

THE ACTUALITY AND EXPECTATION OF APPLICATION OF PRECISION FORGING IN CHINA

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Summary

The precision forging developed very fast in recent years due to the development of the automobile industry in China. Several actual examples are given to show this development and the direction of the precision forging in China should move forward is pointed out.

Keyword: precision forging, China

1. Introduction

Forging industry always develops due to the development of automobile industry. The development of precision forging technology is determined by the development of automobile parts supplier.

It took 40 years that the automobile output of China increase from 0 to 1 million (1952~1992). It took 8 years that the output rise from 1 million to 2million (1992~2000). From 2million to 3million it only took 2 years (2000~2002). In 2002 the output of automobile in China is 3.25 million. It is 38.5% higher than the last year's output. Among them 1.1 million are cars (55% higher than last year) . The rank of automobile output arises from 6th to 5th.

The top five automobile output nation

Rank	Nation	Total output (ten thousand)	Increase than last year(%)
1	United States	1224.4	7.15
2	Japan	1025.8	4.29
3	German	547.8	-3.75
4	France	337.6	-5.63
5	China	325.1	38.50

It is prospected that the China output increase rate will keep on 15%~20% in 2003. The total output will arise to more than 4 million. The output rank on the world will move forward to the 4th. If the increase rate keep on the level as this the output will grow up to 6 million in 2005(2 million are cars). The biggest potential automobile market now can be seen grow into the actual one. This brings a good opportunity to the development of precision technology in China.

2. Clutch-operated screw press and precision forging technology

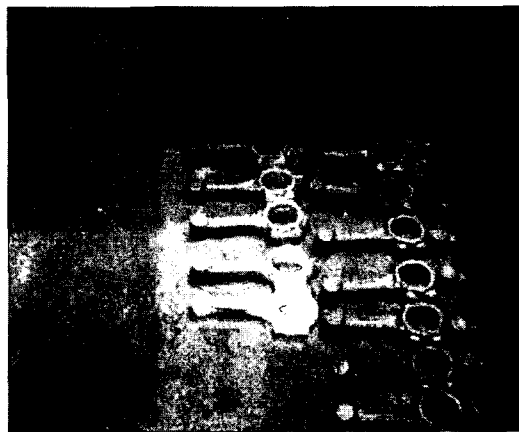
The clutch-operated screw press is very suitable for precision forging. It has been developed firstly by Siempelkamp.Corp(German) in 1970s. Now it is used as typical precision forging press after more than twenty years improvement. Some Germany company such as Eumoco-Hasenclever and Beche can manufacture series clutch-operated screw press from 4MN to 112MN. Beijing Research Institute of Mechanical and Electrical Technology (BRIMET) developed medium type and minitype clutch-operated screw press aim at the Chinese forging market. They have developed and manufactured more than 30 sets of this press in recent years (now they are developing 40000KN press). These presses were used for precision forging instead of hot die forging press which are much more expensive. The precision forged parts include connecting rod (1-2Kg), crankshaft (10-2K0g) and fore-shaft (80-120Kg) of automobile. Here three examples were given.

2.1 Precision forging connecting rod (550g weight) on 10000KN clutch-operated screw press

Several years ago the weight tolerance requirement for connecting rods weight from 500g to 800g is $\pm 2\%$. The parts forged on crank press can fulfill the requirement. Now the weight tolerance requirement is $\pm 1\%$. That means the weight difference is 6~8g and the thickness difference is below 0.1mm. The crank press forged parts cannot fulfill the improved requirement. The connecting rods (weight 550g) forged on 10000KN clutch-operated screw press fulfill the requirement very well.

