produce workshop

高效结晶器总成
Efficient crystal assembly



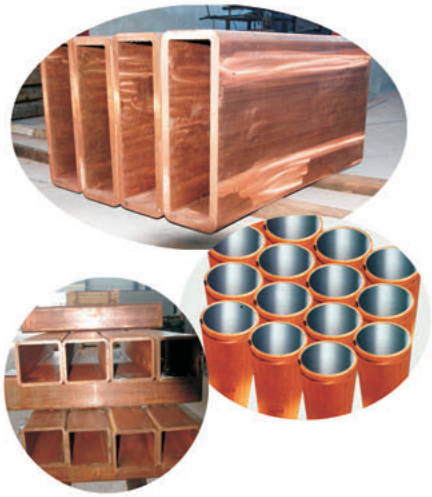
高效结晶器总成
Efficient crystal assembly



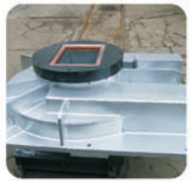
管式结晶器连铸工艺的科技先锋
Tubular mold casting process technology pioneer

设计先进合理，铜管全长冷却、无死角、无导流灯，铜管内腔为双抛物线特殊的连续锥度，结晶器结构设计简洁、拆装方便。上口为铜法兰带子母口防止铜管上口变形和漏水，该结晶器备件消耗少，只需要更换铜管及足辊。

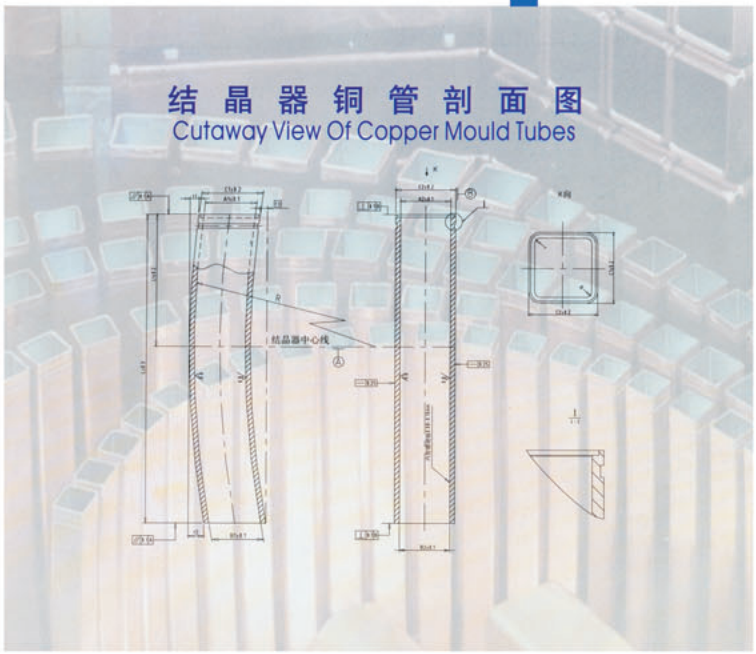
rational design of advanced, full-length copper tube cooling, no dead, no light diversion, a special copper cavity for dual-parabolic continuous taper, mold design simple, easy disassembly . Catchy copper brass flange with a catchy picture distortion and to prevent mouth leaks, the mold parts consumption, only need to replace the copper pipe and Foot roller



