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# **Discussion Papers In Economics And Business**

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# **Technological advantage and market loss: Siemens and the X-ray machine business in Japan (1900–1960) \***

Pierre-Yves DONZÉ<sup>†</sup>

## **Abstract**

This paper focuses on the involvement of Siemens on the market for radiology equipment in Japan between 1900 and 1960 from a business history perspective. It explores why the German multinational was unable to keep its dominant position on the Japanese market in the interwar years, despite its technological competitiveness. In particular, it examines the strategic choices made by the firm (export, licensing, direct investment) in relation to the changing economic and technological environment, highlighting the importance, for foreign multinationals, of working together with national trading firms involved in the distribution of drugs and products for doctors, as the Japanese medical market was already well structured when the country opened up to the West. Four phases have been identified. At first, before World War I, German manufacturers of X-ray machines, especially Siemens, enjoyed a virtual monopoly in Japan and favored an export strategy. The political and technological shifts that occurred during the war (interruption of trade with Germany, development of the Coolidge X-ray tube by General Electric) led to a more competitive market in Japan. Siemens reorganized its involvement in this business via a contract signed with a domestic medical goods trade company, Goto Fuundo (1926). Yet this proved insufficient to overcome the competition, and Siemens finally decided to relocate some of its production facilities for X-ray machines in Japan by entering into a joint venture with Goto (1932). Relations between Siemens and Goto were severed by the war, and Goto tried until the 1950s to go it alone in this field but failed due to a lack of organizational capability. As for Siemens, it reverted to its export strategy approach, re-entering the market in the 1950s.

**JEL** : F23; N85; O32

**Keywords:** Siemens, Goto Fuundo, X-ray machines, medical market

**Note:** In this paper, the names of persons appear following the usage in Japan, that is, with the family name preceding the first name.

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## Introduction

Medicine experienced a paradigm shift in the 20th century, changing from a small-scale, half-charitable activity to one of the main sectors of the economy.<sup>1</sup> The transformation of medicine into a business came about in the first half of the 20th century, largely driven by the introduction of new technologies, such as drugs mass-produced by the pharmaceutical industry, medical laboratories and surgery equipment.<sup>2</sup> Among these innovations that contributed to make medicine a profitable and growing activity, X-ray machines take pride of place: they changed the very nature of hospitals, which became institutions managed like modern enterprises and established themselves as key actors on the health care market.<sup>3</sup> Soon after the discovery of X-rays by Wilhelm Roentgen (1895),<sup>4</sup> the manufacture of X-ray machines became a high-growth business, rapidly controlled by the multinationals of the electrical appliances industry (General Electric, Westinghouse, Siemens, Philips), as well as some independent specialized and mainly German firms (Müller; Reiniger, Gebbert & Schall; Veifa).<sup>5</sup> The key technology of these devices quickly appeared to be the X-ray tube, and the fact that the electrical appliances enterprises had mastered vacuum tube know-how allowed them to become the main actors of this new industry.

Within the general framework of the global expansion of this industry, Japan appears as a particular case for at least three reasons. First, one must consider the specific structure of the Japanese medical market. In comparison with other countries, it is characterized by relatively atomized, highly privatized health-care institutions (hospitals, clinics),<sup>6</sup> a particularity which meant that the health-care system relied on an increased number of small institutions rather than on the concentration of health care in a few major urban hospitals. Indeed, the number of hospitals increased from 395 establishments (of which 38.7% were private) in 1880 to 1344 (93.8% private) in 1920 and 2925 (96.1% private) in 1935. The proportion of beds per hospital even tended to drop during the interwar years – from 37.9 in 1920 to 30.8 in 1935. As for the clinics, included in the censuses since 1934, there were 35,772 in 1935.<sup>7</sup> Keen competition on the Japanese health-care market obviously accelerated the diffusion of new medical technologies, as possession of state-of-the-art equipment gave establishments a clear edge. Second, Japan was one of the very rare countries where domestic firms were able to compete effectively over time with global multinationals in the X-ray machine field. This was

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<sup>1</sup> Donzé 2005.

<sup>2</sup> Blume 1992, Löwy 1993, Stanton 1999, Pickstone 2000 and Stanton 2002 (particularly her introduction, 1–18).

<sup>3</sup> Rosner 1982, Howell 1995 and Donzé 2007.

<sup>4</sup> About radiology in general, see Holtzmann Kevles 1997.

<sup>5</sup> Chandler 1990, pp. 218-219 and 579, Kees 2003.

<sup>6</sup> Ikai 2010, Sugaya 1981. According to the definition set up in 1933 by the Health Bureau of the Ministry of Interior in 1933, hospitals (*byoin*) are health centers with 10 beds and more, while clinics (*shinryojo*) have fewer than 10 beds. This limit was raised to 20 beds in 1948.

<sup>7</sup> Nihon tokei kyokai 2006, vol. 5, pp. 170–171.

the case of the company Shimadzu Works (*Shimadzu seisakujo*), which arrived on this market after the First World War, and succeeded in challenging Siemens and establishing itself as the dominant actor of this business in the 1920s.<sup>8</sup> Third, X-ray machines are a particular technology which became stable in the 1930s, that is, in an environment which was not favorable for foreign enterprises in the case of Japan, due to an industrial policy aimed at helping a national industry grow.<sup>9</sup> The features of this environment (high-growth market, local competitors, unfavorable policy to foreign firms) made it necessary for the multinationals involved in this business to adopt specific strategies. This paper focuses on the case of the German multinational enterprise Siemens, attempting to shed light on its strategy for the Japanese market for X-ray machines. The course of Siemens on this particular market between 1900 and 1945 was characterized by its failure to keep the dominant position it had until World War I. Even if it enjoyed an undeniable technological advantage on the worldwide market of X-ray machines, it was unable to prevent newcomers from challenging it in Japan.

As most of the German multinationals were doing on a global scale, Siemens gave priority to an export strategy rather than direct investments up to World War II, but did relocate part of its production when so compelled by local political conditions or competition with other firms, especially in Central and Eastern Europe.<sup>10</sup> This phenomenon has been clearly explained by Kudo Akira in the case of Japan.<sup>11</sup> The presence of Siemens in Japan goes back to 1861, with the gift of a telegraph to the Emperor upon the occasion of the signing of the treaty between Germany and Japan.<sup>12</sup> In the 1870s, the German firm delivered several electrical devices and appliances to the army, the administration and private companies. At first, it exported its products through trading companies, subsequently arranging for representation in Japan by sending Hermann Kessler in, who opened an office in Tokyo (1887).<sup>13</sup> The company was officially registered under the name of Siemens Schuckert Electric Co. in 1905 (thereafter Siemens Japan). Even though it favored exports and did not make any direct investments in production, Siemens played a key role in technology transfer towards Japan, through the German and Japanese engineers who installed and maintained its equipment. In 1898, Siemens Japan employed eight persons, six of whom were Japanese.<sup>14</sup> However, the main feature of the strategy adopted by Siemens in Japan before 1945 was the realization of a large direct investment after World War I, with the creation of the joint venture company Fuji Electric (*Fuji denki*) together with the *zaibatsu* Furukawa (1923), a new firm to which

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<sup>8</sup> Shimadzu 1967.

<sup>9</sup> Mason 1992, pp. 48-99, Udagawa 1987, Yuzawa and Udagawa 1990, Gaimusho tokubetsu shiryobu 1978.

<sup>10</sup> Imakubo 2000.

<sup>11</sup> Kudo 1998.

<sup>12</sup> Siemens K.K. 1987, Takenaka 1991, Takenaka 2009, and Siemens Corporate Archives, Munich (thereafter SCA), 7912 *Chronology of Siemens-Schuckert D.K.K., Tokyo, 1944.*

<sup>13</sup> Siemens K.K. 1987, p. 17.

<sup>14</sup> SCA, 7912 *Chronology of Siemens-Schuckert D.K.K., Tokyo, 1944*, p. 5.

Siemens gradually transferred its production during the interwar years.<sup>15</sup>

Yet most research carried out on Siemens in Japan during the first part of the 20th century failed to consider the case of X-ray machines, a sector which also led in 1933 to a second joint venture with a Japanese trading company specialized in medical goods, Goto Fuundo. This joint venture was only mentioned in passing by the Ministry of Foreign Affairs in its analysis of foreign direct investment (FDI) published in 1948,<sup>16</sup> which is incidentally the main source used by historians who focused on FDI in Japan before World War II. Although he used another source, also published in 1948, Kudo only listed Goto Fuundo as an operating company of Siemens & Halske without giving any details of its activities or explaining its specific development.<sup>17</sup> This historiographic gap can also be explained by the unique path of medical business within the Siemens group. Originally integrated within the enterprise Siemens & Halske, the X-ray machine division was spun off into a new company when Reiniger, Gebbert & Schall merged – Siemens-Reiniger-Veifa GmbH (SRV, 1925). Since then, this new firm based at Erlangen has been responsible for the production of medical devices within the Siemens conglomerate (currently: Siemens Healthcare). It still has its own archive center there, while the documents usually used by historians working on Siemens are kept in another, Munich-based institution (Siemens-Archiv-Akt, SAA). This institutional compartmentalization of archives is no doubt why Siemens' activities with regard to X-ray machines have not been taken into consideration.

One should also mention that the business of medical devices – essentially X-ray machines – was only a sideline in comparison with other traditional sectors of Siemens (telegraphs, turbines, power stations, electrical appliances). It was, however, the only sector to lead to specific direct investment and was instrumental in modernizing medical equipment and turning medicine into a business in Japan. The involvement of Siemens in the business of X-ray machines in Japan is approached hereafter in four parts, which look at the firm's strategic choices (export, licensing, direct investment) against the background of the changing economic and technological environment.

## **1. The beginnings of radiology in Japan: a monopoly of German manufacturers (1900–1914)**

Up until World War I, the market of X-ray machines for medical use consisted only of imports with the exception of a few machines assembled with imported parts from 1908 onwards by

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<sup>15</sup> Watanabe 1984.

<sup>16</sup> Gaimusho tokubetsu shiryobu 1948, p. 99

<sup>17</sup> Kudo 1998, p. 28.

