A TRIP THROUGH A LARGE BICYCLE FACTORY.

We think that few of the readers of the SCIENTIFIC AMERICAN have an adequate idea of the time and money expended in the manufacture of what is known as a truly high grade bicycle. It is difficult to realize that there are altogether more than nine hundred separate parts to one of these popular machines, and when we see this large number of intricate parts brought together and formed into a symmetrical machine, weighing only twenty-four or twenty-five pounds, and possessing sufficient strength to carry a heavy man over country roads for thousands of miles without sign of failure, we realize the great perfection to which the manufacture of the wheel has attained.

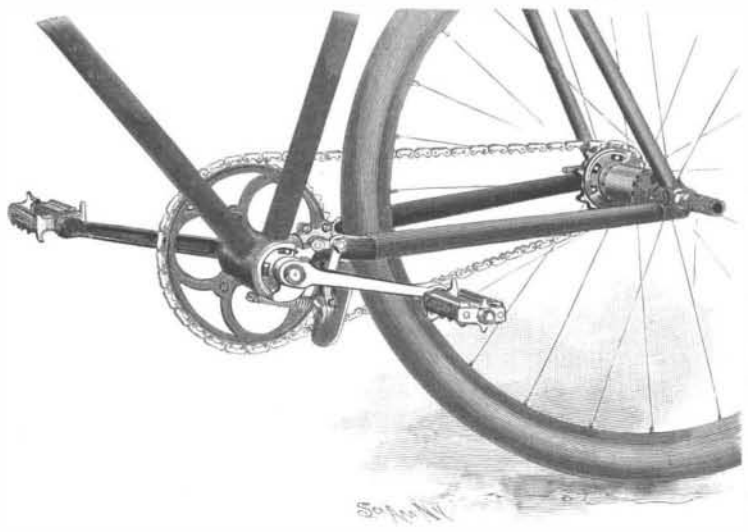


Fig. 9.—THE MORROW BRAKE.

In the earlier days of the industry the bicycle was frequently manufactured in the machine shops of establishments where it formed only a small part of the output, and the bicycle parts were manufactured by the use of such tools as the shop possessed. But as soon as the industry began to assume its present proportions, manufacturers realized that special efforts must be made to keep pace with the demand and meet a competition which was evidently going to be fierce and sustained. They bent their energies to the construction of special tools and machinery for the more rapid, accurate and cheaper execution of the new class of work. So thoroughly have the old methods been changed that, with few exceptions, the best known wheels are now built in factories that are exclusively devoted to bicycle manufacture, and are equipped from end to end with tools that have been specially designed for this purpose.

In the present article we illustrate the design and manufacture of the modern bicycle as carried out at the factory of the Eclipse Bicycle Company, Elmira, N. Y.

It should be noted, in the first place, that this firm builds its bicycles "from the ground up," all such parts as pedals, chains, hubs, cones, shells, and even the saddles being manufactured on the premises. Every nut, large and small, is turned from solid bars of steel, and the distinguishing characteristics of the finished wheel, at which the makers have aimed during the past few years, are strength and durability. In the years when the craze for lightness was at its height, this wheel was maintained at the reasonable weight which is now the standard for the average bicycle. That the policy was productive of a remarkably strong machine is shown by the well known illustration of one of these wheels carrying a load of sixteen men at one time, and, as an evidence of the durability of its machines, the firm quotes with pardonable pride the case of a 20,600 mile ride, in which an Eclipse wheel carried its rider round the entire circuit of the United States.

