8.

Diamond Chain and Manufacturing Company of Indianapolis, Indiana, U.S.A., 1890 – 1918

By Robert McCullough, Vermont, USA

In 1897, precisely when troubling trends in the bicycle industry began to cause alarm among some perceptive company owners, an English-born engineer living in California, Ernest Ransome, coincidentally demonstrated the great potential for reinforced concrete as a building material for industrial and commercial architecture that would benefit bicycle manufacturers. In 1884, Ransome had patented a method of strengthening concrete using twisted iron bars to create secure binding between the two materials, and he followed that invention with patented systems for assembling buildings of reinforced concrete, initially using a combination of load-bearing walls and interior cages of reinforced concrete, but soon achieving full skeletal-frame construction.[1]

In Bayonne, New Jersey, Ransome designed a plant for the Pacific Coast Borax Company in two phases, with the 1897 factory and its large 1903 addition among the country's earliest industrial buildings to exhibit the viability of his inventive construction methods. Ransome designed two other factories in 1903, one in Greensburg, Pennsylvania and the other in Beverly, Massachusetts, at long last offering what America's factory mutual insurance companies had been seeking for most of the nineteenth century: an industrial structure generally immune to fire.[2]

In addition, reinforced concrete offered benefits that extended well beyond protection from fire. The material's overall strength greatly surpassed that of load-bearing brick, the latter far more vulnerable to compression and tensile stresses. As well, the fully integrated, monolithic composition of skeletal-frame reinforced concrete structures absorbed motion and vibration from heavy machinery much more efficiently than traditional methods of resting timber floor beams in pockets of brick walls, even when secured by anchor bolts. Skeletal frames also accommodated expansive window walls, permitting natural light to penetrate further into factory interiors. Combined, all these advantages encouraged industrial buildings of greater size, improving economies of scale and, ultimately, potential for profit in the bicycle industry.[3]

Although knowledge regarding the technology of reinforced concrete construction circulated rapidly, the bicycle boom had ended by the time Ransome had demonstrated the material's full potential in 1903: Well before then, the American Bicycle Company had begun closing rather than building factories. Yet a few firms, notably the Diamond Chain and Manufacturing Company in Indianapolis, maintained the bicycle industry's aura of progressivism and turned to reinforced-concrete construction, erecting a new factory in 1917 that nudged the bicycle industry's contributions to nineteenth-century industrial architecture into the twentieth century. **[Figure 1]**

Figure 1. Diamond Chain and Manufacturing Company factory. Author's photo.

Figure 2. Arthur Newby.

The Indianapolis factory is historically significant because it displays the influence of Ransome's innovations, but also because the building exploits other advances in concrete constructional engineering developing at the time, notably a more advanced method of skeletal frame construction reliant on floor slabs of reinforced concrete, but without the heavy beam and girder framing used by Ransome. Instead, mushroom-head columns countered shear stresses with reinforced cantilever and material mass at the juncture of the columns and floor slabs, the latter poured over a labyrinth of reinforcing rods – a design advanced by another

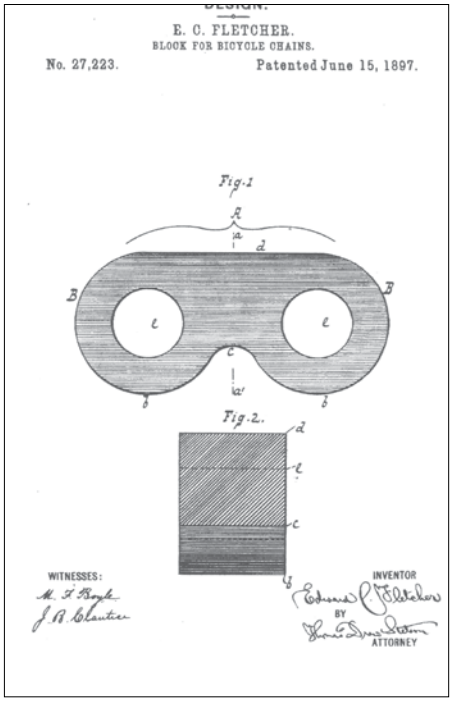


Figure 3. Fletcher chain bloxk patent.

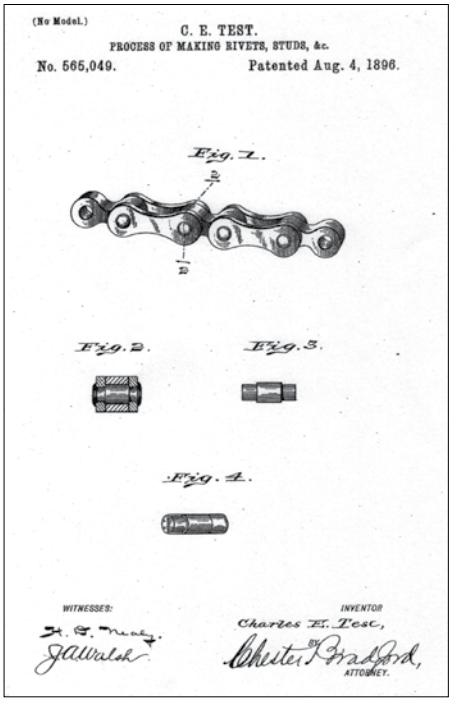


Figure 4. C.E. Test chain rivet and stud patent.

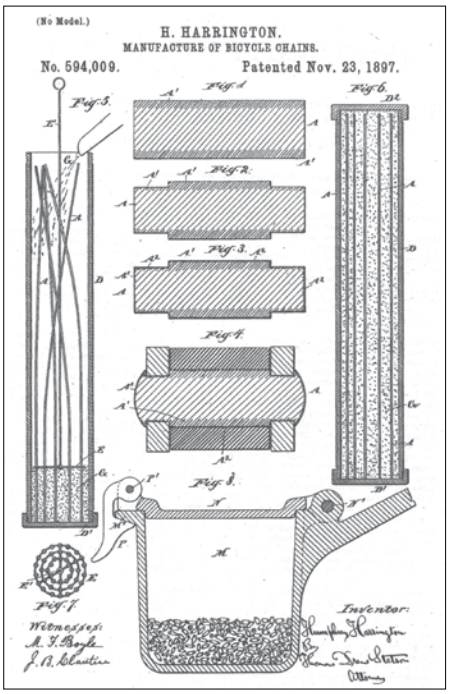


Figure 5. H. Harrington patent for a process for carbonizing and hardening chain rivets.

engineer, Claude A. P. Turner.[4]

The Diamond Chain and Manufacturing Company factory is especially significant, too, for the company's contributions to the history of bicycle manufacturing, one of the very few companies to emerge from the ruins of the American Bicycle Company Trust and to resurrect its business successfully: Both the company and its factory survive today, although the latter is threatened.

Indianapolis Chain and Stamping Company

Indianapolis grew into one of the country's eminent cycling cities, with an active cycling club; a contingent of shops along North Pennsylvania Street – the city's Bicycle Row; a celebrated cycling track, the Newby Oval that was completed just in time for the city to host the annual meet of the League of American Wheelmen in 1898, and thereafter a stop on the national racing circuit; a Wheelway League that adapted the towpath of the ill-fated Indiana Central Canal into a well-groomed bicycle path; a journal, The Indiana Woman, with a regular column titled "Wheel Whirls" together with an annual issue devoted solely to bicycles; and the starting line for the career of world champion cyclist Major Taylor. The city also supported nearly a dozen gainful bicycle manufacturers as well as numerous producers of parts, but none more successful than the Indianapolis Chain and Stamping Company. The business was formed in December 1890 by entrepreneurs Arthur C. Newby **[Figure 2]**, Edward C. Fletcher, and Glenn Howe, the concern's sole owners who soon were joined by Charles E. Test, who became a principal partner. Newby occupied the president's chair, and the company timed its entry into the trade perfectly – just as the shift from high-wheel ordinaries to chain-driven safety bicycles unleashed the bicycle boom. Adroitly, Newby marketed the company as the country's only (and later the first) manufacturer of chains designed exclusively for bicycles, at a time when England and France dominated the chain industry. With pooled capital of only $5,000, the partners adopted a diamond trademark and began production in a tinner's shop on South Street, employing twenty-five workers to produce 100 chains each day.[5]

Newby, born in 1865 to a farming family in Monrovia, Indiana, moved to Indianapolis in 1881 and gained experience in both accounting and machine manufacturing at Nordyke Marmon and Company, which had become one of the country's leading builders of mills and mill machinery. Captivated by bicycles and bicycle racing, he helped to found the city's Zig-Zag Cycling Club, also established in 1890, and in doing so fashioned the first of several racing venues that would propel his career. Both Fletcher and Test, the latter also an alumnus of Nordyke Marmon, endowed the partnership with mechanical expertise, and each was inclined toward invention. Fletcher designed a chain block **[Figure 3]**; Test conceived a process for making rivets and studs **[Figure 4]**; and a third mechanical engineer affiliated with the company, Humphrey Harrington, invented a process for carbonizing and hardening chain rivets **[Figure 5]**: All three of these men assigned their patented originations to the company.[6]

