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Three Articles on the Technology Transfer in Meiji Japan:
The Case of Cotton Spinning Enterprises

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Three Articles on the Technology Transfer in Meiji Japan: The Case of Cotton Spinning Enterprises

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(1) The Architecture of Mill No. 1 at Osaka Bōseki Kaisha (Osaka Spinning Company)

Original Japanese Paper: Naoki Hirai, “Osaka Bōseki (Sangen’ya Kōjō) Dai-ichi Kōjō no kenchiku” (*Nihon Kenchiku Gakkai Taikai gakujutsu kōen kōgai-shū F-2* [Summaries of technical papers of Annual Meeting Architectural Institute of Japan], 2016).

(2) Plans for Japan’s Earliest Spinning Mills: Documents Detailing 2,000-Spindle Mills and Osaka Bōseki Kaisha (Osaka Spinning Company)

Original Japanese Paper: Naoki Hirai, Takenobu Yuki, Kanji Tamagawa and Takeshi Abe, “Shiryō shōkai: Shoki Nihon bōseki kōjō no sekkei zumen—Nisensui bōseki kankei shiryō oyobi Ōsaka Bōseki Kaisha kankei shiryō” (*Shibusawa kenkyū* [Shibusawa studies] 31, Shibusawa Memorial Museum, January 2019)

(3) Drawings for Japan’s First Spinning Mills: New Discoveries in the Hick, Hargreaves & Co. Documents

Original Japanese Paper: Naoki Hirai, Takeshi Abe and Kanji Tamagawa, “Hick Hargreaves Sha bunsho de hakken sareta shoki Nihon bōseki kōjō no sekkei zumen” (*Nihon Sangyo Gijutsushi Gakkai dai 36-kai nenkai kōen yōshi-shū* [Proceedings of the 36th annual conference of the Japan Society for the History of Industrial Technology], 2020)

(1) The Architecture of Mill No. 1 at Osaka Bōseki Kaisha

1. Introduction

Osaka Bōseki Kaisha (Osaka Spinning Company; hereinafter “Osaka Bōseki”), founded by Shibusawa Eiichi and several others in Sangen’ya Village, Nishinari District, Osaka Prefecture, in May 1882, was a pioneering presence in Japan’s modern spinning industry. Researchers have studied the mill’s architecture through analyses of drawings and plans,¹ but details surrounding several parts of the design have remained largely unclear. Drawings and images depicting the mill’s architecture prior to a fire in December 1892 have remained in relative obscurity, making that segment of the mill history particularly difficult to pin down. This paper introduces new resources on that gap in the existing scholarship’s coverage and probes the materials to delineate the architecture of Mill No. 1 in clearer detail.

2. Sources on mill architecture

Drawings in the Shibusawa Memorial Museum: The Shibusawa Memorial Museum purchased a set of Meiji-period spinning-related documents from an antique bookseller that includes drawings for Osaka Bōseki Mills No. 1, 2, and 3. A 2019 exhibit at the Museum featured a portion of the documents, which also appeared in the showcase’s official catalog.² Exactly where the chain of ownership goes back to is difficult to determine, but it would not be surprising if it came from a former warehouse belonging to someone in Matsumoto Jūtārō’s circle.

Toyobo Co., Ltd. archival documents: Among the archival documents on Osaka Bōseki and Yamanobe Takeo are an album containing photographs of the exterior of Mills No. 1 through 3 from before the 1892 fire along with a diary (spanning the dates June 17th, 1881, to December 29th, 1882) that Yamanobe penned during the company’s formative stages.

Platt Saco Lowell documents in the Lancashire Archives collection (UK): The archives of Platt Saco Lowell, a manufacturer of spinning equipment, include the specifications for spinning mules delivered to Osaka Bōseki along with an accompanying machinery-layout³ for the corresponding fine-spinning room.

3. The process of building Mill No. 1

Osaka Bōseki commissioned the head office of Osaka Fujita-gumi to handle the construction of Mill No. 1, which commenced in June 1882 and wrapped the following July. The company had already ordered its spinning equipment from Platt Co. and the boiler and engine from Hick Co. in January 1882; the shipments began arriving that December and had all arrived in Japan by the following April.⁴

A report at the sixth general meeting of the Spinners’ Association in December 1881 noted that Osaka Bōseki officials approached the architecture of Mill No. 1 with a focus on ensuring optimal daylighting performance and airtightness in a large-scale facility, seeking out expert opinions and visiting mills in Tokyo to gather insights. After completing that reconnaissance work,

¹ See, for example, Saburo Noguchi, “Nokogiriyane ni tsuite kyū Ōsaka Bōseki no Sangen’ya Kōjō” [The saw-tooth roof at the former Osaka Bōseki Sangen’ya mill], *Nihon Kenchiku Gakkai Taikai gakujuutsu kōen kōgaishū* [Summaries of academic presentations at the Architectural Institute of Japan Conference], (1997).

² *Kindai bōseki no susume—Shibusawa Eiichi to Tōyōbō* [Encouraging modern spinning: Shibusawa Eiichi and Toyobo], Shibusawa Memorial Museum, (2015).

³ “SPECIFICATIONS” (DDPSL1/80/21/33), PLATT BROTHERS & COMPANY LTD. OF OLDHAM collection.

⁴ *Dai ikkai hanki kōkajō* [Securities report for the first half of the year], Osaka Bōseki, (1884), *Okamura Katsumasa-ō kōjutsu bōseki kaikyūdan* [Okamura Katsumasa reminisces about the spinning industry], Nihon Mengyō Kurabu, (1932).

company officials decided to model the company's approach after the “architectural methods of the typography unit at the Ministry of Finance Printing Bureau” and enlist the assistance of Saitō Yoshitomo, the lead builder and upkeep manager at the organization.⁵

The facility in question most likely refers to a printing plant built in February 1881 on the western side of the Printing Bureau premises (Ōtemachi 2-chōme, Kōjimachi Ward), adjacent to the Ministry of Finance. While details on the structure are scant, records state that the building was a single-story, brick structure (with floor space of 1,073.57 *tsubo* [roughly 3,549 m²]) and a nearly square footprint.⁶ In *Gosenbun no ichi Tokyo sokuryō genzu* [Original measurement drawings for Tokyo, 1:5000],⁷ the building comprises a series of long sections in the east-west direction with an asymmetrical, hipped roof rough atop each section. In all likelihood, these features were reflected in the architectural design for Mill No. 1 at OB.

4. Draft plans by Archibald King

The plan drawings for Mill No. 1⁸ are dated November 10, 1881, and December 6, 1881, and feature two inscriptions: “Yokohama” and “Archibald King.” The name Archibald King also makes several appearances in Yamanobe’s diary, starting with an entry on November 5, 1881, that indicated that Yamanobe had paid a visit to “Mr. King at Ishikawaguchi, Yokohama.” Archibald King⁹ originally made his way to Japan in 1873 to serve at the Imperial College of Engineering along with fellow foreign hire Henry Dyer. During the planning stages for Mill No. 1 at Osaka Bōseki, King was head engineer for engine construction at Hirano Tomiji’s Ishikawaguchi Foundry in Yokohama. The draft plan’s stipulation of 16 spinning mules in the fine-spinning room and the partitioning of the brick wall into five parts both match Platt Co.’s machinery-layout diagram. While there are some differences, such as the wall surrounding the entire facility in the draft plan, the overall structure in the drawing adheres to the working plan.

⁵ Managers of the spinning union Yajima Sakurō, Shibusawa Eiichi, and Hachisuka Mochiaki), “Bōseki kumiai dairokkai sōkai giketsu shushi” [Overview of matters for resolution at the sixth general assembly of the spinning union], documents on Godai Tomoatsu in the Osaka Chamber of Commerce and Industry collection, 1881, and also appearing in *Kindai bōseki no susume—Shibusawa Eiichi to Tōyōbō* [Encouraging modern spinning: Shibusawa Eiichi and Toyobo].

⁶ *Insatsu-kyoku enkaku-roku* [The historical record of the Printing Bureau], Printing Bureau, 1903, and *Insatsu-kyoku gojū-nen ryakushi* [The 50-year history of the Printing Bureau], Printing Bureau, 1920.

⁷ *Gosenbun no ichi Tōkyō sokuryō genzu (Tōkyō-fu Musashinokuni Kōjimachi-ku Ōtemachi oyobi Kanda-ku Nishiki-chō)* [Original measurement drawings for Tokyo, 1:5000 (Ōtemachi, Kōjimachi Ward, and Nishiki, Kanda Ward, Musashi Province, Tokyo Prefecture)], General Staff Land Survey Department, 1883.

⁸ *Kindai bōseki no susume—Shibusawa Eiichi to Tōyōbō* [Encouraging modern spinning: Shibusawa Eiichi and Toyobo].

⁹ See “The Late Mr. Archibald King”, *Industries: A Journal of Engineering, Electricity, & Chemistry for the Mechanical and Manufacturing Trades*, vol. 1, 1886, 401, and Arai Gensui, *Tōkyō Ishikawajima Zōsenjo gojūnen-shi* [A fifty-year history of the Tokyo Ishikawajima Shipyard], Arai Gensui, 1930. Born in Glasgow (UK), Archibald King apprenticed at MC ANDREW & CO., GLASGOW before venturing to Japan in 1873 with Henry Dyer. King oversaw practical training at the Imperial College of Engineering until the institution dismissed him in 1875 on grounds of a criminal transgression. Yamao Yōzō later introduced King to Hirano Tomiji, who enlisted King to head up engine construction at the Ishikawaguchi Ironworks in Yokohama (a branch plant of the Ishikawajima Hirano Shipyard that was relocated to Ishikawajima and integrated into the Shipyard’s operations in 1884). There, King was in charge of marine-engine production and the manufacturing of other machinery. He died of cholera in Tsukiji, Tokyo, on August 28, 1886, at the young age of 38.

5. The mill layout and actual mill architecture

A look at the mill-layout plan as of June 1890 (Figure 1) shows that Mill No. 1 (single-story, 1883) occupied the center of the building site (single-story, 1883), with Mill No. 2 (a three-story addition, 1886) next to Mill No. 1 on the south side. Whereas the Mills No. 1 and 2 lie on the north-south axis, Mill No. 3 (four-story, 1889) sits on the eastern edge of the premises, separate from the other two facilities.

The plan drawings for the second mill addition (Figure 2), images (Images 1 and 2), and other sources provide enough clues to create a clear picture of what Mill No. 1 looked like. The mill's main structure was brick (laid by UK personnel) and had floor space of 1,109.45 *tsubo* (roughly 3,668 m²). The boiler house and engine house were apparently on the east side, the cotton-mixing room and scutching room on the north side, a rope race in the middle, and, on the other side of the rope race, a card room, roving room, fine-spinning room, and reeling room in a process-sequenced row from north to south. The area to the west of the rope race was close to square in shape, and a 10-piece saw-tooth roof covered the facility. The south face had pantiling, while the north face provided daylight access via an array of slanted glass panes. The side walls had only a smattering of small windows, so it appears doubtful that the designers intended the side walls for lighting purposes.

The design of Mill No. 1 captures the architectural features of the spinning mills that popped up in the wake of the 1891 Mino-Owari earthquake and Sino-Japanese War (1894–95), characteristics that set the standard for future spinning mills to come. Distinctive features include its single-story, brick structure with a nearly square footprint and its use of the north side of the saw-tooth roof for daylighting instead of the side windows—a stark contrast with the architectural designs of Mills No. 2 and 3, which embody what many consider the “trademark” Osaka Bōseki design.¹⁰

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¹⁰ Okamoto Sōtarō, “Bōseki kōjō no kenchiku ni tsuite” [The architecture of spinning mills], *Kenchiku Zasshi* [Journal of Architecture and Building Science] 23, no. 269, May 1909.

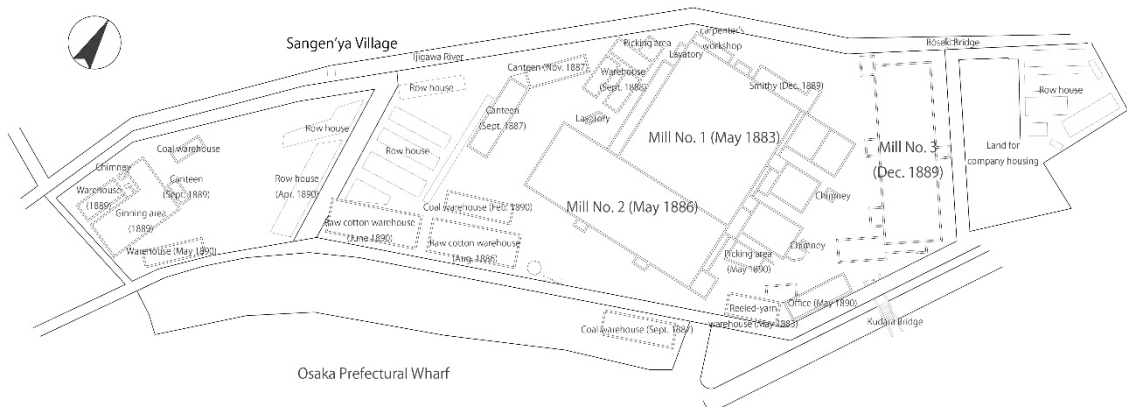


Figure 1. Site plan, Osaka Bōseki (as of June 1890)
(Created based on drawings in the Shibusawa Memorial Museum collection)

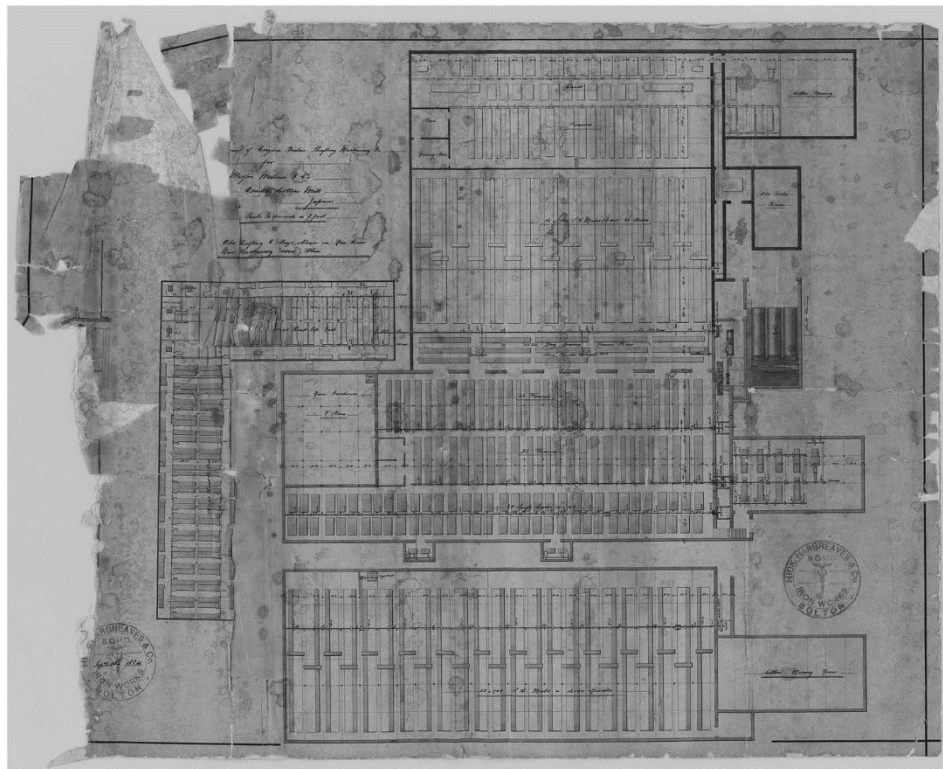


Figure 2. Addition plan, Mill No. 2 at Osaka Bōseki (Hick Co., Ltd., September 25, 1894)
(Shibusawa Memorial Museum collection)

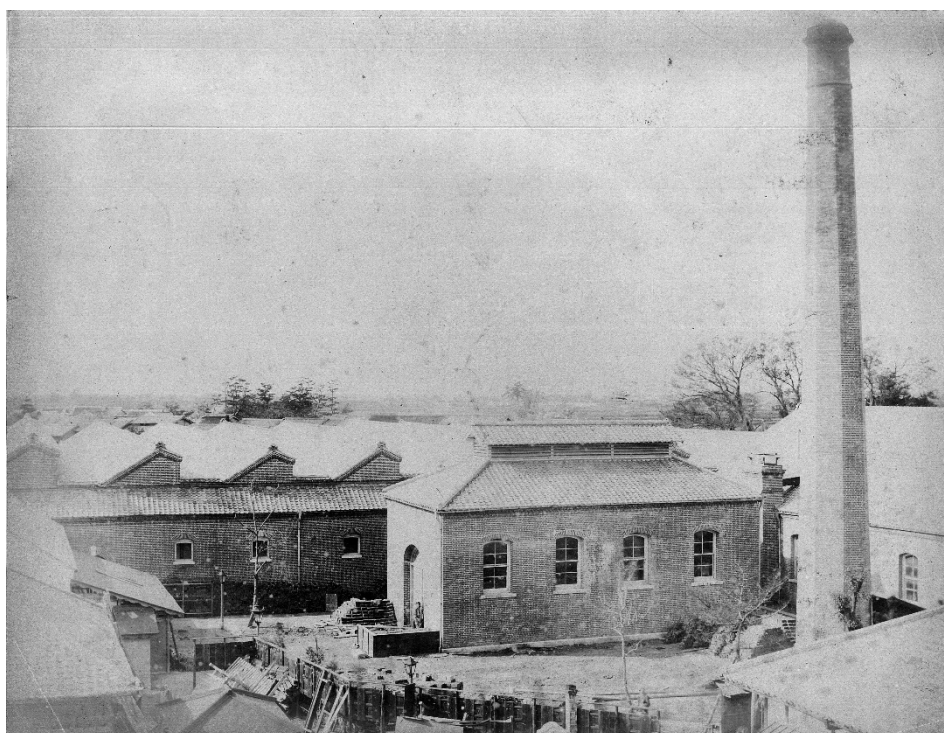


Image 1. View of east elevation, Mill No. 1 at Osaka Bōseki
(Toyobo Co., Ltd. collection)



Image 2. View of south and west elevations, Mill No. 1 at Osaka Bōseki
(Toyobo Co., Ltd. collection)

(2) Plans for Japan's Earliest Spinning Mills: Documents Detailing 2,000-Spindle Mills and Osaka Bōseki Kaisha¹

1. Introduction

The Shibusawa Memorial Museum collection is home to numerous design drawings (plans) for Japanese spinning mills dating back to the second half of the nineteenth century, a period when the cotton-spinning industry joined the railroad and mining industries as the engines driving the early stages of Japan's industrialization process. Given its central position in that dynamic, the spinning industry has been a popular subject for study from a wide array of perspectives in fields ranging from economic, business, and industrial history to the history of industrial technology and architecture. Despite the breadth of the existing scholarship, however, relatively few researchers have used actual mill-design drawings for their analyses.