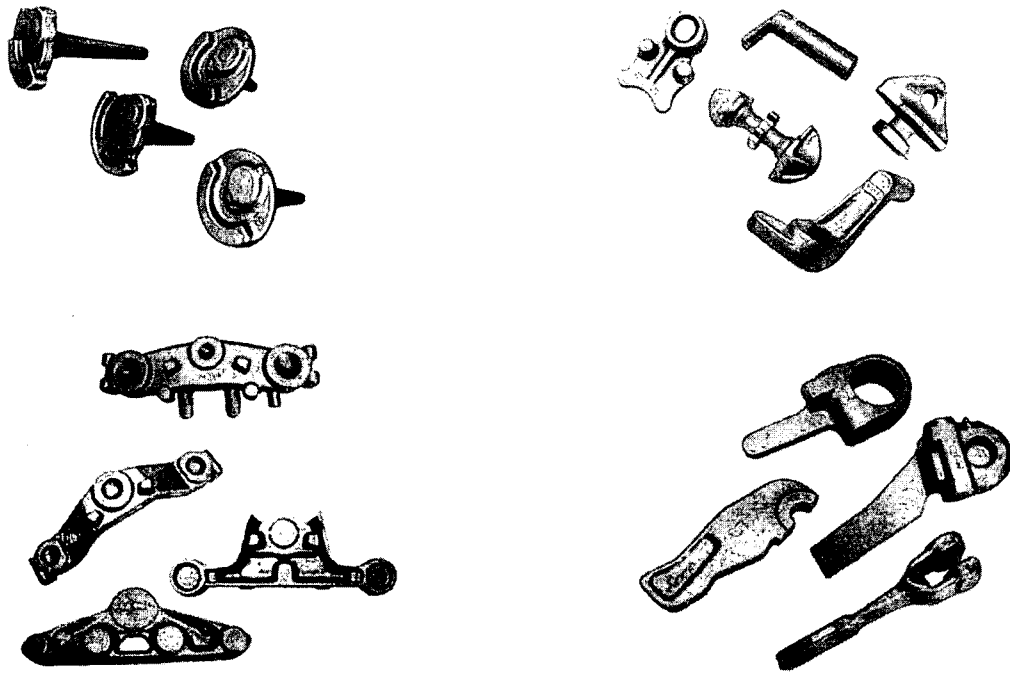


The 10000KN clutch-operated screw press production line



The connecting rods forged on 10000KN clutch-operated screw press

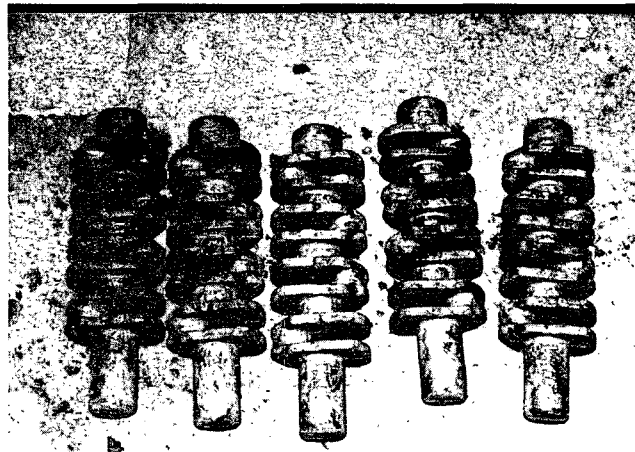
Many enterprises involved in precision forging employ clutch-operated screw press because this type of press not only has high productivity and high precision, it also can be used as multi-station press. The 10000KN type and 6300KN type produced by BRIMET are very successful in market. The photos are precision forging parts forged on these presses. The BRIMET will continue to develop 4000KN type and 8000KN type to satisfy the market's demand.



The precision forged parts produced on clutch-operated screw press

2.2 Precision forging crankshaft (four crooked, 15Kg weight) on 25000KN clutch-operated screw press

This crankshaft's 4 crooked and balance blocks have large departure from the axis of the shaft. The distance between crooked and balance block is very little. These positions cannot be filled very well when the crankshaft be forged on crank



