

## EDISON'S MANUFACTURING OPERATIONS

Docs. 2343 and 2368

Edison had largely completed his rapid transformation from full-time inventor to major manufacturer by the summer of 1882. Though not permanent—it was just one episode in a long career—the change anticipated the exponential growth of the electrical industry and its future dominance in American manufacturing. He assumed this role because his financial backers in the Edison Electric Light Company preferred to hold and license his patents rather than invest directly in the factories needed to make equipment for his electric light and power system.<sup>1</sup> Drawing on all the financial successes of his inventive career, Edison became a major partner in four capital-intensive enterprises that made nearly every item for his system, from heavy equipment like dynamos, to the small items used by individual consumers, such as fuses, switches, and lamps. He controlled two of these concerns, the Edison Lamp Company and the Edison Machine Works. He had a large stake in the others, the Electric Tube Company and Bergmann & Company. Together these shops employed more than a thousand workers representing a wide range of skills in a variety of processes and materials, from cast metals to glass to slender bamboo. The glass lamp globes and the steam engines to drive dynamos were the only significant components of Edison's light and power system not under his direct control. The Corning Glass Works met his increasing demand but neither of the two engine builders whose designs he trusted could keep pace. The availability of engines became a major bottleneck in building both central generating stations and small isolated lighting plants, and he obtained a license to manufacture the preferred

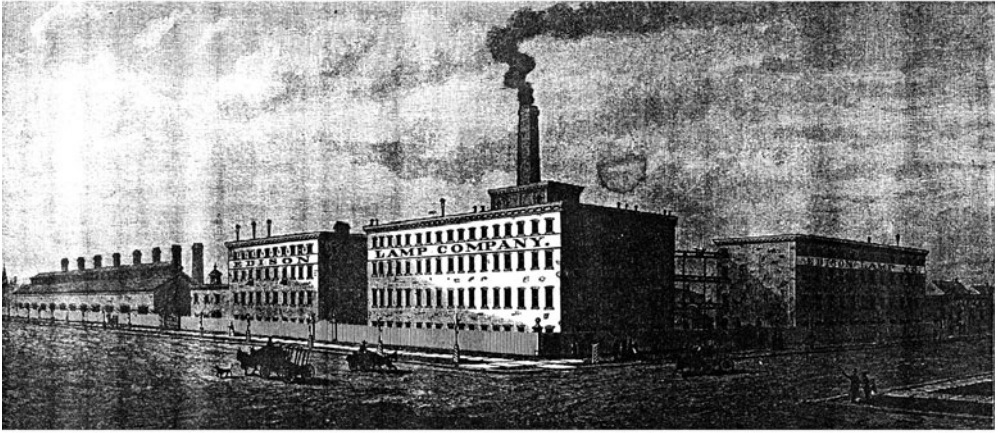
Armington & Sims engine himself.<sup>2</sup> Edison and his principal associates—Edward Johnson, Charles Batchelor, Francis Upton, and John Kruesi—had provided start-up capital in early 1881. They kept supplying additional funds for operation and expansion of the Machine Works and, especially, the Lamp Company. The prices these companies charged other Edison interests for their goods sometimes became points of contention.<sup>3</sup>

Edison delegated to Samuel Insull, nominally his secretary, the task of integrating the production of his shops with respect to demand for their goods in the United States and abroad. Three factories were located in different sections of New York City and the other across the river in Harrison, New Jersey. Because he was either at his office uptown or at Menlo Park, Insull conducted most business with them by correspondence although he frequently traveled to the Machine Works to confer with Edison.<sup>4</sup> It was a big assignment in addition to his other duties, and he once complained privately that while Edison “has millions at stake in working so hard I have nothing.”<sup>5</sup> He relished the authority, however, and expected of the superintendents the same acquiescence they gave Edison. His oversight often involved coordinating the production and shipments of goods. The shops sold their products to U.S. companies operating under license from the Edison Electric Light Company, chiefly the Edison Electric Illuminating Company of New York and the Edison Company for Isolated Lighting, and to Edison concerns in Great Britain, France, and elsewhere. Insull kept track of their accounts, particularly those of the overseas companies. These companies generally expected to receive shipments promptly and make payments slowly. Because the large investments in material and labor resulted in cash shortages, he often made advances on Edison’s behalf to meet payroll and keep production going at the Machine Works and the Lamp Company. (Edison obtained large amounts of cash by liquidating most of his telephone interests in Britain. He also borrowed about \$37,000 from Drexel, Morgan & Company in July using electric light stocks as collateral.)<sup>6</sup> He coordinated foreign orders, which were routinely divided among separate ships and even different ports, though he passed request for discounts directly to Edison. He also was charged with providing drawings of special machine tools and dynamos to Charles Batchelor, who was starting a factory outside Paris for the Electric Light Company’s licensee in continental Europe. He was frustrated by numerous design changes in the course

of dynamo production and, especially, by the perceived unresponsiveness of the Machine Works. Though freely admitting his lack of technical expertise, Insull formed his own opinions about the management and workmanship at the shops, frequently to the detriment of the reputation of the Machine Works.<sup>7</sup>

