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# Reference of Western Hydraulic Technologies in a Garden during the Late Ming Dynasty: Taking Qieyuan and the Hydraulic Methods of the Far West as an Example

Yuting CHEN

**Abstract:** The description of “Matteo Ricci’s Jiegao (桔槔)” in Zhang An (章闢)’s Qieyuan ji (且園記) evidences the presence of Western hydraulic technology in a garden during the late Ming Dynasty. Located in Lingcheng District (陵城區), Dezhou City, Shandong Province, the garden was built between 1629 and 1634. It belonged to Fan Jingwen (范景文), with Mai Erxuan (麥而炫) as the author of Qieyuan ji. Speculations surround the hydraulic technology used in “Matteo Ricci’s Jiegao,” positing the utilization of Yuheng Che (玉衡車) or Hengsheng Che (恒升車) as documented in *Hydraulic Methods of the Far West (Taixi shuifa 泰西水法)*. This work may have been a reference to Francesco di Giorgio Martini’s (1439–1501) *Trattati di architettura ingegneria e arte militare* (1476–1477). The application of hydraulic technologies in late Ming gardens was not widespread, and writings introducing Western hydraulic technologies tended to focus on practicality.

## Introduction

Western hydraulic technologies were applied to Chinese gardens from the Qing Dynasty onward. Contrary to popular belief, this paper points out that Western hydraulic technologies had already appeared in a garden during the late Ming Dynasty. During this period, Jesuit missionaries, such as Nicolas Trigault (1577–1628) and Sabatino de Ursis (1575–1620), led by Matteo Ricci (1552–1610), entered China and became famous for their rich and advanced knowledge of European religions, astronomy, mathematics, geography, science and technology, and art. The technologies related to fountains, a crucial element in Western gardens, were already mentioned in *Hydraulic Methods of the Far West*, co-authored by Ricci’s students—Sabatino de Ursis and Xu Guangqi (徐光啓, 1562–1633). In the late Ming Dynasty, Western hydraulic technologies were adapted in the garden known as Qieyuan (且園), reflecting the changes in late Ming gardens under the Sino–Western cultural exchange.

## 1. Western hydraulic technology in Qieyuan, Ming Dynasty

In *Gujin tushu jicheng’s Kaogong* (古今圖書集成, 考工典), roll 120, Qieyuan ji was mentioned, and a description of something like a fountain appears in the text: “There was a spring in the pavilion, and the sound echoed thinly. This spring has no roots but is alive, sometimes pouring over rocks, and the water has the momentum of a fast river, as if it has inherited the spirit of Ricci’s Jiegao. However, the principle is not particularly difficult to understand, as one reaches out to the mouth of the spring and obtains the source of the spring’s water” (Chen, 1964, pp. 1116–1117).

The description of “Ricci’s Jiegao” (利瑪氏桔槔) in the text is striking. “Jiegao” is a traditional Chinese device used for drawing water from a well, similar to a shadoof. People hang a lever from a tree or a wooden shed next to the well, attach a stone to one end, and lift the bucket at the other end with the downward weight of the stone to draw water with less effort. Before Matteo Ricci and other missionaries came to China, the only small water-drawing devices in China were the Jiegao and windlass. The description of “This spring has no roots but is alive” in *Qieyuan ji* means that the spring does not have a mouth, but the water is flowing. This states that the water effect does not require human labor to operate, and the water-lifting device can operate on its own. This depiction suggests that “Ricci’s Jiegao” differs from the traditional Jiegao, and its principle is very likely to be the technology of pump brought by missionaries from the West during the late Ming Dynasty. Combined with the characterization of “rootless spring,” this spring can be assumed to be similar to a fountain.