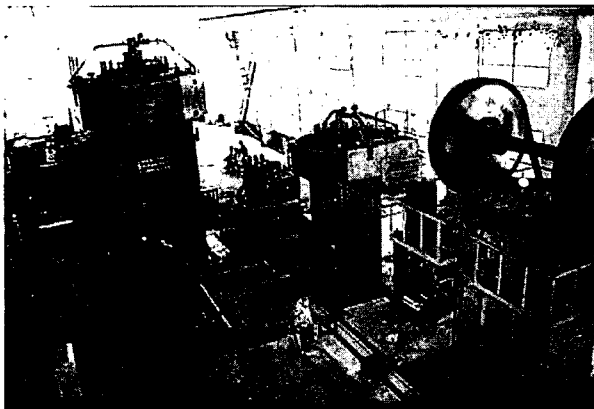
The precision forged crankshaft

press. The forging process is forged on die forging hammer. The die can be filled after 6~7 blows. The blank is 18.9 Kg weight and the draft angle is 3° . The die can be used for forging 2000 parts. From November 2002 the part is forged on 25000KN clutch-operated screw press. The forging process is preforging, finish-forging. The blank's weight is reduced to 17.5Kg. The draft angle is 1.5° and the longevity of the die is improved to 6000.

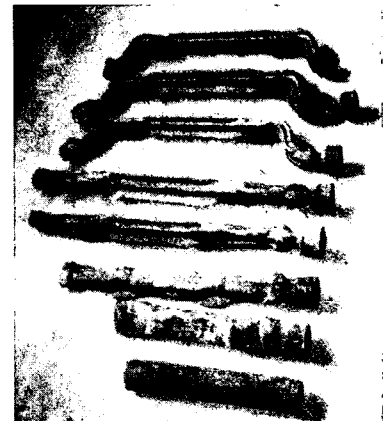
2.3 Forging heavy truck forebeam (120Kg weight) on 25000KN clutch-operated screw press

The traditional forging method for this part is forged on automatic forging production line (the main press is 125-160MN hot die forging press). In China there

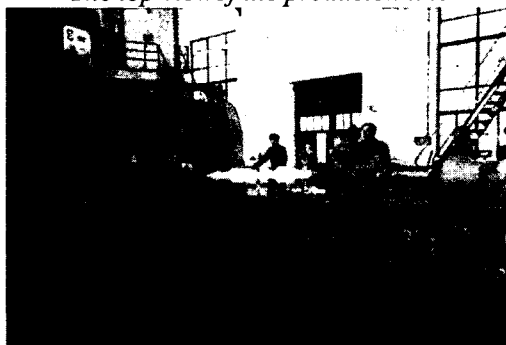
are three automatic production lines (120-125MN) specialized in forging heavy truck forebeam. The output of heavy truck (10-15^T) is increased very fast in recent year. In 2002 the output is 0.25 million (61% higher than last year). The three production lines cannot satisfy the market demand any more. The BRIMET developed a new forging process for these parts. The process is precision roll forging and integer forging. Using the new process the clutch-operated screw press (the capacity is 25-40MN) can instead of 125-160MN hot die forging press. The investment of the new production line (3 millions \$) is only one sixth as old one. The main improvement of the new technology is roll forging the I-shaped beam (80% of the whole beam in length) and spring pedestal which are very hard to be formed. This method obviously decreases the deformation of the forging step. The forging step just bend and form the two ends of the part (about 20% of the whole part in length). So the main forging press with smaller capacity can be selected. Now there are 4 new production lines have been set up in China. The forging process and relevant equipment are: heating (two set of 750KW medium frequency heating furnace) → four steps roll forging (Φ1000mm automatic roll forging machine) → bending and finish-forging (25000KN or 40000KN clutch-operated screw press) → trimming (10000-12500KN trimming press) → hot sizing (16000KN clutch-operated screw press). There are four manipulators be employed in the new production line and all operations are handled automatically. The biggest forebeam that can be forging on these production lines is 150Kg in weight. The quality of the forged part is equivalent to the parts forged on 125MN press lines. The longevity of the forging die is as double as the old forging die because the deformation is decreased. The productive cost is also decreased 20%.