#### EDISON LAMP COMPANY

Edison organized the Edison Lamp Works during the summer of 1880 with Francis Upton and Charles Batchelor. The factory began operating by the end of that year under Batchelor's supervision in a building convenient to the Menlo Park laboratory. Upton relieved Batchelor at the beginning of 1881, about which time its name changed to the Edison Lamp Company and it became a formal partnership including longtime Edison associate Edward Johnson. By that summer the factory had over a hundred workers and could turn out 1,000 lamps each day and night, although it rarely did so because there was as yet no commercial need for so many. However, it could not turn a profit nor come close to breaking even. Several circumstances contributed to this problem. One was the extensive ongoing experiments to improve lamp efficiency, lifetime, and manufacturing processes.<sup>8</sup> Another was the partnership's contract to sell lamps to the Edison Electric Light Company, its largest customer, at a price that did not cover the costs of relatively small-scale production. Exacerbating this situation was the fact that many lamps, otherwise satisfactory, could not provide their rated intensity within a specified narrow voltage range; these contributed to the factory's unsold inventory. At bottom, though, lamp fabrication was irreducibly labor-intensive at this time. This led Upton and Edison to search almost immediately for cheaper labor. On the first of April 1882 the factory ceased production at Menlo Park and began moving to Harrison, near the much larger Newark labor market. The renovated plant there could accommodate daily production of 1,200 lamps immediately and, ultimately, up to 40,000 per day. At the time of the move the factory employed somewhat over 100 men; about 150 hands worked in Harrison.<sup>9</sup> When production resumed at the end of May, Upton and his new superintendent of manufacturing, William Holzer, found that female workers could substitute for men. They reduced labor costs in some operations by half. To their dismay, however, they found rival manufacturers luring away skilled glassblowers, forcing them to raise wages at least until new hands (including women) could be trained.<sup>10</sup> Edison also guarded against visitors who might give



*The Edison Lamp Works  
in Harrison, New Jersey.*

sensitive manufacturing information to the public or competitors.<sup>11</sup> By late August 1882, Upton had enough confidence in his manufacturing routines to order tools to get the factory “ready for any demand.” He did this by inside contracting with his own employees in the belief that “idle help is far more expensive than idle tools.” The factory’s secretary reported its output and financial condition directly to Edison at weekly and monthly intervals. While Edison was at Menlo Park in the summer of 1882, Upton went there every Friday morning to consult with him.<sup>12</sup>

Operating expenses and the move to Harrison gave the Lamp Company a large appetite for cash, which the partners supplied through frequent assessments on their shares. Edison and Upton also made personal loans totaling almost \$30,000 in the middle of 1882. The opening of the Pearl Street station in September 1882 and the prospect of a more favorable contract with the parent company gave Upton reason for optimism in the fall, but Insull reported that the factory continued “to absorb money right along,” nearly \$200,000 of it by this time.<sup>13</sup> In September 1882, Upton predicted the factory would not earn a consistent profit for at least a year and possibly two.<sup>14</sup> The Lamp Company was incorporated in 1884. Its output eventually grew so large and production costs relatively so small that Edison, according to one account, gleefully declared a dividend every Saturday night.<sup>15</sup> It merged with two other Edison firms in 1889 into the new Edison General Electric Company.