To follow out the whole process of building a bicycle would require more space than is practicable, and it will be sufficient to select some of the most important and novel features of this particular machine. Attention is drawn to the Morrow hub, a special form of which has been designed to match the direct T-headed spoke which is used on this machine. The desire to attach the spoke to the hub without a bend has led to a variety of ingenious devices, and the accompanying illustrations show the details of one of the most successful efforts in this direction. The hubs, which are made from a solid bar of steel, have flanges turned on each end. The piece is then placed vertically in a gang drill, and the holes for the spokes are drilled through each flange. This machine carries as many drills as there are holes in one flange. The hub is then taken to a milling machine, where a slot is cut from the periphery of the flange to every alternate hole of each pair of inside flanges. These slots are cut so that they will be at right angles to the direction of the spokes. The T-headed spoke is inserted by passing the head down the slot and pushing it sidewise into the opposite hole in the adjoining flange. The heads are formed in three operations on a special machine. The steel wire is first upset, then headed, and finally the bur is sheared off. The advantages sought in this design are strength, ease of adjustment (obviating the necessity of taking the wheel out of the frame, in order to put in a spoke), and a tangential pull which will bring no bending strain on the spoke itself. On the front page of this issue will be found illustrations of the machines specially built for the making of the hubs and spokes.

Illustration No. 6 shows the machine for the upsetting and forming of the head; illustration No. 2 shows the machine for milling slots in the flange of the hub, and illustration No. 3 shows one of the gang drills that bores the necessary number of holes for the spokes, this gang of drills boring the entire number of holes at one operation.

Particular care is taken in the manufacture of the bearings. The cones and cups are turned from solid bars of a special high grade tool steel, and after being carefully tempered in a lead bath, they are drawn to temper in oil and then inspected, ground, and polished. The bearings are rendered dustproof by the method of bevel groovings, which tends to work the dust out of rather than (as is often the case) into the bearings. The adjustment of the crank hanger bearings will commend itself to all wheelmen who have trouble on this score. The cup is provided with a notched periphery, and associated with this is a loose ring with three projecting lugs which reach across the notches and engage recesses in the barrel of the crank hanger. By removing the ring and turning the cup the space of only one notch, the bearing will be adjusted just $\frac{1}{1000}$ inch. The ring is kept in place by a dust cap which snugly incloses the end of the hanger, as shown in the cut.

This company has not followed the fashion of divided crank axles, believing that it is not a sound policy, judged on mechanical grounds. The cranks, which are square, fluted and slightly tapered, are carefully oil tempered. The right crank is formed in one piece with the clover leaf (as the spider is named in this wheel) and the crank axle. Forgings are finished in special machines, two of which are shown at work "profiling" a crank and a spider. The profiler is one of the many ingenious and time-saving machines used in this works. The forging, of whatever design, is fastened to a sliding table on which is fixed a pattern of exactly the same size and shape as the piece is to be. The sliding head carries the vertical cutter and also a vertical pin which bears against the pattern or "former," as it is called. The distance between the "former" and the work being the same as that between the guiding pin and the cutter, it is evident that the latter, in passing around the rough forging, will cut it out to the same profile as the "former."

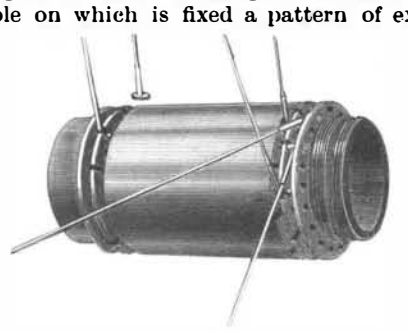


Fig. 10.—FRONT HUB, SHOWING METHOD OF ATTACHING SPOKES.

The Eclipse Bicycle Company favors, as we have said, the continuous axle, the right crank and the axle being in one piece. The left crank is attached by a very neat and effective device, the details of which are shown in Fig. 12. The end of the axle, which is threaded, is milled out so as to leave an inclined surface adapted to receive the flat side of a small key. A small projecting web or key, of metal, is left on the axle, which engages a transverse slot on the key and locks it in the crank. The key is not tapered and it fits snugly in the crank in the same position as the ordinary tapered key; but, unlike the latter, its ends are flush with the surface of the crank. Crank and key are pushed on over the end of the axle and an annular lock nut is then screwed on, wedging the crank tightly in place. It has all the neat appearance and smooth finish of a keyless crank.