Unlike so many new ventures in bicycle manufacturing during the 1890s, bubbling with publicity, promotion, and proclaimed superiority, the Indianapolis concern conducted business a safe distance from those distractions, quietly reinvesting profits and quickly becoming the country's dominant manufacturer of bicycle chains. By the summer of 1891, the firm had increased its capital to $7,500, and by December 1892, production had moved to the third floor of an industrial loft on West Maryland Street, the Reaume Building, providing space large enough to shelter the firm's sixty machines and a similar number of employees. By fall of the following year, capitalization had climbed to $30,000 and employment

approached 150, forty of whom were women. At the start of the 1895 season, the company employed 350 workers who attended 140 machines of various types, turning out 1700 chains daily.[7]

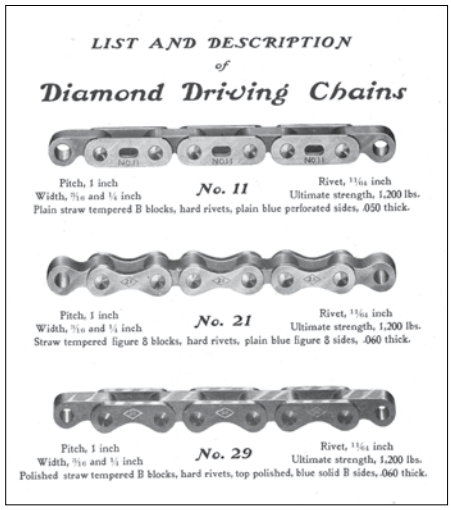
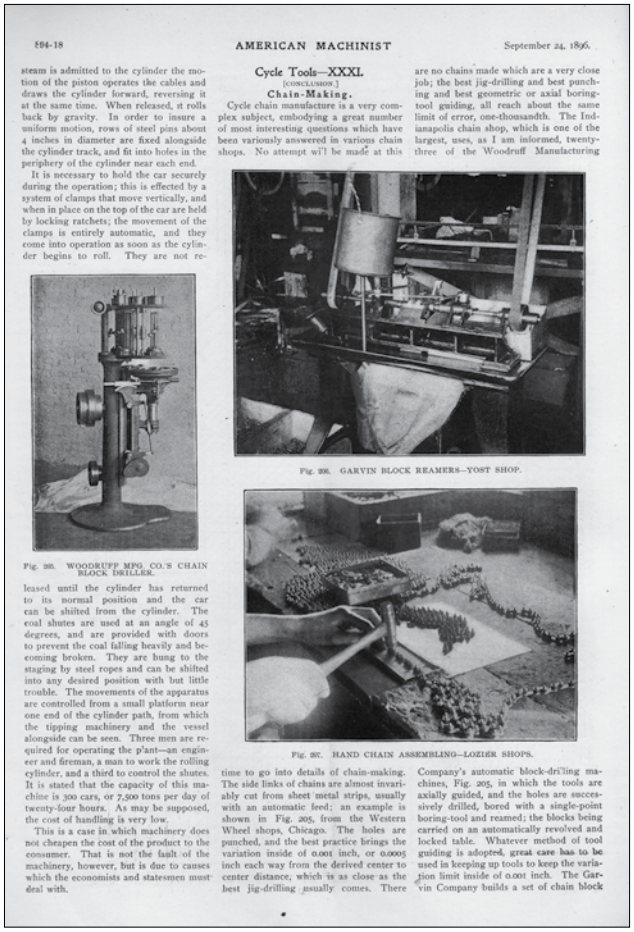


Figure 6. American Bicycle Company, Automobile and Cycle Parts Co. Subsidiary, Diamond Chain Factory, 1901-1902 Catalog. Author's document.

Initially, the company produced block chains, which by the 1890s had become the most widely used type of chain for bicycles. Chain-blocks consisted of solid, sinuously-shaped units of hardened steel, each with two holes for the rivets that held the chain's side plates in place **[Figure 6]**. During its early years, the firm relied heavily on handwork, but by 1895 machines controlled almost all aspects of production. Mechanization had surged forward in 1894 when the company purchased multiple machines designed by the Woodruff Manufacturing Company in Hartford: Each machine was capable of automatically drilling, reaming, and counterboring the chain-blocks **[Figure 7]**. Raw materials arrived in the form of six-foot lengths of steel for the blocks; six-foot lengths of narrow, flat steel strips for side plates; and ten-foot lengths of heavy wire for rivets. Attendants used the Woodruff machines to fabricate blocks; passed the flat strips through a stamping machine to form side plates; and fed wire into machines that measured and cut rivets. Workers then assembled the pieces loosely by hand in preparation for riveting by machine, followed by inspection and testing to stresses of 1,200 pounds.[8]


594-18 AMERICAN MACHINIST September 24, 1896.

steam is admitted to the cylinder the motion of the piston operates the cables and draws the cylinder forward, reversing it at the same time. When released, it rolls back by gravity. In order to insure a uniform motion, rows of steel pins about 4 inches in diameter are fixed alongside the cylinder track, and fit into holes in the periphery of the cylinder near each end.

It is necessary to hold the car securely during the operation; this is effected by a system of clamps that move vertically, and when in place on the top of the car are held by locking ratchets; the movement of the clamps is entirely automatic, and they come into operation as soon as the cylinder begins to roll. They are not released until the cylinder has returned to its normal position and the car can be shifted from the cylinder. The coal shutes are used at an angle of 45 degrees, and are provided with doors to prevent the coal falling heavily and becoming broken. They are hung to the staging by steel ropes and can be shifted into any desired position with but little trouble. The movements of the apparatus are controlled from a small platform near one end of the cylinder path, from which the tipping machinery and the vessel alongside can be seen. Three men are required for operating the plant—an engineer and fireman, a man to work the rolling cylinder, and a third to control the shutes. It is stated that the capacity of this machine is 300 cars, or 7,500 tons per day of twenty-four hours. As may be supposed, the cost of handling is very low.

This is a case in which machinery does not cheapen the cost of the product to the consumer. That is not the fault of the machinery, however, but is due to causes which the economists and statesmen must deal with.

Fig. 205. WOODRUFF MFG. CO.'S CHAIN BLOCK DRILLER.

Cycle Tools—XXXI.
[CONCLUSION.]
Chain-Making.

Cycle chain manufacture is a very complex subject, embodying a great number of most interesting questions which have been variously answered in various chain shops. No attempt will be made at this time to go into details of chain-making. The side links of chains are almost invariably cut from sheet metal strips, usually with an automatic feed; an example is shown in Fig. 205, from the Western Wheel shops, Chicago. The holes are punched, and the best practice brings the variation inside of 0.001 inch, or 0.0005 inch each way from the derived center to center distance, which is as close as the best jig-drilling usually comes. There are no chains made which are a very close job; the best jig-drilling and best punching and best geometric or axial boring-tool guiding, all reach about the same limit of error, one-thousandth. The Indianapolis chain shop, which is one of the largest, uses, as I am informed, twenty-three of the Woodruff Manufacturing Company's automatic block-drilling machines, Fig. 205, in which the tools are axially guided, and the holes are successively drilled, bored with a single-point boring-tool and reamed; the blocks being carried on an automatically revolved and locked table. Whatever method of tool guiding is adopted, great care has to be used in keeping up tools to keep the variation limit inside of 0.001 inch. The Garvin Company builds a set of chain block

Fig. 206. GARVIN BLOCK REAMERS—YOST SHOP.

Fig. 207. HAND CHAIN ASSEMBLING—LOZIER SHOPS.

Figure 7. Chain Block Driller. Woodruff Manufacturing Co. American Machinist, September 24, 1896.

