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AN INQUIRY INTO THE HISTORY OF THE CHINESE  
TERMS *JIQI* (MACHINE) AND *JIXIE* (MACHINERY)

Within the context of modern mechanical engineering, the Chinese technical terms *jiqi* 機器 ('machine', 'machinery', 'apparatus'), and *jixie* 機械 ('machinery', 'mechanism', 'mechanical'), have long been given specialist definitions. In ancient China, however, the two terms were rarely used. Drawing on a selection of relevant texts and documents this essay will trace their occurrences and changes of meaning.

1. *Ji* 機, *Qi* 器, AND *Xie* 械

1. *Ji* 機

*Ji* has many meanings in ancient Chinese. In the early period, one of its basic meanings referred to the trigger mechanism on a crossbow, i.e., something with a controlling function. The Eastern Han glossary *Shiming* 釋名 (Explanations of names, ca. 200 AD) mentions the term in the chapter "Shibing" 釋兵 (Explanations concerning the military): "Nu 弩, the crossbow, is [pronounced like] nu 怒, anger. ... [it] is also used to refer to the skill of setting something in motion (*ji zhi qiao* 機之巧) or the guardian mechanism (*shuji* 樞機) of doors and windows by means of which opening and closing are controlled."<sup>1</sup> In the *Shuowen jiezi* 說文解字 (Describing the pictograms and explaining the compound characters), published around the same time, we read: "*Ji*: what controls the beginning is called *ji*. It is written with [the radical] *mu* 木 'wood'; and it is pronounced like *ji* 几."<sup>2</sup> In the late Ming, Wang Zheng 王徵 described and explained the crossbow and its 'controlling mechanism' (*ji*) in detail in his *Xinzhi zhuqi tushuo* 新制諸器圖說 (Illustrated explanations on new machines of all kinds) (cf. Figure 1).<sup>3</sup>

<sup>1</sup> Liu Xi 劉熙. 1936. *Shiming* 釋名 (Explanations of names). *Sibu congkan* 四部叢刊 ed. Shanghai: Shangwu yinshuguan, p. 28.

<sup>2</sup> Xu Shen 許慎. 1981. *Shuowen jiezi* 說文解字 (Describing the pictograms and explaining the compound characters). Beijing: Zhonghua shuju, p. 118.

<sup>3</sup> Wang Zheng 王徵. 1936 [1627]. *Xinzhi zhuqi tushuo* 新制諸器圖說 (Illustrated explanations on new machines of all kinds). *Congshu jicheng* 叢書集成 ed. Shanghai: Shangwu yinshuguan, p. 38.

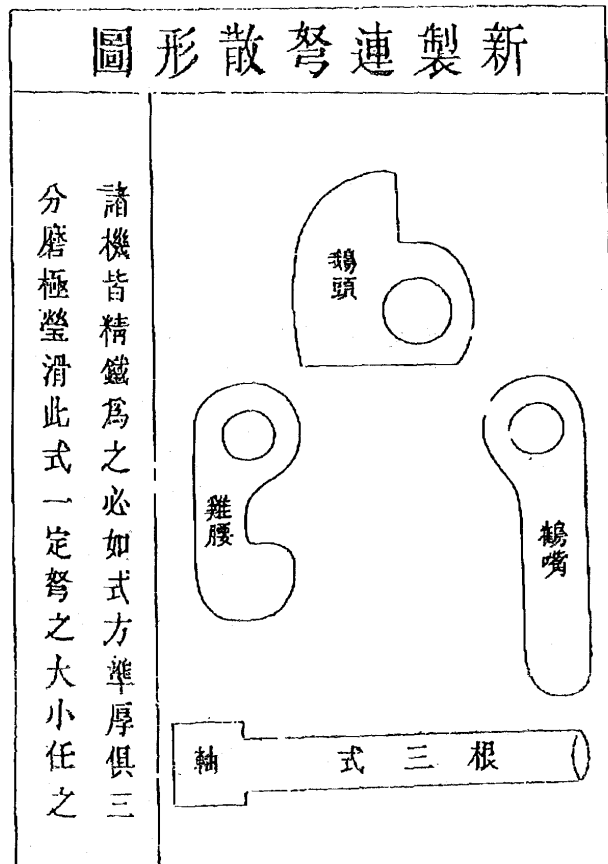


Figure 1. The trigger mechanism of a crossbow. From Wang Zheng. 1936 [1627]. *Xinzhì zhuqì tushuò*, p. 38.

Another meaning of *ji* was 'skilful' or 'clever'. Mei Yingzuo 梅膺祚 (fl. 1570–1615) defined it as such in his *Zihui* 字匯 (Character dictionary): "*Ji* is equivalent to skilfulness; or versatility". Similarly, the Qing scholar Xu Hao 徐灝 (1810–1879) wrote in his *Shuowen jiezi zhujian* 說文解字箋 (Random commentary to the *Shuowen jiezi*): "*Ji* can be extended to designate versatility (*jibian* 機變)." <sup>4</sup> In the *Liezi* 列

<sup>4</sup> Both quotations are taken from Hanyu da zidian bianji weiyuanhui 漢語大字典編輯委員會 (ed.). 1986. *Hanyu da zidian* 漢語大字典 (Comprehensive dictionary of Chinese characters) [hereafter *HYDZD*]. Chengdu: Sichuan cishu chubanshe and Wuhan: Hubei cishu chubanshe, p. 1298.

子 chapter “Confucius” (*Zhongni* 仲尼) we find the phrase: “Have the officials not heard that the men from Qi and Lu have many skills (*ji*)?” In his commentary, Zhang Zhan 張湛, a scholar from the Eastern Han, explains: “*Ji* here means ‘skilful’ or ‘clever’ (*qiao* 巧); men who are skilful and able in many respects.”<sup>5</sup> In extension, *ji* can also refer to matters of a secretive nature and to the crux or reasons for the changes in a certain state of affairs.<sup>6</sup>