This paper aims to help address that lack by introducing several archival documents in the collection of the Shibusawa Memorial Museum. To do so, the paper begins by outlining how the documents came to be part of the collection and providing a general overview of the materials. Then, the paper draws on the documents to present two case studies—the prototype for 2,000-spindle mills, which represented a pioneering force in Japan's modern cotton-spinning community, and Osaka Bōseki Kaisha (Osaka Spinning Company, and now Toyobo; hereinafter “Osaka Bōseki”), which was Japan's first 10,000-spindle facility. In examining the two cases, the paper also uses the drawings to highlight three companies that were apparently integrally involved in the drafting process.

The archival documents that we present herein suggest that firms in the United Kingdom (hereinafter “UK”), which had already undergone its industrial revolution and entered a maturity phase, not only exported spinning-related machinery to Japan (a relative latecomer to the industrialization process) but also sent personnel to install the machinery and train Japanese workers in using the equipment. Perusing the drawings, one also finds evidence indicating that British companies even helped set up transmission-shaft systems for operating the machinery and provide entire mill layouts as part of an extensive range of services for their Japanese recipients. The sources thus bring new, valuable perspectives into the conventional scholarship on the history of the cotton-spinning industry.

2. The history of the Japanese spinning industry

In 1867, the Satsuma Domain launched Japan's first mechanical cotton spinning mill: the Kagoshima Spinning Mill. Subsequent years saw more cotton mills emerge, with the Satsuma Domain establishing the Sakai Cotton Mill in 1870 and Tokyo-based merchants launching the Kashima Spinning Mill in 1872 (also known as the “Shiso Sanbōseki” [three pioneering spinning mills]). The Meiji government then began importing spinning machinery to propel Japanese spinners forward. With a secure supply of equipment, the government created its own facilities: Kan'ei Aichi Bōsekisho (the Government-Operated Aichi Spinning Mill, launched 1881) and Kan'ei Hiroshima Bōsekisho (the Government-Operated Hiroshima Spinning Mill), which was purchased via a government disposal by a private firm just before its scheduled opening in 1882 and subsequently launched as Hiroshima Bōseki Kaisha (Hiroshima Spinning Company). The government also sold off some of its machinery acquisitions to private firms (on interest-free ten-year payment plans). The operations that emerged from that context, or “Jukkibō” (“ju” refers to

¹ Each of the authors was largely responsible for different portions of the paper. Hirai wrote the majority of the drawings' explanations; Yuki wrote the discussions of trends in the spinning industry, the history of Platt Co., and the history of Mitsui & Co.; and Abe was responsible for the portion providing information on Hick Co. In terms of the overarching concept the paper, the authors drew substantially on Tamagawa's research and worked together to organize the paper, verify the details, and make revisions as necessary.

the number 10, in this case the 10 private s that each received one spinning machine from the government), included the likes of the Tamashima Spinning Mill (Okayama Prefecture, founded in 1882), Ichikawa Spinning Mill (Yamanashi Prefecture, 1882), Mie Spinning Mill (Mie Prefecture, 1882), Shimomura Spinning Mill (Okayama Prefecture, 1882), Toyoi Spinning Mill (Nara Prefecture [then part of Osaka Prefecture], 1883), Shimada Spinning Mill (Shizuoka Prefecture, 1884), Enshu Spinning Mill (Shizuoka Prefecture, 1884), Nagasaki Spinning Mill (Nagasaki Prefecture, 1884), Shimotsuke Spinning Mill (Tochigi Prefecture, 1885), and Saga Bussan Company (Saga Prefecture, dissolved).²

There were initially numerous limitations on the operations of these mills, all of which were 2,000-spindle spinning facilities. Location was one important factor, as the mills required a stable supply of domestic cotton and access to waterwheels for power purposes. The new establishments also had relatively minimal fundraising capabilities and ran at an extremely small scale. Despite the challenges, however, some of the mills garnered a growing base of investors and used that influx of resources to expand their operations to a scale of around 10,000 spindles. As steam engines began making their way into the facilities and imports of low-cost Chinese cotton started streaming into the market, spinning mills began to face fewer hurdles and enjoy more operational freedom.³ The Table here provides a comparative breakdown of 2,000-spindle mills and Osaka Bōseki. As the numbers show, the years between 1884 (during the “Matsukata Deflation” period⁴) and 1889 (when companies emerged into the spotlight in the Japanese economy) saw considerable growth in productivity and profits not at Osaka Bōseki but rather at several of the 2,000-spindle mills that had expanded by taking advantage of that leeway and installing ring spinning machines.

The story of Osaka Bōseki traces back to Shibusawa Eiichi, whose hopes to found a 10,000-spindle spinning mill laid the conceptual foundation. Building on that idea, prominent Tokyo merchants like Kakinuma Tanizō and Satsuma Jihei, along with Osaka businessmen Matsumoto Jutarō, Fujita Denzaburō, and others, rounded up support for a new venture, secured funding from Hachisuka Mochiaki and other members of the noble class, and eventually founded Osaka Bōseki in 1882. The company officially went into operation in 1883.⁵ For the company’s location, the founders chose Sangen’ya, Nishinari-gun, an area of Osaka Prefecture that had a good combination of access to raw cotton, products, and coal transport. Securing the requisite equipment for the mill was the work of Yamanobe Takeo, who had studied spinning techniques in the United Kingdom. Yamanobe ordered the new establishment’s spinning machinery from Platt Brothers & Co., (UK; hereinafter “Platt Co.”) and power machinery from Hick, Hargreaves & Co. (UK; hereinafter “Hick Co.”), which he then delivered to the facility. The company had Yamanobe translate spinning-related technical documents, too, and enlisted four spinning apprentices (Sasaki Toyokichi [the younger brother of First National Bank clerk Sasaki Yūnosuke], Kadota Akitoshi [a friend of Shibusawa Eiichi], Okawa Eitarō [a nephew of

² The other mills (companies) in the Table obtained their funding from various sources: Himeji Bōseki was a prefecture-run enterprise; the machinery at Kuwanohara Bōseki, Miyagi Bōseki, and Nagoya Bōseki was paid for by the national government; Shibutani Bōseki launched on a government loan; and Okayama Bōseki got its start with a capital loan for the promotion of industry.

³ Founded in 1882, the Japan Cotton Spinners’ Association not only converted raw cotton but also played a central role in improving labor measures, enhancing the industry’s technical capabilities, dealing with merchants, and more (Kanji Tamagawa, “Bōseki Rengōkai sōsetsu no rekishiteki igi” [The historical significance of the creation of the Japan Cotton Spinners’ Association], *Gijutsu to bunmei* [Technology and civilization] 5, no. 1, 1989).

⁴ As for the “Matsukata Deflation”, see Steven J. Ericson, *Financial Stabilization in Meiji Japan: The impact of the Matsukata reform*, Cornell University Press (Ithaca & London), 2019.

⁵ The authors referenced *Hyakunen-shi: Toyobo, jō* [A 100-year history: Toyobo, part I] (Toyobo Co., Ltd., 1986) for their descriptions of Osaka Bōseki.

Shibusawa Eiichi], and Okamura Katsumasa [the second cousin of Yamanobe Takeo]) to get hands-on training with 2,000-spindle mill operations. Having spared no pains in preparing for the start of operations, the company set its mill in motion under the supervision of a technician on loan from Platt Co., who helped install the machinery and train employees in how to use it. Osaka Bōseki also had the mill run around the clock, one of several strategies that the company used to fortify a production framework in conditions where the available capital was scarce relative to the labor on hand. In addition, the company brought its raw-material costs down by purchasing Chinese cotton at roughly three-fourths the price of Japanese cotton. By limiting production costs and pumping out items at mass-production levels, Osaka Bōseki Kaisha posted impressive profits right out of the gate. The company also expanded its operations during its infancy, adding a fabric division via a buyout. The target was Osaka Shokufu Kaisha (Osaka Weaving Company), which Osaka Bōseki personnel, led by Yamanobe, had spearheaded in 1887. The recession of 1890 crippled the new company, however, so Osaka Bōseki moved in to purchase the startup and turn it into its own fabric-producing arm. Although the new fabric division had its share of struggles in the aftermath of the merger, it eventually found itself on the right track within the successful Osaka Bōseki framework: by 1893, fabric accounted for over 10% of Osaka Bōseki's total sales

Table 1: Spinning mills (spinning companies) in the late nineteenth century

Mill (company) name	October 1884									Established	Location
	Spindles		# of days in operation	# of hours in operation per day	Yarn count	20s yarn production per spindle per month (A)	20s yarn output per hour per female mill worker (B)	Wages for female mill workers (C)	Profit (yearly) (D)		
	Ring	Mule									
Mie		2,000	28.0	24.0	14	870	54.9	8.4	4,951	June 1882	Kawashima District, Mie Prefecture
Tamashima		2,000	26.0	24.0	Wa-13	966	37.5	7.6	6,406	January 1882	Asakuchi District, Okayama Prefecture
Nagoya										April 1885	Nagoya District, Aichi Prefecture
Shibutani-Dōjima		3,000	29.0	16.0	Wa-14	368	27.7	10.0	1,987	August 1880	Kita District, Osaka Prefecture
Hiroshima		3,000	15.0	12.0	15	201	24.9	5.8		July 1883	Aki District, Hiroshima Prefecture
Okayama		2,000	27.0	12.5	Wa-13	389	17.2	5.2	745	July 1881	Okayama District, Okayama Prefecture
Himeji										1880	
Nozawa-Shimotsuke										January 1885	Haga District, Tochigi Prefecture
Shinomura		2,000	19.0	24.0	Wa-12	662	31.8	6.7	2,880	October 1882	Kojima District, Okayama Prefecture
Nagasaki		2,000	25.0	10.5	Wa-14	398		9.0	120	December 1884	Urakami, Nagasaki Prefecture
Toyoi-Daiwa		2,000	28.0	12.0	Wa-13	403	35.0	7.4	2,525	December 1883	Yamabe District, Osaka Prefecture
Miyagi		2,000	26.0	10.5	12	369	23.7	8.8	2,324	April 1884	Miyagi District, Miyagi Prefecture
Ichikawa-Watanabe		2,000	23.0	22.0	14	654	39.3	8.9	371	March 1882	Ichikawadimon, Yamanashi Prefecture
Shimada		2,000	29.0	11.0	12	471	37.3	8.4	2,823	January 1884	Shida District, Shizuoka Prefecture
Enshū										November 1884	Toyoda District, Shizuoka Prefecture
Aichi		2,000	28.0	14.0	15	477	29.1	9.9	2,291	December 1881	Nagoya District, Aichi Prefecture
Kuwanohara		2,000	29.0	24.0	Wa-15	568	43.0	10.1	505	February 1882	Shimashimo District, Osaka Prefecture
Osaka		10,500	27.0	24.0	Wa-12	995	60.8	7.0	17,162	July 1883	Nishi District, Osaka Prefecture

Mill (company) name	December 1889									1889 figures/1884 figures (comparison by ratio)			
	Spindles		# of days in operation	# of hours in operation per day	Yarn count	20s cotton production per spindle per month (A)	20s cotton output per hour per female mill worker (B)	Wages for female mill workers (G)	Profit (yearly) (H)	20s cotton production per spindle per month (E/A)	20s cotton output per hour per female mill worker (F/B)	Wages for female mill workers (G/C)	Profit (yearly) (H/D)
	Ring	Mule											
Mie	4,422	11,800	24.0	24.0	15	1,459	65.2	8.3	11,343	1.7	1.2	1.0	2.3
Tamashima	7,020	4,000	27.5	24.0	13	2,091	79.8	6.5	18,508	2.2	2.1	0.9	2.9
Nagoya	1,000	8,000	23.0	24.0	16	1,187	73.2	7.2	4,930				
Shibutani-Dōjima	8,464	2,400	22.0	24.0	16	1,254	63.7	11.9		3.4	2.3	1.2	
Hiroshima	3,000	4,000	25.0	21.0	14	1,118	49.3	7.2	5,494	5.6	2.0	1.2	
Okayama	4,824		26.5	24.0	14	2,510	61.9	8.5	22,327	6.5	3.6	1.6	30.0
Himeji	2,752	2,000	24.0	24.0	14	1,153	38.9	9.0	3,477				
Nozawa-Shimotsuke		4,000	26.0	22.0	12	970	69.4	9.5	16,117				
Shinomura	1,608	2,000	22.0	24.0	15	1,590	76.9	8.3	7,844	2.4	2.4	1.2	2.7
Nagasaki	1,608	2,000	26.0	24.0	14	1,252	44.5	9.0	5,662	3.1		1.0	47.2
Toyoi-Daiwa		2,000	25.5	24.0	12	916	49.7	8.4		2.3	1.4	1.1	
Miyagi		2,000	28.0	11.0	13	390	26.6	6.6		1.1	1.1	0.8	
Ichikawa-Watanabe		2,000	27.0	24.0	13	1,021	57.2	7.6		1.6	1.5	0.9	
Shimada		2,000	27.0	24.0	13	935	52.4	8.8		2.0	1.4	1.0	
Enshū		2,000	25.0	24.0	14	795	39.8	7.5					
Aichi		2,000	24.0	24.0	16	701	36.9	9.1		1.5	1.3	0.9	
Kuwanohara		2,000	27.0	24.0	Wa-15	724	43.5	9.3		1.3	1.0	0.9	
Osaka	19,760	27,300	22.0	24.0	16	1,260	83.8	11.2	16,315	1.3	1.4	1.6	1.0

Sources: Takamura Naosuke, *Saihakken: Meiji no keizai* [Rediscovering the Meiji economy], Hanawa Shobo, 1995; Takamura Naosuke, *Nihon bōseki-gyō-shi josetsu, jō* [Introducing the history of Japanese spinning, part 1], Hanawa Shobo, 1971; and Kingawa Taichi, Honpō menshi bōseki-shi [A history of cotton spinning in Japan], vols. 2-3, Nihon Mengyō Club, 1938.

(The table was created by Yuki Takenobu.)

and almost 15% of the company's profits. The division had become one of the company's core business drivers.

3. An overview of the sources

3.1. The sources: Background and current condition⁶

The sources at the core of this paper were obtained by the Shibusawa Memorial Museum in 2013. The Shibusawa Memorial Museum decided to acquire the materials in light of three key factors: they included drawings for Osaka Bōseki and Mie Bōseki (Mie Spinning Company), both of which Shibusawa Eiichi, the museum's namesake, had helped found; they represented important primary sources for understanding modern industrial history and business history; and museum organizers were planning an exhibition on Shibusawa Eiichi and Toyobo for their 2015 lineup. After obtaining the materials, the museum created a provisional catalog of the sources with the help of Takashi Kakiuchi, a specialist in cotton spinning and wool spinning at Kureha Bōseki and Toyo Bōseki (both now Toyobo Co., Ltd.). The process of cataloging the pieces eventually identified 90 drawings, documents, and other materials in three envelopes pertaining to spinning and weaving mills. Considering that some of the pieces had deteriorated to a significant degree, the team decided to photograph the items for use in analysis and research.

A portion of the drawings appeared with related items in "The Advancement of Modern Spinning: Shibusawa Eiichi and Toyobo," a special exhibition at the Shibusawa Memorial Museum (March 14–May 31, 2015), and also featured in the exhibition's official catalog.