The inventions by Test, Fletcher, and Harrington, developed in 1895 and 1896, improved various aspects of that production system. Test devised a method of hardening just the center portions of rivets inserted through the chain-blocks, charging the rivets with carbon followed by immersion in a hardening compound, all the while protecting the rivet heads with caps in order to main-

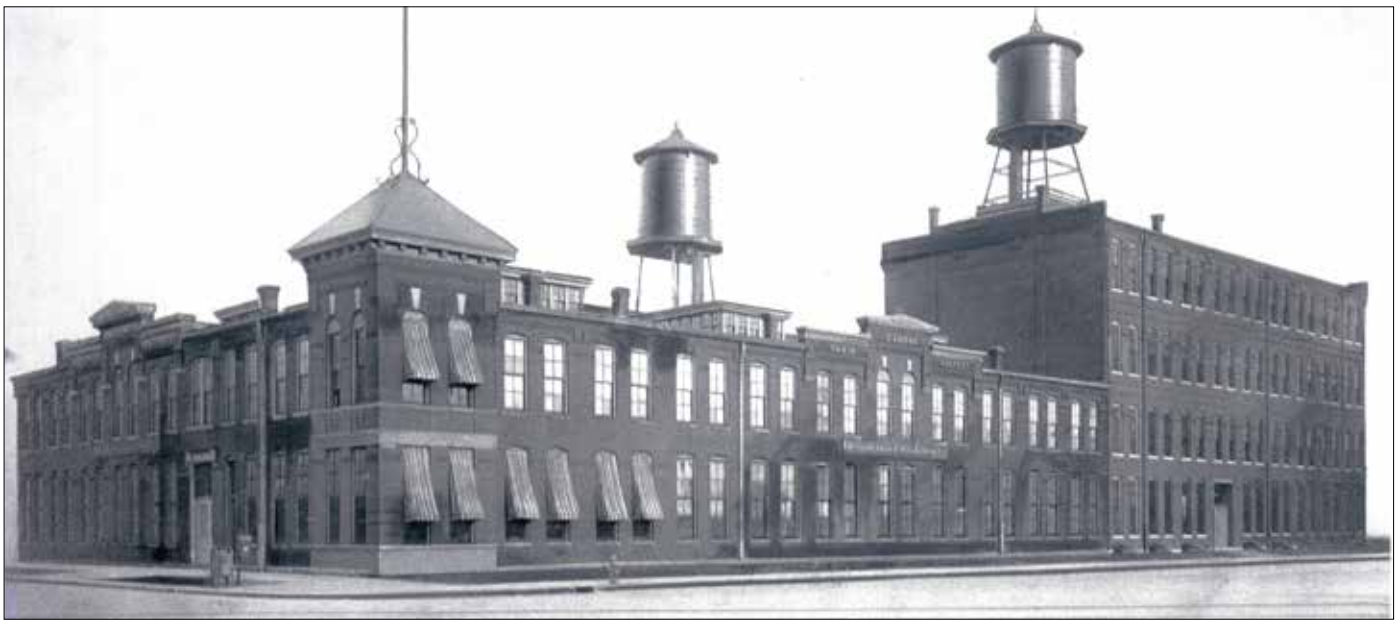


Figure 8. Indianapolis Chain and Stamping Co. factory, 1895. Corner of Kentucky Avenue and West Georgia Street. Courtesy Diamond Chain and Manufacturing Co.

Figure 9. Factory illustration in company trademark. Author's document.

tain proper softness during the heading process. Fletcher simplified the shape of chain-blocks by giving the outer-face of the block a flat profile, noticeably distinct from the sinuous profile of the inner-face that engaged the sprockets, and thus giving the company's chains a recognizable design **[Figure 3]**. Harrington improved Test's system of rivet-hardening with a four-part process, beginning with carbonizing of shortened lengths of wire, followed by machining to reduce the diameter of the rivet necks and cutting them to length. A second carbon treatment toughened the entire surfaces of the fully shaped rivets, and the procedure concluded with a third hardening by sudden cooling from red heat.[9]

Georgia Street Factory

Mechanization improved the company's capacity to meet growing demand, but regiments of machines required additional space, so late in 1895 the company built a new factory located at the southeast corner of Georgia and Mississippi Streets, where the two intersected one of the city's planned radial corridors, Kentucky Avenue **[Figure 8]**. The factory's prominent, square tower capped by a pyramidal roof announced the location of the company's front office, and the tower also anchored the street corner by rising above the plant's two-story elevations, the longest of which, 150 feet, fronted Mississippi Street (later called South Senate Avenue and today South Capitol Avenue). Pavilions, defined by projecting parapets, corbelled entablatures, and central pediments but otherwise a continuation of adjoining wall surfaces, displayed the company's moniker on both street elevations and suggested the hand of an architect (as yet unidentified). The use of an architect is also suggested by other embellishments including exaggerated keystones above arched panels to accent windows on the second stories of the tower and pavilions; bracketed eaves on the tower; extensive brick corbelling below the eaves on all facades; and brick panels on the tower. Workers entered the building on the Georgia Street side, through paired doors that opened beneath a very large transom framed by a bracketed entablature. The company added an illustration of the building to its diamond trademark, evidence that company factories became insignia of industrial accomplishment during the machine age **[Figure 9]**.[10]

Thoughtfully designed but long-since demolished, the factory took the shape of a stunted U in plan, with load-bearing brick walls typifying standard mill construction and establishing fifty-foot widths for the main block facing Mississippi Street and each of the building's two wings. However, a one-story power plant filled the central void, and thus the entire, composite volume of space occupied a rectangular footprint of substantial width and constrained window arrangement that necessitated a series of rectangular monitor skylights to improve light penetration for portions of the second floor **[Figure 10]**. Along street facades (and possibly other facades as well), the factory's architect placed elongated windows in evenly spaced pairs. Absent piers, the wall spans supporting floor beams were slightly wider than the vertical spans between windows, which numbered twenty along the plant's Mississippi Street elevation;

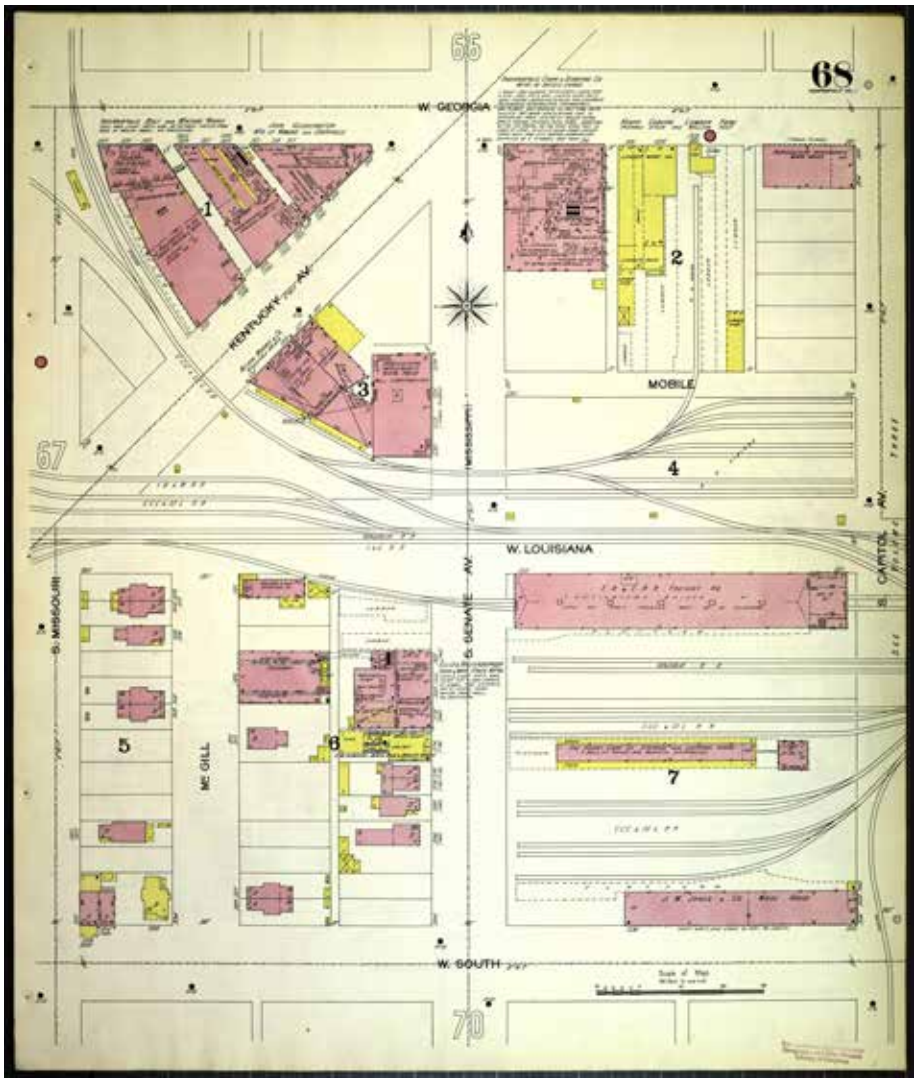
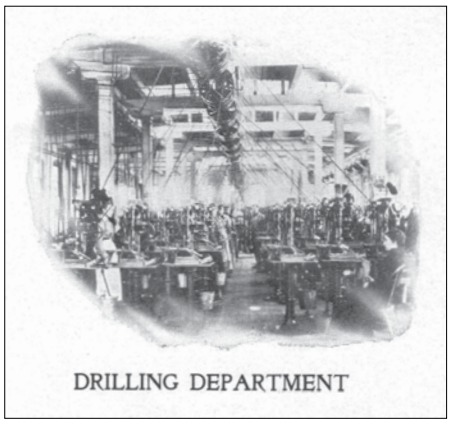


Figure 10. Factory layout. Sanborn-Perris Map Company, Insurance Maps of Indianapolis, Vol. 1 (1898): Plate 68.

timber posts also supported those floor beams, possibly single rows at mid-span. Boilers fired by natural gas fed a steam engine that powered a dynamo that supplied electricity to the motors turning mill shafting which the company configured efficiently for group drive. The plant's power system also provided electricity for incandescent lighting. Builders installed automatic, wet sprinklers throughout the factory, supplied by city mains and a 15,000-gallon water tank mounted on the roof for use only in the event of fire.[11]



Figures 11 and 12. American Bicycle Company, Automobile and Cycle Parts Co. Subsidiary, Diamond Chain Factory, 1901-1902 Catalog Author's document.