A technical challenge of building a fountain involves overcoming gravity to move water in an upward direction. This challenge is the same as creating a waterfall on a rockery. In pre-Ming Dynasty gardens, high-altitude locations often lacked a natural water source, but sometimes it was necessary to create a waterfall. Therefore, water was frequently manually transported from lower elevations. For example, in the garden named Genyue (艮嶽), the royal garden of the Song Dynasty, a waterfall was made on an extremely large rockery. During that time, as a water pump was unavailable, they created the waterfall in three steps: first, they placed a wooden water tank in the highest part of the rockery; second, the servants carried the water from the bottom of the mountain to the top; third, they opened the gate to release water when the emperor visited (Zhang, 1966, p. 7).

### 1.1 Historical investigation of Qieyuan

Thus far, Qieyuan is the only example of a Western fountain in a garden during the Ming Dynasty. It was short-lived, and the only existing historical material about Qieyuan is *Qieyuan ji*. In *Qieyuan ji*, the phrase “get Jiangling (抵將陵)” (Chen, 1964, p. 1116) implies that Qieyuan is in Jiangling, the ancient name of the Lingcheng District in Dezhou City.

The author of *Qieyuan ji* is Zhang An (章闇) of the Ming Dynasty. Mingren Zhuanji Ziliao Suoyin mentioned that “Mai Erxuan (麥而炫) was given the courtesy name Zhang An (章闇), from Gaoming” (GZT, 1991, p. 504), so *Qieyuan ji*’s author is Mai Erxuan. In the article, Mai Erxuan recounted two poems written by his teacher, which are included in the collected works of Fan Jingwen (範景文, 1587–1644). “The teacher sent me a letter, which said: ‘I want to build a small rockery and channel the water between the rocks, looking for people who are good at creating gardens. You bring such a person along to meet me.’ ... The plaque of the garden reads ‘Qieyuan’” (Chen, 1964, p. 1116). Thus, Qieyuan’s owner was Fan Jingwen, who was then the Minister of War and the Minister of Works.

Regarding the completion date of Qieyuan, the record mentions a building named “Weiyuan Hall (味元堂)” and the antique “ancient plate (古盤)” in Qieyuan. According to the annals of Fan Jingwen, the Weiyuan Hall was built in 1621, and

Fan Jingwen obtained the ancient plate in 1628 (Shen, 2016, pp. 14–16). In *Qieyuan ji*, the following is also written: “In former times, I had not yet completed the Lan Garden. In recent years, I have been working in the army (‘I had not yet completed the Lan Garden’ is just modesty.)” (Chen, 1964, p. 1117). According to the two annals of Fan Jingwen, the Lan Yuan was completed in 1624 (later destroyed in a war), and Fan Jingwen worked in the army in 1629, 1630, 1634, and from 1635 to 1637. From 1635 to 1637, Fan Jingwen spent most of his time in Nanjing, dealing with busy affairs; he did not have time to go back to Shandong to build a garden. Therefore, Qieyuan was built between 1629 and 1634.

## 1.2 Type of hydraulic technology in Qieyuan and *Hydraulic Methods of the Far West*

The Western hydraulic technology of “Ricci’s Jiegao” mentioned in *Qieyuan ji* is presumed either “Yuheng Che (玉衡車)” or “Hengsheng Che (恒升車).” They are the two kinds of water-lifting devices described in *Hydraulic Methods of the Far West*, which was co-authored by the Italian missionary Sabatino de Ursis (熊三拔) and Xu Guangqi.

Among the writings of missionaries in the late Ming Dynasty is *Hydraulic Methods of the Far West*, composed for agricultural purposes after the death of Matteo Ricci. Ursis served as a Chinese student and assistant to Matteo Ricci, and Xu was the minister of rites. Initially, Xu intended to translate Western works on hydraulics with Ricci, but Ricci recommended Ursis to Xu. This book was not a direct translation of Western works on hydraulics; rather, it selectively incorporated elements beneficial to Chinese agriculture. The translation involved creating hydraulic machinery and illustrating the book with text based on actual machinery (Xu, 1983, preamble). Although Ursis dominated the study of hydraulics during the late Ming Dynasty, Mai Erxuan attributed the Western water-lifting devices to Matteo Ricci, a representative of the Western missionaries and a symbol of Western knowledge in that era. Ricci’s Jiegao in *Qieyuan ji* should be attributed to Ursis’s Jiegao.