Shimadzu Works, a manufacturer of scientific instruments.<sup>18</sup> As we lack foreign trade statistics for these machines, it is not possible to determine the various market shares for individual countries. However, a qualitative approach brings out the virtual monopoly exercised by German manufacturers, mainly Siemens & Halske, Reiniger, Gebbert & Schall AG (RGS) and Veifa. The book on Japanese radiology published in 1969 by Goto Goro as some annals does not mention the acquisition of foreign X-ray machines that were not German prior to 1914.<sup>19</sup>

Thus, the Japanese Imperial Army ordered one of the first radiology devices installed in Japan from Siemens in December 1898, for its school of medicine.<sup>20</sup> As for the company Siemens Japan, 1901 was the year it received its first order from the Army, consisting of “a great many Siemens-Roentgen apparatuses”.<sup>21</sup> In any case, the Army and the Navy were the first customers of the German firm at the beginning of the 20th century. Japanese officers were impressed by the portable X-ray machines used on the battlefield by the German Army during the Boxer War and decided to acquire some.<sup>22</sup> In 1904, in connection with the war against Russia, the Imperial Army ordered some new X-ray equipment from Siemens, especially for its garrison hospitals of Hiroshima and Matsuyama.<sup>23</sup> After the war, the Army and the Navy decided to equip all their hospitals with Siemens X-ray machines (1906).<sup>24</sup>

As the volume of orders rose, Siemens Japan adopted a strategy to actively develop this business, notably in civilian medical circles. In 1909, it launched new machines, and two years later it opened a separate division for medical devices that employed four persons, all Japanese citizens, including a doctor,<sup>25</sup> developing a communication policy aimed at increasing recognition for its products among civilian doctors. In 1903, Siemens had already presented an X-ray machine at the Fifth National Industrial Exhibition of Osaka that had impressed the public.<sup>26</sup> But the goal of such an event was above all to stress the technological superiority of Siemens as a whole. Opening the medical division in 1911 had a more practical aim: increasing sales of X-ray machines and penetrating the private medicine market. Thus, in 1910, a Siemens engineer displayed some devices at a conference of the Japanese Medical Society (*Nihon igakkai*).<sup>27</sup> This strategy of diversification towards the private sector was successful. In the years leading up to World War I, Siemens of course continued its shipments to the Army but extended in parallel its activities targeting universities and some of the most

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<sup>18</sup> Goto 1969, p. 64.

<sup>19</sup> Goto 1969.

<sup>20</sup> Goto 1969, p. 22.

<sup>21</sup> SCA, 7912 *Chronology of Siemens-Schuckert D.K.K., Tokyo, 1944*, p.6.

<sup>22</sup> SCA, 7912 *Chronology of Siemens-Schuckert D.K.K., Tokyo, 1944*, p.6.

<sup>23</sup> SCA, 7912 *Chronology of Siemens-Schuckert D.K.K., Tokyo, 1944*, p. 7.

<sup>24</sup> Goto 1969, p. 55.

<sup>25</sup> Goto 1969, p. 69.

<sup>26</sup> SCA, 7912 *Chronology of Siemens-Schuckert D.K.K., Tokyo, 1944*, p. 7.

<sup>27</sup> Goto 1969, p. 75.

renowned private hospitals (Hayashi Hospital; Juzen Hospital; Ogata Hospital; Tamura Hospital; etc.).<sup>28</sup> In 1913, Siemens delivered scores of X-ray machines, especially to the Navy and to several prefecture hospitals (Aichi, Gifu, Hiroshima, Yamaguchi), that is, benchmark medical institutions in their regions.

The virtual monopoly that German manufacturers, particularly Siemens, had over the Japanese market for X-ray machines can be explained by two factors: the relative weakness of American and British manufacturers until 1914, and the fascination of the Japanese scientific and medical world for German medicine. At the time, Germany and the other German-speaking countries (Austria and part of Switzerland) were the favorite destination of Japanese doctors trained abroad in the late 19th century.<sup>29</sup> Moreover, when the Faculty of Medicine of the University of Tokyo was founded, in 1871, its chairs were entrusted first to German doctors then, in the next generation, to Japanese doctors trained in Germany, mainly at the University of Berlin.<sup>30</sup> Of special note is the case of Julius Scriba (1848-1905), a professor of surgery at the University of Tokyo who trained many Japanese surgeons. In February 1898, he brought back an X-ray machine from Germany and set it up in his department.<sup>31</sup> The social networks of medicine appeared to have been a decisive channel for the supply of X-ray equipment in Japan until 1914.

## **2. Political and technological breakdown: towards a competitive market (1914–1930)**

The First World War was a double breakdown, on both the political and technological levels, ending Siemens' hegemony on the Japanese market for X-ray machines. On the one hand, as occurred in other sectors of the economy, the war interrupted economic relations with Germany.<sup>32</sup> Not only were imports of German goods stopped overnight, but holdings of German companies, especially patents, were seized by the Japanese authorities. In the case of X-ray machines, the abrupt disappearance of German firms, which had totally controlled this market until 1914, made it possible for rival companies to launch into this activity. This was notably the case with other foreign manufacturers, such as the American company Victors X-Ray Corporation, close to General Electric. With the war, the Japanese importers and distributors launched non-German X-ray machines and sometimes tried to engage in production. For example, the trading house Iwayashi Iwamoto Tokichi marketed X-ray machines made by the British firm Watson and the American company Victors, delivering

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<sup>28</sup> Siemens Corporate Archives, Med-Archiv Erlangen (thereafter MAE), unmarked folder, *Die Tätigkeit des Haus Siemens in Japan auf das Gebiet der elektromedizinischen Technik*, 31 May 1958.

<sup>29</sup> Donzé 2010.

<sup>30</sup> Tokyo daigaku igakubu hyakunenshi henshuiinkai 1967, pp. 123–34.

<sup>31</sup> Goto 1969, p. 22.

<sup>32</sup> On the relationships between Japan and Germany, see Kudo, Nobuo and Pauer 2009.

around ten to hospitals in 1915.<sup>33</sup> In addition, it set up a radiology division that was absorbed after the war by the company Tokyo Medical Electric Co (*Tokyo igaku denki*), founded in 1916.<sup>34</sup> As for the company Goto Fuundo, which went on to partner with Siemens in the mid-1920s, it redirected its sourcing from Germany to France, the United States and the United Kingdom.<sup>35</sup> Moreover, some domestic producers, such as Shimadzu, Tokyo Electric Medical Care (*Tokyo iryo denki*) and Akiyama, began at the time to produce their own devices.<sup>36</sup> For example, in 1915 Shimadzu marketed its first serially produced X-ray machine for medical purposes, the A model.<sup>37</sup> These Japanese producers also took advantage of the absence of German manufacturers to export their goods during the war, mainly to Russia, India, China and Australia.<sup>38</sup> In the first half of the 1920s, numerous small companies brought machines onto the market. By 1923, the following companies were marketing some X-ray devices: Shimadzu, Dainihon Roentgen, Okura Roentgen, Morikawa Works, Akiyama Works and Goto Fuundo, not to mention distributors of foreign machines.<sup>39</sup>

Mention should be made of a major technological breakthrough in the United States, at the laboratory of the multinational General Electric Co (GE) – the development of the Coolidge X-ray tube (1913).<sup>40</sup> The particularities of this tube (high vacuum; tungsten spiral filaments for heating) enabled an easy control of the dosage of rays by delinking their volume (current) from their penetrative power (voltage). This innovation made possible an excellent application of radiology to medicine, largely contributing to its rapid diffusion. In Japan, this technology was controlled by Tokyo Electric Co, a GE-affiliate founded in 1905 that enjoyed a monopoly on imports and sales of Coolidge tubes in Japan, and subsequently their manufacturing, from 1920 onwards.<sup>41</sup> Yet until the early 1930s, GE did not produce complete X-ray appliances but only tubes, which were sold to appliance makers. The American multinational was however not the sole tube producer, even if its tubes were the best quality. GE's main rivals were German companies, namely Müller and Phoenix, which were producing in the 1920s respectively for the Dutch company Philips and Siemens. In Japan, there were also several manufacturers producing lower-quality copies (Kanezawa Medical Appliances Co, Shibuya Roentgen Co).<sup>42</sup> But until the beginning of the 1930s, both GE and Tokyo Electric produced only X-ray tubes which they supplied to X-ray machine

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<sup>33</sup> Goto 1969, p. 126.

<sup>34</sup> Goto 1969, p. 160.

<sup>35</sup> Goto 1969, p. 126.

<sup>36</sup> SCA, 15 Ln 376, R. Momotani, *Future prospects in Japan with special consideration of the Siemens & Halske business*, November 1919.

<sup>37</sup> Goto 1969, p. 126.

<sup>38</sup> SCA, 15 Ln 376, R. Momotani, *Future prospects in Japan with special consideration of the Siemens & Halske business*, November 1919.

<sup>39</sup> Goto 1969, pp. 223-224.

<sup>40</sup> Siemens 1957, vol. 2, pp. 79–80. On the Coolidge tube, see Arns 1997.

<sup>41</sup> Tokyo shibaura denki 1963, p. 474.

<sup>42</sup> Goto 1969–1970.

manufacturers, especially Shimadzu. The latter indeed approached Tokyo Electric and used Coolidge tubes for its machines from 1917 onwards.<sup>43</sup> An agreement was even signed in 1922 between the two firms, thereby securing Shimadzu's supply.<sup>44</sup>

In the early 1920s, when Siemens was planning to come back onto the Japanese market for X-ray machines, the structure of this market had changed radically. Although its main rivals on the global scale, namely General Electric and Westinghouse Electric, did not take the opportunity to engage into this business, despite a favorable commercial flow between 1914 and 1918, some local newcomers had emerged and established themselves as dominant actors, especially Shimadzu, which benefited from GE technology and adopted a particularly active strategy of promotion of its machines within medical circles. The new competitiveness of this market throughout the world led Siemens to restructure this division, both on a global scale and in Japan.

### *2.1 New organization of Siemens*

The German industry for X-ray machines underwent broad concentration wave in the 1920s which benefited Siemens.<sup>45</sup> This rationalization of the means of production, made necessary by the financial difficulties which many manufacturers faced after World War I, enabled this sector of German industry to recover its prewar competitiveness. The main merger that occurred at the time was the takeover of the company Reiniger, Gebbert & Schall AG (RGS) by Siemens & Halske (1924). Founded at Erlangen in 1886, RGS was a maker of electrical devices for medicine that embarked in 1896 on the production of X-ray machines for Wilhelm Roentgen.<sup>46</sup> After becoming a joint stock company in 1906, it opted for a strategy of growth based on the acquisition of small rival firms, for example the Frankfurt-based manufacturer of X-ray machines Veifa Werke (1916), subsequently setting up a holding company, Industrieunternehmungen AG (Inag), in 1921. Bringing together some twenty small and medium-sized firms involved in the production of medical appliances and materials, including the X-ray machine makers RGS, Veifa, Sanitas and Polyphos, this holding aimed at centralizing distribution in order to compete with big enterprises like Siemens. However, this strategy was not financially viable, resulting in the takeover of RGS and Inag by Siemens & Halske in 1924. Siemens then merged RGS with its own X-ray machines division into a new enterprise, Siemens-Reiniger-Veifa GmbH (SRV, 1925), subsequently renamed Siemens-Reiniger Werke AG (SRW, 1927).

