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Work at Moctezuma, 1908

Work at the Moctezuma Brewery in the 1900's did not affect the federal government. It had negligible importance in the national economy. And its product, only for pleasure and conspicuous consumption, sold in a very competitive market. But by 1908 work at Moctezuma mattered considerably statewide and substantially in Orizaba, for the capitalists who owned the company were highly influential, made the brewery a good customer of the Mexican Railway, the local inter-urban railroad, and the local electric company, and paid notable taxes to the state and the city.¹ Also the 450 men and boys who did the work at the brewery formed the fourth largest contingent of workers in the city.²

Like work at the textile mills nearby, this work took place in a modern factory. By 1908 "an enormous establishment" of several large buildings across seven or eight acres, the brewery was in production practically all year round.³ It included an industrial supply of water and an industrial sewer. It had industrial transportation via two spurs on the Mexican railway, which it faced just across the square south, and the inter-urban track on the street along its east side. Its two central towers five stories high, three boilers for 175 horsepower, two steam engines, electric power lines carrying three-phase 60-cycle alternating current at 6,600 volts, and many motors, pumps, and machines constituted industrially powerful and industrially mechanized means of production. Big windows for some rooms, solid walls for others, sawtooth roofs on some buildings, and shacked vents on the roofs of others provided industrial control of light

¹. J.R. Southworth, *El estado de Veracruz-Llave* (n.p., 1900), 124; Morcom to Minister of Communications, October 8, 1907, Archivo Histórico de la Secretaría de Comunicaciones y Obras Públicas, C 1/315; A. Rodríguez Sariol, "Datos de la Empresa de luz eléctrica," August 24, 1907, and Eduardo Vignon, "Relación de las Industrias establecidas en este Municipio correspondiente al año de 1906," September 18, 1907, Archivo Municipal de Orizaba (henceforth AMO), 257/6; "Datos Ministrados al Museo Comercial de Filadelfia," November 6, 1906, AMO, 244/9; "Padrón de causantes del derecho de patente," October 31, 1906, and "Fábricas y Molinos," November 1, 1906, AMO, 259/1; Periódico Oficial del Gobierno del Estado de Veracruz-Llave, July 3, 1906, June 22, 1907, July 11, 1908.

². Percy F. Martin, *Mexico of the XXth Century*, 2 vols. (New York, 1907), II, 236.

³. *Ibid.*, II, 236. El Reproductor, January 18, 1906. "Escritura," July 13, 1906, in "Testimonios de la escritura constitutiva de 'Cervecería Moctezuma,' S.A.," July 15, 1960, Archivo de Manuel Gómez Morín, 144.

and climate.⁴ The work happened in "order and precision," in "various and multiple operations," and in an industrially certain sequence.⁵ Administratively the division of labor was by then in fifteen departments: cuartos calientes, "hot rooms," the brewhouse; casa de maquinaria, the new "machine house," or machinery department; cuartos fríos, "cold rooms," the stockhouse; hielo, the ice plant; patio, the yard; establos, the barn; obras, construction and maintenance; secadora, the drying plant; envase, packages, the new barrel- and bottle-storage sheds; bodega, the storehouse; embarrilado, barreling; embotellado, bottling; tonelería, the cooper shop; cajonería, the box factory; and taller mecánico, mechanical repairs, the machine shop. In practice there were at least four times as many subdivisions among craftsmen, workmen, and laborers. Whistles at 6 a.m. and at 6 p.m. six days a week signalled the standard industrial day and week.⁶ And production as such was "phenomenal," in the aggregate and in the articles actually produced.⁷ The 114,096 barrels of beer recorded in 1908, for example, were actually some 36,000 kegs and ponies and some 33,000,000 pint bottles of beer.⁸

⁴. El Reproductor, July 27, 1895, February 22, March 8, and March 15, 1900; Southworth, Veracruz, 124, 131; "Mexican Brewery and Ice Plant," The Western Brewer, January 15, 1901, 21-26, 29; "Cervecería Moctezuma, S.A.," *ibid.*, September 1904, 391-392; Julio Zárate, *Album del estado de Veracruz* (n.p., n.d.), 44-45; Auguste Génin, *Notes sur le Mexique* (Mexico, 1908-10), 5; Eugenio Espino Barros, ed., *México en el centenario de su independencia* (Mexico, n.d., 1910?), 173; Miguel Alemán Velasco, ed., *Documentos gráficos para la historia de México: Veracruz, 1858-1914* (Mexico, 1988), 145; José M. Naredo, *Estudio geográfico, histórico y estadístico del cantón y de la ciudad de Orizaba*, 2 vols. (Orizaba, 1898), II, 260, 264-267; McGraw Central Station Directory and Data Book, 1921-1922 (New York, 1922), 805; "Vista de la ciudad de Orizaba," in *Orizaba: Monumento en honor de los hijos del estado de Veracruz, defensores de la patria en los años de 1847 y 1848* (Xalapa, 1903), frontispiece; "Panorama del Cerro de Borrego desde la Cervecería Moctezuma-Noroeste," *Panorama Moctezuma Papers of Manuel Escobar*; Bernardo García Díaz and Laura Zevallos Ortiz, *Orizaba* (Mexico, 1989), 50-51.

⁵. R.G. Eslava, "Orizaba," *El Reproductor*, January 12, 1905.

⁶. Roberto Saviñón, "Primera parte del informe...de la visita que practicó a la Cervecería Moctezuma, S.A.," March 13, 1922, and "Continuación del informe correspondiente a la Cervecería Moctezuma, S.A.," March 31, 1922, *Archivo General de la Nación, Departamento de Trabajo* (henceforth AGN-DT), 17/1/6/6 (old style); J. Martínez Garza, "Datos sobre algunas industrias manufactureras establecidas en Orizaba," *Boletín de la Secretaría de Fomento*, ep. 2a., III (1903-04), 189-192; "Mexican Brewery," 24-26; J.A. Celis O. and R.M. de la Mora, "Plano General de la Cervecería," November 25, 1940, (for a copy of which I thank Christian Reiterhardt of Cervecería Cuauhtémoc); Interview with Manuel Zorrilla Rivera, April 28, 1975; Interview with Gabriel Camaleño, July 27, 1977; Interviews with Jorge Fleischmann, August 15, September 7, 1977. Cf. Testimony by Samuel Gompers, in *U.S. Industrial Commission, Report of the Industrial Commission*, 19 vols. (Washington, 1900-02), XVII, 410-412; and Ludwig Andorfer, *Die Rationalisierung in der Brauindustrie unter Berücksichtigung ihrer Einwirkung auf die Arbeiterschaft* (Nürnberg, 1929), 44-49.

⁷. Adolfo Dollero, *México al día* (Mexico, 1911), 732.

⁸. "Producción de la 'Cervecería Moctezuma,' S.A., desde su fundación hasta la fecha," December 31, 1939, and Jorge

As at other factories work happened continually out in the brewery yard on the yard boss's orders. There seven days a week, day and night at the gates and patrolling along the walls and fences, were the porteros, the watchmen. There also seven days a week, in the barn or out in the corral north of the buildings, were the barn foreman and two or three stable boys, who took care of horses, mules, harness, and wagons, especially the brewery's two double-decker Abresch delivery wagons.⁹ There Monday through Saturday at work in construction and maintenance from 6 a.m. to 6 p.m. were several masons, carpenters, handymen, and two or three gangs of laborers, often as many as 50 or 60 men and boys. And there every working day for the same 12 hours was the yard crew, the brewery's second largest department of workers, some 100 men and boys, working usually in various gangs unloading freight.

Two or three times a week, for instance, a Mexican Railway yard crew would remove an empty box-car from the spur along the front of the brewery, and spot a car loaded with 19 tons of good, clean, bagged, pale malt in front of the brewhouse. A brewery yard-crew gang would rig a chute from the loaded car down into the brewhouse's basement, into a belt-and-bucket elevator's boot, and every day when called go feed the elevator, for 3-1/2 or 4 hours unloading, opening, and emptying 40-45 93-lb. bags of malt an hour down the chute. Almost every week a railroad yard crew would remove another empty box-car from the same spur, and spot next to the car of malt a car loaded with 30 tons of bagged rough rice, and daily for 1-1/2 or 2 hours a brewery gang would unload, open, and empty 40-45 100-lb. bags of rice an hour down the chute and into the boot. Once a week, from a refrigerator car only that day on the spur, a gang would quickly unload 16 175-lb. bales of cold, green hops and grunt them up to cold storage on the brewhouse's second floor. Once or twice a week from a car of firewood on the spur a gang would unload its 12-13 cords and stack them alongside the track under a wood shed, and daily another gang would carry 2-1/2 or 3 cords back to the boiler room.

Fleischmann to Verlag Hans Carl, March 17, 1953, Archivo de la Cervecería Moctezuma; Interview with Gabriel Camaleño, July 26, 1977; Interviews with Jorge Fleischmann, August 31, September 7, 1977; "Mexican Brewing and Breweries," *One Hundred Years of Brewing* (Chicago, 1903), 636; E. Struve, *Die Bierbrauerei und die Bierbestuerung in den Haupt-Kulturländern* (Berlin, 1909), 462.

A barrel of beer is 31 gallons. On measurements of beer, see Robert Wahl and Max Henius, *American Handy-Book of the Brewing, Malting and Auxiliary Trades* (Chicago, 1901), 80, 96, 102, 915. On kegs (7.75 gallons) and ponies (3.875 gallons), see Edward H. Vogel, Jr., et al., *The Practical Brewer* (St. Louis, 1946), 141. On variations then in the contents of pint bottles, see Allen R. Smart, "Twentieth-Century Brewery Accounting," *The Western Brewer*, November 1912, 238, and "Bottled Beer," *ibid.*, May 1914, 213.

⁹. Zorrilla Rivera, April 28, 1975; Camaleño, July 26, 1977. On the Abresch wagons, *The Brewers' Journal*, March 1, 1905, 215; "Chas. Abresch Co.," *The Western Brewer*, January 1908, advertising p. 14.

Every day a railroad yard crew would remove six or seven empty box-cars from the spur west around by the bottle-storage sheds, and spot there six or seven cars loaded with cases and boxes of empty bottles. Usually every day an inter-urban teamster would bring a car of empty packages, barrels and boxes of empty bottles, around to the sheds too. From these cars every day a yard gang would unload the barrels, cases, and boxes, 1,800-2,000 of them, 110-120,000 bottles a day, and carry them into the sheds.¹⁰

Besides, in and out of the yard and back and forth across it through the day, teamsters would be driving wagons, often with a yard gang in tow. Nearly every day a driver would take a wagon out across the square to the railroad freight dock, pick up boxes of fittings, boxes of crowns, cases of labels, drums of caustic soda, barrels of lubricating oil, cylinders of ammonia, and other packages of supplies, and deliver them back at the storehouse, on the street along the east side, where a yard gang would unload them. Every morning two Abresch drivers would take these wagons out to the brewery's wholesale agency on the same street, pick up barrels and boxes of beer, and leave to make local deliveries, and every afternoon return to the sheds with empty barrels and boxes of empty bottles, which a yard gang would unload. At least once a day a driver would take a wagon of heavy supplies from the storehouse around to the various departments that wanted them, where a yard gang would unload them.¹¹ At least once a day a driver would collect a wagon load of trash and garbage and take it to the incinerator at the drying plant, out by the storage sheds, where a yard crew would unload it. Usually 12-15 times a day a driver would take a wagon load of spent grains to the drying plant, and a yard gang would unload them.

Out in the sheds, eight sheet-iron halls, baking under the sun, chilly under the rain, the work was like that of the yard gangs, but in one place, in detail, and discriminating. In the one shed for barrels every morning the cooper would spend a couple of hours examining yesterday's returns, usually 140-145 kegs and ponies. At each he would hook out the

¹⁰ Zorrilla Rivera, April 28, 1975; Camaleño, July 26, 1977; Fleischmann, August 31, September 7, 1977; Saviñón, March 13, 1922, AGN-DT, 17/1/6/6; A. Mantel, "The Brewing Industry in Mexico," *The Western Brewer*, November 15, 1901, 446; Eslava, "Orizaba"; Martínez Garza, "Datos," 191; Southworth, Veracruz, 124; Espino Barros, México, 173; Alemán Velasco, Documentos, 145; "Ayer 1896" and "Chalet de botellas de vidrio, 1907," Escobar papers; Albert de Baer, "Mexico," *United States Consular Reports*, 324 (September 1907), 145-146; Gonzalo Arzamendi, Jr., "La influencia del medio en la seguridad e higiene industrial, aplicada a la industria cervecera," September 1964, 3-4, in *Biblioteca Henry O. Sturm, Jr., Asociación Nacional de Fabricantes de Cerveza*. Cf. "Allsopp's Bottling Plant," *The Western Brewer*, February 15, 1901, 65.

¹¹ On the storehouse and agency, "Mexican Brewery," 26. On the incinerator and drying plant, Eslava, "Orizaba"; Espino Barros, México, 173; Alemán Velasco, Documentos, 145; Fleischmann, September 7, 1977.

bung and any still corked vent, take the barrel by the chime, knock it lightly on the belly with the hook, and listen for the tone, dead from the damaged, clear and ringing from the sound. The damaged his apprentice would mark and set aside for repair. The sound he would feel with a finger through the bunghole, to tell if the surface around inside it was smooth or rough. The rough he would mark and set aside for relining.¹² Once they had enough good barrels, from yesterday's returns and earlier ones by then repaired and relined, 140-145, the cooper would tell the yard boss, and on his orders a yard gang would load them on a wagon alongside the shed, which a driver would take to the front of the bottle house, where the same gang would unload them.

In the sheds for bottles, from 6 a.m. to 6 p.m. amid the constant racket of wood clacking on wood and glass jingling, the shed gang would be receiving and sorting bottles. The cases were shipments of new ware from the United States, dark brown medias, pints, factory clean; the boxes, shipments of returned pints, dirty, often with wire around the neck, and typically with at least part of a label still stuck on them. Broken boxes and chipped, cracked, and broken bottles the gang would throw into the trash. The good bottles it would dewire, rebox, the bottles acostados (lying down in the box), 10 across, six deep, and stack them on armones, two-wheeled carts waiting alongside the sheds. Carters would continually push the loaded carts to the front of the bottle house, 1,800-2,000 boxes a day. There another yard gang would continually unload the carts and restack the boxes.¹³

Also as at other factories six days a week from 6 a.m. to 6 p.m. a warehouse gang worked in the storeroom. Its men would help unload the supply wagon, truck or carry the packages to the proper place to store them, stack or shelve them, watch for leaks of any liquid, and continually remove and reload packages for delivery to their destination. Likewise in the agency a gang would unload the kegs, ponies, and boxes trucked there, saddle the barrels, stack the boxes, watch for leaks, load the Abresch wagons, and load the inter-urban cars for delivery in the mill towns up the

¹². Interview with Luis E. Sánchez, August 10, 1977; G.J. Siebel, "Handling and Pitching of Packages," *The Western Brewer*, June 15, 1897, 1047, 1049; F.P. Hankerson, *The Cooperage Handbook* (Brooklyn, 1947), 138; Kenneth Kilby, *The Cooper and His Trade* (Fresno, 1989), 19, 41. Cf. George Ehret, *Twenty-Five Years of Brewing* (New York, 1891), 96-102.

¹³. Camaleño, July 26, 1977; Sánchez, August 10, 1977; Interview with Daniel Sierra Rivera, September 5, 1977; Mantel, "Brewing Industry," 446; de Baer, "Mexico," 146; Charles H. Sulz, *A Treatise on Beverages* (New York, 1888), 388-392; Philip Dreesbach, *Beer Bottlers' Handy Book* (Chicago, 1906), 100; Raoul M. Vázquez to Luis E. Sánchez, May 31, 1977 (for a copy of which I thank Luis E. Sánchez); "Esteban González Rojas" and "Andrés Durán Alvarado," Escobar papers.

valley.

But, being a brewery, Moctezuma was an odd sort of factory. The definitive work there, brewing and fermenting, was a combination and succession of mechanical, chemical, and biological operations. However orderly, precise, industrial, it remained the practice of an ancient art: "...the mechanisms do not form a connected series," the chemical "play of delicate affinities" and the biological reactions were always "somewhat uncertain," and the operations were significantly "manual."¹⁴ Both brewing and fermenting operations were also intrinsically occasional, differentiated into sequential tasks. Unlike operations in a textile mill, they could not happen simultaneously and continuously but only by the batch, one after another.¹⁵ Each brew was therefore a particular event. Puffs of black smoke would rise episodically from one of the 70-foot chimneys behind the brewhouse, a white plume of vapor would stream from the old or the new 85-foot ventilator, and whiffs of cooking grains and hops would drift through the neighborhood, for two, three, or four hours at a time. In 1908 this happened one, two, or three times a day ordinarily six days a week 50 weeks of the year, altogether some 145 brews in the 60-barrel kettle and some 425 brews in the 250-barrel kettle, each one numbered and dated.¹⁶ And every time the brew's author, the brewmaster, was there. This was not for technical supervision. The brewmaster knew mysteries of water, heat, grains, and time that he did not think he ought to know how to explain. He had not learned them at an academy, but from his experience, his "practical education." For the eight different beers then made at the brewery he carried in his head not formulae but recipes. When he appeared, it was to keep the authoritative record, announce a peremptory order, give masterly direction, or declare a conclusive judgment. On any day Monday through Saturday he would have a brew started whenever he reckoned was best, maybe at 4 a.m., maybe at 7:30 a.m., maybe at 10 p.m. During the brews he read gauges and his watch, thermometer, and saccharometer,

¹⁴ Andrew Ure, *The Philosophy of Manufactures* (London, 1835), 2, 13. A good summary of contemporaneous practice in the industry in the United States, followed also by large breweries in Mexico, is Robert Wahl, "Brewing and Malting," in *Industrial Chemistry: A Manual for Student and Manufacturer*, eds. Allen Rogers and Alfred B. Aubert (New York, 1913), 688-704.

¹⁵ Carl Rach, "Brew House Arrangement and Mashing Methods," *The Western Brewer*, October 15, 1901, 406-407; R. Norris Shreve, *The Chemical Process Industries*, 2nd ed. (New York, 1956), 1, 9-22.

¹⁶ "Producción," December 31, 1949, *Archivo de la Cervecería Moctezuma*; Fleischmann, September 7, 1977; Fred Ophuls and A.B. Stickney, *The Thermal Engineer in the Brewery* (New York, 1933), 16. Cf. Carl Rach, "Four Months of Strenuous Work in the Two Largest Breweries of Indiana," *The Brewers' Journal*, May 1, 1904, 287-289, and June 1, 1904, 335-336. On the kettles, "Mexican Brewery," 21; "Cervecería Moctezuma," 392; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6.

but made his decisions by sight, smell, taste, and feel. And on any day Monday through Saturday work ended in the brewhouse whenever he ruled that the day's work was done, maybe at 7:30 p.m., maybe at 9:30, maybe at 1:00 the next afternoon. Similarly in the stockhouse each batch in fermentation bore a number and a date, had its page in the brewmaster's records, underwent his practical tests day or night at the hours he determined, and on his word that it was beer counted as a batch done. So in the "hot rooms" and the "cold rooms" the working day and the working night were irregular, arbitrary, and indefinite. Only between tasks could workers eat or go to the toilet.¹⁷

It was also odd for a factory that one of the processes of production, fermentation, required the adoption and development of a life. This life was that of the microbes in the yeast that fermented the brews into beer, saccharomyces cerevisiae, the type at Moctezuma named Chicago No. 1. It was of a cultivated and inhibited kind. It could not fight other microbial forms, mold, bacteria, mycoderma, wild yeast, which would ferment a brew into an acid or a solvent. And even free of them it needed special care--"Proper nourishment, proper temperature, sufficient air, exclusion of adverse influences generally"--or it would weaken, sicken, and die. Consequently the brewmaster insisted on cleanliness, "the first consideration in every brewery," especially in the stockhouse. Consequently as well he depended on the cold there, temperatures between 23° and 52° F., low enough to chasten the undesired forms of life, but high enough to permit the privileged to reproduce. Given the natural temperatures in Orizaba, annually averaging 65°, rising to 80° or higher most days every month, in the 90°s in May, production was possible then only through mechanical refrigeration.¹⁸ And since the brews came one after another, and the microbes never took a night off or a Sunday or a holiday, the refrigeration had to run practically all the time. While the brewmaster kept charge of the brews in the cold, there was another master in charge of making this cold, the maestro de maquinaria, the master mechanic in the machinery department, who logged

¹⁷. Sánchez, August 10, 1977; Fleischmann, August 15, September 7, 1977. Cf. Leonardo M. Mayer, "¿De manera hijo que quieres ser maestro cervecero?" November 1961, Biblioteca Sturm. Cf. Charles Russert, "Mission of America's Brewing Academies," *The Western Brewer*, October 15, 1901, 403-405; Frank Keeling, "Status of the Modern Brewer," *The Brewers' Journal*, May 1, 1902, 291-294; Testimony by Gompers, Industrial Commission, VII, 625, 650; Charles Booth, *Life and Labour of the People of London*, 17 vols. (London, 1902), 2nd ser., III, 122; Emil Wolff, *Lohnsystem und Löhne in der Brauindustrie* (Berlin, 1912), 86-94, 148-159.

¹⁸. On the yeast, Fleischmann, September 7, 1977. On the special care it required, Wahl and Henius, *American Handy-Book*, 516-518, 520-522, 542-543, 742; J.E. Siebel, "Pure Yeast and Beer Taste," in *Original Communications of the Zymotechnic Institute* (Chicago, 1891), 32-34; "The Production of Pure Beer," *The Western Brewer*, January 1904, 11. On temperatures in Orizaba, Naredo, *Estudio*, II, 6; Moisés T. de la Peña, *Veracruz económico*, 2 vols. (Mexico, 1946), I, 31.

in at 6 a.m. and out at 6 p.m., but stood responsible at any hour for having every cold room at the right degree of cold. As sure as the brewmaster was of his art, so sure was the maestro of his several trades. From his experience as a practical stationary engineer (except for his weakness in electricity), he was a master of mechanical observation, olfaction, gustation, palpation, and auscultation, a devotee of the log, precautions, and precision, a virtuoso in fashioning woods and metals, and a wonder at erecting, running, and repairing all manner of machines. In his department and in the stockhouse work went round the clock, two shifts a day, seven days a week, a daily and a nightly effort to preserve a vital condition.¹⁹

Most oddly and most importantly production took a long time, for the process of fermentation lasted from three or four to six months.²⁰ Compared to the volume of the brews daily started or the volume of the beer daily finished, the volume of the stocks in the process on any day was ordinarily therefore at least 70 times greater. This was why the cold rooms at Moctezuma by 1908 measured some 800,000 cu. ft.²¹ As one, two, or three brews were done on brewing days in 1908, so from 27,000 to 38,000 barrels, all the brews stocked since the day before to nearly six months ago, averaging the work of the past 120 days, were every day still in the course of production, all zymologically alive, all perishable. Probably 90% of the brews in the process wanted to be at about 34° F. If the refrigeration was not right even for some hours, much less failed, the brews of the 120 days previous would go bad, and 120 days of refrigeration go for naught.

Only in finishing its product did this factory function on a classic factory system. Since the final product consisted of not only a perishable article of consumption but also a clean, durable container, not merely beer, but beer in decontaminated kegs, ponies, and pint bottles, all ready for retail, the final processes of production were barreling and bottling. And since the product was daily "a very large number of individuals," beers in scores of kegs and ponies and scores of thousands of bottles, "a great multitude of things, all of exactly the same kind," both processes took factory

¹⁹. Fleischmann, August 31, September 7, 1977. Cf. "Brewmasters and Engineers," *The Western Brewer*, November, 1905, 526; G.J. Patitz, "Engineering Problems in the Brewery Power Plant," *ibid.*, April 1912, 171.

²⁰. Sánchez, August 10, 1977; Fleischmann, September 7, 1977; Martínez Garza, "Datos," 190. Cf. Wahl and Henius, *American Handy- Book*, 758-759; J.G. Friedhoff, "Cellar Treatment," *The Western Brewer*, March 15, 1901, 93; Lorenz Herzinger, "Fermentation and Cellar Work," *ibid.*, May 15, 1901, 182; Francis Wyatt, "Notes on Bottle Beer Brewing," *ibid.*, January 1907, 30; Ophuls and Stickney, *Thermal Engineer*, 4.

²¹. "Mexican Brewery," 21, 22, 29; *The Western Brewer*, April 1907, 188; *The Brewers Journal*, May 1, 1907, 314; *Modern Mexico*, October 1907, 30.

organization.²² Already in 1900 the barreling and the bottling department had some notable machines. By 1904 they had some impressive series of maneuvers and mechanisms. By 1908, featuring "maximum order and the most scrupulous cleanliness," they ran on the latest line for mechanized and continuous operations.²³ In these departments the chiefs were department cabos, foremen. There the working day was the standard.

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Moctezuma's most significant and complicated installation was therefore its main power plant, which as the master mechanic directed the work there gave heat, force, and most importantly incessant cold.²⁴ At first the master had only a single train of work to supervise. The original plant had one source of power, the 60-hp boiler, one prime mover, the 75-hp engine, and one main line-shaft. The boiler's steam went on a 24-hour variable load, for heat for steeping and boiling in the brewhouse, for heat for cleaning and pasteurizing in the bottle house, and for power on the engine driving by direct connection the 15-ton refrigerating machine and turning by belt the shaft for the plant's pumps and elevator and the brewing, barreling, and bottling machinery. There was no excess capacity for an emergency: some surplus power, but no spare engine or machine for making cold.²⁵ By 1901 the new equipment required the master to conduct several different operations. The plant had three sources of power, three prime movers, and two main line-shafts. One source, one of the two 100-hp, wood-fired Cook boilers in the shed at the northwest corner of the brewhouse, was on a usually 12-hour variable load entirely for heat for the brewhouse and the bottle house. The other boiler, on a 24-hour variable load, powered both of the two 140-hp Corliss engines in the brewhouse, which together continuously cranked around two 10-foot flywheels belted to 40-inch pulleys on a 6-inch main line-shaft, which in turn transmitted (at peaks) 160 horsepower up the line for the then new, 100-ton horizontal double-acting Vilter ammonia compressor (erected in the brewhouse's new north extension) and 120 horsepower down the line for the plant's pumps and elevator and the brewing

²². Charles Babbage, *On the Economy of Machinery and Manufactures*, 4th ed. (London, 1835), 120, 268.

²³. Eslava, "Orizaba." "Mexican Brewery," 22-26, 28; "Cervecería Moctezuma," 392.

²⁴. Lorenzo Campano, *Manual del cervicero y del fabricante de bebidas gaseosas y fermentadas*, new ed. (Mexico, 1927), 1; "Brewing in Milwaukee," *The Western Brewer*, January 15, 1895, 85-89, 99; G.E. Lob, "The Power Question in the Brewery," *ibid.*, March 1912, 133-135; Max Delbrück, *Illustriertes Brauerei-Lexikon* (Berlin, 1910), 544-546; Ophuls and Stickney, *Thermal Engineer*, 16-18.

²⁵. *El Reproductor*, July 27, 1895; Zárate, *Album*, 45.

machinery. The third source was Segura, Braniff's Iztaczoquitlán hydroelectric plant. Its power, transmitted to the transformer substation near the Mexican railway station and stepped down to 220 volts, went on a 12-hour variable load into the bottle house to the third prime mover, the 200-hp Westinghouse motor, which from 6 a.m. to 6 p.m. turned a 40-inch pulley on the bottle house's 6-inch main line-shaft for barreling and bottling.²⁶ There was by then the standard excess capacity for the most important duty. If either boiler wanted shutting down, brewing could stop, and the other, good boiler keep both engines going for refrigeration. If the 100-ton machine wanted stopping, the engines could be reconnected to their two by then old 50-ton Vilter machines for the regular cold. If either of the engines broke down, the 100-ton machine could be disconnected and the good engine connected to its old 50-ton machine for enough cold to get the stocks through the emergency.