高效结晶器铜管
Copper Mould Tubes

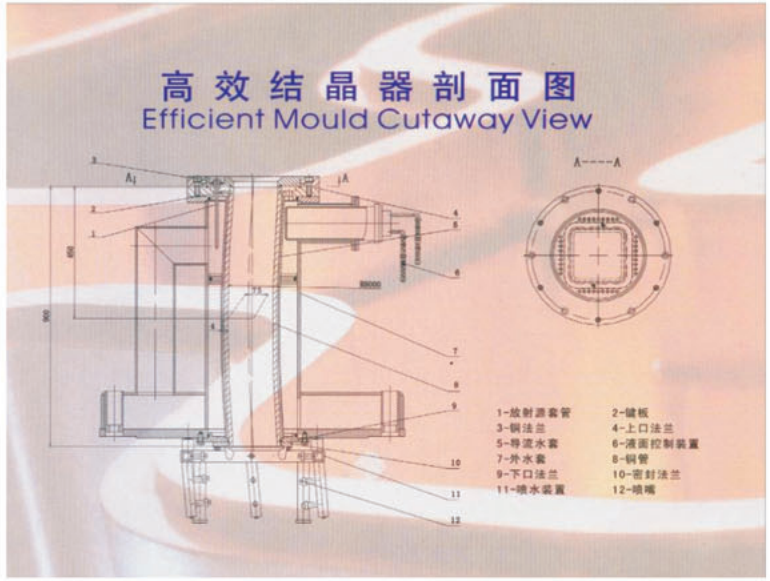


技术参数
Technical parameters



结晶器铜管的主要规格
Copper Mould Tubes Main Specifications

规格 (Size)	90＊90、100*100、110*110、120*120 130*130、130*240、150*150、150*320 160*160、160*220、180*220、198*256 200*200、200*230、240*300、260*320 220*300、230*250、250*280、200*350 200*410、180*410、180*480、200*500 165*500、180*500、165*540、180*575 165*580、180*600	抛物线、双抛物线 连续锥度 Parabola Double-parabola Continous Conic Angle
长度 Lenght	780、812、850、900、1000	
铸坯半径 Radius	5000、5250、6000、7000、8000、9000、10000	
材质 Material	磷脱氧铜（Tp2）、含银铜（Cu-Ag）	

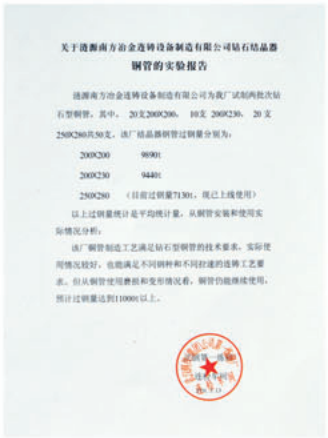


高效结晶器技术参数
Technical tiems Of Efficient Mould Cutaway View

单位：mm
Unit：mm

项目 Name / 参数 Item / 型号 Model	铸坯断面 Cast-Slab Cross Section	铸坯半径 Cast-Slab Radius	铜管长度 Copper Tube Length	铜管材料 Copper Tube Material	铜管壁厚 Copper Tube Ply	铜管锥度 Copper Tube Conic Angle	水冷工作压力 Water Work Pressure	水冷流量 Water Flux	水冷速度 Water Speed	水缝宽度 Water-gap Width	型试 Mould Type
FLJ110	110x110	R5000 R5250 R6000 R8000	780 1200	磷脱氧铜 Fpc	10	全抛物线连续锥度 All Parabola Continuous Conic Angle	0.5~0.7Mpa	100~200m³/h	大于 10m/s	3.5±0.3 4±0.3 4.5±0.3 5±0.3	方坯 Billet
FLJ120	120x120				10、12						
FLJ130	130x130				10、13						
FLJ150	150x150				10、12、13						
FLJ160	160x160			含银铜 Ag Cu	14						矩形坯 Rectangle Slab
ZLJ150x320	150x320				20						
ZLJ180x220	180x220	R9000			16						方坯 Billet
ZLJ200x200	200x200	R10000			18						
ZLJ200x230	200x230	R10000			20						矩形坯 Rectangle Slab
ZLJ220x300	220x300	R9000			20						
ZLJ230x250	230x250	R10000			20						
ZLJ230x280	250x280	R10000			20						

成功案例
Successful Case



关于济源南方冶金连铸设备制造有限公司钻石结晶器钢管的实验报告

济源南方冶金连铸设备制造有限公司为我厂试制两批次钻石型钢管，其中： 20支200X200， 10支 200X230， 20 支 250X260共50支，该厂结晶器钢管过钢量分别为：

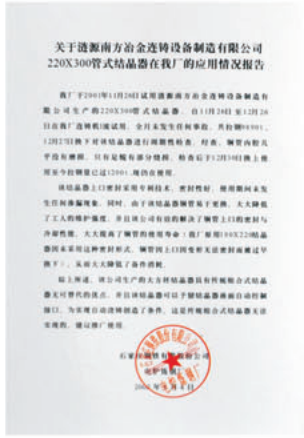
200X200 9890t

200X250 9440t

250X280 （目前过钢量7130t，现已上线使用）

以上过钢量统计是平均统计量，从钢管安装和使用实际情况分析：

该厂钢管制造工艺满足钻石型钢管的技术要求，实际使用情况较好，也能满足不同钢种和不同拉速的连铸工艺要求。但从钢管使用磨损和变形情况看，钢管仍能继续使用，预计过钢量达到11000t以上。