Company Growth.

Between 1896 and 1899, Newby guided the firm profitably, and in 1897 the city assessed the corporation's value at $100,000. By the following year, workers operated more than 260 screw, milling, drilling, riveting, reamer, and counter-sink machines **[Figures 11 and 12]**, supplying at least sixty percent of the chains required by American bicycle manufacturers. The fortune quietly being amassed by the company's small group of owners did not escape notice by other Indianapolis venture seekers, and the inevitable competition finally arrived in 1896 when local investors led by Frank Wood formed the Indiana Bicycle Chain Manufacturing Company, skimming at least some of the older firm's profits.[12]

Newby built upon the firm's continuing success resourcefully and invested in bicycle manufacturing via the Hay and Willits Manufacturing Company, founded by partners Thomas Hay and Van Burton Willits, who built Outing bicycles. In addition, Hay, Newby, and other representatives of the city's bicycle shops and manufacturers met in Hay's office in May 1897 to form the Indianapolis Cycle and Athletic Club, with the goal of constructing a top-tier racing track. Newby and Frank Wood agreed to head a committee tasked with soliciting stock subscriptions for the project, and incorporation of the Indianapolis Cycle Track Company followed a year later. Newby served as president, Test as vice-president, and architect and cyclist Herbert Foltz as secretary. Other key investors included Carl Fisher, Edward Fletcher, and James Allison as manager. Designed primarily by Foltz and Newby after careful study of model tracks, the quarter-mile oval opened with a dedication on July 4, 1898, offering the paying public a fast surface of white pine boards, a grandstand capable of seating 2,000, and other amenities emulated by only a few other cycling tracks in the country.[12]

As a parts supplier (and a part requiring periodic replacement, at that), Newby's company was a step or two removed from the immediate effects of bicycle overproduction and the looming decline in sales. Still, his business was not immune to those influences, and the failure of the Central Cycle Manufacturing Company in Indianapolis in June 1897 likely forewarned the chain maker of impending trouble **[Figure 13]**. Established in 1890 with modest capital and secure in its hard-won reputation for building high quality Ben Hur bicycles **[Figure 14]**, the company, through no fault of its own, had suffered a $16,000 loss when the Chicago concern Davidson and Son, that sold Davidson bicycles, reneged on its contract with Central Cycle in 1896. Anticipating the 1897 season in a practiced manner, the Indianapolis firm's president, Lucius M. Wainwright, had ordered necessary materials early in the year, but sales had lagged due to the glut of lower-priced bicycles: This, together with the absent revenue from the Davidson concern, caused the company's cash reserves to dwindle. Invoices for those materials normally required for the company's operations had come due, including a bill for $1,286 from Indianapolis Chain and Stamping Company, which obtained a court order placing the business in receivership while banks scrambled to secure loans by recording mortgages against the Central Cycle's real property and chattels.[14]

The company's assets at the time, including accounts receivable of $45,000, exceeded liabilities of $94,000 by a substantial margin. Also, Wainwright was well regarded by the city's cycling community. Nevertheless, in December 1897 the receiver elected to conclude the company's affairs and, after paying banks and other creditors, sold the factory (valued at $40,000), fixtures, machinery, inventory of bicycles, parts, patent rights, and trademark name to the highest bidder, Van Camp Hardware Company, which paid $14,000 for the aggregate and moved the business to Marion, Indiana, where Van Camp continued to build Ben Hur bicycles for a short period. In an abortive effort, Wainwright had offered to pay $10,000 for those same assets.[15]

The episode is important for several reasons. The failure of Central Cycle illustrates, as well as any example, the difficulty of small but well-managed bicycle manufacturers to negotiate the industry's perilous terrain after 1897, with little room for even the slightest misstep or miscalculation and scant opportunity to recover from precariously balanced debt. Such failures also placed the few company owners who managed to adapt and remain in business, for example William Schact in Angola, in a much stronger light. Irony also surrounds the relationship between Newby and Wainwright. Although the former forced the latter's company into court-supervised insolvency, Wainwright would later become the second most important figure in the history of the Indianapolis Chain and Stamping Company, and in many ways supplanted Newby.

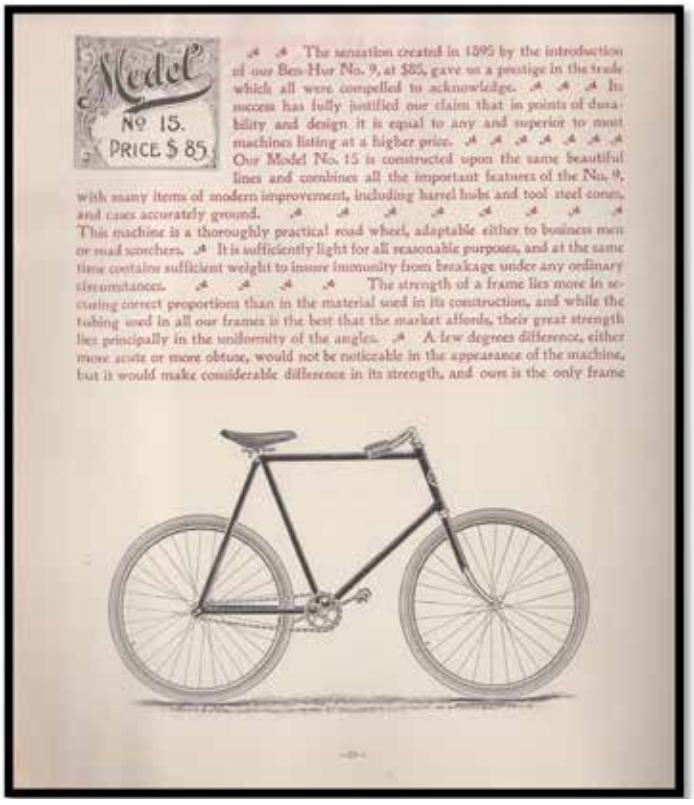
American Bicycle Company

Although evidence of widening faults in the bicycle industry continued to accumulate after 1897, those trends had little effect on the chain company's overall profitability, and it continued to dominate market share by a substantial margin. Thus, Newby and Test, who acquired the interests of Fletcher and Howe, found themselves in a commanding position when organizers of the American Bicycle Company came calling during the spring of 1899. Although discussions about a possible combination among chain manufacturers had begun to circulate by then, Newby granted Spaulding an option to purchase the Indianapolis concern in June of that year, one of more than a hundred such options granted to the trust, but he continued to negotiate for favorable terms long after ABC had reached agreements with the more than forty other companies ultimately joining the trust. Not until mid-December of that year did transfer of the Indianapolis plant occur, and newspapers reported that the chain company may have been the only firm to be purchased outright by the trust for cash.[16]

The complexities surrounding formation of the ABC defy concise description but nevertheless are important in order to understand the significance of Newby's contract with the trust. Early in May 1899, prior to acquisition of any companies, the ABC secured articles of incorporation in New Jersey, with authorized capitalization of $80,000,000, apportioned into $35,000,000 of preferred stock at a guaranteed dividend rate of 7%, and $45,000,000 of common stock. However, the process of negotiating with some of the companies to be acquired became so tortuous that the ABC abandoned its original intention to use proceeds from the sale of stock to purchase companies outright. Instead, promoters devised a plan to issue $10,000,000 of twenty-year debenture bonds offered at 5% interest; $9,300,000 of preferred stock secured by the plants; and $17,700,000 of common stock. Company owners were given the choice of accepting payment in the form of cash or bonds (the latter discounted from face value to 92½ %) totaling not more than thirty percent of book value based on appraisals of the plants; preferred stock not more than thirty percent; and common stock, not more than fifty percent. Sale of some of the bonds to the public via underwriters in New York and Boston provided the company with the cash needed to conclude acquisitions.[17]

In June, organizers of ABC met at New York's Waldorf Astoria Hotel to negotiate with representatives of companies being considered for inclusion in the trust, and owners of the concerns selected returned to the hotel a month later to begin implementing the financial plan. On July 18, Albert Spaulding authorized circulation of official press announcements regarding the trust's formation, including the list of manufacturers joining the conglomerate together with notice of an inaugural stockholders meeting and a meeting to elect a board of directors. Talks with some companies persisted throughout the summer, but ABC had acquired almost all the factories by the end of September 1899. Although Newby traveled to New York for the meetings in both June and July, he declined to give reporters any information about his agreement with Spaulding following the June gathering. Coincidentally or not, he was also the lone absentee among representatives of all the manufacturers at the meeting in July, pleading illness on the day.[18]