By 1908 the plant's divisions were systematic, and the master mechanic on his daily morning and evening rounds walked through a new order. Of the two 100-hp boilers, one on a 24-hour variable load steamed only for heat, in brewing, barreling, and bottling; the other was a spare. From Iztaczoquitlán, where by then the plant was Orizaba Electric Light and Power's, high-tension lines brought the current at 6,600 volts also on a variable 24-hour load into the brewery's new substation, behind the brewhouse, in the west wing of the new machine house. There in the high-tension room on the second floor, through three conductors, closed disconnecting switches, and a closed oil circuit-breaker behind the first panel of a two-panel, marble switchboard, the current flowed onto the main bus-bar behind the switchboard.²⁷ Thence branched two 6,600-volt circuits. On one the current flowed through three conductors to the bus

²⁶ El Reprodutor, June 18, 1896; *ibid.*, July 30, 1906; *The Western Brewer*, September 15, 1896, 1699; *ibid.*, October 15, 1896, 1922; "Mexican Brewery," 21-26, 29; Zárate, *Album*, 44; Southworth, Veracruz, 124-125; Martínez Garza, "Datos," 191-192; Rodríguez Sariol, August 24, 1907, and Vignon, September 18, 1907, *AMO*, 257/6. For the boilers, the steam engines, and the 50-ton and the 100-ton compressors, see *The Vilter Manufacturing Co., Refrigerating and Ice Making Machinery, Catalogue A (Milwaukee, 1909)*, 29, 33-35, and "Calderas verticales del año 1906," "Motores 'Corliss' para casos de emergencia, 1922," "Compresoras de amoniaco, para casos de emergencia, 1922," and "Compresoras de amoniaco, enero 1922," photographs, in *Album de la Cervecería Moctezuma, Orizaba, Ver. (Mexico, 1922)*. Cf. William Nottberg, "Electric Power for Breweries," *The Western Brewer*, January 15, 1906, 25-27; *Electrical World*, February 3, 1906, 293; C.F. Hettinger, "How to Generate and Utilize Power in Breweries," *The Western Brewer*, May 15, 1906, 226-228; Otto Luhr, "Economy and Simplicity in Brewery Power Plants," *ibid.*, December 15, 1909, 628-629.

²⁷ Fleischmann, September 7, 1977. On Orizaba Electric Light and Power, *Periódico Oficial del Gobierno del Estado de Veracruz-Llave*, January 4, 1908; *Electric Review*, January 4, 1908, 32; McGraw Central Station Directory, 805; Roberto Saviñón, "Informe...correspondiente a la visita que practicó en la Planta Eléctrica de Iztaczoquitlán," February 26, 1922, AGN-DT, 17/1/6/6; Westinghouse Electric and Manufacturing Co., Detail and Supply Department, Circular No. 1504: *Alternating Current Switchboards*, May 1909, 1-16. Cf. Frank Koester, *Hydro-electric Developments and*

bar behind a marble-paneled switchboard on the machine house's first floor, in the engine room, and from this bar through a closed oil circuit-breaker it went in six phases through six conductors into the armature winding on the stator of the new, 500-hp Westinghouse synchronous motor. Beside the marble board on the first floor, from behind a slate switchboard, direct current from the motor's 15-hp exciter flowed back into the motor's field. The motor was a marvel. On its bedplate, bearings, and shaft the shiny, black electro-magnetic machine stood about 9 feet high, measured about 8 feet wide and 8-1/2 feet long at its base, and weighed some 10 tons. Its squirrel-cage-wound, salient-field-pole rotor, constantly revolving at 225 rpm, driving the exciter by direct connection, drove at the same speed a 56-inch, 20-grooved flywheel, which drove by the American rope system across about 20 feet a 14-foot, 20-grooved wheel, which in turn drove at a constant 75 rpm the old and the new 100-ton Vilter compressors. The other 6,600-volt circuit was the source of two low-voltage circuits. From behind the second panel of the second-floor switchboard, through a closed oil circuit-breaker, three conductors carried single-phase currents down to the substation's first floor into three, single-phase, 75-kw transformers in parallel. From them, through three conductors back up to the second floor and through a closed, low-tension, air circuit-breaker on the first panel of a three-panel, slate switchboard, three single-phase currents at 220 volts flowed onto the main low-tension bus-bar behind all three panels of the board. Through air circuit-breakers on the second and third panels two wires from the second carried single-phase current for light, and three wires from the third panel carried three-phase current for power, to the cut-out cabinets in all the brewery's departments, to the various light and motor switches, and into the lights and motors on. Of these ordinarily the largest was the old 200-hp motor, removed to the new repair shop to turn its line shaft.²⁸ So the power available sufficed for any expectable emergency. If

Engineering (New York, 1909), 280-308; Warren H. Miller, "Alternating-Current Industrial Power Plants," *Electrical World*, June 3, 1909, 1376-1379; William Koedding, "The Application of Electrical Power in the Brewery," *The Western Brewer*, March 15, 1912, 111-112; H.W. Peck, "Modern Practice in Switchboard Design," *The Electric Club Journal*, December 4, 1904, 634, May 1905, 311-315, June 1905, 380-383, August 1905, 508-511, and October 1905, 634-640; "Fulton Ice Company's Plant," *Refrigerating World*, January 1924, 13-15.

²⁸. Fleischmann, August 15, September 7, 1977. For the motor's switchboard, see "Freezing plant, brewery at Orizaba," photograph in the *The Epicure*, "How to See Mexico," *Overland Monthly*, July 1910, 39. For the motor, *ibid.*, 39; "Compresoras de amoniaco, enero 1922," *Album de la Cervecería*; Dollero, México, 782; Westinghouse Electric and Manufacturing Co., Circular No. 1133: Westinghouse Revolving Field Alternators, June 1906, 3-11; "Westinghouse, Doing It Electrically," *Refrigerating World*, February 1917, 5; Educational Department, Westinghouse Electric and Manufacturing Co., *Synchronous Motors: Westinghouse Extension Course Number 14* (E. Pittsburgh, 1931), 8-9, 42, 78, 86-100. For the compressors in 1908, "Freezing plant," in *The Epicure*, "How to See Mexico," 39; "Compresoras de amoniaco, enero 1922," *Album de la Cervecería*; *The Western Brewer*, July 15, 1907, 402; *Ice and Refrigeration*, July 1907, 33; *Modern Mexico*, October 1907, 31. (The authors of the last three articles mistook Moctezuma's new total

Iztaczoquitlán went down, if the 500-hp motor failed, or either of the 100-ton machines, the spare boiler would drive the otherwise idle steam engines and thereby the two old 50-ton compressors, to keep the stocks cold enough for many hours.

Finally, between the central buildings and the bottle-storage sheds, stood a small, simple power station for destruction and by-production at the drying plant. On the brewery's rule of cleanliness, daily destruction of trash and garbage, including usually 500-550 lbs. of wet, spent hops, was a sanitary necessity. And by-production turned a daily mess into a useful substance. On an average working day 11 or 12 tons of dry malt and rice went into the brewery, and 13 or 14 tons of wet, spent grains came out. Left wet for more than 24 hours, they would ferment and rot. Dried, they would make 2.5-3 tons of sweet meal, "an unsurpassable food for cattle" in the dairies around the city and upcountry.²⁹ The plant comprised the incinerator, to burn the waste; a 90-ft. chimney, to give good draft on wet refuse and throw gases, smoke, and fumes high and far away; and inside an adjacent frame building the old 75-hp boiler, a little motor, and the motor-driven dryer, a horizontal, sheet-iron drum about 22 ft. long, 5 ft. in diameter.³⁰

The continuous work for power and refrigeration happened then on the master mechanic's orders in the boiler room and in the new machine house. At the boilers, water-tube, upright, quick steamers, a day-shift and a night-shift fireman by turns watched the gauge of the one lit, tended its feed heater and pump, and fueled its furnace.³¹ On a rare, easy night, nothing brewing, the hardest duty was staying awake. Taking the shift at 6 p.m., the fireman would test the safety valve, climb the ladder up to the boardwalk by the water-gauge glass, blow down the column, test the glass's water level by the gauge cocks, climb down, blow off the mud drum, and examine and oil the pump. He would have no more

refrigerating capacity for its newly acquired refrigerating capacity.) On the wiring for lights and motors, "Departamento de botellería en 1908," "Departamento de embotellado en 1920," "Departamento de embotellado, 1921," "Lavadoras de botellas, 1920," "Lavadoras de botellas, vista del subsuelo en 1922," and "Máquina de hacer clavos, 1922," Album de la Cervecería; R.G. Hudson, "Wiring of Buildings for Light and Power," in *American Handbook for Electrical Engineers*, ed. Harold Pender (New York, 1914), 1938-1940, 1949-1950, 1952, 1963. For the old motor in its new place, "Máquina de hacer clavos, 1922," Album de la Cervecería.

²⁹. Saviñón, March 31, 1922, AGN-DT, 17/1/6/6.

³⁰. Fleischmann, September 7, 1977. Eslava, "Orizaba"; Espino Barros, México, 173; Alemán Velasco, Documentos, 145. Cf. Wahl and Henius, *American Handy-Book*, 871-873; Felix Mendelsohn and Maurice E. Stern, *Brewers and Bottlers Universal Encyclopedia* (Chicago, 1910), 165, 237; W. Goslich and K. Fehrmann, *Brauerei-Maschinenkunde*, 2 vols. (Berlin, 1914-1920), II, 318-320.

³¹. "Calderas verticales del año 1906," Album de la Cervecería; "Mexican Brewery," 21; Cecil H. Peabody and Edward F. Miller, *Steam Boilers* (New York, 1905), 27-29.

to do until 5 a.m. but keep an eye on the gauges, about every hour toss a chunk of wood into the furnace, and sooner or later clean the fire and the ash pit. Only on the last hour of his shift would he fire fast, every six or seven minutes, to raise the day's steam for the bottle house. On the rare day without a brew the fireman would fire the furnaces but about every 10 minutes, to maintain the heat for cleaning and pasteurizing; any time after noon he would clean the fire and the pit. On brewing days, however, the brewmaster would usually have the master mechanic calling for thousands of pounds of steam an hour at least three times a day. For a 250-barrel brew from 10 p.m. to 1 a.m., a 60-barrel brew from 6 to 9 a.m., and another 250-barrel brew from 2 to 5 p.m, plus the regular needs for bottling, the night fireman would fire every two or three minutes during the first brew, clean the fire and haul ashes between 1 and 5 a.m., and fire again every two or three minutes from 5 to 6 a.m., and his fellow on the day shift would work twice as hard, firing every two or three minutes from 6 to 8 a.m., not quite so fast the next hour, more slowly the next two, only every 10 minutes the next three hours, when he would clean the fire and haul ashes, but practically non-stop, a chunk every minute or two, from 2 to 5 p.m.³²

As the master mechanic directed once every couple of weeks the fireman would overhaul the boiler. A fireman on a slow stretch would drain the other boiler down to the water line, fire it up to the due pressure, and change the boilers over. In a day the boiler cut out would cool down, and one or the other firemen would drain it into the sewer. Then whenever they had the time one or the other would wash out the mud drum, run the blowing pipe and hose into the heating space and steam the worst soot off the tubes, brush the rest off, put a light in the lower drum, open the upper drum, and look down the tubes to examine their inner surface, push the scraper down any that looked scaly, clean the blow-off cock and the check valve, and refill the water drums to the top.³³

In the machine house, the power always on and the machinery constantly moving, the main work was "eternal

³². Camaleño, July 26, 1977; N. Hawkins, *Maxims and Instructions for the Boiler Room* (New York, 1901), 14, 18, 24-27, 37-47, 196-201, 218-221; Robert H. Thurston, *A Manual of Steam-Boilers* (New York, 1888), 440-471; The Babcock and Wilcox Co., *Steam, Its Generation and Use*, 35th ed. (New York, 1913), 173, 201; Hermann von Schrenk and William K. Hatt, "Wood," in *Mechanical Engineers' Handbook*, ed. Lionel S. Marks (New York, 1916), 579.

³³. Hawkins, *Maxims*, 27, 45, 70-71; Peabody and Miller, *Steam-Boilers*, 28, 110-111; Babcock and Wilcox, *Steam*, 298-300; *Coal Miners' Pocketbook*, 11th ed. (New York, 1916), 426, 434-435; Arthur D. Pratt, "Steam Boilers," in *Mechanical Engineers' Handbook*, 936-937; Otto Luhr, *Mechanical and Refrigerating Engineers' Handbook* (Chicago, 1913), 306.

vigilance."³⁴ There under the master mechanic were an electricista and a maquinista refrigerador, practically a refrigerating engineer, and his assistants, a condenser man and a greaser. The electricians by turns documented their extensive and detailed vigilance of Moctezuma's electric system in the machine-house log in the engine room. Doing his duty, day or night, an electrician started his shift by recording the weather and temperature outside, and at mid-shift (noon or midnight) recorded them again. Hourly he called the Orizaba Electric Light and Power station generator at Escamela, to confirm mutual expectations of load, then made the rounds of the house upstairs-downstairs, seeing that all the wiring and insulation were in good condition, that connections were tight, that front and back the switchboards were clean and dry, that synchronizing lamps, voltmeters, ammeters, and wattmeters indicated no trouble, that the big motor was shiny clean, dry, and scarcely humming, felt barely warm, had full lubricators, and smelled of paraffin, that its exciter was clean and dry too, not sparking, singing, or humming, or hot either, and that the transformers were clean, dry, and buzzing. The meter readings and anything unusual he noted in the log; any serious fault day or night he reported to the maestro. And going off his shift, he logged its maximum load, average load, and load factor.³⁵

Coming on his shift in the engine room at 6:00 a.m. or p.m., the engineer faced the motor and the compressors. Although he did not understand the motor, it was in his care. He would keep an eye on the synchronizing lamps and the various meters, and whenever he saw the power factor in decline, he would wheel the marble board's rheostat right or left a click (or two, or three), to cut resistance out or in, increase or decrease the exciter's current into the big motor, and keep it duly overexcited, floating, running light, making the current lead correctly.³⁶ But the compressors were his main pride,

³⁴. "The Engine Room," *Ice and Refrigeration*, October 1912, 125.

³⁵. Camaleño, July 27, 1977; Fleischmann, September 7, 1977; "Engineers' Log for Ice and Refrigerating Plants," *Refrigerating World*, September 1913, 79; Charles H. Herter, "The Refrigerating Engineer's Log," *ibid.*, December 1913, 53; D.B. Rushmore and E.A. Lof, "Power Stations, Hydroelectric," in *American Handbook*, 1107-1108; Westinghouse, Circular 1504, 4-6, 8; "Electric Machinery Operation," in *Machinery's Encyclopedia*, 7 vols., eds. Erik Obert and Franklin D. Jones (New York, 1917), III, 1-3, 6-7, 9-11; F.B. Crocker, "Running a Generator or Motor," *The Technical World*, March 1905, 80-81; Norman G. Meade, "Installation and Care of Electric Motors," *Power*, February 18, 1908, 246; "Catechism of Electricity," *ibid.*, January 12, 1909, 134-135.

³⁶. Fleischmann, September 7, 1977; B.G. Lamme, "Synchronous Motors for Regulation of Power-Factor and Live Pressure," *Transactions of the American Institute of Electrical Engineers*, XXIII (1904), 481-510; Murray C. Beebe and F.A. Kartak, "Electrical Engineering," in *Mechanical Engineers' Handbook*, 1568, 1576, 1583, 1593-1596; Paul MacGahan, "Power-Factor Meters and Their Application," *The Electric Club Journal*, September 1904, 462; H.W. Peck, "Modern Practice in Switchboard Design," *ibid.*, January 1905, 41-44; Westinghouse, Circular 1504, 3-4, 6, 13-14, 18-19; J.E. Latta, "Why Use a Rheostat in the Alternate Field Circuit," *Power*, December 7, 1909, 958-959.

interest, and worry. Right-hand and left-hand alongside the driving wheel, otherwise identical, each with a 16-inch cylinder and a 32-inch stroke, frosted suction lines from hangers nearly 14 feet high seeming to lock the cylinders down for the pistons, they made together a great duplex double-acting pump nearly 16 feet wide and 22 feet long, weighing a good 20 tons, and as they pumped around 600-800 cu. ft. of ammonia a minute from cold vapor to hot gas they made the refrigeration system run. The engineer walked slowly and silently around the three machines. In his tow came the greaser, continually wiping everything metal, fixed, and in reach clean and dry. The drive rope a brownish blur overhead, the driving wheel whirling at 75 rpm, the pistons pressing back and forth at 150 strokes a minute, the frost-covered suction valves right and left at the crank end and the head end each sucking vapor and going "absolutely noiseless" to its seat 75 times a minute, the warm discharge valves right and left at the crank end and the head end each discharging gas and clacking into its seat 75 times a minute, the engineer and the greaser would look, listen, smell, and feel for trouble in the system. Most intently they looked at the frost lines on the inlet side of the cylinders (to see that they were about where they usually were), listened for knocking or pounding, smelled for burnt packing, and felt the outlets and discharge pipes (to know that their temperatures were as warm as usual). But the engineer also studied the clearance marks on the guides and crossheads, the automatic oil pumps dripping three or four times a minute, and the back-pressure and head-pressure gauges high up on the east wall, the back pressure quivering about 33 psi, the head pressure about 165 psi. He heard the sweet silence of the motor and compressor bearings and the steady, rumbling rhythms of the electric pumps in the room next door. He sniffed for the hartshorn stink of an ammonia leak in the compressors and the piping. He touched the piston rods, at blood heat, and the cool pipes to the cylinders' water jackets. He noted the suction and discharge pressures in the log, left the greaser on guard, and made his rounds.³⁷

³⁷. "Compresoras de amoniaco, enero 1922," *Album de la Cervecería; Ice and Refrigeration*, July 1907, 33; Vilter, *Catalogue A*, 8, 10-11, 15, 33-35; "Vilter Refrigerating Machinery," *The Engineer*, October 15, 1906, 676-677; Mendelsohn and Stern, *Brewers and Bottlers*, 591; Arthur M. Greene, Jr., *The Elements of Refrigeration* (New York, 1916), 44-46, 70-71, 360-361, 433-434; J.E. Siebel, *Compend of Mechanical Refrigeration and Engineering*, 7th ed. (Chicago, 1906), 136-138, 303-304; "Accidents," *Ice and Refrigeration*, October 1912, 125; Luhr, *Handbook*, 507-508; Gideon Harris et al., *Audel's Answers on Refrigeration and Ice Making: A Practical Treatise*, 2 vols. (New York, 1911), I, 93, 95, 180, II, 623.

On the compressors' needs, Fleischmann, September 7, 1977; Harris, *Audel's Answers*, I, 68-69, 75, 82, 87, 92, 96-98, 103-104, 111-115, 119-122, 125, 137-143, 205, 211-213, 216, 223, 230, 244-248, 253, II, 489, 491, 493, 628; Siebel, *Compend*, 302-308, 320; F.E. Matthews, "Experiences in a Refrigerating Plant," *Power*, December 1905, 793-795; idem, "Condenser and Back Pressures in Refrigerating Plants," *ibid.*, January 26, 1909, 191; Edwin W. Miller, "Hints to Refrigerating Engineers," *Refrigerating World*, September 1917, 25-26; idem, "Refrigerating Plant Troubles," *ibid.*, April 1918, 22-23; idem, "A Day with the Troublemán," *ibid.*, July 1918, 30; Charles H. Herter, "Ammonia

In a damp and drafty room upstairs the condensers dwarfed him and his condenser man. Two batteries of eight coils each 24 pipes high and 22 feet long stood side by side nearly 10 feet high in steel pans each 16 feet wide and 26 feet long, clean, cold water falling from troughs on top down the coils to liquefy the hot gas inside and run off from the pans into a hot-water tank. The condenser man walked slowly and silently around the coils. He watched and listened that the water flowed evenly and equally over them. He looked at the condenser's glass gauge, to see two or three inches of liquid ammonia, "alive, full of bubbles, chasing up and down." Always he listened for the crackling sound or the stink of a leak. Continually he felt the water at the bottom pipes, that it was no warmer than usual. The engineer observed the temperature of the water going on the condenser, about 60°, and that of the water going off (which he would feel to make sure), about 90°. He came back down to the room below, next door to the motor and compressors, saw that the pumps were oiled and the floor clean and dry, observed the big liquid receiver's glass gauge between half and three quarters full. He put his ear to the pipe from the receivers to the main liquid valve, and heard no whistle or rattle of gas, but the continuous, sonorous rush of liquid.³⁸

Back in the engine room, his rounds complete, he recorded the temperatures, and he and the greaser returned to the room's routine, circling the machinery, searching for trouble. Usually they found none, which by the rule intensified their expectations of some. On the hour the greaser filled the oil cups and emptied the fullest drip pan.³⁹ Upstairs likewise the condenser man continued circling the condenser. Usually he found no trouble either, but he too duly searched. Ordinarily at 8 a.m. the engineer left the greaser on guard and followed the main liquid line across the bridge and along the catwalk on the wall of the next building east, the cellars. At three locations along the line, he cracked the cellars' expansion valves, fourteen in all. Since the valves were at so many different distances from the main liquid valve, and wanted very fine adjustment and mutual balance, it took "considerable skill and judgment" to adjust them properly, to

Accident Prevention," *ibid.*, July 1918, 15.

³⁸. On the ammonia in the gauge, Harris, *Audel's Answers*, I, 210. On the condenser and its needs, "Mexican Brewery," 24, 25; Vilter, *Catalogue A*, 33; Harris, *Audel's Answers*, I, 148-149, II, 398-399; F.E. Matthews, "Purge Device for Ammonia Condensers," *Power*, March 30, 1909, 601; Carl Nessler, "Brewery and General Refrigeration," *Ice and Refrigeration*, January 1912, 23; N. Decateur, "Expansion Coil Efficiency," *Refrigerating World*, January 1912, 23; W.S. Doan, "The Ammonia Compression Refrigerating System," *ibid.*, March 1917, 4, and July 1918, 30.

³⁹. Herter, "Refrigerating Engineer's Log," 55; Van R.H. Greene, "The Value of an Engine Room Log," *Refrigerating World*, April 1916, 25, 27; W.S. Doan, "The Ammonia Compression Refrigerating System," *ibid.*, September 1918, 32.

read their frost lines and crack each valve differently to increase all the flows of ammonia equally. He then went off to the hop-storage room, where he cracked its expansion valve, and to the ice plant, where he cracked two more. The feel of each valve of all the 17 he daily handled, he could tell in his sleep. Back in the engine room in 15 or 20 minutes he screwed down a little tighter the compressors' stuffing-box glands. As he ordered the condenser man turned up the water on the condenser.⁴⁰ (Ordinarily at 8 p.m. the night engineer would pinch each valve back to reduce the flow of ammonia, and the condenser man would reduce the flow of water.)

If the night before the brewmaster had started a 250-barrel brew, he would then have ordered special refrigeration for it about 11-1/2 hours later, and the master mechanic would have forewarned the engineer when he came on duty. At the right time a fellow at the Baudelot cooler on the east side of the fourth floor of the brewhouse would open its expansion valve for 25 tons for nearly four hours, making the peak load on the system. As soon as the engineer saw the frost lines carrying back on the inlets and the back pressure falling, he would go tell the condenser man how much more water to put on the condenser. The condenser man would do as commanded. And the engineer would go crack the ice-plant, hop-storage, and cellar valves further, each just to its turn. The cold especially drawn, however, was impossible to predict exactly, and even if the engineer reset the valves right in relation to each other he almost inevitably set them all too high or too low. It usually took one or two more corrections of the water and the valves, maybe an hour, to get the adjustments right. Meanwhile, if the greaser felt the piston rods too hot or too cold, he would try his hand at the stuffing box. The system's balance eventually restored, the engineer, the condenser man, and the greaser would return to their routines. At noon the engineer made his rounds and entries in the log again (as the night engineer would at midnight). When that afternoon the fellow at the cooler turned off the special load, the engineer, the condenser man, and the greaser would work again for maybe an hour on adjustments to restore the system's balance at the ordinary load, then

⁴⁰. On expansion valves, Fleischmann, September 7, 1977; Harris, Audel's Answers, I, 82, 99, 100, 111, 127, 138, 144, 167, 236-237; Luhr, Handbook, 512, 536, 648-650. Sidney W. Walker, "The Electrical Driving of Cold-Storage and Ice-Making Plants," Electric Review, February 17, 1906, 264; "To Calculate Amount of Refrigeration Required," Refrigerating World, July 1913, 48; F.B. Fulmer, "The Operation of Ammonia Compression Machines," *ibid.*, September 1913, 57-58; George Berna, "Practical Experience in Operating Refrigerating Plants," *ibid.*, May 1914, 43-44; Edwin W. Miller, "Why the System Failed to Work," *ibid.*, October 1917, 22.

On the stuffing box, The Engineer, October 15, 1906, 676; Edwin W. Miller, "Hints to Refrigerating Engineers," Refrigerating World, June 1917, 23-24, and "Hints," *ibid.*, September 1917, 25-26; M.W.E., "One Way to Pack Worn Ammonia Rod," *ibid.*, November 1917, 27.

On adjustments at the condenser, Wahl and Henius, American Handy-Book, 319, 352; Harris, Audel's Answers, I, 100, 204-205, 213, 216, 223, 236, 248; Decateur, "Expansion Coil Efficiency," 23.

return to their routines for the rest of the afternoon.⁴¹

Other duties were less frequent but essential to maintenance of the system. Once a week the master mechanic directed an inspection of the cellars' expansion coils for leaks. Having called from the machine shop a couple of mechanics with wrenches, oil cans, and pipefitters' supplies, he would take them and a helper hiking for an hour or two through the cold rooms. It was dark there, and master and men carried candles to light their way. At every joint they would stop and sniff for gas, squirt oil around stinky fittings, and where they found bubbles pull up a loose flange bolt or calk the leak or make it up with glycerine litharge and a rubber and sheet-iron sleeve. Every two weeks on the maestro's command the engineer would rig indicators on the compressors' cylinders, study the diagrams of the pistons' work, and report signs of trouble in valves or rings. Every other week too he would blow out the oil trap between the compressors and the condenser to keep the ammonia as pure as he could. Every month the mechanic and he would test the ammonia, drawing a liquid sample into a flask and as it boiled away watching for any residue; the sample would be pure enough.⁴² And since about every six weeks the continually extreme variations of temperature in the compressors' stuffing boxes would bring out the system's most troublesome fault, cracked and leaky packing, so often the mechanic would have the system shut down for an hour or two for mechanical inspection and repair. As ordered the engineer would close the main liquid valve, watch the back pressure, and when it fell to about 10 psi close the main suction valves. The load off the motor, he would turn to the marble boards and throw the oil circuit-breaker open, and while the motor slowed open the field switches, open the three-pole double-throw switches, and reclose the circuit breaker. Facing the compressors again, he would wait until the motor stopped, slowly close the main discharge valves, and call to the condenser man to turn off the water. Then on one compressor he would unscrew and retract the stuffing box's outer cap, retract the oil gland, pull its packing, undo the nut on the main gland, retract it, unbolt, unscrew, and retract the inner cap, pull the outer, non-metallic packing, and repack the piston, readjust the glands, and reclose the box. Then on the other compressor he would

⁴¹. "Mexican Brewery," 24-25; Wahl and Henius, *American Handy-Book*, 308, 324-325, 675; Harris, *Audel's Answers*, II, 487-488; Siebel, *Compend*, 245-246, 249; Americus [A.F. McClatchey], "Refrigeration in the Brewery," *Ice and Refrigeration*, July 1899, 23; Greene, *Elements*, 183-186, 314-318; Ophuls and Stickney, *Thermal Engineer*, 3-10.