3.2. Drawings for Japanese spinning mills from the nineteenth century

To this point, drawings for spinning mills from the dawning of Japan's industrial age have been in scant supply. That handful of drawings has drawn some interest, of course. Publications that have used the documents, whether in their actual form (primary) or academic studies of the drawings (secondary), are as follows.

One of the available sets of materials comprises construction blueprints for the Kagoshima Spinning Mill.⁷ Using the Kagoshima Spinning Mill drawings, Kanji Tamagawa examined the distinguishing features of the contemporary spinning machinery.⁸ Susumu Mizuta, meanwhile, analyzed the same sources in an effort to classify spinning mills into patterns according to building type.⁹ There are also extant primary sources for 2,000-spindle mills: among them are the drawings for the Shimada Spinning Mill,¹⁰ Shimotsuke Spinning Mill,¹¹ and Kan'ei Aichi Bōsekisho, the latter of which appeared in a report by Takehiro Amano, et. al.¹² Tamagawa also

⁶ Section 3 (1) was written by Miho Nagai, a curator at the Shibusawa Memorial Museum.

⁷ "Kagoshima Bōsekisho kankei shiryō" [Historical records pertaining to the Kagoshima Spinning Mill], Shoko Shuseikan Museum Collection.

⁸ Kanji Tamagawa, "Kagoshima Bōsekisho sōsetsu tōsho no kikai setsubi ni tsuite" [The Kagoshima Spinning Mill's original machinery and equipment], *Sangyō kōkōgaku* 41, 1986.

⁹ Susumu Mizuta, *Bakumatsu-Meiji shoki no yōshiki sangyō shisetsu to Gurabā Shōkai* [Western-style industrial facilities in the bakumatsu-early Meiji period and Glover & Co.], Kyushu University Press, 2017. The work first appeared in "Setsuritsu kei oyobi kenchiku ruikei ni miru Satsuma-han'ei Kagoshima Bōsekisho: Igrisu shihon kara mita Shūseikan-jigyō no kenkyū (2)" [What the Kagoshima Spinning Mill's founding and architectural patterns tell us: A study of the Shūseikan-jigyō project from the perspective of British capital (2)], in *The Architectural Institute of Japan's Journal of Architecture and Planning* 593, 2005.

¹⁰ "Shimada Bōsekisho kankei shiryō" [Historical records pertaining to the Shimada Spinning Mill], Suzuki family collection.

¹¹ "Nozawa-ke monjo" [Nozawa family documents], Tochigi Prefecture Office of Public Records.

¹² Takehiro Amano, et al., *Kan-ei Aichi Bōsekisho no kinkyū chōsa hōkoku* [A report on the

incorporated the drawings to locate similarities linking machinery-layout diagrams for different mills, finding that the drawings for the Shimotsuke Spinning Mill likely used the overall structure of a 2,000-spindle mill as a composite template for its design.¹³ A diagram stipulating the machinery layout at Kumamoto Bōseki made an appearance in the catalog for Dobson & Barlow, a spinning machinery manufacturer.¹⁴ Scholar Keishi Isoda compared the drawing in the catalog with the actual structure, which was still standing at the time of the study, to explore the dynamics of how technology made its way from a foreign source and into Japan.¹⁵ The National Archives of Japan also house layout plans and other documents on two other spinning facilities—the Shinmachi Spinning Mill and Aichi Spinning Mill—for which Yukio Okamoto and Kenji Imazu created facsimile reproductions.¹⁶

Considering the relatively sparse sources that have conventionally been available to researchers, the spinning-related drawings now in the Shibusawa Memorial Museum collection—90 pieces in total—provide a new wealth of information to explore; the drawings offer revealing looks at a host of mills, including facilities belonging to Osaka Bōseki and many of the 2,000-spindle spinning mills that were so vital to the Japanese spinning industry in its formative stages. The majority of the drawings were drafted during the construction of their respective mills, while several of the pieces are original drawings from the United Kingdom that illuminate the various relationships between the mills in Japan and companies and engineers abroad. The drawings previously available to past researchers are, for the most part, Japanese drafters’ reproductions of original drawings. The new sets of sources in the Shibusawa Memorial Museum collection include numerous originals, thus presenting scholars with a unique bevy of new insights: not only do they highlight how companies incorporated power machinery and spinning machinery into the mill-construction process, but they also foster clarity on the question of how people planned the construction of mills in the first place—a valuable understanding that helps elucidate the process of technology transfer in the spinning industry. On top of that, the original drawings paint clearer, more compelling pictures of the mechanical and architectural technologies from the United Kingdom than purely textual information ever could.

4. The drawings

The sets of sources comprise a total of 90 items, some of which depict mills that are difficult to identify. Generally, however, the drawings fall into eighteen basic categories: drawings pertaining to (1) spinning mills with throstle spinning frames and spinning mules, similar to the Kagoshima Spinning Mill; (2) 2,000-spindle spinning mills; (3) Osaka Bōseki; (4) Takada Shōkai (Takata & Co.); (5) Mie Bōseki; (6) Settsu Bōseki; (7) Asahi Bōseki; (8) Kishiwada Bōseki; (9) Hosoto Bōseki; (10) Shanghai Bōseki; (11) Ajino Bōseki; (12) Matsuyama Bōseki; (13) Kyoto Orimono; (14) Asa Lees & Co.; (15) Brooks & Doxey; (16) Calico weaving sheds; (17) Woolen spinning and weaving mills; and (18) Dai-ichi Kenshi Bōseki.

This paper delves into categories (2) and (3), examining the drawings to cull information on the architectural and mechanical features on a facility-by-facility basis.

government-operated Aichi Spinning Mill emergency survey], Aichi Association of Research and Preservation of Industrial Heritage, 1980, 40.

¹³ Kanji Tamagawa, “Shimotsuke Bōsekisho no kikai setsubi ni tsuite” [The machinery and equipment of the Shimotsuke Spinning Mill], in *Shimotsuke Bōsekisho chōsa hōkokusho* [A research report on the Shimotsuke Spinning Mill], Mōka Board of Education, 1994.

¹⁴ Machinery Calculations, second edition, Dobson & Barlow, 1897.

¹⁵ Keishi Isoda, “Kumamoto Bōseki Kōjō tatemono no heimen no keikaku ni tsuite” [Ground-floor plans for the Kumamoto Spinning Mill building], in *Nihon Kenchiku Gakkai keikaku-kei ronbun-shū* [Planning-related papers of the Architectural Institute of Japan] 615, 2007.

¹⁶ Yukio Okamoto and Kenji Imazu, *Meiji zenki kan’ei kōjō enkaku* [A history of government factories in the early Meiji period], Toyo Bunkasha, 1983.

Table 2. Drawings and tables pertaining to 2,000-spindle mills
(The Shibusawa Memorial Museum collection)

Source #	Title	Drafter	Date	Size	Notes	Mill
1-01	Tamozt Minami Esq / Imperial Japanese Consulate / London	Wm Higgins & Sons	May 28, 1880	570×820	"Copy" inscribed on the bottom-left corner	2,000-spindle mill
1-02	Messrs Mitsui & Co / Shimomura Spinning Mill / Japan.	Hick, Hargreaves & Co.	June 27, 1987 (stamped with the Mitsui & Co. seal on July 8, 1887)	500×595	"Transmitted by Hick Co. (UK)/Drawings for Shimomura Spinning Mill Plant 2" inscribed on the back	Shimomura Spinning Mill (Mill No. 2)
1-03	Shimomura Bōsekisho enjin ryakuzu (Shimomura Spinning Mill Engine Diagram)			490×610		Shimomura Spinning Mill (Mill No. 2)
1-04	TAMASHIMA COTTON MILL. / Tamashima Spinning Mill			540×660	Blueprint	Tamashima Spinning Mill
1-05	Meiji 22 nen kandanhyo (1889 Weather Table)	[Tamashima Spinning Mill]	[ca. 1890]	410×570	Blueprint	Tamashima Spinning Mill

Titles are as given on the documents themselves. Brackets ([]) mark information missing from the documents themselves and deduced based on the information in the drawings. Forward slashes (/) denote line breaks. A square (□) denotes a word or words on a missing part of the document. The authors determined which mill each drawing depicts. Source numbers were assigned by the authors for the purposes of the paper and are not the official source numbers used by the Shibusawa Memorial Museum. Document sizes are from the Shibusawa Memorial Museum catalog.
(The table was created by Hrai Naoki.)

Table 3. Drawings pertaining to Osaka Bōseki
(The Shibusawa Memorial Museum collection)

Source #	Title	Drafter	Date	Size	Notes	Mill
2-01	Meiji 23 nen 6 gatsu (June 1890) / Nishinari-gun Sangen'ya (Sangen'ya, Nishinari District) / Osaka Bōseki Kaisha	[Osaka Bōseki]	June 1890	295×650		Entire site
2-02	GENERAL PLAN of ARRANGEMENT / of GEARING / For. MESSRS MITSUI'S MILL / OSAKA JAPAN	Archibald King	November 19, 1881	328×765		Mill No. 1
2-03	PLAN OF SPINNING MILL / TO BE ERECTED AT / OSAKA JAPAN	Archibald King	December 6, 1881	630×430		Mill No. 1
2-04	Plan of Boiler Seatings, and / Arrangement of Engines, &c. / Cylinders, 15ins & 27ins diameter. / Stroke of Pistons 2 feet. / Messrs Mitsui & Co. Japan.		[1882, etc.]	720×1115		Mill No. 1
2-05	Plan and Elevation showing Main Gearing Wall / with Pulley Shafting of Main Rope Driving / for Messrs Mitsui & Co. Osaka Japan	Hick Hargreaves		535×710		Mill No. 1
2-06	MESSRS MITSUI & Co. / LONDON. / OSAKA COTTON MILL. JAPAN. / EXTENSION PLAN No.3			630×940		Mills No. 1 & 2
2-07	□ of Engine Boilers Shafting Machinery & c / for / Messrs Mitsui & Co / Osaka Cotton Mill / Japan	Hick Hargreaves	September 25, 1884	685×820		Mills No. 1 & 2
2-08	Osaka Bōseki Kaisha/ Dai 2 gō kōjō 2 kai heimenzu (Second floor plan for Mill No. 2)			398×198		Mill No. 2
2-09	General arrangement of Boilers & Pipe sc. / Messrs Mitsui & Co. Osaka Mill No.3		August 20, 1887	743×860		Mill No. 3
2-10	Plan & Elevation showing Arrangement of High Pressure / Heating Pipes in Boiler House. for / Messrs Mitsui & Co Osaka Japan			568×760		Mill No. 3
2-11	MESSRS MITSUI & Co. OSAKA MILL.No.3	Hick Hargreaves	July 21, 1887	710×1055	Marked "Fuyō butsu (Discard)" on back	Mill No. 3
2-12	Plan and Elevation of Osaka Mill No.3. Showing Ironwork for Fireproofing. / Messrs Mitsui & Co.		July 21, 1887	753×1053	Marked "Fuyō (Discard)" on back	Mill No. 3
2-13	Refer to Mr. Yamanobe's letter / dates Osaka December 21st 1887.		(Stamped with the Mitsui & Co. seal on January 27, 1888)	250×365		Mill No. 3
2-14	Refer to Mr. Yamanobe's letter / dates Osaka December 21st 1887.		(Stamped with the Mitsui & Co. seal on January 27, 1888)	250×390		Mill No. 3
2-15	[Osaka Bōseki, Ground floor plan for Mill No. 3]			390×430	Blueprint	Mill No. 3
2-16	OSAKA MILL			560×410	Blueprint	Mill No. 3
2-17	[Osaka Bōseki, Section of Mill No. 3]			415×430	Blueprint	Mill No. 3
2-18	OSAKA MILL No.3			460×820	Blueprint	Mill No. 3
2-19	SIDE ELEVATIONS OF NEW COTTON MILL / MESSRS MITSUI & COM. OSAKA MILL No.3			490×953	Blueprint	Mill No. 3

Titles are as given on the documents themselves. Brackets ([]) mark information missing from the documents themselves and deduced based on the information in the drawings. Forward slashes (/) denote line breaks. A square (□) denotes a word or words on a missing part of the document. The authors determined which plant each drawing depicts. Source numbers were assigned by the authors for the purposes of the paper and are not the official source numbers used by the Shibusawa Memorial Museum. Document sizes are from the Shibusawa Memorial Museum catalog.
(The table was created by Hrai Naoki.)

4.1. Drawings and tables for 2,000-spindle mills

4.1.1. 2,000-spindle mills

Drawing [1-01] appears to be the machinery layout for a prototype 2,000-spindle mill. An inscription in the bottom-left corner reads “Tamozt Minami Esq / Imperial Japanese Consulate / London,” suggesting that the intended recipient of the drawing was Japan’s consul in London, Minami Tamotsu (“Tamozt” was likely a British rendering of Minami’s given name).¹⁷ In the bottom-right corner, meanwhile, is an inscription reading “Wm Higgins & Sons / King St Iron Works / Salford, M’chester, / May 28th 1880.” From this piece of text, one can deduce that the drawing was the work of a Salford-based firm by the name of William Higgins & Sons. However, the document in the collection may not be the actual original; in the bottom-left corner of the page, one can see the word “Copy.”

Minami, who took his post as Japan’s consul in London in 1876, was in charge of purchasing supplies from the UK on behalf of the Japanese government. The government ordered ten sets of 2,000-spindles (*jukkibō*) from the UK. Records suggest two arrived in Japan in October 1880.¹⁸ Based on the date of drawing [1-01], Minami would have received the document well prior to that initial delivery. The timing thus suggests that the drawing was a prototype—not an actual plan for a specific facility—as the 2,000-spindle mill project was still in development; this explains why the document lists neither a mill name nor an intended building location.

The drawings feature two separate buildings: one for the scutching room and one for the card and spinning room. Although most plans would have called for a power system between the two rooms to transmit power to both sides via a shaft, there is no evidence of an intermediary power system in drawing [1-01]. The drafters most likely omitted the power component from the drawing to leave room for either a water (hydraulic) power source or a steam power source, which

¹⁷ According to Hitoshi Tomita, *Umi o koeta Nihonjinmei jiten* [A who’s-who of Japan around the world] (Nichigai Associates, 1985), various public records from 1881 (“Ryōji Minami Tamotsu Eikoku zaikin himen no ken” [Record of Consul Minami Tamotsu’s service in the United Kingdom], “Ryōji Minami Tamotsu Shōshokikan tennin no ken” [Reassignment of Consul Minami Tamotsu to serve as junior clerk], and “Gaimu Shōshokikan Minami Tamotsu tennin no ken” [Reassignment of Foreign Ministry Junior Secretary Minami Tamotsu], *Kōbunroku: Meiji jūyōnen* [Public records: 1881]), and “Gondaishokikan Minami Tamotsu hoka nimei hishoku himei no ken” [The relief of duties of First Secretary Minami Tamotsu and two others] (*Kōbunroku: Meiji jūnananen* [Public records: 1884]), the basic details on the life of Minami Tamotsu (1846–86) are as follows. Minami was born to a retainer of the Aizu Domain in 1846. As an employee of the Ministry of Finance, he accompanied Yoshida Kiyonari to the United States in 1872 to pursue his studies. In 1874, Minami assumed a position on the Taxation Board. Two years later, he received an order to serve as Japan’s consul in London. He returned to Japan from that post in 1881, became a junior secretary at the Ministry of Foreign Affairs that same year, and was then reassigned to the Ministry of Agriculture and Commerce, where he served as first secretary and a member of the High Council of Agriculture, Commerce, and Engineering (as the director of commercial affairs). In 1884, he was relieved of his official duties. Records indicate that Minami met with Yamanobe Takeo, who was staying in the United Kingdom, on April 28, 1879. According to “Minami Tamotsu Rondon zairyū ininjō” [Minami Tamotsu proxy (London)] and “Rondon ni ryōji o hichi ni tsuki kakuchō kōkyūhin gai ryōji ni toriatsukahashimu” [A consulate shall be established in London and entrusted with purchasing items for government agencies], *Dajō ruiten, dai ni-hen, Meiji yōnen – Meiji jūnen* [Meiji government cabinet records, vol. 2, 1871–77], the government apparently notified Minami that he, as consul, would be responsible for purchasing items from the United Kingdom on its behalf.

¹⁸ Kinugawa Taichi, *Honpō menshi bōseki-shi* [A history of cotton spinning in Japan], vol. 2, Nihon Mengyō Kurabu, 1937.

required different power-system structures.

The diagram for the scutching room features one scutcher along with space for one cotton opener. For the card and spinning room, meanwhile, the drawing calls for five carding machines, one drawing frame, one slubbing frame, two roving frames, four spinning mules (with 500 spindles each), and one card grinding machine. The card and spinning room has beams spaced at 20 in. (2 spans) for 40 in. (3 spans) in the beam direction and 74 ft. 6 in. (7 spans) in the ridge direction, while the walls are 18 in. thick all around.

The overall configuration of the mill and machinery in the drawing bears a striking resemblance to the three drawings among which Tamagawa also found similarities (the machinery-layout diagrams for the Shimotsuke, Shimada, and Aichi Spinning Mills),¹⁹ which implies that drawing [1-01] or its original was the model for the other three. Determining whether there were any differences between the design plans and the actual mills with 2,000 spindles across the country, however, requires further inquiry.