The Qing scholar Duan Yucai 段玉裁 (1735–1815) glossed the character in his *Shuowen jiezi zhu* 說文解字注 (Commentary to the *Shuowen jiezi*) as follows: “The function of *ji* is to control the beginning, therefore everything that controls a beginning can be called *ji*.”<sup>7</sup> In the chapter *Song Wei ce* 宋衛策 (The intrigues of Song and Wei) of the *Zhanguo ce* 戰國策 (The intrigues of the Warring States) we read: “Gongshu Pan designed a climbing device (*ji*) for Chu so that they could attack Song.” Yao Hong 姚宏 comments: “*Ji*, like *xie* 械, means a kind of ladder or stairs.”<sup>8</sup> The biography of Zhang Heng 張衡 in the *Hou Han shu* 後漢書 (Book of the Later Han) contains the expression “a closing and opening mechanism” (*shiguan faji* 施關發機), in this context, *ji* refers to the mechanical parts of Zhang Heng’s famous seismograph.<sup>9</sup> In the Yuan period, Wang Zhen 王禎 (1571–1644) wrote in his *Nongshu* 農書 (Treatise on agriculture): “The surface sieve is used behind water-mills; its mechanism (*ji*) is similar to that of the water-power reciprocator (*shuibai* 水排).” Here, *ji* refers to the transmission mechanism of the surface sieve and the water-power reciprocator.<sup>10</sup> In his *Xinzhi zhuqi tushuo*, Wang Zheng also calls all

<sup>5</sup> *Chongxu zhide zhenjing* 沖虛至德真經 (The true classic of the abyssal void and the highest virtue) or *Liezi* 列子. 1936. *Sibu congkan* 四部叢刊 ed. Shanghai: Shangwu yinshuguan, p. 15.

<sup>6</sup> Cf. *HYDZD*, p. 1298.

<sup>7</sup> Cf. Duan Yucai 段玉裁. 1981. *Shuowen jiezi zhu* 說文解字注 (Commentary to the *Shuowen jiezi*). Shanghai: Shanghai guji chubanshe, p. 262.

<sup>8</sup> *Zhanguo ce jiaozhu* 戰國策校注 (An annotated edition of the Intrigues of the Warring States). 1936. *Sibu congkan* 四部叢刊 ed. Shanghai: Shangwu yinshuguan, p. 252.

<sup>9</sup> Fan Ye 范曄. 1965. *Hou Han shu* 後漢書 (Book of the Later Han). Beijing: Zhonghua shuju, p. 1909. [Translation adapted from Joseph Needham. 1959. *Science and Civilisation in China. Vol. III: Mathematics and the Sciences of the Heavens and the Earth*, Cambridge: Cambridge University Press, p. 627.]

<sup>10</sup> Cf. *Zhongguo kejishi ziliao xuanbian—nongye jixie* 中國科技史資料選編·農業機械 (Selected materials for the history of Chinese science and technology: Agricultural engineering). 1985. Edited by Qinghua daxue tushuguan kejishi yanjiuzu 清華大學圖書館科技史研究組. Beijing: Qinghua daxue chubanshe.

kinds of transmission mechanisms *ji*.<sup>11</sup> The cited passages demonstrate that *ji* is used as a general allusion to moving mechanisms and parts, including rather complex and skilfully manufactured devices, in particular transmission mechanisms assembled from many individual parts. All of these have a controlling, transmitting or driving function, and all reflect the ingenious conceptions of their designers and are beneficial to their users.

In a related sense, *ji* is specifically employed to refer to the ‘loom’. For example, in the chapter *Weiyun* 微韻 (Rhymes on *wei*) of the Song glossary *Jiyun* 集韻 (Collected rhymes) we find the explanation: “A *ji* is a weaving tool.”<sup>12</sup> Duan Yucai comments in his *Shuowen jiezi zhu*: “*Ji*: when in the ensuing passages we read of ‘a *ji* supporting the warp and a *ji* supporting the woof’, then *ji* designates weaving tools.”<sup>13</sup> Likewise, Sima Qian 司馬遷 (145–86 BC) relates in a passage of his *Shiji* 史記 (Records of the Historian): “His mother threw away the shuttle, stepped down from the loom (*ji*), leapt over the wall and walked away”.<sup>14</sup> Xue Jingshi 薛景石 mentions several weaving tools in his *Ziren yizhi* 梓人遺制 (Traditions of the joiner’s craft) from the Yuan dynasty. In this book, *-jizi* 機子 serves as a suffix in compounds such as *huajizi* 華機子 ‘loom for weaving ornaments’, *lijizi* 立機子 ‘vertical loom’, *xiao bu wojizi* 小布臥機子 ‘small horizontal cotton loom’ or *luojizi* 羅機子 ‘loom for weaving gauze’, but perhaps all these technical terms were only used in particular regions.<sup>15</sup> In the Ming dynasty, Song Yingxing 宋應星 (1587–?) introduced several weaving tools containing the suffix *-ji* in his *Tiangong kaiwu* 天工開物 (Exploitation of the works of nature, 1637), e.g., *huaji* 花機 ‘loom for weaving ornaments’, *yaoji* 腰機 ‘backstrap loom’, *zhi ronghe ji* 織絨褐機 ‘loom for weaving fine and coarse cloth’, and *buji* 布機 ‘cotton loom’.<sup>16</sup>

<sup>11</sup> Wang Zheng 1936, pp. 21–42.

<sup>12</sup> Cf. *HYDZD*, p. 1298.

<sup>13</sup> Duan Yucai 1981, p. 262.

<sup>14</sup> Sima Qian 司馬遷 . 1959. *Shiji* 史記 (Records of the Historian). Beijing: Zhonghua shuju, p. 2311.

<sup>15</sup> Cf. Xue Jingshi 薛景石 . 1932. “Ziren yizhi” 梓人遺制 (Traditions of the joiner’s craft), *Zhongguo yingzao xueshe huikan* 3.4, pp. 135–76; 153, 161.

<sup>16</sup> Cf. Yang Weizeng 楊維增 . 1987. *Tiangong kaiwu xinzhu yanjiu* 《天工開物》新注研究 (A study on a new commentary to the *Tiangong kaiwu*). Nanchang: Jiangxi kexue jishu chubanshe, pp. 68, 69 and 85.