Volume 2 of the *Hydraulic Methods of the Far West* describes the hydraulic machines “Yuheng Che” (Fig. 1) and “Hengsheng Che” (Fig. 2). The spring in Qieyuan must have used one of these two machines. From *Hydraulic Methods of the Far West*: “Yuheng Che, is a device for lifting water from a well or spring... ..with Yuheng Che, a manpower can be used as several people’s force; irrigating fields with it, you can save about four-fifths of the manpower.” In addition, Yuheng Che is described as follows: “(to draw water with Yuheng Che) The water from the well spurts upward, like water from a spring” (Xu, 1983, roll 2), which is very similar to a fountain. Some ancient fountains operated on a similar principle, using the natural gravitational force of water falling from a height, eliminating the need for manpower. The principle of Hengsheng Che is similar to that of Yuheng Che; however, Hengsheng Che draws water faster and with greater ease. Ge Qinyun argued that Yuheng Che is a Ctesibian force pump, whereas Hengsheng Che is a suction lift pump (Ge, 2018). Ctesibius is an ancient Greek and the inventor of the pump. To clarify the introduction of these two types of machinery into China, the references to these two types of pump technology must be further clarified.

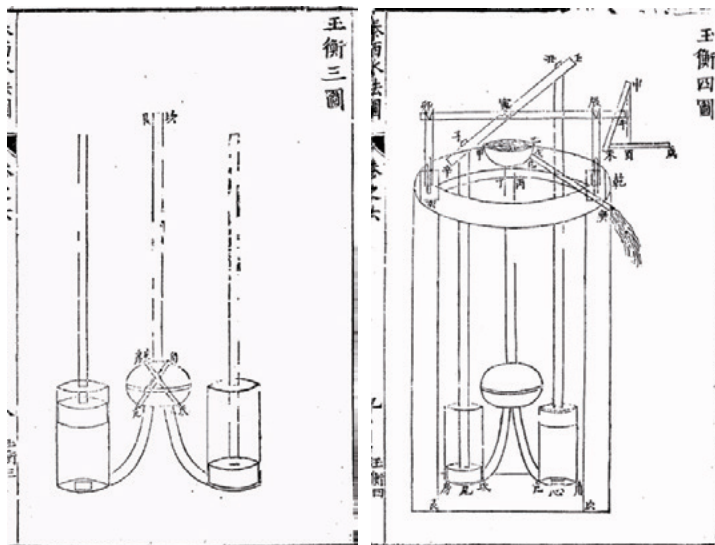


Fig. 1 Yuheng Che in *Hydraulic Methods of the Far West* (Xu, 1983)

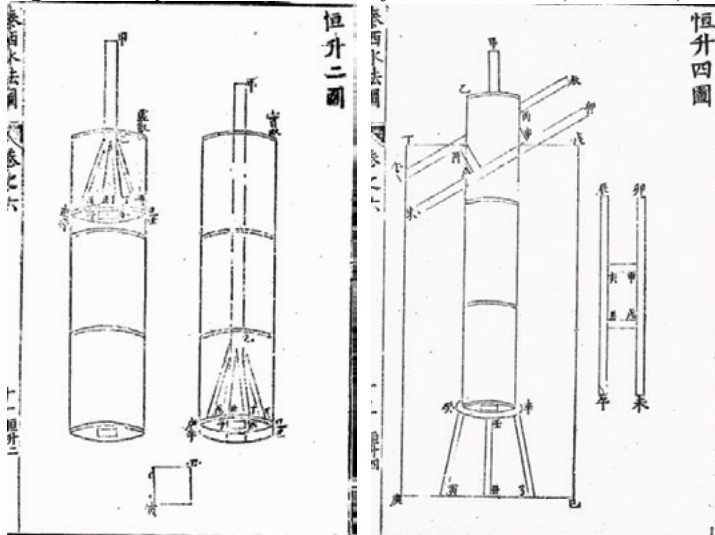


Fig. 2 Hengsheng Che in *Hydraulic Methods of the Far West* (Xu, 1983)