Two of our illustrations show the manufacture of the chain, a work to which the company devotes special care. Fig. 1 shows the process of riveting the pins. This is done by two opposite and swiftly revolving pairs of steel disks, the axis of revolution, as will be seen from the cut, being transverse to the axis of the disks. The latter are held in two jaws and are free to rotate on their axes. The inner edges of the disks are beveled so that, as the two sets are pressed together on the ends of the rivet, they upset them and form the desired heads. Another of the many machines concerned in the manufacture of the chain is shown in Fig. 5, where the chain blocks are being sawed wholesale from a bar of steel which has been rolled to the special figure 8 section used by this company. A gang of twenty saws is used on one shaft and the cutting is done so cleanly that the blocks require no further finish than they receive in the friction of the limbering machine. The chains are made from a special grade of chain

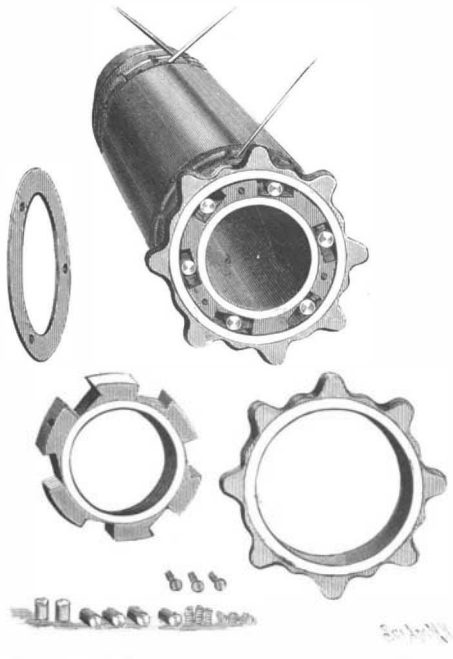


Fig. 11.—THE MORROW HUB AND DETAILS OF SPROCKET CLUTCH.

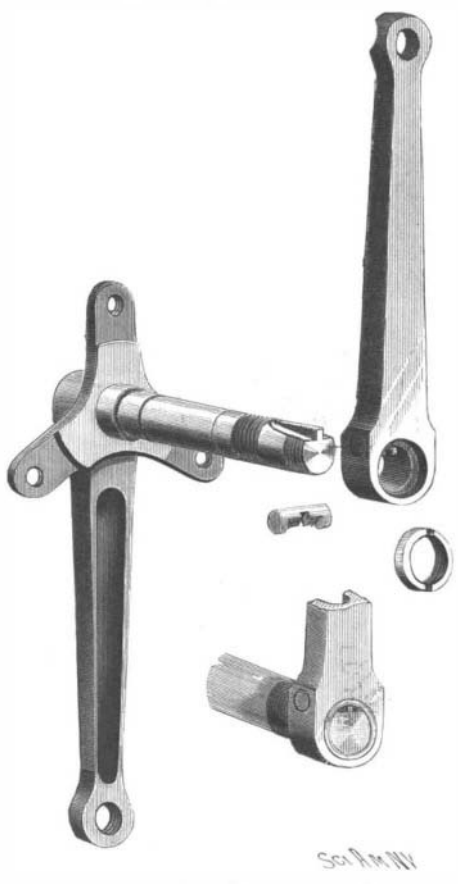


Fig. 12.—CRANK DETAILS SHOWING METHOD OF ATTACHMENT TO AXLE.

Fig. 13.—HANDLE BAR ADJUSTMENT.