#### EDISON MACHINE WORKS

At the end of February 1881 Edison organized a company to produce his dynamos. It was originally established as a part-

nership with Edison providing 90% of the capital and Charles Batchelor 10%. In early March 1881 Edison leased the plant of the Aetna Iron Company, a firm owned by the shipbuilder John Roach, located on a 200-foot frontage at 104 Goerck Street in lower Manhattan near the East River.<sup>16</sup> It came with some equipment but over the next six months Edison spent about \$18,000 to refurbish the building and about \$125,000 to equip it with machinery and tools.<sup>17</sup> He built it into a major manufacturing establishment employing hundreds of workmen under the imperious supervision of Charles Dean, a machinist with several years of experience working for Edison. During the summer of 1882 he leased a small plot at the rear of the Works and constructed a four story storage building so as to clear all available “room for manufacturing so that I can boom the business all over the world.”<sup>18</sup>

The Machine Works shipped its first dynamo in September 1881. By the end of May 1882 it had finished nine of the big C machines (including the prototype for Paris), nearly 300 Z dynamos, the workhorse of the isolated lighting business, and a handful of others. During the summer of 1882 bookkeeper Charles Rocap reported that he and Dean expected to produce 15 to 20 K dynamos and 12 to 15 125-light dynamos each week. In mid-July the Works had under construction 15 Jumbo, 50 K, and 150 L dynamos, to be sold for a total of \$352,500.<sup>19</sup> Payroll records no longer exist but about 100 new men started in July after problems with the supply of materials were solved; another 500 reportedly were added later in the summer, bringing the total employment to 800 men. In November Rocap valued the capital equipment of the Machine Works at about \$185,000 and its inventory between \$180,000 to \$230,000.<sup>20</sup>

Alongside its manufacturing operations, the Machine Works was also a major site for design and testing. Charles Clarke, the Edison Electric Light Company's chief engineer, designed new models of isolated plant dynamos there. Gustav Soldan supervised the Machine Works drafting room, which made drawings of dynamos and related equipment. George Grower designed and developed a new model of consumption meter. Francis Jehl and William Andrews ran the Testing Room, a department under the control of the Edison Electric Light Co. which tested finished dynamos, wire conductivity, insulation, and consumption meters. Workers also learned in the Testing Room how to wire buildings and to set up and repair dynamos.<sup>21</sup>

In the summer of 1882 Insull grew worried about the lack of

*Edison Machine Works,  
at 104 Goerck Street,  
New York.*



oversight of the shop's accounts. Early in 1883 he persuaded Edison to give him full control of its finances, over objections from Goerck St. Having forced the issue, he reported that Edison "supported me in a bully fashion and I came out on top of the heap."<sup>22</sup> Subsequent investigations revealed that Dean had been taking kickbacks from suppliers. Edison was reluctant to believe the accusation but Insull persuaded him to fire Dean and Rocap in August 1883. Gustav Soldan took over the manufacturing operations and Insull managed their financial affairs from 65 Fifth Avenue.<sup>23</sup> The Machine Works was incorporated in 1884 with Edison as president, Batchelor as treasurer and general manager, Kruesi as assistant manager, and Insull as secretary. During a strike a year later, it moved production to Schenectady, N.Y.<sup>24</sup> It was consolidated into the Edison General Electric Company in 1889.

#### ELECTRIC TUBE COMPANY

The Electric Tube Company manufactured insulated underground electrical conductors. These were the least visible elements of the Edison system but perhaps its most symbolically significant because of Edison's desire to emulate gas distribution and his public denunciations of hazardous overhead wires. Its first large orders were for the First District in New York. Edison and John Kruesi, a longtime associate and skilled machinist to whom Edison entrusted the manufacturing, personally supervised installation of the tubes in the trenches emanating from the Pearl Street station. The company fabricated conductors for other plants like those in Milan, London, and Paris.

Unlike Edison's other manufacturing concerns, the Electric Tube Company was incorporated at its outset. This may explain the relative lack of correspondence with either Edison or Insull, and the consequent dearth of information about it. Edison, Kruesi, and Charles Batchelor each had a one-fifth interest; the other two-fifths were owned by partners in Drexel, Morgan & Company. Edison seems to have given full operational responsibility to Kruesi though retaining disbursement authority himself.<sup>25</sup> The company was capitalized at \$25,000, nearly all of it invested in equipment and drawings. It paid out \$24,000 monthly for materials and wages but was earning "a very considerable profit" in 1882, according to a newspaper account. Up to 100 men worked at its shop at 65 Washington Street, on the west side of lower Manhattan.<sup>26</sup> Kruesi began considering a new site in Brooklyn in late 1882, hoping to double his capacity of one-half mile of tube per week.<sup>27</sup> The Electric Tube Company moved to Brooklyn in April 1884 and was absorbed by the Edison Machine Works around 31 December 1885.<sup>28</sup>