The top view of the production line



The precision forged forebeam



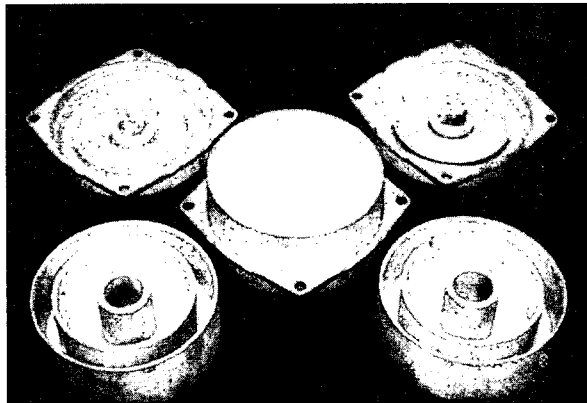
The roll forging machine



25000KN clutch-operated press

3. Precision forming of non-ferrous metal

3.1 High intensity non-ferrous metal parts (especially the aluminum alloy parts) are employed more and more in the car instead of steel parts. That can satisfy the demand for the lighter cars. The airbag generator parts and air conditioner compressor parts are typical aluminum alloy parts used in cars. This year the demand for airbags increases greatly in China. Two companies (one in Shijiazhuang, another one in Jinzhou) specialized in airbag manufacture have been built. They can produce 0.4 million airbags one year. In Xiangfan a company has been built to manufacture air conditioner compressor for Citroen (a trade mark of cars). Its output is 0.15 million a year. The two parts' near net shape forming technologies all need to be developed. The BRIMET developed damp extrusion and counter pressure technology for these two parts. The Institution cooperates respectively with Jiangsu Airship Company and Xiangfan Fushun Company build two cold extrusion production lines (main press is 10000KN cold extrusion press). Forming these two parts in batch is realized (0.2 million sets in 2003). The precision grade of the parts satisfies the requirement of near net forming (IT8-9).



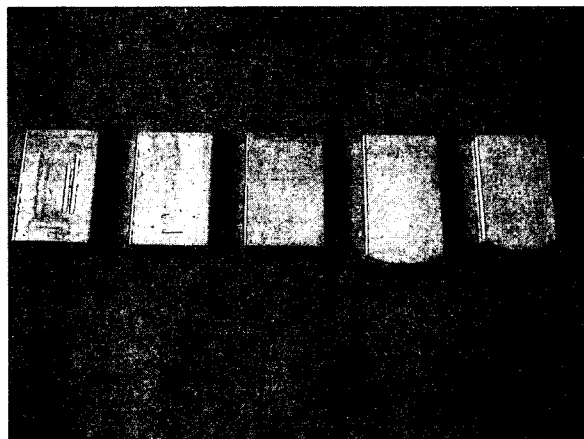
The precision forged airbag parts



The precision forged scroll

3.2 Forming technology for rectangle shell of mobile phone's Li-ion battery

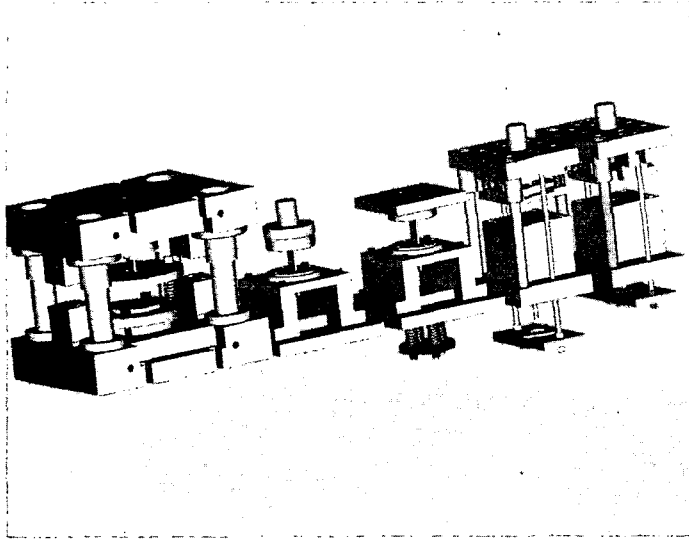
The demand for Li-ion battery increased very quickly in recent years because the development of mobile telecom industry and prevalence of the digital camera. The manufacture technology for rectangle shell of the battery is a focus now. There are two materials (stainless steel and aluminum alloy) be used to produce the shell. The output of shell made of stainless steel is 7-8 hundreds million a year in China. The output of aluminum alloy shell is 1-2 hundreds million. It is predicted that the aluminum alloy shell will totally instead of the shell made of stainless steel for the



The rectangle shell

material cost factor and some problem with the manufacture technology.