⁴². On inspection and repair of coils, F.E. Matthews, "Experiences in a Refrigerating Plant," *Power*, November 1905, 652-654; Miller, "Hints," June 1917, 23. On indicators, Harris, *Audel's Answers*, I, 86, 103, 121; Siebel, *Compend*, 335, 338-340, 538-539; Nessler, "Brewery and General Refrigeration," 24. On the oil trap, Miller, "Hints," June 1917, 23; Decateur, "Expansion Coil Efficiency," 24. On the sample, Harris, *Audel's Answers*, I, 148, 162; Siebel, *Compend*, 111-112, 540; W.S. Doan, "The Ammonia Compression Refrigerating System," *Refrigerating World*, February 1917, 39-40.

do the same. Saving the most delicate question for himself, the master would open the chamber of any suspect valve and examine the valve and its seat. Ordinarily he would find no grinding necessary, replace the valve, reclose the chamber, and order the system restarted. Accordingly on finishing the packing the engineer would call to the condenser man to turn the water on again, and go make sure that it was running cold and in due plenty. Back down at the compressors he would open the discharge valves and loosen the suction valves from their seats. At the boards he would close the ac field switch into its discharge clip, close both three-pole double-throw switches into their upper clips to start at one-third voltage, and wait a few seconds while the motor began running. Then he would very slowly open the compressors' suction valves. The load on the motor, he would throw the first three-pole double-throw switch into its lower clips for two-thirds voltage, wait another few seconds, throw the second switch into its lower clips for full voltage, and seeing the motor at nearly full speed close the dc field switch into its main clips for excitation. As soon as he saw the back pressure at about 25 psi, he would go open the main liquid valve. In a few minutes the low and the high pressures would be as before, and the proper refrigeration restored.⁴³

In contrast, work at the drying plant was simple, all in the plant, and concretely by-productive. There were ordinarily only three workers, a foreman, who operated the dryer, a fireman, and a sack man, all for the standard day. The fireman would keep the trash and garbage in order, and after every fire clean out the incinerator, reload it, and blow down the boiler. When he could tell by the smoke from a brewhouse chimney, the steam from a ventilator, and the smell over the yard that a big or little brew was nearly done, he would light a fire and raise the regular head of steam. Before long the teamster would bring the brew's first wagon load of spent grains, the first of eight or nine loads if the brew had been a big one, and a yard crew would shovel them into a wide trough that led down to a hopper over the dryer's feeder.

⁴³. On the packing problem, Vilter, Catalogue A, 15; Harris, Audel's Answers, I, 97, 104, 110-116, 212, II, 491; William Westerfield, "Operating Troubles," *Ice and Refrigeration*, September 1909, 75-76; N. Decateur, "Knocks and Pounds in Ammonia Compressors," *Refrigerating World*, June 1917, 21; M.W.E., "One Way to Pack," 27.

On shutting down and restarting the compressors, Siebel, *Compend*, 321; Miller, "Hints," September 1917, 25; Doan, "Ammonia Compression Refrigerating System," September 1918, 31-32; E.W. Miller, "Carelessness in Refrigerating Plants," *Refrigerating World*, March 1919, 32; N. Decateur, "Overhauling the Refrigerating Plant," *ibid.*, October 1917, 11; Harris, Audel's Answers, I, 147; Matthews, "Experiences," December 1905, 792, 795; W.S. Doan, "The Ammonia Compression Refrigerating System," *Refrigerating World*, January 1919, 33-34, and April 1919, 32; F.B. Fulmer, "The Operation of Ammonia Compression Machines," *ibid.*, August 1913, 50.

On stopping and restarting the motor, H.R. Mason, "Switchboard Pointers," *Power*, June 2, 1908, 849; Koester, *Hydroelectric Developments*, 298; "Switches, Air-Break," in *Machinery's Encyclopedia*, VI, 155, 158-159; F.A. Annett, *Electrical Machinery*, 2nd ed. (New York, 1938), 381, 386-388.

That load and a quarter of the next would fill the hopper, 40 bushels, about 2,500 lbs. The foreman would let steam into the drum's heating coil, oil its bearings and gears, switch on the motor, open the hopper, fill the drum, close the hopper, watch the gears turn, and wait for about 45 minutes. On time the sack man would bring several burlap sacks, hang one on the drum's discharge spout, and the foreman would open the discharge, fill the sack with sweet dried grain, 100 lbs., and close the discharge. One after another they would fill ordinarily five sacks, which the bagger would set aside on a platform by the boiler, to keep them dry. The foreman would refill the drum, and they would do another load. So from a big brew they would dry ordinarily seven drum loads in seven hours, turning some 17,500 lbs. of wet grains into some 35 100-lb. sacks of feed. On an average day they would work around 11 hours, for 50-55 sacks, which sooner or later one yard crew or another would load on customers' wagons.⁴⁴

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On all these conditions then production at Moctezuma could proceed. It started in the brewhouse. The workers there from Monday through Saturday including the brewmaster ordinarily numbered only 11, all men, no boys. They tended the house's equipment and made the brews, usually besides the brewmaster five or six fellows during the day, four or five at night. The hot, humid, and dimly lit rooms where they worked, up and down the old tower for 60-barrel brews, up and down the new tower for 250-barrel brews, had white walls and ceilings, tiled floors, gleaming chutes, vessels, and vents, slick, varnished stairs, and an atmosphere of powerfully sweet and tangy aromas. Depending on the brewmaster's decision whether and when to brew and in which kettle, the hours of work varied daily and nightly from three or four to 10 or 12, and for different workers on the same brew they began and ended at different times. Only one operation was entirely mechanical, that of the new automatic electric pump, which forced cold Tlachichilco brewing water up to the cold-water tanks on the east side of the fifth floor. Otherwise brew by brew workers on different floors did various alternating and overlapping tasks to accomplish four successive processes: milling, mashing, boiling, and cooling.⁴⁵

⁴⁴. Fleischmann, September 7, 1977. Wahl and Henius, *American Handy-Book*, 871-872; Goslich and Fehrmann, *Maschinenkunde*, II, 318-320.

⁴⁵. Sánchez, August 10, 1977; Fleischmann, August 31, September 7, 1977; "Mexican Brewery," 21-22, 24-25; *The Western Brewer*, July 15, 1904, 328; "Cervecería Moctezuma," 392; Martínez Garza, "Datos," 191; Martin, *Mexico*, II, 236; Saviñón, March 13, March 31, 1922, AGN-DT, 17/1/6/6; Arzamendi, "La influencia del medio," 4. Cf. Wahl and Henius, *American Handy-Book*, 361-363, 647-676; Carl Rach, "Points That Are of Importance in the Arrangement of a Brew-house," *The Brewers' Journal*, September 1, 1904, 487-488; W. Stanley-Smith, "Labour in the Brewhouse," *Journal of The Federated Institutes of Brewing*, VIII (1902), 132, 138, 139.

The first process took place on the fifth floor. There in the old tower was the head of the elevator, with its spouts. There between the towers were the malt and rice bins. And there in the new tower were a 210-bushel, sheet-iron rice hopper, nearly 8 ft. in diameter and 9 ft. high, two Kaestner milling machines, one for malt, one for rice, and a fellow in charge of them.⁴⁶ Ordinarily five or six hours a day between 6 a.m. and 6 p.m. he operated the electrically powered elevator, to lift every day maybe 8 tons of malt, 4 tons of rice, and spout the loads into their bins, so maintaining supplies and making the air a fog of malt dust. But typically every day he also did the one, two, or three millings each of which started a brew, and each time this required a series of several operations. As the brewmaster ordered he might start the work at any hour. If yesterday the brewmaster had ordered a 250-barrel brew today, mashing to commence at 8 a.m., he would arrive at the bins no later than 5:30 a.m. to make sure that supplies were sufficient. In the inevitable dust he examined their quality, looking for adulterations, mould, weevils, sniffing for mustiness or rancidness, feeling the malt for how mellow (or glassy) it was. Knowing that the dust would explode at a spark, he cleaned and wiped ceilings, walls, and machinery surfaces and swept wet sawdust across the floor. Then he saw that the rice hopper and on the fourth floor the 400-bushel, sheet-iron malt hopper, nearly 10 ft. in diameter, 11 ft. high, were empty and clean. Back up on the fifth floor, everything ready by 6 a.m., he adjusted the malt-milling machine to the right grind (the mellow the malt, the coarser the grind), opened the outlet into the malt hopper, switched the mill on, opened the chute from the malt bin, and set himself to watch, hear, and smell the raucous machine crush the malt and pour the grist and husk down into the hopper. Every few minutes he felt the grist, to make sure the grind was right. When nearly an hour later the hopper's automatic scales read full, ordinarily 8,750 lbs., he closed the chute, switched the machine off, shut the open outlet, opened the outlet into the rice hopper, switched the mill back on, and reopened the chute. Several minutes later, 1,250 lbs. of grist having run down into that hopper, he closed the chute, switched the mill off, and shut that outlet. Then he adjusted the rice mill to the right grind, opened its outlet to the rice hopper, switched the mill on, opened the chute from the rice bin, and set himself for another test of his senses. When half an hour later the mill had crushed the right weight of rice, ordinarily 5,000 lbs., and poured the grits on top of the grist in the rice hopper, he closed that chute, switched off that machine, and shut that outlet. In all the new dust he took a stiff brush and scraper and cleaned both mills' inside

⁴⁶. "Mexican Brewery," 24, 25, "Cervecería Moctezuma," 392; Saviñón, March 13, March 31, 1922, AGN-DT, 17/1/6/6/6. Wahl and Henius, *American Handy-Book*, 648, 650, 652-653. Cf. Milo S. Ketchum, *The Design of Walls, Bins, and Grain Elevators* (New York), 213-214, 225-226, 318-321.

corners and crevices. Carefully he wiped the area clean again, which finished the milling.⁴⁷ By then it would be about 8 a.m.

As soon as the fellow could arrange for a yard gang below, he ran the elevator again for the usual five or six hours to refill the bins. Afterward he cleaned everything again, including the elevator, examined its belt and buckets, and repaired any dangerous defect. Then he did another grind of malt and another of rice for the next big brew, did yet another of both for the next little brew, and cleaned the machinery and the area yet again.⁴⁸ He ended the day at about 5:30.

Mashing, batición, "the most important of brewing processes" and the one that took "the greatest possible skill," happened on the fourth and third floors.⁴⁹ For 250-barrel brews the equipment was in the new tower, all piped for the boiler's steam, on the fourth floor a 150-barrel rice tub, 10 ft. in diameter, 8 ft. high, and a 380-barrel hot-water tank, 14 ft. in diameter, 10-1/2 ft. high, and on the third floor a 330-barrel batidor, a Goetz and Flodin mash tun, 16 ft. in diameter, 9 ft., 9 in. high. For small and large brews the workers were two mashers and two helpers, a masher and helper to a brew, working as the equipment was emptied and cleaned, as they could go without sleep, and as the brewmaster ordered. The 250-barrel mash started last night, at 10 p.m., for example, would not be all done until the masher and the helper who had

⁴⁷ Fleischmann, September 7, 1977; Campano, Manual, 16-17, 107-108; Mantel, "Brewing Industry," 446. Wahl and Henius, American Handy-Book, 462-463, 466-467, 470, 620-621, 629, 637-646, 652-653, 711-712, 716, 773-774, 844-845, 991. Cf. Adolph Derian, "Mashing and Boiling the Wort," *The Western Brewer*, April 15, 1903, 142; O. Windt, "Malt Grinding and the Evolution of the Four and Six Roller Malt Mills," *ibid.*, April 1914, 149-153.

⁴⁸ Cf. E.S., "Beer," *Spons Encyclopedia of the Industrial Arts: Manufactures and Commercial Products*, 32 vols. (London, n.d.), VI, 384.

⁴⁹ Julian L. Baker, *The Brewing Industry*, (London, 1905), 74. Rach, "Brew House Arrangement," 406. The description of the equipment and the work of mashing in this paragraph and the two following derives from Sánchez, August 10, 1977; Fleischmann, September 7, 1977; "Mexican Brewery," 24-25; "Cervecería Moctezuma," 392; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6; Mendelsohn and Stern, *Brewers and Bottlers*, 150-151; Campano, Manual, 24-27; Wahl and Henius, *American Handy-Book*, 368-369, 376, 379-381, 609, 656-667, 716-724, 730, 845-846, 851, 1140-1142. Cf. Ernst Hantke, "On the Control of Operations in Breweries," *The Western Brewer*, October 15, 1897, 1856-1860; Rach, "Brew House Arrangement," 405-407; Derian, "Mashing and Boiling," 142; Frank Schaefer, "Malting and Brewing," *The Western Brewer*, August 15, 1903, 334; Max Wallerstein, "Notes on Malting and Mashing," *ibid.*, April 15, 1904, 141-145; Rach, "Four Months of Strenuous Work," May 1, 1904, 287-289, and June 1, 1904, 335-337; Francis Wyatt, "Notes on Bottle Beer Brewing," *The Western Brewer*, January 15, 1907, 30-31; Otto Luhr, "Economy and Simplicity in the Brewhouse," *ibid.*, December 1909, 629; William Clasman, "The Utilization of Exhaust Steam in the Brewery," *ibid.*, March 1913, 121; Ehret, *Twenty-Five Years*, 62-66; Vogel, *Practical Brewer*, 54-75; "Cerveza," *Enciclopedia Universal Ilustrada*, 70 vols. (Barcelona-Bilbao, 1912-1930), XII, 1408-1411, 1417; Walter J. Sykes and Arthur R. Ling, *The Principles and Practice of Brewing*, 3rd ed. (London, 1907), 487-489, 512, 515-519.

worked it left at about 6:30 or 7 a.m. At the equipment no later than 7:30 to commence today's mash at 8 a.m., the other masher and his helper found the rice and malt hoppers full, the hot water as the tank's thermometer indicated at 170°, and the rice tub and the mash tun empty and clean inside and out. They started the day by recleaning and rewiping every surface dry, the masher the outfits, the helper the walls and the floor. There shortly would be the brewmaster himself, "constantly on the alert."⁵⁰

At 8 a.m. by the brewmaster's watch the process began. The masher opened valves and the chute from the rice hopper to run 70 barrels of cold and hot water and the hopper's contents into the rice tub and bring its thermometer up to 100°, and the helper switched on the tub's 10-hp motor to stir the water, grist, and grits at a slow, 14 rpm and dough it in. The brewmaster left. In about 15 minutes the masher turned on steam through the tub's six steam inlets to raise the temperature fast to 158°. At that heat he let the grits and grist cook for half an hour. Meanwhile he and his helper went down to the third floor, he opened valves and the chute from the malt hopper so that 60-odd barrels of cold and hot water and 8,750 lbs. of grist poured together into the tun and mixed according to its thermometer at 100°, and the helper switched on the tun's 15-hp motor to rake the water and grist at a slow, 12 rpm and dough it in. Back on the fourth floor by 9:00 the masher increased the rice tub's steam to bring the contents to a boil. By 9:45 the water, grist, and grits had decocted into a sweet, yellowish, seething paste.

The brewmaster had reappeared. Seeing and smelling that both mashes were ready, he gave the word to continue. The masher turned off the tub's steam, switched off the stirrer, and ran the rice decoction down into the malt infusion, in about 15 minutes raising the tun's temperature to 154°. (If the smell of either mash had been off, the brewmaster would have taken that time to open the tun's manhole and throw in a good 75 lbs. of bone black.) The masher then shut the tub's outlets, went back downstairs, and ran a shot of hot water through the tun's underlet. The helper came upstairs, broke out hose and brushes, turned on the water, and commenced the task of cooling the tub down and scrubbing it clean. If he could, he took his time getting inside the tub; when he hurried he usually slipped and bruised and burned himself. The brewmaster beside him at the tun, the masher increased the steam to keep the mash at 154° and raked and swept it for 15 minutes, then put more steam to it to raise the temperature in the next 15 minutes to 163°, then

⁵⁰. Ehret, *Twenty-Five Years*, 63.

switched off the rakes. The brewmaster opened the tun's manhole and watched for the break. As the grist sank the surface of the mash looked "grained or mottled," "marble-like."⁵¹ He called the break good, and left. (If the surface had been "red, carrotty or muddy," and "the whole mass in agitated or in a boiling condition," he might well have called for the masher's hide.)⁵² The masher opened the tun's taps a few seconds to flush out some of the underdough, then closed them, to let the mash rest. At once he went back upstairs, flushed the tub's pipes with steam and hot water into the brewhouse sewer, made sure his helper was wiping the walls and floor clean and dry again, then resumed his place at the tun. Within half an hour the brewmaster rejoined him. Anxious that the rest not be too short or too long, the master saw that the mash had turned "a very dark color," and began taking samples for his saccharometer.⁵³ At about 11 a.m. the saccharometer floated high enough, and he pronounced the mash done, a sweet wort, and left. The masher flushed out more underdough, closed the taps, opened them again gradually for a proper flow down into the grant, and switched on the grant pump. For 10 or 15 minutes, while the wort ran turbid, he pumped it back into the tun. When the flow began to run "quite bright," he switched off the pump, and the strong, "first" wort drew off down into the big Goetz and Flodin kettle on the second floor.⁵⁴ By the slow, steady fall on the gauge he saw that it was running evenly and at a good rate. In about an hour and a half the wort had drained so low that the surface barely covered the grains. The masher switched the rakes on again, to chop the upperdough into the grains, and turned on the sparger, to shower 170° water around inside the tun and get the remaining extract into the flow. The grains roused and the flow even again, he switched off the rakes and went on sparging for over two and a half hours, using nearly 200 barrels of water. At about 3:30 p.m. the brewmaster returned. The saccharometer indicated almost no sweetness in the remaining liquid, and the master could taste none. Ordering the run ended, he left. The masher turned off the steam and the sparger, closed the taps, opened the tun's grain trap, and switched on the rakes, for the scraper to push the spent grains into a chute to the grains wagon.

⁵¹. Arzamendi, "La influencia del medio," 4; Wahl and Henius, *American Handy-Book*, 720-721; Hantke, "Control of Operations," 1857. On the saccharometer, Campano, *Manual*, 3-10; Wahl and Henius, *American Handy-Book*, 947, 963-969.

⁵². Hantke, "Control of Operations," 1857.

⁵³. *Ibid.*

⁵⁴. Wahl and Henius, *American Handy-Book*, 721.

Meanwhile the helper brought hose and brushes. As soon as the grains were gone, the masher switched off the rakes, and the helper commenced the task of cooling down the tun, taking out its false-bottom plates, and scrubbing them and all the other parts clean inside and out, trying not to slip, fall, and burn himself. When he finally had the outfit clean, the masher flushed its pipes into the sewer and had the helper clean and dry the walls and floor. For them the day ended at about 5:00. But just about then, if the brewmaster had so ordered, the masher and the helper who had done last night's big brew would return to start another.

Boiling, actually boiling and hopping, el cocimiento, cooking, was by comparison simple.⁵⁵ It took place in the two copper kettles sunk in the second floor, las ollas, and right under them the two steel hop-jacks on the first floor, the coladores. The big, pear-shaped kettle in the new tower stood 10-1/2 ft. in diameter at the bottom, 13-1/2 ft. across at its middle, its shell 8 ft. 9 in. from the floor to the bottom of its rim.⁵⁶ There for the previous brew a kettleman and his helper had ended a day's work at maybe 10:15. There for this brew by 10:30 the other kettleman had begun the day recleaning liquid and pressure gauges, rubbing the kettle's copper outside and inside to a fiery radiance, shining brass attachments and fixtures to resplendence, and his helper had dried walls and floors again and again. When at about 11:30 the first wort poured into the kettle, the kettleman took charge of it. He closed the kettle's door, sent his helper to prepare the hops, and began watching the liquid gauge. As soon as wort covered the kettle's heating surface, he let steam into the jacket to bring the thermometer up to 190°. As the kettle filled he studied the gauges and the thermometer and continually increased the steam to hold the temperature at 190°. Meanwhile in the hop room, wearing a hopsack coat, his helper pulled bunches from a bale of third-rate hops, tore them apart, cracking the hop cones to bare the lupulin's sparkling grains, and sacked them. When he had done 120 lbs., by the shop room's scale, he set the sack aside and from a bale of second-rate hops did another sack of 120 lbs. Then from a bale of first-rate hops he did a sack of 60 lbs. Finished

⁵⁵. The description of the work of boiling derives from Sánchez, August 10, 1977; Fleischmann, September 7, 1977; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6; Campano, Manual, 122-129; Wahl and Henius, American Handy-Book, 346, 380-381, 474, 479-481, 670-673, 724-728, 846-847. Cf. Hantke, "Control of Operations," 1857; Rach, "Brew House Arrangement," 405-407; Derian, "Mashing and Boiling," 142; Schaefer, "Malting and Brewing," 334-335; Wyatt, "Notes," 30-31; Hettinger, "How to Generate," 227; Ehret, Twenty-Five Years, 41, 45, 64, 66-70; Vogel, Practical Brewer, 76, 78, 82-84; Sykes and Ling, Principles and Practice, 522-526.

⁵⁶. "Mexican Brewery," 21, 24, 25; The Western Brewer, July 15, 1904, 338; "Cervecería Moctezuma," 392; Campano, Manual, 22-23, 129; Wahl and Henius, American Handy-Book, 75-78, 667-669, 1141.

by about 3:15, he took some 25 lbs. from the third-rate sack back to the kettle. When at about 3:40 the flow of wort stopped, the kettle-man opened the kettle's door and raised the steam to 215°, which sent the wort into "a state of vigorous ebullition"; he dropped the hops into it, which kept it from boiling over.⁵⁷ About 4:30 the brewmaster arrived and began watching the wort for a good first break. The kettleman had his helper bring the rest of the third-rate hops. In about 10 minutes the brewmaster saw through the steam the countless tiny flakes on the bubbling surface suddenly clump into coagulations, shortly sink, and leave the seething liquid clear and sparkling; he dumped the rest of the third-rate hops into it. For another 40 minutes the wort boiled. The helper brought the other 120-lb. sack. The brewmaster looked then for a second break, saw it, and dumped through the door the second-rate hops. The helper brought the 60-lb. sack. For 30 minutes more the wort boiled, during which time the brewmaster went down to the first floor, examined the hop-jack there, 15 ft. in diameter, 6-1/2 ft. high, made sure that the door was shut and the door's bolts solid and tight, and climbed back up to the kettle. Then he added the first-rate hops. This quickly made the sweet wort into bitter wort, and ordering it run out immediately, he left. So at about 6:00 the kettleman turned off the steam, went downstairs, and opened the kettle's outlet into the hop-jack. With him came his helper, who tended to the 4-inch centrifugal wort pump beside the jack, especially to see that its packing was not too tight. (Down there these fellows might remember most sinkingly the accident at the Cervecería Cuauhtémoc in Monterrey in August, 1900, when, with 160 barrels in the jack, a bolt holding the door gave way and "the entire mass of boiling wort poured into the room, filling it several feet high," leaving the kettleman "literally boiled to death" and three other men "terribly burned."⁵⁸) It took about 15 minutes for the kettle to empty into the jack. The kettleman let the bitter wort rest and the hops settle for another 15 minutes, then opened the jack's outlet, and the helper switched on the pump. The hops remaining on the jack's false bottom, the wort poured down into the pump and at 350 gallons a minute was impelled up a pipe to the fifth floor. Toward the end the kettleman sparged the hops for a few minutes, maybe 15 barrels of hot water. At about 7:00 he turned off the sparger, opened the jack's door, and closed its outlet. His helper switched off the pump and broke out shovels, hose, brooms, brushes, and buckets of yeast, ash, and sulphuric acid. And together they commenced the task of cooling down and cleaning the

⁵⁷. Arzamendi, "La influencia del medio," 4; Wahl and Henius, *American Handy-Book*, 725; Hantke, "Control of Operations," 1857.

⁵⁸. *The Western Brewer*, November 15, 1900. 459.

kettle, the hop-jack, and the pump inside and out. If they finished them without burning themselves at least a bit, they were lucky. When they had cleaned them, the kettleman flushed the kettle's and the jack's pipes into the sewer, and his helper cleaned and dried the first- and second-floor walls and floors. They ended the day at about 8:30 p.m. By then, if the brewmaster had ordered the mash at 5:00, the other kettleman and his helper would be ready to receive it.

The cooling process, the last in the brewhouse, was the "most troublesome."⁵⁹ For any brew it happened at two places. The first place, by one or the other cold-water tank on the fifth floor, was where the pipe from a hop-jack below would deliver the wort into a sheet-iron beer tank, the small tank in the old tower, the large one, like the 250-barrel hop-jack, 15 ft. in diameter, 6-1/2 ft. high, in the new tower. For both small and large brews the second place was downstairs between the towers, in a dimly lit, narrow, high, purified, and ventilated room, on the Baudelot cooler, a 15-ft. long, 11-ft.-high stand of 24 lengths of copper water coil over 14 lengths of iron ammonia coil. At a beer tank or the cooler whenever a wort wanted cooling the fellow in charge of these outfits, the cooling man, worked alone in 6- or 7-hour stints.⁶⁰ For last night's 250-barrel brew he would have worked maybe from 7:30 a.m. to 2 p.m. For this brew he began the day at about 5:30 p.m., making sure that the big beer tank was clean, its atomizer clear, its thermometer right, and its outlet open. Then he went downstairs and looked over the cooler room and the cooler, making sure that the walls, the floor, the coils, the trough above them, and the collecting pan below them were all clean and that the wort valve over the trough, the inlet valve to the water coil, and the pan's outlet for production were closed, its drain to the sewer open. All in order, he went back upstairs to the beer tank.

There he found the brewmaster. Together they waited. When at about 6:30 the wort came, they saw it amid

⁵⁹. Alfred C. Chapman, *Brewing*, (Cambridge, 1912), 62-63.

⁶⁰. The description of the work and equipment of cooling in this paragraph and the one following derives from Sánchez, August 10, 1977; Fleischmann, September 7, 1977; "Mexican Brewery," 24, 25; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6; "Enfriadores de cerveza, 1922," *Album de la Cervecería*; Campano, *Manual*, 130-135; Wahl and Henius, *American Handy-Book*, 308, 324-325, 363, 375, 380, 649, 651, 670, 673-675, 727-729, 734, 740, 743, 840, 845, 847, 1141-1142; Harris, *Audel's Answers*, II, 483-487; Hans Lorenz, *Modern Refrigerating Machinery* (New York, 1905), 162-164, 191. Cf. J.E. Siebel, "The Infection of Wort and Beer by Bacteria," *The Western Brewer*, October 15, 1891, 2358; idem, "Historical Outlines of Brewing in the United States," *ibid.*, February 15, 1898, 281; idem, "Refrigeration of Beer and Wort," *Ice and Refrigeration*, June 1899, 407; Americus, "Refri-geration," 22-23; F. Avenarius, "Fermentation," *The Western Brewer*, February 15, 1903, 76; Lorenz Herzinger, "Fermentation and Cellar Work," *ibid.*, May 15, 1903, 182; "The Production of Pure Beer," 11; Schaefer, "Malting and Brewing," 335; Victor H. Becker, "The Relationship of Refrigeration to the Art of Brewing," *The Western Brewer*, May 1912, 222-223; Greene, *Elements*, 314-318; Siebel, *Compend*, 244-245, 249; Luhr, *Handbook*, 655-656; Ehret, *Twenty-Five Years*, 72-74.

clouds of vapor spraying properly down into the tank, the thermometer reading about 160°. The brewmaster took a sample for his saccharometer, and left. When at about 7:00 the tank was full, the cooling man went back down to the cooler and opened the water inlet, the wort valve, and (assuming the engineer knew of the coming load) the cooler's ammonia expansion valve. From the trough the wort began running in a brilliant golden film down the long, high stand of cold copper and then the frigid iron pipes into a white, 60°, billowy froth in the pan at the bottom and out into the sewer. Quickly the fellow opened the outlet for production, closed the drain to the sewer, and let the wort run down and away to the next stage of work. In a minute he closed the wort, the expansion, and the water-inlet valves. At about 7:30 he again faced the brewmaster, who inspected the cooler, went up and saw the temperature in the tank, and came back down and told him to start the full run, which he promptly did. Together they watched the filmy flow down the pipes, the teeming froth below. The brewmaster took the flow's temperature, 150° going on the cooler, 50° coming off, and left. The cooling man alone stood watch at the cooler for the next three and three-quarters hours. At about 11:15 the last wort ran out, the brew completed. The fellow shut the cooler down, went up and hosed out the beer tank, came back down, scrubbed the cooler's trough, joints, and pan, and hosed it all off. If the next brew was on its way, he would return for it at about 4 a.m.