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<sup>43</sup> Goto 1969, p. 148.

<sup>44</sup> Shimadzu 1967, p. 45. Goto 1969, p. 179 quotes 1920.

<sup>45</sup> Siemens 1957, vol. 2, pp. 81–85 and SCA, 7912 *Chronology of Siemens-Schuckert D.K.K., Tokyo*, 1944, p. 4.

<sup>46</sup> Siemens 1957, vol. 1, p. 280.

This rationalization of production in Germany in 1924 also provided an occasion to restructure the import and distribution of X-ray equipment in Japan. For Siemens, this business was secondary in comparison with other key sectors such as telecommunication and energy. In the report on business opportunities in Japan that he wrote in November 1919, Momotani R., an employee of Siemens Japan, did not pay so much attention to X-ray machines and tubes.<sup>47</sup> In 1923, when the joint venture Fuji Electric was set up by Siemens & Halske and the *zaibatsu* Furukawa, a medical division employing six persons was organized.<sup>48</sup> However, according to the corporate history published by Fuji Electric, it only imported products and was not involved in production.<sup>49</sup> Yet this division showed growth during the months following the Great Kanto Earthquake (1 September 1923). Many hospitals and clinics used the reconstruction as an opportunity to reorganize themselves into modern medical institutions.<sup>50</sup> Between September 1923 and June 1926, Siemens delivered to medical establishments, mainly based in the Tokyo area, a total of 101 X-ray machines, 20 X-ray tubes and 32 various medical devices, such as electrocardiograms and diathermy devices.<sup>51</sup>

This division was headed from 1924 onwards by a German engineer sent by Siemens & Halske, Otto Kresta. A holder of a PhD in physics who specialized in X-ray devices, he played a key role in the reactivation and the development of the medical networks of Siemens.<sup>52</sup> Indeed, he participated actively in events organized by the Japan Roentgen Association (*Nihon rentogen gakkai*) from 1924 onwards. He was the only foreigner to attend regularly up until World War II, and gave papers in German on X-ray machines, their operation and their use, which were then published in the journal of the Association (*Japan Roentgen Association Review; Nihon rentogen gakkai zasshi*). This strategy of communication aimed at scientific circles was also used in the 1920s and 1930s by the main rival companies of SRW (Shimadzu, Tokyo Electric).<sup>53</sup> Its objective was to strengthen the scientific image of the firm within the medical world and also to make its own new machine known. After 1926, Kresta continued his activities inside the company Goto Fuundo, the medical goods trading company with which SRW signed an agreement.

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<sup>47</sup> SCA, 15 Ln 376, R. Momotani, *Future prospects...*, op. cit.

<sup>48</sup> SCA, 7912 *Chronology of Siemens-Schuckert D.K.K., Tokyo*, 1944, p. 2.

<sup>49</sup> Fuji denki 1957, p. 281.

<sup>50</sup> The same phenomenon can also be observed in the industry. See Imaizumi 2008.

<sup>51</sup> MAE, unmarked folder, *Die Tätigkeit des Haus Siemens in Japan auf das Gebiet der elektromedizinischen Technik*, 31 May 1958.

<sup>52</sup> Momotani 1955, p. 42.

<sup>53</sup> See for example Shimadzu 1967.

Tab. 1: Papers presented by Otto Kresta at the Japan Roentgen Association, 1924–1929

Title	Date
Technology of deep therapy devices	1924
X-rays and their application	1924
Protection against radiation from R-ray machines	1926
New trends in the X-ray field	1929
The Japanese climate and the processing of Roentgen machines	1929

Source: Goto 1969, various pages.

Note: No more conferences are mentioned after 1929.

## 2.2 A successful newcomer: Shimadzu Works

SRW was not the only X-ray machine producer to take up a specific communication strategy towards the medical world. Indeed, the policy introduced through Kresta’s engagement within Japanese medical networks since 1924 appears as an attempt to react to the establishment of a competitive newcomer, namely the company Shimadzu Works (*Shimadzu seisakujo*), which was then challenging the dominant position of SRW, thanks to the adoption of a completed strategy of market penetration. Of course, the development of Shimadzu did not rely solely on marketing strategy, but also depended on an internalization policy of know-how and technological capabilities. Founded at Kyoto in 1875 as a scientific instrument maker, this family firm also engaged in the production of X-ray device for medical purposes in 1908, successfully launching its first serial-produced machine in 1915. It built its organizational capabilities in the development of X-ray machine in the 1920s on the hiring of university-graduated engineers and the subcontracting of R&D to outside research centers.<sup>54</sup> However, the key factor of Shimadzu’s ability to challenge Siemens on the Japanese market was undoubtedly the adoption of an original marketing strategy, which consisted of three main thrusts: establishing networks in the medical world, organizing scientific events and setting up schools for radiology technicians.

First of all, Shimadzu established ties with medical circles through doctors. This approach appears as a key element of the expansion strategy towards the medical field adopted by the company in the 1910s. When Shimadzu was turned into a joint stock company in 1917, Shimadzu Genzo, owner of the firm and main shareholder, comprised 42 persons, of whom 12 were doctors. These practitioners were a key resource for the commercial opportunities of the

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<sup>54</sup> Shimadzu 1967.

firm. They all had similar profiles: after graduating from the Universities of Tokyo and Kyoto then training in Europe, they were running private hospitals they owned, in addition to which several were engaged in professional associations, when Shimadzu Corporation Ltd was founded (1917).<sup>55</sup> The career of Ogata Masakyo perfectly exemplifies these various aspects. Born in 1864, himself the son of a doctor, he studied medicine at the University of Tokyo before training in Germany and Austria, where he specialized in gynecology-obstetrics (1888–1892). Upon his return to Japan, he joined the hospital founded by his father at Osaka – which had acquired a Siemens X-ray machine at the beginning of the 1910s – where he took over the management. Obtaining his PhD in medicine from the University of Tokyo in 1905, he was a notable of Osaka in the early 20th century. President of the Osaka Physicians’ Association and of the Osaka Midwifery Association, as well as Vice-President of the Dai-Nihon Physicians’ Association, he also served as Director of the Osaka Charity Hospital’s College of Medicine and was a member of the Osaka Municipal Assembly. Finally, he ran a medical laboratory in the city of Osaka.<sup>56</sup> Like him, the doctors who joined Shimadzu were entrepreneurs who helped turn medicine into a business. For these private practitioners, new technologies such as X-ray machines were destined to not only improve their medical practice but also strengthen their position on the medical market, which was then becoming more and more competitive.<sup>57</sup> As for the firm itself, the purpose of this collaboration with such doctors was obvious: it allowed the company to access networks facilitating the sale and distribution of new devices, which were then launched on the market.

Shimadzu also developed a communication policy, primarily geared to organizing and participating in scientific events. For example, in 1921 it ran a one-week course (*koshukai*) introducing the principles of X-ray machines and their possible applications to medicine. Organized each year, this course became increasingly popular, with 22 participants in 1921, 80 in 1922 and 113 in 1924.<sup>58</sup> It was subsequently taken over and pursued in 1940 by the Japanese Medical Radiology Society (*Nihon igaku hoshasen gakkai*).<sup>59</sup> In addition to this one-week course, Shimadzu actively engaged in the scientific life of medicine from the mid-1920s onwards, mainly through the engineer Fukuda, who participated in the activities of the Japanese Roentgen Association, presenting papers at annual conferences and publishing articles in the society’s journal.<sup>60</sup> Shimadzu itself organized some scientific events. In February 1924, to mark the first anniversary of Wilhelm Roentgen’s death, the enterprise set up a Roentgen Festival (*rentogensai*), gathering together in Kyoto more than 200 persons who

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<sup>55</sup> Shimadzu 1967, p. 36.

<sup>56</sup> Iseki 1921-1930, vol. 2, 78-79

<sup>57</sup> Ikai 2010, 78-88.

<sup>58</sup> Shimadzu 1967, 49. The numbers are unknown for the following years. In 1923, a similar course for dentists was organized.

<sup>59</sup> Shimadzu 1967, 49.

<sup>60</sup> Goto 1969-1970.

heard a series of scientific communications.<sup>61</sup> A similar event has taken place since then every year, a practice which still exists today. Moreover, Shimadzu has also published since 1925 its own scientific journal, the *Shimadzu Radiology Bulletin* (*Shimadzu rentogen jiho*), which largely consists of articles by the firm's employees.<sup>62</sup>

Finally, the last communication strategy adopted by Shimadzu was to set up a training center for radiology technicians. While contributing to the professionalization of the assistants in charge of X-ray machines in hospitals and clinics, the firm not only ensured the training of a new generation of technicians able to use X-ray equipment effectively but also backed the diffusion of this new technology into Japanese healthcare institutions and encouraged the use of its own apparatuses. The Training Center for X-Ray Technology (*Rentogen gijutsu koshujo*) was opened at Kyoto in 1927. Renamed the Special School for X-Ray Technology (*Rentogen gijutsu senshu gakko*) in 1935, it remained a pioneer until the 1950s, playing a key role in the training of X-ray technicians in Japan until then. Together with the Osaka School of Physiotherapy, which was founded in 1935 and ran courses for X-ray technicians from 1935 onwards, it was the only training center for these technicians until 1950.

As the gross sales of the X-ray machine division of Shimadzu are unknown before 1935, it is difficult to consider the growing competitiveness of this firm towards Siemens. According to the corporate history published by Shimadzu, the sale of X-ray devices amounted at only one or two machines each year at the beginning of the 1910s. It grew up to about 100 machines and a value of 700,000 yen in 1924, and then to 250 machines in 1926, for a value estimated at 1.7 million yen.<sup>63</sup> In comparison to this growing importance, the export of X-ray machines by SRW to Japan was less than 300,000 yen both in 1924 and 1926.<sup>64</sup> Siemens had been overcome in the first part of the 1920s by a domestic competitor who had adopted an active marketing strategy of accessing a growing medical market.

### 2.3 *The agreement with Goto Fuundo (1926)*

In reaction to the loss of its market share, in 1926 SRW entered into an alliance with a small trading firm specialized in the sale and the distribution of drugs and medical goods, Goto Fuundo. Founded at Tokyo in 1886 by Goto Setuzo, a young graduate of the Faculty of Pharmacology of the University of Tokyo (1883), this company was originally a manufacturer and distributor of medicine that subsequently diversified into the trade then the production of

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<sup>61</sup> Shimadzu 1967, 50.