关于济源南方冶金连铸设备制造有限公司220X300管式结晶器在我厂的应用情况报告

我厂于2001年11月24日试用济源南方冶金连铸设备制造有限公司生产的220X300管式结晶器，自11月24日至12月26日在我厂连铸机调试试用，全月未发生任何事故，共拉钢9890t，12月27日拆下对该结晶器进行测量性检查，对表、铜管内腔无平均有磨损，只有是螺有部分磨损，检查后于12月30日换上使用至今拉钢量已达12001.3t仍在使用。

该结晶器上口密封采用专利技术，密封性好，使用期间未发生任何漏钢现象。同时，由于该结晶器铜管易于更换，大大降低了工人的维护强度，并且该公司有效的解决了铜管上口的密封与冷却性能，大大提高了铜管的使用寿命；我厂使用10X220结晶器因未采用这种密封形式，铜管因上口因变形无法密封而减过早的下线，从而大大降低了操作的机。

以上所述，该公司生产的大方形结晶器具有传统结合式结晶器无可替代的优点，并且该结晶器可以于铸钢结晶器振动自动制振口，为实现自动连铸创造了条件，适宜传统结合式结晶器无法实现的，建议推广使用。

莱钢120*360mm断面高效管式结晶器研制与应用

一、高效结晶器的热点及采用新技术

1 、部件少，仅有结晶器钢管，整体水套，上口定位法兰主要部件，易于装拆，更换结晶器钢管方便，键板调整水缝方便，检测水缝直观，互换性好。

2 、上口密封远离热区，直接通水冷却，上口密封圈密封可靠，密封圈寿命长。

3 、采用窄水缝，水缝组装时直接用塞规测量，保证水缝均匀，在同等水压下增大冷却水流速（达 10 米每秒以上），水路畅通，无导流条和导流钉，沿结晶器铜管全长获得冷却。

4120*360mm 断面结晶铜管已申请国家专利，专利号 ZL97238779.X 。

120*360mm 断面结晶铜管为国内铜管宽厚比最大。到达 3 为国内首创，结晶器铜管内腔采用满足很宽拉速的抛物线曲线（连续锥度），结晶器钢管上设止口，通过上口定位法兰衬紧，保证上口有足够的刚度，防止拉坯力对铜管的上口的变形。

5 、结晶器水套已获国家专利，专利号 ZL99249777.9 。

外水套与导流水套阻焊为一体，导流水套有足够的刚性和内腔具有较高的精度，四阖水缝均匀，减少了结晶器导流水套备件的消耗，导流水套内腔镀硌，，防止生锈，表面光滑，保证冷却水流动无阻，外水套与导流水套组装为一体，可以拆装，排污方便。

6 、结晶器钢管上口定位法兰已获得国家专利，专利号为 ZL99049776.0

上口定位法兰采用紫铜，传导性好，不粘钢、不挂钢。直接水冷防变形，带止口咬住结晶器钢管上口不变形，四周设置润滑油槽，结晶器润滑均匀。

120 * 360mm cross-section of dishes and efficient steel tubular mold development and application of

First, the characteristics of mold and efficient use of new technologies

1, small parts, only the copper mold, the overall water jacket, catchy positioning flange main components, easy assembly and disassembly, easy to replace the copper mold, keypad easy to adjust the water gap, water testing seam intuitive, interchangeable good.

2, catchy sealed away from the hot zone, directly cooled by water, catchy ring seal reliability, long life seals.

3, a narrow water gap, water seam assembly with plug directly measured, to ensure uniform water gap, the same water pressure in the cooling water flow rate increases (up to 10 meters per second or more), water flow, and no diversion of lead flow nails, obtained along the length of the cooling copper mold.

4, 120 * 360mm brass mold section has applied for national patents, patent No. ZL97238779.X.

120 * 360mm brass section for the domestic copper mold generous than the maximum. Reach 3 for the domestic first mold cavity used to meet a wide brass casting speed of the parabolic curve (continuous taper), located on the mold brass spigot, by positioning the flange lining tight catchy, catchy enough to ensure stiffness, strength of copper to prevent the casting of the refrain of the deformation.

