REPORT

of

Committee on Thesis

The undersigned, acting as a Committee of the Graduate School, have read the accompanying thesis submitted by William B. Fieldhouse for the degree of Master of Arts. They approve it as a thesis meeting the requirements of the Graduate School of the University of Minnesota, and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts

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History of the Flour Milling Industry of Minneapolis

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PREFACE

The establishment of towns and their development, in the course of a few decades, into large and important cities, furnishes a valid reason for the faith, pride, and frequent boastfulness of the western citizen. Minneapolis came into existence only sixty-two years ago, and during the last of that period it has acquired a reputation as the leading metropolis of the northwest. It is the largest primary wheat market in the world; and its flour mills are equally noted for their size and annual production. It is evident at a first glance that its growth is closely associated with the development of its flour manufactures. The origin and progress of that industry has, therefore, seemed a proper subject for historical study. In this thesis the writer has undertaken to give a detailed account of the mills that provided a basis for the later growth; he has treated the improvements that aided the development of manufacture; described the nature of prominent causes for discouragement; and endeavored to point out the relation existing between the industrial and municipal rate of progress.

The milling men of the city have cheerfully assisted the writer in his efforts to learn the facts. He desires to make special acknowledgment of his indebtedness to Mr. Frederick J. Clark, vice-president of The Miller Publishing Company; Mr. C. J. Blythin, former manager and secretary of the Barber

Milling Company; Mr. W. De La Barre, engineer-agent and treasurer of the Minneapolis Water Power Company; Mr. C. A. Lang, superintendent of mills of the Northwestern Consolidated Milling Company; and Mr. M. L. Ludwig, in charge of the Northwestern D Mill, of the Northwestern Consolidated Milling Company.

Chapter 1.

EARLY MILLS, 1821-71

Government Mills

On Sunday morning, March 30, 1879, the Minneapolis Fire department responded in full force to an alarm of fire. "A vast column of smoke was seen wreathing itself heavenward from the very center of the great flouring mills on the Falls."[1] The burning building was the City Mill, on Canal street between Sixth and Seventh avenues South. The walls were of wood and the hours spent by the firemen in an endeavor to save it proved futile; and thus disappeared the oldest structure then in the city of Minneapolis, erected by the United States government fifty-eight years before -- two years after troops came to the mouth of the Minnesota river to build a fort and establish the authority of the government in a wilderness of prairie and forest inhabited by the Indians.

The United States troops arrived in the summer of 1819, and, in the winter of 1820-21, began the construction of a saw-mill at St. Anthony Falls to manufacture lumber for the building of the fort at the mouth of the Minnesota. Built of logs obtained from the pineries of the Rum River, the saw-mill measured thirty by fifty feet; and, equipped with a muley saw, duly turned out the lumber required for the building of the fort and its

1. Minneapolis Tribune, March 31, 1879.

furniture.[1] In 1883, a grist-mill, sixteen or eighteen feet square, was raised beside the saw-mill. As far as possible Colonel Snelling proposed to be independent of outside means of support, and this year his soldiers placed under cultivation 210 acres of land, of which 100 acres were devoted to the raising of wheat. The government forwarded one pair of buhr mill stones, 337 pounds of plaster, and two dozen sickles, charging the garrison with the cost of this material, and, in turn, paying for the flour manufactured.[2]

As millers the soldiers could not boast of any skill. The wheat moulded, and the bread baked from the flour was black and bitter. Perhaps the number of grains not wheat, gathered and threshed out by careless hands, and the lack of an effective bolting apparatus, may have been contributory causes. At any rate, the soldiers refused to eat the bread and evinced their

1. Folwell, Minnesota, 55; Prescott, "Autobiography and Reminiscences," in Minnesota Historical Collections, 6: 479. For the dimensions of the saw-mill, see Mitchell and Stevens, Geographical and Statistical History of the County of Hennepin, 116; also the Tribune's Annual Exhibit of the Manufacturing and Commercial Industry of the Cities of Minneapolis and St. Anthony for 1870, p. 20. Mr. Edward A. Bromley, in his article, "The Old Government Mills at the Falls of St. Anthony," (M. H. C., 10: 636 -- pt. 2), gives the dimensions as fifty by seventy feet, basing his statement on the authority of George E. Huey, who operated the saw-mill from 1852 to 1855. The picture of the mill made in 1857, preserved by Mr. Bromley in the Minneapolis Album, does not support his belief in these figures. If the larger measurements are correct, the government mill would, in the matter of ground space, have been the second largest among the twelve mills operating at the falls in 1870, and it is probably that had such been the case, it would have been of greater commercial importance. The statements in the two sources that agree on the smaller dimensions were made while the mill was standing, and the writer has accepted them as correct.

2. See Bromley, "The Old Government Mills," in M. H. C., 10: 636 (pt.2); Keating, Expedition to the Sources of St. Peter's River, 1: 305; Northwestern Miller, January 9, 1880.

resentment by carrying a stock of the unpalatable fare to the parade ground and angrily throwing it down; and, as this was literally quarreling with their bread and butter, it is recorded that Colonel Snelling was provoked to remonstrate with them.[1] Ten years later, when Major Bliss was commandant at the Fort, flour was one of the articles supplied the garrison from St.Louis, and the impression prevailed that wheat could not be raised successfully in a climate so cold as that of Minnesota.[2] Such an opinion is not difficult to understand at the present day. The wheat planted by the soldiers was a soft winter variety and was quite liable to be winter-killed in a northern latitude. A generation later the pioneer farmers of Minnesota repeated the same experiments and arrived at the same conclusion.[3]

The grist-mill was then used to grind corn. The Minnesota Pioneer of February 2, 1850, states that during the season the mill had already ground four thousand bushels of corn and had an equal amount in prospect. In an advertisement appearin the St. Anthony Express of the date of May 31, 1851, the miller gives notice of his readiness to grind corn, rye, oats, peas,

1. Adams, "Reminiscences of Early Days at Red River Settlement and Ft. Snelling, 1820-26," in M. H. C., 6: 95.

2. Bliss, "Reminiscences of Ft. Snelling," in M. H. C. 6: 339.

3. "Nearly all the wheat crop of 1859 was spring-sown, and, following the example of other northwestern states, winter wheat has not been generally tried throughout the state. In many localities where it has been tried, the result has not been deemed favorable to its reputation as a reliable crop, and from the experience, especially of the last two or three winters, an opinion has extensively grown up that winter wheat cannot be successfully grown in Minnesota." First Annual Report of the Commissioner of Statistics for the Year Ending January 1st, 1860, p. 93.

buckwheat, and salt, but wheat is not mentioned.[1] It is true that some wheat was raised at that time in Minnesota, for the United States census of 1850 reported a crop of 1,401 bushels; but an idea of the slow rate of its production in the neighborhood of St. Anthony Falls may be gathered from the story that, three years later, when a farmer living between St. Paul and St. Anthony brought in a grist of thirty-two bushels, he set a new record and furnished a subject of lively conversational interest.[2] In 1849 the government leased the grist-mill and saw-mill to Hon. Robert Smith, of Illinois. A Mr. Bean was employed as the first miller, and in 1851 the grist-mill was rented by Calvin A. Tuttle, whose advertisement has been noted, and by whom it was operated until 1855. To this date, the history of this small mill -- scarcely larger than the average cabin of the frontiersman -- can be definitely traced. It was torn down a few years later, its growing inadequacy in a period of extending settlements and improvements apparently justifying its destruction.

Turning now to the saw-mill, built at the Falls in 1821 and destroyed by fire in 1879, it appears that it was converted into a grist-mill in 1857. George E. Huey operated it until 1855; then it was leased to Leonard Day, and, after a period of two years, it was sold to Thomas H. Perkins and Smith Ferrand. The saw was

1. Quoted by Bromley, "The Old Government Mills," in M. H. C., 10: 642 (pt. 2).
2. Hesler, "Historical Sketch of the Minneapolis Water Power," in the Northwestern Miller, August 22, 1879; see also the description accompanying "St. Anthony in 1857, The Milling District," in Bromley, Minneapolis Album.

then removed and stones and milling machinery were substituted. These gentlemen sold it in 1862 to Messrs. Perkins and Crocker, who named it the City Mill.[1] In 1870, while owned by J. C. Berry and Company, and containing three run of stones, it had a daily capacity of 145 barrels of flour, but manufactured only 15,000 barrels of flour for the year. One reason for this is seen in its production of 1,700,000 pounds of feed during the same period. At this time its value was placed at $8,000.[2] When destroyed, the City Mill contained five run of stones and was one of three of equal capacity among the Minneapolis mills then standing.[3] Upon its site the Northwestern Flour Mill, raised a few months after the fire, stands today as Mill D of the Northwestern Consolidated Milling Company.

Private Mills on the East Side.

The first private mill to be established within the boundaries of what later became the city of Minneapolis, was located on the east side of the river, in the rising village of St. Anthony. Franklin Steele was the first considerable owner of the town-site and the water-power, and in 1848 he commenced the

1. Bromley, "The Old Government Mills," in M. H. C., 10: 641 (pt. 2). In one of these mills, August 20, 1849, was held the first court of the second judicial district, Associate Justice Bradley B. Meeker being the presiding judge, and Franklin Steele the foreman of the grand jury. John H. Stevens, in an address delivered before the Minneapolis Lyceum, in January, 1855, says the court was held in the grist-mill. (St. Anthony Express' Historical Sketch of St. Anthony and Minneapolis, from Their First Settlement to November, 1855). General Richard Johnson says it was held in the saw-mill. ("Ft. Snelling from Its Foundation to the Present Time," in M. H. C., 8: 428).

2. Tribune's Annual Exhibit for 1870, p. 30.

3. Minnesota Commissioner of Statistics, "Tenth Annual Report," in Executive Documents, 1878, vol. 3: 332.

building of a dam. Two saw-mills were erected the same year and two more were in operation the following year. By 1851, the village contained two grocery stores, a hardware store, blacksmith shop, newspaper, two hotels, a library, a fraternal order, and five church organizations. The same year it gained its first grist-mill,[1] built by Richard Rogers between First and Second avenues Southeast, and containing one run of stones, which was used for grinding feed. The next year Franklin Steele obtained a half-interest in this mill and another run of stones was added for grinding wheat.[2] With a hand punch, Mr. Rogers perforated pieces of zinc and sheet iron, and so made the cleaning machinery; while the flour was bolted through a twelve foot, thirty-two inch reel.[3]

The Rogers mill on the east side, and the Tuttle mill on the west side of the river, commanded the trade until 1854, when Rollins, Upton, and Eastman built the Island Mill on the east side of Hennepin Island. This was a three story, wooden building, on a stone foundation measuring forty by sixty feet; it contained three run of stones, had a daily capacity of one hundred barrels, and was probably the first merchant mill in the state. The wheat supply was obtained from Illinois, Iowa, and Wisconsin, that which came up the river having to be unloaded at St.Paul and carried the remainder of the way in wagons at an expense of from

1. St. Anthony Express' Historical Sketch of St. Anthony and Minneapolis.
2. Rogers, "History of Flour Manufacture in Minnesota," in M. H. C., 10: 39 (pt. 1).
3. "Minneapolis Water Power," in Northwestern Miller, August 22, 1879.

two to three dollars a ton.[1]

The profits of the mill were large. Colonel Rogers declares that the firm realized twenty-four thousand dollars profits the first year, a third more than the mill's cost;[2] while F. E. Hesler states that it paid for itself in two years,[3] Notwithstanding the charge of transportation the wheat laid down at the mill cost no more than a dollar bushel, and the flour brought from nine to twelve dollars a barrel. The mill was without serious competition and had the advantage of supplying a rapidly enlarging market, since an enormous increase of population set in the year following its construction. Hon. Charles E. Flandrau states that thirty thousand people were brought by the packet boats to St. Paul in the year 1855, and all authorities agree that this period was remarkable for a flow of immigration.[4] Minneapolis and St. Anthony were both getting the benefits of this immigration, and the St. Anthony Express placed the population of the former, near the close of 1855, at one thousand persons, and of the latter at three thousand.[5]

1. Upton, "Notes of Early St. Anthony," in Holcombe and Bingham, History of Minneapolis and Hennepin County, Minnesota, 150; and St. Anthony Express' Historical Sketch of St. Anthony and Minneapolis.