<sup>62</sup> It was renamed *Shimadzu Hyoron* (1940) and still exists today. See [www.shimadzu.co.jp/tec\\_news/index.html](http://www.shimadzu.co.jp/tec_news/index.html) (website accessed 19 March 2010).

<sup>63</sup> Shimadzu 1967, 353 and 356.

<sup>64</sup> MAE, 770-2, *Unser Export nach Japan und unsere zukünftigen Aussichten*, 20 October 1934.

medical instruments and machines.<sup>65</sup> This shift from pharmacy towards mechanics, which most certainly induced a technological paradigm shift, was not exceptional and can be observed in several other cases. For example, this is what happened in the Osaka-based company Shiraimatsu, a drug trading house established 1716 which converted to mechanics and the production of equipments for hospitals in the 1870s.<sup>66</sup> Another case is provided by the company Sankyo, specialized in the import and distribution of drugs. In 1908, it opened a division for importing and trading in medical devices, essentially from Germany. Nevertheless, it did not engage in production of machines.<sup>67</sup> This transfer towards new activities can obviously be explained by the specificity of the medical market, structured during the Edo period, and these firms' control of distribution channels, which facilitated the flow of new products.

Goto Fuundo followed a similar path along which medical instruments and appliances, particularly X-ray machines, quickly took an important place beside drugs. Indeed, this company did not give up the business of medicines despite the growth of the appliances division. According to the 1928 edition of *The Japan Industrial Directory*, Goto possessed a drug factory at Nakano Wards, Tokyo, as well as several sale subsidiaries throughout Japan, including one at Osaka, in the historical area of drug traders, Doshomachi.<sup>68</sup> This infrastructure is still mentioned in the 1936 edition of the directory.<sup>69</sup> Moreover, among the five members of the board of directors of this family firm, there was Fukuhara Shinzo, the son of the founder of the cosmetics company Shiseido, that is, a business which largely used the same sales and distribution channels as the pharmaceutical industry.<sup>70</sup>

Beside its involvement in the medicines business, Goto Setuzo soon launched into the import and distribution of surgical instruments and equipment for hospitals. He regularly published a trading catalog, the tenth edition of which came out in 1906.<sup>71</sup> Among the foreign machines he offered, there were some X-ray machines. In September 1900, he already delivered one to the Faculty of Medicine of Sendai Second High School.<sup>72</sup> Three years later, Goto Setuzo's tour of Europe, probably in Germany, marked a decisive step.<sup>73</sup> That same year, he imported some parts for X-ray machines from the German company Hirschman (1903) to Japan.<sup>74</sup> In 1908, he obtained the exclusive importation and distribution rights for Japan for the X-ray

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<sup>65</sup> Goto 1969, p. 42.

<sup>66</sup> Shiraimatsu kikai 2002.

<sup>67</sup> Yamashita 2010, p. 145.

<sup>68</sup> *Nihon kogyo yokan*, 1928, p. 105.

<sup>69</sup> *Nihon kogyo yokan*, 1936, p. 127.

<sup>70</sup> 20 seiki nihon 2001, vol. 2, pp. 22-29.

<sup>71</sup> Goto 1906.

<sup>72</sup> Goto 1969, p. 30.

<sup>73</sup> Goto 1969, p. 42.

<sup>74</sup> Goto 1969, p. 42.

machines from the firms Hirschman and RGS.<sup>75</sup> Moreover, he began to do business with Siemens, from which he ordered several medical appliances in 1912, including six X-ray tubes and a complete set of radiology equipment (orthoscope).<sup>76</sup> Finally, Goto Fuundo adopted an active strategy of communication targeting medical circles early on. In April 1908, it organized for example a demonstration of the practical use of X-ray machines at a meeting of the Japanese Digestive Organs Diseases Association (*Nihon shokakibyō gakkai*).<sup>77</sup> The following year, Goto Ryohei published some articles on the use of X-ray machines in the journal of this society.<sup>78</sup>

In order to maintain and repair the medical appliances and X-ray machines sold to the hospitals and clinics, Goto Fuundo was obliged to internalize some technical know-how which subsequently helped it launch into production. In 1915, it engaged an engineer, Watanabe Motomu, who graduated that same year from the Electric Department of Tokyo Industrial College (Tokyo Institute of Technology since 1929).<sup>79</sup> In 1921, he went on a business trip to Europe together with the doctor Fujinami Goichi, a pioneer of radiology in Japan and a professor at Keio University.<sup>80</sup> Watanabe subsequently served on the board of directors until after the war.<sup>81</sup> A second engineer, Kawamura Kosaku, joined the company around 1917. He graduated from the same department as Watanabe<sup>82</sup> and became chief engineer of Goto Fuundo around 1921.<sup>83</sup> Finally, Goto Fuundo tried to start producing X-ray machines in 1918, a decision that was clearly linked to the opportunity opened up by the interruption of imports from Germany due to the war. Goto Fuundo founded a subsidiary that year, Tokyo Electric Industry (*Tokyo denki kogyō*), whose purpose was to manufacture electrical appliances and particularly X-ray machines.<sup>84</sup> To do so, it relied on top-flight researchers. While the technical direction of the new firm was entrusted to Iwayama, an engineering graduate,<sup>85</sup> Goto Fuundo hired as consultants professor Fujinami and professor Torikata Uichi, who held a PhD in electrical engineering from the University of Tokyo and was at the time director of the Electrotechnical Laboratory of the Ministry of Communication.<sup>86</sup> Despite such excellent knowledge resources, this new firm seems to have quickly given up its activities. On the one hand, it is not quoted in 1919 in the main

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<sup>75</sup> Goto 1969, p. 64.

<sup>76</sup> SCA, 7912, Lieferübersichten, 8 June 1935.

<sup>77</sup> Goto 1969, p. 64.

<sup>78</sup> Goto 1969, p. 67.

<sup>79</sup> Goto 1969, p. 128.

<sup>80</sup> Goto 1969, p. 194. On Fujinami, see Iseki 1921-1930, vol. 2, p. 222.

<sup>81</sup> He was still a member of the Board in 1950. Goto Fuundo, *Eigyō hokokusho*, 1950.

<sup>82</sup> *Nikan kogyō shimbun* 1934, p. 201.

<sup>83</sup> Goto 1969, p. 194.

<sup>84</sup> Goto 1969, p. 160.

<sup>85</sup> Goto 1969, p. 160.

<sup>86</sup> Iseki 1921-1930, vol. 5, p. 250.

directories listing industrial companies in the country.<sup>87</sup> On the other hand, the company Goto Fuundo was restructured in 1919, taking the form of a joint stock company with a capital of 550,000 yens.<sup>88</sup> The objectives of this new society were notably the “manufacturing of [...] surgical, chemical, physical, bacteriological, and optical apparatus and instruments, and other general electrical apparatus and instruments”<sup>89</sup>, beside the traditional activities of Goto (manufacture and sale of drugs, trade of various medical materials, hospital equipment). The medical instruments and machines workshop of Tokyo Electric Industry was then clearly taken over by Goto Fuundo in 1919, with a directory published in 1936 mentioning the existence of a mechanics workshop attached to the company.<sup>90</sup>

Despite these difficulties, Goto Fuundo was a major dealer in medical appliances in the 1920s. During that decade, it signed many exclusive import and distribution contracts with various foreign medical equipment manufacturers, mainly German, such as the companies Mayer & Rotzler (1923), Veifa-Werke (1924), Phoenix, (1924), RGS (1924), all part of the holding Inag.<sup>91</sup> In return, Inag received 50,000 yen of the capital of Goto Fuundo (that is 9.1%), a share which went to Siemens after it took over Inag. Other similar contracts were signed with Siemens (1926), as well as the German manufacturer of devices for dentists, Adam Schneider (1928), and the Swiss producer of hospital equipment Schaeerer (1928).<sup>92</sup> For all these firms, access to the Japanese medical market was the purpose of such agreements with Goto Fuundo. For example, the contract signed with Mayer & Rotzler explicitly specified that “Goto engages to make a generous advertisement for Mayer’s products, adapted to the territory covered by the agreement. Goto especially undertakes to provide, as need be, catalogues in Japanese and Chinese language to the doctors and to draw their attention to the innovations through appropriate leaflets, advertisements and publications in key journals, as well as giving thought to a well-equipped, appropriate space for sale and demonstration.”<sup>93</sup> The contracts signed with the other firms bore similar clauses, with those signed with RGS and Phoenix also stipulating the organization of “Roentgen courses” twice a year.<sup>94</sup>

For Siemens, the takeover of Reiniger, Gebbert & Schall AG (RGS) led to the restructuring of the distribution of medical goods on the Japanese market and the signature of an exclusivity contract with Goto Fuundo, which evidently possessed better networks with medical circles than Fuji Electric. In 1926, Goto Fuundo signed two contracts, one with Siemens Reiniger Werke (SRW), giving it exclusive rights to distribute its products on the Japanese market, and

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<sup>87</sup> This company was for example not cited in the 1919 and following editions of the *Nihon kogyo yokan*.

<sup>88</sup> Goto 1969, p. 170.

<sup>89</sup> MAE, unmarked folder, *Statutes of S. Goto Fu-undo Co. Ltd.*, not dated (probably 1919).

<sup>90</sup> *Nihon kogyo yokan*, 1936, p. 127.

<sup>91</sup> MAE, unmarked folder, Contracts between Goto Fuundo and various foreign firms.

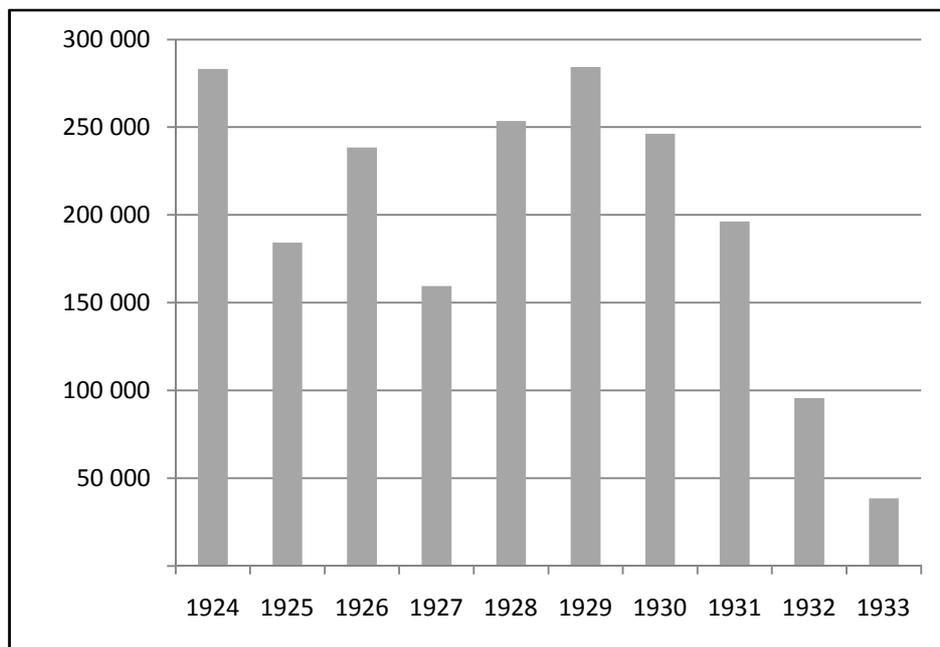
<sup>92</sup> MAE, unmarked folder, Contracts between Goto Fuundo and various foreign firms.