In general, however, the names of mechanical devices in ancient China do not contain *-ji* as a suffix. Rather they have individual designations, such as *shuibai* 水排 ‘water-power reciprocator’, *louche* 耨車 ‘seed plough’, *shuiche* 水車 ‘water-raising wheels’, *shanche* 扇車 ‘rotary winnowing fan’, *dui* 碓 ‘tilt-hammer’, *mo* 磨 ‘grinding mill’, *long* 礮 ‘rice huller’, *nian* 碾 ‘roller mill’, *fengxiang* 風箱 ‘bellows’, *fashiche* 發石車 ‘catapult car’, etc. In mechanical appellations, such as *lulu* 轆轤 ‘well-windlass’, *taoche* 陶車 ‘kiln carriage’, *feiche* 飛車 ‘aerial carriages’, *shuiche* ‘water-raising wheels’, *tongche* 筒車 ‘noria’ or ‘peripheral pot wheel’, *fangche* 紡車 ‘spinning (or spindle) wheel’, *zhache* 軋車 ‘rolling carriage’, *tangche* 糖車 ‘sugar wheel’ and *shanche* ‘rotary winnowing fan’, the word *che* 車 ‘carriage’ or ‘wheel’ is used as a complement to another word or as a suffix, thus reflecting the common feature of all these devices of possessing revolving or spinning components. Only from the mid-nineteenth century onwards, following the influx of Western machines and the modernization of the manufacturing industries, is *ji* increasingly used as a suffix in the designations of machines and mechanical devices. One typical example is the wide-spread use of the term *qiji* 氣機 for ‘steam engine’.<sup>17</sup>

## 2. Qi 器

The term *qi* 器 is also used frequently in ancient China. The *Shuowen jiezi* states: “*Qi* means ‘utensil’ or ‘vessel’ (*min* 皿).”<sup>18</sup> And the Qing scholar Duan Yucai comments: “*Qi* is the general designation for all kinds of utensils and implements.”<sup>19</sup> In fact, one of the basic meanings of *qi* was early on extended to refer to common utensils or appliances. Huan Kuan 桓寬, from the Western Han, writes in his *Yantie lun* 鹽鐵論 (Discourses on iron and salt, first century BC):

Xian Liang said: ‘Agriculture is the greatest profession under heaven. Iron utensils 鐵器 (*tieqi*) are most useful to the people. The people benefit from using utensils as they apply less effort and achieve more merit; the peasants will find pleasure in this and increase their efficacy.’<sup>20</sup>

<sup>17</sup> Cf. Alexander Wylie (Weilie Yali 偉烈亞力) and Xu Shou 徐壽. 1868. *Qiji faren* 氣機發軔 (The beginner’s guide to the steam engine). Shanghai: Jiangnan zhi-zaoju.

<sup>18</sup> Xu Shen 1981, p. 49.

<sup>19</sup> Duan Yucai 1981, p. 86.

<sup>20</sup> *Zhongguo kejishi ziliao xuanbian—nongye jixie* 1985, p. 28.

*Qi* here refers to utensils and appliances used in agriculture, *tie* emphasizes the material from which they are made. The *Hou Hanshu* directly employs the term *nongqi* 農器 ‘agricultural implements’:

[Du Shi] manufactured a water-power reciprocator in order to cast agricultural implements; [by means of the latter] less effort was used and more merit achieved, and this was to the benefit of the common people.<sup>21</sup>

In the Yuan dynasty, Wang Zhen specifically presented various kinds of agricultural implements and machines in the chapter “Nongqi tupu” 農器圖譜 (Illustrated manual of agricultural implements) of his *Nongshu*; some of these utensils were called certain kinds of *qi*, e.g., *shuiqi* 水器 ‘water implements’, *gaiqi* 溉器 ‘irrigation utensils’, *ken-tianqi* 墾田器 ‘machines for the reclamation of fields’ and so on.<sup>22</sup> In this way, *-qi* came to be employed as a suffix and was turned into a general designation for machines and simple tools. Similarly, in the *Tiangong kaiwu* we find the terms *bingqi* 兵器 ‘military weapons’ and *huoqi* 火器 ‘firearms’.<sup>23</sup>

When Johann Terrenz Schreck (Deng Yuhan 鄧玉函, 1576–1630) and Wang Zheng translated a specialized book on mechanical implements in the late Ming, the *Yuanxi qiqi tushuo luzui* 遠西奇器圖說錄最 (Diagrams and explanations on the wonderful machines of the Far West), they continued to designate all kinds of mechanical implements as *-qi* and praised European devices as *qiqi* 奇器 ‘wonderful machines’.<sup>24</sup> The term *qiqi* was also used by Dai Rong 戴榕 in his *Huang Fuzhuang xiaozhuan* 黃復庄小傳 (Short biography of Huang Fuzhuang), written during the Qing.<sup>25</sup>

Moreover, the meaning of *qi* was extended to designate ‘means’. One example for this usage can be found in the *Hanfeizi* 韓非子: “Rewards and punishments are the beneficial means (*qi*) of the country.”<sup>26</sup>

<sup>21</sup> Fan Ye 1965, p. 1094.

<sup>22</sup> Cf. *Zhongguo kejishi ziliao xuanbian—nongye jixie* 1985, pp. 190, 195 and 344.

<sup>23</sup> Yang Weizeng 1987, pp. 318, 330.

<sup>24</sup> Cf. Johann Terrenz Schreck (Deng Yuhan 鄧玉函) and Wang Zheng 王徵. 1936 [1627]. *Yuanxi qiqi tushuo luzui* 遠西奇器圖說錄最 (Diagrams and explanations on the wonderful machines of the Far West). *Congshu jicheng* 叢書集成 ed. Shanghai: Shangwu yinshuguan, *passim*.

<sup>25</sup> Cf. *Zhongguo kejishi ziliao xuanbian—nongye jixie* 1985, pp. 190–1.

<sup>26</sup> Chen Qiyou 陳奇猷 (ed.). 1958. *Hanfeizi jishi* 韓非子集釋 (Collected explanations on the *Hanfeizi*). 2nd enlarged ed. 2 vols. Beijing: Zhonghua shuju, p. 392.

### 3. Xie 械

The *Shuowen jiezi* offers the following explanation for the term *xie*: “*Xie* means ‘fettters’ or ‘handcuffs’ (*zhigu* 桎梏). The character is written with [the radical] *mu* 木 ‘wood’; and it is read like *xie* 戒. Some say it is a general name for ‘utensils’ or ‘implements’ (*qi*), others say it means ‘to hold’ or ‘to restrain’.”<sup>27</sup> Hence, the term has the meanings ‘implement of punishment or torture’, ‘to restrain or detain’, ‘machinery, mechanical implement’ and ‘utensil’ or ‘appliance’.