Weekly, usually after the last brew on Saturday, the brewmaster ordered a brewhouse overhaul. The miller examined the elevator and the milling machine, put them in good repair, and lubricated bearings. The master mechanic had a fellow from the machine shop examine the rice tub's and the mash tun's moving parts, and repair and readjust them as needed. The kettleman on duty loaded the house's pipes with a hot, 5% caustic-soda solution, cooked the crud inside them loose, and gave them several warm- and cold-water flushings. The helpers painted ceilings and walls with milk of lime to disinfect them. The fellow in charge of cooling scrubbed out the beer tank and did a "doubly thorough" cleaning of the cooler, yeast, ash, and acid on the copper part, a warm, 2% caustic-soda solution on the iron, then a good scrubbing and hosing. By Monday the kettleman, the helpers, and the man at the cooler would all have new burns hurting them.⁶¹

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The next stage of work on the brews was just east in the cuartos fríos, a much larger, more subdivided, and more

⁶¹. Fleischmann, September 7, 1907; Arzamendi, "La influencia del medio," 4. Wahl and Henius, American Handy-Book, 840-845, 847, 857; "The Production of Pure Beer," 14.

divisive place. By mid-1908 the stockhouse externally was 76 feet wide, 40 feet high, 285 feet long. Inside in fact and by name it was four adjoining buildings, the three-story "House No. 1" in front, three rooms to a floor, with a door on each floor back into the three-story "House No. 2," which connected likewise back into the four-story "House No. 3," which connected back into the new, four-story, 120-ft-long "House No. 4"; each house had separate sewers. Altogether there were then 20-odd "cold rooms," all numbered, all ordinarily behind ponderous closed doors, almost all cold, dark, damp, and because of the outfits arrayed in them practically impassable but by narrow aisles or passageways right along the walls (white-tiled but always in deep shadows). The only sound was of pumps throbbing in the dark. Since House No. 4 had come into service, some rooms in Nos. 2 and 3 had been shut down, and refrigeration there turned off; but as insulated as they were even they remained chilly. The cold elsewhere took work to bear. Of the refrigerated rooms one on the top floor of No. 3 and another on the top floor of No. 4 were at about 45°. All the others were nearly freezing, 32°-34°. On the floor there were sometimes patches of ice. The dark was a strain too. With daylight faint through painted windows, no light at night but weak bulbs switched on only as needed, it concentrated isolation and drained memory. The damp dampened everything. At nine-tenths of saturation it made the cold heavy, the dark murky, and the body lose heat fast. In use or not the rooms were lonely, gloomy places.⁶²

In this gloom the installations were almost all stationary, silent, menacing. Hanging in the cold and dark overhead in every room were hundreds of feet of ammonia pipe (altogether some seven miles), ice-covered in the refrigerated rooms.⁶³ In No. 1 on every floor stood shadowy rows of Stecher oak vessels, on the top floor 12 60-barrel starting and fermenting tubs and 12 closed, 35-barrel storage vats, on the second floor 36 more such storage vats, on the

⁶². Sánchez, August 10, 1977; Fleischmann, August 15, August 31, September 7, 1977; Southworth, Veracruz, 124; Zárate, Album, 45; Pérez Milicua, Veracruz, 47; "Mexican Brewery," 21, 26, 29; Martínez Garza, "Datos," 190-191; Eslava, "Orizaba"; The Western Brewer, April 15, 1907, 188; The Brewers' Journal, May 1, 1907, 314; Modern Mexico, October 1907, 30; "Fachada de la fábrica en 1906" and "Construcción de los cuartos fríos en 1908," Album de la Cervecería; Espino Barros, México, 172; Alemán Velasco, Documentos, 145; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6; Celis O. and de la Mora, "Plano General"; Arzamendi, "La influencia del medio," 5. Cf. Wahl and Henius, American Handy-Book, 325, 354-381; Americus, "Refrigeration," 24; F. Widmann, "The Development of the Buildings and Equipments of Breweries from Pioneer Times to the Present Day," The Western Brewer, October 15, 1901, 29-32; Delbrück, Lexikon, 29, 461-464, 521-522, 573-574; Louis Lehle, "Notes on Brewery Design," The Western Brewer, January 1912, 10-15; C.F. Daum, "Outlines of Engineering Notes," n.d., 86, in Biblioteca Sturm; Ehret, Twenty-Five Years, 75-79.

⁶³. The Western Brewer, July 15, 1907, 402; Ice and Refrigeration, July 1907, 33; "Tinas de fermentación, 1922" and "Cuartos fríos, tanques de conservación, 1922," Album de la Cervecería.

first floor in the west room 12 20-barrel chip casks for clarification. The dark shapes in No. 2 were uniform. There across every floor stood four somber rows of 10 closed, 50-barrel, native-wood vats, 6-1/2 ft. in diameter at the bottom, over 8 ft. high, all for storage on the top two floors, 25 for storage and 15 for clarification on the first floor. In No. 3's shades were more 60-barrel Stecher starting and fermenting tubs ranged across the top floor, a duplication of No. 2 across the lower three floors. No. 4 had the most awesome and spectral outfits. There were the new, colossal Pfaudlers, painted white outside, ghostly in the dark, lined inside with white glass enamel, one row of seven 125-barrel and four rows of six 300-barrel, open-topped, iron starting and fermenting tanks along the fourth floor, three rows of six horizontal 550-barrel steel storage tanks, each 9 feet in diameter, 36 feet long, along the third floor, three more rows of almost the same size and dimensions on the second floor, the same for storage and clarification on the first floor. In the tubs, vats, and tanks of Nos. 3 and 4 was about 95% of stock, some 160-165 brews successively in the course of zymotechnic transubstantiation into finished beer, the newest, brewed yesterday, just beginning, the oldest, brewed 100-150 days ago, beer ready for the next stage of production. Dimly visible below various vessels in all the rooms in use, coiled on the wet cement floor or lying snake-like across an aisle, disappearing into the darkness, were long lengths of still rubber beer hose. In the shadows down some aisle in every room, almost always with a hose connected to it, stood a single, wheeled machine. This was the room's beer pump, on electric drive on the top floors on No. 1 and No. 4, hand-cranked elsewhere. In one or another aisle on the ground floor in every house, also ordinarily in operation, was a small, electrically powered, mobile air compressor.⁶⁴

These houses smelled inside therefore nothing like the brewhouse, but mostly foul and forbidding. The air on the top floors was ventilated and fairly sweet, but in the rooms below it carried musty, sour stench, stinging vapor, and

⁶⁴. The description of installations in the cellars derives from Sánchez, August 10, 1977; Fleischmann, August 15, August 31, September 7, 1977; "Mexican Brewery," 26, 29; Martínez Garza, "Datos," 190-191; "Cervecería Moctezuma," 392; Eslava, "Orizaba"; The Western Brewer, April 15, 1907, 188; *ibid.*, July 15, 1907, 463; Dollero, México, 782; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6; "Cuartos fríos," Escobar papers. On cooperage, Wahl and Henius, *American Handy-Book*, 78, 677-682; "The Story of the Tank," The Western Brewer, October 15, 1897, 1868-1874a; "Stecher Cooperage Works," *ibid.*, February 1908, advertising p. 25; The Pfaudler Co., Pfaudler Glass Enamelled Steel Equipment for the Chemical Industry, Bulletin C-5 (Rochester, n.d.), 24, 30; Mendelsohn and Stern, *Brewers and Bottlers*, 301-305, 454, 603; Daum, "Bottling Engineering Notes," n.d., 11, in *Biblioteca Sturm*; Delbrück, *Lexikon*, 303-311, 571-573; Goslich and Fehrmann, *Maschinenkunde*, II, 195-203. On pumps and air compressors, Mendelsohn and Stern, *Brewers and Bottlers*, 63, 227-231, 355, 377-381, 484; Goslich and Fehrmann, *Maschinenkunde*, II, 240-243.

layers of dizziness and suffocation.⁶⁵

Only two rooms in the stockhouse were not quiet or dark (except at night and on Sunday). Both were mainly for mechanical operations. One was No. 1's recently remodeled first-floor east room, the new washroom for dirty packages. It was not cold, but it was dismal, as crowded as any of the other rooms, very wet, and rank. There under a few weak bulbs were scores of returned kegs and ponies, along the east wall dirty ones, along the west wall clean ones, between them the new, electrically powered, 32-ft.-long barrel-washing machine, along the north wall a filtermass washer, a filtermass press, a chip washer, and a Rüdiger hose-cleaning machine, and all across the floor draining pools and drying puddles of beery wash water.

The other room with much machinery was just next door, No. 1's first-floor middle room. Recently remodeled as the racking room, it remained very cold, refrigerated at least to 34°, but it too was dismal, crowded, and wet. There among scores of washed kegs and ponies, the empties along the west wall, the full along the east, were a big 180 cfm at 60 psi air compressor, a little 10 cfm at 10 psi compressor, their tanks, a large and a small pressure-regulating pump, a big 50-barrel Kiefer beer filter, a 30-barrel Loew filter, and the Colby racking machine.⁶⁶

During any 24 hours (even on Sunday) the brewmaster usually appeared in the stockhouse several times, to order the right treatment to turn the brews into beer.⁶⁷ To see that his orders took effect he had two lieutenants, a day and

⁶⁵. Fleischmann, August 15, September 7, 1977; Arzamendi, "La influencia del medio," 5. Wahl and Henius, *American Handy-Book*, 771, 848-849; *The Western Brewer*, April 15, 1902, 122-123; *ibid.*, June 15, 1902, 195-196; *ibid.*, September 15, 1902, 342; *ibid.*, September 15, 1903, 367-368; *ibid.*, March 1904, 109; H.W. Rohde, "The Role of Oxygen in the Brewing Industry," *ibid.*, October 15, 1910, 500-503.

⁶⁶. The description of the wash room and the racking room derives from Sánchez, August 10, 1977; Fleischmann, September 7, 1977; *The Western Brewer*, February 15, 1907, 102; *ibid.*, December 15, 1907, 656. Cf. Wahl and Henius, *American Handy-Book*, 365, 691-694; Siebel, "Handling and Pitching," 1047. On the equipment in the wash room, Mendelsohn and Stern, *Brewers and Bottlers*, 26-27, 31, 279, 281-282, 296-298; Delbrück, *Lexikon*, 318-320, 330-333, 773; Goslich and Fehrmann, *Maschinenkunde*, II, 214-218, 239-240. On the machinery in the racking room, Wahl and Henius, *American Handy-Book*, 684-687, 765-769; Dreesbach, *Bottlers' Handy Book*, 54, 58-59, 71-72, 76-79, 306-307; Mendelsohn and Stern, *Brewers and Bottlers*, 186, 201, 228, 236-237, 333, 341, 343, 350, 358, 379-380, 486, 578-579; Delbrück, *Lexikon*, 4, 93-99, 253-256, 311; Goslich and Fehrmann, *Maschinenkunde*, II, 230-240, 243-259; Gilbert Wilkes, "Purchased Power in Breweries," *Electrical World*, February 2, 1935, 269.

⁶⁷. The description of cellar work in this paragraph and the several following derives from Sánchez, August 10, 1977; Fleischmann, August 15, August 31, September 7, 1977; Saviñón, March 31, AGN-DT, 17/1/6/6. Cf. Hantke, "Control of Operations," 1857-1858; "Brewmasters and Engineers," 526; Stanley-Smith, "Labour," 127-132; Wahl and Henius, *American Handy-Book*, 733-769; Booth, *Life and Labour*, III, 122-123; Ehret, *Twenty-Five Years*, 75-82; Testimony by Gompers, *Industrial Commission*, XVII, 274, 410, 624-625; *United States Brewers' Association Yearbook* (n.p., 1909),

a night cellar boss, on duty there round the clock Monday through Saturday and on call Sunday. And six days a week the bosses had five "first men," three during the day, two at night, to direct and lead the ordered work. Continual orders and constant close attention to their execution were necessary for the work that went round the clock there, not because it was especially varied or complicated or difficult, but because unlike work in the brewhouse or the machine house it followed no predictable routine. Every brew evolved into beer in the same way, in an inalterable, uninterrupted, and irreversible sequence of four phases, pitching, fermentation, rest, and clarification. But each phase took a different vessel, and from brew to brew, given accidental and deliberate differences in worts and the vagaries of micro-organic life, natural heat, and artificial cold, the same phase took different times to complete. The date that the brewmaster marked on a vessel and kept in his records to recall when the brew inside had begun a particular phase gave no certainty of the date when the brew would end that phase and want transfer to another vessel, or be finished. The wort just brewed, for example, the sample of which would have shown maybe 14 3/4 Balling on the brewmaster's saccharometer, would flow into a starting tank on House No. 4's fourth floor, be pitched with the yeast in the tank, then sit for "18-30 hours."⁶⁸ As soon as it started to ferment, it would be drawn by a pump into a fermenting tank on the same floor for a primary fermentation that took from eight to 16 days. Then it would be drawn by gravity and pump into a storage tank on one of the lower three floors for a rest and secondary fermentation of usually more or less three months. Pumped finally into a chip tank on the first floor, it would be krausened and clarified over a week or two. The entire course for one brew to become beer might last three months; for the next, five.⁶⁹ Since there were always so many brews in the house, almost every operation necessary for pitching, fermentation, rest, and clarification happened almost every day (or night), but in any sequence, at any hour.

The workers in the stockhouse from Monday through Saturday including the cellar bosses and the first men ordinarily numbered only 18, there too all men, no boys. As ordered they tended the house, the equipment, the brews, and the beer. Unlike their fellows in the brewhouse they worked regular shifts, and most of them not so much by the task

89; F.W. Rickers, "A Comparison of the Cellar Treatment of German and American Lager Beers," *The Brewers' Journal*, December 1, 1908, 49-51; George Wilkinson, "Brewery Accounting," *The Western Brewer*, January 15, 1912, 17; Smart, "Twentieth-Century Brewery Accounting," 233; Delbrück, *Lexikon*, 662-663; Vogel, *Practical Brewer*, 90-122.

⁶⁸. Wahl and Henius, *American Handy-Book*, 736; Fleischmann, September 7, 1977.

⁶⁹.Martínez Garza, "Datos," 190. Cf. Wahl and Henius, *American Handy-Book*, 733, 736-737, 759, 761, 774; G.J. Friedhoff, "Cellar Treatment," *The Western Brewer*, March 15, 1903, 93-94; Herzinger, "Fermentation," 182; Schaefer, "Malting and Brewing," 335; "The Production of Pure Beer," 11-12, 15; Delbrück, *Lexikon*, 373, 573.

as on one or another detail. Besides the boss from 6 a.m. to 6 p.m. usually nine men did the day shift in four subdivisions: a watchman for the doors, a first man and a laborer for starting and fermenting, a first man for pumping, a pumpman, and two washermen to empty, fill, and clean vessels, and a first man and a laborer in the wash room and the racking room. From 6 p.m. to 6 a.m. besides the boss there were usually seven men in three subdivisions, there being no night shift in the wash and racking rooms. (A special detail for an urgent operation on a Sunday might therefore be only two or three men.) Because of the conditions in which they worked they practiced a nearly clannish attitude. They referred to the rooms not by numbers or function, but by the names of saints, el cuarto de San Simón, for example, or el de San Luis de Gonzaga, on whose day work in that room had first happened. They spoke of the vessels not by numbers or function either, but by their look, las albercas ("the water tanks," or "steeping vats," the fermenting tubs in No. 1), los chamacos ("the little boys," the storage vats in No. 1), las cochinitas (the little sows, the chip casks in No. 1), las quarterolas ("the quarter casks," the vats in Nos. 2 and 3), las conchas ("the conchs," the enameled fermenting tanks in No. 4), las ballenas ("the whales," the great darkly pale tanks in No. 4). They even had a sort of uniform: in the cold they all wore homemade hopsack coats, although nothing but huaraches on their feet.⁷⁰

Every working day at 6 a.m. the brewmaster and the day-shift cellar boss met in the frigid gloom on the ground floor of No. 2, 3, or 4. One or the other would pull from his pocket a faucet handle, which he kept like a key, since on the brewmaster's orders the handles had been removed from the taps of all the vessels for clarification, and would turn on the flow of finished beer from two or three vessels into their hoses to a header on a pipe line toward the next and final stage of production. Maybe they would see at the header's lantern, or observation glass, that a quarterola on the line was almost empty. Then (except on Saturday) they would go to No. 1, turn on the flow from two or three cochinitas toward the racking room, maybe see that one of them would soon run out, and in the racking room switch on the big and little compressors and regulating pumps. Back among the cochinitas they would take samples from a couple of other casks, study them for brilliance (or turbidity) and carbonic acid, taste them, and in consequence the master would decide which to rack next. Upstairs they would do likewise at the two or three chamacos where the beer had rested longest, try the samples to see if any tasted too bitter, sweet, or tart, or oniony, or cellarish, and wanted doctoring, and in consequence the

⁷⁰. Sánchez, August 10, 1977; Fleischmann, August 15, September 7, 1977; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6.

master would decide which to clarify next. Then they would return to Nos. 2 and 3, consider some samples from the most rested beers in the cuarterolas, decide which of them to clarify next and whether to doctor any, consider some of the most clarified beers, and decide which of them to run off next. So they would return to No. 4, consider the most clarified and the most rested beers in the Pfaudlers, and the master would decide on them.⁷¹ Every decision they marked on the selected vessel and noted in their respective records.

If this was the day to commence a mash at 8 a.m., the brewmaster would then hurry upstairs with the boss to determine the work that should happen in No. 4's fermentation over the next 24 hours. At each starting and fermenting tank the brewmaster would review the marks on the tank, climb its ladder, survey the head on the brew, blow away a patch of the foam, measure the brew, measure the brew's sugar and heat on his saccharometer and thermometer, study the brew's color, and in consequence give his order. At a five- or six-day-old "young beer" in the throes of high kraeusen, covered with tall, lathery, brown-topped clumps, its saccharometric reading considerably less than yesterday, maybe down from 7.0 Balling to 5.7, but its heat too high, maybe 53°, its color a foxy red: run the tank's attemperator colder. At a 10-day-old brew covered with a spotty, brownish foam, having fermented down to maybe 4.7 and cooled down to 39°, its color a deep black: probably ripe for tanking, but see the sample. At a four-day-old "young beer" entering high kraeusen, its head high, creamy, mounting and browning in the middle, its Balling maybe 10.5, its temperature 51°: pump to another tank. At yesterday's first wort still in its starting tank, covered with lumpy, dirty spume, little white bubbles around the edge, still 14.75 on the saccharometer, maybe 49° on the thermometer: skim and if ready, pump into a fermenting tank. At a day-old "young beer" in low kraeusen, its head pure, white curls, its readings maybe 12.2 and 51°: turn on the attemperator. At another in low kraeusen: draw 40 or 50 barrels into a particular chip tank on the ground floor. At another seven-to-12-day-old brew, its head a thick, brown-peaked cap, its Balling barely down from yesterday, maybe from 4.9 to 4.75, but considerably colder, maybe down from 46° to 44°, its color still reddish, but much darker: see the sample. So he examined every tank of "young beer" there, in all usually 12 or 13.⁷² Then he would unlock a

⁷¹. Fleischmann, August 15, September 7, 1977. Wahl and Henius, *American Handy-Book*, 681-686, 758-766, 769-772, 774; Dreesbach, *Bottlers' Handy Book*, 51-52, 54, 306-308; Friedhoff, "Cellar Treatment," 93-94; Herzinger, "Fermentation," 182; Schaefer, "Malting and Brewing," 335; Daum, "Bottling Notes," 10-11; Delbrück, *Lexikon*, 3, 6-8, 10-11, 31, 313-314, 354, 511, 528-529, 571-574.

⁷². Sánchez, August 10, 1977; Fleischmann, September 7, 1977; Mantel, "Brewing Industry," 446. For the look of

cabinet of sample glasses of the usually seven or eight seven-to-12-day-old brews, light a candle, and look at the samples, holding the glasses one after another before the light. Practically every day he saw one, two, or three samples from ripe beers settled perfectly clear: run them to rest. He would throw out the other samples, clean the glasses, draw today's samples, watch the yeast particles in them begin to bunch in a good cold break (or not), and lock them in the cabinet for later.⁷³ Finally he would tell the cellar chief when to inspect last night's 250-barrel brew for pitching, maybe at 9:30. So short, simple, and contingent, his orders were in daily different and unpredictable combinations.

Meanwhile the first men and other workers there since 6:00 had been at one or another of their duties. The watchman would have been making his rounds of the stockhouse, patrolling to see that all its doors were shut, not only the outside doors, two of them, along the west wall of Nos. 3 and 4, but also the doors between the rooms on each floor, to keep the cold in each room at the right degree. Any door he found open he closed and reported to the cellar boss. Along the way in the dark he might also spy other faults that he would not try to correct but would usually report.⁷⁴

The fellows who handled starting and fermentation might have been at preparation and maintenance. The first man would then have been in the yeast room on No. 4's top floor, inspecting the already clean copper yeast-storage tubs, pails, sieves, skimmers, and dippers, draining the water off fresh yeast for the next pitching, watering yeast for the pitching after that, preparing another day's finings (3/4 lb. isinglass, 3 oz. tartaric acid, a dash of sulphuric acid, dissolved in 20 gallons of water). The laborer would have been in the fermenting rooms scrubbing scummy patches off the floor, rinsing dirty water away, sweeping rinse water into the sewer, or in the yeast room using yeast, ash, and acid on dirty tubs, pails, sieves, skimmers, and dippers.⁷⁵

wort on its way to becoming beer, Campano, *Manual*, 139, 149, 153; Wahl and Henius, *American Handy-Book*, 677, 733-740, 742, 743, 747-752, 757-761, 773-774; Avenarius, "Fermentation," 77; Friedhoff, "Cellar Treatment," 93; Herzinger, "Fermentation," 182; Schaefer, "Malting and Brewing," 335; Delbrück, *Lexikon*, 28-29, 53, 122-123, 233-234, 363-365, 375-376, 548. On attemperators, Wahl and Henius, *American Handy-Book*, 306-307, 375, 679-680, 736, 740; Siebel, *Compend*, 251-252; Delbrück, *Lexikon*, 362-363.

⁷³. Fleischmann, September 7, 1977. Wahl and Henius, *American Handy-Book*, 736-737, 742, 757; Friedhoff, "Cellar Treatment," 93.

⁷⁴. Camaleño, July 27, 1977; Fleischmann, August 15, September 7, 1977; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6. J.E. Siebel, "Refrigeration," 204; Americus, "Refrigeration," 24; Celis O. and de la Mora, "Plano General."

⁷⁵. Fleischmann, September 7, 1977. Wahl and Henius, *American Handy-Book*, 488-490, 678, 680, 737, 741-747, 749, 751, 763-765, 847-850. Cf. Friedhoff, "Cellar Treatment," 93-94; Herzinger, "Fermentation," 182; Schaefer, "Malting and Brewing," 335; "The Production of Pure Beer," 11; Mendelsohn and Stern, *Brewers and Bottlers*, 157, 275;

At the same time the pumpmen might first have looked over continuing transfers of beer. Wherever from floor to floor they found beer hoses that the night shift had laid out, they would have made sure that connections were still tight and the hoses under proper pressure, as straight as possible, and in wide curves where turns were necessary, no twists or kinks. Maybe in No. 2 or 3 they had come across a cuarterola from which the night shift had just finished pumping a rested beer to clarification. They would have disconnected the hoses from the vats' spring valves and the pump, washed out the pump, carried the hose in stiff, cold coils to the Rüdiger hose-cleaning machine in the wash room, connected the coils, connected one end to the machine, inserted a brush they called a chimahuate (wooly caterpillar) into the hose, connected the other end to the machine, and turned on the warm water to the machine. In a few minutes, the hose's inside scrubbed clean, they would have turned off the water, disconnected the hose, taken out the chimahuate, taken the hose apart, and carried it in soft, warm coils back where it belonged.⁷⁶ Then maybe on yesterday's orders they had climbed to the top floor of No. 4 and connected a hose from the outlet cock of a concha of ripe beer across the floor and down the stairs to a handpump beside a ballena on a lower floor, connected a short piece of hose from the pump to the ballena's inlet, unscrewed the ballena's bung, opened its inlet, and very gently and very slowly opened the fermenting tank's faucet to maybe only a half turn, for a flow into the rest tank "without the least concussion or agitation of any kind."⁷⁷ So rendered, the flow would take about eight hours.

The washermen would have gone to work where the first men in pumping told them, on vessels that the night shift had started but not finished cleaning. This morning the first pumpman might have sent one fellow to a concha from which a brew in high krausen had lately been moved and on which maybe an hour's work had been done. A light left on by the tank would have signalled which one it was. There the fellow would have found the tank's manhole door open, a long-handled wrench, which he and the others called an escopeta (shot gun) lying beside it, a water hose run inside, an open, dripping tap, a wooden ladder, a pail of old yeast, a pail of milk of lime, some brushes, and a sponge inside, crust around the top of the tank outside, scum around the top inside, and a brownish film on the white, glassy interior. This

Delbrück, Lexikon, 29-31, 464.

⁷⁶. On the Rüdiger machine, *The Western Brewer*, February 15, 1907, 102; Delbrück, Lexikon, 752. On the chimahuate, Sánchez, August 10, 1977; Mendelsohn and Stern, *Brewers and Bottlers*, 210.

⁷⁷. Wahl and Henius, *American Handy-Book*, 758. Fleischmann, September 7, 1977; Arzamendi, "La influencia del medio," 5; Delbrück, Lexikon, 10-11.

would take maybe two hours of work to finish, more if (as often happened) the water pressure fell and water ran only in a trickle. The fellow would have crawled through the manhole, hosed off the tank's inside, shooting cold water all around, gone around on the ladder, taking extreme care not to scratch the enamel, scrubbing the scum around the top loose, and hosed it off and down and out the tap. He would then have smeared yeast on the attemperator coil, which softened the crust on it into scum, and scrubbed clean the coil, the inner rings behind the tank's outside flanges, any patches of scum on the sides and bottom, and the taphole, rinsing and rinsing. (If he forgot to clean the taphole, he might as well have done nothing, but probably no one would know.) Everything clean inside, he would have put the pail, brushes, sponge, and hose out, climbed out, and carefully lifted the ladder out. Then he would have soaked, softened, scrubbed, and rinsed away the crust around the top of the outside. The outside all clean, he would have climbed back inside with the hose and sponge, rinsed the inside again, sponged the bottom dry, climbed out again, made sure he had left nothing inside, closed the manhole door, and with the wrench screwed the door's locking bolt up tight. Finally he would have cleaned the brushes and sponge, turned off the water, turned off the light, put the wrench and the cleaning materials and equipment back, and left to look for the foreman to find out where he should go next.