#### BERGMANN & COMPANY

Edward Johnson, a longtime Edison associated, entered into a silent partnership in 1879 with Sigmund Bergmann, a former Edison employee who had started his own machine shop. S. Bergmann & Company manufactured a variety of items for Edison, including early sockets and fixtures. In April 1881 Edison joined the partnership, which became known as Bergmann & Company, though his participation was not formalized until September 1882.<sup>29</sup> The firm was the sole manufacturer of sockets, fixtures, fuses, switches, instruments, and related material for the Edison lighting companies. Bergmann

*The new Bergmann & Co. factory on Avenue B in New York, where Edison set up a laboratory on the top floor late in 1882.*



took out a number of patents for these items. Insull described him as “sharp as chain lightning” and Edison reportedly admired his shrewd (and sometimes deceptive) business practices.<sup>30</sup> These were exemplified by the secretive manner in which Bergmann at this time acquired, through a third party, a larger building on Avenue B from a rival lighting firm. Bergmann had employed about 50 men at his old shop on Wooster Street; he employed about 300 in the new plant, which was enlarged in late 1882 or early 1883.<sup>31</sup> The firm was absorbed into the new Edison General Electric Company in 1889.

1. For Samuel Insull’s overview of Edison’s manufacturing in the spring of 1881 see Doc. 2092. An exception to the Edison Electric Light Co.’s detachment from manufacturing occurred in Canada (see Doc. 2286 n. 8).

2. See Doc. 2343. Armington & Sims struggled to expand their capacity to meet Edison’s anticipated demand, and Edison seems to have had at least a small role in helping them. Edison enjoyed a close relationship with them and favored their engine but would not publicly endorse it for fear of alienating builders of the Porter–Allen engine, the only other candidate to power his large direct-connected steam dynamo. Armington & Sims to TAE, 1 Oct. 1881, DF (*TAED* D8129ZBO; *TAEM* 58:283); TAE to Armington & Sims, 4 Aug. 1882, Lbk. 7:852 (*TAED* LBo07852; *TAEM* 80:791).

3. See, e.g., Docs. 2310 and 2318 n. 10.

4. Jehl 1937–41, 986–87.

5. Insull to Edward Johnson, 17 Jan. 1882, LM 3:20 (*TAED* LM003020; *TAEM* 84:21).

6. TAE promissory notes to Drexel, Morgan & Co., 1 and 6 July 1882, Miller (*TAED* HM820164C, HM820164D; *TAEM* 86:477, 480).

7. See, for example, Doc. 2259.

8. See headnote, Doc. 2177. Edison estimated in early 1883 that starting the lamp factory had cost \$250,000, “most of which has been sunk in experimental work.” It was only about that time that the factory began to break even. TAE to Société d’Appareillage Électrique, 6 Mar. 1883, Lbk. 15:414 (*TAED* LBo15414; *TAEM* 82:203).

9. The move and facilities at Harrison are briefly described in Edison Electric Light Co. Bulletin 11:3–4, 27 June 1882, CR (*TAED* CBo11; *TAEM* 96:720); Harrison employment from *Edisonia* 1904, 141.

10. Upton to TAE, 11 June and 26 July 1882, both DF (*TAED* D8230ZAY, D8230ZBG; *TAEM* 61:777, 794).

11. See Docs. 2160, 2309, and 2312 esp. n. 8.

12. Upton included a list of the tools and equipment he expected for each department in a 23 August letter to Edison (DF [*TAED* D8230ZBW; *TAEM* 61:814]). Philip Dyer’s reports are in Electric Light—Edison Lamp Co.—Accounts (D-82-31), DF (*TAED* D8231; *TAEM* 61:854). On the weekly meetings see Upton to TAE, 17 Aug. 1882, DF (*TAED* D8230ZBT; *TAEM* 61:811).

13. Doc. 2343; Insull to Grosvenor Lowrey, 14 Nov. 1882, Lbk. 14:421 (*TAED* LBo14421; *TAEM* 81:1006).



14. Upton to Batchelor, 9 Sept. 1882, Unbound Documents, Batchelor (*TAED* MBo77; *TAEM* 92:445). Upton enclosed an itemized summary of the factory's production expenses and income from 1 January 1881 to 1 July 1882.

15. Jehl 1937-41, 816; see also App. 1.B.54.

16. John Roach (1813-1887) was a prominent shipbuilder who played a leading role in the U.S. Navy's transition to iron vessels after the Civil War. He acquired the Aetna works in 1852. In the late 1860s he obtained several small marine-engine plants in New York and consolidated his operations at the Morgan Iron Works on the East River, developing what one naval historian has called "the finest marine-engine works" in the U.S. In 1871 he moved his shipbuilding operations to Chester, Pa. (*DAB*, s.v. "Roach, John"; Swann 1965, 14-26). Before New York City built housing projects over it in the 1940s, Goerck St. ran north and south from Grand St. to East 3rd St. between Mangin and Lewis Sts., two blocks from the East River (Spewack 1995, 81); see also Docs. 2055 and 2060 and Jehl 1937-41, 957-1029.