4.1.2. Shimomura Spinning Mill

Another facility that features in the set of sources is the Shimomura Spinning Mill ([1-02] and [1-03]). The heading of drawing [1-02] is “Messrs Mitsui & Co / Shimomura Spinning Mill / Japan,” while the back of the drawing bears a handwritten note: “Transmitted by Hick Co. (UK)/Drawings for Shimomura Spinning Mill No. 2.” It also appears that Hick Co. and the Mitsui & Co. London branch placed their seals on drawings [1-02] and [1-03], which are dated June 27, 1887, and July 8, 1887, respectively.

Equipped with a 2,000-spindle mill from a government sell-off in 1880, the Shimomura Spinning Mill launched in October 1882. About four years later, the mill began adding ring spinning frames—and by around 1889, the facility eventually boasted a total of 3,068 spindles between its original spinning mules and the new ring spinning frames.²⁰

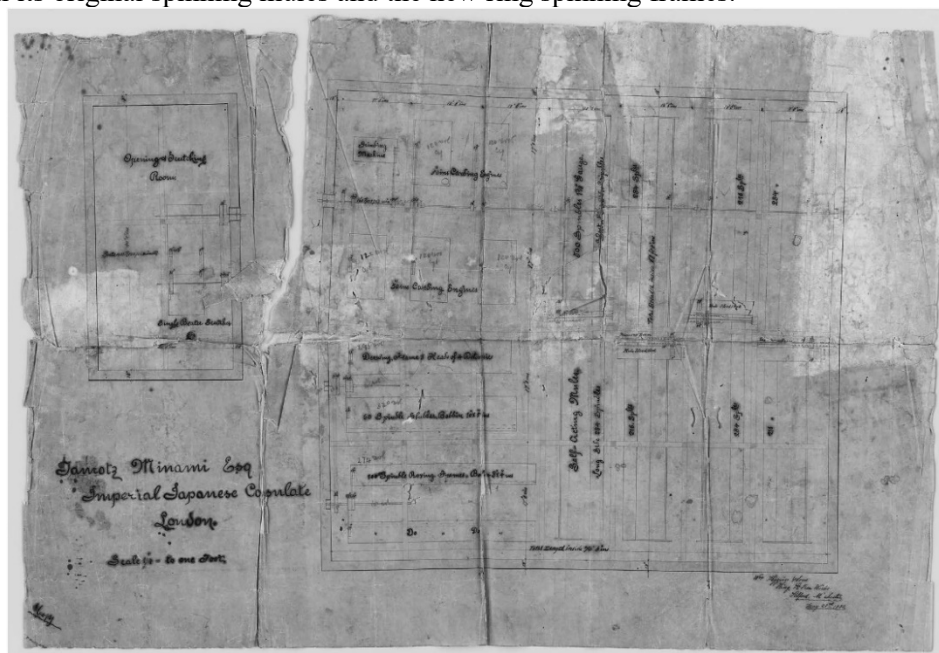


Figure 1. Machinery layout drawing for a prototype 2,000-spindle mill [1-01]
(Shibusawa Memorial Museum collection)

¹⁹ Tamagawa, “Shimotsuke Bōsekisho no kikai setsubi ni tsuite” [The machinery and equipment of the Shimotsuke Spinning Mill].

²⁰ Kinugawa Taichi, *Honpō menshi bōseki-shi* [A history of cotton spinning in Japan], vol. 3, Nihon Mengyō Kurabu, 1938.

Given the timing and nature of the documents, it would appear that drawing [1-02] was drafted for the purposes of expanding the mill to accommodate new ring spinning frames. The drawing stipulates an enlargement of the existing boiler and engine houses, which were to house a new boiler and steam engine, as well as plans for a new mill next door. The machinery requirements for the new mill comprise seven carding machines, one drawing frame, one slubbing frame, one intermediate frame, two roving frames, and six ring spinning frames (with 268 spindles each). According to the drawing, the ring spinning frames in the new mill were to have a total of 1,608 spindles.

Drawing [1-03], which bears the title “Shimomura Spinning Mill Engine Diagram,” illustrates the relationships among the existing boiler, the new boiler, and the new steam engine. It would be safe to conjecture that drawing [1-03] was drafted in Japan around the same time as drawing [1-02].

4.1.3. Tamashima Spinning Mill

The sources also include two blueprints ([1-04] and [1-05]) for the Tamashima Spinning Mill. Drawing [1-04] lays out a plan for the mill under the title “TAMASHIMA COTTON MILL. / Tamashima Bōsekisho.” The Tamashima Spinning Mill got its start with the purchase of four spinning mules (with 500 spindles each) from the government in 1881 and upscaled its operations in October 1884 upon receiving another four spinning mules (with 500 spindles each) from Saga Bussan. Further expansions included the construction of a second mill, according to researchers.²¹ Although hard evidence for placing the drawing in a broader context is scant, one could speculate that the document came about during one of the mill’s expansion efforts.

The drawing positions the boiler/engine house (housing two boilers and one steam engine) and scutching room (with one cotton opener and four scutchers) on the left, a rope race in the middle, and the card and spinning room on the right. In the lower half of the rendering for the room are 22 carding machines, three drawing frames, three slubbing frames, two intermediate frames, and 16 roving frames. The upper half of the room, although absent of any stipulations for machinery placement in the actual drawing, would almost assuredly have been for ring spinning machinery.

Item [1-05], titled “1889 Weather Table,” is a record of weather conditions at the Tamashima Spinning Mill from January to December 1889. In addition to listing daily temperatures in Fahrenheit, the table also uses a series of symbols to denote the corresponding weather conditions (clear, rainy, cloudy, clear during the day/rainy at night, clear in the morning/cloudy during the day/rainy at night, and snowy). The information for the second half of the year (from July to December) includes atmospheric pressure readings and details on wind direction as well. From the level of detail, it would appear that changes in the weather were significant factors affecting the stability of production at spinning mills.

4.2. Osaka Bōseki²²

In the collection, one can find at least 19 drawings pertaining to the overall layout and three individual mills of Osaka Bōseki (later the Sengen’ya Mills). The drawings date back to the 1880s and early 1890s, making them a rare glimpse of what the mills were like before a fire impacted Osaka Bōseki’s operations in December 1892. The documents are not all from a single set, of course; they represent a smattering of drawings by different drafters, from different years, featuring different facilities, and serving different purposes. As all the documents appear to be

²¹ Kinugawa, *Honpō menshi bōseki-shi* [A history of cotton spinning in Japan], vol. 2.

²² This section includes portions of Naoki Hirai, “Osaka Bōseki (Sangen’ya Kōjō) Dai-ichi Kōjō no kenchiku” [The architecture of Mill No. 1 at Osaka Bōseki (Sangen’ya)] (in *Nihon Kenchiku Gakkai Taikai gakujutsu kōen kōgai-shū F-2* [Summaries of technical papers of Annual Meeting Architectural Institute of Japan], 2016).

pre-construction plans, too, there is no guarantee that the resulting structures reflected the drawings' stipulations exactly.

4.2.1. Layout of the mills

Drawing [2-01] shows the layout of the mills and ancillary facilities at the Osaka Bōseki site as of June 1890. Next to each facility on the diagram are its name (and, for the main mills, the corresponding numbers of floors), date of completion, and date of reconstruction, thereby providing a clear picture of Osaka Bōseki's history to that point.

The document depicts the mill premises between the Sangen'ya River to the north and the Ijigawa River to the south, with the Osaka Prefectural Wharf along the south side, the Bōseki Bridge to the northeast, and the Kudara Bridge forming the eastern edge. Mill No. 1 (shed, completed May 1883) stands just east of the center of the site. Adjacent to Mill No. 1 on the south is Mill No. 2 (a three-story structure, May 1886), while Mill No. 3 (a four-story structure, December 1889) occupies a spot on the eastern edge of the premises. Starting with a single, one-story mill (shed) in the middle of the site, Osaka Bōseki thus evidently branched out within a relatively limited space by building medium-rise mills as it ramped up production. The positioning of the mills also reflects an attention to lighting. Constructed with a saw-tooth roof, Mill No. 1 needed access to stable streams of light from the north—which is why the drawing calls for the structure to align with the north-south axis. The same goes for Mill No. 2, an addition to Mill No. 1. The four-story Mill No. 3, on the other hand, does not have a north-south orientation; the designers likely envisioned the building letting light in through windows along the side walls.

In addition to the three mills, drawing [2-01] situates a reeled-yarn warehouse, raw cotton warehouse, and coal warehouse on the south side of the premises and a ginning area (completed 1889), ancillary warehouse, and another coal warehouse on the southwestern edge of the site. In building up its production capacity via new mills, therefore, Osaka Bōseki added the requisite ancillary facilities accordingly. The presence of a ginning area and accompanying facilities in the drawings also suggests that Osaka Bōseki planned to gin imported Chinese seed cotton in-house.

4.2.2. Mill No. 1

The collection also includes two drawings that appear to be draft plans for Mill No. 1, although the name “Osaka Bōseki” is absent from the actual documents ([2-02] and [2-03]).

Both drawings feature the signature of an “Archibald King” and the word “Yokohama.” The signature likely belonged to an *oyatoi gaikokujin* (a foreign government advisor hired by the

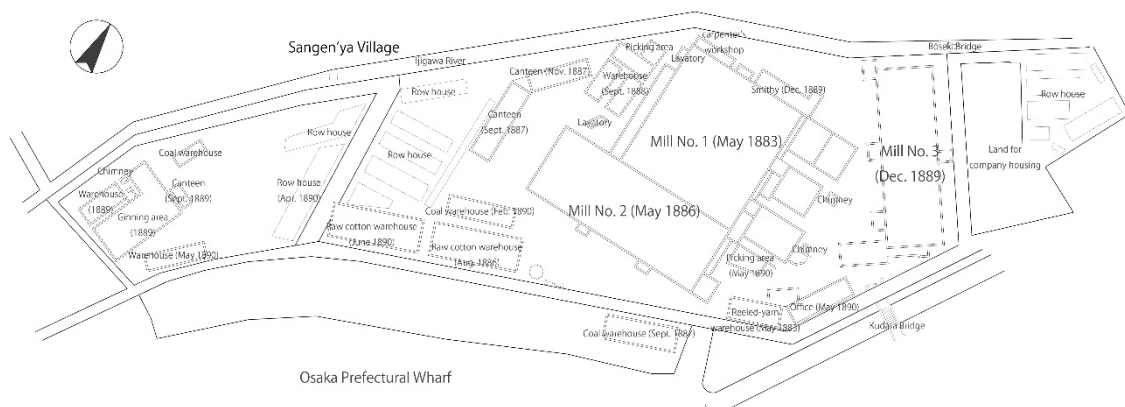


Figure 2. Site plan, Osaka Bōseki (as of June 1890)
(Created based on drawings in the Shibusawa Memorial Museum collection)

Meiji government) named Archibald King,²³ who originally made his way to Japan in 1873 to serve at the Imperial College of Engineering along with fellow foreign hire Henry Dyer. During the planning stages for Mill No. 1 at Osaka Bōseki, King was head engineer for engine construction at Hirano Tomiji's Ishikawaguchi Ironworks (in) Yokohama. Yamanobe Takeo, who led the mill-construction project at Osaka Bōseki, also noted in a diary entry on November 5, 1881,²⁴ that he had paid a visit to “Mr. King, Ishikawaguchi, Yokohama,” further corroborating the assumption that the man behind the signature and the former *oyatoi gaikokujin* were one and the same. Considering that the name “King” makes several other appearances in the subsequent pages of his diary, it would be reasonable to conclude that King assisted with the construction at Yamanobe's request.

Drawing [2-03], a “PLAN OF SPINNING MILL / TO BE ERECTED AT / OSAKA JAPAN,” has a date inscription reading “December 6, 1881.” The plan calls for a structure measuring 215 ft. 0 in. (11 spans) in the beam direction and 291 ft. 0 in. (24 spans) in the ridge direction, with a brick wall around the power system to form a rectangular footprint. The partitioning of the brick wall into five parts matches the stipulations in Platt Co.'s machinery-layout diagram.²⁵ Apart from the brick wall, the overall composition of the power system appears to follow the implementation schemes that appear in the drawings for the mill's expansion initiative ([2-06] and [2-07]), although the reeling room may have measured one span instead of two.

The bottom of the drawing (corresponding to the east side of the premises) is where the power system and related facilities reside, with a ginning/cotton-mixing room and scutching room bordering the power area to the right. A rope race separates the facilities at the bottom from the upper portion of the drawing, where the card room, spinning room, reeling room, and warehouses sit side by side, right to left, in order of their places in the overall production sequence. In the scutching room are one cotton opener and four scutchers, while the card room houses 32 carding machines, four drawing frames, four slubbing frames, six intermediate frames, and 12 roving frames. The drawing calls for 16 spinning mules (700 spindles each) in the spinning room, a count that matches the numbers from the planning stage. (Ultimately, Osaka Bōseki decided to build the structure according to plan but with 15 mules instead of the initial 16.) In the reeling room, there are 52 reeling machines (40 hank reels) for creating finished products.

Drawing [2-02], titled “GENERAL PLAN of ARRANGEMENT / of GEARING / For. MESSrs MITSUIS MILL / OSAKA JAPAN,” is a detailed floor plan addressed to Mitsui & Co. The document prescribes a boiler house for one boiler, a house with a steam engine for converting steam into power, and a rope race with ropes for transmitting the power to the various machinery.

²³ See “THE LATE MR. ARCHIBALD KING.”, *Industries: A Journal of Engineering, Electricity, and Chemistry for the Mechanical and Manufacturing Trades*, vol. 1, 1886, 401, and Arai Gensui, *Tōkyō Ishikawajima Zōsenjo gojūnen-shi* [A fifty-year history of the Tokyo Ishikawajima Shipyard], Arai Gensui, 1930. Born in Glasgow (UK), Archibald King apprenticed at Mc Andrew & Co., Glasgow before venturing to Japan in 1873 with Henry Dyer. King oversaw practical training at the Imperial College of Engineering until the institution dismissed him in 1875 on grounds of a criminal transgression. Yamao Yōzō later introduced King to Hirano Tomiji, who enlisted King to head up engine construction at the Ishikawaguchi Ironworks in Yokohama (a branch plant of the Ishikawajima Hirano Shipyard that was relocated to Ishikawajima and integrated into the Shipyard's operations in 1884). There, King was in charge of marine-engine production and the manufacturing of other machinery. He died of cholera in Tsukiji, Tokyo, on August 28, 1886, at the young age of 38.

²⁴ Yamanobe Takeo, *Nisshi* [Diary] (June 17, 1881–December 29, 1882), Toyobo Co., Ltd. collection.

²⁵ “SPECIFICATIONS,” Platt-Saco-Lowell documents, Lancashire Archives collection [UK], DDPSL1/80/21/33.

Also evident in the drawing are an ancillary equipment–maintenance area, carpenter’s workshop, coal warehouse, and chimney. The bottom-right corner lists a date of November 19, 1881, suggesting that Mitsui & Co. was working on both importing the machinery and constructing the mill in the early stages of the planning process.