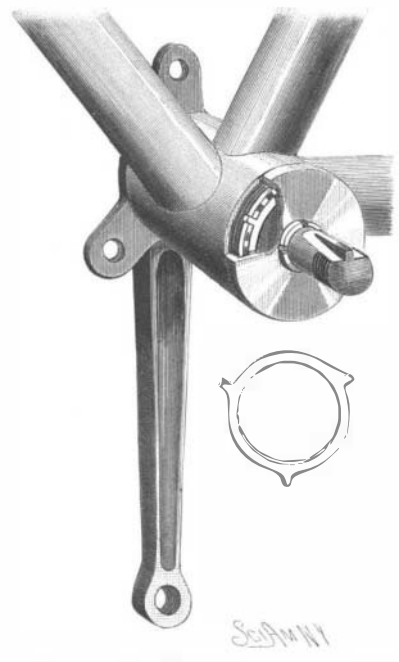


Fig. 14.—ADJUSTMENT OF CRANK HANGER BEARINGS.

steel, and, after being carefully hardened, they are put in the chain limbering machine, Fig. 4, which consists of a series of large and small sprockets, over which they are run at a speed of 500 revolutions per minute under a tension of 50 pounds. After being tested under a pull of 1,000 pounds in the testing machine, the chain is ready to be put on to the bicycle.

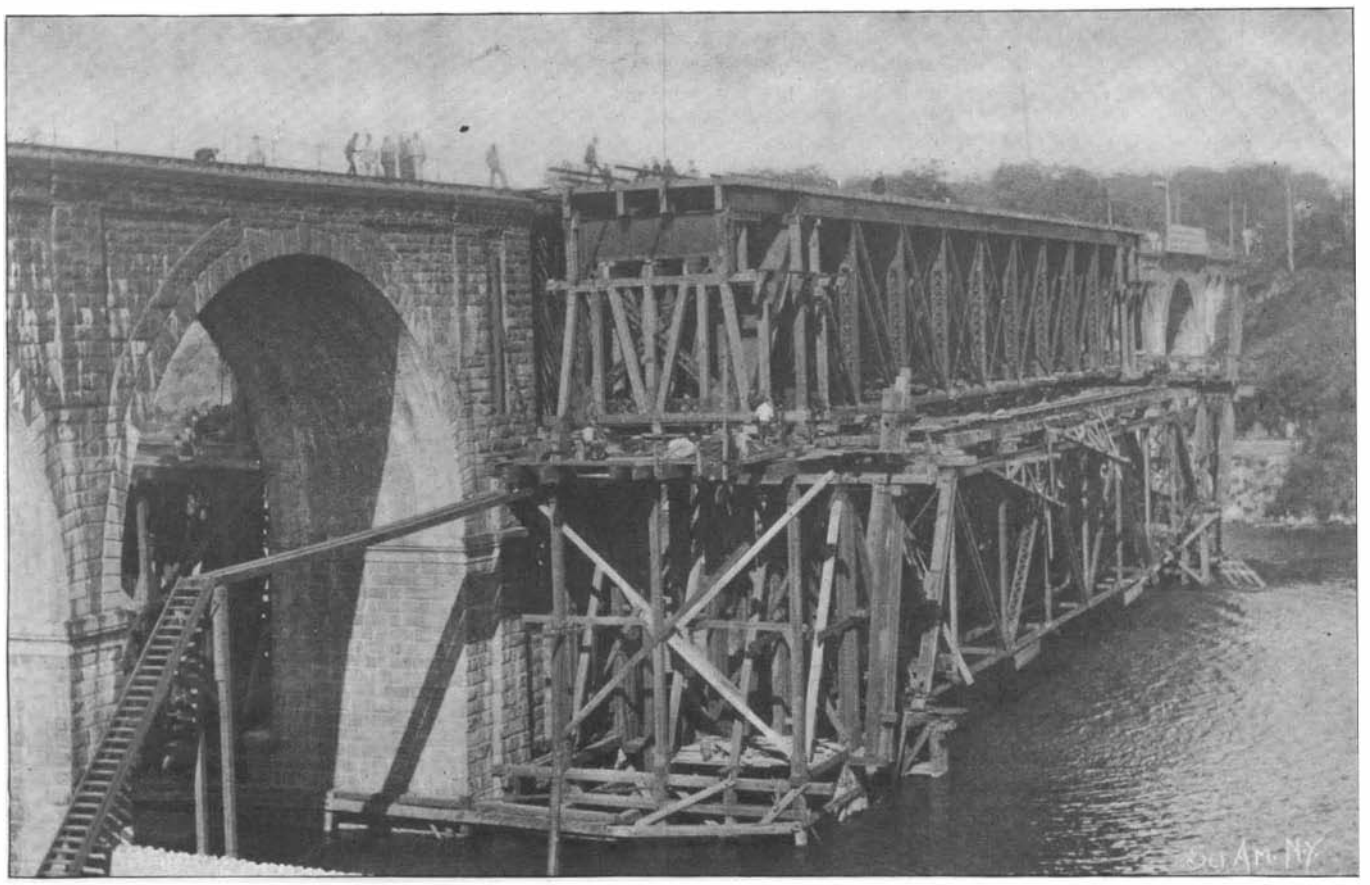
Many of the Eclipse bicycles are fitted with the Morrow brake, which avoids the objectionable features of the ordinary plunger brake, and which gives the wheelman full command of his mount on the steepest hills. Moreover, it enables him to hold his pedals stationary for the purpose of coasting. The mechanism consists of a friction clutch on the rear hub, another clutch on the left crank, and a spoon brake controlled by the latter. In the normal position the rear sprocket clutch is locked and the crank clutch is free. If it is desired to coast, a slight back pressure on the pedals releases the sprocket clutch and allows the rear wheel to run independently of the chain and cranks. To set the brake all that is now necessary is a rather sudden application of back pressure to the pedals. This sets the crank clutch. The external ring of this clutch is provided with a projecting arm which is pivotally connected to an arm on the spoon brake. By pressing down on the pedals the ring is turned backward and the brake is set against the wheel with any pressure desired. It will thus be seen that the rider can coast or set the brake by varying the back pressure upon the pedals, and the leverage is so greatly in his favor that he can stop the rear wheel altogether in cases of emergency.