When it finally lurched forward, ABC controlled about two-thirds of the country's bicycle production. Newby's company, alone, commanded roughly



Figures 13 and 14. Catalog, Central Cycle Manufacturing Company, c. 1896. Author's document.

the same for chain manufacturing, but with an important difference: chain manufacture was a growth industry with glowing prospects for motorcycles, automobiles, hoisting equipment, conveyors, and a host of other uses. By contrast, the bicycle industry was already in decline. Reporters speculated that Newby, simply as one partner in the concern, had accumulated a personal fortune of more than $100,000 during the few years leading up to

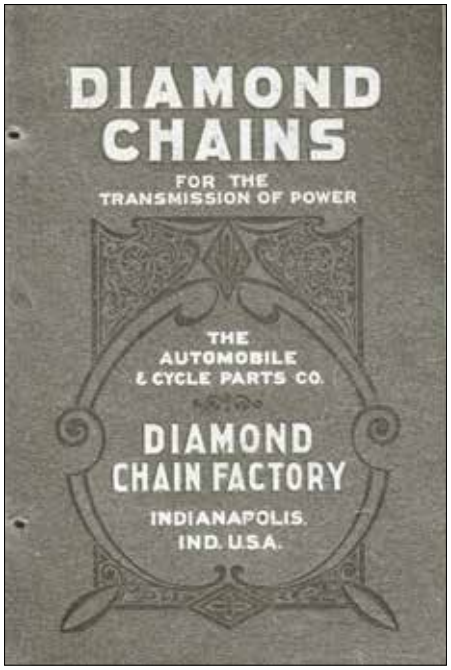


Figure 15. American Bicycle Company, Automobile and Cycle Parts Co. Subsidiary. Diamond Chain Factory, 1901-1902 Catalog. Author's document.

formation of the trust. Accepting even partial payment in any combination of obligation or equity added a factor of risk to the iron-clad ledger books that Newby and his partners had compiled. Nor did the prospect of management positions within ABC, likely resulting in a reduction of annual income, hold much appeal. Thus, from several financial perspectives, Newby and Test had limited motivation to join the combination. Yet, should the chain company remain apart from the trust, the Trust could acquire another chain manufacturer such as Frank Wood's company, and deal Newby's business out of a healthy percentage of the bicycle market, or at the very least emerge as a substantial competitor, which benefitted neither side.[19]

Negotiations between Newby and Spaulding continued during the fall, with Newby calculating correctly that his company's dominant market position and the Indianapolis plant's superior capacity, increased by 300 percent from inception, would eventually force Spaulding to buy the company outright. In the end, both parties may have received what they wanted. The ABC acquired a very successful chain manufacturer, and Newby and Test cut their ties to the industry cleanly, voluntarily resigning from the company they had led, telling reporters they both needed rest, and adding another chapter to the tangled origins of ABC. As fall turned to winter, though, each side eventually learned what the other had in mind. Test and Newby promptly founded the National Motor Vehicle Company, with Test as president, and ABC began organizing the trust into several internal divisions including bicycles, automobiles, and parts manufacturing, with the American Bicycle Company Chain Factory joining the third category and under the leadership of Lucius "Lew" Wainwright, serving the first two divisions as well as other industrial sectors. That same fall, the Indiana Chain Company joined a host of outsiders to form the Cycle Trades' Protective Association. Years later, after interest in bicycle racing had declined and the Newby Oval had been dismantled, Newby renewed his partnership with Carl Fisher and James Allison, added another partner, Frank

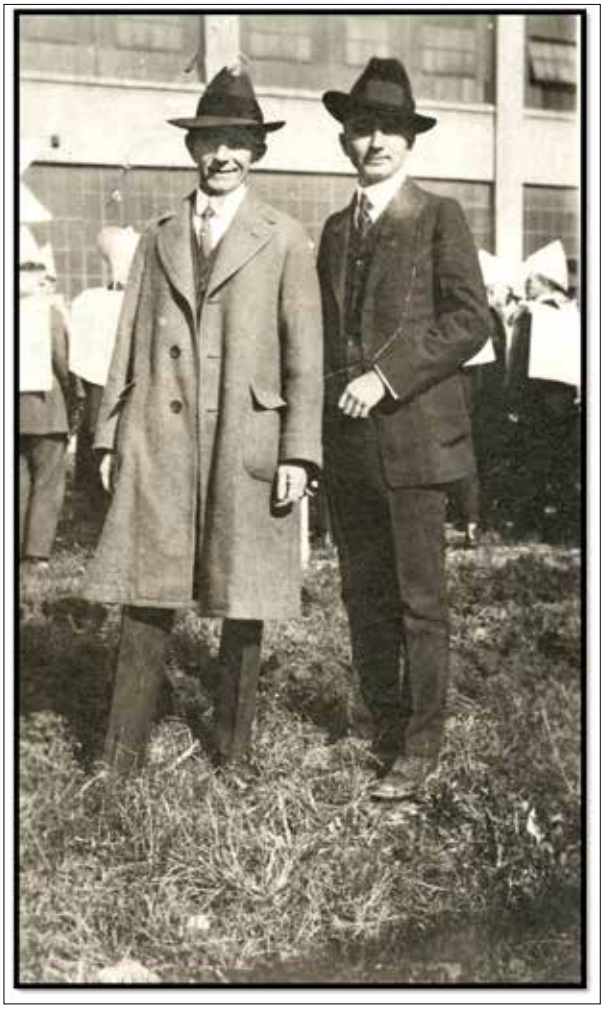
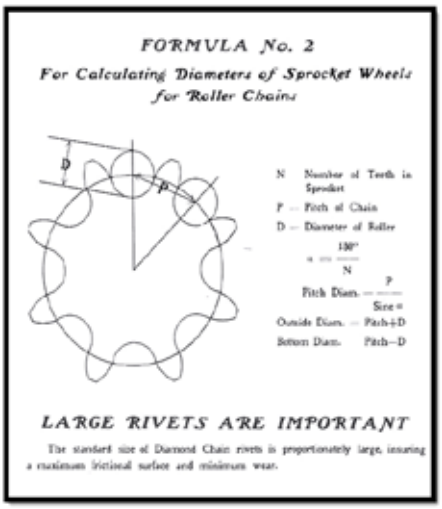


Figure 16. Lucius (left) and Guy Wainwright. Courtesy Indiana Historical Society.



Figures 17 and 18. American Bicycle Company, Automobile and Cycle Parts Co. Subsidiary. Diamond Chain Factory, 1901-1902 Catalog. Author's document..

Figure 19. Kentucky Avenue Factory, completed 1918. Courtesy Diamond Chain and Manufacturing Company.

Figure 20. Courtesy Diamond Chain and Manufacturing Company.

Figure 21. Courtesy Diamond Chain and Manufacturing Company.

Wheeler, and in 1909 built the Indianapolis Motor Speedway.[20]

With Wainwright at the helm, the chain company became an oasis of comparative calm during the trust's brief, tumultuous existence. Although the ABC's internal divisions provided at least the appearance of organized production, the company's ledgers required such constant finagling to meet unforeseen obligations that many of the companies joining the trust maintained existing day-to-day management. Production at the chain factory became more diverse to meet the heavier demands of motorized vehicles, and conversion of the local Indiana Bicycle Company plant to the manufacture of Waverly electric vehicles likely aided the continuing process of broadening chain production to supply automobile manufacturing. To their credit, Wainwright's engineers won a gold medal in the category of Civil Engineering and Transportation at the 1900 Paris Exposition, and company agents Wilbur and Orville Wright employed the firm's specially designed chains on their airplane at Kitty Hawk in 1903.[21]

Focus by cycling historians on the declining popularity of bicycles during the ABC's short life has obscured the role that the trust's parts manufacturers played in keeping the company from sinking during its first year, and subsequent events suggest that demand for chains from other manufacturing sectors remained stable. Wainwright stood in good position to judge his company's profitability, or at least its potential for success, and likely took careful note of the revenue being siphoned by the parent concern. However steady that flow of income may have been, ABC's losses continued to mount during 1901 as revenue from bicycle sales plummeted. In December 1901, the restructuring of ABC into a holding company for its newly-incorporated subsidiaries (the American Cycle Manufacturing Company and the International Motor Car Company, but also the Automobile and Cycle Parts Company **[Figure 15]** which changed its name to the Federal Manufacturing Company in July 1902), accomplished little or nothing, and in August of that year the trust failed, resulting in the appointment of receivers.[22]