Two other drawings ([2-04] and [2-05]) bring the machinery layout for Mill No. 1’s power system into even more revealing detail. Drawing [2-05] is a rendering that focuses specifically on

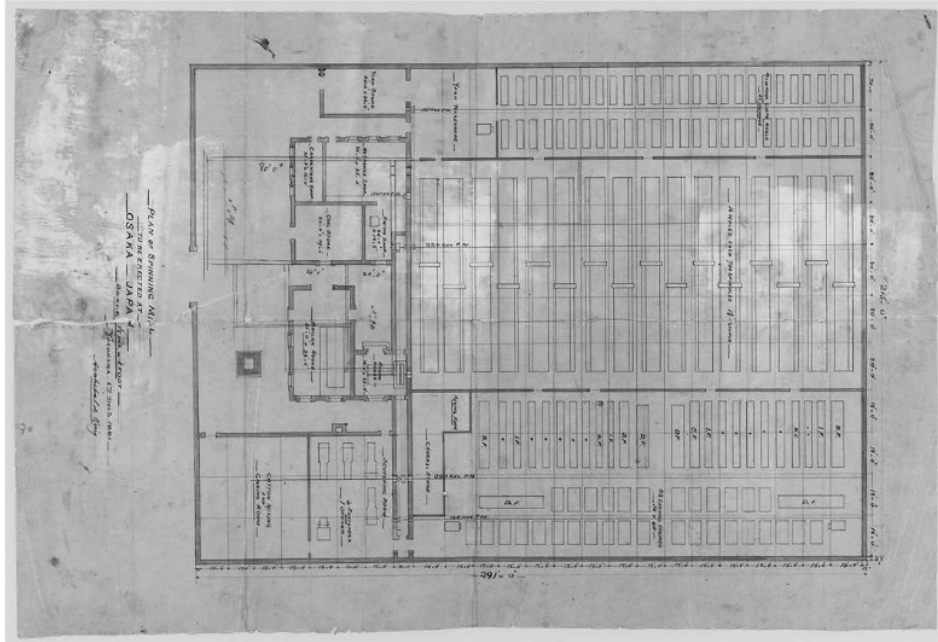


Figure 3. Machinery layout plan, Mill No. 1 at Osaka Bōseki [2-03]
(Shibusawa Memorial Museum collection)

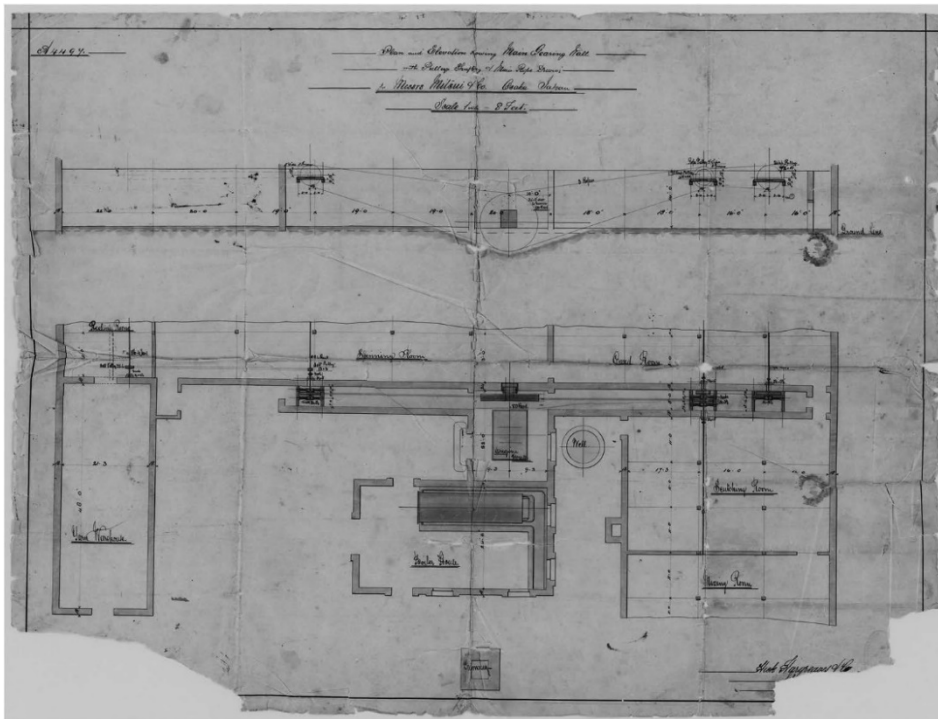


Figure 4. Machinery layout drawing, Mill No. 1 at Osaka Bōseki [2-05]
(Shibusawa Memorial Museum collection)

the boiler house, engine house, and rope race constituting the mill's power system. Although a portion of the document is missing, a visible inscription of "Hick, Hargreaves & Co." at the surviving bottom-right corner of the drawing indicates that Hick Co.—the manufacturer of the mill's boiler and engine equipment—was behind the drafting. While drawing [2-05] covers the same scope as drawing [2-02], the similarities are not total; the warehouse, for example, is in different locations in the two documents. Drawing [2-05] also exhibits a relatively distinctive design. Whereas other mills often elevated the engine-house floor to push the rope race's eave height up, the drawing for Mill No. 1 situates the steam engine close to ground level and brings the middle of the rope race down to connect the engine to the pulley system.

Like drawings [2-02] and [2-05], drawing [2-04] focuses on the power system and renders the boiler and steam engine in exhaustive detail. The drawing contains meticulous specifications about a variety of elements, including the dimensions of the pipes connecting the boiler and engine, the dimensions of different instruments, the prescribed distances between the equipment and the brick walls, and wall thickness. Obviously, machinery placement and installation played a pivotal role in designing and building mills.

The overall plan for Mill No. 1 called for a brick shed structure with a nearly square footprint—a stark contrast with the architectural designs of Mills No. 2 and 3, which embody what many consider the "trademark" Osaka Bōseki design. The design of Mill No. 1 captures the architectural features of the spinning mills that popped up in the wake of the 1891 Mino-Owari earthquake and Sino-Japanese War (1894–95), setting the standard for future spinning mills to come. Although research has shown that Mill No. 1 launched operations with spinning mules and a total spindle count of 10,500, the drawings in the Shibusawa Memorial Museum collection reflect what the original plans for the mill building envisioned: accommodations for not 15 but rather 16 spinning mules with 700 spindles each.

4.2.3. Mill No. 2 (an addition to Mill No. 1)

In terms of documents relating to the construction of Mill No. 2, an addition to Mill No. 1, there are two drawings that appear to have been by drafters in the UK ([2-06] and [2-07]) and one with indications of Japanese origin ([2-08]). Together, the three drawings provide a clear picture of not only the builders' intentions for Mill No. 2 but also the actual state of Mill No. 1 at the time of the addition.

On drawing [2-07], one finds handwritten text—"□ of Engine Boilers Shafting Machinery & c / for / Messrs Mitsui & Co / Osaka Cotton Mill / Japan" and the date September 25, 1884—along with the official seal of Hick Co. (the Soho Iron Works).²⁶

The drawing casts the walls and machinery of existing the Mill No. 1 in a different color from those of the new mill (Mill No. 2), which indicates that Hick Co. drafted the drawing in the run-up to the addition. According to the plan, Mill No. 2 was to be a new, two-story structure—replete with a new power system—standing on the south side of the single-story Mill No. 1 building. The plan drawing also calls for the construction of a new single-story reeling room as part of an overhaul of the manufacturing process.

In its rendering of Mill No. 1, the drawing includes one cotton opener, four scutchers, 30 carding machines, two drawing frames, and 15 spinning mules. That was the existing equipment, apparently, as the drawing indicates that the next phase was to augment the setup with one more spinning mule (which was part of the original plan when Mill No. 1 was under construction but ultimately scrapped), move the reeling machines to a separate building, and install 15 ring spinning frames (256 spindles each) in their place. The plan for the addition (Mill No. 2), meanwhile, stipulates an extensive list of installations: three new boilers and one steam engine; one cotton opener, eight scutchers, 68 carding machines, 58 slubbing, intermediate, and roving

²⁶ The "□" at the beginning of the title denotes an illegible word or words, the number of which is unknown.

frames on the first floor; 23 spinning mules (700 spindles each) on the second floor; and 136 reeling machines (40 hank reels) in the separate building.

Drawing [2-06], bearing the title “MESSRS MITSUI & Co. / LONDON. / OSAKA COTTON MILL. JAPAN. / EXTENSION PLAN No.3,” lacks any formal indication of the drafter’s identity. Based on the content of the document, however, it was likely drafted by the manufacturer of the mill’s power machinery and sent to the Mitsui & Co. London branch, which was serving as the go-between on the mill-expansion project. The drafter color-coded the drawing, using green for the boiler and red for the pulleys and ropes; the power-machinery manufacturer probably intended the document to help clarify the placement of the machinery and the corresponding power configuration.

Drawings [2-06] and [2-07] are similar plans, but they evince decidedly different approaches to the architecture of Mill No. 2. Whereas drawing [2-07] stipulates a two-story structure for the new addition, drawing [2-06] has the building as a three-story structure with the reeling area on the third floor. In drawing [2-06], the basic footprint is essentially the same as the design in drawing [2-07], as the addition was to accommodate the installation of 23 mule spinners. However, the addition features more pillars in the beam direction on the second floor to support the third story.

Drawing [2-08], whose title and constituent room names are all in Japanese, is a plan for the second floor of Mill No. 2. The document calls for a “spinning area” with 18 spinning mules, but the size of the design is smaller than what actually came about in the actual mill, according to drawing [2-06]. Absent from the drawing are ropes, shafts, and the other elements of the power system.

While Mill No. 1 stood just one story high, the company planned Mill No. 2 to be a two- or three-story structure (ultimately opting for the three-story design)—the first-ever endeavor to build a multi-story spinning mill in Japan. The original idea was to build Mill No. 2 as an addition to Mill No. 1, but the new mill ended up on an entirely different power system. In terms of the

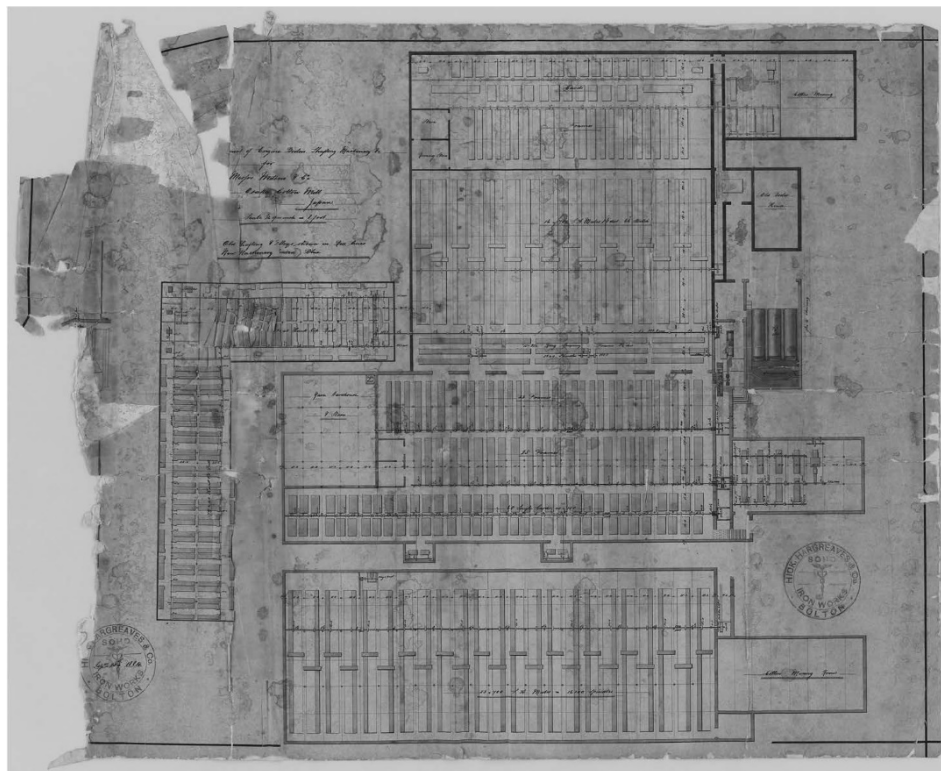


Figure 5. Addition plan, Mill No. 2 at Osaka Bōseki [2-07]
(Shibusawa Memorial Museum collection)

actual spinning process, too, all the steps from cotton opening to spinning took place on different production lines at the two mills. The drawings also suggest that Mills No. 1 and 2 shared a reeling area for the finishing phase. In addition to the overall layout of the production system, the drawings also indicate that the facilities continued to do use spinning mules for the majority of their spinning operations but also worked to incorporate ring spinning frames for some of the work on a trial basis.

4.2.4. Mill No. 3

The 11 drawings for Mill No. 3 fall into two categories: drawings outlining the machinery layout and drawings with a focus on the building's architecture.

First, the machinery-layout drawings comprise two documents for the power system ([2-09] and [2-10]) and one for the machinery layout of the mill as a whole ([2-11]).

Drawings [2-09] and [2-10] are plans for expanding Mill No. 1 (and the Mill No. 1 boiler room) and supplying steam to Mill No. 3, a new construction project, via underground piping to avoid creating any obstacles or blockages on the ground. While the standard approach to mill construction would normally involve putting the boiler house and engine house side by side, the planning process for Mill No. 3 most likely opted for a pipe-linked, separated system to make use of the existing facilities and save limited space. The two illustrations are slightly different in scope, with drawing [2-09] showing the relationships between the boiler and the steam engine and drawing [2-10] depicting the boiler itself.

On the other hand, drawing [2-11] shows the machinery layout for the whole mill in plans and sections for floors 1–4. Titled “MESSRS MITSUI & Co. OSAKA MILL.No.3,” dated July 21, 1887, and stamped with the official Hick Co. seal, the drawing was likely prepared by drafters at Hick Co. and sent to Mitsui & Co., the agent for the building initiative.

In the area of the drawing representing the southeast side of the mill, one can see an engine house containing two steam engines that supply power to pulleys on each floor via a rope race extending all the way up to the fourth floor. The machinery layout on the first floor consists of a mixing and scutching room, which is home to two cotton openers, 14 scutchers, and one willow (for waste spinning), as well as a card room, which contains 61 carding machines, two drawing frames, eight slubbing frames, 11 intermediate frames, and 21 roving frames. On the floor above is a card room that contains another 61 carding machines, 17 drawing frames, seven slubbing frames, 11 intermediate frames, and 21 roving frames. The third-floor layout calls for a battery of 72 ring spinning frames, while the plans for the fourth floor prescribe 180 reeling machines (40 hank reels), seven waste carding machines for waste spinning, seven finishing carding machines, two Derby Doublers, and two waste spinning mules. The drawing also situates “stair” areas for staircases and hoists (for loading and unloading supplies) at various locations along the periphery of the structure.

Second, there are eight drawings on the architecture of Mill No. 3; three are hand-drawn ([2-12], [2-13], and [2-14]), while the other five are blueprints ([2-15]–[2-19]).

Drawing [2-12], the “Plan and Elevation of Osaka Mill No.3. Showing Ironwork for Fireproofing. / Messrs Mitsui & Co.,” comprises a plan, elevation, and section of Mill No. 3's main structure. The overall conception calls for a four-story, brick building with steel poles, steel beams, and a continuous brick vaulted ceiling (a “fireproof-floor” design). The rendering also includes color-coding for the different materials—red for the brick sections and blue for the steel—but makes no specifications about the machinery inside the facility. Bearing a date of July 21, 1887, and the official Hick Co. seal, the drawing indicates that Hick Co. had a hand in planning the building as a whole, particularly the steel structure providing the main frame.

The drawing spells out the various dimensions of the building in clear detail. According to the specifications, Mill No. 3 was to measure 232 ft. 0 in. (21 spans) in the ridge direction and 100 ft. 0 in. (5 spans) in the beam direction. The four floors have individual heights of 14 ft. 0 in. (first floor), 16 ft. 0 in. (second floor), 15 ft. 0 in. (third floor), and 12 ft. 0 in. (fourth floor). The

plans stipulate wall-thickness dimensions that taper slightly toward the top; the walls were to be 2 ft. 10 in. thick on the first floor, 2 ft. 5 in. thick on the second, and 2 ft. 0 in. thick on the third and fourth floors. In all, the building comprises a stack of four floors with fireproof-floor designs under a five-section hipped roof. At the top of each stair area in the drawing is a note reading “Cistern placed in here for Sprinkler etc.,” which would lead one to conclude that the facility was also to have a water tank for sprinklers to safeguard against fire risks.

Drawings [2-14] and [2-13], both detailed cross-sections, offer a closer glimpse of the fireproof-floor design. The two documents have the same identifying markings—an inscription reading “Refer to Mr. Yamanobe’s letter / dates Osaka December 21st,” the official seal of the Mitsui & Co. London branch, and the date January 27, 1888. Considering the nature and apparent timing of drawing [2-12], it would be logical to assume that Hick Co. (the manufacturer of the fireproof floor) sent the document to Osaka Bōseki via the Mitsui & Co. London branch in response to Yamanobe Takeo’s letter dating December 21, 1887.

In terms of what they show, exactly, drawings [2-14] and [2-13] are detailed cross-sections of the fireproof-floor design around the pillars and small beams, respectively. The plan places large, steel-frame beams in the beam direction with smaller, steel-frame beams (I-beams) in between. The small beams form the base points for the brick vault, a single-layer structure that would then be overlaid with lightweight (coal-cinder) concrete to support floor boarding. At the time of the mill’s construction, this type of fireproof flooring was one of the approaches that builders would take to designing brick structures with wooden floors. Evidence of brick-vault fireproof floors in Japan stretches back to a mill that wrapped construction in 1871, and researchers have also identified several other examples in Japan from the late 1880s onward.²⁷ Many of the examples incorporated the flooring approach partially—but the drawings for Mill No. 3 indicate that the structure was to employ the design throughout.

The five blueprints ([2-15]–[2-19]), meanwhile, have no discernible information identifying who drafted the documents or when the drafting took place. However, drawings [2-15] and [2-17] match three illustrations in an article on the architecture of Mill No. 3²⁸ by Sasaki Toyokichi, who was directly involved in the construction of the mill (drawing [2-15] matches “Diagram #1” in the article, while drawing [2-17] matches “Diagram #2” and “Diagram #3”). The drawings were thus either working plans or documents for similar purposes.

Drawing [2-15] is a plan of the first floor. Although the drawing largely adheres to the specifications in drawing [2-12], the two drawings exhibit some differences in where they place the stairs and hoists. The article by Sasaki indicates that the end of the “rope chamber” (rope race) is the “dust flue”; the “scutching area” is on the southeast side; and the “card room” is on the other side of a partition from the scutching area. In the middle of elevation for the southwest side is an ancillary “card-grinding room,” while each corner of the side has a “stair” area with a stairwell, “elevating device” (hoist), and “lavatory” with an “iron water tank” on top of it. The stair areas at both ends of the southwest side and the “engine house” area also have doorways leading to and from the mill.