5, mold water jacket has been the national patent, Patent No. ZL99249777.9

External water flow guide sleeve and welded into one kit, sets of guide there is enough water cavity has a high rigidity and precision, the four fun-filled water, joint evenly, reducing the set of spare parts mold guide water consumption, water comprising a chamber guide Ge-plated to prevent rust, smooth surface to ensure the unimpeded flow of cooling water, external water flow guide sleeve and sleeve assembly as a whole, can be removable, sewage convenient.

6, mold steel catchy positioning flange has obtained national patent, Patent No. ZL99049776.0

Catchy positioning flange copper, good conductivity, non-stick steel, not hanging steel. Direct water-cooled anti-distortion, only the mouth bite with catchy brass mold without distortion, surrounded by setting oil tank, mold lubricant evenly.

成功案例
Successful Case

二、效管式结晶器的生产实践及应用效果

二, Effective mold tube production practice and application results

1、高效管式结晶器的生产实践

2003年5月15号1#机120*360断面全部采用高双管式结晶器，结晶器水量调到180-200t/h, 二冷自动配水良好，采用液面自动控制，火焰切割机工作正常，拉速最高达到1.9米每分钟左右，连拉92小时，过钢量2300吨，结晶器铜管下台后检查，钢管四个面度硌层的磨损距下口最大有20cm, 弯月面处无变形，其他部位正常。

2。高效管式结晶器应用效果

1)、实现了高拉速生产

由于采用高效结晶器钢管，新型抛物曲线倒锥度，大结晶器水量以及其他新技术使拉速得以提高，正常工作拉速1.8m-1.9m/分.最高达2.0m/分。

2）、铸坯表面质量良好

铜管内腔链度曲线平整光滑，精度高，摩擦阻力小，同时水缝均匀一致，精度保持好，使得冷却均匀，铸坯表面质量良好，管式结晶器使用以来未发现铸坯表面缺陷，铸坯合格率100%。

3）、因结晶器原因造成的事故停机大大降低

结晶器上口密封采用专利技术，密封圈远离热影响区并直接通水冷却，下口采用圈边伸缩性密封，密封性能好，密封圈寿命长，加之结构简单，零件少，故障率低，大大提高了铸机生产作业率，上口定位法兰采用紫铜，导热性好，不粘钢，不挂钢，生产事故少。

4）、维修方便

由于结构简单，拆装方便，组合式结晶器组装需要一天的时间，而管式结晶器仅用2-3个小时，使得维修工作量大大减少。

5）、经济效益明显

管式结晶器较组合式铜板结晶器成本低，组合式铜板结晶器一套总成12万元，管式结晶器一套总成5.8万元，消耗件铜板一套8万元，铜管一支2万元，目前铜管通钢量已达到8000多吨已于铜板寿命持平，吨铜成本降低2-3元，120*360断面年产量35吨以上，每年仅铜管节省费用70万元。

连铸机产量增加10%，每吨钢坯增加效益600元，年创效益350000*0.1*600=2100万元，铸坯合格率提高0.05%，年创效益350000*0.0005*600=10.5万元

采用管式结晶器后，年综合效益2000万元以上。

1, tubular mold efficient production practices

May 15, 2003 360 1 # 120 * all the high double-cross-section tubular mold, mold water transferred to 180-200t / h, two automatic with cold water well, using the automatic liquid level control, flame cutting machine is working properly , casting speed up to 1.9m/min around and even pull 92 hours, over the amount of 23000 tons of steel, brass mold to step down after the inspection, four surface-plated brass Ge layer has worn away, under the port's largest 20cm, meniscus place free of distortion, and other parts of the normal.

2, Efficient tubular mold application results

1), to achieve a high pull-speed production

As a result of high copper mold, the new parabolic curve inverted taper, a large amount of water mold, and other new technologies, to increase casting speed, casting speed in the 1.8-1.9 working m / min up to 2.0 m / min.

2), the slab surface quality good

Brass cavity chain curve is smooth, high precision, small friction, and uniform water gap, to maintain good accuracy, making the cooling uniformity, good surface quality of the slab, since the tubular mold was found using the slab surface defects, strand 100% pass rate.

3）, due to mold causes of accidents greatly reduced downtime

Mold catchy sealed using patented technology, ring away from the heat-affected zone and directly cooled by water, under the port side of scalability using ring seal, sealing performance, long life seals, combined with simple structure, fewer parts, low failure rate , greatly improving the operating rate of production of casting machine, catchy positioning flange copper, thermal conductivity, non-stick steel, not hanging steel, industrial accidents less.