The foreman might have sent the other washerman to a cuarterola left clean and sponged dry but still open. This fellow would have brought a lit candle, a pot of tallow, and an escopeta to the vat. Having looked through the manhole and seen by the light of the candle that nothing remained inside, he would have doused the light, rubbed tallow around the manhole door, closed it, and screwed it up tight. Then as told he might have gone to clean the cuarterola from which the night shift had lately moved the rested beer to clarification. Besides the candle, tallow, and wrench he would have brought cleaning equipment there for maybe three hours' work. Having screwed open the manhole door and pushed it in, he would have hosed off the bottom, then put the lit candle inside. If it did not go out, he would have put hose, brushes, and sponge in too and crawled inside. Between the flickering light and his own steady shadow he would have sprayed cold water all around, scrubbed the sides lengthwise and crosswise, and rinsed and rinsed.⁷⁸

⁷⁸. Sánchez, August 10, 1977; Fleischmann, August 15, September 7, 1977; Arzamendi, "La influencia del medio," 5. Wahl and Henius, *American Handy-Book*, 681-682, 840, 847-852; Friedhoff, "Cellar Treatment," 94; "Dry Walls in Breweries," *The Western Brewer*, March 15, 1903, 108; *ibid.*, September 15, 1903, 367-368; "The Production of Pure Beer," 12-13; "Causes of Bad Flavor in Beer," *The Western Brewer*, March 15, 1904, 109; *ibid.*, December 1905, 552; "Application of Disinfectants in the Brewery," *ibid.*, September 15, 1906, 443; Mendelsohn and Stern, *Brewers and Bottlers*, 139, 174-175, 210, 213, 305; Delbrück, *Lexikon*, 134.

The other two men on the shift would have been in the racking room. Separated from the contingencies in starting, fermentation, rest, and clarification, they alone in the stockhouse had a routine to follow. Their first duty every day was to bring already flowing beer on line and (except Saturday) on tap. Accordingly at 6 a.m. the first man would have seen that all due connections were tight, that by-passes from the big filter's discharge and from the racking machine's beer inlet were open to scrap barrels, that the air-compressor and regulating-pump motors had oil in their wells, that the compressors' and the pumps' oilers were full, and that the filters' discharge lanterns showed clear water. As soon as the compressors and pumps were running, he would have positioned himself at the racker. Remembering stories he had heard of compressor explosions, listening for leaks in the air lines, watching with one eye the pressure gauges on the compressors, their air tanks, the pumps, and the filters, he would have closed the racker's back-pressure air valves, beer outlet valves, and gauge-glass valves, opened the air supply into its tank, and readjusted the air regulator and blow-off valve for 10 lbs., then turned the handle at each of the three racking arms' operating valves to raise the arms up and back, and opened the back-pressure air valves and the beer outlet valves. Having by then rolled empty kegs and ponies up near the machine, the laborer would have put three of them bunghole up on the racker's bottom rods. The first man would have pulled the arms down one after another, guiding each arm's seal and filling tube into a bunghole. While he kept one eye on the pressure gauges, he would have studied the lantern by the beer inlet and by-pass, which was showing ever less water, ever more beer. As soon as he saw beer there clear and free of bubbles, he would have closed the by-pass, opening the inlet into the tank, and opened the gauge-glass valve. At once he would have turned to study the big filter's discharge lantern. Shortly he would have seen clear and bubble-free beer there and closed that by-pass, putting that flow on line.

Some six or eight minutes after being opened the racker's tank would have been about half full, and the first man would have started racking. At each arm he would have pulled the lever on the operating valve down, then taken a bung out of a basket under the tank and the mallet off a tray in front of the tank, in seconds seen solid beer in the first operated arm's sight glass, raised the arm up and back, and driven a bung into the open hole. The laborer would have rolled the package down the treadle, rolled it aside, and put another empty keg or pony in its place. Even as the first man lowered the arm on it, guided the seal and filling tube into its bunghole, and opened the operating valve to fill it, there would have been a second package to remove, a third, and so on. Soon the laborer would have had no more empties at hand, or way

to roll the full ones aside. Several times the first man would have stopped and waited, watching the gauges, looking at the lanterns, seeing if any of the operating valves' stuffing boxes were leaking, listening if the pumps were blowing off, feeling if the compressors or pumps were hot, while the laborer brought another batch of empties and moved the full ones out of the way. Even so the two would have racked nearly the entire product for the day's packaging, some 145 kegs and ponies, by 8 a.m.

About then the cellar boss appeared on No. 4's top floor and gave the first man there his orders. Like the brewmaster's these were brief; different every day, always quite particular: today prepare to pitch a big brew at 9:30, run this concha's attemperator colder, skim that concha's head and that one's too, remember to harvest the yeast here, and turn on the attemperator there. On a floor below maybe in No. 3 the boss soon found the first man for pumping, told him of the young beer that might need moving, and ordered him to pump a certain concha's beer into another concha, to draw a particular other concha's beer to rest, to take the empty cuarterola off the line and put a certain other cuarterola on, to take the empty cochinilla off the tap and put a particular other one on, and to draw a particular chamaco's beer into clarification and kraeusen it. Maybe in No. 2 he came across the watchman, whom he told to watch most closely maybe the cuarterolas in a certain aisle on the ground floor; on some of them the faucet spindles were slightly stripped. In No. 1 he turned off the flow from the cochinillas on tap and next door in the racking room closed the valve on the air line to them, inspected the room, and began counting the bunged packages. There was no need for orders. Shortly the first man there heard the little regulating pump sucking and turned the valve to cut it off from the cochinilla's header, letting water into the pump and the small filter. As soon as he saw bubbles in the racker's lantern he opened the by-pass to run the last, watery beer into its scrap keg, for the laborer later to carry up to the fermenting room for addition to No. 1's next fermentation. Within 10 minutes he had emptied the racker into the day's last 20-30 packages, turned off the little air compressor, drained its air tank, filled the small filter with water, and turned off the little pump, and the laborer had rolled the last bunged packages away. By then too the cellar boss had inspected the wash room, and back in the racking room recorded the day's packaged production.⁷⁹ After calling the first man's attention to any faults he had found, he went to

⁷⁹. Sánchez, August 10, 1977; Fleischmann, September 7, 1977. Wahl and Henius, *American Handy-Book*, 685-688, 766-769, 838, 892-893; Dreesbach, *Bottlers' Handy Book*, 50-53, 307-308; Friedhoff, "Cellar Treatment," 93-94; *The Western Brewer*, July 15, 1902, 254; *ibid.*, June 15, 1905, 218-219; *ibid.*, March 1906, 144; Delbrück, *Lexikon*, 3-5, 10-11, 31, 94, 96-99, 311-313, 734; Goslich and Fehrmann, *Maschinenkunde*, II, 236-240, 244, 254-258, 261-268. On the Colby racker, "Cervecería Moctezuma," 392; "Departamento de Embarrilar, 1922," *Album de la Cervecería*; The

record the changes the pumpmen had already made and to observe the preparations for pitching.

The watchman continued his rounds of the doors hour after hour through the day. But as ordered he moved ever more often and unexpectedly down the certain aisle on No. 2's ground floor. Now and then he hid between cuarterolas there to observe a pumpman or washerman dawdling around one of the vats.

On the boss's orders in No. 4's yeast room the first man in fermentation examined a tub of a cold, fetid liquid the color of old ivory, fresh yeast. Sure that the yeast was sound and vigorous, he had the laborer get a copper pail and pour seven buckets of it, about 35 gallons, into the mixing tub, wheel it to the starting tank where the next wort would soon arrive, and wheel the air compressor and a handpump there too. He then connected the compressor's hose to the tub's air inlet, closed the top air valve, opened the bottom air valve, and had the laborer connect a clean beer hose to bring the first flow from the wort delivery pipe into the mixing tub. Ready there, he left, opened wider the valve on one concha's attemperator, turned another one's on, and returned. About 9 a.m. the latest-brewed wort's first barrel ran at 59° into the tub. The first man switched on the compressor to mix the yeast and the wort for maybe five minutes, stopped it, and let the mixture begin to work into a primer. While it worked he had the laborer take the beer hose off and connect a short piece of hose from the tub's bottom air valve to the starting tank's inlet. In maybe 15 minutes, the yeasted, aerated wort having made a brownish, live soup, the first man closed the tub's lid tight, opened its top air valve, closed its bottom one (letting the primer run out), and switched the compressor on again. In a couple of minutes the primer was all in the tank. He switched off the compressor and in the same instant had the laborer close the tank's inlet. He took off the piece from the tub to the tank, connected the beer hose to the handpump, connected the piece from the pump to the tank, reopened its inlet, and waited. The laborer took the tub back to the yeast room, and set to cleaning it. In about five minutes the expected brew began flowing at 49° into the tank, mingling with the primer. The pitching was underway.⁸⁰

The next hour the boss and the first man passed in another round of the conchas there and the albercas in No. 1, studying their heads and taking their temperatures. The first man then returned to the concha being filled, where the

Western Brewer, January 15, 1910, between advertising pp. 128-129; Mendelsohn and Stern, *Brewers and Bottlers*, 249, 330-335.

⁸⁰ Fleischmann, September 7, 1977. Wahl and Henius, *American Handy-Book*, 550, 555-556, 677-678, 734-741, 785; Avenarius, "Fermentation," 76; Herzinger, "Fermentation," 182; Schaefer, "Malting and Brewing," 335; Wyatt, "Notes," 31; Delbrück, *Lexikon*, 28-29, 53, 463.

laborer brought him the air pipe and a long pole. He connected the compressor's hose to the pipe, climbed the tank's ladder, took the pipe and the pole, fixed the pole on the pipe's upper end, sank the pipe's lower end and vent gently to the tank's bottom, had the laborer switch the compressor on again, and for five minutes moved the pipe around and up and down, mixing the primer thoroughly into the wort and aerating it.

The compressor off, the tank still filling, the first man left the pipe in the mixture, climbed down, and went to the starting tank that needed skimming. The laborer brought the skimmer and a couple of wheeled slop barrels. From up on the tank's ladder the first man scooped up a layer of lumpy, dirty spume, strained the liquid, and dumped the scum into a barrel. So he continued, and the laborer periodically dumped one or another barrel's slop into the sewer, until they had the liquid's surface clean for the cellar boss to examine, nearly noon, and he could see the new, fine, white froth already spreading from around the rim toward the center.⁸¹

Back at the tank being filled the first man ran the air pipe again for a few minutes around in the mixture, further to blend and aerate it. The cellar boss and he made yet another round of the fermentations. Along the way at one of the brews in high kraeusen the boss saw too much brown stuff in the head, and ordered the dark splotches scooped out. The laborer washed the skimmer, the barrels, and the floor around the skimmed tank.

At about 1:15 the first man handpumped the last of the cooled wort into its concha. In the instant the laborer closed the tank's inlet. For the third and last time the first man roused the mixture, which finished the pitching. He disconnected the beer hose from the pump and ran that end into the sewer, and the laborer took the air pipe and pole, the pump, and the short hose away for cleaning.

Soon they were at the kraeusen that had turned too brown. The first man skimmed its biggest, darkest clumps. The laborer cleaned up again.

By 2:00 they got to the concha whose 10-day-old beer would be going to rest. This was the thinnest, the trickiest, and the main head to skim. When the first man finished it, the cellar boss and he made the day's last round of the fermentations. The laborer cleaned again.

It was time then to harvest yeast. The first man went to the fermenting tank by then emptied into storage,

⁸¹. Fleischmann, September 7, 1977. Wahl and Henius, American Handy-Book, 680, 735-736; Mendelsohn and Stern, Brewers and Bottlers, 275; Delbrück, Lexikon, 25, 374-375.

climbed the ladder, and looked down at the dark brown pool in the bottom. The laborer brought the yeast dipper, the yeast pusher, a slop barrel, a scrap barrel, and some yeast pails. The first man skimmed the brown top layer, maybe 15 gallons, into the slop barrel, which the laborer dumped into the sewer. He ladled the creamy, thick, firm middle layer, some 45 gallons, into pails, which the laborer periodically took back to the yeast room and emptied into a yeast tub. Finally he pushed the liverish bottom layer, maybe another 15 gallons, down the opened outlet and into pails that the laborer dumped into the scrap barrel to save for detergent.

After that both fellows returned to the yeast room. From a tub of yesterday's yeast crop the first man loaded the yeast washer, and turned on its water. For maybe 20 minutes he let the water whirling up run off the dregs and the light, sick, or wild yeast rising into the washer's spill ring, as the heavy, healthy yeast held firm below. Then he turned off the water, and cranked the washer around and around to drain the water and following it the creamy, stinking stuff, which he caught in pails under the washer and dumped into a yeast tub. So he ran another load, maybe 20 gallons, enough from the two to pitch a big and a small brew tomorrow. While he tended to the yeast tubs, the laborer, who had been cleaning dirty tools, cleaned the yeast washer, the pails, and the floor around.⁸² The day they owed in the cold done, they doffed their hopsack coats, tried to stamp some life into their feet, and went out into the evening that to them always seemed warm.

During all this work on fermentation, the pumpmen had been working as ordered on their cold detail. They had started on the most pressing changes, to keep the flow of beer on the line and on tap even. In No. 2 or 3 the first man, supposedly the only fellow in the house besides the brewmaster and the cellar chief to carry handles to the faucets on the vessels for clarification, had closed the emptied cuarterola's outlet. The other pumpman had dis-connected its hose and connected a clean hose from the ordered cuarterola to the header on the line. And the first man had opened its outlet. Then in No. 1 they had likewise disconnected the emptied cochinita and connected the ordered one to the header there. While the first man looked for the washermen, to tell them to clean the emptied vat and cask, the other pumpman had cleaned the dirty hoses and put them back in their respective rooms. Together again in No. 1 they had connected a hose from the chamaco ready for clarification, down to an empty, clean cochinita, and let the rested beer gently down from the

⁸². Fleischmann, September 7, 1977. Wahl and Henius, American Handy-Book, 680, 737, 741-742, 744, 747, 749, 751, 785; Delbrück, Lexikon, 29-31, 464.

vat to the cask; this would take about 45 minutes to fill. After seeing in No. 4 that the concha running to rest was running smoothly, the first man had returned to the chamaco running to clarification, the other pumpman to the receiving cochinita. As soon as the fellow below saw the cask nearing four-fifths full, he had reported to the fellow above, who had then begun pinching back the vat's outlet to close it without a tremor as the cask reached nine-tenths full. The fellow below had handpumped the beer left in the hose into the cask. Joining him there, the first man had disconnected the hose from that cochinita and connected it to another clean, empty cask.⁸³ Once he and the other fellow had this flow running, they had found on the top floor the alberca of young beer ordered for krausening, connected it down to the nearly filled cochinita, and gently let in the dose for the full 20 barrels.⁸⁴ On hearing the chamaco empty, seeing the second cask nearly full, they had again handpumped the last gallons, krausened this beer too, then cleaned the pump and hoses.

At around 11:00 the boss and the first man had gone on a round of all the vessels for clarification. Studying the porquería (foam thick and brown with "impurities," tallow, hop resin, etc.) oozing from open bungholes, the boss had considered which of them to fine and bung. At a vessel filled and krausened maybe four days ago he had taken a sample, seen enough white foam, enjoyed the taste (which he might have shared with the first man), and decided to bung it. At a vessel already bunged he had taken a sample, seen big, fading bubbles, and had the first man attach the bunging apparatus, to hold the pressure at 5 lbs., for a good, creamy foam. At a vessel already on the apparatus the first man had made sure the apparatus and its connections to the others were properly tight. After the round the boss had had the other pumpman bring the day's finings, in a barrel if for one of the ballenas, 25 gallons of cold, yellowish, runny jelly, to the tank to be bunged. Through a hose that the first man had inserted at first all the way to the other end of the tank and gradually pulled out the pumpman had handpumped the finings into the tank's beer. The first man had then screwed its bung tight into its bushing.⁸⁵ He and the other pumpman had cleaned as usual.

By early afternoon the cellar boss had seen the new froth on the tank in No. 4 and ordered it pumped to ferment

⁸³. Fleischmann, September 7, 1977. Wahl and Henius, *American Handy-Book*, 892-893; Dreesbach, *Bottlers' Handy Book*, 50-54, 306-307.

⁸⁴. Sánchez, August 10, 1977; Fleischmann, September 7, 1977. Wahl and Henius, *American Handy-Book*, 758-759; Friedhoff, "Cellar Treatment," 93; Herzinger, "Fermentation," 182; Schaefer, "Malting and Brewing," 335.

⁸⁵. Fleischmann, September 7, 1977; Campano, *Manual*, 201. Wahl and Henius, *American Handy-Book*, 684, 689, 737-738, 741, 761, 763-766; Dreesbach, *Bottlers' Handy Book*, 51-53; Friedhoff, "Cellar Treatment," 93-94; Herzinger, "Fermentation," 182; Mendelsohn and Stern, *Brewers and Bottlers*, 214, 252, 318.

in a clean concha. The pumpman had made the connections there as elsewhere, except for the use of the floor's electric pump, switched on the motor, and gone on another round of hoses and connections. More than dutiful in one dark alley on the ground floor, the first man may have used one of the handles he carried to take a sample of clarifying beer for himself and the other fellow. Back in No. 4's fermenting room about an hour and a half later for the pump's delivery of the last few gallons of the youngest beer into the clean concha, they had let the concha fill, stopped the pump and at once closed the full tank's inlet, disconnected the hose, cleaned the pump, and coiled the hose to carry it away to the wash room. The first man may then have left to look for a washerman, to tell him to come and clean the dirty concha. On the way to the wash room alone with the dirty hose the other pumpman may have stopped on the ground floor, used a makeshift handle of his own on one of the ballenas or cuarterolas, and conducted his test of its beer's progress.⁸⁶ Back again among the conchas by 3:00 the pumpmen had found the tank they were to run to rest, connected it down to a particular, half-full ballena on the third floor, and let it gently begin flowing, as it would continue to flow for the next eight hours. Only a few minutes later the first man had been at the concha he had that morning started running "without the least concussion or agitation," to see it running empty, and the other pumpman had been below at the ballena it was just half-filling, to handpump its last gallons to rest. Together they had cleaned the pump, cleaned the hose, and put it back. Then they had made the connections to pump the concha of beer entering high kraeusen into a clean concha. This transfer ending about 5:30, they had time to clean the pump and take the hose to the wash room, but no more, before they left the cold and their coats to go on numb but soon aching feet into the warm evening.

Meanwhile as the first pumpman had directed them the washermen had cleaned five vessels and started two more. The fellow who had finished the concha at about 8:00 had as ordered then started on the just emptied cuarterola. This vat being one of those used for clarification, he had first to take out its wood chips, all slick and slimy and brown with finings and sludge. Once he had collected them at the manhole, 3,500-4,000 6- to 12-inch beech and hazel shavings, 100-120 lbs. dirty and wet, he had carefully removed them with a chip hook into a couple of chip boxes and carried them to the wash room for cleaning. Back inside the cuarterola by 8:30 with candle, hose, brushes, and sponge, cleaning it as his fellow had been cleaning another, he had sprayed and soaked it all around, scrubbed the sides lengthwise and crosswise, scrubbed the bottom likewise, rinsed and rinsed, scrubbed out the taphole, rinsed again, and sponged up the

⁸⁶. Sánchez, August 10, 1977; Fleischmann, August 15, September 7, 1977.

water on the bottom by 11:30. Then to prepare the vat for its next clarification he had to reline the bottom with clean chips. On large vessels laying clean chips was ordinarily work for two men, one outside throwing the chips in, the other inside scattering them around. But the cuarterolas were so small, 50 barrels, and the cochinitas much smaller, only 20 barrels, that they took only one man. The washerman there had brought a box of clean wet chips, maybe 65 lbs., from the wash room, thrown them inside the vat, crawled back inside, spread the chips more or less evenly over the bottom, crawled out, tallowed the door, and screwed it tight by 11:45, and cleaned the floor around the vat in another 15 minutes. The other washerman had finished the cuarterola on which he had been working and cleaned the floor around it by 9:30, and had as ordered then started on the emptied cochinita, from which he had to remove maybe 1,500-1,600 chips, 45-50 lbs. dirty and wet, before he had begun spraying and scrubbing and rinsing the cask, to finish cleaning it, laying it with clean chips, and closing it by noon.⁸⁷

At 12:30 on the first pumpman's orders the fellow who had started the morning on a concha had started the afternoon on the chamaco. At the same time the other fellow had returned to the cochinita to clean the floor around it. Then waiting for a vessel to clean he had cleaned floors in several rooms for nearly two hours, until the first pumpman sent him to the concha by then emptied of that day's first young beer. The fellow working on the chamaco had finished it at about 3:00, for lack of a vessel cleaned floors for over an hour, and at the first pumpman's word started at about 4:30 on the concha from which the yeast had just been harvested. The other fellow, having finished the concha of the day's first young beer, had as ordered started on another, the last emptied that day, at about 5:30. As the night shift had left work at 6 a.m. for the day shift to continue, so the day shift stumbling and in pain left work at 6 p.m. for the night shift to continue.

After the cellar boss's inspection of the wash and racking rooms that morning the first man and the laborer there had continued as usual through the routine of their daily duties. Having finished racking, the first man had flushed the little pressure-regulating pump, the racking machine, and the lines between them, and the laborer had cleaned the hoses and the floor around the racker. Together then they had saddled the day's full kegs and ponies in the southeast corner near the door in preparation for their removal. That done, they had gone into the warmth of the wash room to feel the big

⁸⁷. Fleischmann, September 7, 1977; Campano, Manual, 202, 212-213; The Western Brewer, December 15, 1904, 526; Wahl and Henius, American Handy-Book, 487-488, 762-763, 787-788, 838, 850; Herzinger, "Fermentation," 182; Delbrück, Lexikon, 529, 773.

compressor and its motor and see how many boxes of dried, dirty chips had stacked up from the night before; evidently nothing from a ballena, which would have yielded maybe 15 boxes, only the remains of some cuarterolas and cochinitas, maybe five boxes, but enough to wash. The first man had had the laborer dump the chips into the chip-washing machine, then turned on the machine's cold water, switched on the motor for the machine, listened to the chips slapping and rustling round and round, back and forth, for maybe 10 minutes, turned off the cold water and turned on the hot, watched it running off until in maybe 15 minutes it looked clear, turned off the hot water and turned the cold back on again for maybe five minutes to cool the chips, turned off the water, stopped the machine, and had the laborer, who had meanwhile cleaned the chip boxes, unload it into them and stack them ready for the next washerman who came for them.⁸⁸ By then a gang had come to take the packages in the racking room. The first man had counted the kegs and ponies to go, recorded the numbers, and supervised the removal, the laborer rolling the little cold barrels one after another through the door into the wash room, the fellows in the gang carrying them out the front of the building next door and loading them on wagons that would take them around to the agency, all done by noon. About 1:00 another gang had come to bring the packages for tomorrow. As directed it had delivered them to the wash room, and while the laborer rolled them into rows for him, bungholes up, the first man had commenced candling them, one by one, poking a little electric light through the vent, peering through the bunghole to see if any trash was inside, bits of bung, cork, splinters, and poking a short, thin spear through the hole to spike and extract it.⁸⁹ Once the laborer had made the rows, he had stacked candled packages three or four high around the loading end of the barrel-washing machine. And once the first man had finished candling, about 2:30, he had counted the kegs and the ponies, recorded their numbers, and turned on the hot water to the washing machine's soaking tank. In a few minutes the tank had filled sufficiently, maybe 100 gallons of water as hot as the hand could stand it. The first man had turned it off, seen that the machine was still set to run the usual 3-1/3 barrels a minute, opened the valve to the scrubber and the two hot sprinklers, turned on the cold water to the third and last sprinkler, switched on the motor for the machine, and taken his position at the loading end, the laborer at the other end to unload. As the first man laid empty packages on the ramp down to the soaking tank, they had rolled one after another down to the

⁸⁸. Fleischmann, September 7, 1977; Wahl and Henius, *American Handy-Book*, 694, 850-851; Mendelsohn and Stern, *Brewers and Bottlers*, 27, 251, 297.

⁸⁹. Fleischmann, September 7, 1977. Siebel, "Handling and Pitching," 1047; Delbrück, *Lexikon*, 58.

machine's automatic lifting attachment, each gone up and over on the attachment one every 18 seconds into the tank, soaked there three or four in a row half-filled with hot water and bumping along to an elevator at the end of the tank, ridden up one after another again every 18 seconds, rolled down another ramp, tripped a lever to open the scrubber and go lifted into it, rolled round and round in place there each for its 18 seconds under a shower of hot water and between spring-powered brushes, then gone each bumped forward by the barrel behind it onto another roller, rotated in place there one at a time until a prong below sprang up into its bung-hole and retracted, moved steadily forward on a conveyor to take each in its turn the first hot sprinkler up the bung-hole to wash out its insides, then the second to rinse, then the cold sprinkler to rinse again and cool, moved steadily forward again, draining, to go finally one every 18 seconds on the lifting attachment at the other end up and over to the ramp and platform from which the laborer had one after another removed them; as he took each off the platform he had hammered a cork into its vent and stacked it nearby.⁹⁰ By 3:30 the last package had been stacked, and the first man had shut down the washing machine, running the tank's foul, sour water off into the sewer. He and the laborer had then carried the clean packages into the racking room and saddled them along the west wall for tomorrow. By 5:00 the laborer had cleaned the chip-washing and the barrel-washing machines and the floor around them and the first man had oiled the barrel-washing machine's bearings and gears and cleaned its rollers and brushes. About then the cellar boss had arrived for another inspection of the wash room and the racking room, then left. On time at 5:20 at a header somewhere in No. 2, 3, or 4 he had turned off the flow from the cuarterolas or ballenas on the line and turned off the air pressure on them. Waiting in the racking room, feeling the motors, watching the gauges flicker into new readings, the first man had heard the big pump sucking, cut off the connection from the header, cut water into the pump and the big filter, and looked to the filter's discharge lantern. On seeing bubbles in the flow there he had by-passed that last, watery beer into its scrap keg. When in a few minutes he saw clear water in the lantern, he had closed the by-pass, stopped the pump, turned off the water, and cut air into the line beyond the by-pass to press the last good beer forward. In about a minute, watching the compressor's gauge move higher and stop, he had turned off the air. He had waited a minute, then let water into the line to flush it. And at 5:30, when he saw the compressor's gauge rise and stop again, he had switched its motor off. Finally he had drained the big air tank, resealed it, and reoiled the compressors'

⁹⁰. "Lavadora de barriles, 1922," *Album de la Cervecería*. Wahl and Henius, *American Handy-Book*, 691-692; Mendelsohn and Stern, *Brewers and Bottlers*, 26-27, 31, 279, 281-282, 296; Delbrück, *Lexikon*, 318-319; Goslich and Fehrmann, *Maschinenkunde*, II, 208-209, 214-218.

and pumps' motors and cylinders, and the laborer had wiped the motors and machinery, cleaned the floor, cleaned the cleaning equipment, and stored it, to leave with the others at 6:00.⁹¹

There was a routine in the wash and racking rooms on Saturdays too, only it was different. In the morning instead of racking the first man and the laborer cleaned the racker and the racking room. While the first man gently scrubbed and rinsed the racker's lanterns, gauge glass, and sight glasses, removed its filling tubes, took them down, scrubbed and rinsed their parts, reassembled them, and put the tubes back on, took off the beer hoses, cleaned them on the Rüdiger, and replaced them, oiled the machine's pistons, and loosened any tight packing in the operating cylinders, the laborer ran the water in the racker's tank into the sewer, removed the door at the end of the tank, crawled inside, scrubbed all around two or three times, especially the inlet and outlets, crawled out, thoroughly hosed out the inside, replaced the door, and refilled the tank with water. Together they washed the room's ceiling, walls, and floor with milk of lime. Earlier than on other days they got the packages for Monday, candled and washed them, and counted, recorded, and saddled them in the newly clean racking room. That afternoon the first man toiled in maintenance over the barrel-washing machine's gearing, valves, and tension; the laborer sooner or later washed chips and scrubbed and rinsed the barrel- and the chip-washers.