2. "History of Flour Manufacture in Minnesota," in M. H. C., 10: 39 (pt. 1).

3. "Minneapolis Water Power," in the Northwestern Miller, August 22, 1879.

4. Flandrau, "Progress of Minnesota during the Half Century," in M. H. C., 9: 590. See also Williams, History of St. Paul, 357, in M. H. C., vol. 4. W. W. Folwell says: "The season of 1855 saw 50,000 people in the territory; that number was doubled in 1856. The sales of public lands, which in 1854 had been but 314,715 acres, rose to 1,132,672 in the next year, and to 2,334,000 in 1856." Minnesota, 131.

5. St. Anthony Express' Historical Sketch of St. Anthony and Minneapolis.

The Island Mill was the first to ship Minnesota flour to eastern markets.[1] This was done in 1858. It is related that a farmer named Getchell, from the town of Champlin, was responsible for the venture: wishing to send money back east, and distrusting the mails, he decided to freight the amount in the form of flour, with the result that an order was returned for one hundred barrels more. Since the cost of transportation was $2.25 a barrel, and the chances of deterioration were much greater on a long haul than with the scientifically packed, purified flour of today, it is evident that the popularity of Minnesota flour, even at this early day, can be explained only upon the ground of its superiority. The brand soon adopted was that of "Minnesota Mills," and reference to the mill itself is now usually made under that name. In 1863, upon W. F. Cahill entering the firm, two run of stones were added, a cooper shop was built, and an improved method of flour packing was adopted. Five years later the mill was remodeled and in 1870 "high grinding" was tried, by which the wheat was only gramulated instead of being pulverized at once into flour, and the

1. Rogers, "History of Flour Manufacture in Minnesota," in M. H. C., 10: 39 (pt. 1); Hesler, "Minneapolis Water Power," in the Northwestern Miller, August 22, 1879. Colonel Rogers and F. E. Hesler place the date of shipment in 1858; and Charles A. Pillsbury, in an article entitled "American Flour," (Depew, One Hundred Years of American Commerce, 1: 269), states the year was 1859. But James J. Hill, in his "History of Agriculture," (M. H. C., 8: 377), thinks it was in 1862 that the first shipment was made, giving the credit to the same mill. Mr. Hill adds: "It was not considered that Minnesota flour would be accepted as genuine, and to make it genuine, it was branded 'Muskingum Mills, Troy, Ohio -- The Genuine.' ... Within about three months after the first shipment, the quality of the flour of the 'Muskingum Mills' was so very much better than the other . . . flour of Ohio that we were compelled to change the brand. Since that time it has dated from Minnesota."

product obtained, the "middlings," was cleaned and ground. This flour brought fifty cents a barrel more on the eastern market than had previously been obtained. The experiment of high grinding was a new idea in this country, although Austrian millers had employed the system from the beginning of the nineteenth century. Its development in America was too general for the credit of introducing it to be assigned to any one mill. It can be said of the Island Mill, however, that it was among the first to try the improvement, as it was among the first, a short time later, to recognize the value of the purifier and prepare for the new process of milling.[1]

The mill realtered and equipped with purifiers was, however, destined never to run. For, after the completion of all improvements, upon the morning of March 5, 1872, the mill was burned down, resulting in a total loss to its owners.[2] It was not rebuilt. As the first important merchant mill, and the first to ship flour from the state, the position of this mill must ever remain unique in the history of an industry whose growth has placed Minneapolis among the chief milling centers of the world.

The same fire that destroyed the Island Mill also burned the River Mill, which adjoined the former on the south. The River Mill was built in 1856 by B. C. Morrison and N. M. Prescott. It started with two run of stones, which was finally

1. Hesler, "Minneapolis Water Power," in the Northwestern Miller, August 22, 1879. See also Rogers, "History of Flour Manufacture in Minnesota," in M. H. C., 10: 39 (pt.1). For an account of the Austrians' early adoption of the method of high grinding, see a paper read by Theodore Voss at a meeting of the Amalgamated Society of London Operative Millers, found in the Northwestern Miller, December 22, 1882.

2. Minneapolis Tribune, March 6, 1872.

increased to four run. A small grist-mill with two run of stones, located in the basement of a four-story building occupied as a furniture factory, was also destroyed by this fire. It was built by Messrs. Stamwitz and Schober in 1864. The Summit Mill, erected in 1865 by Messrs. Erb and Kassube, with four run of stones, completes the list of early mills built on the east side of the river. All stood on Hennepin Island; and water, instead of fire, destroyed the last mentioned mill by washing away its foundation in the spring of 1870, during the period of havoc resulting from the breaks in the river-bed.[1]

Private Mills on the West Side.

The City Mill, as has been stated, was converted into a flour mill in 1857, being originally the old government saw-mill. The year 1859 saw the erection of the Cataract Mill, the first privately built mill on the west side of the river. Its location was where it now stands, at the corner of First street and Sixth avenue South. Built from the limestone quarried on the river bank, it was three stories high, contained four run of stones, and possessed a daily capacity of 175 barrels of flour. It was a merchant mill, shipping almost all its products to Chicago from the very start.[2] The builders were W. W. Eastman and Paris Gibson -- the latter being now better known as the late United States senator from Montana, and, at an advanced age, residing at Great Falls,

1. Hesler, "Minneapolis Water Power," in the Northwestern Miller, August 22, 1879; United States Chief of Engineers. Annual Report, 1879, p. 1163, (War Department, Messages and Documents, py. 2).

2. Mr. Edwin R. Barber, president and treasurer of the Barber Milling Company, and the junior member of the firm referred to in the mill's history, gave the writer his information on this mill.

Montana. This firm operated the mill for four years, and then took Messrs. Judd and Brackett into the partnership; and the four began the erection of the North Star Woolen Mills upon the corner diagonally across the street from the Cararact Mill. Upon its completion the interests were divided, Judd and Brackett keeping the flour mill, and Eastman and Gibson taking the woolen mill. Misfortune attended the owners of the flour mill; by a mortgage and its subsequent foreclosure, the property passed into the hands of "Commodore" Davidson, of St. Paul, who was the owner of a line of river steamers. For a time the mill was operated under a lease by George A. Brackett, nephew of one of the late partners; but in the winter of 1871 it was purchased by Daniel R. Barber, by whom it was leased to his son-in-law, J. Welles Gardner. The latter operated it until 1873, when the partnership of Gardner and Barber was formed. Mr. Gardner died in 1876. The firm was then organized under the name of D. R. Barber and Son, which remained its style until 1896 when it was incorporated as the Barber Milling Company.

This mill obtained its first purifiers from the originator of them in this country; for, when in 1871 George A. Smith perfected the LaCroix purifier in the Washburn B Mill, the supplanted La Croix was employed by the Cararact Mill to introduce his machine there. In 1876 six run of stones was added, increasing the capacity to four hundred barrels of flour a day. It was not so ready, however, to adopt rolls, the stones not being discarded until the winter of 1881-82. Porcelain rolls made in Europe and sold by a St. Louis firm were then installed, together with chilled-iron rolls with sharp corrugations manufactured by E. P. Allis and Company, of Milwaukee. The present size of the

mill is forty-five by ninety feet. It is five stories high and has a daily capacity of twelve hundred barrels. It holds a prominent place among the unconsolidated companies at the falls today, and its brands are well known.

The next mill to be built was the Union, which was erected by Henry Gibson in 1863, and located upon a site about a half block west of the Cararact.[1] Beginning with four run of stones, it was remodeled and its capacity increased at the successive periods of change in the milling industry already referred to and finally became one of the group of the Northwestern Consolidated Milling Company's mills. It is now being town down, having served only as a store-house for a number of years.

In 1865 the canal, or mill-race, was extended six hundred feet, and the next year the Arctic, the Minneapolis, the Taylor, and the Washburn B mills were added to the west side number. The Arctic was built by Perkins and Crocker and contained three run of stones. The name was changed afterward to the St. Anthony and after passing through the hands of several owners it came into the possession of the Northwestern Consolidated Milling Company, which is tearing it down along with the Union. The Minneapolis Mill was built by Messrs. Frazee and Murphy, and contained six run of stones. Fire destroyed it December 4th, 1881, but it was rebuilt and is now operated under the name of the Washburn D Mill. The same fire destroyed the Taylor Mill, erected by Taylor Brothers. It was rebuilt and has now become

1. Hesler, "Minneapolis Water Power," in the Northwestern Miller, September 5, 1879.

the Pillsbury B Mill.[1]

The Washburn B Mill was erected by Hon. Cadwallader C. Washburn, whose name must ever remain prominently identified with the flour milling history of Minneapolis. The mill possessed eleven run of stones and was known for a long time as the "big mill." On the ground it measured sixty-two by ninty-four feet, and it stood six stories high. Mr. Washburn leased the mill to Judd and Brackett, the same firm then operating the Cataract Mill, but which, overcome by financial reverses as noted in the history of the latter mill, was compelled to surrender it at the end of two years. In 1869 it was operated by the firm of Christian, Tomlinson and Company, and then, upon the withdrawal of Mr. Tomlinson toward the end of 1869, Mr. Washburn formed a partnership with George H. Christian under the name of George H. Christian and Company.[2] To this firm belongs the signal distinction of introducing the new process of milling in this country. It was George H. Christian who "discovered" E. N. La Croix, and it was in the Washburn B Mill that the first purifier in the United States was built. As the details of the new process are of great importance in the history of milling, the subject will be dealt with separately in a later chapter.

In 1867 Russell and Huy built the Dakota Mill and equipped it with three run of stones.[3] Still standing, it is operated by the Cannon Valley Milling Company; and has long been known as the only frame mill at the falls, though its exterior

1. Minneapolis Tribune, December 5, 1881.
2. Northwestern Miller, August 10, 1883.
3. Hesler, "Minneapolis Water Power," in the Northwestern Miller, September 5, 1879.

is now protected by a sheet-iron covering. Sometime between 1867 and 1870 a mill with three run of stones was built by Noble and Walker and operated under the name of the People's Mill. Henry Bauchmann, an employee of the Northwestern Consolidated Milling Company, recalls that it stood upon a pier crossing to a small island near the foot of Sixth avenue South, upon which a number of saw-mills had also been constructed. This mill was torn down in the middle seventies when the United States government found that the existence of piers in the river dangerously narrowed the passage of the river at the falls and ordered their removal.[1]

This completes the record of the flour mills built at the Falls of St. Anthony prior to the year 1871, when the new process of milling was inaugurated.[2] The change wrought by an improved system soon led to the erection of most of the twenty-three mills now standing in the city and to the increased production of the high-grade flour by which Minneapolis gained her world-wide reputation as a flour manufacturing center. Yet progress was not made without difficulties. At one time the falls were in danger of passing into a useless series of rapids; again, some of the biggest mills were destroyed by fire and explosion;

1. United States Chief of Engineers, Annual Report, 1874, p. 280, (War Department, Messages and Documents, vol. 2, pt. 2). The board of officers of the Corps of Engineers which convened at Minneapolis, April 15, 1874, to consider and report upon a means for the preservation of the falls, strongly recommended the removal of the piers. The records of the Minneapolis Water Power Company show that the lease of power to the People's Mill was cancelled in October, 1875.

2. Two mills were under construction during 1870; the Zenith, with five run of stones, erected by Tomlinson and Company, on the west side; and the Main-Street Mill, with three run of stones, by McMullen and Shanton, on the east side. But neither operated until 1871.

while throughout the period of improvements,"patent sharks" added their strife to the sum of hindrances. An account of the principal events of the new era will suffice to indicate the course and scope of the growth.