Diamond Chain and Manufacturing Company

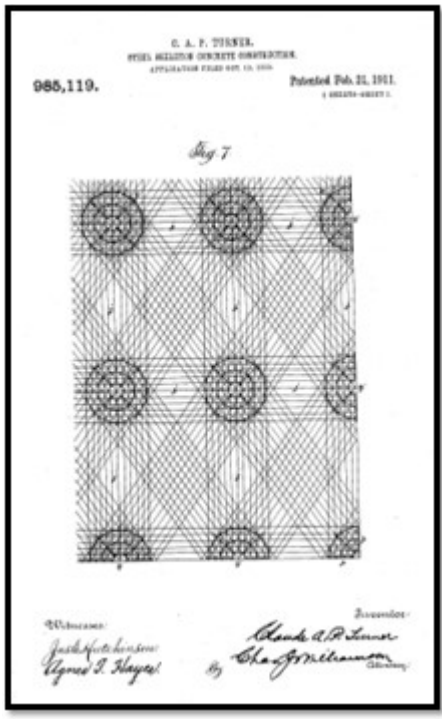
As did Wainwright, Garford recognized the ability of the parts company to generate revenue, particularly given the growing automobile market, and after Pope finally wrested control of the ABC from Coleman and his western cohorts in 1903 via the insolvency proceedings, he sold the Federal Manufacturing Company to Garford, who in turn negotiated with Wainwright for the sale of the chain factory at a time when Garford's own financial standing teetered precariously. In 1905, Wainwright and several local investors incorporated the Diamond Chain and Manufacturing Company, capitalized at $400,000, and took title to the Georgia Street factory and its machinery. Wainwright, with a controlling interest, served as president **[Figure 16]**, E. C. Dunmeyer, vice president, and A. D. Johnson, secretary and treasurer: Other investors included H. B. Hibben, C. E. Coffin, and O. B. Jamison. By then, the factory's capacity had increased to 5,000,000 feet of chain annually: This chain included roller chains, and it varied widely in weight, pitch, and purpose [23] **[Figures 17 and 18]**.

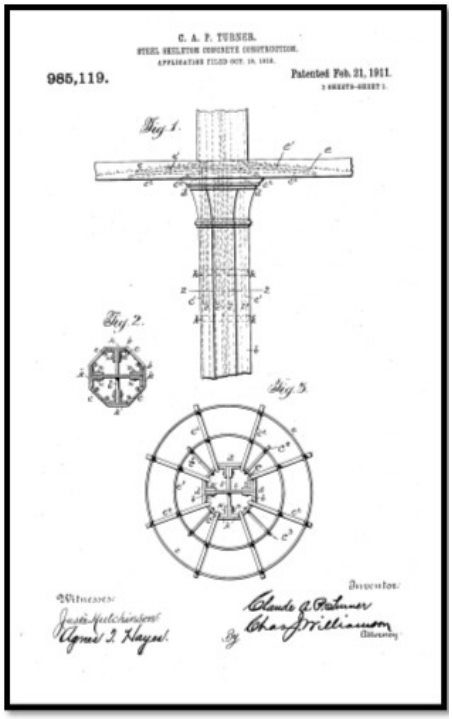
Whether Wainwright approached the negotiations with Garford as an insider with undisclosed plans for new clientele; or whether Garford recognized the chain company's potential value but quickly needed to recoup his personal losses from ABC by concentrating investment in the automobile-parts industry; or whether the sale represented an arm's length transaction for both parties, Wainwright's bold scheme paid great dividends – for the company's employees, for the city, for Wainwright's investors, and for Wainwright personally. Production increased so steadily that within a decade the company had outgrown the capacity of

its 1895 factory and four other manufacturing sites that had been added. New plans followed, consolidating production at a modern plant nearby on a five-acre site at the corner of West Street and Kentucky Avenue, doubling the size of the older building.[24]

Kentucky Avenue Factory

Completed early in 1918, just in time to host the Indianapolis Automobile Show during the week of 25 February, the four-story factory of skeletal-frame, reinforced-concrete construction offered a nearly uninterrupted sweep of exhibit spaces more than four-hundred feet long, with minimal columnar obstructions, and a wash of natural light from seemingly limitless window walls **[Figure 19]**. Few industrial buildings have enjoyed a more illustrious grand opening, and show organizers decorated the factory with red, white, and blue bunting and 1800 flags, including those of the country's wartime allies; evening musical performances provided entertainment; as did motion pictures depicting the evolution of motor-vehicle manufacturing. Wainwright wisely donated use of the building, and although the exhibits of automobiles, trucks, and tractors offered the main attractions (especially the tractors), the extravaganza also showcased both the impressive new building and the company itself



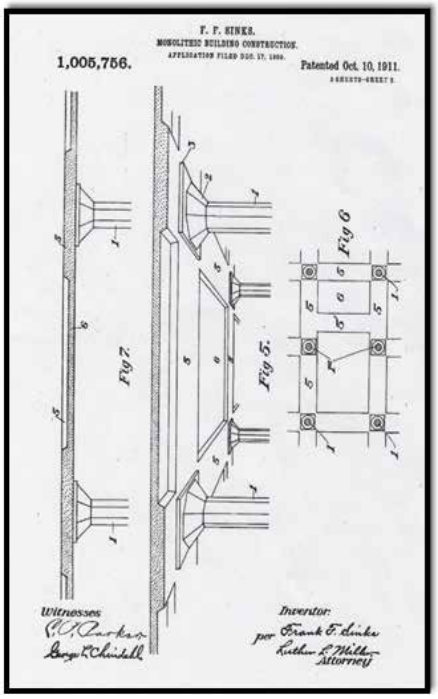


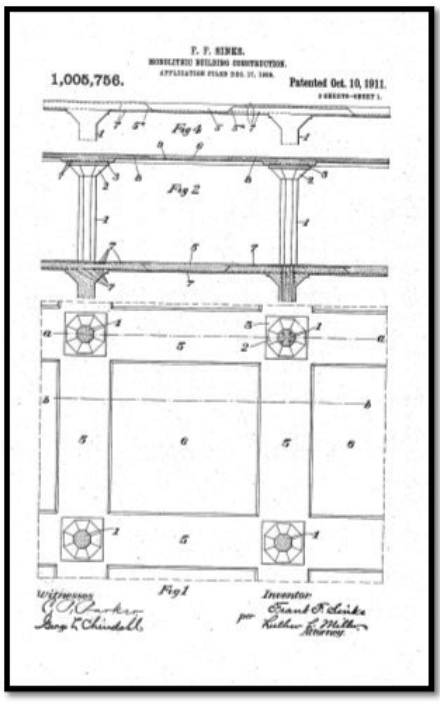
Figures 22 and 23. C.A.P. Turner concrete patents.

– a bonanza of free advertising and a momentary monopoly on good will [25] **[Figure 20]**.

The factory's sophisticated architecture and engineering were every bit as worthy of display as the motorized vehicles **[Figure 21]**. The principal advances in design concerned the monolithic floor slabs and flared column heads that together eliminated the beams and girders used in earlier construction, thus increasing natural light and reducing shadow; improving fire protection by facilitating the placement of sprinkler heads; simplifying the installation of overhead mill shafting; maximizing flexibility for the location of floor partitions and aisles or passageways; and for the organization of interior loads. Most of those benefits also contributed to significant improvements in overall economy. The expensive forms required for beams and girders became unnecessary thereby reducing the quantity of materials required and speeding construction. Ceiling height also could be adjusted precisely to meet production needs, thus maximizing usable space and minimizing the total cost per-square foot of that space. In addition, the diameter of the columns could be adjusted easily according to varying load requirements for different floors.[26]

Evolution of those innovations can be credited to several notable designers, including self-taught engineer and renowned builder from Massachusetts, Orland Whitney Norcross; Minneapolis engineer Claude Allen Porter (C.A.P.) Turner; and engineering partners from Chicago, Theodore Condron and Frank F. Sinks. Turner, probably the most inventive of the four, grouped belts of iron reinforcing rods of varying diameter and embedded them lengthwise, crosswise, and diagonally in the floor slab, with each directional band con-





Figures 24 and 25. F.F. Sinks patents.

verging above each column head, thus tying floor to column securely **[Figures 22 and 23]**. He also introduced distinctive, widely flared column heads that he called mushroom columns, and iron reinforcing in those heads configured to create a circumferential cantilever: These innovations distributed support over a larger floor area thereby spreading the shear stresses occurring at the column perimeters. Turner obtained several patents for his designs between 1907 and 1912, but Norcross had anticipated Turner's multiple-way reinforcement of floor slabs by introducing a metallic network of heavy wire netting embedded in the lower portions of the floor, earning a 1902 patent that courts later sustained as the structural equivalent of Turner's system for reinforcing floors. However, Turner's inventive column heads and integrated alignment of slab-reinforcing gained widespread use, and he continued to refine his design, replacing reinforcing rings at column heads with concentric spirals to address the peculiar radial and circumferential stresses occurring at the juncture of column and floor slab.[27]