<sup>93</sup> MAE, unmarked folder, Contract between Goto Fuundo and Mayer & Rotzler (art. 3), 18 August 1923.

<sup>94</sup> MAE, unmarked folder, Contracts between Goto Fuundo and various foreign firms.

the second with Fuji Electric, concerning the sale in Japan of the possible production of medical appliances by this company.<sup>95</sup> The 1926 contract between SRW and Goto Fuundo was extended in 1931 and then again in 1934 for four years.<sup>96</sup> In this context, Otto Kresta, head of the medical division of Fuji Electric from 1923 onwards, was engaged by Goto Fuundo in 1926.<sup>97</sup> Paid by Goto Fuundo out of the funds owed to SRW, Kresta became a member of the board of directors and played a key role as a technical consultant until World War II.<sup>98</sup>

Fig. 1: Sales from SRW to Goto Fuundo, in yen, 1924–1933



Source: MAE, 770-2, *Unser Export nach Japan und unsere zukünftigen Aussichten*, 20 October 1934.

Note: Unknown before 1927.

For SRW, the commercial and financial consequences of this agreement were however disappointing, as it did not enable it to overcome the competitiveness of Shimadzu and put an end to a growing loss of market share. While the 1926 contract mentioned the guarantee of annual orders for at least 250,000 yen,<sup>99</sup> this sum was reached only three times by 1933,

<sup>95</sup> SCA, 7912, *Vertretung des UB Med und seiner Vorgänger in Japan, 1887-1979*, 1979, p. 4.

<sup>96</sup> MAE, 770-2, Contracts between SRW and Goto Fuundo, 12 November 1931 and 1 January 1934.

<sup>97</sup> Momotani 1955, pp. 53-54

<sup>98</sup> National Diet Library, Tokyo, Archives of the Supreme Commander of the Allied Powers (thereafter SCAP), CPC 41470, Memo, 2 October 1946.

<sup>99</sup> MAE, unmarked folder, Contract between SRW and Goto Fuundo, 1926.

including for a year before the signature of the contract (see figure 1). Between 1926 and 1931, Goto Fuundo's orders from SRW only averaged 229,701 yen. Afterwards, the 30% devaluation of the Japanese yen in December 1931 made German products more expensive and largely explain the drop in orders, which plummeted from 95,550 yen in 1932 to 35,500 in 1933. However, SRW was still competitive with other foreign multinational enterprises. According to a SRW internal document, the German firm exported X-ray machines to Japan to the tune of 77,000 marks in 1933, that is, more than the official value of the German foreign trade statistics (76,000 marks).<sup>100</sup> Obviously, Siemens had no German rival in Japan. Moreover, American exports of X-ray machines amounted to a paltry 7,100 marks that same year.<sup>101</sup> However, SRW's real competition appeared on the domestic market in the early 1930s, with the growth of Tokyo Electric and Shimadzu. The position of Goto Fuundo on the market of medical devices was indeed weakening in the first half of the 1930s, with a dividend rate that dropped from 10% in 1927 at least to 7% in 1930, 5% in 1931 and 4% in 1935.<sup>102</sup>

### **3. Producing in Japan (1930–1945)**

The decision to transfer production of X-ray machines to Japan was a consequence of the new competitiveness of this market, following the launch of General Electric (GE) in the production of complete X-ray equipment; until then, it had produced only X-ray tubes, leaving the production of full equipment to a subsidiary, the Victors X-Ray Corporation, a Chicago-based manufacturer of medical devices in which GE invested in 1920 and merged in 1926.<sup>103</sup> The upcoming end of the validity of GE's patent on the Coolidge X-ray tube in the mid-1930s – 1934 in the case of Japan – on the one hand, and the development of German multinationals in this business on the other hand led GE to become involved in the business of complete X-ray machines, a high-growth market in the 1930s.

For Siemens, the issue was not the technology but rather the market. At a very early stage, it controlled its supply of Coolidge-type high vacuum X-ray tubes. Even though its rival Allgemeine Elektrizitätsgesellschaft (AEG) obtained manufacturing rights for the European market for the GE patent shortly before World War I broke out, Siemens held some patents for Germany related to tungsten anti-cathodes necessary to the production of Coolidge X-ray tubes. Thus, an agreement was signed between the two German multinationals, whereby AEG could use the Siemens patents but undertook in exchange to produce a determined quantity of

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<sup>100</sup> MAE, unmarked folder, Gegenwärtiger Stand des SRW-Geschäfts in Japan, 4 January 1939.

<sup>101</sup> MAE, unmarked folder, Gegenwärtiger Stand des SRW-Geschäfts in Japan, 4 January 1939.

<sup>102</sup> MAE, 174, Dividendenzahlungen von Goto.

<sup>103</sup> General Electric 1963, p. 6.

X-ray tubes for it.<sup>104</sup> Until the end of the 1920s, Siemens had no problems supplying tubes. Besides, two independent manufacturers emerged as producers of high-quality X-ray tubes exported throughout the world, the companies C.H.F. Müller and Phoenix Röntgenröhrenfabriken AG. While Müller was taken over by the Dutch multinational enterprise Philips in 1927,<sup>105</sup> SRW bought up Phoenix in 1932. Founded in 1918, this firm above all supplied Veifa with X-ray tubes and worked essentially for Siemens after 1925.<sup>106</sup> In fact, its takeover in 1932 reflected Siemens' desire to secure its supply of X-ray tubes.

In reaction to the arrival of GE on the X-ray machines market, SRW tried to establish an international cartel with other European firms (AEG, Philips, Müller, Elema-Schönander) for a share of the world market.<sup>107</sup> Under this agreement, Japan belonged to the markets attributed mainly to Siemens, together with Latin America, Sweden, Norway, Italy, Spain, Yugoslavia and Switzerland. According to a document dated 1934, Siemens and Philips shared the Japanese market with a relative proportion of 62%/38%.<sup>108</sup> Philips and Müller could thus export in Japan but no priority was given to their action. It was a privileged area of Siemens' business, where it encountered only American and domestic competitors.

The Japanese market for X-ray machines changed radically in the 1930s when GE's patent for the Coolidge tube expired (July 1934).<sup>109</sup> Until then, the involvement of Tokyo Electric, GE's subsidiary in Japan, in the business of radiology had been limited to the import and then the manufacture of tubes, an agreement having been signed in 1922 with the main Japanese manufacture of X-ray machines, the company Shimadzu Works.<sup>110</sup> Anticipating the end of their monopoly, GE and Tokyo Electric had begun to produce complete installations in the 1930s with the launch of the Giba 75 machine in 1932, a standardized X-ray machine which ensured the success of Tokyo Electric in the market.<sup>111</sup> Moreover, Tokyo Electric also founded in 1930 a sales company, Nippon Medical Electric (*Nihon iryo denki*), whose task was to market the machines imported from GE and produced in Japan by Tokyo Electric.<sup>112</sup> As for the production of tubes, this market saw the arrival of several newcomers after 1934. Shimadzu in particular managed to secure its supply of high-quality tubes thanks to its cooperation arrangements with the company Japan Quartz Industry Co (*Nihon sekiei kogyo*), to which it subcontracted R&D. In 1934, it designed a prototype of a Coolidge-type tube

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<sup>104</sup> Siemens 1957, vol. 2, p. 80.

<sup>105</sup> Kees 2003, p. 82.

<sup>106</sup> Siemens 1957, vol. 2, p. 85.

<sup>107</sup> MAE, 753, Verträge auf dem Arbeitsgebiet der Siemens-Reiniger-Werke AG. This document is undated but more recent than 1932, as its maps represent Manchukuo, which was founded then. Except the United States, Canada, Mexico, the United Kingdom and France, this agreement covers the entire world.

<sup>108</sup> MAE, 770–2, letter received from an anonymous correspondent in Berlin by Otto Kresta, 28 July 1934.

<sup>109</sup> Shimadzu 1967, p. 378.

<sup>110</sup> Shimadzu 1967, p. 45. Goto 1969, p. 179 cites 1920.

<sup>111</sup> Tokyo shibaura denki 1963, p. 708.

<sup>112</sup> 21 seiki 1998, p. 8.

based on a model of the German firm Müller.<sup>113</sup> The production of these tubes was then brought back to Shimadzu (1940).<sup>114</sup> The Japanese market for X-ray machines thus became very competitive in the early 1930s, due to the arrival of Tokyo Electric and the strengthening of Shimadzu's organizational capabilities. Already in 1930, the management of Siemens feared the creation of a big Japanese X-ray company based on the rapprochement between Goto Fuundo and Shimadzu.<sup>115</sup> In November, the German direction explained to Kresta its will to become closer to Goto Fuundo, in order to avoid this company drifting from SRW: "We consider right to tie up already now and for the longer as possible with Goto concerning the production."<sup>116</sup> That was done two years later.

### *3.1 The set-up of Goto Fuundo Manufacturing (1932–1934)*

In June 1932, SRW signed in Japan a contract with Goto Fuundo to set up a joint venture, Goto Fuundo Manufacturing (GFM), confirmed by the German management in November 1933.<sup>117</sup> Afterwards, SRW continued to support the development of Goto Fuundo, by participating in various capital increases (July 1938, February 1939, September 1939)<sup>118</sup> and by granting a loan of 50,000 yen (April 1937).<sup>119</sup>

The objective of the new company GFM was, according to its statutes, "to produce electro-medical apparatus, light therapeutic apparatus and Roentgen apparatuses for medical purpose" except "high-vacuum or gas discharge tubes."<sup>120</sup> The capital of the new enterprise amounted to 400,000 yen, shared equally between SRW and Goto Fuundo. SRW did not pay any cash but received its shares in exchange for the free provision of licenses and know-how. It undertook to give GMF the necessary patents and blueprints for its devices, as well as practical assistance through some engineers.<sup>121</sup> GFM obtained the exclusive and free license for the production in Japan of SRW's X-ray machines. As for Goto Fuundo, it obtained its shares against the provision of its factory and some cash. The company GFM was established at the same address as Goto Fuundo, and naturally took over its production facilities.