Saturday's routine was also different in that it did not end at 6 p.m., for there was yet more cleaning to do. As soon as the first man had switched off the big pump and the big compressor at 5:30, he and the laborer had disconnected the big filter from the line, wheeled it next door into the wash room, run its water into the sewer, and unloaded its plates of sopping, dirty filtermass into the filtermass-washing machine. The first man washed the mass, in cold water for maybe half an hour, at least until the foaming died down, in 175°-195° water for an hour. Meanwhile he gently cleaned the filter's lanterns and gauge glasses, and the laborer cleaned the filter's tank and plates. After the first man rinsed and cooled the filtermass, the laborer put successive wads of it in the filtermass-packer and squeezed the water out of them, to reform quesos, or filter cakes, each of which he took out of the press, put on a plate, and reloaded into the filter. It would ordinarily be 8 p.m. before they had the filter reconnected into the line and refilled with water and the filtermass-washer

⁹¹. Sánchez, August 10, 1977; Fleischmann, September 7, 1977. Wahl and Henius, *American Handy-Book*, 691-692; Dreesbach, *Bottlers' Handy Book*, 54-55, 479-483; G.E. Schneider, "Beer Bottling," *The Western Brewer*, February 15, 1903, 75-76.

and packer clean and dry. (Every two or three weeks they would likewise clean the small filter as well, if they could in the afternoon, if not later in the evening.) Then the first man did weekly maintenance on the motors, air compressors, and regulating pumps, changing oil, cleaning cylinders, adjusting packing, tightening discharge valves, resealing couplings, and the laborer cleaned air filters and tanks and all the consequent messes. Ordinarily not until 9:00 could they leave sure that the rooms and equipment would be ready for Monday morning.⁹²

Work on the night shift was all on nightly different orders. At 6 p.m. on the day of the mash commenced at 8 a.m. the brewmaster himself or the day cellar boss gave the night boss the orders for the next 12 hours, which he promptly relayed as they applied. No more foreseeable than the day boss's, these orders were just as particular, and according to them the night shift's details did their various duties. Wherever he was told to watch most closely, the night watchman made his rounds most often and most unexpectedly. In fermentation the first man and the laborer cleaned, pitched the morning's brew at 7 p.m., skimmed a concha, adjusted attemperators, harvested the yeast from two conchas, maybe pitched another big brew at 4 a.m., and between tasks and at the end cleaned again and again. In pumping the first man and the other fellow changed a cuarterola on the header, ran one alberca to another, ran a concha to one, two, finally five cuarterolas, ran one ballena to another and krausened it, finished the run started earlier from a concha to a ballena, maybe took a sample or two, and ran one cuarterola to another and krausened it. And on the first pumpman's orders the washermen finished cleaning the two conchas left to them, removed the chips from the cuarterola taken off the header, cleaned it, laid it chips, maybe took some samples themselves, cleaned an alberca, cleaned another concha and yet another, started cleaning a ballena (which would take about seven hours to finish), started cleaning another cuarterola, and between cleaning vats and tanks, if not napping, cleaned floors. Since there was no night shift in the wash and racking rooms, the dirty chips left in the wash room were like a huge, laquered nest in the morning.

* * *

Along the west side of the brewhouse, in the ice plant, were three more dimly lit, quiet, wet, cold rooms, for the forecooling tank, the ice tank, and ice storage. There the maestro was the master mechanic, although he rarely appeared

⁹². Fleischmann, September 7, 1977. Arzamendi, "La influencia del medio," 5. Wahl and Henius, American Handy-Book, 687, 840-849; Dreesbach, Bottlers' Handy Book, 678-679; Mendelsohn and Stern, Brewers and Bottlers, 201-203, 236, 249, 250, 330-334; Delbrück, Lexikon, 313, 330-332; Goslich and Fehrmann, Maschinenkunke, II, 259-261; "Air Compressors," Machinery's Encyclopedia, I, 41-42, 59.

except for weekly inspections. Back and forth through these rooms ordinarily only two men worked around the clock, one during the day, one at night, Monday through Saturday. Like the men in the stockhouse, they wore hopsack coats, but only huaraches on their feet.⁹³ Unlike in the stockhouse, their work was routine.

The fellow coming on duty at 6 a.m. would first tend to the water-supply equipment in the forecooling room. Seeing that the filter on the line was clean, he would start the pump to draw water through it and refill the 5,000-gallon tank. Then he would tend to the ice, going next door into 32° and onto the deck around the ice tank. This was an enormous steel box, 16 feet wide, 8 feet deep, 67 feet long, divided crosswise into nine equal compartments, 8 feet deep, 16 feet long, each with three steel freezing plates 8 x 16 feet. Below along the tank's east wall ran six headers, for compressed air, liquid ammonia, suction, hot gas, liquid reserve, and drainage. And there at each compartment were an expansion valve to the expansion coils in the freezing plates, open, a valve to each of the headers, open for air, ammonia, and suction, closed to the other three, and a steam valve to pipes under the bottom and up the ends of the tank, closed. At the usual back pressure and the ordered adjustment of the expansion valves it took nine days for the plates to freeze great cakes of ice 10 inches thick on both sides. And as scheduled in succession every working day for nine days a different compartment's plates reached the 10-inch standard. Walking around above the tanks, the worker would lift the inspection lids on one compartment after another to see that the air was circulating the water and how the ice was growing. Going below, he would adjust expansion valves to maintain the scheduled rates of freezing and keep the coils from frosting through.

At last at the compartment on its ninth day of growth he would start the day's "harvest," closing its connections to air, ammonia, and suction. Above again he would take off the compartment's covers, move the overhead traveling crane over the compartment, and at the front of the room crank the tilting table nearly vertical. By then the ice in the compartment would have tempered. Below again the worker would let hot gas into the compartment's plates, the gas's condensation out the liquid reserve line, and steam into the pipes under the bottom and up the ends. Above again he

⁹³. Fleischmann, September 7, 1977; "Mexican Brewery," 21, 25; Martínez Garza, "Datos," 191; Eslava, "Orizaba"; U.S. Department of Commerce, Bureau of Foreign and Domestic Commerce, "Ice-Making and Cold-Storage Plants in Mexico, Central America and West Indies," Trade Information Bulletin No. 229, May 19, 1924, 26; Mendelsohn and Stern, *Brewers and Bottlers*, 588. Cf. Siebel, *Compend*, 209-210; Andrew J. Dixon, *Manual of Ice-Making and Refrigerating Machines* (St. Louis, 1894), 88-89; Irving Warner, "Experiences in the Manufacture of Plate Ice," *Transactions of the American Society of Refrigerating Engineers*, III (1907), 114.

would shortly see the six great cakes floating alongside the plates in the water. Below again he would turn the hot gas, condensation, and steam off.

Back up on deck to stay for a while he would pull the crane's hoisting chains down, fish them around the ends of one of the cakes, hoist it clear, a wonderful thing hanging there, very nearly 8 x 16 feet x 10 inches, a good three tons, hard, cold, transparent, glistening, and move it forward until it rested against the tilting table. Carefully letting out the chains with one hand, he would carefully crank the table back horizontal with the other, lock the table in place, take the chains off the ice, and move the crane back to the open compartment.

Then he would take the ice tools from a closet and commence making the cake on the table into blocks. With a hand saw he would mark the ice crosswise and lengthwise in 2-foot squares, cut along the groove of the forward outside length, deeper and deeper, until in about 15 minutes he had the cut 6 or 7 inches deep, and bar off the length. So he would cut and bar off the next two lengths. Likewise he would make the cuts across the first length and bar it into eight blocks, each reduced by waste and cutting to something less than 2 x 2 feet x 10 inches, but enough to weigh 150-160 lbs. These one by one he would slide down an incline off the table, pull with tongs into the storage room next door east, and pack with straw behind the blocks already stacked there. Working hard, sweating in the cold, he would take three hours to cut and store all 32 blocks.

So through the morning he would harvest and cut another cake and by noon have stored its blocks. It would be time then to do as he did, inspect the ice again and if necessary readjust expansion valves. In the afternoon he would harvest and cut a third cake, store its blocks, and get maybe halfway into a fourth by 6 p.m.

The fellow coming on duty then would do much the same sort of work on his shift. First, the pump having filled the forecooling tank, he would open the expansion valve to the coil in the tank to cool the 4,500 gallons of filtered water there to 32° by 4 a.m. Once he had the valve right, he would flush the filter, reversing its valves, opening the reversed outlet into the sewer, restarting the pump, watching the filter's lantern until the flow from the charcoal and quartz inside looked clear, resetting the valves in the due direction, watching the lantern again until the new flow looked clear, turning the outlet back into the line, and turning off the pump. Next he would make his first inspection of the ice, readjust any valves wrong, finish cutting the fourth cake, and store its blocks. By midnight he would have harvested, cut, and stored the fifth cake's blocks, after which he would make his second inspection of the ice and necessary readjustment of

valves. Then he would fish up the last cake. As soon as he had hoisted it out of the compartment, he would open the compartment's drainage, to run the cold, dirty waste water, nearly 1,000 gallons, into the sewer. At about 3:30 a.m. he would finish cutting and storing the last blocks, altogether 192 (if neither man had broken any), almost 15 tons. With a hose and if needed a brush he would clean the compartment out. When he had it ready, about 4 a.m., he would hang a big hose into it, turn on the water from the cooling tank, and fighting sleep go put the ice tools away, oil the air compressor, blow off its receiver, and look for leaks. At about 5 a.m. he would return to the compartment, and as it reached full turn off the water. Below he would reopen the connections to air, ammonia, and suction, maybe go back up and clean the deck, maybe nap where he was.⁹⁴

In the ice-storage room another five or six fellows also worked every working day, but usually not the same five or six, and usually only in the cool hours between 6 and 8 a.m. They made up the daily ordered gang that moved the ice from storage to distribution, two or three men inside the room with starting chisels, tongs, and hooks removing stored blocks and sliding them out the front door, a man just outside on the loading platform who slid the blocks across a skid from the platform to the trans-portion, and a man or two hooking the ice there into place. A few blocks they put on carts to go only around the corner of the building east to Moctezuma's own saloon and its agency. They put a few more on the Abresch wagons, a few more in other wagons, and a few more on trolleys for delivery around Orizaba and in the mill towns up the valley. Maybe 100-110, most of a day's full production, they packed in insulation in a Moctezuma-leased Mexican Railway box car, for shipment that day down to the port of Veracruz. The others they stood in Moctezuma-leased box cars rebuilt as insulated cars, ordinarily 10 blocks a car, six or seven cars a day in the spring and

⁹⁴. Fleischmann, September 7, 1977; "Mexican Brewery," 21, 22, 25. Mendelsohn and Stern, *Brewers and Bottlers*, 526; J.J. Cosgrove, *Sanitary Refrigeration and Ice Making* (Pittsburgh, 1914), 266, 268, 270, 272-274, 312; Greene, *Elements*, 276-280, 286-287, 303-304, 427, 431; Frank H. Abbey, "Improved Methods of Handling Manufactured Ice at Ice Plants and Icing Stations," in *Premier Congrès international du froid*, 3 vols. (Paris, 1908), III, 113; Louis Block, "Ice Making Machinery," *ibid.*, III, 125-126; Edgar Penney, "Elements Governing the Selection of the 'Plate' System and the 'Can' System," *Transactions of the American Society of Refrigerating Engineers*, I (1905), 55, 57; "What Is the Best Method of Thawing Off Plate Ice?" *ibid.*, II (1906), 205-206; Siebel, *Compend*, 204-209, 517; J. Wemyss Anderson, *Refrigeration* (London, 1908), 138-139; Warner, "Experiences," 107, 120-121; Frank E. Matthews, *Elementary Mechanical Refrigeration* (New York, 1912), 92-94; Harris, *Audel's Answers*, II, 452-453, 459-460; Henry Hall, "The Ice Industry of the United States," in U.S. Department of the Interior, Census Office, *Tenth Census of the United States*, 22 vols. (Washington, 1883-1888), XXII, 8-9, 12-17; Joseph C. Jones, Jr., *America's Icemen* (Humble, 1984), 15, 25-29, 32-35, 47-48, 61, 63-70; Interview with John Mellen, August 1, 1994; Gifford-Wood Co., *Natural Ice Harvesting Equipment* (n.p., n.d.), 58, 82-83, 108.

fall, to precool them before loading and leave some ice for the freight on the road.⁹⁵

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Once a year, in August, around the time called la guayabada, in the machinery department, the stockhouse, and the ice plant, the brewmaster and the master mechanic ordered a general overhaul. As ordered in August, 1908, much ordinary work for the first time continued as before, but for three weeks or more much also stopped for the other, extraordinary work to happen. In all three departments this was the time when workers cleaned and repaired boilers, machines, connections, coils, and valves. In the stockhouse, in Nos. 3, 2, and 1, it was also varnishing season, when workers stripped and revarnished the insides of the wooden vessels. Already for three months the brewmaster and the cellar bosses had been preparing the cold rooms for this event, bringing all new storage and clarification into No. 4, where neither the new coils and valves nor the new Pfaudler tanks needed special attention, and leaving one by one the other houses' tubs, vats, and casks empty.⁹⁶

For three months too another master had been making ready. This was the tonelero, the cooper, master of the double arch, wizard in angles and curves, savant in the grain, rings, and strengths of woods. While the vessels were still full, he had inspected them, studying heads, bungs, staves, plugs, joints, hoops, and bottoms, and noted the repairs necessary. Since then he had been cutting ever more finely the pieces he would need for them.⁹⁷

Overhaul of the refrigerating system began simply and unobtrusively with the regeneration of its ammonia, to

⁹⁵. Zorrilla Rivera, April 28, 1975; Camaleño, July 26, 1977; Fleischmann, September 7, 1977; "Mexican Brewery," 21, 22-23, 27-29; Compañía Editorial Pan-Americana, Estado de Veracruz (México, 1923), 126. Cf. N. Steenberg et al., "L'application du froid aux transports par voie ferrée," in Premier Congrès, III, 565; T.N. Wylie, "Organization of Cold-Storage Transport or [sic] Railways," *ibid.*, III, 572; Franz Spalek, "Die Kälte am Transportwege von Nahrungsmitteln," *ibid.*, III, 613; J.H. Bracken, "The Refrigerator Car--Retrospective and Prospective," Transactions of the American Society of Refrigerating Engineers, IX (1913), 140-142, 144-145; M.E. Pennington, "Standard Refrigerator Car Development," *Ice and Refrigeration*, January 1919, 27-28; United States Federal Trade Commission, Report of the Federal Trade Commission on Private Car Lines, June 27, 1919 (Washington, 1920), 32, 79, 212-213, 224; John H. White, Jr., *The Great Yellow Fleet* (San Marino, 1986), 15-16, 22, 46, 108, 128, 134; *idem*, *The American Railroad Freight Car* (Baltimore, 1993), 123-125, 129-130, 272-278.

⁹⁶. Camaleño, July 26, 1977; Sánchez, August 10, 1977; Fleischmann, September 7, 1977. Wahl and Henius, *American Handy-Book*, 852-858; E.T. Skinkle, "Overhauling the Ice Plant," *Ice and Refrigeration*, November 1906, 171-174; Decateur, "Overhauling," 11-13; Delbrück, *Lexikon*, 286, 360, 568-570.

⁹⁷. Sánchez, August 10, 1977; Fleischmann, September 7, 1977. Delbrück, *Lexikon*, 128-129, 306-311, 314-315; Alfred Franklin, *Dictionnaire historique des arts, métiers et professions* (Paris, 1906), 700-701; Hankerson, *Cooperage*, 14-15, 24-27, 44; Kilby, *The Cooper*, 18-41, 53-54.

reclaim it from the water and oil it had accumulated during the past year. The regenerator, a horizontal tank about 5 feet long, 10 inches in diameter, lay on a stand below the liquid receivers in the machine house. Fed from the receivers' drains, holding a steam pipe inside, feeding back into a suction line, it was an elementary still. On the master mechanic's orders, under the engineer's supervision on his rounds, a fellow from the machine shop operated the apparatus by turning valves in the right sequence and at the right moment. He would open the inlet to let polluted liquid ammonia into the tank, watch the tank's gauge glass until it showed a little over half full (about 10 gallons), close the inlet, watch the tank's pressure gauge for maybe a minute until it showed 90-100 psi, open the outlet to let clean vapor back into a compressor's suction, watch the gauge until it showed the system's back pressure, close the outlet, open the drain at the bottom to run off the oil and water, close the drain, all in under five minutes, and start again. It took him two days to distill the system's entire charge. In the meantime the maestro led a painstaking search of the stockhouse for ammonia leaks, burning special sulphur sticks to smoke them out. All the leaks he found, he marked, and had a mechanic patch and close. He also inspected the boiler room, where shortly as ordered a carpenter, a mason, and a mechanic with pipefitter's and boilermaker's tools arrived to put ladders, chimneys, and the spare boiler and its braces, furnace, fixtures, attachments, and connections right and tight.⁹⁸ In Nos. 3, 2, and 1 the washermen cleaned the last cuarterolas and cochinitas used.

The morning all the wooden vessels stood clean the major work commenced. The master mechanic ordered the engineer to run the new compressor only for the hop room, the Baudelot cooler, No. 4, the racking room, and the ice plant, to run the old compressor only for Nos. 3, 2, and 1, to gas their coils (except the racking room's) to loosen the ice on them, then pump them out into the condenser's old battery. The engineer accordingly set the valves to divide the system in two. Then closing the old main liquid valve, turning the expansion valves to the old cold rooms wide open, closing the old compressor's suction valves, and opening its by-pass discharge valves, for hot gas to shoot into the coils in Nos. 3, 2, and 1, he pumped the pressure in them up to about 50 psi, waited for the ice to break, then returned the valves to stop the hot gas and bring the pressure back down to normal, but left the main liquid valve choked off and opened the old liquid receiver into a couple of storage tanks. So in about two and a half hours he pumped the pressure all the way

⁹⁸. Sánchez, August 10, 1977. Harris, *Audel's Answers*, I, 186-241, 243; Mendelsohn and Stern, *Brewers and Bottlers*, 521; J.C. Calhoun, "Closing Down a Plant," *Ice and Refrigeration*, November 1906, 169-171, and December 1906, 225-226; Skinkle, "Overhauling," 171-172; Matthews, "Experiences," November 1905, 653; Miller, "Hints," June 1917, 23; Decateur, "Overhauling," 12.

down to zero, supposedly clearing all ammonia from the coils, and stopped the compressors. He waited some minutes, watching the suction gauge on the old compressor to see if the pressure rose (a sign there was still ammonia in the coils). When it did not, he restarted the compressors, pumped the pressure in the choked coils down into a vacuum, and set the old compressor's valves so that it ran idle.

In Nos. 3, 2, and 1 the cellar boss had yard gangs start scraping the ice off the coils, shoveling it into carts, and dumping it outside. The master mechanic and the boss went inspecting the coils to see if any was refrosting (proof of liquid ammonia still in it). Sure that a coil was empty, the maestro had a mechanic disconnect it from the system at both ends.⁹⁹

By the end of the day all the coils were bare and open. And as ordered the gangs had opened all the vessels and put little charcoal stoves in those on the ground floor, to begin fire-drying them.¹⁰⁰ Outside in the yard, another gang cleaned out the deep well. Down by the river yet another gang began the annual clearance of sand and brush from around the water-supply intakes. In the new pumphouse a mechanic overhauled the stand-by well pump, as in the following days he would overhaul the other well pump and the two river-water pumps.¹⁰¹

The next morning the master mechanic ordered the old compressor stripped. The engineer stopped the compressors again. As soon as he disconnected the driving wheel from the old one, he restarted the new one, leaving the old one dead. The shop's best mechanic, waiting for the machine, proceeded to strip it, which took him till noon to finish. The maestro between his other duties examined the compressor's cylinder, piston, piston rings, valves, guide, crosshead, connecting rod, crank, oiler, lubricator, main shaft, and alignment, and gave the mechanic orders for cleaning out the water jacket and water connections, scraping the cylinder clean, turning up the piston rod, regrinding valves, rebushing the rod end of the cylinder and the stuffing-box gland, repacking the box, refitting and readjusting pins to brasses, and rebabbiting the main-shaft bearing. On the floor and in the shop these jobs took two days to do. Meanwhile in the then defrosted cold rooms other mechanics on the maestro's orders overhauled pumps and air compressors, made steam and

⁹⁹. Sánchez, August 10, 1977. Siebel, *Compend*, 309; Harris, *Audel's Answers*, I, 81-83, 147, 158; Cosgrove, *Sanitary Refrigeration*, 306; Matthews, "Experiences," December 1905, 794; Skinkle, "Overhauling," 172; Miller, "Hints," June 1917, 24; Decateur, "Expansion Coil Efficiency," 24.

¹⁰⁰. Sánchez, August 10, 1977; "The Production of Pure Beer," 13; Wahl and Henius, *American Handy-Book*, 854.

¹⁰¹. Skinkle, "Overhauling," 171.

compressed-air connections to the ammonia headers, and ran open joints off the coils' suction end to the outside. Likewise in the ice plant a mechanic made steam and air connections to the ice tank's hot-gas header and an outlet outside.¹⁰² That night as ordered the fireman built a good head of steam in the spare boiler.

The next day the maestro had the coils blown out and tested under pressure in Nos. 3, 2, and 1. At one header after another a mechanic would turn steam at maybe 90 psi into a coil, clearing the pipe of any oil collected in it, blow it out with air for half an hour, clearing it of scale and drying it, and cap its outside end. When he had capped the last coil, he put compressed air at 10 psi into one after another, and the maestro and another mechanic went tightening flanges, first on the blasts, then on the whistles, replacing split pipes and spongy fittings, putting in new gaskets, and resoldering loose joints. As ordered then the mechanic at the headers put in more air to raise the pressure to 100 psi, and when the maestro and the other mechanic had stopped the leaks then, he raised the pressure to 200 psi, for them to catch the last little peeps and bubblers. This pressure he left on the coils to test them overnight. Similarly during the day in the ice plant, once the tank man had harvested the day's plate, a mechanic had blown out the empty compartment's freezing coil and put 200 psi on it, and closed any leaks. (So everyday for the next eight days a mechanic would blow out the day's empty compartment, pump up the pressure in the coil, and make the coil tight, and one day along the way blow out, test, and tighten the Baudelot cooler's and the racking room's coils.) Back in No. 4 the cooper had appeared and told the cellar boss which vessels in Nos. 3, 2, and 1 (only a few) to leave for repairs.

In the morning the pressure on the tested coils had slipped several pounds. The master mechanic ordered it raised again to 200 psi, which the mechanic did. The maestro and the other mechanic looked for more leaks, but found none. The mechanic at the headers let the air out of the coils. And both mechanics took the steam and air connections down and reconnected the coils to the system.¹⁰³

Meanwhile the cooper and his apprentice arrived bearing bench and tools and went to the repairs they were to do on the ground floor. At a cuarterola that had leaked between several staves they would pull the fasteners from the

¹⁰². Sánchez, August 10, 1977; Skinkle, "Overhauling," 172; Coal Miners' Pocketbook, 346-347, 484; Luhr, Handy Book, 538; Vilter, Catalogue A, 8-14, and Catalog P, 20-24.

¹⁰³. Sánchez, August 10, 1977. Harris, Audel's Answers, I, 162-165, 169-170; Matthews, "Experiences," November 1905, 652-653; Skinkle, "Overhauling," 172; Calhoun, "Closing Down," December 1906, 225; Nessler, "Refrigeration," 24; F.W. Fredrichs, "Clearing Ammonia from Compression Plant," Refrigerating World, December 1916, 41.

head hoop and another hoop or two down, drive the hoops off, pull them each not even a hair tighter, drive them back on, carefully using the chime maul on the head hoop, and refasten them. At a vat that had leaked between two staves they would remove the head hoop, loosen the other hoops above the leak, with a chincing iron caulk the joint, and refix the hoops. Where a drain bushing had leaked, they would loosen all the hoops but the bottom one and take the cracked stave out, and the cooper would try the new stave he had made, with jointer and crozer trim the angles and curves to make edges fit edges and crozes fit beads as closely as he could, chince seams, and reset the bushing; he would let the apprentice hoop up by himself. At a leak in a cant of a bottom the apprentice would also get to crawl underneath the vat, punch the leak, and drive a plug into it. Where the cants in a head had sprung the cleats and come apart, the apprentice would remove the head, and the cooper would try the new head he had made, with a heading knife make the bead fit the croze as closely as he could, chince seams, and retighten the head hoop.¹⁰⁴

Most loudly the cellar boss had work started inside the tubs, vats, and casks. A yard gang of some 30 men and boys moved into Nos. 3, 2, and 1, took the little stoves to vessels on the second floor, then divided among the rooms on the ground floor, one fellow to a vessel, crawled into a vat or cask and set to scraping off grayish beer scale and sanding away old varnish. It took six hours of hard, steady work in dark, dusty, stuffy, hot, solitary confinement, sneezing and coughing, to scrape, sand, and wipe clean a quarterola's insides.

The next morning the mechanic overhauling the compressor finished its repairs. By mid-afternoon he had reassembled the machine. The master mechanic inspected it, dead, starting, and running (idle), and approved. The engineer pumped a vacuum on the reconnected coils to test them again over night. That evening the gang scraping and sanding finished the vessels on the ground floor. By then every man and boy in the gang was coughing phlegm.¹⁰⁵

At 6 a.m. the following morning the maestro found the pressure on the coils back up to atmospheric. As ordered the engineer pumped 200 psi on them again, and the maestro and a mechanic went looking again for any last little leaks. After they closed all they detected, the pressure held till the test ended at 6 p.m. In the meantime that day the cooper and his helper had started repairing vessels on the second floor. And there on the cellar boss's orders, having

¹⁰⁴. Sánchez, August 10, 1977; Fleischmann, September 7, 1977. Mendelsohn and Stern, *Brewers and Bottlers*, 214, 252, 400, 450, 454; Hankerson, *Cooperage*, 15-16, 44, 138-140, 147-150, 167-173; Kilby, *The Cooper*, 18-19, 24-26, 33-34, 37-41, 53-57; Delbrück, *Lexikon*, 128-129.

¹⁰⁵. Sánchez, August 10, 1977. "The Production of Pure Beer," 12-14; Delbrück, *Lexikon*, 286, 360, 568-570.

moved the stoves to the third floor, the gang had been scraping and sanding the vats that were sound.

As soon as he logged in the next day the master mechanic ordered the engineer to pump the condenser's old battery out. At his first opportunity the engineer accordingly stopped the old compressor and turned the main liquid valve and the expansion valves to Nos. 3, 2, and 1 wide open, letting the liquid run into the coils there, vaporize, stay, and warm up. He reset the compressor's valves, suction and discharge closed, by-passes open, to reverse its action. He watched its back- and head-pressure gauges, and when he saw them equalized, he had the condenser man turn off the water on the old battery. As ordered a mechanic and his helper soon arrived to build steam and air connections to the battery's gas header and fit a joint from its main liquid line to open air. With them came a second helper, to scrape the battery's coils clean of mud and scale. That afternoon the maestro returned and led a painstaking, sulphur-burning search of the coils, marking their leaks and having a mechanic pull their loose flanges up tight. On the maestro's word then that the battery was ready to pump, the engineer shut the expansion valves to Nos. 3, 2, and 1, and restarted the compressor, which slowly began sucking ammonia vapor back from the battery's coils and discharging it back through the return valve into the expansion coils. In a couple of hours, having pumped a slight vacuum on the battery's coils, he stopped the old compressor, closed its by-passes, cracked its discharge valves for a minute, then closed them, leaving the expansion coils full, the battery empty, and the compressor clear.¹⁰⁶ By evening the fittings were in place to blow the battery out, and in the stockhouse the gang had almost finished its work on the second floor.