## 2. Reference books for Hydraulic Methods of the Far West

Regarding the reference books for *Hydraulic Methods of the Far West*, Albert Koenig pointed out that *Hydraulic Methods of the Far West* references Daniel Barbaro's version of *Ten Books on Architecture* (*I Dieci Libri Dell'Architettura*). Koenig notes that the illustration of Longweiche (龍尾車, a large water pump similar to the Archimedeian screw pump) in *Hydraulic Methods of the Far West* bears a striking resemblance to the illustration in Barbaro's *Ten Books on Architecture* (Figs. 3 and 4). Barbaro's version was previously in the Jesuit Library in Peking (Koenig, 2020).

However, Barbaro's *Ten Books on Architecture* depicts a more convenient mechanism than labor-intensive pumps. A part of this mechanism operates on the same principle as Yuheng Che, but it is modified to automatically lift water through the flow of the river and a waterwheel (Fig. 5). This machinery is a combination of a waterwheel and a pump. Although the textual description of this machinery does not mention the inventor, it repeatedly attributes the pump's invention to Ctesibius. Barbaro asserted that the idea of the water pump mentioned in the original version of *Ten Books on Architecture* by Vitruvius during the Roman period was derived from Ctesibius in ancient Greece (Vitruvio, 1567, p. 462). Barbaro's Italian translation renders Ctesibius's Latin name as Ctesibio following the Italian tradition of male names.

Given the potential influence of Barbaro's edition of *Ten Books on Architecture* on the depiction of Longweiche in *Hydraulic Methods of the Far West*, a question arises: why does the Yuheng Che (Ctesibius' water pump) in the same work (Fig. 6), which was designed for agricultural purposes, lack a reference to the even more labor-saving, self-irrigating machinery shown in Barbaro's illustration? Moreover, considering that waterwheels have been used in Chinese agriculture since at least the Tang Dynasty (Zhou, 2010, p. 533), no obstacle hinders the creation or application of waterwheels.



Fig. 3 Illustration in Barbaro's  
*Ten Books on Architecture* (Vitruvio, 1567)  
*Hydraulic Methods of the Far West* (Xu, 1983)

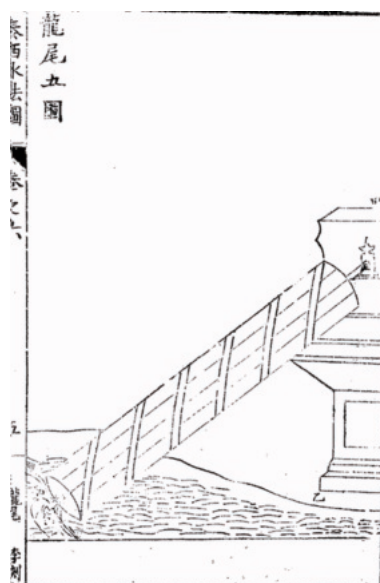


Fig. 4 Illustration of Longwei Che in  
*Hydraulic Methods of the Far West* (Xu, 1983)

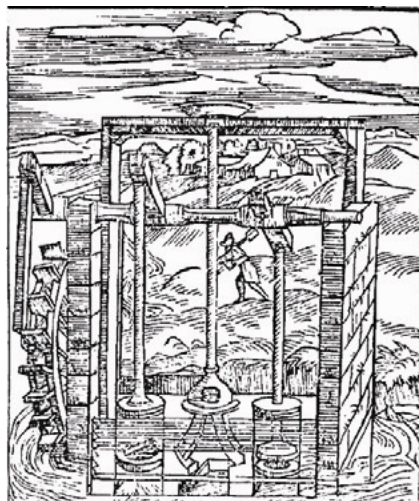


Fig. 5 Illustration in Barbaro's *Ten Books on Architecture* (Vitruvio, 1567) *Hydraulic Methods of the Far West* (Xu, 1983)