At the close of 1870 nine mills were in operation on the west side, and three on the east side, of the river, representing an investment of $432,500, and totaling a run of fifty-four mill stones and a daily capacity of 3,285 barrels of flour. The total product for the year was 244,998 barrels, valued at $1,347,489, and all except 42,529 barrels were shipped to other markets of the United States.[1] Upon comparison with the output of the mills at the present time, these figures seem insignificant, for a single company now produces nearly as much in a week. But bearing in mind how brief had been the period of growth of the industry, and how crude were the methods of manufacture, the figures clearly indicate that the foundation had been solidly laid.

1. Tribune's Annual Exhibit for 1870, p. 20.

Chapter 11.

THE PERIOD OF EXPANSION

The Introduction of the Purifier

Before 1870 the manufacture of flour was a comparatively simple process. It consisted of making as much flour as possible at a single grinding. The upper stone alone revolved and the grain was admitted through an opening at the shaft called the "eye;" both stones were grooved with furrows running obliquely from the center to the circumference and gradually decreasing to a fraction of an inch in depth; the edges of the furrows were dressed sharp, and the surface between the grooves was irregularly picked to produce sharp points. Subjected to the action of the stones in this condition, the wheat was both cut and crushed and, pushed along the furrows by the revolution of the stone and the pressure of inpouring grain, was squeezed from the shallow orifices at the rim in a commingled mass of bran and flour. A fair proportion of the bran and dust was then bolted out; the remainder constituted the finished product. The stones required dressing every seven or eight months. Machines for this purpose were invented toward the close of the old period, effecting a saving of labor as well as improving the result. Keeping the surfaces picked also demanded regular attention, for the majority of millers believed that roughened planes made more flour. This notion proved to be erroneous. Finally, the upper stone had to be so nicely balanced that it would not variate from the level,

since unequal pressure, besides the damage it wrought by friction, resulted in an uneven quality of the product.[1]

In order to keep up with the demand for flour, which began to be felt about 1850, millers set the stones closer together and increased the speed of the "runner." The method of close, hard grinding demonstrated what seemed to be the disadvantage of spring wheat, namely, its richness in gluten. Gluten, says Dondlinger, is the "nitrogenous or tissue-building part of the wheat, and it supplies the same important food elements as are furnished by lean meat and the casein of milk."[2] This element composes the hard shell just under the thin coating of bran and so adheres to the latter that the separation could not be made by a single grinding, unless by employing a pressure that resulted in pulverizing the bran as well as the gluten; a portion of the bran could then pass through the meshes of the bolting reels which made the flour dark and specky. Starch is the chief ingredient of winter wheat and it separates readily from its tougher

1. For the process of milling before 1870 see Dondlinger, The Book of Wheat, 286; Edgar, The Story of a Grain of Wheat, 151; Pillsbury, "American Flour," in Depew, One Hundred Years of American Commerce, 1: 269; Rogers, "History of Flour Manufacture in Minnesota," in M. H. C., 10: 46 (pt. 1); and an article by Albert Hoppin, forming part of the special agent's report to the census bureau, in the Northwestern Miller, December 24, 1880.

The discovery of a new method of dressing the surfaces of the stones between the grooves furnishes an interesting story. The Vermillion was the name of a mill at Hastings, Minnesota, built toward the close of the old period of milling by Mr. Stephen Gardner, and its proprietor had gained the reputation of making a superior flour from spring wheat. Many millers of the state made pilgrimages to Hastings to learn the secret of manufacture and were generously given the run of the mill to learn what they could. It appeared that Mr. Gardner, himself, was not in the possession of the "secret," which consisted of the fact that his stoneman dressed the surface of the stones between the grooves smooth, instead of picking them according to the traditional custom. This difference saved the grain from the exhaustive cutting it had

coating of bran, the product being a comparatively white flour under the system of close grinding. In order to enter the market on an equal footing with his competitors, the spring wheat miller was, therefore, obliged to be satisfied with a flour made from the smaller proportion of starch contained in his grain, which compelled him to use more wheat in the manufacture of a barrel of flour. The glutinous part he used for a low grade of flour which was commonly sold to the Indians, and was known in local parlance as "red dog."

About 1870 spring wheat millers began to understand the nature of their problem, and, as has been noted in the history of the Island Mill, they raised the upper stone so that it would only granulate the wheat and then reground this product. But the granulated wheat, the "middlings," was unavoidably mixed with a little flour, bran, and dust, and a practicable means of cleaning was required if the advantage sought in a successive reduction was to be worth anything. A means was discovered in the use of the purifier,

formerly received under the system of close grinding; by merely crushing the wheat, more of the bran, as well as the germ, could be ejected in the process of bolting, thereby making a purer flour. Mr. George H. Christian, of Minneapolis, was one of the pilgrims to the Hastings mill and hired the stoneman to take charge of a similar department of work in the Washburn B Mill. The date of this engagement was February, 1870, it being the same time that E. N. La Croix, of Faribault, came to Minneapolis to undertake an important piece of work for Mr. Christian. George A. Smith was the name of the expert stoneman -- a name which acquired an unenviable prominence a few years later in the eyes of the milling fraternity. Smith met with considerable difficulty in educating the men under him and at one time was confronted with a strike; for the stone dressers naturally objected to an innovation that deprived them, as a trade, of employment in a branch of their work. He succeeded, and Mr. Christian promoted him to the position of head miller. The story has a double interest, as the chance that led to the association of La Croix and Smith in the same mill becomes, in view of the consequences, somewhat remarkable. See the Northwestern Miller, Holiday Number, 1883-4.

2. The Book of Wheat, 283.

and for the discovery the millers of the United States are indebted to E. N. La Croix, a French millwright, residing in Minnesota.

Edmund N. La Croix was born at Nobressart, Belgium, in 1818.[1] During his childhood his parents moved to Harcourt in northeastern France, where his father became the proprieter of a grist-mill. Edmund, with his brother Nicholas, four years older, went to school at Harcourt, and afterward attended a Lycee at Virton, Belgium. The brothers then took a course in engineering at the Challons branch of the Ecole des Arts et Metiers, which enjoyed a reputation of being nearly as good as the parent school at Paris. Only Edmund completed his course and received a degree. After graduation he found employment at the iron works at Longwy, Luxemburg. Nicholas had gone into business and had become a director in an omnibus company which operated between Paris and Metz; but the traffic of this concern was ruined when a railroad was built through its territory, and in 1845 Nicholas emigrated to America, accompanied by his family and his brother Edmund. New York, with its English speaking population, called forth a feeling of discouragement. Nicholas' watch stopped and chance led him to a jewelry store whose repairman was a French-Canadian; the friendly watch-mender advised them to settle in Montreal, where they would find a majority of the inhabitants speaking their own language. To Montreal they went. Nicholas launched out in business as a millwright; Edmund followed his profession of engineer, and

1. The writer is indebted to Mr. Joseph La Croix, nephew of E. N. La Croix, for the facts dealing with the career of the La Croix brothers. Mr. Joseph La Croix is eighty-two years old and resides at 2602 Pleasant avenue, Minneapolis.

at Quebec married the daughter of a French seigneur. In 1861 an advertisement of his services that Nicholas had placed in a trade periodical brought him an answer from Alexander Faribault, who wanted to have a mill built at Faribault. This led to his location at the town founded by him employer. In the same year Edmund moved to Delhi, Ohio, to install the machinery of a distillery plant. After a year or so Edmund, with his family, joined his brother at Faribault where the two lost several thousand dollars in building and operating a distillery plant of their own. In 1886 they ventured their capital in a flour mill, the firm consisting of the brothers, and Joseph, the son of Nicholas La Croix. This, too, proved a failure, because of a freshet washing away their dam. Their losses had exhausted their capital and Edmund sought work at his profession. He came to Minneapolis in 1870 and went to George H. Christian, the manager of the largest flour mill in the city, with a proposition to build a purifier for him.

The idea of a purifier was not original with La Croix. It had been patented in France in 1855, and long before that had been used by the Austrians. Theodore Voss explains its origin as follows: "In the beginning of our century (nineteenth) Austrian millers first began to purify middlings by means of hand sieves, in which they agitated them and then skimmed off the lighter husk particles which rose to the surface. They manufactured from these purified middlings a flour of extra find quality, and when they found this very profitable they endeavored to make more middlings by raising the runner and grinding several times. . . There soon arose so great a demand for this fine flour that they could not purify a sufficient quantity of middlings by hand until Paur

invented the first middlings purifier."[1] Mr. Voss adds that, as a result of the change in the quality of the Austro-Hungarian flour, the purifier was afterward imported into Germany, France, America, and England. The order in which it was introduced in the several countries indicates how far behind the times was the American flour manufacturer, and the fact contrasts strangely with the progress he made in the decade following his awakening. The La Croix brothers possessed an engineering manual with descriptions of the French machine and in their mill at Faribault had installed a simplified form of purifier, attaching it to the end of the reel. It went by the name of "shaker," and lacked an apparatus to brush the underside of the sifting cloth. Mr. Joseph La Croix says that it was his duty to stand beside the contrivance and brush the cloth with his hand, a task which he recalls as sufficiently tedious. His father, Nicholas La Croix, thought that a traveling air blast would be more effective than a traveling brush, but the means of making either one were not at hand and the need was accordingly neglected. At that time neither one of the brothers had any idea that their fortunes might be recouped by perfecting the machine to the standard of the French model and taking out a patent upon it in this country.

Mr. Christian heard Edmund La Croix's plan of purifying middlings with favor. La Croix started work upon a machine in February of 1870 and was employed upon it at intervals for a little

1. From a paper read before the Amalgamated Society of London Operative Millers, found in the Northwestern Miller, December 22, 1882. See also an interview with C. C. Washburn in the Minneapolis Tribune, March 18, 1879. Charles A. Pillsbury states that Paur invented the purifier in 1810. See his article, "American flour," in Depew, One Hundred Years of American Commerce, 1: 272.

more than a year. The result is described by F. E. Hesler as follows: "The first machine was crude affair, being 24 by 48 inches in size, having but one kind of cloth and that a No. 2, furnished by O. A. Pray & Co. A simple suction fan, without regulating slats of any kind, furnished the air currents, and if the cloth was to be cleaned at all it had to be brushed by hand, and very inconvenient it was to handle it."[1] Greater pains, it may be inferred, had been taken with this machine than in the construction of the "shaker" in the Faribault mill; and it is also clear that the traveling brush needed to free the cloth from stoppages was not the simplest kind of a device to apply. If La Croix had been spurred by the thought of a patent he would, perhaps, have persevered until he had completed the machine. Mr. Joseph La Croix says that, at this juncture, his uncle was called to do some work on a mill out of town, and that, although he did no further work on the machine, he left directions for the making of the brush. C. C. Washburn and D. R. Barber later declared that the idea of the brush belonged wholly to La Croix.[2] But now came George A. Smith, the head miller of the Washburn B Mill, with a request to see what he could do in the way of an improvement, and Mr. Christian gave him leave to experiment. Smith built another purifier upon the principle employed in the construction of the first, and succeeded in adding the traveling brush.

The flour made from the purified middlings was at first

1. Hesler, "Minneapolis Water Power," in the Northwestern Miller, September 5, 1879.
2. See a report of the meeting of the Minnesota Millers Association in the Northwestern Miller, July 4, 1879.

mixed with the best grade manufactured under the old system. It brought an increase in price of fifty cents a barrel, and created a demand "ten times greater than could be supplied." As the reason for the advance was perfectly clear, Mr. Christian decided to send to the market a special consignment made only from the purified middlings. This product was so favorably received that it caused the remarkable advance in price of three dollars a barrel.[1] Millers today say they are satisfied with a profit of five or ten cents a barrel and look back upon the high prices that signalized the success of the purifier with somewhat the same wonder that miners recall the fortunate days of a gold "strike". Mr. Christian tried to keep the new machine a secret, but his competitors could not be deceived into believing that flour so superior in quality and market value to that of their own manufacture was due to ordinary processes of milling; by some means they discovered the key to the mystery and equipped their mills with like improvements.