In addition, *xie* refers to weapons and other devices. The *Zhouli* 周禮 (The rites of Zhou) contains this sentence in the chapter “Tian-guan” (The Office of Astronomy): “Every three years, he checked the governance of all officers in order to know the people’s wealth and the amount of implements and weapons (*qixie*).”<sup>28</sup> Zheng Xuan’s commentary reads: “Here, *xie* is like arms or weapons.”<sup>29</sup> And Wang Zhen writes in his *Nongshu*: “The well-sweep is a device (*xie*) to regulate the water.”<sup>30</sup> Hence, the meanings of *xie* and *qi* are closely related.

### 2. Jiqi 機器

The word *jiqi* is used intermittently in ancient texts. Its meaning refers to mechanical appliances and implements. In the Song dynasty, Huang Tingjian 黃庭堅 (1045–1105) wrote in his poem “He Xie gong ding heshuo mancheng zhi er” 和謝公定河朔漫成之二 (Regulating the northern spread of the Yellow River with Mr. Xie, 2): “Diminishing the water’s position power at the straight ditches troubled the able officers; the appliances (*jiqi*) were drawn onto the sand and the naval soldiers gathered.”<sup>31</sup> The Song poem “Zhuhu fu” 珠湖賦 (The ballad of Pearl Lake) by Cui Gongdu (?–1097) 崔公度 contains the verse: “Alas, although I have closely inspected every detail, / I doubt that I

<sup>27</sup> Xu Shen 1981, p. 125.

<sup>28</sup> *Zhouli* 周禮 (The rites of Zhou). 1936. *Sibu congkan* 四部叢刊 ed. Shanghai: Shangwu yinshuguan, 2.30.

<sup>29</sup> Cf. *HYDZD*, p. 1209–10.

<sup>30</sup> Cf. *Zhongguo kejishi ziliao xuanbian—nongye jixie* 1985, p. 423.

<sup>31</sup> Huang Tingjian 黃庭堅 . 1983. “He Xie gong ding heshuo mancheng zhi er” 和謝公定河朔漫成之二 (Regulating the northern spread of the Yellow River with Mr. Xie, 2). *Siku quanshu* 四庫全書 . Taipei: Taiwan shangwu yinshuguan, vol. 1113, p. 397.

have understood the mechanism (*jiqi*).”<sup>32</sup> And in the “Shuiche fu” 水車賦 (The ballad of the water wheel) by the Ming scholar He Jingming 何景明 (1482–1521) we read: “He said ‘There is a machine (*jiqi*) / for raising water; / square wheels revolve around an axis; / on turning, they lift it up.’”<sup>33</sup>

In the *Qiqi tushuo* by Johann Terrenz Schreck and Wang Zheng, *qi* and *ji* are employed several times. In the first chapter of their work, the authors also use the compound *jiqi*:

Today, minute machines (*jiqi*) are employed by means of which one is able to lift up heavy weights at once, raise them high and make them go far. Hence, if one is able to understand this science [i.e. mechanics] and know the principles of these machines, then what may seem strange at first will once again appear as ordinary.<sup>34</sup>

Perhaps Schreck and Wang associated the terms *qi*, *ji* and *jiqi* with the Latin word *machina*.

Nevertheless, prior to the mid-nineteenth century *jiqi* is not used with great frequency. In specialized works on technology, such as Wang Zhen’s *Nongshu* and Song Yingxing’s *Tiangong kaiwu*, the word is not employed at all.

During the crisis of the mid-nineteenth century Western steamboats, cannons and machines gradually became known in China. After 1839, some Chinese officials used technical terms such as *huolunchuan* 火輪船 ‘steamship’, *bingxie* 兵械 ‘military weapons’, *huoqi* 火器 ‘firearms’ and *qixie* 器械 ‘machines’ in their descriptions of European navies.<sup>35</sup>

In 1842, Wei Yuan 魏源 (1793–1856) printed the first edition of his *Haiguo tuzhi* 海國圖志 (Illustrated treatise on the maritime countries) in 50 *juan* in Yangzhou. The second edition of 1846, which was extended to 100 *juan*, included the *Huolunchuan tushuo* 火輪船圖說 (The steamship illustrated and explained) by Zheng Fuguang 鄭復光 .

<sup>32</sup> Cf. *HYDZD*, p. 1332.

<sup>33</sup> He Jingming 何景明 . 1983. “Shuiche fu” 水車賦 , in: id. *Dafu ji* 答復集 (The works of Dafu). *Siku quanshu* 四庫全書 ed. Taipei: Taiwan shangwu yinshuguan, vol. 1237, p. 23.

<sup>34</sup> Schreck and Wang 1936, p. 55.

<sup>35</sup> Cf. Qi Sihe 齊思和 et al. (eds.). 1964a. *Chouban yiwu shimo (Daoguang chao)* 籌辦夷務始末 (道光朝) (Documents on the handling of barbarian affairs during the Daoguang era). 6 vols. Beijing: Zhonghua shuju; and id. (eds.). 1964b. *Chouban yiwu shimo (Xianfeng chao)* 籌辦夷務始末 (咸豐朝) (Documents on the handling of barbarian affairs during the Xianfeng era). 8 vols. Beijing: Zhonghua shuju.



The text had been written between 1841 and 1843. In his description of the steamship's engine, Zheng employed the word *jiju* 機具 'mechanical appliance', and further on he wrote: "... it did not result in the destruction of the machine (*jiqi*)."<sup>36</sup> Moreover, after the term *feilun* 飛輪 'fly wheel' Zheng added the note "For this name see the *Qiqi tushuo*", which indicates that he may have employed the word *jiqi* in the same sense as Wang Zheng before him.

In 1859, Joseph Edkins (Ai Yuese 艾約瑟 1823–1905) and Li Shanlan 李善蘭 (1810–1882) jointly translated William Whewell's *An Elementary Treatise on Mechanics* as *Zhongxue* (Mechanics). The work is a general introduction to Western mechanics and its applications. In chapter 16, they mention the words *huolun jiqi* 火輪機器 'fire-wheel apparatus' and *huolunji* 火輪機 'fire-wheel machine'<sup>37</sup>; and in chapter 18 they use the term *huojiqi* 火機器 'fire machine':

When the water in the iron pot of the fire machine is boiling, the steam will expand. Out of fear that the pot may burst, small slits are prepared that are able to open and close automatically.<sup>38</sup>

The terms *huolun jiqi*, *huolunji* and *huojiqi* all refer to the steam engine. After mentioning the term 'perpetuum mobile' (*hengshengche* 恆升車) in their work, Edkins and Li add a note reading "see *Qiqi tushuo*".<sup>39</sup> This implies that they may have derived the term *jiqi* from that book.