The BRIMET developed a technology for the shell. The process is back extrusion,



The process developed by BRIMET: back extrusion → ironing → cutting

ironing and cutting. The blank is rectangle. This process is very easy to be realized and the cost of die is comparatively small. The investment of equipment is also very little. But using this process the automation is difficult to be realized and the productivity of the multi-step ironing is not very high. The advanced technology from foreign country is automatic continuously drawing the thin sheet (0.4-0.6mm).

The quality of the product

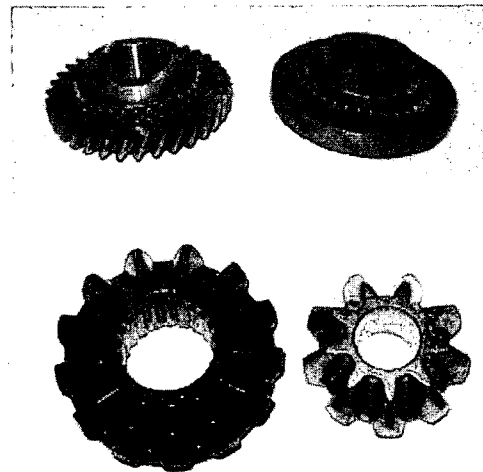
manufactured with this advanced line is quite steady and the productivity is also very high. But the equipments and dies employed in this line are expensive. Now in China there are only two companies (one in Shenzhen, another one in Wuxi) have this advanced production line. The One in Shenzhen used the production line imported from TOSHIBA, Japan. The another one also used the equipments from Japan. Besides these two companies other companies involved in this field all employ several single presses, manual manipulate. These simple lines all have the problem such as low productivity and high waster rate. The BRIMET now is developing the automatic production line.

4. Some cold die forging parts developed recently

Jiangsu Sunway Group is the largest professional cold forging company in China. They have developed more than 100 types cold forging parts these years. The cold forging part output of the company is more than 6000 ton a year. In recent years they focus their effort on the development of spur gear cold forging. For the sake of shorten developing periods, they cooperated with NICHIDAI Company from 2001. Now they begin to manufacture gearbox reverse gear and starter motor gear after they imported the divided flow technology and mold. The diameter of the gears is less than 70mm. The precision grade of the cold forged gears' tooth is about IT7-9. They manufactured more than 1 million small modulus spur gears in 2002. It is the first company in China can produced cold forged gears in batch.

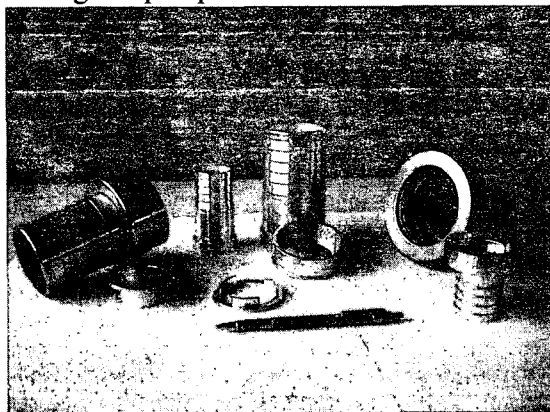
Jiangsu Pacific Precision Forging Ltd. has cooperated with NICHIDAI Company for many years. They produced bevel gear and synchronizer gear and gear ring using the imported cold extrusion technology. They have the best equipment condition for cold

forging. They possess of two 6300KN cold closed die forging presses made by KOMATSU company, three rotary forging press (2000KN and 4000KN) made by SCHMID Company. They also have more than 10 sets of imported mold manufacturing equipment. The precision grade of the tooth of the gear they produced is IT7-8 and the dimension precision is IT7. The productivity is 6-20 pieces per minute. They want to produce 3.55 million pieces cold forging parts in 2003. The manufacture process of there typical forging parts synchronizer gear ring is: blanking→rotary forging ring→isothermal normalizing → preforging → phosphating and soap treatment→forging→cold extrusion conical part→cutting→heat treatment→blasting→grinding→packing.