The impetus given to flour manufacture by the use of the purifier was soon manifested in Minneapolis by the erection of new mills. In 1871 Leonard Day and M. B. Rollins constructed the Zenith Mill; in 1872 Leonard Day and Company erected the Palisade Mill; in 1873 Messrs. Cahill, Loring, Fletcher, and Hineline converted the stone building formerly used as the city's water works into the Holly Mill; Messrs. W. W. Eastman, Paris Gibson, and George H. Eastman built the Anchor Mill; and C. C. Washburn began the construction of the mammoth Washburn A Mill, long known as the

1. The early History of the new process milling can be found in the Northwestern Miller, December 24, 1880, and August 10, 1883.

largest and most complete mill in the United States; in 1874 N. R. Thompson and Charles Hoyt built the Diamond Mill; and in 1875 Messrs. Stamwitz and Schober built the Phoenix Mill, Messrs. Pettit and Robinson, the Pettit Mill, W. P. Ankeny, the Galaxy Mill, and Charles A. Pillsbury and Company reconstructed an old building into the Empire Mill.[1] The use of the purifier meant that a barrel of flour could be made from about four-fifths of the amount of wheat required before its adoption; or, to the raiser of spring wheat it meant an addition in price of twenty cents a bushel.[2] This fact became a prominent element in the growth and prosperity of the state. Between 1870 and 1875 the population increased thirty-six per cent, and the production of wheat showed a gain of seventy-eight per cent. From a population of 18,079 in 1870, Minneapolis rose to 32,721 in 1875.[3] The place of the purifier in the history of the flour milling industry is thus clearly indicated. The rolls, when they came later, facilitated the process of manufacture, and automatic machinery gave the mills their scientific character as flour producers; but "patent" flour and white bread trace their origin directly to the purifier.

Edmund N. La Croix cannot receive the honor due to the inventor of this machine, for he only introduced it in this country. But his services should give him a position second only in degree to that honor -- especially as he never received any

1. Minnesota Commissioner of Statistics, "Eighth Annual Report," in Executive Documents, 1876, vol. 2: 957; Wyman, "Manufactures," in Atwater, History of Minneapolis, 2: 591, 608, 613, 614, 618.
2. Flandrau, "Progress of Minnesota during the Half Century," in M. H. C., 9: 591; Northwestern Miller, August 10, 1883.
3. Minnesota Commissioner of Statistics, "Eighth Annual Report," in Executive Documents, 1876, vol. 2: 779.

share in the financial benefits that were immediately gathered by the adoption of his idea. La Croix died in 1874, leaving a widow and four daughters destitute in the goods of this world. When George A. Smith, Christian's head miller, added the traveling brush to La Croix's purifier, he felt so satisfied with his performance that he applied for a patent upon the improvement. He succeeded then in organizing a company, which built a factory at Jackson, Michigan, for the manufacture of the Smith Purifier. But collecting royalty upon the machines already in use in the United States was the first business of this concern. This was a procedure that precipitated a legal contest with the millers, who maintained that the purifier had been used too long in Europe to admit of any of its essential features being patentable in America. Smith and his company asked for a royalty of $250 a run of stones and in the summer of 1876 brought suit for collection against Gardner and Moore of Cannon Falls, Minnesota. At the same time he gave notice to a number of other millers that they would be prosecuted in turn unless they complied with his demands. The threatened millers met at Minneapolis, November 28, 1876, to form a protective association,[1] and more than a year passed before Smith renewed his attack. The reason for delay was caused by the appearance upon the scene of a bolder leader in the scheme that had for its object the exploitation of the gains of the milling industry, one W. F. Cochrane, who was also the patentee of a purifier; and he, it was supposed, had persuaded Smith to yield his claims until his own venture in the interest of larger spoils had been tried. Cochrane picked out the biggest companies in the

1. Northwestern Miller, March 28, 1879.

United States for his victims. In May of 1877, accompanied by his attorney, he visited Minnesota and declared his terms were two thousand dollars a run of stones, with royalty during the life of the patent, provided settlement was promptly made, and six thousand dollars a run of stones, with the same royalty, if he was put to the expense and trouble of bringing suit. In the case of the Washburn A Mill, then operated by J. A. Christian and Company, his demands amounted to $300,000. To clear away all doubts that might have existed as to the firmness of his purpose, Cochrane secured an injunction against Christian and Company and compelled this firm, before it could resume business, to furnish bonds for $250,000 and agree to render a periodical statement of its affairs to the court.[1] Menaced by a practical confiscation of their property, the victims entertained a sentiment for Cochrane and his associates that can only be compared to the implacable hostility a private citizen feels for a bandit. The members of the state association accepted the cause of Christian and Company as their own and contributed twenty-five dollars a run of stones to the cost of the defence; and the executive committee of the National Millers' Association provided the legal counsel. By agreement with the counsel for the prosecution, the suit against J. A. Christian and Company and against the Atlantic Milling Company of St. Louis were united for the purpose of trial, which began in the latter city February 10, 1879, before the United States Circuit Court.

The trial lasted seventeen days and the case is consid-

1. Northwestern Miller, March 28, 1879.

ered one of the most important in the history of patent litigation. In brief, the fact of the case show that Cochrane had received a patent on his invention July 6, 1863, and that on April 24, 1874, his patent had been reissued to him, on his representation that the original patent failed to emphasize the use of the machine as a purifier. The defence contended that his original invention was merely an apparatus for bolting flour, and that the broader claims he had incorporated in the reissued patent constituted his only title to the invention of a purifier. The validity of the reissue was the question presented for the decision of the court. It will be noticed that eleven years intervened between the dates of his two patents; that is to say, the improved character of the invention was sought to be established at a time when the purifier had acquired a fundamental place in the new process of milling. The court declared the reissued patent invalid, giving the millers a complete victory.[1]

The case was not carried to the Supreme Court. But Cochrane and Smith now justified the suspicion that their interests had been pooled by combining their respective companies into the Consolidated Middlings Purifier Company, and applying themselves to the business of winning the claims for royalty made by Smith. Both the La Croix brothers had died in 1874, but Joseph La Croix had secured a patent upon his uncle's machine and had organized a manufacturing company. Notice had been duly served upon him that he was infringing the Smith patent, but, instead of

1. The trial is reported in the Northwestern Miller, under dates of February 21 and February 28, 1879. The decision of the court appears in the issue of March 21, following.

starting a suit against him, the new Consolidated Company deemed it wiser to offer La Croix a round sum for all claims he maintained to his uncle's invention. On the other hand, representatives of the National Millers' Association urged him not to sell. La Croix decided to stand by the millers. The issue never came to the point of a trial. To the mind swayed by ideas of poetic justice is suggested the likely conclusion that the conspirators had finally grown discouraged by the uncompromising attitude of the millers and the honorable staunchness of La Croix. But, in reality, the attitude of the millers was not uncompromising. When the Consolidated Company offered to reduce the royalty demanded from two hundred and fifty dollars to twenty-five dollars a run of stones, the National Association, at its annual meeting at Chicago, 1879, in May, decided to accept the offer[1] -- thereby disregarding the interests of Joseph La Croix and leaving him to the sober task of reflecting upon the wisdom of his unbusiness-like habits.

The settlement drew a vigorous protest from the Minnesota millers. Thirty-six of the members of the state association met at the Nicollet House, July 1, 1879, to consider the matter and to decide upon their course of action. "Those of our millers here think the settlement was a great mistake and do not feel like giving the Smith and Cochrane blackmailers a club to beat our brains out," was the sentiment of the petition signed for the calling of the meeting. At the meeting, C. C. Washburn stated that there was no doubt in his mind that Smith had got his

1. Northwestern Miller, May 23, 1879.

idea of the automatic brush from La Croix, but granting it was Smith's own notion, he did not believe it was patentable. He did not feel "like surrendering to a gang of rascals who had been defeated at St. Louis and then came to Chicago under another guise and effected a compromise. He had fifty machines and he did not propose to pay a cent of royalty until he was forced to do so by the courts." D. R. Barber made the statement that in 1871, Welles Gardner, his partner in the Cataract Mill, had urged the policy of giving La Croix, who was a poor man, the money he needed to obtain a patent on the brush; but that Smith, meanwhile, had secured a patent. "As to the facts that Smith stole his ideas from La Croix there was no doubt," he asserted. Hon. Gordon E. Cole, of Faribault, who had assisted the counsel for the defense in the St. Louis trial, said that "he had found all lines of evidence in favor of La Croix, that he had followed, stop just a little short of the exact proof necessary to rest a case upon, and he was afraid that although E. N. La Croix was the father of new process milling in this country, at least was one of the greatest benefactors of this state, and it would be most desirable and just to establish his rights, it would not be possible to do it on the evidence obtainable," and he advised the payment of the royalty. His opinion prevailed and the Minnesota millers decided ro abide by the action of the National Association.[1]

Recognition of the Smith patent, it will be seen, gave the Consolidated Company the exclusive right to manufacture the purifier during the life of the patent; although Joseph La Croix

1. The meeting is reported by the Northwestern Miller, July 4, 1879.

still retained his legal right of continuing the struggle that had been abandoned by the millers, if he chose. La Croix yielded. In 1880 his company submitted to an injunction and assigned its patents to the Consolidated Middlings Purifier Company.[1] Fathering the new idea of milling had proven almost as adverse to the interests of E. N. La Croix and family as it had been fortunate to the affairs of others. The competitive struggle seems to leave no place for altruism. But in 1905 Mr. William C. Edgar, the publisher of the Northwestern Miller, revived the subject of La Croix's services to the milling industry, together with the imposition later practiced upon his nephew, with the result that the Minneapolis millers subscribed to a fund that would provide Mr. Joseph La Croix with a moderate pension.[2]

The Adoption of Rolls.

The discovery that the purifier had long occupied a prominent position in the European system of milling had a stimulating effect upon the pride and ambition of the American miller. In 1873 George H. Christian, of the Washburn B Mill, found a description of rolls in a European work on milling and gave an order to the North Star Iron Works to reproduce a set. They were steel rolls and it is claimed they were the first made in Minnesota, although not the first to be used. The same year marble rolls were made by E. P. Allis and Company, of Milwaukee, for Mowbray's mill at Winona, Minnesota; afterward for Kircher's mill at Isinours, Minnesota, and Kern's mill at Milwaukee. But marble

1. Northwestern Miller, November 19, 1880.
2. Information furnished the writer by Mr. R. L. Brown, of the Washburn-Crosby Company.

rolls wore out too soon to be practicable. In the years 1873 and 1874 several Minneapolis millers visited the leading mills in France and Austria, in order to obtain ideas of the best machinery to install in their own mills and to profit by a general study of the European system of milling. They found that rolls were used in a few large mills, especially in Hungary, but that Europe as a whole was not committed to their use. At that time, in fact, the system of gradual reduction had not been clearly worked out anywhere, and the Americans, with their strong commercial sense of the practicable, were looking for improvements that had passed the experimental stage. They returned home, therefore, satisfied with the advantage afforded by the millstone and the purifier.[1]

Credit for introducing the use of rolls in Europe is generally given to the Swiss. Mr. William C. Edgar states that the inventor was Helfenburger, who built a roller mill at Rohrschach, Switzerland, in 1820; but that a more successful invention was made in 1833 by Jakob Sulzberger, of Frauenfeld, Switzerland, who afterward built roller mills at Mayence, Milan, Munich, Leipzig, and Stettin, finally equipping the famous Pester Walzmuehle, of Budapest, with shilled-iron rolls.[2] Sulzberger received credit for the invention by the author of an article on "Flour and Flour Manufacture" in the Encyclopedia Brittanica.[3]

1. See the interview with C. C. Washburn in the Minneapolis Tribune, March 1879; Northwestern Miller, February 4, 1881, and August 10, 1883; Christian, "Early Roller Mills" in Holcombe and Bingham, History of Minneapolis, 160; and Pillsbury, "American Flour," in Depew, One Hundred Years of American Commerce, 1: 269.