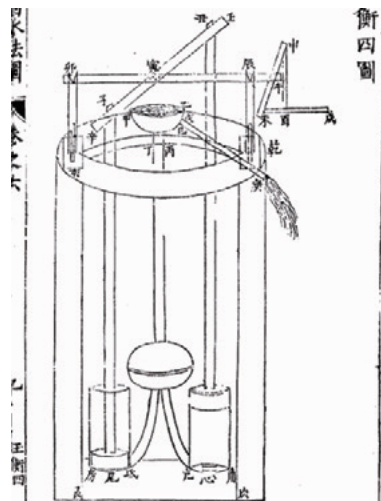
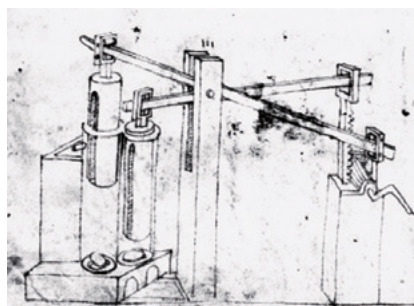
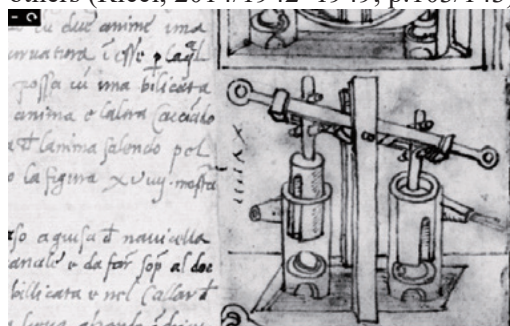


Fig. 6 Illustration of Yuheng Che in *Hydraulic Methods of the Far West*

The paper speculates that *Hydraulic Methods of the Far West* references *Treatises on Architecture, Engineering, and Military Art (Trattati di Architettura Ingegneria e Arte Militare, 1476–1477)* by Francesco di Giorgio Martini (1439–1501). Illustrations from Martini's treatises, depicting the construction and principles of water-lifting machines (Fig. 7), bear a striking resemblance to the illustrations found in *Hydraulic Methods of the Far West*. Despite not undergoing formal publication, several handwritten copies of Martini's work circulated. During his time in China, Ricci possessed several books, bound in various styles. Some of these were brought to China by Ricci himself, whereas others were sent to him by others (Ricci, 2014/1942–1949, p.103/143).



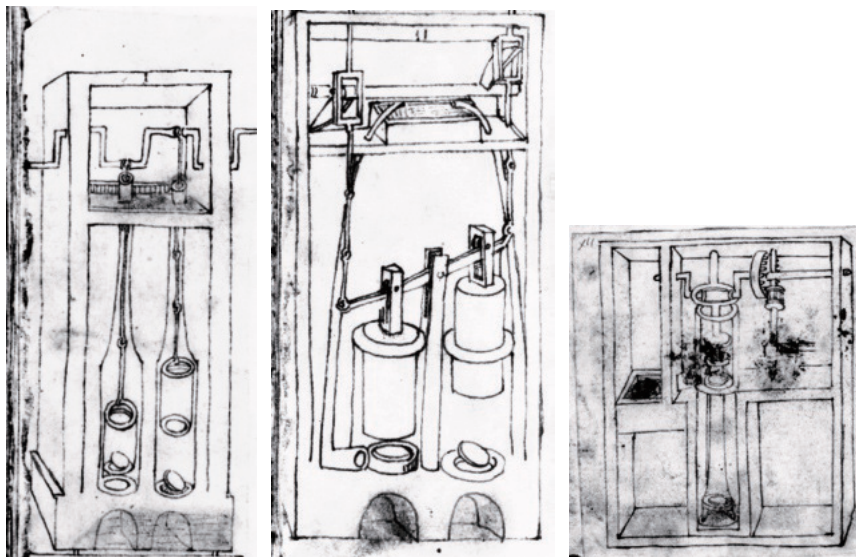


Fig. 7 Illustrations in *Trattati di architettura ingegneria e arte militare* (Martini, 1476–1477)