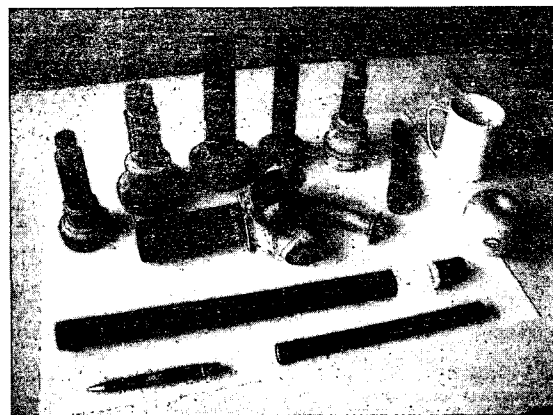


The typical forging parts produced by Jiangsu Pacific Precision Forging Ltd.

Shanghai Jiufeng Automotive Parts Co.Ltd. is a new and developed very fast cold forging company in China. Although they don't have good equipment as the two company introduced above possess, they have developed tens of new cold forging parts in recent years depend on their exceeding technology on cold extrusion process and mold design and manufacture. Now they supply cold forging parts for some famous company. For example the aluminum alloy and magnesium alloy cold forging parts they produced were exported to Japan. These parts are about 10 types. They are all tube parts need the large deformation process. They also supply Shanghai GKN with cold forging parts such as drive shaft and steering shaft etc. The module of these parts is between 1 and 2.5. The longest one is about 500mm long (the tooth along whole shaft in length). The companies have their own special technology like this will have great perspective.



Aluminum alloy and magnesium alloy parts



Drive shaft and steering shaft

Cold forging parts produced by Shanghai Jiufeng Automotive Parts Co.Ltd.

5. Actual example of warm forging

There very few example of warm forging technology (forging temperature below 780°C) used in actual manufacture in China because the problem with the longevity of the mold. Normally the warm-hot forging technology (forging temperature about 900 °C) is used to instead of the warm forging process. This can reduce oxidation and forming force compared with the hot forging technology. Here a successful example of warm forging is introduced. The company has used the warm forging technology for about 10 years. Their products are precision motorcycle



The warm forging parts

gears. The forging process is: blanking (precision shearing)→preforging (700°C~780 °C, 3150KN mechanical press)→lubrication→finish forging (700°C~780 °C, 6000KN mechanical press)→normalizing→inspection.

The material of the mold is 65Nb. The longevity of the preforging mold is one hundred thousand and the longevity of the finish forging mold is 5 thousand. The gibbose part and 60% surface of other part of the gear don't need farther cutting process. The company has produced 14 million warm forging motorcycle gears in 2002 and shared 35% of the market. They accumulated plentiful of experience on mold material heat treatment and lubrication technology. The company is the most successful one applied warm forging technology.

6. Prospect of the precision forging technology in China

The precision technology applied in China is still far behind the advanced countries although it has great improvement in recent years. The main three reasons are the special press for precision forging, automatic production line and mold manufacture technology. Now the automobile industry develops much more faster than the speed imagined. This asks the precision forging technology for higher precision parts and higher productivity. The precision forging industry in China will be improved in such fields as followed:

- a. The special press for cold forging and multi-station press will gradually instead the universal hydraulic press and universal mechanical press commonly used as cold forging press now.
- b. The automatic cold forging and warm forging production line, as well the manipulator and robot will be applied in some advanced company. The manual work will gradually be replaced.

- c. The “C4P” technology for cold die forging parts and mold will be applied more commonly. That will improve the level of design and manufacture greatly and will shorten the development period.
- d. The technology and capacity of mold manufacture will be improved to a new level. More and more companies want to invest on mold manufacture industry.
- e. There will be sino-foreign joint venture companies and foreign investment companies specialized on precision forging and mold manufacture be built because of the first class investment environment.

On all accounts the Chinese automobile industry faces a market as huge as 1300 million people. In average every 1 thousand people possess 130 automobiles in the world. In China every one thousand people just have 15. Even the output of automobile will be up to 10 million a year in 2010 the average number will just climb to 50. So it is absolutely possible that the output improvement keep on a high speed. The high increasing speed of automobile output gives an outstanding opportunity to the development of precision forging. The engineers and researchers who be engaged in precision forging should make great efforts to grasp the opportunity to put the precision forging technology forward to a new level.

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