Drawing [2-18] is an elevation of the southeast side, drawing [2-19] an elevation of the southwest side, and drawing [2-16] a section of the engine house. [2-17] is a section depicting the mill in the beam direction and a detailed section of the fireproof floor. The drawing is essentially a fully rendered version of the hand-drawn counterparts ([2-12], [2-14], and [2-13]). Mill No. 3 employed an architectural design unlike anything else in Japan at the time—a four-story, brick structure—due to the building site’s spatial limitations. Operating within that framework, the

²⁷ Takeyoshi Hori, “Nihon ni okeru tekkin konkūrōto kenchiku seiritsu katei no kōzō gijutsu shiteki kenkyū” [A historical examination of the structural technologies for creating reinforced concrete architectural structures in Japan], doctoral dissertation, 1981.

²⁸ Sasaki Toyokichi, “Kōjō kenchiku no ryakki” [A brief account of mill architecture], *Rengō Bōseki Geppō* [Union Spinning Monthly] 2, Japan Cotton Spinners’ Association, 1889.

builders had to use a fireproof-floor design throughout the facility and rely on the wall surfaces instead of the saw-tooth roof for access to daylight. The drawings reflect a remarkable attention to detail and command of design, bringing every last element together into a seamless whole. The arrangement of the spinning machinery follows the work process in sequential order, with the equipment for the first steps on the first floor and the items for the final phases on the top floor. Machinery-wise, the drawings call for ring spinning frames to handle the spinning tasks but also stipulates spinning mules for handling waste thread. It would appear that Osaka Bōseki imported virtually every component of the construction process—from spinning and power machinery to the architectural design itself—from the UK.

5. The companies behind the drawings

5.1. Platt Brothers & Co.²⁹

Henry Platt (1793–1842) founded Platt Brothers & Company (“Platt Co.”), a manufacturer of textile machinery, in Oldham, Lancashire (UK) in 1821. After getting his feet wet crafting equipment for the wool industry in Lancashire and other markets, Henry formed a partnership with Elijah Hibbert (1801–46) in 1822 and led the company on a foray into manufacturing machinery for non-wool textiles. After Henry’s son John (1817–72) became a partner in the company in 1837, the leadership structure began to shift; John and his older brother Joseph (1815–45) took over the reins of the operation in a joint arrangement and ultimately renamed the company “Platt Brothers” in 1854. Rolling out textile machinery for the domestic market, the company saw such burgeoning growth that its workforce had grown to a size of 4,000 by 1865. Platt Co. continued to enhance its machinery offerings for the textile sector, eventually cementing its reputation as the most technologically advanced company in Oldham. Through systematic

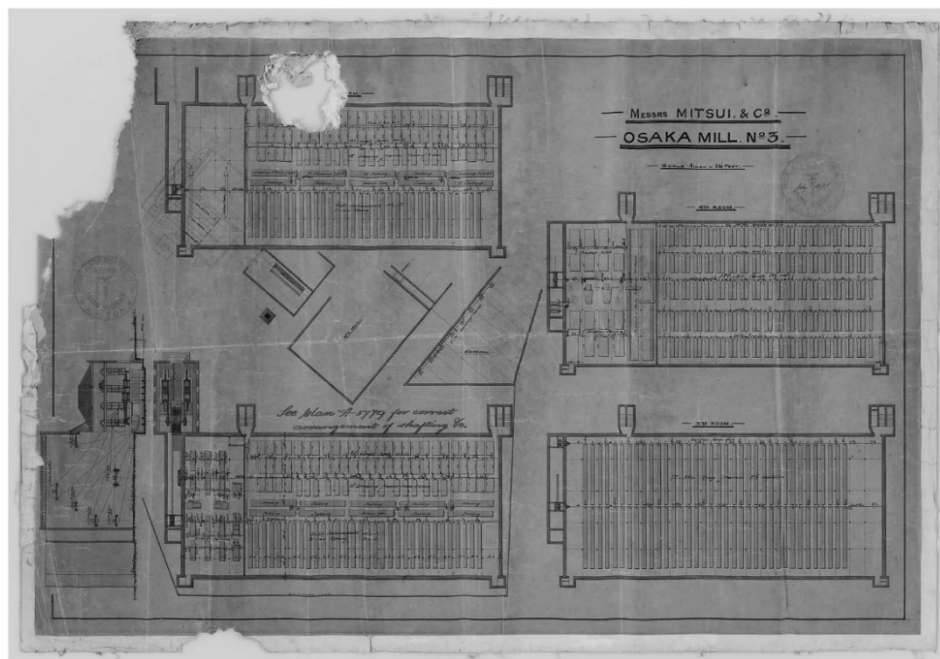


Figure 6. Machinery layout plans, Mill No. 3 at Osaka Bōseki [2-11]
(Shibusawa Memorial Museum collection)

²⁹ The information on Platt Co. is based on Douglas A. Farnie’s two papers “PLATT, John (1817-1872) Textile machinery maker” and “PLATT, Samuel Radcliffe (1845–1902) Textile machinery maker,” in David J. Jeremy (ed.), *Dictionary of Business Biography: A biographical dictionary of business leaders active in Britain in the period 1860–1980, Volume 4*, Butterworth (London), 1985, 725–32.

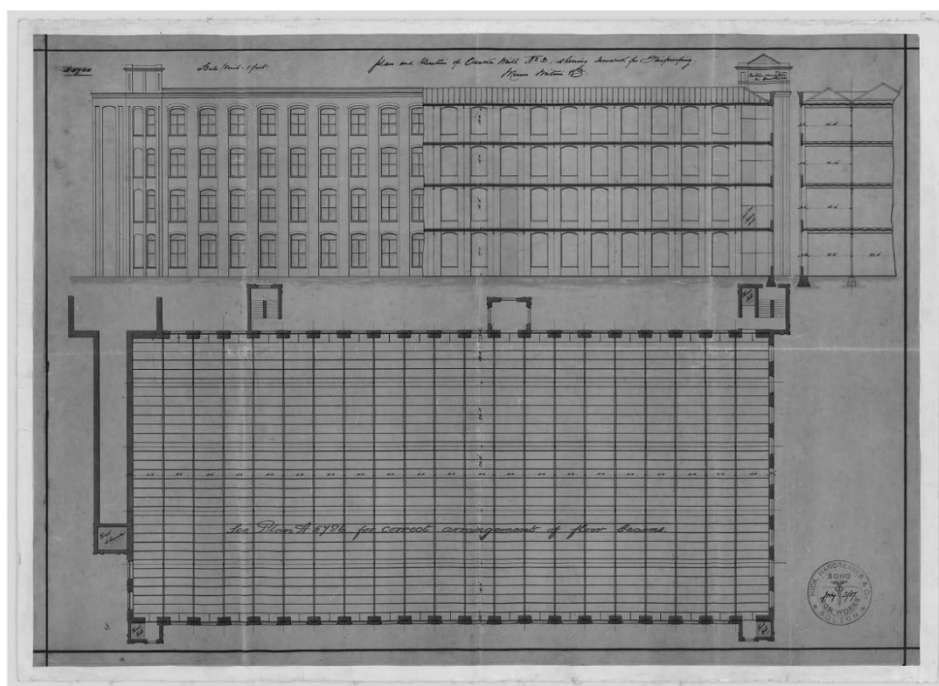


Figure 7. Plan and elevation, Mill No.3 at Osaka Bōseki [2-12]
(Shibusawa Memorial Museum collection)

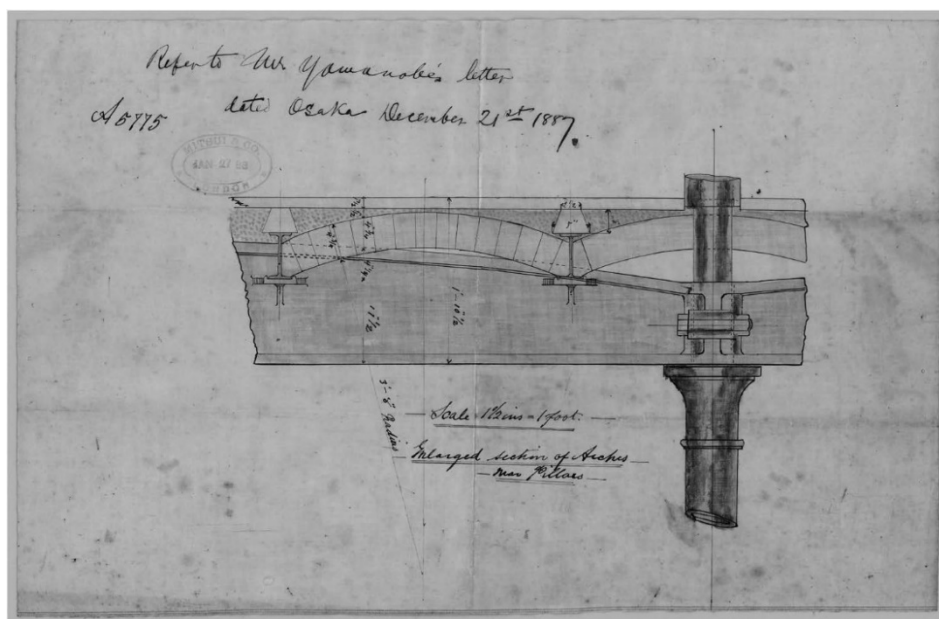


Figure 8. Fireproof floor detail, Mill No.3 at Osaka Bōseki [2-14]
(Shibusawa Memorial Museum collection)

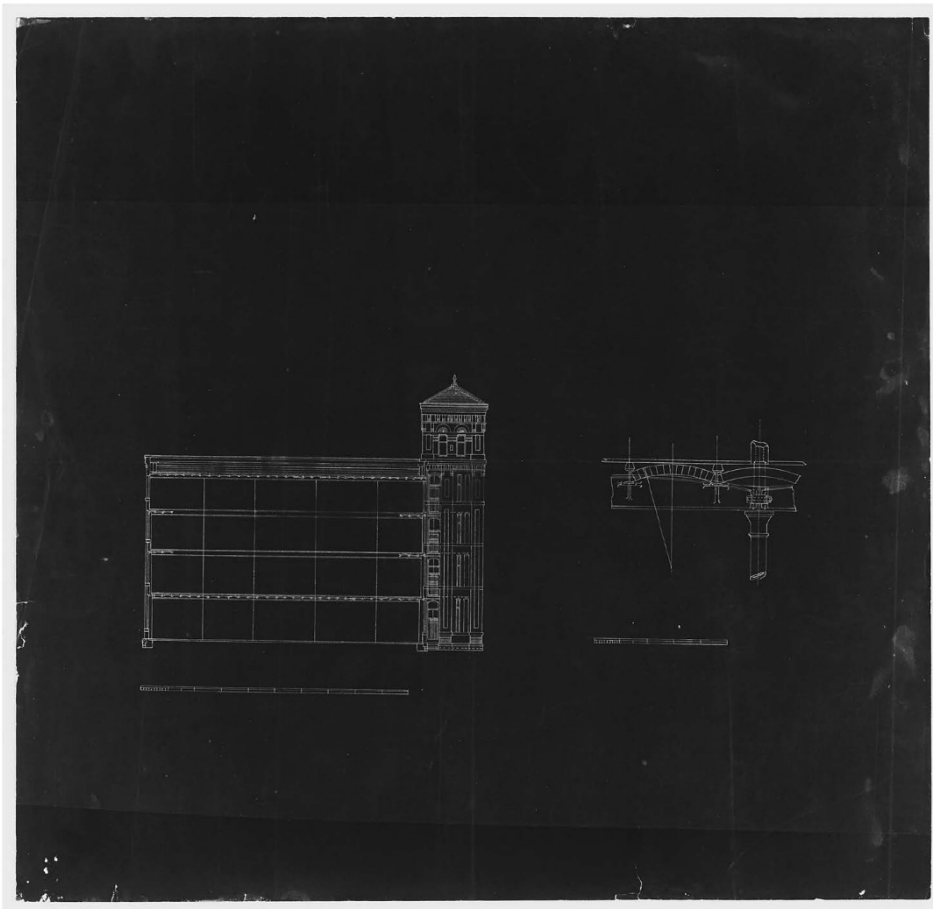


Figure 9. Section and fireproof-floor detail, Mill No.3 at Osaka Bōseki [2-17]
(Shibusawa Memorial Museum collection)

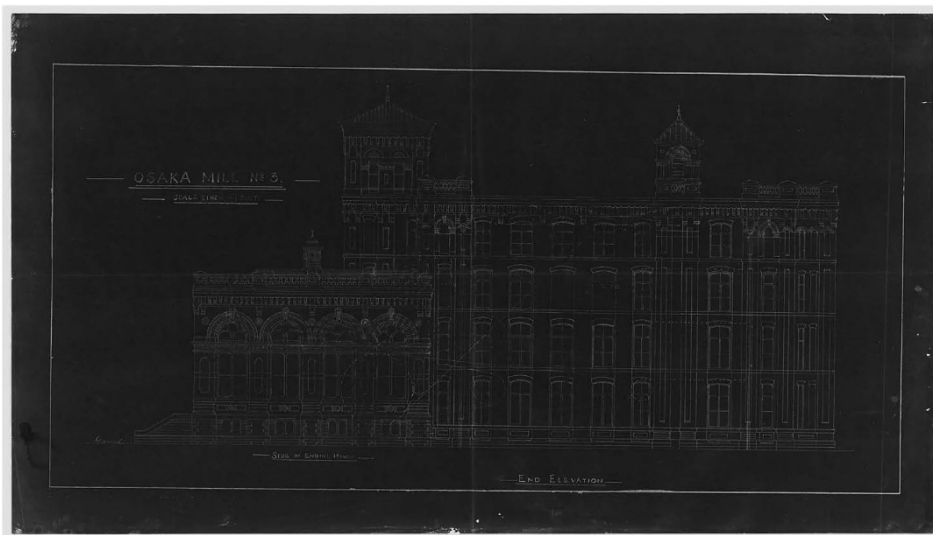


Figure 10. Southeast side elevation, Mill No.3 at Osaka Bōseki [2-18]
(Shibusawa Memorial Museum collection)

improvements to its cotton-spinning technologies, for example, Platt Co. polished off an impressive lineup of carding machines, roving frames, and automatic spinning mules—the last of which boasted speed and productivity levels that far outstripped the competition. Drawing on that potent array of technologies, Platt Co. harnessed its production output of power looms and exports of spinning machinery to develop into the world’s largest manufacturer of spinning machinery in 1879. At the turn of the century, there were around 15,000 workers in Platt Co.’s employ. The company’s primary export destinations were India, Japan, and Brazil, where Platt Co. would send teams of engineers to help install spinning machinery, run operational tests, and teach local workers how to use the equipment.³⁰

Platt Co. was right in the mix of things when spinning mills began going up in Japan. Documents pertaining to the Kagoshima Spinning Mill, which the Satsuma Domain founded in 1867, include a drawing by Platt Co. drafters—a plan for the facility’s machinery layout titled “HIS HIGHNESS THE PRINCE THE SATUMA. JAPAN” and dated January 9, 1866. Scholars believe that Platt Co. had a hand in more than just the design, as evidence suggests that the company dispatched seven members of its engineering force to the Kagoshima site to assist with building the mill, installing machinery, and training workers.³¹ When Osaka Bōseki began operations, meanwhile, Yamanobe Takeo solicited estimates from Platt Co., Howard & Bullough, John Hetherington & Sons, and several other spinning-machine manufacturers. Yamanobe decided to go with Platt Co.’s spinning machines, which were already in use at the Kagoshima Spinning Mill, and a Platt Co. engineer by the name of Nield made his way to Japan to oversee the installation process and instruct users on using the machinery.³²

5.2. Hick, Hargreaves & Co.³³

Hick, Hargreaves & Co. started with Benjamin Hick, who founded Benjamin Hick & Sons in Bolton, United Kingdom, in 1833 and made a name for himself manufacturing locomotives at the company’s Soho Iron Works. Benjamin’s eldest son, John Hick (1815–94), assumed leadership of the company when his father died in 1842. John made his cousins John and William Hargreaves (brothers) partners in the firm three years later. With John Hargreaves on board, the Benjamin Hick company leveraged that expertise into versatility. The company eventually shifted gears in the 1850s, abandoning its dwindling locomotive business for a new venture in selling machinery like steam engines and boilers to spinning mills and other destinations. After John Hargreaves left the company in 1850, his brother William stayed on and helped expand the firm’s workforce to 502 employees in 1852 and 622 in 1864.

After letting go of the Soho plant in 1868, the company renamed itself from Benjamin Hick Co. to Hick, Hargreaves & Co. The shifts had little impact on the company’s output, however, as production remained strong thereafter. Aside from overseeing corporate operations, John Hick also eventually won election to parliament representing Bolton as a member of the Conservative

³⁰ R.H. Eastham, *PLATTS: Textile Machinery Makers*, Garvin Print, 1994, 45.

³¹ Kanji Tamagawa, “Wagakuni menshi bōseki kikai no hatten ni tsuite: Sōshiki kara 1980-nendai made” [The development of Japanese cotton yarn-spinning machinery: Origins to the 1980s], *Gijutsu to bunmei* [Technology and civilization] 9, no. 2, 1995, 3, 7.

³² *Ibid.*, 13–14.