### 3. Tendency to introduce and apply Western hydraulic technology in late Ming gardens

In historical records of late Ming gardens, those that used Western hydraulic technology are a minority. The principle of “adjust measures to local conditions (因地制宜)” appeared in *Yuan Ye* (園冶), a definitive work on garden design completed during the late Ming Dynasty. It discouraged endeavors like constructing labor-intensive artificial waterfalls (such as Genyue’s waterfall), which was seen as an impractical extravagance. In East Asia, the tradition was to preserve the aura of nature in a garden while making it habitable through human intervention. The pursuit of transforming nature into a geometric order flourished concurrently in the West during the late Ming period. Although advanced technologies were easily and quickly accepted, cultural traditions gradually changed.

Moreover, late Ming works introducing Western hydraulic technologies tended to emphasize practical applications for improving people’s livelihoods, with varying approaches across different works. *A Record of the Best Illustrations and Descriptions of Extraordinary Devices of the Far West*, an introduction to Western technology published in 1627, showed a machine with the same principle as the Yuheng Che, named water pistol (水銃). However, this machine was not used to draw water from wells but rather to extinguish fires when they occurred (Fig. 8, Deng & Wang, 1936, pp. 315–318). The reference book for *Extraordinary Devices of the Far West*, Ramelli’s *The Various and Ingenious Machines*, does not elaborate on the machinery used to extinguish fires. Most Western buildings were made of stone, so the necessity to extinguish fires was not as strong as in East Asia, where wooden buildings were prevalent. Furthermore, although *The Various and Ingenious Machines* detailed the water organ (Fig. 9, Ramelli, 1588), which was created for pleasure, these aspects were not cited in the Chinese work.



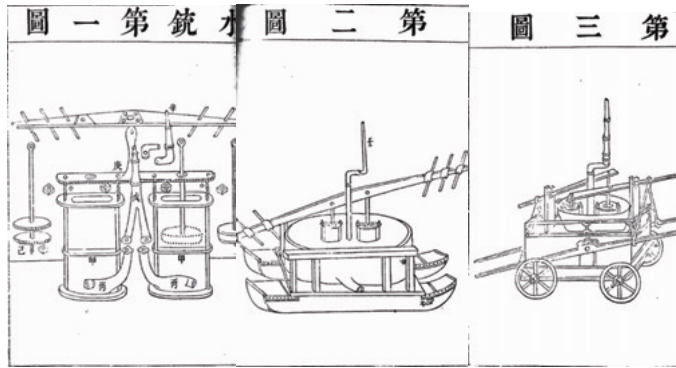


Fig. 8 Illustrations of water pistol in

*A Record of the Best Illustrations and Descriptions of Extraordinary Devices of the Far West*

(Deng & Wang, 1936, pp. 315–318)

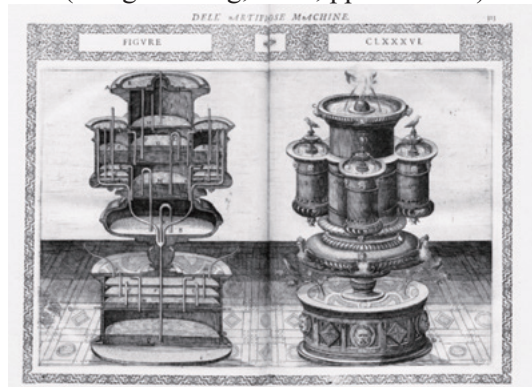


Fig. 9 Illustrations of water organ in *Le diverse et artificieuse machine* (Ramelli, 1588, Figure 36)

## Conclusion

This presentation offers evidence supporting the integration of Western technology into late Ming gardens. Through the investigation of historical materials, this paper attempts to shed light on the trajectory of this technological adoption.

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