Design of the chain company's factory also reveals the contributions of Condron and Sinks, who reinforced Turner's mushroom system by adding depth to the floor slab in the form of wide panels that created a visible grid in the ceiling and linked all column heads **[Figures 24 and 25]**. The partners subsequently limited this paneled-slab construction by placing just a single drop-slab between the column head and the floor slab and by increasing the conical flare of the column head, further absorbing the considerable shear stresses at that location.[28]

Figure 26. Courtesy Diamond Chain and Manufacturing Company

In its completed form, the factory complex offered 120,000 square feet of space, and operable steel sash supported more than three times the window area of the old plant per square foot; white paint on walls and ceiling helped to reflect that light into the factory's far corners. First-floor columns measured two-and-one-half feet in girth, but columns on the top floor supported mostly roof load and were smaller in diameter. The company relied on electrical power and installed fifty, five-and-one-half-horsepower, 220 volt, A.C. motors, but used them to drive overhead mill shafting, probably to avoid the costs of purchasing new machinery driven by individual motors **[Figure 26]**. Despite the measured efficiencies of group drive, the overhead shafting is curiously inconsistent with the advanced floor-slab construction. Quite suitably, though, chains rather than belts transferred power from the motors to shaft sprockets **[Figure 27]**, and workers inserted 10,000 studs in the ceiling at three-foot centers to suspend that shafting and its wheels, some of which still used belts to drive individual machines. When a coal-strike interrupted supplies of electricity in 1918, the company installed gasoline-powered motors. Hot-water heat was engaged in a seasonal battle to replace warmth lost through the enormous expanse of window-walls.[29]

The complex included a second one-story plant, also reinforced concrete but with floor beam and girder construction and taking the form of a

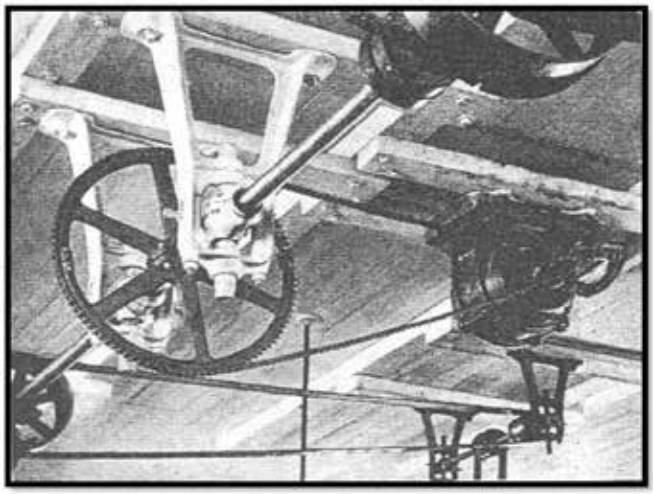


Figure 27. From Industrial Management (July 1916).

Figure 28. Courtesy Diamond Chain and Manufacturing Company.

production shed, with a wide central open floor flanked by side aisles and illuminated by a series of six, rectangular, monitor lights **[Figure 28]**, The building housed raw stock and space for special departments, including hardening, tempering, and rattling – the last with tumblers for surface finishing. A freight dock opened at the building's rear elevation, allowing railroad cars on an adjoining spur to serve the building at floor height.

By the time the company's new factory stood ready for occupancy, Wainwright's recollection of the Central Cycle Manufacturing Company's demise, and the loss to workers who had helped him build the good reputation of Ben Hur bicycles, may have been redeemed in full by rescuing the chain manufacturer from the ruins of ABC. Yet the lessons from that failure may have lingered in his mind because he took extraordinary steps to provide for the convenience of employees in the new building, increasing project costs by an estimated $100,000. Return on that investment seems to have been substantial because by the following summer employment topped 1,000 workers.

Fireproof construction and abundant natural light was supplemented by hundreds of ceiling lamps, many of them with white glass that provided soft hues. He also softened the raw concrete surfaces of floors by installing maple floorboards in nearly all parts of the plant, adding $25,000 to the bill. Upper floors included a kitchen, lunchroom, assembly hall, welfare offices, and first aid room **[Figure 29]**. A one-story part of the plant housed a cooperative grocery store. Two projecting towers on the factory's primary elevation sheltered stairs, avoiding interference with factory floor space, but also included water closets and lockers; workers in the gritty hardening department had special showers, as well. In assembly rooms, women worked at specially designed metal benches with individual partitions and rows of metal boxes for different parts at each station, all within easy reach **[Figure 30]**. Those benches stood diagonally across the floor in staggered rows, achieving economy of floor space and maximizing access to natural light; so, too, did many of the machine tools on shop floors.[30]

The company continued to grow and in 1928 erected an Art Deco office addition at the factory's easterly end, designed by Indianapolis architects Bishop, Knowlton, and Carson **[Figure 31]**. In fact, the company's growth has rarely lulled, large additions have been built, and today the company belongs to the Timken Company conglomerate with its roller chains serving industries

Figure 31. Courtesy Diamond Chain and Manufacturing Company.

Figure 32. Diamond Chain and Manufacturing Company, 2022. Author's photo.

Figures 29 and 30. From Industrial Management (July 1916).

as diverse as forestry, agriculture, construction, and oil and gas. Unfortunately, today (2022) the factory is closed and threatened with demolition **[Figure 32]** further depleting the scarce remnants of cycling history in our built-up environment. ●

1 Patent 305,226, titled "Building Construction," dated September 16, 1884 (application filed May 1, 1884), issued to Ernest L. Ransome.

2 "A Large Monolithic Factory Building," Engineering Record 38 (1898): 188-189. "Reinforced Concrete Construction in a Factory Extension at Bayonne, N.J.," Engineering Record 50 (July 2, 1904): 16-10; George P. Carver, "Reinforced Concrete Building Work for the United Shoe Machinery Co., Beverly, Mass.," Engineering News 53 (May 25, 1905): 537-546; Reyner Banham, "Ransome at Bayone," Journal of the Society of Architectural Historians 42 (December 1983): 383-387; and Carl Condit, American Building Art; The Twentieth Century (New York: 1961).

3 Carl Condit, American Building Art; The Twentieth Century; Bradley, The Works, 155-159.

4 Patent 623,686 titled "Machine for Molding Hollow Concrete Building-Blocks," dated April 25, 1899 (application filed February 26, 1898); Patent 674,874, titled "Concrete Wall for Buildings," dated May 28, 1901 (application filed March 21, 1900); Patent 727,428, titled "Machine for Molding Hollow Concrete Building-Blocks," dated May 5, 1903 (application filed May 29, 1902); all issued to Harmon S. Palmer. See also Carl Condit, American Building Art.

5 Alice Taylor Reed, "When the Wheelmen Came to Town," Indianapolis Star Magazine (August 9, 1970): 25-27; Judy Keene, "The Start of Indy's Racing Tradition," Indianapolis Star Magazine (May 4, 1980): 50, 52, 53; and "Here is a Wheelway," WCTR 17 (August 7, 1896): 60. See also " Manufacturer of Chains," Indianapolis Sunday Journal (April 28, 1895): 1; "Arthur C. Newby, Pioneer Bicycle, Auto Maker, Dies," Indianapolis Star (September 12, 1933): 1; "Arthur Newby Rites Wednesday," Indianapolis News (September 12, 1933): 4; Edward G. Flaningham, "Diamond Chain Company," in Encyclopedia of Indianapolis, David J. Bodenhamer et al, eds. (Bloomington: Indiana Univ. Press, 1994): 504-505; Tony Hadland and Hans Erhard-Lessing, Bicycle Design (Cambridge: MIT Press, 2014): 148-151; Andrew Ritchie, Major Taylor. The Extraordinary Career of a Champion Bicycle Racer (Baltimore: Johns Hopkins University Press, 1998): 21; and "Zig-Zag Cycling Club of the Gay Nineties, Youthful Indianapolis Wheelmen Staged Races, Runs and Relays, All Teaching Them Early How to Spell "Spill," Indianapolis News (February 7, 1931): 1.

6 "Arthur C. Newby, Pioneer Bicycle, Auto Maker, Dies," Indianapolis Star (September 12, 1933): 1; "Charles E. Test Dead," Richmond Item (June 23, 1910): 1; Patent 565,049, titled "Process of Making Rivets, Studs, & c.," dated August 4, 1896 (application filed February 19, 1895), issued to Charles E. Test; Design Patent 27,223, titled "Design for a Block for Bicycle Chains," dated June 15, 1897 (application filed October 13, 1896), issued to Edward C. Fletcher; Patent 594,009, titled "Manufacture of Bicycle-Chains," dated November 23, 1897 (application filed January 14, 1897), issued to Humphrey Harrington.