³³ For our description of Hick, Hargreaves & Co., we referenced D.A. Collier, “HICK, John,” in David J. Jeremy (ed.), op. cit. 1985, 205–29; David Lewis, “Hick, Hargreaves & Co. Engineers, Soho Foundry, Bolton, 1833–2002,” in *Industrial Archaeology North West, Vols. 1–3*, 2003, 18–20; and Philip William Pilling, “Hick Hargreaves & Co.: The history of an engineering firm c. 1833–1939, a study with special reference to technological change and markets,” doctoral dissertation, University of Liverpool, 1985. We also drew on an email (June 7, 2018) from Roger Holden, a British historian of industrial technologies, who provided us with more information on the company’s overseas operations.

Party.

The company, having carved out a sterling reputation for building quality engines and boilers across the machinery spectrum, provided a full lineup of service operations (millwright work)—not only manufacturing but also installing equipment and outfitting transmission-shaft systems (line shafting) for powering it—to the broad base of customers that Benjamin Hick Co. had started developing years prior in Europe, Asia, and South America. In the process of diversifying its capabilities and offerings, Hick, Hargreaves & Co. found itself handling a scope of work that extended to designing the layout of entire mills.

5.3. Mitsui & Co.³⁴

Mitsui & Co.'s extensive involvement in importing raw cotton and dealing in cotton yarn made the firm another important player in the dawning of the Japanese spinning industry at the end of the nineteenth century. One key role that Mitsui & Co. played was serving as a go-between in the effort to secure spinning machinery for Osaka Bōseki, as previous sections noted. Having forged a relationship with Platt Co., Mitsui & Co. signed an agency agreement with the British manufacturer in 1886 and met with a Platt technician to discuss the technical aspects of the machinery. In the end, Mitsui & Co.'s imports of Platt Co. machinery would go on to equip the majority of the spinning companies that sprouted up across Japan over the ensuing years; between January 1892 and January 1893, Mitsui & Co. handled 81% of the contracts that Japanese spinning companies signed to obtain additional spindles.³⁵ The transactions for spinning machinery went through the company's London branch, which paid for the items via bills of exchange at financial institutions like the Yokohama Specie Bank's location in London. Research shows that as of 1908, Platt accounted for 87% of the combined 1.89 million spindles at Japanese spinning establishments³⁶. Cotton imports represented another area where Mitsui & Co. was highly active. After making its first venture into buying foreign cotton with a connection for Chinese cotton shortly after establishing its Shanghai branch in 1887, Mitsui & Co. opened a location in Bombay to commence imports of India cotton in 1893 and later began purchasing American cotton for the Japanese market in the latter half of the 1890s. Before long, cotton imports were the company's main product line. For its cotton transactions, Mitsui & Co. would discount notes and apply the corresponding amounts toward payments for cotton-import notes. The company also dealt in cotton yarn, importing mostly from the United Kingdom and Bombay and then selling the acquisitions to Japanese wholesalers Hiranuma and Hibiya.

6. Closing remarks

Drawing on a host of design drawings for Japanese spinning mills in the Shibusawa Memorial Museum collection, this paper examined drawings for 2,000-spindle mill—pioneers in modern cotton spinning—and Osaka Bōseki—Japan's first 10,000-spindle spinning operation—to uncover compelling findings. The drawings not only reveal that establishing the early-day spinning facilities was a collaborative effort between the British firms Platt Co. and Hick Co., Japanese companies like Mitsui & Co., and key engineers like Yamanobe Takeo but also suggest that the spinning companies in Japan depended on their UK counterparts for everything from formulating the layouts for their spinning machinery and organizing transmission-shaft systems to designing the mills themselves. In addition, the drawings provide a direct lens on what machinery and architecture the mills employed as well as how the components changed over time.

³⁴ The information on Mitsui & Co. in this section is based on *Kōhon Mitsui Bussan Kabushikigaisha 100 nen-shi* [Printed Manuscript: A 100-year history of Mitsui & Co.], Japan Business History Institute, 1978.

³⁵ The remaining 19% was via H. Lucas & Co. (16%), which dealt in Dobson products, and C. Illies & Co. (3%), which handled Samuel Brooks & Doxey Ltd. products.

³⁶ Tamagawa, "Wagakuni menshi bōseki kikai," 5.

The drawings for the 2,000-spindle mill prototype are the work of William Higgins & Sons. The firm drafted the documents through an arrangement with Consul Minami Tamotsu, who was then representing Japan in London. Rather than stipulating specifications for a specific mill, however, the drawings likely served as a guide that the Japanese government could use to build a model of the facilities it was asking wealthy individuals across the country to begin building. Although past research has established that 2,000-spindle mills ran on power from waterwheels, the drawings in the Shibusawa Memorial Museum Collection illustrate designs that would have been compatible with either waterwheels or steam engines.

Also in the collection of primary sources are drawings for a ring spinning–frame expansion at the Shimomura Spinning Mill, a facility that started out from the prototype of the 2,000-spindle mill and then began to augment its operations by installing ring spinning frames during the first enterprise boom in Japan. Through a close examination of the drawings for the mill, one finds that Mitsui & Co. played a mediating role in the expansion initiative and helped the facilities secure a boiler and steam engine each from Hick, Hargreaves & Co. Drawings for an expansion to the Tamashima Spinning Mill, another 2,000-spindle mill, provide evidence suggesting that weather changes had a sizable impact on stable mill operations.

The collection also includes drawings for Mills No. 1–3 at the Osaka Bōseki's Sengen'ya facility, Japan's first-ever 10,000-spindle mill. Starting out with the single-story (shed) Mill No. 1, Osaka Bōseki later expanded—but did so upward, building multi-story additions due to the site's space restrictions. The company also ginned Chinese seed cotton, according to the drawings. One of the insights one can glean from the Osaka Bōseki drawings for Mill No. 1, likely by the hand of Archibald King (then residing in Japan), is that Mitsui & Co. not only imported the mill's machinery but also played a broader role across the entire mill-construction effort from the early planning stage onward. Hick Co. was doing more than just sending boiler and steam-engine equipment to Japan, too; it was also drafting drawings for the layout of the machinery. Mill No. 1, a brick, single-story structure on a nearly square footprint, served as a template for spinning mills that companies built across Japan after the Mino-Owari earthquake and Sino-Japanese War.

Drawings for Mill No. 2 at the Sengen'ya site, most likely the work of Hick Co., are also in the collection. Ostensibly the first spinning facility in Japan to have more than one story, Mill No. 2 presents a captivating case for another reason—the plans call for the installation of ring spinning frames, albeit only on an experimental basis. Mill No. 3 was another multi-floor structure, and the corresponding drawings in the Shibusawa Memorial Museum's holdings paint revealing pictures of both the facility's machinery layout and its architectural design. Hick Co. was involved in the drafting of both types of documents, and the sources also place Mitsui & Co. in the mix of entities with a hand in the mill's construction. The drawings are a trove of interesting findings, showing that the mill had a reservoir for sprinklers and fireproof flooring to safeguard against fire risks, specifications that would let daylight in through the side walls instead of the saw-tooth roof, and a spinning-machinery lineup that consisted primarily of ring spinning frames—a notably early adoption.

By comparing the drawings in the Shibusawa Memorial Museum collection with surviving materials from companies on the supply side in the UK, it would be possible to learn even more about how the companies behind the drawings operated within a role-sharing context, how they coordinated amongst themselves, and how the transfer of spinning-related technologies actually transpired.

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(3) Drawings for Japan's First Spinning Mills: New Discoveries in the Hick, Hargreaves & Co. Documents

1. Introduction

In November 2019, the authors visited the Bolton History Centre in Bolton (UK), to examine documents pertaining to Hick, Hargreaves & Co. ("Hick Co.") in the Bolton Archives and Local Studies Service collection. This presentation delves into several design drawings that we identified in the collection, particularly documents pertaining to Mills No. 1–3 at Osaka Bōseki Kaisha (Osaka Spinning Company; hereinafter "Osaka Bōseki"), and the revelations they contain about Japan's first wave of spinning mills.

2. Bringing the drawings to light

For years, researchers studying nineteenth-century Japanese spinning mills had little more than a smattering of drawings to draw on for primary evidence. That changed in 2013, however, when the Shibusawa Memorial Museum added 90 design drawings (plans) for a prototype of a 2,000-spindle mill, Osaka Bōseki, and other Meiji-period Japanese spinning mills to its collection. After receiving permission from the museum to view the drawings firsthand, we set to work on interdisciplinary research into technology transfer in the spinning industry.¹ Over the course of our investigation, one of the entities with connections to the drawings that captured our attention was Hick Co. Past studies have already profiled several other firms that delivered spinning machinery to Japan, including Platt Brothers & Co., and discussed how the companies would dispatch teams of technicians to Japan to help install machinery and train operators. However, few studies have devoted much attention to firms on the other side of the machinery equation: the companies that, like Hick Co., provided Japanese mills with the boilers, engines, and other components to make the spinning machinery run. The new drawings in the Shibusawa Memorial Museum collection help fill that hole in the existing scholarship. Among the documents are numerous drawings by Hick Co. that point to deeper involvement: that the company not only delivered products to Japan but also offered a wide range of engineering solutions essential to mill construction. To shed more light on the many roles that Hick Co. played in that process, we decided to examine the Hick Co. documents available in the United Kingdom. It was there that we found numerous drawings for some of the earliest Japanese spinning mills, discoveries that form the thrust of this paper.

3. The history of Hick, Hargreaves & Co.

Hick, Hargreaves & Co. started with Benjamin Hick, who founded Benjamin Hick & Sons in Bolton, United Kingdom, in 1833 and made a name for himself manufacturing locomotives at the company's Soho Iron Works. Benjamin had worked to inculcate his technical prowess in his eldest son, John Hick (1815–94), who assumed leadership of the company when his father died in 1842. John then changed the name of the firm to Benjamin Hick Co., Ltd. in 1845 and appointed his stepbrothers John and William Hargreaves to be partners in the new company. The brothers were railway operators, not engineers. The company eventually shifted gears in the 1850s, abandoning its scuffling locomotive business for a new venture in selling machinery like steam engines and boilers to spinning mills and other destinations. After John Hargreaves left the company in 1850, his brother William stayed on and expanded the firm's workforce to 502 employees in 1852 and

¹ See, for example, Naoki Hirai, Takenobu Yuki, Kanji Tamagawa and Takeshi Abe, "Shiryō shōkai: Shoki Nihon bōseki kōjō no sekkei zumen—Nisensui bōseki kankei shiryō oyobi Ōsaka Bōseki Kaisha kankei shiryō" [Plans for Japan's Earliest Spinning Mills: Documents Detailing 2,000-Spindle Mills and Osaka Bōseki Kaisha (Osaka Spinning Company)] (*Shibusawa kenkyū* [Shibusawa studies] 31, Shibusawa Memorial Museum, January 2019) for details on the research.

622 in 1864.

Aside from overseeing corporate operations, John Hick also eventually won election to parliament representing Bolton as a member of the Conservative Party. In 1868, John Hick severed ties with the Soho Iron Works and changed the name of Benjamin Hick Co. to Hick, Hargreaves & Co. The shifts had little impact on the company's output, however, as William Inglis, Robert Luthy, and other first-rate engineers kept the firm churning steadily ahead.

The company, having carved out a sterling reputation for building quality engines and boilers, provided a full lineup of service operations (millwright work)—not only manufacturing but also installing machinery and outfitting transmission-shaft systems (line shafting) for powering it—to the broad base of customers that Benjamin Hick Co., Ltd. had started developing in Europe and Asia years prior. In the process of diversifying its capabilities and offerings, Hick, Hargreaves & Co. found itself handling a scope of work that extended to designing the layout of entire mills.²

4. An overview of the Hick, Hargreaves & Co. documents

Before the closure and dismantling of Hick Co.'s former Soho Iron Works in 2002, archivists at Bolton Library worked to catalog and preserve an enormous amount of the company's historical documents.³ As of 2020, the Bolton Archives and Local Studies Service now holds a significant portion of the sources on Hick Co. in its collection. The documents are accessible to users at the Bolton History Centre [Image 1] in Bolton Art Gallery, Library & Museum, a complex that houses Bolton Central Library.

The set of sources, "HICK, HARGREAVES & Co. LTD, ENGINEERS AND MILLWRIGHTS, SOHO WORKS, BOLTON," spans the years 1819 to 1980 and uses the identifier "ZHH" at the beginning of each item code. The archivists have sorted the materials into 38 separate series, including customer records, mechanical and architectural drawings, engine catalogs and lists, manufacturing records for steam engines, images of engines (and their negatives), wage records, generator records. In the holdings, one can find numerous drawings with connections to Meiji-period Japanese spinning mills: documents for Osaka Bōseki, first of all, and also a host of design drawings detailing mill machinery and architecture for Shimomura Spinning Company, Hirano Spinning Company, Osaka Weaving Company, Kanakin Seishoku (Calico Weaving Company), Mie Spinning Company, Dōjima Spinning Company, Kurashiki Spinning Company, Senshū Spinning Company, Amagasaki Spinning Company, Okayama Spinning Company, Settsu Spinning Company, Kurume Spinning Company, Sakai Spinning Company, Matsuyama Spinning Company, Wakayama Spinning Company, and Tenma Spinning Company.

5. An overview of the drawings for Osaka Bōseki

The earliest drawing for a Japanese spinning mill in the Hick Co. documents is one for Osaka Bōseki Mills No. 1–3 [Table 1]. In this paper, we refer to drawings by their item numbers (after the ZHH/3/A identifier) in brackets. All the documents are original drawings on thick paper lined with thin fabric. The drafters evidently used a color-coding scheme for their work, using different hues for the brick walls, power machinery, spinning machinery, and other design elements. The drawings are not fully intact; the top quarter of each is missing [Image 2], and the remaining

² P. W. Pilling, *Hick, Hargreaves & Co.: the history of an engineering firm c.1833-1939. a study with special reference to technological change and markets*, Doctoral Thesis at University of Liverpool, 1985. We also drew on an email (June 7, 2018) from Roger Holden, a British historian of industrial technologies, who provided us with more information on the company's overseas operations.

³ "Firm is moving after 170 years", *The Bolton News*, November 14, 2002 (<https://www.theboltonnews.co.uk/news/5953820.firm-is-moving-after-170-years/>).

portions appears to be incomplete. An inscription reading “Soho Iron Works Bolton” appears on many of the drawings, too, and the documentation for Mill No. 3 also features the signature or seal of Bolton architect George Temperley⁴ [Image 3]. The intended recipient listed on most of the documents is “Mitsui,” suggesting that the London branch of Mitsui & Co. was an agent for the construction project.

5.1. Mill No. 1 (completed May 1883)

Three drawings in the collection were ostensibly for the initial construction of Mill No. 1: a machinery-layout diagram for the power system [1882/1], a detail drawing of the power-transmission machinery [1882/2], and an overall machinery-layout diagram [1882/28] [Image 4]. Another drawing in the set, a layout plan and detail drawing of the heating pipes [1889/3], was for a later renovation project. The initial drawings show how the line shaft transmits power to the various spinning-machinery components, stipulating detailed dimensions for the pulleys, ropes, shaft, and other parts of the power-transmission system, as well as the beams and hangers that hold everything in place. In addition, the documentation depicts the architectural elements of the rooms housing the power system (the boiler room, engine house, and rope race) with details on the requisite column spacing, brick-wall spacing, and wall thickness for installing the machinery.

5.2. Mill No. 2 (completed May 1886)

Mill No. 2 (an addition to Mill No. 1) is the subject of several drawings, too. Two correspond to the initial construction effort: a machinery-layout diagram for the power system [1885/15] and an overall machinery-layout diagram [1885/16] [Image 5]. An additional layout plan and detail drawing of the heating pipes for a later renovation project [1886/1], meanwhile, was for a subsequent renovation effort. The initial drawings illustrate the power system for Mill No. 2, which is separate from the existing power system, and stipulate the configuration for supplying the spinning machinery with power via a line shaft. In meticulous detail, the drafters of the drawings carefully mapped out the relationships between the pulleys and ropes—crucial components in powering the equipment—along with the necessary architectural dimensions for installation.