4）, easy maintenance

As the simple structure, easy accessibility, modular mold assembly time of a day, and tubular mold only 2-3 hours, making the maintenance workload considerably reduced.

5）, economic benefit

Tubular crystallizer crystallizer than combined copper and low cost, modular set of copper mold assembly 12 million, a tubular mold assembly 58,000 yuan, 80,000 yuan a consumables copper, brass an support 2 million, the current through the copper tube has reached more than 8,000 tons of steel was flat copper plate life, reduce the cost of 2-3 million tonnes of copper, 120 * 360 sections over 35 tons annual production, annual cost savings of only 700,000 yuan brass . Caster production increased 10%, increase efficiency 600 yuan per ton of steel billet, and annual benefits 350 000 * 0.1 * 600 = 2100 million, the slab passing rate 0.05%, and annual benefits 350 000 * 0.0005 * 600 = 105,000 yuan Using tubular mold, the annual overall efficiency than 20 million yuan.

成功案例
Successful Case

唐山XX钢厂150*330、150*460矩形坯结晶改造方案

Tangshan Steel ** 150 * 330, 150 * 460 R8m combined rectangular billet continuous casting machine mold there are several problems.

1. 原连铸机及结晶器

唐山 ** 钢厂 150*330 、 150*460 R8m矩形坯连铸机组合式结晶器存在以下几个问题

1.1 结晶器采用四块铜板组合，结构复杂，组装及更换铜板困难，整体性差，内壁，水套接缝口易出疲劳性损伤，铜板分量重，制造成本高，铜管壁厚，冷却散热慢，冷却水不均匀，严重影响连铸机拉坯速度和铸坯质量。

1.2 结晶器铜管内锥度值太少，气隙消除太少，传热效率低。

1.3 导流水套设计水缝误差太大，导流水套内腔没有精加工，内腔几何精度无法控制，铸坯还在结晶器中两面冷却不均匀。

1.4 结晶器上口密封圈容易烧坏，结构复杂，不便于拆装

2. 150*330. 150*460 结晶器改造方案

2.1 将组合式结晶器改为管式结晶器，结构简单，易于拆装、更换结晶器铜管方便，铜管重量轻，铜管壁厚薄，冷却散热快，通过导流水套的窄水缝冷却，沿结晶器铜管全部冷却均匀，有利于确保连铸机拉坯质量，可满足高效连铸高拉速的要求。

2.2 结晶器铜管内腔采用较大的双抛物线锥度，符合凝固规律，减少气隙，提高传热效率，确保出结晶器口不漏钢的铸坯凝固的安全厚度，

2.3 结晶器铜管上口部位设置止口，通过上口定位法兰衬紧，保证结晶器铜管上口部位有足够的钢度，防止拉坯时铜管上口塌腰和变形。

2.4 采用高精度的导流水套，设计水缝最大为 3.8mm ，最小水缝为 3.3mm, 无导流钉，导流水套两端通过精加工止口固定在外水套上，消除了装配结晶器铜管的误差，导流水套内腔通过成型焊接后进行精加工，内腔尺寸控制在 0.3mm 公差，保证了铸坯在结晶器中四面冷却均匀。

2.5 结晶器上口通过定位法兰将密封圈压在铜管顶端，远离高热影响区，直接水冷却，密封圈不容易烧坏，导流水套与外水套组装为一体，易于拆卸，更换结晶器铜管方便，键板调整水缝方便，检查水缝直观，消耗备件少。

3. 应用实例

3.1本公司为石钢电炉炼钢厂，改造 220*300 管式结晶器，解决了铸坯鼓肚、脱方、裂纹、上口密封烧坏的问题，拉速也明显提高，单支结晶器铜管过钢量比改造前 3000T 提高到 12000T 。

3.2 本公司对唐山荣成钢厂 165*225 、 165*280 、 180*330 、 150*460 、 180*550 管式结晶器进行了改造，改造后拉速明显提高，而且铸坯质量好，同时解决了以前铸坯鼓肚现象，现在该厂已经全部使用我公司设计和制造的管式结晶器。