Around the year 1860, the term *jiqi* had not yet found its way into popular usage. On 2 June 1864, the Zongli Yamen appended a letter among a collection of memorials that had been sent in by Li Hongzhang 李鴻章 (1823–1901), then Governor of Jiangsu. In this letter Li Hongzhang described the circumstances in which the Shanghai Arsenal had been moved from Shanghai to Suzhou:

Since recently, we have a Western steam engine (*qilu* 器爐) in my modest province. All the machines (*jiqi*) used for [cutting] building wood, punching holes, cutting screws and casting bullets are related to the

<sup>36</sup> Zheng Fuguang 鄭復光 . 1846. *Huolunchuan tushuo* 火輪船圖說 (The steamship illustrated and explained). Reprinted in: Wei Yuan 魏源 (ed.). 1875 [1852]. *Hai-guo tuzhi* 海國圖志 (Illustrated treatise on the maritime countries). 100 *juan*. Shao-yang jidangwu zhai 邵陽急當務齋 ed., 85.3.

<sup>37</sup> Joseph Edkins (Ai Yuese 艾約瑟) and Li Shanlan 李善蘭 (trs.). 1859. *Zhongxue* 重學 (Mechanics). Shanghai: Mohai shuguan, 16.5b.

<sup>38</sup> *Ibid.*, 18.3a.

<sup>39</sup> *Ibid.*, 16.14a.

steam engine. ... They move without relying on human force. Unfortunately not all the machines (*jiqu*) we bought have arrived and the foreign artisans are not sufficiently skilled to manufacture large cannons that can be used on ships. They can do no more than file and cast bombs and projectiles.<sup>40</sup>

From this point onwards, the term *jiqu* appears more and more often in memorials and other writings from officials associated with the Self-Strengthening Movement, such as Zeng Guofan 曾國藩 (1811–1872), Li Hongzhang, Zuo Zongtang 左宗堂 (1812–1885) or Yixin 奕訢 (i.e. Prince Gong, 1833–1898), and subsequently it came to be used by others as well.

During the late Qing *jiqu* was sometimes employed to specifically refer to ‘Western cannons’<sup>41</sup>, but its basic meaning continued to correspond to the English word ‘machine’. In a memorial dated 20 September 1865, Li Hongzhang offered a rather colourful description of the general meaning of *jiqu*:

A report by Ding Richang 丁日昌 states: In the Hongkou area of Shanghai the foreigners have established an iron factory for manufacturing ‘machines’ (*jiqu*). There they are able to build large and small steamships, shrapnel, Western rifles etc. ... According to your minister’s [Li Hongzhang’s] opinion all the implements (*qi*) which are used in this iron factory to manufacture machines (*qi*) should be copied and rebuilt one after the other according to [the Western] methods, irrespective of what kind of machine (*jiqu*) they are ...

In today’s predicament, manufacturing machines will help us to resist foreign aggression; it is the root of self-strengthening ...

As your humble minister has also described, Western machines (*yang jiqu*) can be manufactured for tilling and weaving, printing and glazing. They are beneficial to the daily life of the common people and were not originally designed to function as arms and weapons. They are wonderful in employing the force of water and fire in order to save human labour and expenses, and it takes no more than the dragging of the trigger or the pushing and pressing of cogwheels — once one part is moved, the whole structure will move ... Your minister reckons that in a few decades the rich peasants and great merchants of China will certainly

<sup>40</sup> Sun Mintang 孫敏棠 (ed.) 1957. *Zhongguo jindai gongyeshi ziliao* 中國近代工業史資料 (Materials on the history of modern industry in China). Beijing: Kexue chubanshe 1957, pp. 258–60.

<sup>41</sup> Cf. e.g. the passages quoted in: *Yangwu yundong* 洋務運動 (The Westernization Movement). 1961. Edited by Zhongguo shixuehui 中國史學會. 8 vols. Shanghai: Shanghai renmin chubanshe, vol. 1, pp. 13–4.

imitate Western mechanized production in order to seek their own profit and that the officials will have no means to prevent this.<sup>42</sup>

In 1865, Li Hongzhang and Zeng Guofan commissioned Ding Richang 丁日昌 (1823–1882) to purchase the plant operated by Thos. Hunt & Co. in Hongkou, Shanghai, and integrate it into the Suzhou “Foreign Arms Office” (*yangpaoju* 洋炮局). On the basis of this institution, the Jiangnan Arsenal (*Jiangnan jiqi zhizao zongju* 江南機器製造總局) was established.<sup>43</sup> In the following years, the Qing government founded more than twenty so-called ‘machinery offices’ (*jiqiju* 機器局), i.e. arsenals. In Shanghai, Canton and other cities a number of privately run machinery factories began to operate. Thus, the introduction of Western machines went hand in hand with the rise and development of modern industry. In the late Qing period, ‘machinery’ (*jiqi*) almost became a synonym for Western technology and industry.

When the Qing government promulgated the “Statutes for Colleges of Higher Education” (*Daxue xuetang zhangcheng* 大學學堂章程) in 1903, it decreed that twenty-three subjects were to be taught in the curriculum of ‘machinery and engineering’ (*jiqi gongxue* 機器工學), amongst others ‘machinery’ (*jiqixue*), ‘mechanical manufacturing’ (*jiqi zhizaoxue* 機器製造學), ‘mechanical geometry’ (*jiqi jihexue* 機器幾何學) and ‘applied mechanics’ (*jiqi lixue* 機器力學).<sup>44</sup> In this way, the term *jiqi* became one of the Chinese expressions used to denote ‘mechanical engineering’. In 1909, Yung Wing (Rong Hong 容闈, 1828–1912) published his autobiographical account *My Life in China and America* in English. In 1915, the book was translated into Chinese by Xu Fengshi 徐鳳石 and Yun Tiejiao 惲鐵樵 and published under the title *Xixue dongjian ji* 西學東漸記 (Records on the dissemination of Western knowledge in China). The translators rendered ‘mechanical engineering’ as *jiqi gongcheng* 機器工程.<sup>45</sup> The question of whether the two terms *jiqi gongxue* and *jiqi gongcheng* were or

<sup>42</sup> *Yangwu yundong* 1961, vol. 4, pp. 10–4.

<sup>43</sup> Cf. Zhang Baichun 張白春. 1992. *Zhongguo jindai jixie jianshi* 中國近代機械簡史 (A short history of modern machinery in China). Beijing: Beijing Ligong daxue chubanshe, pp. 12–4.