The management of GFM depended rather on Japanese managers linked to Goto Fuundo. Its

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<sup>113</sup> Shimadzu 1967, p. 378. In fact, the tubes of the firm Müller were made at that time by the Dutch company Philips, to which Müller had belonged since 1927. See Kees 2003.

<sup>114</sup> Shimadzu 1967, p. 80.

<sup>115</sup> MAE, unmarked folder, Letter from SRW to Otto Kresta, 4 November 1930.

<sup>116</sup> Ibid.

<sup>117</sup> MAE, unmarked folder, Agreement between Goto Fuundo and SRW, 30 June 1932-25 November 1933. The agreement was signed in 1932 in Japan and countersigned in Germany in 1933.

<sup>118</sup> MAE, 174, various financial statistics on Goto, 1935-1943.

<sup>119</sup> MAE, 174, Verzinsung des Darlehns, 1935-1944.

<sup>120</sup> MAE, unmarked folder, Agreement between Goto Fuundo and SRW, 30 June 1932-25 November 1933, art. 3.

<sup>121</sup> Ibid., art. 4.

board of directors was composed of three members, of whom two designated by Goto Fuundo and one by SRW, as well as an Japan citizen inspector appointed by SRW.<sup>122</sup> Goto Fuundo was in charge of the management of GFM and undertook to pay a minimum dividend of 6% and guaranteed Siemens 10% royalties on the sales and minimum annual orders for 300,000 yen, instead of 200,000 yen.<sup>123</sup>

However, SRW was not only looking for an agreement that could ensure good financial results. Its concern was above all to control technology transfer. In particular, the German multinational wanted to control potential innovations realized within GFM as well as possible cooperation arrangements with other firms. The 1932 agreement on the establishment of the joint venture included a long article on innovation, which mentioned notably that “inventions and other propositions for improvements proceeding from the supervisors or employees shall be communicated by Factory to SRW immediately, at the latest by the time when the protection rights for such inventions or improvements are applied for in Japan. To utilize such inventions and improvements and to acquire protection rights outside of Japan, SRW is authorized exclusively.”<sup>124</sup> Moreover, it planned that the “Factory shall not acquire the rights of other inventions and protection rights unless SRW explicitly agrees to each such case. In case SRW expresses its agreement, it will advise Factory as to the acquisition. Factory shall do its best to help SRW acquire these rights for utilization outside of Japan under at least the same advantageous conditions. It depends on the decision of SRW whether or not it accepts the conditions.”<sup>125</sup>

The prudence of SRW can also be observed in the transfer of production, limited as much as possible. The GFM production site was the workshop that Goto Fuundo possessed in the Tokyo area since 1919, where it produced spare parts for X-ray machines and other medical devices.<sup>126</sup> Destroyed during the Kanto Great Earthquake in 1923, this factory was moved in 1927 to Urawa Ward, in the city of Saitama. It developed a production of “general medical apparatuses such as Incubator, Mechanical Disinfection Apparatus, Centrifugal Precipitator, Water Steriliser, Electric Transformer, Diapylis Treatment Apparatus and all kind of Roentgen equipment.”<sup>127</sup> After 1934, this factory was not only the production center of SRW products in Japan, but also the place where Goto Fuundo continued to manufacture appliances and instruments on its own, an ambiguous situation that led to problems between Goto Fuundo and Siemens after World War II. When he came to Berlin in December 1933, Kresta spoke with two SRW representatives about launching a first production program in Japan, for

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<sup>122</sup> Ibid., art. 12.

<sup>123</sup> Ibid., art. 11.

<sup>124</sup> Ibid., art. 16.

<sup>125</sup> Ibid., art. 16.

<sup>126</sup> SCAP, CPC 41476, Letter from Goto Fuundo to an unknown recipient, 13 June 1949.

<sup>127</sup> Ibid.

a value of some 100,000 marks and a limited volume of machines (30 small X-ray machines, 10 heliophos, 20 diathermy machines and various other appliances).<sup>128</sup> The discussions showed that the transfer of production was restricted to a maximum, that is, to machines whose import to Japan was no longer competitive. These smaller devices, which were meant for the Army, the Navy and private hospitals, had a high-growth potential due to increasing demand, but imported products were too expensive because of the high exchange rate and the cost of foreign currencies after the devaluation, combined with the cheap labor in Japan. It was then decided to assemble these machines in the GFM factory with some parts imported from Germany and others produced there. However, the launch of production was postponed for about a year due to some negotiations with Tokyo Electric / GE.

At the same time as this production program was launched in Japan, the SRW management began negotiations with Tokyo Electric in early 1934. The director of Tokyo Electric, Yamaguchi, approached Siemens in the spring of 1934 on the occasion of a trip to Berlin. He proposed to take over the production in Japan of SRW's medical devices.<sup>129</sup> Kresta proposed to his German management to found a new joint venture company with Tokyo Electric and Goto Fuundo, endowed with a capital of 2.7 million yen, split between Tokyo Electric (44.4%), in charge of production, Goto Fuundo (29.7%), responsible for marketing, and SRW (25.9%), which would supply patents and brands.<sup>130</sup> However, Yamaguchi set some conditions to this agreement: he wanted to centralize all production at Tokyo Electric's factory and transfer Goto Fuundo's workshop there.<sup>131</sup> These conditions were not accepted by both partners. On the one hand, SRW claimed a negotiation with GE on the global scale and an agreement between both multinationals. As for Goto Fuundo, on the other hand, it was not acceptable to give up its production facilities.<sup>132</sup> The impossibility to reach a satisfactory agreement finally led SRW to envisage transferring production in Japan within GFM.

### *3.2 The growth of production in Japan (1935–1940)*

The production of SRW machines under license really got underway in 1935. According to a document dispatching the GFM manufacture by the origin of products between 1933 and 1937, no production took place in Japan in 1933 and 1934 (see figure 2). However, once the decision to produce X-ray machines in Japan was taken by SRW, the transfer was quick to realize and grow, as it can also be observed in the case of Fuji Electric since the mid-1920s.<sup>133</sup>

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<sup>128</sup> MAE, unmarked folder, Protokoll über eine Besprechung – Fabrikation in Japan, 7 December 1933.

<sup>129</sup> MAE, 770-2, Letter from Sehmer (SRW Berlin) to Otto Kresta, 9 May 1934.

<sup>130</sup> MAE, 770-2, Letter from unknown correspondent (Berlin) to Otto Kresta, 28 July 1934

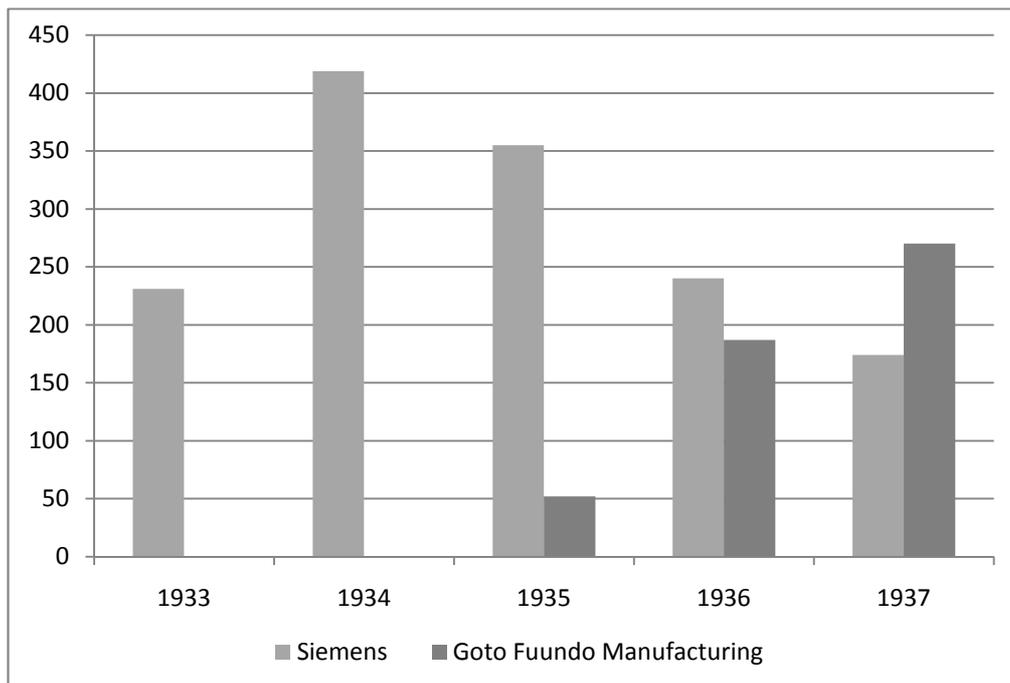
<sup>131</sup> MAE, 770-2, Letter from Otto Kresta to SRW, 28 July 1934

<sup>132</sup> MAE, 770-2, Letter from unknown correspondent to SRW, 28 August 1934.

<sup>133</sup> Udagawa 1987, p. 25. See also Watanabe 1984.

The value of products imported from Germany and sold by Goto Fuundo declined steadily from 1934 onwards, dropping from 419,000 yen in 1934 to 174,000 yen in 1937, while the value in-house production increased sharply, from a mere 52,000 yen in 1935 to 270,000 yen in 1937. In relative numbers, the share of domestic production went from 12.8% in 1935 to 43.8% in 1936 and 60.8% in 1937.

Fig. 2: Gross sales of Goto Fuundo as the origin of products, in thousands of yen, 1933–1937



Source: MAE, unmarked folder; *Gegenwärtiger Stand des SRW-Geschäfts in Japan*, 4 January 1939.

Note: Unknown after 1937.

Moreover, together with this growth of manufacturing in Japan, the transfer of production was also characterized by an enlargement of the kind of machines, the production of which was taken over by GFM. The evolution of the production programs between 1935 and 1938 shed a light on this phenomenon (see tab. 2). In 1935, GFM produced little more than orthoscopes. From the following year onwards, however, the variety became larger, with not only different kinds of X-ray machines but also diathermy devices. Thus, the transfer of production was accompanied by a real technology transfer, also highlighted by the fact that the volume of parts sent by SRW stagnated after 1934. The value of the parts supplied to GFM rose to the 35,800 mark in 1935, 22,600 in 1936 and 33,000 in 1937.<sup>134</sup> Together with the growth of

<sup>134</sup> Ibid.

production, GFM did not face a strengthening of its dependency on SRW but rather the internalization of some resources.