5.3. Mill No. 3 (completed December 1889)

The collection is also home to 32 drawings pertaining to Mill No. 3. Some provide details on the machinery and equipment, including a machinery-layout drawing for each floor [1888/4], a detail drawing of the engine house and rope race [1887/2], a detail drawing of pulleys and other elements of the rope race [1887/21], a detail drawing of the area around the boiler [1887/5], a detail drawing of the water tank above each staircase [1887/15], a detail drawing of the hoists [1888/2], a layout plan and detail drawing for the heating pipes [1888/3], a detail drawing of the fireproof doors [1888/7], and a detail drawing of the shaft hangers to be affixed to the beams and pillars [1888/9]. General architectural drawings comprise a general plan for the ground floor [1887/19], elevations [1887/52] and [1887/54] [Image 6], a section [1887/55], an elevation of the engine house [1887/3],

⁴ According to Architects of Greater Manchester 1800–1940

(<https://manchestervictorianarchitects.org.uk/architects/george-temperley>) and “Death of Mr. G. Temperley,” *The Bolton Evening News*, May 28, 1927, George Temperley (1851–1927) worked as a mill architect for 17 years under George Woodhouse (known for Bolton Town Hall, among other works) before striking out on his own. In his later years, Temperley ran an office with his son Thomas. Temperley’s body of work includes the Board Room and Offices, Bolton Union Spinning Company (Bolton), Wilton Mill (Radcliffe), Taking Down Brick Walls at Albion Corn Mill (Stockport), Falcon Mill (Bolton), Ena Mill (Atherton), and Drake Mill (Farnworth). Observers also believe Temperley to have worked on mills in Japan (Osaka Bōseki), Russia, Mexico, and more.

and a section of the engine house [1887/4]. Also in the set are a detail drawing of the stairs [1887/16], a staircase section, [1888/8] a detail drawing of the steel beams for the fireproof floor [1888/10], and a detail drawing of the various lintels [1888/12]. George Temperley's signature or seal appears on several drawings, including bricklaying diagrams, [1887/23] and [1887/24], a foundation plan [1887/10], foundation detail drawings [1887/9] and [1887/11], a detail drawing of the stairs [1887/18], detail drawings of the windows [1887/14] and [1887/17], a detail drawing of the top of the staircase [1887/53], a detail drawing of the cesspool [1887/13], and detail drawings of the engine house windows [1887/12], [1887/20], and [1887/6] [Image 7]. In addition to illustrating how the power machinery and line shaft fit into the design, the drawings paint a clear, painstaking picture of the relationships between the machinery and the building's architectural dimensions as well as the design, structure, and equipment of the building itself. That level of detail extends to a variety of other drawings as well, especially those for the fireproof floor beams and lintels that played an essential role in bringing the large, brick building to fruition, the stairs, the fireproof doors, and other iron components.

6. Conclusion

Through our examination, we successfully identified numerous drawings pertaining to the machinery and architecture of early Japanese spinning mills in the Hick Co. company documents. The drawings not only provide the observer with a clear picture of the machinery and architecture in plans for mills but also highlight Hick Co.'s role in the mill-construction effort. Examining the drawings for Mills No. 1 and 2 at Osaka Bōseki, we found clear instructions on the appropriate architectural dimensions to enable the installation of power-transmission equipment. The drawings for Mill No. 3, meanwhile, show that an architect with an affiliation to Hick Co. was responsible for drafting the design—and, as a result, the documents go as far as specifying architectural considerations with no direct connection to the mill machinery. Evidence also suggests that Hick Co. extended its reach all the way to supplying Osaka Bōseki with the necessary building supplies. Hick Co.'s wide-ranging involvement in the process of constructing actual mills is also evident in the drawings. Not only did the firm supply Osaka Bōseki with products from its power-machinery lineup and corresponding transmission mechanisms, but it also apparently offered input on building the mills to facilitate the installation and launch of machinery—and, in some cases, a full complement of requisite technologies and products for making the structure itself a reality. The Osaka Bōseki-related drawings that we found in the Hick Co. documents match the drawings in the Shibusawa Memorial Museum collection and *Rengo Bōseki Geppō* (Union Spinning Monthly, 1889) almost exactly. By analyzing the Hick Co. drawings in context with these other sources, we hope to delineate the roles that companies and individuals played in realizing technology transfers within the spinning industry.

Acknowledgements: The authors would like to thank the Bolton Archives and Local Studies Service for allowing them to photograph and publish selections from the Hick Co., Ltd. company documents. This study was supported by a *kakenhi* Grant-in-Aid for Scientific Research (JP19H01511) from the Japan Society for the Promotion of Science.

Table 1. Drawings pertaining to Osaka Bōseki
(Bolton Archives and Local Studies Service collection)

Source	Title	Date	Drafter	Mill
1882/1	Messes Mitsui & Co. [Machinery layout drawing for power system]	October 10, 1882	②	1
1882/2	Messes Mitsui & Co. [Power transmission machinery details]	December 1882	②	1
1882/28	Messes Mitsui & Co. / General Plan Showing Arrangement of Machinery Shafting Engines etc for Messrs Mitsui & Co. for Osaka Japan [Machinery layout plan]	September 12, 1882	②	1
1885/15	Plan & Elevations of Main Rope Driving showing position of Engine Rope Pulleys etc for Messes Mitsui & Co. [Machinery layout drawing for power system]	March 3, 1885	②	1・2
1885/16	Messes Mitsui & Co. [Machinery layout plan]	February 4, 1885	②	1・2
1886/1	Mitsui & Co. / General Arrangement and Details of Heating Pipes for Mill Messes Mitsui & Co. Osaka Japan [Heating pipe layout drawing]	July 14, 1886	②	2
1887/2	Messes Mitsui & Co. Osaka Mill. No 3. [Rope race detail]	October 19, 1887	②	3
1887/3	FRONT ELEVATION / SIDE ELEVATION [Engine house elevations]	—	—	3
1887/4	TRANSVERSE SECTION / LONGITUDINAL SECTION [Engine house	—	—	3
1887/5	Messes Mitsui & Co. Messes Mitsui & Co. Osaka No 3 Mill [Boiler details]	June 29, 1888.	②	3
1887/6	□rior Elevation of Door Screen &c. / Half Interior Elevation of Door Screen &c. / Half Plan of Door & Screen / Half Plan of Window &c. / Section □hro Door, Window &c. [Engine house window detail]	October 12, 1887	③④	3
1887/9	untitled [Foundation sections]	—	—	3
1887/10	untitled [Foundation plan]	September 1887	④	3
1887/11	untitled [Foundation details]	September 5, 1887	—	3
1887/12	untitled [Engine house window detail]	October 18, 1887	③	3
1887/13	untitled [Cesspool detail]	September 13, 1887	③	3
1887/14	untitled [Window details]	August 31, 1887	③④	3
1887/15	Messes Mitsui & Co. Osaka No 3. Mill Japan. [Water tank detail]	December 22, 1887	②	3
1887/16	Osaka Mill No 3 Messes Mitsui & Com. / Osaka Mill No.3 Japan per Messrs Mitsui & Co. [Stair detail]	September 22, 1887	②	3
1887/17	untitled [Window detail]	September 6, 1887	③④	3
1887/18	untitled [Staircase details]	—	—	3
1887/19	Osaka Mill No 3 / Messes Mitsui & Co. / Japan / GROUND PLAN [Ground floor plan]	1887	②	3
1887/20	untitled [Engine house window detail]	October 7, 1887	③	3
1887/21	Osaka Mill No 3. Messes Mitsui & Co. [Power transmission machinery details]	1887	②	3
1887/23	untitled [Bricklaying diagrams]	August 30, 1887	④	3
1887/24	untitled [Bricklaying diagrams]	September 3, 1887	③④	3
1887/52	untitled [Elevations]	—	—	3
1887/53	untitled [Penthouse detail]	September 8, 1887	③	3
1887/54	Osaka Mill No 3 Messes Mitsui & Co. Japan [Elevations]	1887	②	3
1887/55	untitled [Sections]	—	—	3
1888/2	Osaka Mill No 3 [Hoist detail]	October 18, 1888	②	3
1888/3	Messes Mitsui & Co. Osaka Mill No. 3 [Heating pipes layout plan]	June 25, 1888	②	3
1888/4	Osaka Mill No 3 / Messes Mitsui & Co. [Machinery layout plans]	April 2, 1888	②	3
1888/7	Messes Mitsui & Co. No. 3. Osaka Mill. [Fireproof door details]	September 27, 1888	②	3
1888/8	Osaka Mill. No.3. Mitsui & Co. Japan. [Staircase section]	—	②	3
1888/9	Osaka Mill No.3. Mitsui & Co. Japan. [Shaft hanger details]	—	①	3
1888/10	Messes Mitsui & Co. Osaka No. 3 Mill. [Steel beam details]	July 14, 1888	②	3
1888/12	Osaka Mill No.3. Messes Mitsui & Co. Japan. [Lintel details]	Aug 23, 1888	①	3
1889/3	Osaka No.1 Mitsui & Co. [Heating pipe layout drawing]	July 4, 1889	②	1

Source numbers are the official source numbers used by Bolton Archives and Local Studies Service. Titles are as given on the documents themselves. Brackets ([]) mark information missing from the documents themselves and deduced based on the information in the drawings. Drafters are as follows: ①Hick Hargreaves & Co. Bolton, ②Hick Hargreaves & Co. Soho Iron Works Bolton (Soho Iron Works Bolton), ③G. TEMPERLEY ARCHITECT BOLTON (seal), ④G.T. (G. TEMPERLEY) (signature). The authors determined which mill each drawing depicts. A square (□) denotes a word or words on a missing part of the document.

(The table was created by Hirai Naoki.)



Image 1: Bolton History Centre



Image 2: Removing the drawings from storage



Image 3: A seal and signature on a drawing [1887/14]
(Bolton Archives and Local Studies Service collection)

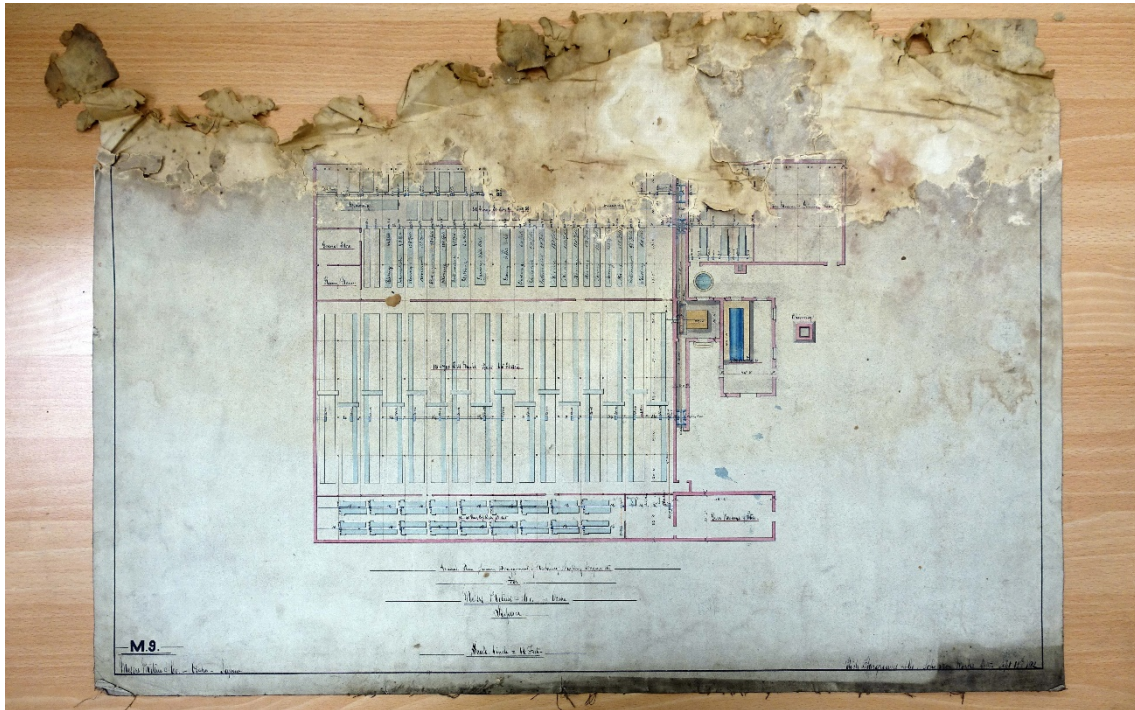


Image 4: Machinery layout plan, Mill No. 1 at Osaka Bōseki [1882/28]
(Bolton Archives and Local Studies Service collection)

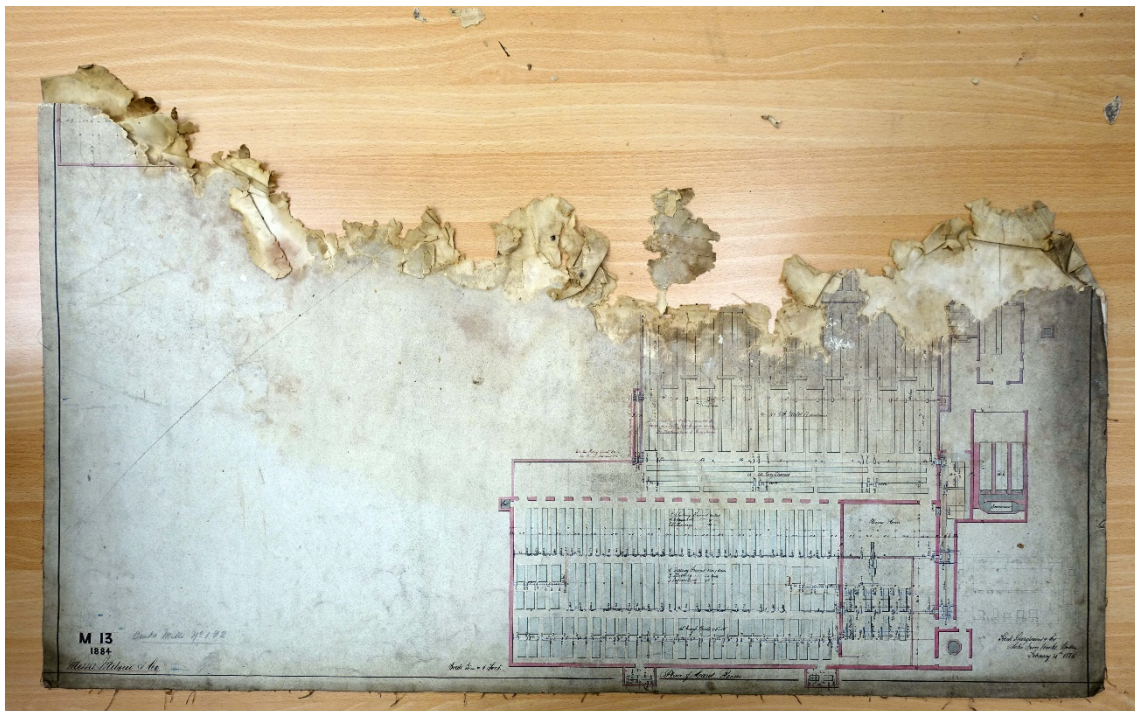


Image 5: Machinery layout plan, Mill No. 2 at Osaka Bōseki [1885/16]
(Bolton Archives and Local Studies Service collection)



Image 6: Southeast side elevation, Mill No. 3 at Osaka Bōseki [1887/54]
(Bolton Archives and Local Studies Service collection)

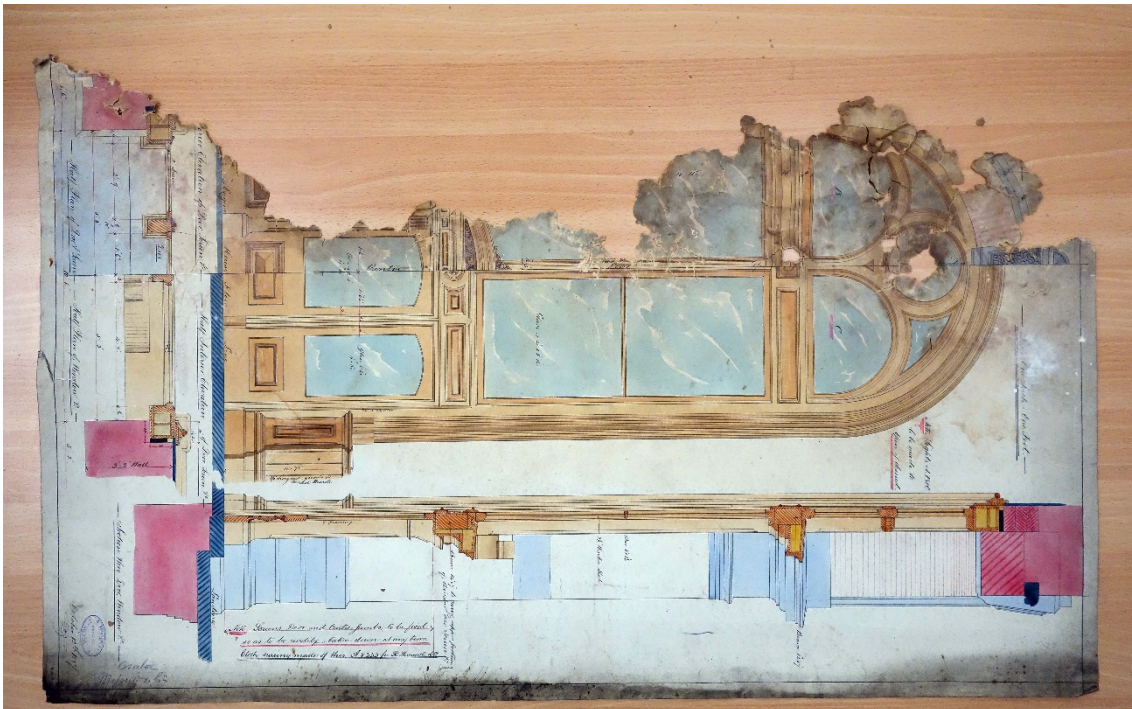


Image 7: Engine house window detail, Mill No. 3 at Osaka Bōseki [1887/6]
(Bolton Archives and Local Studies Service collection)