<sup>44</sup> Cf. Shu Xincheng 舒新城. 1981. *Zhongguo jindai jiaoyushi ziliao* 中國近代教育史資料 (Materials on the history of modern education in China). 3 vols. Beijing: Renmin jiaoyu chubanshe, vol. 2, pp. 605–6.

<sup>45</sup> Cf. Xu Fengshi 徐鳳石 and Yun Tiejiao 惲鐵樵 (trs.). 1915. *Xixue dongjian ji* 西學東漸記 (Records on the dissemination of Western knowledge in China). Shanghai: Shangwu yinshuguan, p. 99.

were not imported from Japanese, as some authors have argued, awaits further investigation.

### 3. JIXIE 機械

Already early in the Warring-States period, some authors combined *ji* and *xie* into the compound *jixie* in order to describe certain kinds of devices and especially their artfulness. In the *Zhuangzi* 莊子 we find a passage depicting the ancient swape or well-sweep (*jiégao* 桔槔, see Figure 2) which illustrates quite well the meanings of *ji* and *xie*, their relationship, and even uses the two words together in a compound:

Zigong [520–456 BC] had been wandering in the south in Chu, and was returning to Jin. As he passed a place north of the Han (river), he saw an old man working in a garden. Having dug his channels, he kept on going down into a well, and returning with water in a large jar. This caused him much expenditure of strength for very small results. Zigong said to him, ‘There is a contrivance (*xie*) by means of which a hundred plots of ground may be irrigated in one day. Little effort will thus accomplish much. Would you, Sir, not like to try it?’. The farmer looked up at him and said, ‘How does it work?’. Zigong said, ‘It is a lever made of wood, heavy behind and light in front. It raises water quickly so that it comes flowing into the ditch, gurgling in a steady foaming stream. Its name is the swape.’ The farmer’s face suddenly changed and he laughed, ‘I have heard from my master’ he said, ‘that those who have cunning devices (*jixie*) use cunning in their affairs, and that those who use cunning in their affairs have cunning hearts (*jixin* 機心). Such cunning means the loss of simplicity. Such a loss leads to restlessness of the spirit and with such men the *dao* will not dwell. I knew all about [the swape] but I would be ashamed to use it.’<sup>46</sup>

Obviously, *xie* is used here to denote devices similar in kind to the swape or well-sweep, emphasizing the appliance in its entirety. *Ji* has the meanings of ‘artful’ and ‘complex’, and thus points to particularly ingenious parts; on the other hand, it is used to designate the basic components of the swape-*xie* and its peculiar features, such as the lever. It is the *ji* that enable the *xie* “to accomplish much with little

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<sup>46</sup> Cf. *Nanhua zhenjing* 南華真經 (The true classic of Nan Hua) or *Zhuangzi* 莊子 . 1936. *Sibu congkan* 四部叢刊 ed. Shanghai: Shangwu yinshuguan, p. 94. [Translation follows Joseph Needham. 1965. *Science and Civilisation in China. Vol. IV: Physics and Physical Technology. Pt. 2: Mechanical Engineering*. Cambridge: Cambridge University Press, pp. 332–3.]

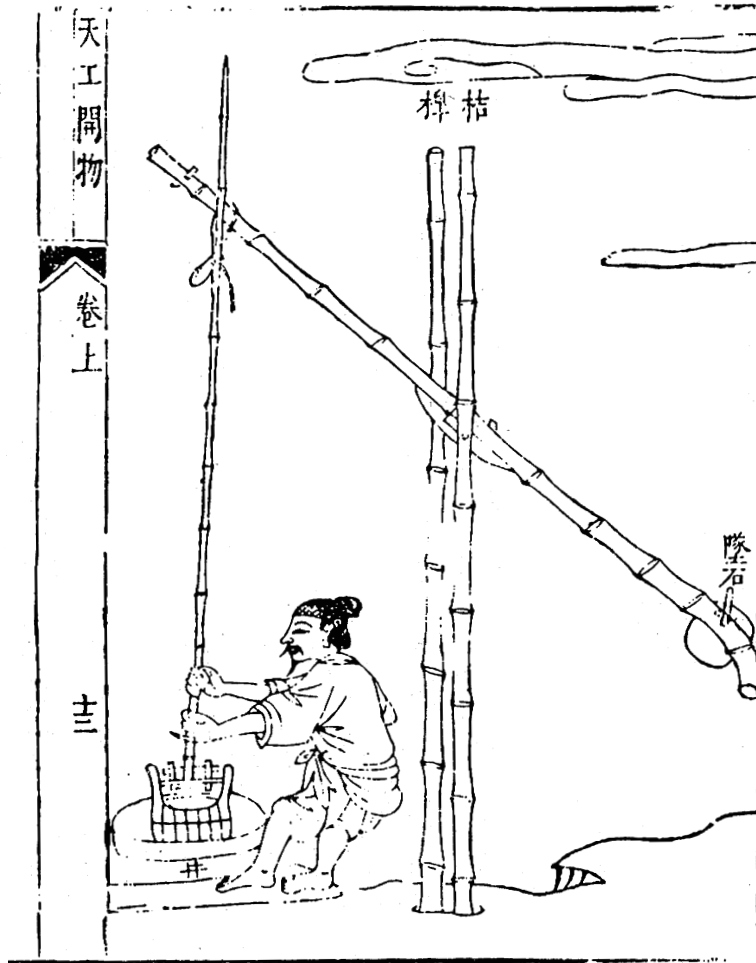


Figure 2. The well-sweep. From Song Yingxing's *Tiangong kaiwu* (1637). Yang Weizeng 1987, 1.13a.

effort". *Jixie* can either denote 'ingenious' or 'artful' appliances, or it may refer to a device that has been assembled from ingeniously working parts. In this way, it embraces the most basic features of machinery. In chapter 15 of the *Hanfeizi* we find a passage emphasizing the characteristic functions of *jixie* in a very similar way:

The advantage of boats, carriages and ‘machinery’ (*jixie*) is that little effort is needed to achieve great merit. This is truly very beneficial.<sup>47</sup>

Modern definitions of *jixie* will also invariably stress this feature.