7 "Manufacture of Chains," Indianapolis Sunday Journal (April 28, 1895): 1. In the Indianapolis Journal under the column heading "Industrial Notes," see (June 6, 1891): 6; (September 5, 1892): 6; (November 21, 1892): 8; (December 12, 1892): 8; and (September 30, 1893): 8. See also "New Corporations," Indianapolis Journal (September 30, 1893): 8.

8 "Manufacture of Chains," Indianapolis Sunday Journal (April 28, 1895): 1; Horace Arnold, "Bicycle Tools – 31," American Machinist 19 (September 24, 1896): 894-896; "Chain Block Drilling and Reaming Machine," Iron Age 53 (June 14, 1894): 1125; and Hadland and Erhard -Lessing, Bicycle Design, 148-151.

9 Patent 565,049, titled "Process of Making Rivets, Studs, & c.," dated August 4, 1896 (application filed February 19, 1895), issued to Charles E. Test; Design Patent 27,223, titled "Design for a Block for Bicycle Chains," dated June 15, 1897 (application filed October 13, 1896), issued to Edward C. Fletcher; Patent 594,009, titled "Manufacture of Bicycle-Chains," dated November 23, 1897 (application filed January 14, 1897), issued to Humphrey Harrington.

10 "Manufacture of Chains," Indianapolis Sunday Journal (April 28, 1895): 1; "Industrial Notes," Indianapolis Journal (October 14, 1895): 8; "Will Employ 500 People," Indianapolis Journal (November 4, 1895): 3; and "Industrial Notes," Indianapolis Journal (December 23, 1895): 3. The Berkshire Life Insurance Company may have provided financing for construction of the factory; see "Plans for the New Chain Works," Indianapolis Journal (June 4, 1895): 6.

11 "Manufacture of Chains," Indianapolis Sunday Journal (April 28, 1895): 1; "Will Employ 500 People," Indianapolis Journal (November 4, 1895): 3; and Sanborn Perris Map Company, Insurance Maps of Indianapolis, Vol. 1 (1898): Plate 68. Mississippi Street became South Senate Avenue and later South Capitol Avenue. Today, the Pan Am Tower and Plaza stand at the former site of the company's factory.

12 "Arthur C. Newby, Pioneer Bicycle, Auto Maker, Dies," Indianapolis Star (September 12, 1933): 1; "Industrial Notes," Indianapolis Journal (December 21, 1896): 6; "Corporation Values," Indianapolis Journal (July 2, 1897): 8; Sanborn-Perris Map Company, Insurance Maps of Indianapolis (1898): Vol. 1, Plate 68. "Search for Health Futile for Motor Firm Officer," Indianapolis Star (June 23, 1910): 12.

13 "For a Bicycle Track," Indianapolis Journal (May 8, 1897): 3; "New Bicycle Track Company," Indianapolis Journal (April 6, 1898): 8; "Bicycle Track Officers," Indianapolis Journal (April 8, 1898): 6; Judy Keene, "The Start of Indy's Racing Tradition," Indianapolis Star Magazine (May 4, 1980): 50, 52-53.

14 "A Cycle Company Fails," Indianapolis Journal (July 4, 1897): 8; "Judgments Against Central Cycle Co.," Indianapolis Journal (October 30, 1897): 8.

15 "A Cycle Company Fails," Indianapolis Journal (July 4, 1897): 8; "Judgments Against Central Cycle Co.," Indianapolis Journal (October 30, 1897): 8; and "Sale of Cycle Plant," Indianapolis Journal (December 10, 1897): 6. The Frost Gear Case Company of New York moved into the factory; see "Gear Cases and Wheels," Indianapolis Journal (February 27, 1898): 3.

16 "In the Bicycle Trust," Indianapolis Journal (June 9, 1899): 8; "Floats. American Bicycle Company," WCTR 23 (July 20, 1899): 7-8; "In the Trust's Hands," Indianapolis Journal, (December 19, 1899): 8. "American Bicycle Company," Moody's Manual of Industrial and Miscellaneous Securities, John Moody, ed. (New York: O.C. Lewis Company, 1900): 296-299.

17"Floats. American Bicycle Company," WCTR 23 (July 20, 1899): 7-8; Arthur S. Dewing, "The American Bicycle Company," in Corporate Promotions and Reorganizations (Cambridge: Harvard Univ. Press, 1914): 249-268; "Transferred to Trust," Indianapolis Journal (October 1, 1899): 1; "American Bicycle Company Issue of $10,000,000 5% Sinking Fund Gold Debentures," Indianapolis Journal (October 3, 1899): 7; "Its Capital $80,000,000," Indianapolis Journal (June 24, 1899): 5.

18 "In the Bicycle Trust," Indianapolis Journal (June 9, 1899): 8; "Floats. American Bicycle Company," WCTR 23 (July 20, 1899): 7-8; "Its Capital $80,000,000," Indianapolis Journal (June 24, 1899): 5; Dewing, "American Bicycle Company," 249-268.

19 Diamond Chain and Manufacturing Company, "It Happened One Christmas. A Brief History of the Diamond Chain and Manufacturing Company, a Leading Industry of Indianapolis." Indianapolis: published by the author; typewritten pamphlet available at the Indiana Historical Society.

20 "Independent Makers Organize," WCTR 24 (November 9, 1899): 13; "In the Trust's Hands," Indianapolis Journal, (December 19, 1899): 8; "Charles E. Test Dead," Indianapolis Journal (1910), photocopy (n.d.) available at the Indiana Historical Society. Test's obituary notes that he had sold his interest in the chain company in 1896 because of ill health, but other reports confirm that he remained with the company as secretary. Newspaper accounts also state that ABC purchased the chain company outright, meaning cash The delay in acquisition of the company may have been due to the ABC's lack of cash during the fall of 1899, conditions that continued throughout the company's short and troubled history.

21 "Gold Medal Awards," Indianapolis Journal (August 20, 1900): 8. Epperson, Pedaling Bicycles to America, 178-193; Edward G. Flaningham, "Diamond Chain Company," in Encyclopedia of Indianapolis, 504-505.

22 For a detailed chronology of the events leading to restructuring of the ABC, default on bond payments, and appointment of the receivers, see Notice of Appeal, Supreme Court, County of New York, Pope Manufacturing Company vs. Rubber Goods Manufacturing Company, Vol. 1061, Supreme Court Appellate Division, First Department (1905); part of the case is reported in 47 NYS 73. See also "Big Company Changes Name," BWMR 45 (July 31, 1902): 473.

23 "Factory Changes Owners," BWMR 51 (April 15, 1905): 55; "An Important Concern," Stoves and Hardware Reporter (March 30, 1905): n.p. Epperson, Pedaling Bicycles to America, 193-194.

24 Diamond Chain Manufacturing Company, The New Plant of the Diamond Chain and Manufacturing Company (Indianapolis: the author, July 16, 1917); a printed pamphlet available in the company's archives. See also "New Plant of Diamond Chain Company," Industrial Management 56 (July 1918): 22-25.

25 In the Indianapolis Star, see "Auto Show Will Meet February 11-16," (December 30, 1917): 14; "Tractors to be Feature at Show," (January 20, 1918): 7; "Interest is Keen in Auto Exhibit," (January 27, 1918): 7; "Auto Show Work Moving Briskly," (February 3, 1918): 8; "Auto Show Space All Taken," (February 10, 1918): 5; and "Show Prospects are Gratifying," (February 24, 1918): B14.

26 Condit, American Building Art, 166-169.

27 Patent 698,542, titled "Flooring for Buildings," dated April 29, 1902 (application filed November 22, 1901), issued to Orlando W. Norcross. See also the following patents issued to C.A.P. Turner: Patent 859,858, titled "Steel Skeletal Construction for Concrete Buildings," dated July 8, 1907 (application filed January 23, 1906); Patent 985,119, titled "Steel Concrete Construction," dated February 21, 1911 (application filed October 19, 1910); Patent 1,003,384, titled "Steel-Skeleton Concrete Construction," dated September 12, 1911 (application filed June 11, 1907); Patent 1,036,384, titled "Reinforced Concrete Construction," dated August 20, 1912 (application filed 1-19-11); Patent 1,072,532 titled "Reinforced Concrete Construction," dated September 9, 1913 (application filed April 12, 1912); and Patent 1,217,536, titled "Flat-Slab Floor," dated February 27, 1917 (application filed April 20, 1915). See also Drum v. Turner, 219 F. 188, (1914), and Condron Co. v. Corrugated Bar Co., 256 F. 672 (1919).

28 Patent 1,005,756, titled "Monolithic Building Construction," dated October 10, 1911, (application filed December 17, 1909), issued to Frank F. Sinks; and Condit, American Building Art, 166-169.

29 Diamond Chain Company, New Plant. See also "New Plant of Diamond Chain Company," Industrial Management 56 (July 1918): 22-25.

30 Ibid.