2. The Story of A Grain of Wheat, 165.

3. 10: 549 (eleventh edition).

In a paper read before the Institute of Civil Engineers of Great Britian, William Bishop Harding says the first roller mill was constructed in Switzerland about the year 1820, and relates the subsequent history as follows: "In the year 1839 was founded the first roller mill in Hungary, the 'Josef Walzmuehle,' named after the Archduke Josef, who was then Prince Paletin. This mill was designed by Mr. Fehr, a Swiss engineer, and the installation comprised thirty-six roller mills, . . . This mill afterwards passed into the hands of a company, and became known as the 'Pester Walzmuehle,' and under the present directorate sixty-four roller mills and several pairs of stones were added, some years since. The original rollers are still at work, however, and doing good service; they are much smaller than what are now manufactured, being only six inches long and five inches in diameter."[1]

Authorities are, then, agreed that the invention is of Swiss origin, and that the first mill of importance to use rolls was the "Pester Walzmuehle," erected at Budapest in 1839. As an instance of the fact that rolls were not permanently installed in many European mills until a much later date, the history of the roller mill at Stettin, as furnished by one of its directors, may be cited. "It was built in 1838, after the plan of a roller mill at Frauenfeld, Switzerland. It produced superior flour, but was not a pecuniary success, since fine flour was not then in such demand and did not bring such high prices as has since been the case. After four years, therefore, it was refitted with stones." The mill was burned in 1875 and rebuilt on the stone system; but a

1. Northwestern Miller, June 30, 1882.

roller mill was added by way of experiment. Not until 1881 was the roller system adopted throughout.[1]

In 1874 Frederick Wegmann, of Zurich, invented the porcelain roll. His invention awakened interest in the subject throughout Europe. The same year he began its manufacture at Naples, and made arrangements with Ganz and Company, of Budapest, for its production in Hungary. This firm operated an iron foundry, and when it met with difficulty in obtaining a good grade of porcelain it cast the rolls in iron. The success of the iron roll was so great that the company could not be induced to return to the use of porcelain, and in 1878 Wegmann severed his relations with it and established a porcelain roll factory at Zurich. The porcelain roll was introduced in America by Allis and Company, of Milwaukee, on the recommendation of W. D. Gray, the firm's engineer, who had gone to Europe in 1876 to study European processes of milling.[2] The principal defect of this roll was its liability to breakage and the excessive din made by the connecting gears. Mr. Gray corrected the last by substituting belts; but the proneness to break was an inherent difficulty, and the practical flour manufacturers of Minneapolis were not disposed to exchange the reliable mill stone for an improvement that could not stand up under the commercial test. In time the porcelain roll was employ-

1. From a report of the German Millers' Association, held at Stettin, June, 1882, in the Northwestern Miller, August 25, 1882.

2. An interesting letter from a correspondent in Europe, giving an intimate view of Wegmann and his manufacturing troubles, can be found in the Northwestern Miller, March 14, 1879. Allis and Company narrate their connection with Wegmann, and the disadvantage of the porcelain roll, in the same periodical, under date of February 4, 1881.

ed for cleaning the bran and rolling the flour in the final stages of reduction; but as it possessed no advantage that the smooth iron roll did not have, it was finally discarded.

The growth of the idea of reducing the wheat to flour by a gradual process brought the question of corrugations into prominence. European millers made an exhaustive study of their possibilities. The grooves were cut parallel with the axis of the roll, or spiral, in the fashion of a screw, and numerous variations in form were based upon round, square, and sharp ridges, and upon matters of depth and distance between the points. Mr. W. De La Barre informed the writer that he had seen more than a hundred different styles of corrugation in a Budapest museum. In 1876, the Centennial Exposition at Philadelphia had on exhibition a mill with sharp corrugated rolls. Daverio, a Swiss miller, had sent them and Sellers Brothers, of Philadelphia, bought them for use in their mill. Mr. De La Barre states that this was the first mill in the United States that ground with corrugated rolls. Ganz and Company, of Budapest, were the principal manufacturers of the sharp corrugated roll, and Allis and Company obtained from them the rights of manufacture and sale in this country.[1] During the year 1878 rolls were installed in many mills throughout the United States. The committee on mill machinery at the sixth annual convention of the Millers National

1. Mr. De La Barre is the engineer-agent and treasurer of the Minneapolis Water Power Company. He was born in Austria and came to this country in 1865. In 1880 he entered the employ of C. C. Washburn, and had charge of the construction of the Washburn A Mill and the re-building of the Washburn B Mill.

Association, held at Chicago in May, 1879, reported that rolls had proved so successful for many purposes in granulation that they were rapidly coming into general use and to some extent were superseding the use of buhrs.[1] No change, however, had yet been made in Minneapolis mills. Following the explosion of May 2, 1878, the mills had been rebuilt on the stone system; but C. C. Washburn had determined to devote sufficient space in the new Washburn C Mill, the construction of which began in 1878, to make a thorough experiment of the value of roller milling. Some of the rolls in his experimental mill were of European manufacture, and the others were made by Allis and Company who had been given the contract of installing the machinery. Mr. Edgar says that this was the first complete roller mill in the United States, and probably the first complete automatic roller mill in the world.[2]

The Minneapolis millers had led in the adoption of the purifier; but it is evident that they felt some reluctance in accepting the second important change in milling. Their conservatism was, in part, the result of success: the purifier had enabled them to use the nutrient value of spring wheat, and had been the means of so improving the quality of the product, that in 1878 Minnesota patent flour held the leading position on the market.[3] It was not clear then that a more prosperous financial condition

1. Northwestern Miller, May 16, 1879.
2. The Story of a Grain of Wheat, 164. Mr. De La Barre is also authority for the statement that C. C. Washburn was the first to adopt the roller system in Minneapolis. On this subject see the St. Paul Pioneer Press, May 15, 1882, and the Northwestern Miller, May 19, 1882.
3. The best brands sold on the local market at $8 and $8.25 a barrel. See quotations in the Minneapolis Tribune, January 2, 1878.

would follow a further improvement in the manufacturing process. Indeed, the expense of remodeling their mills to meet the proposed change presented a grave objection in itself. In the following excerpt from an editorial in the Northwestern Miller, April 25, 1879, may be perceived the existence of a feeling of protest. "One of the chief problems in the art of milling as it stands to-day is whether the time-honored mill stone shall retain its place in the economy of the mill, or whether it shall be superseded by something else. . . . We believe as yet there has been no mill put in operation in this country which entirely dispenses with the use of mill stones, though there are several which rely principally upon rollers for producing the finer grade of flour, and nearly all new process mills use rollers more or less. There is now in process of construction in this city a complete roller mill which is being put in as an experiment to practically solve the problem whether the best flour can be made by means of rollers alone, or whether mill stones shall still be indispensable adjuncts to our milling system. It is too soon to predict the entire abandonment of the mill stone, and it may safely be asserted that its use will continue for centuries to come." The editor thought the capabilities of the mill stone had not been fully tested, and declared that important differences of opinion about size, speed, dress, and amount of work that it could do, implied ignorance of the prime principles. "Among the best millers," he adds, "by careful attention to the fundamental principles, the mill stone has reached a degree of efficiency in the most advanced milling methods, which leave it largely a matter of doubt whether anything has been yet invented which will surpass it. . .

Millers, though liberal in experimenting and quick to take advantage of that which they find beneficial, are, like other mortals, loth to give up that to which they have long been accustomed and which they know to be good."

It is not necessary to say that the experiment in the Washburn C Mill demonstrated the advantage of the roll over the mill stone. By the spring of 1881 there were two hundred and thirty-one pairs of rolls and only thirty-five run of buhrs in operation in the three Washburn mills; and the mammoth Pillsbury A Mill, erected the same year, installed one hundred sets of rolls and ten run of buhrs.[1] The small number of stones were retained for finishing inferior grades of flour; but it was soon learned that porcelain or smooth iron rolls could do this work more efficiently, and then this remnant of a time-honored system was banished from service. The visitor to the milling district today may see, at what was originally the foot of Seventh avenue South, about a hundred square feet of pacing, formed from a layer of choice French buhrs, -- a proof, without sentiment, that the mill stone has been abandoned in the modern milling system.

In principle, rolls do not greatly differ from mill stones. But since their manipulation is much simpler, the grain can be cracked, the dust freed from the crease, the germ liberated, and the gluten and starch loosened from the bran and powdered, in the gradual manner that is best suited to the exact accomplishment of the project. The grain passes through five sets of rolls in the course of reduction to flour. The first three sets are corrugated,

1. Northwestern Miller, March 25, and April 8, 1881.

and the size of the corrugations respectively decrease with the function of rubbing the bran from correspondingly finer particles of middlings. At the end of each "break," the product passes through a scalper in order to sift the middlings from the bran and to preserve what flour is made. When the middlings are finally separated they are purified; they are then ready for grinding on the two smooth rolls remaining. This is a brief description of the process as employed at the present time, but it does not materially differ from the system in use when rolls were first installed in Minneapolis mills.[1]

The question whether sharp or dull corrugations were best, troubled American millers for some time. The different styles were patented, and the manufacturers of rolls with special corrugations were so insistent upon their respective advantages that the problem soon gathered the additional weight of partianship. The solution was, in fact, important for Minneapolis millers, and remains so today, as it must be made regularly from year to year with the variations in the quality of the wheat. One year the grain will be dry and glassy, and a dull corrugation easily loosens the bran; but the next year may produce a crop whose texture is equally tough, and then a sharp ridge does better work. The shades of difference in the quality of the wheat from year to year are, indeed, numerous. Millers soon saw the necessity of dressing the rolls to meet all conditions, and the patented form early gave way to the head miller's ideas upon the subject. The tougher wheat was preferred because the bran rubbed off without

1. Northwestern Miller, December 24, 1880.

breaking into so many fine pieces and its separation from the middlings was made more easily. Recently the plan of soaking a crop of dry wheat in water has given good results; but there are essential differences in the quality of the grain that persist from year to year, and the change in the dress of the corrugation is still necessary. For many years the large Minneapolis mills have maintained their own machine shops where the change in form is made. The exact character of the corrugation used in each mill has always been one of the head miller's "secrets."[1]

1. An able article upon the subject of corrugations, while the question was mooted, was written by Mr. De La Barre for the Northwestern Miller, February 4, 1881. It is an argument in favor of the sharp corrugation, which was used by the Washburn mills.

Mr. P. V. Lawson has written an article on "The Invention of the Roller Mill" (Wisconsin Historical Society, Proceedings, 1907, pp. 244-258), in which he gives to John Stevens, of Neenah, Wisconsin, full credit for the invention of the roller mill in 1880, and denies its European origin. His statement follows: "In Hungary, the great milling centre of the European continent, they made black bread. There was a tax laid on each run of stone; and the demand for flour increasing, rather than add more run of stone, they devised a cutting machine to aid the stone. This was composed of a set of wooden or iron rolls having their faces fitted with numerous sharp teeth or knives, through which the grain was passed, cutting it into shreds, which were then run through between the mill stones, and ground to powder. This process greatly increased the product of the stones, and saved the payment of the tax. This wheat saw-mill used to aid the stone was the only roller mill devised in Hungary; but was not the non-cutting roller mill invented in Neenah, now the milling method generally used throughout the civilized world." The author furnishes an illustration, taken from the Encyclopedia Britannica, of a cross-section of a pair of rolls with sharp corrugations. It is to this set that he applies the term "wheat saw-mill." Such a roll was made in Budapest by Ganz and Company, from whom Allis and Company obtained the rights of manufacture and sale in America. W. D. Gray, the latter company's engineer, obtained some patents upon the gearing and adjustment of the rolls, and the roller mill was called by his name.