Tab. 2: Number and kinds of machines produced by GFM, 1935-1938

	1935	1936	1937 (second semester)	1938 (first semester)
Ultratherm (diathermy device)	-	17	18	15
Heliolox 300 mA 60 kV (X-ray machine)	-	-	-	3
Heliodor Duplex (surgery appliance)	-	4	-	-
Tuto Heliophos (X-ray machine)	1	5	2	3
Orthoscope (X-ray machine)	22	17	-	4
Pantoscope (X-ray machine)	-	1	6	5
Tele-Pleoscope (X-ray machine)	-	1	-	2
Tele-Pantoscope (X-ray machine)	-	4	7	4

Source: MAE, unmarked folder; *Gegenwärtiger Stand des SRW-Geschäfts in Japan*, 4 January 1939.

Note: Unknown after 1937.

However, despite this collaboration and the production in Japan, SRW and Goto Fuundo registered only a very small number of patents, although they were used in Japan. For the years 1900–1945, while their main rivals Shimadzu (37 patents registered in the field of X-ray machines) and Tokyo Electric (71 patents) made frenzied use of legal protection for their technologies in Japan, SRW registered only six, all between 1926 and 1933, and its partner Goto Fuundo only two, one in 1927 and one in 1939.<sup>135</sup> This feature of SRW can be surprising, as Siemens was in other cases a great user of the patent system.<sup>136</sup> As a result, it was thus legally possible to copy most of SRW's X-ray machines in Japan. For SRW, this strategy embodied the technological competitiveness Siemens enjoyed in the field of X-ray machines and stemmed from a desire to dominate the market by the excellence of the products: as it transferred the production and assembly of consistently the best quality X-ray machines to GFM, SRW would thus prevent their copy by domestic manufacturers that did

<sup>135</sup> Database of the Industrial Property Digital Library, [www.ipdl.inpit.go.jp/homepg.ipdl](http://www.ipdl.inpit.go.jp/homepg.ipdl) (accessed in February and March 2010) and Japan Patent Office 1958.

<sup>136</sup> Boch 1999.

not have the necessary organizational capabilities to develop such equipment. According to a report by the Tripartite Commission dated 1954, this was a deliberate strategy of SRW: “It might have been the intention of SRW to keep Goto Factory in possession of devices always new and up-to-date as a precautionary measure to prevent competing companies from imitating devices.”<sup>137</sup> The testimony of Goto Fuundo’s board of directors runs along the same lines. In a letter sent to the Ministry of Finance in February 1954, they wrote: “Our Company could manufacture and sell newest SRW type apparatuses by copying at the factory those equipments which were imported as goods from SRW under the terms of sales agreement. Our Company took pride in the novelty and superiority of our products as compared with articles of other makers. This was acknowledged by all persons interested in this line of business, whereby Our Company was placed in a position to compete with any other maker at a margin sufficient to pay for the license fee.”<sup>138</sup> Despite the development of its technological facilities, GFM still depended on SRW for some parts of the production process, probably with regard to practical know-how and tacit knowledge.<sup>139</sup> It tried to register some patents for copies of SRW machines in Japan but never succeeded: “the application has always been rejected on the ground that the said equipment was a fact widely known to the public.”<sup>140</sup> Besides, Goto Fuundo was not able after 1945 to successfully develop its own machines without the support of SRW.

A look at gross sales for GFM between 1936 and 1945 shows two distinct phases in the development of the firm (see figure 3). First, the years 1936–1940 are characterized by the transfer of production and of technology from SRW, with gross sales that rose from 137,000 yen in 1936 to 326,000 yen in 1939, the stagnation observed in 1940 resulting quite obviously from the severance of commercial relations with SRW due to the war in Europe. Indeed, the last delivery of X-ray machines and parts from Germany occurred in September 1940.<sup>141</sup> These four years of cooperation with SRW had a positive impact on the ability to compete of Goto Fuundo, which was marketing GFM production. While its dividend rate was dropping in the years 1930–1934, it entered a new period of growth (5% in 1937, 7% in 1938 and 8% since 1940).<sup>142</sup> However, in comparison with its main rival on the Japanese market, Shimadzu, GFM’s growth was limited. While Shimadzu saw gross sales for its X-ray machines division go up from 1.7 million yen to 2.5 million yen in 1937,<sup>143</sup> sales by Goto

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<sup>137</sup> SCAP, CPC 34029, Disposition of vested interests formerly owned by Siemens Reiniger Werk AG under licence agreement with K.K. Goto Fuundo, 5 March 1954.

<sup>138</sup> SCAP, CPC 34029, Letter from Goto Fuundo to the Minister of Finance, 5 February 1954.

<sup>139</sup> This can also be observed in the chemical industry, for example. Kudo 1998.

<sup>140</sup> SCAP, CPC 41476, Letter from Goto Fuundo to an unknown recipient, 13 June 1949.

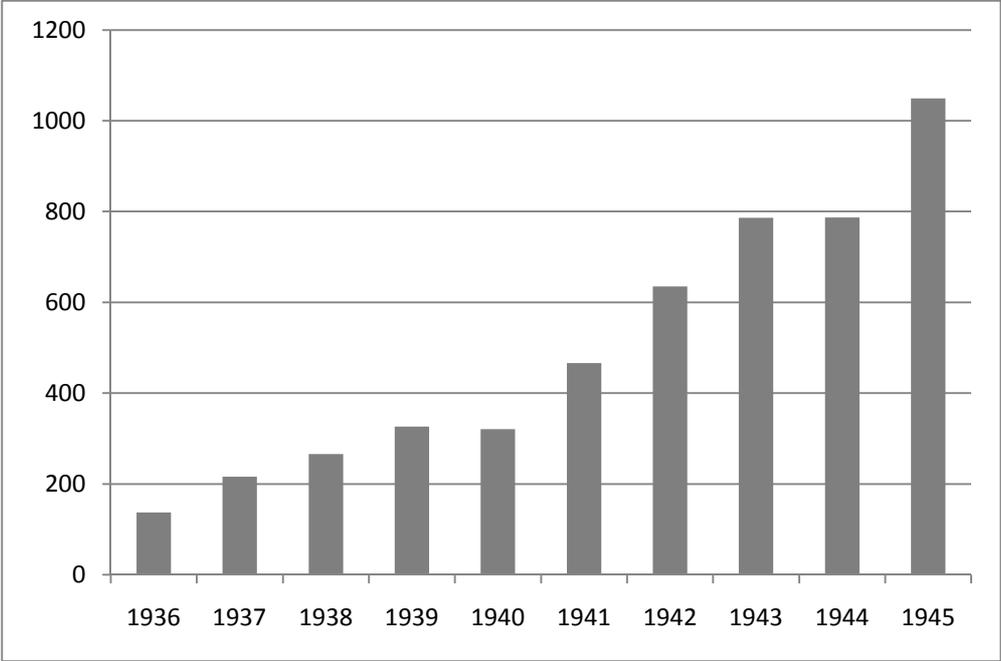
<sup>141</sup> SCAP, CPC 34029, Letter from Goto Fuundo to the Minister of Finance, 5 February 1954.

<sup>142</sup> MAE, 174, Dividendenzahlungen von Goto, 1927-1943.

<sup>143</sup> SCAP, USB-12, M1654-7, Interview with Shimadzu Manufacturing Co. Ltd, 26 October 1945.

Fuundo of SRW products only rose from 407,000 yen to 444,000 yen over the same period.<sup>144</sup> These numbers apparently include only SRW products (imported from Germany and manufactured by GFM). Overall gross sales of Goto Fuundo, consisting as well of products made in-house and goods supplied by firms other than SRW, must have been higher but there are no supporting documents. However, for SRW, which distributed all its production in Japan through Goto Fuundo, this comparison with Shimadzu reveals a situation on the Japanese X-ray machines market that was completely different to what it was before the First World War: between 1914 and 1935, SRW moved from a virtual monopoly to a second-rank competitor.

Fig. 3: GFM gross sales, in thousands of yen, 1936–1945



Source: SCAP, CPC 41474, Siemens Reiniger Werke, Cost Accounting, no date.

Note: The values are different to these given in SRW document used for figure 2 but the trend and the order of magnitude are similar.

For Goto Fuundo, the end of commercial relations with SRW in 1940 did not put an end to the growth of the firm, which continued during the war thanks to strong demand from X-ray equipment from the Army and the Navy. GFM gross sales increased steadily despite the cut-off of supplies of German parts and machines, peaking at one million yen in 1945. The value of Goto Fuundo gross sales during these years is not known, but this firm continued to

<sup>144</sup> MAE, unmarked folder, Gegenwärtiger Stand des SRW-Geschäfts in Japan, 4 January 1939.

pay a dividend of 8%, which shows that it enjoyed good business conditions.<sup>145</sup> However, this development could not reverse the balance of power with Shimadzu: gross sales for its X-ray machines division amounted to 6.7 million yen in 1943 and 6.2 million yen in 1944.<sup>146</sup>

#### **4. Difficulties in the post-war period (1945–1960)**

The breaking-off of relations between SRW and Goto Fuundo during the war led after 1945 to a financial conflict, as a result of which both companies continued to operate on their own on the Japanese market for X-ray machines. While Goto Fuundo failed in its go-it-alone strategy, SRW possessed all the financial and technological resources it needed to ensure its come-back on this market in the 1950s.

Business relations between Goto Fuundo and SRW lasted until September 1940.<sup>147</sup> Even though the agreement signed by both partners ran until 31 May 1944, owing to the war in Europe SRW was unable to meet its commitments (delivery of parts, technical assistance).<sup>148</sup> Consequently, Goto Fuundo considered itself released from the contract. It went on producing and developing X-ray machines without any financial compensation to SRW. The problem of financial compensation was raised in 1946 and aggravated relations between both firms until 1953, appearing to be obviously a factor in SRW's decision to stop collaborating with Goto Fuundo. According to a survey made by the Foreign Property Division in 1946, the sum owed by Goto Fuundo to SRW for the years 1940–1944 came to a total of 123,290 yen, in the form of unpaid royalties and dividends. The amount was not contested, and was paid by Goto Fuundo,<sup>149</sup> though Goto Fuundo did object to go on paying licensing fees for the production of X-ray machines after the war. The agreement signed in 1933 between Goto Fuundo and SRW on the establishment of GFM and the transfer of production to Japan concerned a period of twenty years, that is, until 31 December 1953. It made provision for the payment of licensing fees to SRW in exchange for technical assistance (blueprints, patents, engineers). Yet SRW was no longer able to fulfill its commitments. At first, the Tripartite Commission intervened to recoup the licensing fees owed by Goto Fuundo. In July 1952, it had already recovered the sum of 2.2 million yen for the years 1945–1950.<sup>150</sup> However, Goto Fuundo refused to pay any more money after 1951, a decision supported by the American occupation authorities.<sup>151</sup>

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<sup>145</sup> MAE, 174, Dividendenzahlungen von Goto, 1927-1943.