3.3 本公司为莱钢炼钢厂 1# 连铸机设计制造了 120*285 、 120*360 、 120*435 断面的管式结晶器，现全部投入正常使用，使用效果良好，其中 120*285 结晶器拉速由原来的 1.8m/min 提高到 2.4m/min, 通过山东省科技厅成果鉴定，属国内首创，我公司并为莱钢炼钢厂 4# 连铸机设计制造了 230*230 、 230*350 、 275*380 断面的管式结晶器，为莱钢降低成本和提高可观经济效益。

3.4 本公司为唐山汉沽钢铁有限公司， R5.25m 连铸机设计和制造了 165*330 、 165*360 断面的管式结晶器，一次试验成功，比原 165*280 结晶器的拉速要高，而且鼓肚的现象得到了消除，现在已经全部使用我公司设计和制造的 165*330 、 165*360 断面的管式结晶器。

1, the original continuous casting machine and mold

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1.1 mold using four copper combination, complex structure, assembly and replacement of copper difficulties, overall poor, wall, water socket seam prone to fatigue damage, copper heavy weight, manufacturing costs are high, brass wall thickness, cooling heat slowly , uneven cooling water, seriously affecting the continuous casting machine casting speed and casting quality.

1.2 within the mold brass taper value too little, too little to eliminate the air gap, heat transfer efficiency is low.

1.3 sets of design water flow joints guide the error is too large, there is no lead water comprising a cavity finishing, precision cavity geometry can not control, both sides of the slab in the mold in uneven cooling.

1.4mi ring mold is easy to burn out, complex, not easy to dismantle

2，150 * 330.150 * 460 Mold rehabilitation programs

2.1 Combined tubular mold to mold, simple structure, easy disassembly, easy to replace the copper mold, brass light, brass wall thickness, cooling heat quickly, guided by sets of narrow water gap water cooling , copper mold all along the cooling uniformity will help to ensure the quality of continuous casting machine casting, continuous casting can meet the high demands of high pulling speed.

2.2 copper mold cavity with a larger double-parabolic taper, in line with the law of coagulation, reducing the air gap, to improve heat transfer efficiency, to ensure that the mouth does not leak out of the mold steel slab solidification of security thickness

2.3 mi brass mold set only part of the mouth, through the positioning of the flange lining tight catchy, catchy brass mold parts to ensure sufficient rigidity to prevent the casting and deformation when the brass catchy Tayao.

2.4 The use of precision guided water sets, sew the design of water up to 3.8mm, the minimum water crazy is 3.3mm, no diversion nails, lead by finishing only water sets both ends of the water put out a fixed port, eliminating the mold assembly brass error, guided by forming water comprising a chamber after finishing welding, cavity size control in 0.3mm tolerance, to ensure the slab is surrounded by cooling in the mold evenly.

2.5 mi mold by locating the pressure in the brass flange to seal the top, away from heat influence to direct water cooling ring is not easy to burn, cover with external water flow guide sleeve assembly as a whole, easy to remove, replace crystals Copper Tube convenient keypad easy to adjust the water seam, sew visual inspection of water, consumption of spare parts for less.

3，Applications

3.1 Company for the stone EAF steel plant, the transformation 220 * 300 type mold, to solve the slab bulging, off side, cracks, missing seal burn problems, casting speed has improved significantly, the single mold copper over steel than to transform the former 3000T 12000T.

3.2 Company's Tangshan Rongcheng Steel Factory 165 * 225 165 * 280, 180 * 330 150 * 460 180 * 550 crystallizer has been transformed, transformed the casting speed has improved significantly, and the slab quality is good, but solved before the phenomenon of slab bulging, and now the plant has been using all my designs and manufactures tubular mold.

3.3 # 1 company Laiwu steel mill caster design and manufacture a 120 * 285 120 * 360 120 * 435 section of the tubular mold, are all normal use, with favorable results, of which 120 * 285 crystal control the casting speed from the original 1.8m/min to 2.4m/min, Shandong Science and Technology Department through the appraisal, is a national initiative, the company and Laiwu steel mill continuous casting machine design and manufacture of 4 # 230 * 230, 230 * 350 275 * 380 section of the tubular mold, as considerable Laiwu Steel to reduce costs and improve economic efficiency.

3.4 Hangu company Tangshan Iron & Steel Co., R5.25m caster design and manufacture a 165 * 330 165 * 360 section of the tubular mold, a successful, 165 * 280 than the original mold of the casting speed is higher and bulging of the phenomenon has been eliminated, now I have all designed and manufactured using 165 * 330 165 * 360 tubular cross-section of mold.