The sharp ridge in this kind of roll, forms an acute angle. Both the upper and the lower line have a downward slope from the surface of the roll, the upper line slightly curving and being longer, so that the point of the corrugation is much below a line drawn perpendicular to the surface of the roll. This form

Of the important effects produced by the adoption of rolls, one was to increase the manufacturing capacity of the mill, and the second was to lower the price of flour. Steel rolls, revolving upon smooth bearings, ran at a much greater speed than the mill stone, and the passage of the grain through the narrow space separating their arcs was much more rapid than when the

of dress enabled the miller to use the same set of rolls upon dry or tough wheat with good advantage; for the position of the rolls in the frame could be reversed, causing them to run with their dull sides toward the grain, or, again, with one side dull and the other sharp. The Stevens invention was a roller mill having its rolls dressed with only a dull corrugation; it could be used to advantage only upon dry wheat. When roller milling was first adopted in this country, the question of the best style of corrugation was largely a matter of theory, and millers were willing and anxious to experiment; so when the Stevens roll, with a dull dress, appeared in 1880, it was given a fair trial. Mr. Lawson says its inventor collected royalty from twenty-two Minneapolis firms. That does not mean, however, that only the Stevens roll was used in these twenty-two mills. A description of the Pillsbury mills and their machinery in 1889 (Northwestern Miller, November 8, 1889), shows there were two hundred and twenty-five sets of rolls in the Pillsbury A Mill; sixty sets in the Pillsbury B Mill; and thirty-six sets in the Anchor Mill, a total in the three mills of three hundred and twenty-two sets. In this number there were sixty-eight sets of rolls with dull corrugations, and only twenty-seven of them were the rolls patented by Stevens. The remainder were furnished by Allis and Company, and were divided between the smooth roll and the roll with a sharp corrugation. Mr. De La Barre, superintendent of the construction of the Washburn A and B Mills, is authority for the statement that the Washburn mills used the roll with a sharp corrugation; and in the Northwestern Miller, February 18, 1881, the advertisement of Stout, Mills, and Temple, of Dayton, Ohio, states that over one hundred and fifty sets of their rolls were used in the Washburn mills. They manufactured smooth and sharp corrugated rolls. The Cararact Mill used rolls with sharp corrugations. How many more mills employed them the writer has not investigated, but those mentioned represent two-thirds of the milling industry of Minneapolis in respect to daily output. Thus the claim of universality that Mr. Lawson makes for the Stevens roller mill as late in the development of milling as 1907, when the circumstances no longer favored a partial attitude, must be seen to be a highly exaggerated statement so far as Minneapolis is concerned. Says Mr. Lawson: "Governor Washburn's success in milling has been erroneously attributed to the introduction of the Hungarian sustem of gradual reduction milling. There was no such system in Hungary, only that described above, and this if it had been introduced in Minneapolis would

grinding extended over the surface of the stone. This difference, with the advantage gained in the matter of floor space, added sixty-two and two-thirds per cent to the manufacturing power. A definite example is furnished by the Cataract Mill, which had a capacity of four hundred barrels a day under the stone system, and by the change reached a maximum of twelve hundred barrels. On a larger scale the proof is seen by comparing the production of twenty-one mills in 1877 with that of twenty-two mills in 1882. The total for the first period was 1,098,000 barrels of flour, and for the second, 3,124,919 barrels. This enlargement of the supply was naturally followed by lowered prices. By 1883 the best Minnesota grade was quoted locally at between six and seven dollars a barrel, which is not much above its present value.[1]

Smaller profits, but a larger volume of business, was the reward of the millers for the change to the improved system. The people benefited by paying less for their bread. The farmers benefited by the increased demand for wheat, and wheat-raising became so profitable an industry that the cultivation of new lands and the extension of settlement soon promoted the growth of the state. Minneapolis thrived from the growth of its grain receipts

never have made successful milling." The warrant for such a statement, it seems to the writer, ought to rest upon the evidence that the Stevens roll had been adopted by the Washburn mills. Stevens visited Europe in 1884. "By the time he reached Hungary," Mr. Lawson declares, "the only roller mill ever devised in that country was a curiosity or had been sold for old iron." With one dip of the pen he thus destroys the fame of the "Pester Walzmuehle," of Budapest.

1. Minnesota Commissioner of Statistics, "Ninth Annual Report," in Executive Documents, 1877, vol. 3: 169; and the Minneapolis Tribune, January 1, 1883.

and the larger sums of money that were put into circulation on its market; from the building of the great elevators that became necessary for the storage of the grain; from the establishment of allied industries, such as shops for the production of mill and agricultural machinery; from the mercantile development that followed the distribution of profits and wages; and from the investments of her flour manufacturers in business blocks and beautiful residences. In short, the possession of the largest flour mills in the United States, and the advertisement of this important fact as a result of the increasing fame of its flour, established Minneapolis as a city with a future, and its rapid growth followed. The population of the city in 1880 was 46,887. Ten years later it numbered 164,738 persons.[1]

The Export Trade.

The development of flour manufacture under the new process, and the favored position of spring wheat flour on the American market, emboldened Minneapolis millers to seek a foreign trade. In 1878, twenty years after the first shipment was made from the state, the first consignment of flour was sent to Great Britian. Mr. W. H. Dunwoody, of the firm of J. A. Christian and Company, had gone to England the preceding year to secure orders. His task proved to be one of the hardest, for British millers took alarm at the attempt to encroach upon their territory and offered a stubborn opposition. The London Globe intimated the nature of the situation in the following language: "Our millers, among others are apprehensive that the aggressive Yankee is contemplating a raid

1. United States Census for 1890, Population, 198, (pt. 1).

in their preserves, and something like consternation is the result. New markets must be found, and a swoop down on English trade by the predacious millers of Minnesota is gravely apprehended. Minneapolis appears to be the headquarters of the milling fraternity in the states. It is situated in the midst of a wheat growing region, and its numerous streams give it the advantage of unlimited water power, of which it takes advantage to drive 300 pairs of millstones. . . Representatives of American millers are already amongst us, it is said,"[1]

To give effect to their opposition, the English millers descried Minneapolis flour as inferior, and, in order to be consistent, asserted the inferiority of all American wheat, which they were importing in large quantities to manufacture into flour for the English people. Bakers and dealers heard Mr. Dunwoody's arguments in favor of the flour with the air of wisdom peculiar to men with a prejudice. But finally he obtained a small order from a firm in Liverpool, and, on the strength of this order, Christian and Company sent consignments to London, Liverpool and Glasgow. Clearly the Minneapolis millers had no intention of stopping at any point in their campaign short of complete victory! Sending these consignments, however, enabled their representative to pursue a reasonable method of salesmanship; for Mr. Dunwoody had previously been under the disadvantage of the commercial traveler who tries to sell the goods of his house without carrying a sample case. As deaf as the British bakers were to argument, they did not refuse to experiment with spring wheat flour, and

1. Quoted by the Fire Insurance Guide, March, 1878, and copied by the Minneapolis Tribune, May 6, 1878.

the trial itself speedily convinced them. Gluten, which is the particular ingredient of spring wheat flour, has the property of absorbing more water than starch, which is the principal element of winter wheat flour; this is the cause of a superior rising quality in the dough and results in giving a greater number of loaves to the barrel. For the sake of economy, therefore, if not for the superior flavor and nutritious quality of the bread, the British bakers were anxious to obtain more Minnesota flour; even British millers changed front and wanted it to mix with their own flour.[1]

In 1878, the shipment to Great Britian amounted to 109,183 barrels. In 1879, there were 435,729 barrels shipped to the United Kingdom; 2,116 barrels to Holland; 3,230 barrels to Belgium; and 1,460 barrels to France. Germany was added to the list of customers in 1880, with an order for 23,510 barrels, and the total to all European countries for this year was 769,442 barrels, being 38.96 per cent of the production of the Minneapolis mills. The adoption of rolls added a million barrels to the put-put in 1881, and 38.58 per cent of this total was sent to Europe. In 1887 the output was 6,574,900 barrels and 2,650,000 barrels, or 40.30 per cent was exported. There was a gradual increase in the foreign trade up to 1900 when 15,082,725 barrels were produced and 4,702,485 barrels were shipped to Europe. The rate of production had risen faster than the growth of the foreign trade, which was then equal to 31.17 per cent of the output. The home and foreign trade had thus far borne a normal relation;

1. Northwestern Miller, February 11, 1881; Minneapolis Tribune, Jan 1, 1883.

but from 1900 to the present time the volume of foreign trade has gradually decreased. In 1915 there was produced 18,089,195 barrels but only 1,459,690 barrels, or 8.06 per cent was exported. The competition of foreign millers explains the decline, together with the fact that a high protective tariff in several countries has shut the Americans out of a number of European markets.[1]

For a number of years preceding the war, Germany succeeded in establishing a claim to a part of the trade, especially in Holland and Norway; and Russia set up a tariff wall around Finland, into which many Minneapolis consignments had hitherto gone. But the competition of British millers has proven the most serious cause for the loss of foreign trade. In order to save local freight on imported wheat, the British have built mills on the quays of the principal ports of entry. They have also exerted an influence upon ocean carriers, which has resulted in their securing a lower rate for the transportation of wheat. The rate, however, was not lowered on flour, so that American exporters have also to pay an indirect tariff in Great Britian. Finally the Canadian trade, both in wheat and flour, has had an important effect in lessening the volume of foreign business. Canada's immense production of wheat gives the British manufacturer of flour another source of supply. Apart from the advantage this gives to the English, it may be noted that Canada has great possibilities of flour production, and that Minneapolis may some day find Montreal an active competitor in the foreign trade. But the question is one that does not at present concern the

1. Minneapolis Chamber of Commerce, Thirty-third Annual Report, 1915, p. 111.

writer of history. The export trade contributed an important part in the development of Minneapolis mills, and, as such an aid, it contributed to the growth of the city and state. This is true in more than an economic sense. Not only a country, but a definite locality, was advertised to consumers of American flour in foreign districts. It is probably that the previous knowledge of Minnesota possessed by many European immigrants since 1880 was derived from the name and fame of its flour. Better than a book it defined the nature of the opportunity to be found there, for it furnished a concrete example of its industries, and to the man who knew the difference between spring and winter wheat it told the character of the climate. Without doubt, many of the farmers of Minnesota who were born in Scandanavia can trace to this practical source of information the influence that controlled the choice of their settlement in America.

Chapter 111.

DISASTERS

The Danger to the Falls.