In the morning as ordered in the machine house a mechanic disconnected the old battery, blew its coils out one by one with steam, then air, and capped them. As ordered in Nos. 3, 2, and 1 the gang did the last vats on the second floor, moved some stoves to the top floor of No. 3, took the others away, and started scraping and sanding the albercas, chamacos, and cuarterolas on the third floor. By then the cooper and his helper were at work there too. Through the afternoon in the boiler room, the need for extra steam having passed, the fireman turned the steam from the spare boiler into the regular heating lines, and killed the fire in the other boiler. Back in the machine house the mechanic and his helper removed leaky pipes and screw fittings from the old battery, repacked valves, put new gaskets in old joints, cut threads, made new joints up with litharge, straightened, leveled, and cleaned the spray troughs, and cleaned water

¹⁰⁶. Sánchez, August 10, 1977. Harris, Audel's Answers, I, 152-155, 161, 230-231; Luhr, Handy Book, 521, 526, 536; Matthews, "Experiences," December 1905, 794-795; Fulmer, "The Operation of Ammonia Compression Machines," Refrigerating World, July 1913, 50, and "Ammonia Compression Machines," August 1913, 48; Miller, "Troubles," 24.

connections. That evening, the new joints set, the mechanic put 300 psi of air on the battery's coils.¹⁰⁷

It was still practically all there the next morning. The master mechanic therefore ordered the battery reconnected and tested on the machine. The mechanic took down the steam and air connections, put new gaskets in the gas header, and connected the battery back into the system. That evening the engineer again pumped 300 psi on its coils.

This test went well too, and in the morning the maestro ordered the ammonia purged. The engineer accordingly turned the valves to pump the vapor in No. 3's coils back into the old battery. At the battery the condenser man turned on the cooling water, put a pail of water below the battery's purge valve, and ran a hose from the valve down into the pail. Nearly an hour later the engineer stopped the compressors, the condenser man turned a full flow of water on the battery, cracked its purge valve, letting out air and dead gas, and began watching the bubbling in the bucket. As soon as the bubbling stopped and he heard the snapping and cracking of ammonia in water he closed the valve and turned the water down; the engineer let the purged liquid ammonia expand back into No. 3, then restarted the compressors, turning the valves to pump No. 2's coils out into the battery. About 45 minutes later they purged this ammonia. And half an hour after that, having pumped out No. 1, they purged its ammonia. The engineer then pumped Nos. 3, 2, and 1 again into the old battery, its liquid receiver, and the storage tanks.¹⁰⁸

Meanwhile that day in the stockhouse the cooper and his helper had started repairs on the fourth floor of No. 3. By noon the gang scraping and sanding had finished the vessels on the third floors, and taken away the stoves from No. 3. On the fourth floor there that afternoon a small gang of a dozen or so men and boys began work on the last vessels to do, all albercas, which took longer than cuarterolas, but since they had no top were already a sort of release. Over in the boiler room as ordered a carpenter, a mason, and a mechanic had commenced repairs of the other boiler.

The next day the engineer reset all the valves dividing the system in two, pumped out No. 4 into Nos. 3, 2, and 1, opened the old battery into No. 4 for the purged ammonia to circulate there, and then with the condenser man repeated yesterday's operation, leaving all the ammonia purged. The gang scraping and sanding finished the last albercas, men and boys coughing and coughing.

¹⁰⁷. Sánchez, August 10, 1977. Harris, *Audel's Answers*, I, 187, 230; Greene, *Elements*, 142-146, 149-154.

¹⁰⁸. Siebel, *Compend*, 304, 306-307; Matthews, "Purge Device," 601; Nessler, "Refrigeration," 23; W.S. Doan, "The Ammonia Compression Refrigerating System," *Refrigerating World*, April 1919, 33-34.

Then began the most dangerous time and the worst work, revarnishing. As the cellar boss ordered the next morning another gang of some 30 men and boys, some from the group that had stripped the vessels, others fresh from the yard, brought air hose, electric lamps, buckets, brushes, and cans of varnish, pure shellac in pure wood alcohol, to the ground-floor rooms of Nos. 3, 2, and 1. There divided among the rooms, they ran air hoses from the compressors to ventilate the vessels where they would work, put lamps, buckets of varnish, and brushes into the vessels, crawled one fellow to a cask or vat into them, and began each laying down as even a coat of varnish as he could on the bare wood. It took less than three hours of steady work to varnish a cuarterola, but in that time a fellow could breathe enough alcoholic vapor to go shaky, sick at his stomach, faint, and suffocate. This did not happen: by the end of the day the gang had finished all the vessels on the ground floor and about a quarter of those on the second floor, and no one had died. But every one had a headache, runny eyes, a runny nose, and a cough. The second day the gang finished the second floor and more than a third part of the third and the fourth floors. By then the coat had dried on the vessels on the first floor, and the next morning they started all over on the second coat, which took longer. They finished it in three days and a morning. Heads splitting, eyes burning, noses running, chests sore from coughing, stomachs tired from retching, the gang spent the rest of that day removing the debris of the job. Although no one had died yet, the men and boys who had survived the work swore they would never do it again. Two mornings later the second coat had dried on the last alberca varnished.¹⁰⁹ The varnishing season was all done.

On the master mechanic's orders the engineer that day reset the valves to make the refrigerating system one again, and the greaser brought several big cylinders of ammonia for him to complete its charge. He drew a little liquid from a cylinder, tested it, weighed the cylinder, noted the weight, put the cylinder on a tilt by the charging line into the receivers, connected the cylinder to the line, opened the charging valve, and opened the cylinder's valve. The cylinder began to frost. In about half an hour the frost began to fade: the cylinder was empty. When he next got round to it, the engineer closed its valve, closed the charging valve, disconnected the cylinder, removed it, weighed it, noted the weight,

¹⁰⁹. Sánchez, August 10, 1977. Wahl and Henius, *American Handy-Book*, 250, 484-485, 853, 855-858; M. Wallerstein, "Commercial Brewers' Varnishes," *The Western Brewer*, October 15, 1902, 409-410; *ibid.*, November 15, 1902, 434; "Fermenting Vessels and Wild Yeast Infections," *ibid.*, November 15, 1903, 462; Delbrück, *Lexikon*, 286, 360, 568-570.

were all nearly as simple as a soaking wheel to use. The oldest, then only two years old, was a Barry-Wehmiller 18-spindle "Eick" crate soaker, washer, and rinser in one, rated at 45,000 bottles a day. The soaking section, an iron drum 5 ft 4 in. in diameter, 21 feet long with four compartments, discharged at its back end onto a track directly into the washing and rinsing section, its mechanism, three rows of six washing spindles and brushes, and three rows of six rinsing spindles open to view in a frame 4 feet wide, 5 feet long, 6 ft. 4 in. high.¹¹² The two other machines, one a year old, the other brand new, were both 20th Century "Volz" pocket soakers rated at 150 barrels a day. Four-compartment models with "automatic loading device and double brush conveyor," they were big, box-like, iron tanks about 6 feet wide, 15 feet long, 8 feet high.¹¹³ Right behind them too stood their washing machines and rinsers, but these were separate and independently operated.

It was the bottling foreman, floor mechanic, practical heating engineer, and practical chemist in one, who daily prepared, started, stopped, and restored the soaking system. Well before the day's first whistle, at least by 5:30 a.m., he would turn steam into the heating coils in the soakers, to heat the soaking solutions in their first and third compartments to 145°, that in their second compartments to 160°. (The fourth compartments, full of fresh water, had no heating coils). At 6:00 he would switch on their motors and shift the Volz machines into drive. During the day between inspections and trouble elsewhere on the floor he would periodically come and feel the motors, listen to gears, read thermometers, adjust steam valves if temperatures were not right, and oil bearings. And toward the end of the day, ordinarily about 5:20, he would switch off the Eick's motor, shift the Volzes into idle, switch their motors off, turn off the steam, and methodically proceed to refresh the system for tomorrow.

But hour after hour through the day the system took five men and some 30 boys working constantly to load and unload it. The Eick sections took only a man and seven boys. As soon as the foreman switched on the motor there a

¹¹². Barry-Wehmiller Order Book, March 13, 1906, 83/116 (for a copy of which I thank Larry Miller of Barry-Wehmiller); Mendelsohn and Stern, *Brewers and Bottlers*, 147, 149, 433-434; "Eick's Bottle Washing or Sterilizing Apparatus," Patent No. 792,010, June 13, 1905; "Eick's Bottle Washing Apparatus," Patent No. 956,056, April 26, 1910. Cf. "Eick's Bottle Washer and Rinser," *The Western Brewer*, April 1908, 208; The 'Very Klean' Soaker," *The Western Brewer*, April 1908, advertising pp. 80-81.

¹¹³. *The Western Brewer*, April 15, 1907, 188, 216; *ibid.*, July 15, 1908, 379; *The Brewers Journal*, July 1, 1908, 427; Mendelsohn and Stern, *Brewers and Bottlers*, 432. On such machines, *The Western Brewer*, January 15, 1908, advertising p. 128b; *ibid.*, January 15, 1910, advertising p. 118; Mendelsohn and Stern, *Brewers and Bottlers*, 407-413, 418-424.

counter-shaft toward the bottom of the drum's face began turning at $2/3$ rpm. By Geneva motion every 15 seconds it would give one-sixth a revolution to the main shaft through the center of the drum, and 10 pairs of spiders along the shaft inside, each pair carrying in a frame six special iron crates around it, empty and clanking, would rotate together in direct alignment one-sixth a turn to stop so that the front spider presented the end of a crate at the 15-inch square feed opening at the top of the drum's face; the heat from inside flowed out of the opening. The man at his station at that end, already sweating, had five boys taking bottles from the boxes stacked there, each boy handling 10-12 bottles a minute, two at a time, one in each hand, putting them one by one bottoms up in special crates, six bottles by three, which they stacked by him. Every 15 seconds when the first pair of spiders brought round another empty crate he would try to be ready to slide a full crate lengthwise into its frame. When he did, this crate would push the empty ones behind it each back into the next frame until the one on the last pair of spiders slid out of the 15-inch square discharge opening in the back and onto the track into the washing and rinsing machine. Two more crates loaded would push the first one in the washer-rinser out of it and onto an inclined discharging track. And at the end of the track the fourth or fifth boy would take it off and put it on a bench alongside. As the soaker turned and stopped, turned and stopped, clanking and clinking, as the boys in front continually filled the crates, as despite the heat the man continually fed the crates into the opening, not at the rated speed, but missing one or two loads a revolution, and as one boy behind the washer-rinser continually stacked the empty crates and the other boy continually carried them to the front, the bottles inside went around in a soaking solution, filling and emptying once a revolution, each crate loaded pushing the full crates behind it and the empty crates behind them back from frame to frame, compartment to compartment. In about an hour, having loaded 60 crates, the man would go shift the second section into drive. The 61st and every successive crate of bottles he loaded would push a full crate of soaked bottles bottoms up into the washing and rinsing machine. Every 15 seconds by its mechanism in time with the soaker's motion one of these crates would move back over the 18 washing spindles and brushes, and stop. While the soaker's spiders turned, the spindles would extend up into the soaked bottles, wash and scrub them inside and out, then retract, the crate would move back over the 18 rinsing spindles and stop, these spindles would extend up into the bottles and rinse their insides, then retract, and the crate would move back out of the machine onto the discharging track. There the fourth boy took the full crates off the track and stacked them on a bench beside it, and the fifth boy carried them a few yards over to a new mechanical table conveyor headed west, put them on it, and hurried back. So the work at the Eick

ordinarily continued for hours on end. Now and then a younger boy might tire, feel like crying, wander away. The foreman soon had him back in place or another boy from bottle storage to replace him. Finally at 5 p.m., by which time the workers there had filled, loaded, unloaded, and carried away between 1,900 and 2,000 crates, the man began feeding empty crates into the soaker to push the last full crates through. No longer needed, the boys in front went as the foreman told them to help in bottle storage. About 5:20 one of the boys in back took the last full crate of the day off the discharging track and stacked it, and the other boy carried it away to the conveyor.¹¹⁴

The Volz soakers were even simpler to use than the Eick. But they each took 9 or 10 boys, four in front, five or six in back, to tend them. As soon as the foreman switched on their motors and shifted the machines into drive, their drive pulleys began revolving, their great gears and sprocket wheels slowly turning, and their endless chains bringing row after row of 16 empty iron pockets into view, from below across the front, from above across the back, a row every 12 seconds. At once three boys in the heat at the front of either soaker began taking bottles from the boxes stacked by them, each boy handling about 20 bottles a minute, four at a time, two in each hand, laying them beside each other necks forward in the device that automatically and continually lifted and fed them bottoms up into the slowly ascending pockets. In any row they ordinarily could not fill but 12 of the pockets, but at that they each emptied a box of bottles about every three minutes, and the fourth boys were there to keep removing the empty boxes and stacking up full ones. Inside the machines the rows of bottles were slowly and successively wheeling around to fill and empty in each compartment. The boys at the back of either soaker would be clearing the area of anything left in their way, and stacking empty iron crates for 24 bottles. At about 6:20 the first rows of soaked bottles would appear before them and slowly and successively descend, the bottles would slide out of the pockets onto rollers under the double brush conveyor, and the conveyor would carry them to the discharge tray. At once the boys there began taking the bottles out of the tray, putting them one by one bottoms up in the crates, six bottles by four, and stacking the crates on a bench behind them. So the work at these soakers continued hour after hour. From time to time, when the boys in front were near fainting from the heat, they and three of the boys in back would change ends. But ordinarily as at the Eick the work did not change at either

¹¹⁴. Zorrilla Rivera, April 28, 1975; Patent No. 792,010, Drawing Sheets 1-2, Descriptive pp. 1-2; Mendelsohn and Stern, *Brewers and Bottlers*, 149, 241, 408, 410, 414-415, 461; Patent No. 956,056, Drawing Sheets 1-4, Descriptive pp. 2-6. Dreesbach, *Bottlers' Handy Book*, 37-38; Schneider, "Beer Bottling," 75; Albert F. Diehl, "Bottle Shop and Beer Bottling," *The Western Brewer*, June 15, 1903, 273; Daum, "Bottling Notes," 6-7, 9.

end until 5 p.m., by which time at either machine the boys had handled over 38,000 bottles and done some 1,600 crates. The boys in front then stopped feeding the machines, and went to clearing the area. The boys in back continued as before until about 5:20, when they took out the day's last bottles and crated and stacked them.¹¹⁵

Behind these workers, just on the other side of the benches where they stacked the crates, several other workers had also spent hour after hour in constant action. The washing machines there were two new 20th Century Eick 24-spindle automatic models, each with its own motor and rated for three crates a minute at 45,000 bottles a day; each had a man operating it. Beside them two new 20th Century Volz 24-bottle underspout rinsers had each occupied a man and a couple of boys. From the first whistle to about 6:20 a.m. the work had been anticipation and preparation, the men clearing the area and making sure the washers were correctly adjusted, the boys collecting six-by-four crates for their fellows in back of the soaker. But as soon as the soakers began discharging bottles the washing-machine operators had switched on the machines' motors, and men and boys had turned to do the work at their stations. It happened then hours on end the same at either washer, the same at either rinser. Two or three times a minute a washing-machine operator would take a crate of soaked bottles from the bench in front of him, place it in the washer between the pressure plate and the top plate so that the bottles' mouths went into the top plate's 24 mouthpieces, pull the clamping lever down on the pressure plate, shift the machine into gear, watch as the gear drew the pressure plate down and the bottles' necks disappeared through the top plate's holes into the machine's casing (where they went over the 24 spindles), watch water suddenly squirting up into the bottles and brushes suddenly whirling around inside them, watch as the pressure plate and the bottles came back up and the water and brushes stopped, and lift the clamping lever. Two or three times a minute in tandem with him the rinser operator beside him would take the crate of washed bottles out of the washer, place it on the rinser's plate so that the bottles' mouths went into either of its two sets of 24 holes (over 24 nozzles below), turn on the water, watch as it squirted up into the bottles, and turn off the water. And two or three times a minute in tandem with him the boys would

¹¹⁵. Zorrilla Rivera, April 28, 1975; *The Western Brewer*, January 1908, advertising p. 128b; Mendelsohn and Stern, *Brewers and Bottlers*, 241, 407-424, 457; Daum, "Bottling Notes," 6-7; Arzamendi, "La influencia del medio," 6. Cf. Dreesbach, *Bottlers' Handy Book*, 35-38; Schneider, "Beer Bottling," 75; Diehl, "Bottle Shop," 273; "A Model Bottling Shop," *The Western Brewer*, September 1914, 106.

each in his turn take a crate of rinsed bottles off the rinser, go put it on the table conveyor, and come right back.¹¹⁶ By 5:20 when it too stopped this work would have washed, rinsed, and removed some 3,300 crates of bottles.

There remained the last daily chores, refreshing the system and cleaning the machines. As soon as the foreman switched off the motors he started the men cleaning; the boys he sent to bottle storage. He himself mixed a strong caustic soda solution to add to the source of the samples. One man meanwhile rigged hoses from the outlets on all the first and fourth compartments and opened them to drain into the sewer, and the others set to cleaning paper, tinfoil, and dirt from the various brushes. When the first and fourth compartments were empty, the man who had drained them opened the covers on them at the Eick and the manholes into them at the Volzes, hosed them out, closed manholes and outlets, put the hose away, and turned on the water to all the compartments to refill them to their proper level. Usually he timed the flow so that the compartments were all full right at 6:00, when at the whistle he and the other men left. Alone then at the soakers, from the floor at the Eick, on a ladder at the Volzes, the foreman poured enough of the strong solution into the first compartments for a 1/2% solution, enough into the second for 5%, and enough into the third for 2%, and closed them. He would stay there longer only to examine brushes for wear, oil spindles, and give the machines a few last turns to work the oil in.¹¹⁷

Every working day then from not long after the first whistle to not long before the last some 475 crates an hour of soaked, washed, and rinsed bottles were arriving by mechanical conveyor at their destination, the filling machines. These were four new Bishop-Babcock "Eureka" rotary pressure-fillers of the 34-spout type, rated at 120 pints a minute. One on the south side of the conveyor, three in a row along the north side, standing 7 feet high, 3-1/2 feet in diameter at the top, no casing around their parts below, they were obviously intricate and complicated machines. They had at rest an odd grace, like giant, ornate table lamps. The upper part of the machine, the cylindrical, foot-deep, cast-bronze beer chamber, bore decoration to make it look beautifully beerish, a design in relief of hop blossoms all around the outside,

¹¹⁶. "S. Volz, Bottle Rinsing Machine," Patent No. 951,466, March 8, 1910; Mendelsohn and Stern, *Brewers and Bottlers*, 423-424, 429, 433-434, 436, 455-463; *The Western Brewer*, January 1908, advertising pp. 104, 109, 128b.

¹¹⁷. Zorrilla Rivera, April 28, 1975; Mendelsohn and Stern, *Brewers and Bottlers*, 458; Dreesbach, *Bottlers' Handy Book*, 29-30, 35, 37-38, 194-200, 348; Daum, "Bottling Notes," 6,9. Cf. Diehl, "Bottle Shop," 273; Loew, "Bottle Soaking and Cleaning," 253.

and "all other castings are of the best bronze, heavily tin flooded and triple silver plated."¹¹⁸ Around the bottom of the chamber were 34 key levers. From the bottom of the chamber, in a ring near its perimeter, 34 bronze filling valves extended down 12 inches. Likewise in a smaller ring just inside the filling valves 34 air-pressure piston cylinders extended down 12 inches and connected with 34 3-foot-long stems, each of which about a foot down carried a bottle support, a "stirrup," and below went through a guide in a 34-armed spider fixed around a central vertical shaft. At the bottom, just off the base, a hose from the header on the line from the racking room, like a monster electrical cord from a huge outlet, connected to the machine's supply pipe.¹¹⁹

It took experience, concentration, and careful manipulation to prepare the Eureka's to start. At 6 a.m. three operators would go to work on three machines, leaving the fourth for its weekly cleaning. At each machine its operator first opened the inlet on the supply pipe, then opened the machine's air-pressure system, cutting the pressure down to 25 psi in the pipe supplying the piston cylinders, then opened a counter pressure of 5 psi in the pipe to the beer chamber, then opened the exhaust port on the chamber's float-valve system, and then opened the proper valve at the header, letting the racking room's pressure force beer up into the pipe inside the central shaft and upward to fill the chamber above until its exhaust port closed.

Once he had the chamber full the operator simply switched on the machine's motor, shifted the clutch into drive, and became an attendant. The fillers operated automatically and continuously, and since they ran not at their rated speed, but for only 55-60 bottles a minute, the operators could study them in detail.¹²⁰ The operators' helpers, four boys to a machine, gathered to do the work so that there were bottles for the automatic operation to fill. At about 6:20 the operator at the machine at the far end of the conveyor switched on the conveyor's motor. The day's first crates of clean bottles would come riding along. At each filler a boy waited for a crate. As soon as one came by he took it off, carried it around to the filler's feeding end, put it on a table, and went back for another. So in turn did the others, and so they all continued,

¹¹⁸. "The Eureka Is Built for Years of Service," *The Western Brewer*, November 1910, between advertising pp. 18-19.

¹¹⁹. "Departamento de botellería en 1908," *Album de la Cervecería*; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6; "The 34-Spout Eureka Counter Pressure Revolving Beer Bottling Machine," *The Western Brewer*, January 1908, 35; Mendelsohn and Stern, *Brewers and Bottlers*, 66, 71-72; Daum, "Bottling Notes," 15-16; "A Model Bottling Shop," 106-107.

¹²⁰. Interview with Eduardo Torreblanca, July 28, 1977. Daum, "Bottling Notes," 16, 22; Schneider, "Beer Bottling," 75; "The Eureka Is Built for Years of Service," *The Western Brewer*, September 1910, between advertising pp. 18-19.

each delivering two or three crates a minute to the table he served. Meanwhile at each table two boys swiftly took bottles upside down from the crates, one at a time, and taking turns handed them right side up to a third boy who put them two after two, 55-60 a minute, on the machine's feeder. The skill in their manual movements "resembles the nervous revolution of an electric fan."¹²¹ At all three tables another couple of boys continually collected the empty crates and carried them back to the soakers. The operator only observed the air-pressure gauges, the bottles feeding, and the graceful machine moving--the motor's belt drive turning the drive shaft below that turned the worm that turned the central shaft slowly around, so that the spider and the chamber above slowly revolved, the bottles moving in perfect time from the feeder onto the passing stirrups, the key levers rotating up, the pistons releasing, the air hissing, the bottles gradually rising one after another in the stirrups each to receive its filling valve, filling with cold beer, coming off the stirrups onto the discharger on the other side, the pistons pushing the empty stirrups gradually down again, all like some giant, silent music box, or a small, strange, bottle merry-go-round. As long as the boys kept handing bottles to the boy who fed the feeder he kept the machine in drive and filling, hour after hour. By mid-afternoon operator and boys certainly felt that the machine would be "always in order/ bottling away--/ lasting forever/ and a day."¹²²

But it took experience, concentration, and careful manipulation again to shut the Eureka's down in the evening. Ordinarily between 5:20 and 5:25 the beer hoses to the fillers all went slack. This was a warning signal. In a few minutes they refilled, but a minute or so later they went slack again. This was the signal to stop. The operators at once disconnected the hoses from the supply pipes and laid them over toward the sewer, where the water from the racking room to flush them would shortly run. As the chambers emptied in three or four minutes the day's last bottles of beer passed from the machines on time at 5:30. The fellow at the far machine switched off the conveyor's motor. At each machine then the operator shifted the clutch into idle, turned off the air, connected a water hose to the supply pipe, climbed up and disconnected the air line from the gauge on top of the chamber, swung the line aside, all around the chamber unscrewed the T-nuts that fixed its lid on, lowered the chain block from overhead down to put four hooks in eyes on the lid, and gently hoisted the lid off the chamber, so that he could see its porcelain insides and the bronze valve

¹²¹. Eslava, "Orizaba." Zorrilla Rivera, April 28, 1975.

¹²². "The Eureka Is Built for Years of Service," *The Western Brewer*, December 1910, between advertising pp. 18-19. Daum, "Bottling Notes," 15-17; Mendelsohn and Stern, *Brewers and Bottlers*, 71.

caps and cages. Back down on the floor he had his helpers put more bottles on the feeder, turned warm water into the supply pipe, and reengaged the clutch, to flush the pipe and the valves, running the water into the bottles. Up by the slowly revolving chamber he climbed again, with a hose, and hosed the porcelain off with warm water. When it looked clean, he got back down, turned off the water, disconnected the water hose from the supply pipe, reconnected the beer hose, and when the last water ran out, disengaged the clutch and switched off the motor. Then he climbed up yet again, delicately let the lid down exactly as it had been on the chamber, screwed all the T-nuts down tight, and reconnected the air line. Finally he oiled the piston valve seats, and made sure that the boys emptied the bottles of water into the sewer, recrated them and any others left at the machine, and took them back to the washers. Often they worked past 6:00 to leave things right for tomorrow.

Meanwhile all day a mechanic would have been at the fourth filler. Because these machines were so intricate cleaning them was a two-day job. The mechanic would spend a morning, maybe longer, taking out the 34 filling valves and taking them apart. That afternoon and some of the next morning he would spend scrubbing out the valves, most carefully the five "Corliss type" passages that controlled counter pressure, beer and air return, and piston inlet and outlet pressure. He also looked for wear on piston packing, and where he found any adjusted the follower to relieve it. And he scrubbed out the supply pipe. Then he spent several hours reassembling the valves and resetting them in the machine for operation the next morning. And that morning he would start on another filler, and so on day after day, to clean every machine over a week.¹²³

Right beside each Eureka, on the west side, stood a new 7-1/2-ft.-high Crown Cork and Seal "automatic power crown machine." Driven by its own motor, this was "practically a combination of eight independent Crowning Machines," on top like an upside-down bell a big hopper for the crowns, below around the circumference of a circular cage 16 inches in diameter eight vertical cylinders and crowning heads and aligned below them in a circle eight bottle rests, both circles connected and geared to revolve together "continuously and in consecutive order" around a central column; three feet high around the column was a table; below that, housing.¹²⁴ It was a machine simple to prepare,

¹²³. Zorrilla Rivera, April 28, 1975; Daum, "Bottling Notes," 15, 17, 22; "The Eureka Is Built for Years of Service," November 1910, between advertising pp. 18-19; Mendelsohn and Stern, *Brewers and Bottlers*, 71; Schneider, "Beer Bottling," 75-76.

¹²⁴. "Departamento de botellería en 1908," *Album de la Cervecería*; Daum, "Bottling Notes," 26-27; Mendelsohn and

operate, and shut down. At 6 a.m. beside a filler that would run that day the crowner's operator opened a 200-gross box of crowns on a stool by the crowner, climbed up to the hopper, and filled it with crowns. As soon as the filler began filling bottles he switched on the crowner's motor and shifted the machine into drive. As the filler discharged 55-60 bottles a minute the cold, filled bottle moved automatically, smoothly, and in line onto a track to the crowner. Between the filler and the crowner the operator watched the bottles moving, every three or four minutes picked out a leaker or breakage, and dropped it in a trash can below. At 55-60 bottles a minute one bottle after another turned a corner into a feeder on the crowner's table and onto a bottle rest, gradually ascended around on the rest "until the head of the bottle enters Throat of Machine, where it is crowned" and under spring pressure of 575 psi received the crown's seal around its mouth, gradually descended around on the rest, turned another corner in a track on the table, passed onto the discharger, and moved away along another track.¹²⁵ All that the operator ordinarily did all day was to see that the feed remained even, every 10-15 minutes refill the hopper with crowns, every 40-45 minutes carry away the empty box and bring back a full one, and watch the machine's motion and the bottles' movement.

The only trouble he ordinarily faced came from a slack spring, so that the crowns there did not seal on the bottles, or a squeezed spring or some slight slip in the alignment of the heads and the rests, which made bottles break. Then he would have to idle the machine, call for the Eureka operator to stop filling, and go tell the foreman, who would, however, quickly make the readjustment and get him back to work.

Shortly after 5:30 p.m. the day's last bottle there received its crown and seal and moved away, and the operator proceeded to shut the machine down for the night. He simply put it in idle, switched off its motor, washed and wiped clean the throats, rests, and tracks, opened the housing, oiled the gears, clutch, bearings, and drive shaft, reclosed the housing, oiled the hopper and the drive pulley, took the trash can through the door behind the washing machines to dump it in the trash wagon out on the street along the east side of the building, and put the can back where it belonged. If he hurried, he could help the filling-machine operator clean the filler.¹²⁶

Stern, *Brewers and Bottlers*, 83-86, 92-95; "A Model Bottling Shop," 107.