In the *Huainanzi* 淮南子 from the second century BC we read:

If you hide a ‘machine heart’ in your bosom, then your purity is not unadulterated and your divine virtue will be incomplete.<sup>48</sup>

This passage is clearly based on the *Zhuangzi*. The ‘cunning heart’ in the *Zhuangzi* appears here as *jixie zhi xin*—a ‘machine heart’. *Jixie* is thus charged with the negative connotations of ‘tricky’ or ‘skilful but false’. These were still present in the Song period. In his “Xuanfeng yin” 旋風吟 (Lament on the whirlwind) the Song scholar Shao Yong 邵雍 (1011–1077) writes:

How can there be peace if man is not peaceful? /  
Only when the human heart is in a state of peace will the fighting end. /  
He will no longer be willing to see the tricks (*jixie*) played in chess /  
and find pleasure in the language of the lute.<sup>49</sup>

And in the “Biography of Yang Xun” (*Yang Xun zhuan* 楊恂傳) in the *History of the Ming* (*Mingshi* 明史) we find the following passage:

The more cunning tricks (*jixie*) one employs, the more unfortunate things will occur, and it will be very hard to tell whether even more unfortunate things will not happen in the future.<sup>50</sup>

Ji Yun’s 紀昀 (1724–1805) “Luanyang xiaoxia lu yi” 灤陽消夏錄一 (Records of a leisurely summer in Luanyang, 1), published in 1800 in his *Yuewei caotang biji* 閱微草堂筆記 (Brush notes from the Cottage for Inspecting Subtleties), contains the following lines:

He who wants profit only for himself will necessarily harm others. All kind of tricks (*jixie*) have emerged from this and all sorts of injustices and faults have been committed in its name.<sup>51</sup>

<sup>47</sup> *Hanfeizi jishi* 1958, p. 835.

<sup>48</sup> Liu An 劉安 et al. 1936. *Huainanzi* 淮南子. *Sibu beiyao* 四部備要 ed. Shanghai: Shangwu yinshuguan, p. 3.

<sup>49</sup> Shao Yong. 1936. “Xuanfeng yin” 旋風吟 (Lament on the whirlwind), in: id. *Yichuan jirang ji* 伊川壘集 (Collected poems of Shao Yong). Shanghai: Shangwu yinshuguan, 11.82.

<sup>50</sup> Zhang Tingyu 張廷玉 et al. 1974. *Mingshi* 明史 (History of the Ming). Beijing: Zhonghua shuju, p. 6019.

<sup>51</sup> Ji Yun 紀昀. 1932 [1800]. *Yuewei caotang biji* 閱微草堂筆記 (Brush notes from the Cottage for Inspecting Subtleties). Shanghai: Guangyi shuju, p. 8.

During the late Qing, Liu Xihong 劉錫鴻 writes in his “Du Guo Lian-shi lun shishi shu oubi” 讀郭廉使論時事書偶筆 (Random notes on provincial judge Guo Songtao’s 郭嵩燾 discourse on recent books):

In ordinary times people treat each other in an honest and trustworthy manner and do not resort to trickery (*jixie*) and craftiness.<sup>52</sup>

Yet, the term *jixie* is used much more often in ancient China to denote ingenious appliances of any kind, particularly stressing their carefully designed parts. In the Jin dynasty, for instance, Lu Ji 陸機 (261–303) uses *jixie* in his *Bianwang lun* 辯亡論 (Against decline) to describe all sorts of devices employed by the military:

In the past, when the state of Shu first was threatened to be defeated, the ministers designed various schemes. Some wanted to heap up stones to block the stream [of the river in order to submerge the enemy], others wanted to use artful devices (*jixie*) in order to prevent an unfortunate turn of events.<sup>53</sup>

During the Northern Song, the poet Su Shi 蘇軾 (1036–1101) calls the ‘brine-collecting tube-buckets’ (*qushuitong* 取水筒), devices used to lift up water in salt-wells, *jixie*: “In all salt-wells *jixie* are employed. Where profit is to be had, no one fails to know about it.”<sup>54</sup>

In the *Nongshu* and the *Tiangong kaiwu*, Wang Zhen and Song Yingxing describe a multitude of machines, and from time to time they employ the term *jixie* in order to emphasize the ingenuity of the devices described. Thus, Wang Zhen writes in his *Nongshu*:

Assemble an oil-press from a large block of wood, carve a tiny groove in it through which the oil can run out, put the boiled and ground seeds into the iron rings, and the artful device (*jixie*) will be beneficial to your heart and hands.<sup>55</sup>

And further on he says: “The square-pallet chain-pump (*fanche* 翻車) is today called ‘dragon-bone pump’ (*longguche* 龍骨車). It is the most convenient and artful device (*jixie*) among all water-lifting tools.”<sup>56</sup>

<sup>52</sup> Yangwu yundong 1961, vol. 1, p. 288.

<sup>53</sup> Lu Ji 陸機. 1936. “Bianwang lun” 辯亡論 (Against decline), in: id. *Lu Shiheng wenji* 陸士衡文集 (Collected works of Lu Ji). *Sibu congkan* 四部叢刊 ed. Shanghai: Shangwu yinshuguan, p. 44.

<sup>54</sup> Su Shi 蘇軾. 1981. “Tongjing yongshui beifa” 筒井用水韜法 (Methods and equipment for using water in salt-wells), in: id. *Dongpo zhilin* 東坡志林 (Collected writings of Su Shi). Beijing: Zhonghua shuju, p. 77. [Translation follows Needham 1965, p. 142.]

<sup>55</sup> Cf. *Zhongguo kejishi ziliao xuanbian—nongye jixie* 1985, pp. 413–4.

<sup>56</sup> *Ibid.*

In chapter 15 of the *Tiangong kaiwu*, Western cannons are designated as ‘gunpowder machines’ (*huoyao jixie* 火藥機械):

The art of gunpowder machines was first brought to the Southern barbarians by the Western barbarians; only from there it reached China.<sup>57</sup>

In his *Xiyang huolunche huolunchuan tushuo* 西洋火輪車火輪船圖說 (Western steam locomotives and steamships illustrated and explained), published in 1843, Ding Gongchen 丁拱辰 (1800–1875) provides a concise introduction to Western machinery. He says, for instance:

There are also machines and wonderful devices (*jixie qiqi*) in which wind-drums, grinding mills, tilt hammers—really everything—is installed inside. None of them uses human force. They rely only on water, fire, oxen and horses for their movement and rotation.<sup>58</sup>

And talking about steam locomotives, Ding relates:

Canton is a city in which commerce with other countries is conducted. Wonderful machines can be observed everywhere. In the past I saw small models and cautiously tried to remember them. In this way I have acquired a rough understanding of their mechanism (*jixie*). Once I hired skilled artisans and supervised them in assembling a small locomotive by keeping the right dimensions. ... After the steam engine was invented, scientists (*gewuzhe* 格物者) imitated it and built a steamship whose usefulness is even greater. While their shape is different, their mechanism (*jixie*) is similar. The method is to install the machinery of a steam locomotive on a ship, to exchange the great wheel which stirs the water, extend it outside the ship so that it reaches into the water and drives it. ... When the great cannons of our army destroy the cauldron and the machinery (*jixie*), the [ships] can no longer go forward. ... In the past I have used the machinery of a steam locomotive to manufacture a small steamship.<sup>59</sup>

The first ‘device’ described by Ding Gongchen is an agricultural machine. His four other uses of *jixie* refer to the steam engine of a locomotive or a steamship (see Figure 3). This means that the meaning is largely similar to the ancient usages of *jixie* while also corresponding to the Western meanings ‘machinery’ or ‘mechanical’.

<sup>57</sup> Yang Weizeng 1987, pp. 310–1.

<sup>58</sup> Ding Gongchen 丁拱辰 . 1843. *Xiyang huolunche huolunchuan tushuo* 西洋火輪車火輪船圖說 (Western steam locomotives and steamships illustrated and explained). n.p., 4.13–9.

<sup>59</sup> Ibid.



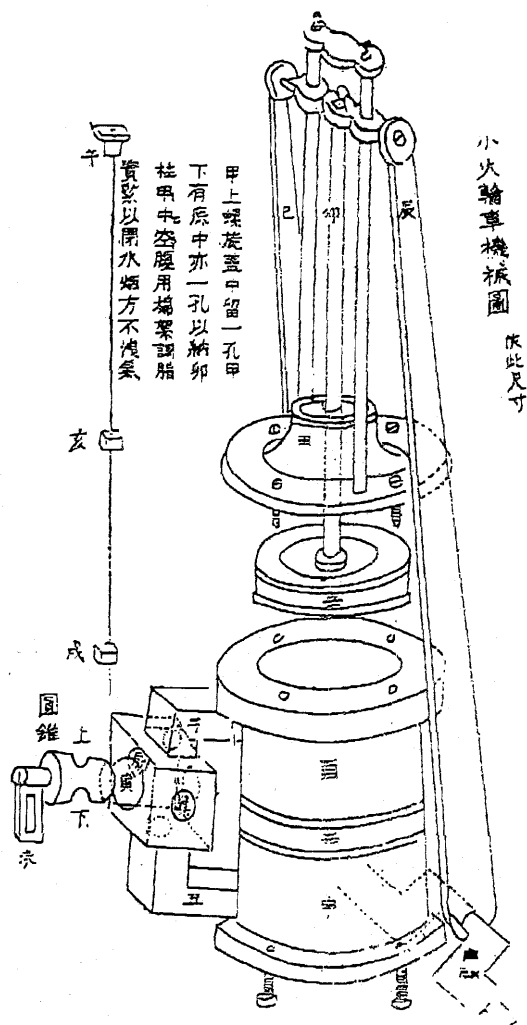


Figure 3. Engine of a steam locomotive. From Ding Gongchen. 1843. *Xiyang huolunche huolunchuan tushuo*, chapter 4.

Nevertheless, the word *jixie* was used far less often than *jiqi* throughout the later half of the nineteenth century. We only find a very limited number of examples, for instance, in a memorial by Zeng Guoquan 曾國荃 (1824–1890), then governor of Zhejiang, on Western steamships:

The method to manufacture them and the complexity of their machinery (*jixie*) is very hard to comprehend, even if one studies it for a long time. For the time being, we should contend ourselves with excelling in driving them. There is no need to inquire below the surface.<sup>60</sup>

When Sheng Xuanhuai 盛宣懷 (1849–1916) established the Chinese-Western School (*Zhong-Xi xuetao*) in Tianjin in 1895, he designed the faculties after the model of the American universities Harvard and Yale. Four departments were founded, among these a ‘School of Mechanical Engineering’ (*jixie gongxue*).<sup>61</sup> In this way, *jixie* eventually became the standard designation of an academic discipline. Since the beginning of the twentieth century, *jixie* has also come to be used as a general term for all kinds of mechanical devices and appliances.

In 1930, Liu Xianzhou 劉仙洲 suggested a Chinese definition of *jixie* after consulting the various definitions to be found in Western textbooks from the late nineteenth and early twentieth centuries:

*Jixie* is a compound body made up of two or more components. If one of its parts is moved, relative or restricted movements will occur in every other part. If we wish to take advantage of *jixie*, some kind of natural or mechanical force is necessary to produce a definite resulting work.<sup>62</sup>

#### CONCLUSION

In ancient China the terms *ji*, *qi*, and *xie* were all used in the sense of ‘implement’, ‘device’ or ‘appliance’. Even the two technical terms *qiqi* and *jixie* already existed in ancient times and were employed to denote ingenious implements or devices. It is possible that the term *qiqi* was used in Wang Zheng and Johann Terrenz Schreck’s *Qiqi tushuo* as an equivalent to the Latin term *machina*. In the 1840s the term *jixie* was used to describe Western ‘machinery’ and ‘machines’. In the early 1860s the term *qiqi* was widely used to refer to ‘machines’ from the West. In the late nineteenth and early twentieth century, the English term ‘mechanical engineering’ was rendered as *jixie gongxue*

<sup>60</sup> *Yangwu yundong* 1961, vol. 2, p. 251.

<sup>61</sup> *Beiyang daxue* 北洋大學 . 1925. *Guoli Beiyang daxue sanshi zhounian jiniance* 國立北洋大學三十周年紀念冊 (Commemorative volume on the occasion of the 30th anniversary of the National Beiyang University). Tianjin: Beiyang daxue, p. 1.

<sup>62</sup> Liu Xianzhou 劉仙洲 . 1962. *Zhongguo jixie gongcheng faming shi* 中國機械工程發明史 . Beijing: Kexue chubanshe, p. 5.

or *jiqi gongxue*; later on *jixie gongcheng* was normalized as the standard translation in modern Chinese.

In this paper, I have only used part of the available historical materials for a preliminary investigation into the history of the technical terms *jiqi* and *jixie*. A more detailed inquiry would certainly have to unearth and examine a larger number of relevant sources.

*Translated by Joachim Kurtz*