<sup>146</sup> SCAP, USB-12, M1654-7, Interview with Shimadzu Manufacturing Co. Ltd, 26 October 1945.

<sup>147</sup> SCAP, CPC 41470, Memo, 2 October 1946.

<sup>148</sup> SCAP, CPC 41473, Memorandum to the Controller Division, no date.

<sup>149</sup> Ibid.

<sup>150</sup> SCAP, CPC 34029, Disposition of vested interests formerly owned by Siemens Reiniger Werk AG under licence agreement with K.K. Goto Fuundo, 5 March 1954.

<sup>151</sup> Ibid.

Above and beyond the financial issue, Goto Fuundo's attitude was marked by a desire to go it alone as far as its development on the X-ray machines market was concerned. Moreover, the Tripartite Commission did not favor SRW's continued involvement in Goto Fuundo. Thus, although SRW still held some shares in the capital of Goto Fuundo (9.1%) and GFM (50%), their boards of directors no longer included any German members.<sup>152</sup> Some negotiations began in 1949 about the purchase of the German shares by Japanese shareholders, but it took some ten years to reach an agreement.<sup>153</sup> In the meanwhile, Goto Fuundo continued its activities in the 1950s, producing prewar X-ray machines and copies of Siemens models.<sup>154</sup> However, it lacked organizational capabilities, such as in-house R&D or technical cooperation with foreign multinationals, to remain competitive in a high-growth market. Indeed, the reconstruction of hospitals and the fight against tuberculosis led to a steadily increasing demand for X-ray machines: national production of X-ray machines for medicine rose from 2,794 machines in 1947 to 3,769 in 1950, 5,042 in 1955 and 7,511 in 1960.<sup>155</sup> The foreign multinationals came back in force to the Japanese market through partnerships with local companies. In 1951, Shimadzu signed a technical cooperation agreement with the American company Westinghouse Electric.<sup>156</sup> As for Toshiba (the former Tokyo Electric, which merged with Shibaura Works in 1939), it resumed relations with GE, which once again became a shareholder (1953), and signed several technical cooperation agreement with various American companies in the 1950s (GE, Western Electric, RCA).<sup>157</sup> When it came to coping with such rivals, Goto Fuundo had not sufficient financial and human resources to remain competitive on this market characterized by endless product innovation. During this decade, while Shimadzu registered 52 patents in Japan, Toshiba 30 and Hitachi 25, Goto Fuundo had only one.<sup>158</sup>

Finally, Fuji Electric, the joint venture in which Siemens was still engaged after the war, bought up the German shares of Goto Fuundo. Yet Goto Fuundo's production and innovation facilities were too weak to enable Siemens to re-establish itself on a growing and competitive market. In 1957, Otto Kresta was replaced by a new representative, Alfred Schenz, whose main task was to develop a medical devices division at Fuji Electric. However, this did not involve the transfer of production to Japan. Siemens reverted to its export strategy, restructuring its representation in Japan accordingly. In 1960, Fuji Electric obtained exclusive rights for the import and distribution of SRW products in Japan, while Goto Fuundo became

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<sup>152</sup> Ibid. and Shokenshori chosei kyogikai shiryō (microfilms), 60<sup>th</sup> management report of Goto Fuundo, 1950.

<sup>153</sup> SCAP, CPC 34029, Disposition of vested interests formerly owned by Siemens Reiniger Werk AG under licence agreement with K.K. Goto Fuundo, 5 March 1954.

<sup>154</sup> SCA, 7912, *Vertretung des UB Med und seiner Vorgänger in Japan, 1887-1979*, 1979, p. 6.

<sup>155</sup> *Kikai tokei nenpo*, various volumes.

<sup>156</sup> Shimadzu 1967, pp. 130 and 140.

<sup>157</sup> Tokyo shibaura denki 1963, pp. 320-321.

<sup>158</sup> Database of the Industrial Property Digital Library, [www.ipdl.inpit.go.jp/homepg.ipdl](http://www.ipdl.inpit.go.jp/homepg.ipdl) (accessed in February and March 2010) and Japan Patent Office 1958.

an agent of Fuji Electric. This strategy paid off, as the value of Japanese imports of X-ray machines from Germany shot up from 1.8 million yen in 1951 to 30.3 million in 1955 and 57.8 million in 1960. In addition, they dominated the market for foreign X-ray machines in the 1950s, with an import share of 42.5% (value), against 30.9% for the United States and 15.4% for Netherlands.<sup>159</sup> Subsequently, the growth of this business led SRW to move the medical devices division from Fuji Electric to the company Siemens Japan Ltd, in charge of the import and distribution of products of the Siemens group that were not produced in Japan (1965). It became an independent subsidiary in 1979, Siemens Medical System Ltd.<sup>160</sup>

## Conclusion

The example of the involvement of Siemens on the Japanese market for X-ray machines and the development of the strategy followed by the German multinational, as presented in this contribution, make it possible to highlight an evolution characterized by both the firm's global strategy and the particular conditions of the Japanese market. Regarding the strategy of the company Siemens Reiniger Werke (SRW), the case study analyzed here confirms the point of view of Kudo Akira, according to which German enterprises favored an export strategy "as far as they were able."<sup>161</sup> Until World War I, German manufacturers totally dominated the Japanese X-ray machines market and then did not envisage any potential transfer of production. However, market conditions evolved in the 1920s towards increased competition, with the emergence of local manufacturers (Shimadzu) and the launch of General Electric and its subsidiary Tokyo Electric into the production of complete X-ray installations rather than only tubes. Notwithstanding, the management of SRW considered only timidly and under pressure the idea of a direct investment. Even though it had access to an infrastructure which could have easily made possible the production of X-ray machines in Japan, either within the company Fuji Electric or with its commercial partner Goto Fuundo, which possessed production facilities since 1919, SRW was reluctant to embark on production in Japan and followed a very cautious technology transfer policy even after the creation of the joint venture Goto Fuundo Manufacturing (GFM), endeavoring to control innovation of this subsidiary and transfer only the most necessary technologies.

The strategy of SRW in Japan can also be explained by the particular conditions of the Japanese health care market, and especially by the distribution networks that were still controlled in the interwar period by drugs trading houses which often dated back to the early Meiji period, or even the Edo era. More than drugs, medical instruments and machines were

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<sup>159</sup> Nihon gaikoku boeki nenpyo 1951-1960. Data not mentioned in 1950 and before 1949.

<sup>160</sup> SCA, 7912, *Vertretung des UB Med und seiner Vorgänger in Japan, 1887-1979*, 1979, pp. 7-8.

<sup>161</sup> Kudo 1998, p. 218.

not traditional consumer goods for a broad public, but rather for specific customers (doctors, hospitals). Consequently, access to the social networks of medicine was a key issue for foreign manufacturers of X-ray machines, which explains the need to collaborate with the trading houses that controlled these distribution channels or to adopt specific marketing strategies as did Shimadzu since the end of the 1910s. Despite its technological competitiveness, Siemens failed in maintaining its dominant position on the medical market due to a lack of involvement into marketing. This was why it entered into an agreement in 1926 with a Japanese firm specialized in the trade of drugs and medical instruments, Goto Fuundo, not one of the big general trading firms (*sogo shosha*). Other firms active on the medical market, such as some Swiss pharmaceutical companies, also used Japanese specialized trading houses to access this particular market.<sup>162</sup>

Nevertheless, access to medical markets made possible through the alliance with Goto Fuundo was not a sufficient comparative advantage for Siemens in the early 1930s in order to recover its market share, and it had to envisage eventually giving up its export strategy for a direct investment. The new competition from domestic firms such as Shimadzu and Tokyo Electric as well as the devaluation of the yen appear to have been two decisive factors in the decision to change strategies. However, despite the establishment of the joint venture Goto Fuundo Manufacturing (GFM) in 1933, SRW kept its cautious attitude in the transfer of technologies related to the production of X-ray machines. It first considered an agreement with General Electric to secure its market share, both in Japan and on a global scale; subsequently, once the transfer of production was decided, this involved only a limited number of machines and was apparently based on the assembling of machines, with key parts, probably tubes, dispatched from Germany. Moreover, the 1933 agreement planned for real SRW control over potential innovations made within GFM. Technologies linked to X-ray machines were controlled by a handful of enterprises in the world, and controlling their spread was a strategy to prevent newcomers from entering the market. Besides, after the breaking-off of relations between SRW and Goto Fuundo due to the war, in 1940, the Japanese side was not able to keep on operating as an independent firm. It abandoned production in the mid-1950s to become a sales agent for SRW products on the Japanese market. Viewed from this angle, the export strategy followed by SRW appears to primarily reflect a desire to maintain its comparative advantage on the market, thanks to its technological resources.

The course of Siemens on the Japanese X-ray machine market during the interwar appears as a failure. Despite its technological advantage, the German multinational was not able to compete effectively with the domestic newcomers since the early 1920s and neither the

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<sup>162</sup> This was for example the case with Ciba, which exported since 1900 its products to Japan towards the medicines' trading and manufacturing company Takeda. See Donzé forthcoming in 2010.

commercial agreement nor the production joint venture with Goto Fuundo helped it to overcome its market loss. Still, one should wonder why so powerful a company as Siemens did not adopt a marketing strategy similar to the one implemented by Shimadzu. Two elements may explain this lack of engagement. Firstly, the relative importance of the Japanese market for Siemens must be taken into account. The German firm enjoyed a dominant position on the European market where it was able to sell large amounts of X-ray machines, as a result of which the Japanese market may have been viewed as secondary by the German managers. Secondly, the position of the X-ray business within the Siemens conglomerate should also be considered. Since the takeover of its main rival in Germany, the company RGS, in 1924, the production of X-ray machines was pursued within a new affiliate company based at Erlangen. The incorporation of this company within the group and the relations with the holding company may also explain the weakness of SRW's marketing strategy with regard to Japanese X-ray machines.

Beyond the case of Siemens, it would be productive to extend this research on the diffusion of X-ray technologies to contribute more largely to the emerging field of business history of medicine. In particular, it would be necessary to take due account of local producers, such as Shimadzu, in order to understand the factors that helped them not only emerge on the market but also growth and compete with foreign multinationals like Siemens or General Electric, and to compare this phenomenon with other countries where newcomers were unable to last (France, United Kingdom). Also, a key issue for understanding the business history of medicine in Japan appears to be the analysis of the other side of the market: the consumers of products such as X-ray machines, namely hospitals, clinics and doctors, that is, the actors who used these new technologies to make medicine a profitable and growing business.

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