The beginning of the new process was marked by a threatened loss of the incomparable water power upon which the existence and growth of the flour milling industry so largely depended. The recession of the limestone ledge due to the corrosive action of the water was the cause of the trouble; but the result was hastened by ill-considered means of adapting the natural power to the purposes of manufacture. That the falls had been receding through the course of a long period of time is evidenced by the fragments of limestone strewing the channel of the river all the way to Fort Snelling. Pouring over the precipice and working out a cavity at the bottom by the force of its descent and weight, the powerful volume of turbulent water than beat back against the lower wall of the cliff; the soft sandstone that supported the harder rock was washed away, and the superstructure broke and fell. The detached pieces, sometimes twenty or thirty feet square, lodged at a salient angle and held the water to sharper play against a new surface of exposed sandrock. So the destruction continued. In the summer of 1867 a freshet caused a recession of sixty feet on the west side, and over three hundred feet on the east side of the falls. Ice or logs running in high water served as additional elements of corrosion, not only of the sandrock at the bottom of the falls, but also of the crest of the ledge, which has been

made frangible by frost during the low water of winter.[1]

A few months after the freshet of 1867, Franklin Cook, a government engineer, measured the depth and length of the limestone forming the bed of the river above the falls. At the edge of the precipice he found it to be from ten to twelve feet deep; fifty feet up-stream it was four feet thick; and twelve hundred feet up-stream it terminated, a white sandrock beginning at that point. It was evident that there was needed only a few more freshets like the last to break up the remainder of the ledge and convert a valuable waterfall into an unproductive series of rapids. As a remedy Mr. Cook proposed an apron, estimated to cost $245,000. "A dam to answer the same requirements as the natural dam answers," he said, "could not be put in for less than $1,200,000." Besides saving the difference in expenditure, a means of preventing the loss would afford "inestimable protection to manufactures and those interested in the mill and water-power companies who have expended a large amount of capital in improving the water-power...and have built the two cities at the falls, and thus have added greatly to the wealth and production of the State." But this appeal failed to move the government officials, and only a little more concern appeared to be felt by those whose interests were directly involved. The flood of 1867 had destroyed an affair, called an apron, which the Minneapolis

1. United States Chief of Engineers,"Annual Report," in Messages and Documents of the War Department, 1870, vol. 2: 278-282, (pt. 2). The citation is to Franklin Cook's report, dated December 7, 1867, to Major G. K. Warren, Corps of Engineers, in charge of the improvements and surveys of the Mississippi River. The writer will hereafter refer to the Annual Reports of the United States Chief of Engineers as Messages and Documents of the War Department.

Water Power Company had constructed the preceding year at an expense of $25,000; and another flood in 1869 interfered with the attempt which was then made to rebuild it. Congress was asked in 1868 to give aid in the form of a land grant, and its refusal seems to have been borne in the same spirit of negligence. Mills, erected upon piers, extended into the river and so narrowed the passage beyond that caused by the construction of the dams that much of the furious energy pounding at the foot of the falls might be attributed to this fact along. Yet, with all these causes of destruction at work, there appeared to be none fitted to awaken the commercial mind to a sense of impending danger.[1]

A final experiment in the commercialization of the water power wrought the catastrophe. In 1868 a company owning the southern end of Nicollet Island excavated a tunnel, which was designed to make water power available to the mills and factories that should be built on its property. W. W. Eastman was a member of the company, and whatever credit is due for the scheme undoubtedly belongs to him. In 1864, as a member of the firm that erected the North Star Woolen Mills, at the southwest corner of First street and Sixth avenue South, he had devised a similar means of obtaining power from the canal. This mill is situated on the side of the canal furtherest from the river, and at the time of its erection it was a problem to the Water Power Company, and to others, how the water could be used and disposed of; for it was the custom to build mills between the race and the river, so that the water, after passing over the wheel, could reach the river

1. Messages and Documents of the War Department, 1872, vol. 2: 296-306, (pt. 2).

again by a convenient channel. Mr. Eastman simply dug a tunnel under the canal, and originated a plan for the disposal of the waste water which has made possible the building of all the mills that now stand on the west side of the canal.[1] The Nicollet Island promoters intended to obtain water power from the level of the mill ponds that would be provided on each side of the island, and proposed to carry the tunnel from a point below the site of the mills to the river at the south end of Hennepin Island, a distance of twenty-six hundred feet. Digging through the soft sandrock underlying the limestone ledge had been proven practicable, and what might have been the industrial development of the city if the project had been successfully completed is a subject worthy of the thought of the theorist.

Excavation was started at the foot of the tunnel on Hennepin Island, instead of at the head in accordance with engineering principles, and on Monday, October 4, 1869, the work had advanced to a point under Nicollet Island, about two thousand feet from the beginning. That forenoon the workmen found water in the bottom of the tunnel; the depth slowly increased and an anxious period was spent in attempting to find the source of the leak. On Tuesday morning an eddy was seen in the river near the west bank of Nicollet Island, about four hundred feet northwest of the head of excavation. This little pool of whirling water remained fixed, unlike the usual pool in a stream, and the explanation for the fact could only be made by supposing the existence of a break in the bed of the river and the flow of the

1. The writer was given the information pertaining to the erection of the North Star Woolen Mills by Mr. Barber.

water through a subteranean channel. Although this was clearly the source of the water that was filling the tunnel, no immediate alarm was felt; by the expenditure of a little time and labor, it was assumed, the break could readily be mended. But the size and force of the whirlpool grew, and suddenly, while men were loading a raft to sink over the spot, it acquired the violence of a maelstrom, and the tunnel at the same time became a roaring sluiceway. At the lower end of Hennepin Island, for a distance of two hundred feet, the surface above the tunnel caved in, carrying down two teams and wagons that were standing before the Summit Mill. A panic followed. It appeared that the whole of Hennepin Island would be washed away, and the employees of the several mills hastened to take out the moveable property from the endangered buildings. A large crowd gathered to witness the strange sight, and a small army of men, including the companies of the fire department, was hard at work in an endeavor to stop the cause of the damage. The attempt to sink a loaded raft into the break was again made, but vainly. A plan that was discussed was to blow up part of the main dam and turn the river into a new channel. It was decided, however, to build a cofferdam around the break. This plan was pursued in the feverish fear that the river would, before the work could be completed, wash out the bed-rock of the falls. "All Tuesday night," states the St.Paul Pioneer in its issue of October 7, "a large force of men kept at work. Huge bonfires were built and locomotive headlights hung up to throw light upon the field of operations." But no greater disaster then occurred, and the cofferdam was built and served

its purpose.[1]

Just how the digging of the tunnel had been the cause of the break in the river-bed may be understood by recalling Franklin Cook's measurements of the limestone shelf. A wedge-like rock twelve hundred feet long, its thin edge rested up-stream upon a soft sandrock subject always to the action of the water. In the form of percolation this action was going on when the tunnel was pushed through the porous substructure. The minute channels soon filtered out a wider course and when an appreciable amount of the sand which supported the river-bed was washed out the weight of the water broke the ledge. Once started, the process of undermining progressed rapidly, until the break had become dangerously extended. Two dangers then, threatened the existence of the falls: one was from recession, and the other was from percolation at the head of the ledge. The cities of St. Anthony and Minneapolis, with a number of private citizens, undertook the work of preservation; and the federal government, as conservator of the navigation of the river, extended aid. The river was a determined antagonist. It raised the height of the tunnel from six to sixteen feet, and widened it from six feet to a width varying from ten to ninety feet. Fifteen days after effecting the first break in the ledge it crushed in the roof of the tunnel between the two islands. July 13, 1871, it burst into the tunnel by washing under the ledge on the east side of Nicollet Island, and, finding the outlet closed by debris, forced its way into the main

1. Contemporary accounts can be found in the newspapers of Minneapolis and St.Paul. For a technical description see Messages and Documents of the War Department, 1879, pp. 1159-1165, (pt. 2).

river by a new channel. Finally, on April 15, 1873, it entered the tunnel by opening a gap in the cofferdam built around the second break and, besides tearing down timber and masonry, drowned one of the workmen.[1]

In the spring of 1870 the city of Minneapolis sent for James B. Francis, engineer of the Lowell Water Works, Massachusetts, to outline a plan of restoration. He recommended an apron to prevent the recession of the falls, a low dam to flood the limestone and prevent frost and abrasion, and the plugging of the tunnel. Such a plan, it will be noticed, did not recognize the danger from percolation at the head of the limestone ledge, unless it was supposed that filling the tunnel would provide against it. Two commitees were appointed to carry on the work. The "Board of Construction" undertook the building of the apron, and the "Union Committee" engaged to fill the tunnel. By an act approved July 11, 1870, Congress appropriated fifty thousand dollars for the preservation of the falls. Colonel J. N. Macomb, Corps of Engineers, stationed at Rock Island, was given the direction of the government expenditure, and Franklin Cook was placed in local charge of the work. Mr. Cook cooperated with the Union Committee and commenced work at the head of the tunnel. As his position was the point of the river's attack when it succeeded in undermining the ledge or bursting through a protective barrier, the duty of repairing the damages fell to him. In 1867 he had pointed out the danger to the falls from recession. As clearly now he defined the

1. Messages and Documents of the War Department, 1874, vol. 2: 379, (pt. 1). Opposite page 286 is a map of the river at the falls, showing the position of the breaks in the river-bed and the extent of the proposed improvements.

danger which existed from the washing out of the sandstone at the head of the ledge, or the danger from percolation. His remedy was a wall that should be built across the river at the head of the ledge, from the top down to a hard stratum below the soft sandrock. Colonel Macomb approved the plan and it was accepted by the board of officers of the Corps of Engineers which met at Minneapolis, August 10, 1872, "for the purpost of considering and reporting upon the whole subject of the preservation of the Falls of St. Anthony and the work now in progress therefor."[1] But Congress did not respond by increasing its annual appropriation of fifty thousand dollars. With the sum voted the following year, the government appropriations amounted to two hundred thousand dollars, a good share of which was spent in repairing damages that had resulted from the want of adequate means of prevention. In April, 1874, a second board of engineer officers met at Minneapolis, whose report declared that the most threatening of all the dangers to the falls was the percolation of water through the underlying soft sandrock. In regard to the remedy the board made the following statement: "The wall at the head of the limestone ledge, proposed by the board of 1872, would effectively cut off the percolations through the soft stratum beneath the limestone ... but its construction now would be attended with greater difficulty as well as greater risk, and the cost would be much greater than formerly estimated. The board is now reluctantly constrained to recommend

1. The board's recommendations can be found in Messages and Documents of the War Department, 1872, vol. 2: 296-306, (pt. 2). For Franklin Cook's plan see Senate Executive Document, No. 59 (in series numbered from 36 to 87), Forty-second Congress, Second Session.

that measures more readily executed and involving less expenditure be undertaken and completed as soon as practicable. ... These measures are the introduction of a dyke of concrete to extend across the river at a position lower down the channel, along a line a short distance above the apron on the Minneapolis side. ... The board is of the opinion that the plan of the board of 1872 should ultimately be carried out, and the whole mass of the sandstone between the crest of the falls and the head of the ledge be preserved by inclosing it between the wall proposed by the board of 1872 and the dyke now recommended to be constructed."

The earnestness of the board was convincing, and June 23, 1874, Congress appropriated $125,000 for the construction of the dyke. Work was begun the following month and, aided by further appropriations, it was finished in November, 1876, at a cost of $212,000. The dyke is joined to the limestone ledge; it consists of a concrete barrier four feet thick, thirty-eight feet deep, and two thousand feet long. The wall recommended for the head of the ledge has never been built. Concerning the other works undertaken for the preservation of the falls, the tunnel was filled by 1874, and the apron was completed at about the same time. In 1877 was begun the construction of two low dams which would keep the limestone covered and free from the action of frost during periods of low water in winter. Improvements to the apron, and the construction of a surface wall at its westerly end, prolonged the operations to the year 1879. For this work of preservation the city and its citizens paid $334,500, and the government'

appropriations amounted to $545,000.[1]

The breaks in the river-bed occurred at a time that was critical in the history of flour milling. Had the falls been lost in 1869 the mills already in existence in Minneapolis might have remained, but it is not likely any more mills would have been built - at least, not until the government had built a dam to take the place of the falls. Pending the construction of such a work, enterprising millers would have sought another location, and how different would have been the history of Minneapolis can best be imagined. This much is certain: that if the falls had been swept away and the water power had been saved by artificial means, the necessary location of the dam above the rapids would have changed the manufacturing site of the city, and its growth would have been delayed by the time and cost of rebuilding. Enough time has passed since the completion of the works of preservation to prove their permanent value. To maintain these works in their present state of effectiveness is the care of the federal government.

Fires and Explosions.