¹²⁵. Mendelsohn and Stern, *Brewers and Bottlers*, 85-86. Arzamendi, "La influencia del medio," 6; Daum, "Bottling Notes," 17, 23-24, 26-27; "A Model Bottling Shop," 106-107.

¹²⁶. Torreblanca, July 28, 1977; Daum, "Bottling Notes," 26-27; Mendelsohn and Stern, *Brewers and Bottlers*, 83-84, 86, 88-90, 92-95; Schneider, "Beer Bottling," 76.

But all day as at the other machines other work was constantly happening. From about 6:20 a.m. onward at each crowner in operation three boys crowded along the discharger track continually took the crowned bottles from it, two in each hand, and put them upright in rectangular steel baskets six bottles by three. Every minute they filled three baskets and part of a fourth, and as they finished them, 20 lbs. each, they lifted them onto the mechanical conveyor—or another boy carried them one by one directly to their destination. By the time the machines stopped in the evening the boys who had worked at them had done altogether more than 6,250 baskets. If boys there then did not wander away, as if on other duty, they too could help clean the filling machines.¹²⁷

The crowning machine not in operation that day might stand in neglect the whole day. But after the mechanic at work on the Eureka beside it put the filler back together, usually late in the afternoon, he examined the crowner. He would open the housing, study in detail how the gears and the clutch were wearing, reclose the housing, remove the hopper, take off the cylinder heads, lift out the pistons and see if they were showing undue wear yet, see that the vaseline in the cylinders was enough and still stiff and clean, put the cylinders back together, see if the throats and dogs were worn yet, test the pressure in the springs, if any were over or under 575 psi reset them correctly, and replace the hopper.¹²⁸ It was often long after the last whistle when he left the machine ready for operation tomorrow.

From the conveyor other boys continually took the baskets of cold, sweating bottles and carried them forward some 15 feet to their destination, the loading end of two big, new Barry-Wehmiller "Ruff Auto-Positive" pasteurizing machines. There they stacked them on the floor, at both machines four, five, or six a minute, at nearby tables collected empty baskets, and carried them back to the crowners for more bottles. So among them every day from about 6:20 to maybe 5:35 they cleared all the day's filled and crowned bottles to the pasteurizers.

These machines, "continuous chain" pasteurizers, were very different from the brewery's old steaming tanks. Sitting beside each other in the second and third aisles over from the west wall, big, black steel boxes of water 10 ft. wide, 15 ft. long, 7-1/2 ft. high, each driven by its own motor and rated at 200 barrels a day, they displayed along both sides the steam, water, and air pipes and valves and thermometers for three internal compartments, 30-inch sprocket

¹²⁷. Zorrilla Rivera, April 28, 1975; Camaleño, July 26, 1977; "Round Cornered Tray," *The Western Brewer*, January 1908, advertising p. 123; *The Epicure*, "How to See Mexico," 39; Mendelsohn and Stern, *Brewers and Bottlers*, 480; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6.

¹²⁸. Daum, "Bottling Notes," 27; Mendelsohn and Stern, *Brewers and Bottlers*, 86, 88, 90-95.

wheels front and back and between their endless chains visible along the top from front to back and at either end horizontal bars from which hung perforated steel trays (75 in all), each to hold five baskets. But as at the old tanks and the new soakers there were no operators, only loaders and unloaders, at each machine a couple of boys at either end.¹²⁹

It was also the foreman who daily prepared the pasteurizers and put them into operation. As soon as he had turned on the soakers' heat he would turn on their air, water, and steam. As soon as he had started the soakers he would return, feel all the compartments on both sides, read the thermometers, and see that they showed the temperatures inside rising as expected. He would also get the loaders in place, and as ordered they would remove any baskets, boxes, and trash cans that would later be in the way. And at about 6:20, when the first bottles arrived from the crowners, he would return again, feel the compartments again, see that the thermometers on the first compartment both read about 125°, those on the second 140°, and those on the third about 105°. As ordered at each machine the loaders would fill a couple of trays, making a starter of 200 lbs. The foreman would switch on the motors. The drive pulleys would begin revolving. The great gears would slowly turn. The chains would pull down at the loading end, up at the unloading end. And the trays at the loading end would very slowly descend, about one a minute, one after another disappearing down into the first compartment, as the empty trays at the unloading end appeared from below out of the third compartment, very slowly ascended, passed over the top, and down to the loading end again. At that speed the machines would take a little more than an hour for a full cycle. The foreman did not wait. When he saw the motion going as always and the loaders loading the trays descending before them he would leave to look for trouble elsewhere. Before the first cycle ended, at about 7:20, he would have the unloaders in place, to take out the warm baskets of pasteurized beer and stack them to the side and farther forward, each stack four baskets high. He himself would ordinarily return only now and then to feel the compartments, read the thermometers, and occasionally adjust a valve.

Constantly lifting the baskets and setting them on the trays, the loaders handled 280-285 baskets an hour.

Constantly taking the baskets off the trays and stacking them, the unloaders handled the same. Usually every few

¹²⁹. Zorrilla Rivera, April 28, 1975; Camaleño, July 26, 1977; "Mexican Brewery," 24-26; Barry-Wehmiller Order Book, March 7, 1905, 59/90 (for a copy of which I thank Larry Terrill); *The Western Brewer*, January 1908, 16; *Modern Mexico*, April 28, 1908, 11; "A.A. Busch, R. Gull, and T.J. Barry, Pasteurizer," Patent No. 713,952, November 18, 1902; Daum, "Bottling Notes," 28-35; Mendelsohn and Stern, *Brewers and Bottlers*, 242-243; "A Model Bottling Shop," 107-108; Dreesbach, *Bottlers' Handy Book*, 104-106, 118-119, 121; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6.

minutes they would find an exploded bottle's shards, and dump them in the can between the machines. So the boys at the pasteurizers worked hour after hour. From time to time, because of the heat, as at the soakers, the loaders and the unloaders would change ends. Other boys continually appeared at the unloading end to carry away baskets from the stacks there to the back end of the nearby tables.

At about 5:35 p.m. the loaders would load the day's last baskets of bottles. If they followed the standing order, they would then help clear the baskets stacked at the unloading end before they left at 6:00. But the unloaders remained after the whistle to finish the last cycle; there being no longer anyone to carry baskets away, they made more and more stacks to the side and forward from the machines. Finally at about 6:40 they would take out the day's last baskets and stack them on or by one of the more than 150 stacks usually by then accumulated. The foreman would return then for the last time. He would switch off the motors, turn off the steam, water, and air, and let the unloaders leave. After he oiled all the gears and bearings and motors, and gave the machines a last turn, he would leave too, maybe as late as 7:30.¹³⁰

In 1908 the tables where the boys from the crowners retrieved empty baskets and the boys who took the full ones from the pasteurizers delivered them occupied a large section of the east half of the floor. There were then five tables, set side by side from north to south, 3 ft. wide, 45 ft. long, each with an 18-inch belt conveyor down the middle, and 6-ft. aisles between them.¹³¹ At the north end of each table, with empty baskets stacked on the floor and full ones on a bench alongside, stood a new Edward Ermold bottle-labeling machine. On belt drive from its own it was rated to label 48 bottles a minute. It had many moving parts, and inside a frame of four upright standards about 3 ft. square at bottom and nearly 6 ft. tall they were all visible and accessible, the drive shaft, the gear wheels, the cam shaft, and the scores of details in the horizontally reciprocating picker carriage and pickers, the paste-feeding mechanism, the label-feeding device, the vertically reciprocating plunger, and the oscillating wipers. Each machine took an operator, and a boy

¹³⁰. Zorrilla Rivera, April 25, 1975; Camaleño, July 26, 1977; "W.J. Ruff, Pasteurizer," Patent No. 801,693, October 10, 1905; The Epicure, "How to See Mexico," 39; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6; Arzamendi, "La influencia del medio," 6. Daum, "Bottling Notes," 28-32, 35, 37-38, 40-41; Mendelsohn and Stern, *Brewers and Bottlers*, 40-41; Cf. Dreesbach, *Bottlers Handy Book*, 126, 134-140; Schneider, "Beer Bottling," 75; Diehl, "Bottle Shop," 274; Frank S. McElroy and George R. McCormick, "Injuries and Accident Causes in the Brewing Industry, 1944," U.S. Department of Labor Bulletin No. 884 (Washington, 1946), 2-3.

¹³¹. "Mexican Brewery," 26; The Epicure, "How to See Mexico," 39; "Departamento de empaque, 1922," *Album de la Cervecería*; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6.

or two to help him; these were the boys who continually brought the full baskets.¹³²

The only variety in the house happened at the Ermold machines, different labels for different beers, Sol, Luna, XX. But the work there did not change. At 6 a.m. every working morning the operators filed back to the machines, sent their helpers to bring baskets from the stacks left overnight at the pasteurizers, and commenced preparations for the day. According to the foreman's recipe they each mixed a supply of adhesive, 20 lbs. of yellow dextrin stirred well in two gallons of hot water for three gallons of paste, and filled the paste-boxes in the paste-feeding mechanisms, each about half a gallon. They filled the shells in the label-feeding devices for the first run of labels, about 4,000. And they wheeled the machines through their motions, seeing that the pickers, the label-feeders' fingers, and the plungers all had the right strokes and that the wipers' pressure was firm but not tight. Then at about 6:30 each at his station switched on that table's conveyor, switched on the labeling machine's motor, stepped on the treadle that shifted the machine into gear, and started labeling. From a full basket on the bench to his left the operator took one bottle after another by the neck with his left hand, put the bottle in the machine's bottle-rest, back against the gage-plate, and watched the automatic motion, the pickers rolling back and up, then forward and up, their faces receiving paste from the paste-roller, the label-feeder's fingers plucking the bottom-most label from the shell, the pickers still rising, taking the label from the fingers onto their paste-coated faces, rolling down and forward, placing the label over the bottle, the plunger descending, pressing the label on the bottle, ascending, the wipers descending, pressing the ends of the label around the bottle, releasing it, ascending, the pickers rolling back and up for more paste. By then holding the next bottle ready in his left hand, he took the labeled bottle out with his right hand, and stood it on the conveyor alongside. This he did 35-40 times a minute, until the machine ran out of labels, or jammed, or wanted a different label. It was a quick operation to shift the machine out of gear and refill the label-feeder and the paste-box. It was a longer stop to extract a jammed or twisted label without disturbing the machine's adjustments. It was a considerable delay to make the adjustments for a different beer, to stop, determine which beer it was (if the foreman had not announced it), take out the rest of the last beer's labels, store them, reset the pickers and the label-feeder, refill the feeder with the proper labels, and top up the paste-box. But from

¹³². Zorrilla Rivera, April 28, 1975; Camaleño, July 26, 1977; "Cervecería Moctezuma," 392; "E. Ermold, Bottle Labeling Machine," Patent No. 632,519, September 5, 1899; "Edward Ermold Bottle Labeling Machine," Patent No. 893,317, July 14, 1908; "Edward Ermold," *The Western Brewer*, January 1908, advertising p. 101; Mendelsohn and Stern, *Brewers and Bottlers*, 116-118, 126; Daum, "Bottling Notes," 44-45; "Iron City Brewing Co.," *ibid.*, February 1908, 99.

interruption to interruption the work continued so that between operator and machine ordinarily 22,000-23,000 bottles a day went labeled onto the conveyor. At about 5:30 the operator did the last of them, switched off the conveyor, shifted the labeling-machine out of gear again, switched off its motor, and began closing the day in cleaning and maintenance. While his helper kept bringing baskets to stack for tomorrow, he washed the machine's paste-box, its rollers, and their shafts clean, washed the pickers, the wipers and the bottle-rest clean, and oiled all bearings and gears. At the last whistle the helper put down the basket where he was, and left. The lubrication of the machine done, the operator left too.¹³³

From 6 a.m. to 6 p.m. every working day along the tables 25 other boys and men worked by hand packing the labeled bottles. As soon as they arrived in the morning, five at each table, they started on the bottles left on the tables from yesterday. Along either side of a table a boy moved slowly north, continually taking fundas, straw bottle-covers, from a big burlap sack in the aisle and putting them down full length over the bottles, bottle by bottle. Behind him came a bigger boy or a man who put the covered bottles lying down in a box, 60 bottles to a box, on a bench beside the table; he could fill a box in under two minutes. And behind him as he left a full box and moved along came a man who worked both sides of the aisle, who swiftly nailed a top on the box, lifted it, over 60 lbs., carried it away, came back with an empty box, and left it on the empty bench. In half an hour the tables were usually all clear. Then, when the labeling-machine operators started the belts and the machines, a few more bottles came down the belts every minute than the boys and men could handle, and not to let the bottles pass, they worked ever farther south. In an hour they would all be 6 to 8 feet toward the south end. It was only the interruptions at the labelers that let them catch up, work back toward the north. Even so when the machines and the belts stopped for the day at 5:30 the table were usually full. The work that continued until the last whistle, making 1,800-2,000 boxes for the day, always left bottles for tomorrow.¹³⁴

The place where the men from the table carried the boxes of bottles was the bottle house's southeast corner. Before a separate "filled bottle storage" room, now like "empty bottle storage" only some 3,000 sq. ft. of floor, it served

¹³³. Zorrilla Rivera, April 28, 1975; Patent No. 632,519, Descriptive p. 4; Patent 893,317, Drawing Sheets 1-4, Descriptive pp. 1-5; Daum, "Bottling Notes," 44-45; Mendelsohn and Stern, *Brewers and Bottlers*, 118; Dreesbach, *Bottlers' Handy Book*, 149-152; "A Model Bottling Shop," 107.

¹³⁴. Zorrilla Rivera, April 28, 1975; Camaleño, July 26, 1977; Sierra Rivera, September 5, 1977; "Enrique Meza Jiménez" and "Luis Marrón Madrigal," Escobar papers; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6; "Departamento de empaque, 1922," *Album de la Cervecería*; Arzamendi, "La influencia del medio," 6-7.

Moctezuma, S.A., Orizaba, Mex."¹³⁶

But most of the work there was pitching, lining any new packages inside with a coat of resin, and relining the old packages that wanted a new coat. This happened ordinarily in the afternoons. While the apprentice moved maybe 40 little barrels into the shed's pitching end, its walls open for the wind to carry away the smoke, the cooper would start a charcoal fire in the pitching heater's furnace, dump enough brown, resinous pitch from the pitch barrel into the pitch kettle to make maybe 15 gallons, and start a wood fire under the kettle. As soon as the heater's spout was hot enough for "burning out," melting the old pitch inside the packages, he would take the packages, two or three a minute depending if they were kegs of ponies, and hang them one after another on the spout, careful that the spout did not touch the bung bushing, and one after another the apprentice would lift the packages off and lay them bunghole down on skids for the old pitch and dirt inside to drain out. By the time they burned them all out and killed the heater's fire, the pitch in the kettle would have melted. When the cooper could spit in it and it made a sharp crackling noise, it was ready. He himself would then leave for more artful duties, inspecting a leaky cask in the stockhouse, jointing edges and tapering ends of tub, vat, and cask staves in the shop, tending to the shop and its tools. The apprentice alone would roll the drained packages around bunghole up, cork them top and bottom, and pitch one after another: put a funnel in the bunghole, ladle pitch into it (a half gallon if a keg, a quarter gallon if a pony), remove the funnel, bung the hole, roll and tumble the package on the ground to coat its insides, put it on a rack over a trough, pull the corks and bung, and set it bunghole down again to drain the excess pitch into the trough and an old barrel. On finishing the last one he would kill the wood fire and pour the drainage in the old barrel back into the kettle for use tomorrow. As soon as he could feel that the new lining in the packages had cooled and hardened, he would stand them all in a row, bungholes all facing out the same direction, and with a hot iron go along the row burning out all the top vents and bungholes. Then he would lay the packages bunghole up again on the skids, burn out the other vents, recork them all, take a hose, spray water over the packages, and fill them all with water. Finally he would empty the packages he had repaired, burned out, pitched, and filled yesterday, and carry

¹³⁶. Sánchez, August 10, 1977; Fleischmann, September 7, 1977; "Mexican Brewery," 23, 26; Martínez Garza, "Datos," 192; "Cervecería Moctezuma," 391-392. Wahl and Henius, *American Handy-Book*, 486, 694-697; Siebel, "Handling and Pitching," 1047-1049; Mendelsohn and Stern, *Brewers and Bottlers*, 314, 399; Hankerson, *Cooperage*, 14-15, 25-26, 137-141, 168-173; Kilby, *The Cooper*, 17-41, 53-57, 78-84. Cf. "Brewing in Milwaukee," 111-113; Ehret, *Twenty-Five Years*, 96-102; U.S. Commissioner of Labor, *XIII Annual Report of the Commissioner of Labor*, 2 vols. (Washington, 1899), II, 936, 938, 940; Booth, *Life and Labour*, I, 251-254.

them forward to go with the good returns tomorrow.¹³⁷

In a basement below the north end of the bottlehouse the carpentry shop occupied a room from east to west about 110 feet long, 30 feet wide, 11 feet high. The northeast corner allowed entrance and exit by stairs and a hand-powered freight elevator. Besides carpenters' tools, stores, and supplies the room had at least a dozen electrically powered wood-working machines--saws, a planer, a tenoner, a brander, and so on. And there every working morning at 6:00 some 12-15 men and boys came for assignments elsewhere around the brewery or in the shop. From then until the last whistle the room was a dusty, deafening place that often smelled of scorched wood. Mainly the work was making the 60-bottle boxes in which full bottles left and empty bottles returned to the brewery; the basement was the cajonería, the box factory.¹³⁸

In 1908 the carpentry-shop foreman usually had four men and four boys making on average 375 boxes a day, for newly imported bottles and to replace worn-out boxes. The materials were only boards, 5/8-inch clean pine for tops, bottoms, sides, and cleats, 7/8-inch hardwood for ends, and 5-penny wire box nails. And the work was simple. It took the millman about half a day to collect, plane, cut to size, and brand the boards for a day's production: 700-800 pieces 6-5/8 in. x 31-3/4 in. for tops, the same for bottoms, 1,400-1,600 pieces 9 in. x 33 in. for sides (also branded "Cervecería Moctezuma, S.A., Orizaba, Mex."), 1,400-1,600 pieces 2 in. x 19-1/4 in. for cleats, and 1,400-1,600 pieces 9 in. x 12 in. for ends. It took three nailers all day to fit and fix such pieces together into 350-400 33 x 19-1/4 x 13-1/4 in. boxes and so many separate 31-3/4 x 13/1/4 in. tops. It took a boy to keep the nailers supplied with pieces and nails, another boy continually to carry new boxes and tops to the elevator and pull them up to the bottlehouse floor, and two more above to unload the elevator and stack boxes and tops up along the bottlehouse's southeast wall as the brewery's necessary stock of shipping containers.¹³⁹

¹³⁷. Siebel, "Handling and Pitching," 1048-1049; Wahl and Henius, *American Handy-Book*, 485-487, 497, 694-697; Mendelsohn and Stern, *Brewers and Bottlers*, 127, 212, 276, 306-309, 313-317, 398-399, 539-540; Delbrück, *Lexikon*, 711-716; Goslich and Fehrmann, *Maschinenkunde*, II, 219-222; Hankerson, *Cooperage*, 50-54.

¹³⁸. Camaleño, July 26, 1977; Sánchez, August 10, 1977; "Mexican Brewery," 23-26; Martínez Garza, "Datos," 192; "Cervecería Moctezuma," 391; Saviñón, March 31, 1922, AGN-DT, 17/1/6/6; "Departamento de cajonería, enero de 1922," *Album de la Cervecería*, Cf. "Brewing in Milwaukee," 112; Booth, *Life and Labour*, I, 202-205.

¹³⁹. "Lavadoras de botellas, vista del subsuelo en 1922," *Album de la Cervecería*; Mendelsohn and Stern, *Brewers and Bottlers*, 162. U.S. Department of Commerce and Labor, Bureau of Manufactures, *Miscellaneous Series No. 5, Packing for Export* (Washington, 1911), 53-54, 66. Cf. U.S. Commissioner of Labor, *XIII Annual Report*, II, 586-595.

Along the north side of the machine house Moctezuma's machine shop was its only base for reproducing its mechanical means of production. Simple and small by comparison with the Mexican Railway's machine shop just south across the tracks, it was a nevertheless noisy, smelly, congested place. Besides tools, fixtures, a forge, benches, stores, supplies, and stock, the room contained the old 200-hp motor, a line shaft, and on belt drive from the shaft several machines, most importantly a 16-in. x 6 ft. engine lathe, a planer, and a tapping machine, "the best thing in the shop."¹⁴⁰ There ordinarily every working morning at 6:00 the master mechanic gave the shop foreman his first orders for the day, and some eight or nine men and boys came for their assignments, four or five skilled metal workers, about as many helpers. Daily the foreman would send a worker to be floor mechanic in the bottle house, and with him a boy for a helper. Weekly he would send a couple of workers and a helper to go with the master and inspect and make tight the stockhouse's coils. Occasionally he would send another worker as a repairman wherever the master wanted him. But on most days most of the men and boys got assignments in the shop. The screams of metal cutting metal would soon sound there, the air would be an oily fog, the floor gritty with chips.¹⁴¹

As in the railroad machine shop the work was typically a random succession of particular jobs and repeat production. It happened more directly than in the railroad shop. Since there was no foundry, the master and the foreman knew better the castings available and the sort of work they could order. And since the place was small, although congested, the foreman, the men, and the boys could more easily find material in the bins or on the racks or around the floor. But the orders were inevitably haphazard. One job would be unusual, unexpected, and urgent, like turning and boring a new bushing for a condenser pump's pulley. Another job would be routine and urgent, like turning up a worn ammonia rod. Most would not be urgent, could be postponed, but wanted to be done soon, like planing a gib-head key for one of the crowners, or repairing or replacing any of the other "little bits of steel and brass" in the bottle house's

¹⁴⁰. Martínez Garza, "Datos," 192; "Máquina de hacer clavos, 1922," "Taller mecánico, 1922," and "Taller mecánico, máquina fresadora universal, 1922," *Album de la Cervecería*. Cf. "Brewing in Milwaukee," 106, 112; Ehret, *Twenty-Five Years*, 85, Booth, *Life and Labour*, 307-308; H. Rolfe, "The Apprentice's Progress," *Home Study for Machinists, Steam Engineers, Etc.*, March 1898, 151; Fred H. Colvin and Frank A. Stanley, *Running a Machine Shop* (New York, 1941), 24-26, 32-40, 87-98, 107-109, 113-114, 130, 158, 160, 232.

¹⁴¹. Camaleño, July 26, 1977; Torreblanca, July 28, 1977; Sierra Rivera, September 5, 1977; Fleischmann, September 7, 1977; Saviñón, March 13, 1922, AGN-DT, 17/1/6/6. Cf. Fred J. Miller, "The Machinist," *Scribner's Magazine*, September 1894, 314-334; U.S. Commissioner of Labor, *XIII Annual Report*, II, 668-671, 1214-1221, 1406-1407, 1474-1475, 1530-1533.

machinery.¹⁴² Only between jobs would repetition work occur, like tapping nuts or cutting bolts.

Consequently, like the railroad machine shop, the brewery machine shop did not feature much division of labor. Of all the brewery's foremen the one there had the most skills. In a single person he was blacksmith, machinist, boilermaker, pipefitter, plumber, millwright, mechanic, sheet-metal worker, and teacher of machining and mechanics. And the skilled workers under him were all at least machinists, some skilled otherwise as well. An unusual, unexpected, urgent, and difficult job, the kind that wanted new fixtures and tools and then took two or three hours to set up, like truing a worn crankpin, the foreman would ordinarily do himself his own way. But he could have any of the other fellows quit something less urgent and do it his way. When a routine and urgent job arrived and there was no one free for it, he could have any of the machinists stop a postponable job or repeat production and do it. And the abandoned job or production he would assign the next fellow free to finish. So it would happen that a machinist who in a couple hours of careful preparation, cutting, and gauging had turned a crown-faced pulley to a tolerance of .001 inch would on his next assignment have nothing more to do than drill bolt holes in an iron beam, or chip centers off new fittings.¹⁴³

The annual general overhaul was the machinists' most planned and wearisome work. It took men and boys away from all other work except major emergencies, held them to schedules, and required much detailed orderliness. Most of it happened outside the shop. As the master mechanic ordered some machinists and helpers not only regenerated the refrigerating system's ammonia, inspected and repaired boilers and the old 100-ton compressor, and blew out and repaired expansion coils and the condenser's old battery, but then also tested all the pressure gauges, cleaned their connections, examined every water, beer, and air pump in the brewery, and made necessary repairs on them. Under the electrician's supervision another machinist and helper inspected the new synchronous motor, felt that its frame and brackets did not unduly vibrate, examined its bearings, saw that its air gap was even all around, flushed its oil reservoir,

¹⁴². "Brewing in Milwaukee," 106. Colin and Stanley, *Running a Machine Shop*, 25, 34-38, 232; John T. Usher, *The Modern Machinist*, 3rd ed. (New York, 1900), 211, 255; Decateur, "Knocks and Pounds," 21; Miller, "Hints," September 1917, 26.

¹⁴³. Sierra Rivera, September 5, 1977; Fleischmann, September 7, 1977. Cf. Miller, "The Machinist," 322; Colvin and Stanley, *Running a Machine Shop*, 25, 36, 115-116, 232-233, 288-289, 291, 334-335; Frederick W. Taylor, "On the Art of Cutting Metals," *Transactions of the American Society of Mechanical Engineers*, XXVIII (1906), 32, 53, 55, 115, 283, 288, 290-291; "The Foreman's Place in Scientific Management," in *Scientific Management*, ed. Clarence B. Thompson (Cambridge, 1914), 395-397; H. Rolfe, "The Apprentice's Progress," *Home Study for Machinists, Steam Engineers, Etc.*, January 1898, 105, February 1898, 128-132, and April 1898, 161-165. Usher, *Modern Machinist*, 203-208, 232-233.

renewed its oil supply, and cleaned its windings and ventilation ducts, then made any repairs the electrician ordered on motors in the brewhouse, the stockhouse, and the bottle house. Meanwhile in the shop the foreman, another machinist, and a helper took inventory, inspected the motor, line shaft, pulleys, belts, and machines for alignment and tension, repaired or replaced faulty pulleys and belts, tested and corrected gauges, tightened loose bolts or screws in the machines, made new screws to replace any too worn to keep tight, dressed and trued grinding wheels, restored oilstones, put loose materials, tools, fixtures, jigs, and oil cans in their proper places, drained the tank of old lubricating oil and filtered it for use again, spun the various collections of oily chips to reclaim cutting oil, cleaned machinery and the floor, and sent the waste to the incinerator.¹⁴⁴

After three weeks or more of these distractions the return to customary shop practice was confusing and difficult. Foreman, machinists, and helpers were back at the work they knew best. But the many jobs pending put extraordinary pressure on them all. The foreman did not reestablish his command of orders and assignments for at least a week. The men did not regain their methods and rhythms in setting up or machining for yet another week. And the boys could not find anything as fast as before until the old litter collected again at the machines and benches and across the shop floor.¹⁴⁵

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¹⁴⁴. Sierra Rivera, September 5, 1977. Frederick W. Taylor, "Notes on Belting," *Transactions of the American Society of Mechanical Engineers*, XV (1893-94), 220-223, 242-244; Rolfe, "The Apprentice's Progress," February 1898, 130-131, and "The Apprentice's Progress," *Home Study for Machinists, Steam Engineers, Etc.*, October 1898, 49-50; Usher, *Modern Machinist*, 27-32, 60-65; Skinkle, "Overhauling," 171-174.

¹⁴⁵. Sierra Rivera, September 5, 1977. Henry P. Kendall, "Unsystematized, Systematized, and Scientific Management," in *Scientific Management*, 107-108.