17. Rocap to TAE, 18 Nov. 1881, DF (*TAED* D8129ZCQ1; *TAEM* 58:317). For details of the building renovations and equipment purchases see Electric Light—Edison Machine Works (D-81-29), DF (*TAED* D8129; *TAEM* 58:203).

18. TAE to Eaton, 27 June 1882, Lbk. 7:592 (*TAED* LBoo7592; *TAEM* 80:686).

19. See Doc. 2293. Rocap to TAE, 15 June and 19 July 1882; Edison Machine Works list of completed dynamos, 10 June 1882; all DF (*TAED* D8233ZBZ, D8234D, D8234B1; *TAEM* 61:1082, 62:9, 7). According to Doc. 2343, the Machine Works used dynamos to pay, in part, for substantial stock holdings in the Edison Co. for Isolated Lighting.

20. TAE to Dean, 5 June 1882, Lbk. 7:403A (*TAED* LBoo7403A; *TAEM* 80:584); Rocap to TAE, 28 June 1882; Rocap to Insull, 14 Nov. 1882; both DF (*TAED* D8233ZCO, D8233ZEJ; *TAEM* 61:1099, 1147); "Electric Light," *New York Tribune*, 14 Aug. 1882, 2. Weekly reports of dynamo production and monthly balance sheets are in Electric Light—Edison Machine Works—Accounts (D-82-34), DF (*TAED* D8234; *TAEM* 62:2); for a general description of the workflow in the plant see TAE memorandum, undated 1883, DF (*TAED* D8334ZBS; *TAEM* 67:434).

21. For general accounts of the Testing Room see Electric Light—Edison Machine Works—Testing Department (D-82-35) and Electric Light—Edison Electric Light Co—Testing Department (D-83-30); both DF (*TAED* D8235, D8330; *TAEM* 62:25, 66:934) and Jehl 1937-41, 959-66.

22. See Doc. 2400; Insull to Edward Johnson, 6 Mar. 1883, LM 3:109 (*TAED* LMoo3109; *TAEM* 84:92).

23. Insull also suspected Dean of taking kickback from lucrative inside contracts with his employees. He believed that Rocap had in some way facilitated Dean's malfeasance, which he estimated cost the Machine Works about \$50,000. Both Edison and Insull wrote recommendation letters for Rocap in 1884. Insull to Batchelor, 5 Nov. 1883; Insull to E. Myers & Co., 18 March 1884; TAE to Charles Warner, 12 May 1884; all DF (*TAED* D8316BEG, D8416AXZ, D8416BON; *TAEM* 65:393; 72:189, 683); Insull to Batchelor, 21 Aug. 1883, LM 3:173 (*TAED* LMoo3173; *TAEM* 84:147).

24. Jehl 1937-41, 1000, 1009-1010.

25. See Doc. 2058 and, e.g., Kruesi to TAE, 14 Dec. 1881, DF (*TAED* D8130ZAD; *TAEM* 58:372).

26. The *New York Tribune* ("Electric Light," 14 Aug. 1882, p. 2) reported its employment at 50 men in August, near the completion of the First District.

27. Electric Tube Co. memorandum, 14 Nov. 1882, DF (*TAED* D8236ZAP; *TAEM* 62:137); Doc. 2333.

28. Kruesi to TAE, 27 June 1882; Electric Tube Co. to TAE, 22 Apr. 1884; both DF (*TAED* D8236Z, D8433O; *TAEM* 62:124, 73:730).

29. See Docs. 2091 and 2343.

30. Insull to Johnson, 17 Jan. 1882, LM 3:20 (*TAED* LM003020; *TAEM* 84:21); see *TAEB* 5 App. 1.F.5, 7-8.

31. See Doc. 2343. The building was at 292-298 Ave. B at 17th St., an intersection that no longer exists. The Edison Electric Light Co. described extensively the building and its equipment in the 28 August 1882 Bulletin. Bulletins 13:23-24 and 16:25-26, 28 Aug. 1882 and 2 Feb. 1883; both CR (*TAED* CBo13, CBo16; *TAEM* 96:738, 789).