An accident more appalling than the disastrous breaks in the river-bed, because of the loss of life, was the fire and explosion of May 2, 1878. A small blaze of unknown origin, but supposed to have been started by the friction of a set of stones, ignited the flour-dust suspended in the atmosphere of the Washburn A Mill and produced a gas which blew up the building with the same terrible effectiveness that accompanies the explosion of

1. Messages and Documents of the War Department, 1874, vol. 2: 277-287, (pt. 1); and 1879, pp. 1159-1165, (pt.2).

a mine of gunpowder. The force of the explosion carried flames into the flour-charged atmosphere of the Diamond and Humboldt Mills and wrought a similar wreck. One wall and the roof of the Washburn B Mill collapsed. The Zenith, the Galaxy, and the Pettit-Robinson Mills had been shut down for a number of days and the flour-dust had settled upon the beams and machinery; but the shock communicated to these buildings threw the dust into circulation, which spread into a sheet of flame when burning missiles were blown through the windows. They were soon destroyed, but did not explode. The fire swept over a large area and added to the ruin an elevator, two planing mills, two machine shops, a cooper shop, a lumber yard, a number of freight cars, and several small buildings. The property loss amounted to $800,720, and eighteen persons, thirteen of whom were in the Washburn A Mill, suffered the loss of life.[1]

The explosion occurred in the evening at twenty minutes past seven. Henry Stephenson, one of the witnesses at the coroner's inquest, was standing on the lower bridge and saw a flame flash out of a window in the basement of the Washburn A Mill; directly it seemed to be sucked in and a puff of black smoke rolled out. The next moment the entire lower floor was in flames, there was a sharp report, and the fire mounted so rapidly from floor to floor that, in an instant, the whole mill seemed to be

1. Contemporary accounts of the explosion of May 2, 1878, can be found in the Minneapolis Tribune, daily issues from May 3 to May 23, 1878; and American Journal of Science and Arts, 116: 301-306 (October, 1878). The author of the last mentioned account was Stephen F. Peckham, Professor of Chemistry, University of Minnesota, and one of the expert witnesses at the inquest.. For a brief treatment, see Rogers, "History of Flour Manufacture in Minnesota," in M. H. C., 10: 51, (pt. 1).

illuminated; so rapid was its progress that he could not tell whether the first report was followed by one or by two more reports. According to the evidence of the majority of witnesses there were three explosions. The first one must have occurred in the dust-room, where the open purifiers kept such a cloud of fine particles in circulation that the employees had to wear sponges for the protection of the mouth and nose. The shock of the first explosion would unavoidably throw into the air the dust that had settled in other parts of the building and cause these which followed.

The Washburn A Mill was the largest mill then at the falls. It was seven and a half stories high and measured, on the ground, one hundred by one hundred and thirty-eight feet. Its stone walls were six feet thick at the base and eighteen inches at the top. The Minneapolis Tribune described it as "the largest, the highest, and probably the heaviest stone structure in Minneapolis." The force of the explosion that tumbled down such a building is not easily expressed. The glass was shattered in the store windows on Washington avenue for a distance of eight blocks from the ruined mills; a stone of fifty pounds weight was hurled for the same distance and found on the roof of the Merriam building; pieces of timber were scattered beyond these points; and persons in the vicinity of the mills were tossed and bruised, and in some cases knocked down.

It was not an uncommon experience to have stones run dry and cause a blaze by heating the grist to a burning temperature; and the number of fires and explosions that had originated in this manner emphasized the need of the utmost watchfulness.

But millers presumed that explosions were produced by the formation of a gas generated from the heated grist and allowed to circulate throughout the mill. A number of experiments were made by L. S. Peck, instructor in physics in the University of Minnesota, and one of the expert witnesses at the coronor's inquest, which proved that flour or middlings did not produce a gas that was an explosive. He explained the subject as follows: "We speak of gunpowder as an explosive, that is, when the proper chemical action takes place between its different parts, gases at a high temperature are produced which require a very great additional space, hence the bursting. ... Flour dust, flour middlings, etc., when mixed with air, thick enough to ignite from particle to particle and separated so that each particle is surrounded by air, will unite with the oxygen in the air producing a gas at a high temperature, which requires an additional space," and causes the same result as in the case of gunpowder. This evidence assisted the mill owners in collecting the full amount of the insurance; for the insurance companies had taken the position that the explosion was of a chemical nature and wanted to limit the amount of damages to the loss occasioned by fire.[1] It was further shown that the danger of explosions proceeded from the open purifiers. So when the mills were rebuilt the enclosed purifier was installed, and soon afterward dust collectors were added. The last provision for safety has so clarified the atmosphere of the modern mill that the possibility of an explosion is exceedingly remote, if it even exists.

1. Minneapolis Tribune, May 21, and July 24, 1878; and Minnesota Insurance Commissioner, "Eighth Annual Report," Executive Documents, 1878, vol. 3: 37.

The fire of second importance in the milling district occurred December 4, 1881. It started in the Pillsbury B Mill at an early hour of the morning, and spread to the Excelsior, Empire, and Minneapolis Mills. All were destroyed. In the course of its burning, the Minneapolis Mill exploded, and a falling wall killed four firemen.[1] Twenty-two lives lost and eleven mills destroyed comprise, then, the disastrous record of three years! The isolated facts present only a subject for moody reflection. But considering the matter from the view of ultimate progress one may discover in these losses the basis for a more substantial development of the milling industry, and a larger growth for the community; for bigger mills took the place of those destroyed, which better served the new era of gradual reduction milling and helped to fulfill the hopes of a thriving city.

1. Minneapolis Tribune, December 5, 1881.

Chapter IV.

CONCLUSION

The most prominent name in the history of the flour milling industry of Minneapolis is that of Hon. Cadwallader C. Washburn. He was born in Livermore, Maine, April 22, 1818, and, in his youth, worked on his father's farm, clerked in a village store, taught school, and studied law. When he was twenty-one he went to Davenport, Iowa and became the surveyor of Rock Island County. In 1842 he had completed his legal studies and was admitted to the bar. He then settled in Wisconsin, and his chief interests there became real estate, banking, and politics, in all of which he made a pronounced success. From 1855 to 1861 he represented the second Wisconsin district in Congress, and then the sixth district from 1867 to 1871. He engaged in the Civil War as colonel of the second Wisconsin cavalry, was made brigadier-general of volunteers in July, 1862, and in November of the same year was raised to the rank of major-general. In 1872 he was elected governor of Wisconsin. At the close of his term of office he turned to the care of his business interests and was active in these duties until his death, which occurred at Eureka Springs, Arkansas, May 14, 1882.[1]

The first of the large flour mills that C. C. Washburn

1. Notable Americans, vol. 10. The material of the volume is presented in alphabetical order.

built at Minneapolis was erected in 1866. His policy at first was to rent the mill, but in 1869 he formed a partnership with George H. Christian and began milling on his own account; he held a similar interest in succeeding firms, although his name does not appear in the style of the company. The second mill was erected in 1873, and the third in 1879. It might be supposed that the possession of such large interests in Minneapolis would result in his residence in the city; but Mr. Washburn's lumber and railroad interests in Wisconsin were quite as important, and so he enjoyed the distinction of being the leading miller of Minneapolis without having the pleasure of being regarded as one of its leading citizens. But, indeed, it is not just because of his large investments in flour mills that he holds his high position in the milling industry. The essence of his character appears to have been a sound progressiveness, and in the business of flour milling this quality was manifested by his readiness to experiment with new and improved methods of manufacture. When La Croix and Smith perfected the purifier in his mill, he sent George H. Christian to Europe to study the methods there and see if further advancement was possible. And when rolls were introduced into this country, Mr. Washburn was the first in Minneapolis, and the first in the United States, to make a thorough experiment with them. He guaged success, not merely from the evidence to be found in its financial rewards, but as well from a consideration of the benefits it created for the community. As children revere the memory of a good father, so the citizens of Minneapolis look back to the man whose dependable qualities added such strength to the industrial development of the city.

The name of Charles A. Pillsbury also looms large in the flour milling history of Minneapolis. He was born at Warner, New Hampshire, October 3, 1842, graduated at Dartmouth College in 1863, and spent the following six years at Montreal as a clerk in the employment of a general commission firm. In 1869 he came to Minneapolis where his uncle, John S. Pillsbury, had resided since 1855. His milling experience began with the purchase of a third interest in a small mill owned by Gardner and Crockett, and the success of this venture resulted in the organization of a new firm in 1872, of which Charles A. Pillsbury became the head. During the seventies the Pillsbury Company operated two mills of their own and leased two more. The latter, with one of their own mills, were destroyed by the fire of 1881. But the same year the new Pillsbury A Mill was completed and the firm was not seriously handicapped by the loss. The Pillsbury A, the rebuilt Pillsbury B, and the Anchor Mills were sold to an English syndicate in 1889. At the same time the syndicate purchased from W. D. Washburn the Palisade Mill in Minneapolis and the Lincoln Mill at Anoka; the east and west side water powers; and the Washburn line of elevators on the Manitoba railroad. The owners styled the firm the Pillsbury-Washburn Flour Mills Company, and Charles A. Pillsbury became the manager of the new concern, retaining this position until his death, September 17, 1899. The mills are now operated by the Pillsbury Flour Mills Company, under a leasr from the English company.[1]

The Pillsbury A Mill is the largest in the world. It has a daily capacity of 12,500 barrels, which is 2,500 barrels

1. Northwestern Miller, November 8, 1889.

more than the daily capacity of the Washburn A Mill. As the builder of such a mill, and the organizer of a business which manufactures one-third of the flour output of Minneapolis, Charles A. Pillsbury deserves to hold a special rank among the notable promoters of the city's growth and welfare. As a captain of industry his methods were fair and honorable; the humble and great alike pay this tribute to his memory.

The English syndicate attempted to get control of the Washburn-Crosby Company's mills. Although the attempt was unsuccessful, the fear of a trust frightened many of the smaller millers of the city and suggested the possibility that the day of the small mill was past. The cost of advertising, the expense of maintaining a selling force, and the sharpness of competition, made a combination of interests seem desirable. Accordingly, in July, 1891, the Northwestern Consolidated Milling Company was formed and included the Galaxy, Columbia, Northwestern, Zenith, Crown Roller, and Pettit Mills. In 1899 this property passed under the control of the United States Flour Milling Company, which endeavored to form a milling trust. It secured an option on the Pillsbury-Washburn Company's mills, and on several of the small independent mills; but failing to get control of the interests, the company surrendered its options and soon afterward passed into bankruptcy. From the wreck of this company was organized the Standard Milling Company, which then became the owner of the stock of the Northwestern Consolidated Milling Company.[1]

1. The facts relating to the formation and subsequent history of the Northwestern Consolidated Milling Company were given the writer by Mr. A. E. Woollan, the company's auditor.

The annual report of the Chamber of Commerce for 1915 gives the total daily capacity of Minneapolis mills as 79,360 barrels, of which 9,800 barrels are produced by seven small companies; 28,500 barrels by the Washburn-Crosby Company; 15,960 barrels by the Northwestern Consolidated Milling Company; and 25,000 barrels by the Pillsbury Flour Mills Company. A rye mill with a daily capacity of 800 barrels is included in the capacity of the Washburn-Crosby Company's output. The average daily output seldom reaches these figures; they merely show the result of test conditions. The capacity of the mills has been increased at various times since the adoption of the roller system. This has been done by using the floor space more economically; by installing improved machinery; and by obtaining a better knowledge of the capabilities of rolls. As an illustration of the last means, it was thought at one time that when rolls had reached a speed of six hundred revolutions a minute they had attained the maximum; but this speed has been increased until they now make eighteen hundred revolutions a minute. Other improvements may yet be added which will increase the daily output.

By the introduction of the purifier into the Minneapolis flour mills, spring wheat became a more valuable crop; a marked increase resulted in the flow of immigration to the state, and new lands came under cultivation. The raising of wheat called for better farm machinery, and railroads to transport the crop to the market. By the adoption of rolls the Minneapolis mills enlarged the wheat market and stimulated the demand for its production. In 1870 the city, with a population of 13,066, acknowledged its greater dependence upon the lumber industry. But under new

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