The sprocket clutch, Fig. 11, consists of a steel disk upon which the sprocket is free to rotate. Around the periphery of the disk are cut out half a dozen rectangular recesses whose bottom faces are not tangent to the periphery but slightly inclined. In each pocket or recess is a hardened steel pin whose diameter is less than the depth of the rear wall of the pocket but greater than the depth of the front wall. The pins are pressed into contact with both the disk and the sprocket by coiled springs. When the sprocket is pulled forward by the chain, the pins also roll forward and become tightly wedged, locking the sprocket to the wheel. On the other hand, when the pull of the chain is reversed, as in back pedaling, the pins are released and the wheel is free to rotate independently of the sprocket. The sprocket is kept in place by a couple of covering flanges, one of which is shown in the accompanying engraving.

The neat appearance and simple handle bar adjustment used on Eclipse bicycles is an attractive feature. The fork head is split and threaded. Upon this are screwed three threaded sleeves, the middle one of which carries a threaded stud. A loose sleeve is passed over the stud and bears upon the outer sleeves above mentioned in such a way that when the nut is tightened the outer sleeves are pressed against one side of the fork stem and the center sleeve against the opposite side, thus securing an even hold upon the handle bar. The device is very efficient and is marked by the neat appearance that distinguishes the various parts of this machine.

We close our notice of this machine and the admirable plant for its construction with a reference to the large number of special tools that are used in the manufacture of all parts, from the minutest to the largest. Before attempting to turn out any number of bicycles, a jig or form is specially made, and in this jig or form is placed whatever part of the bicycle work is being done. All pieces made in such forms will be absolutely alike and interchangeable. After the frames have been entirely completed, they are trued up in another jig or form, to insure that they shall be in perfect alignment.

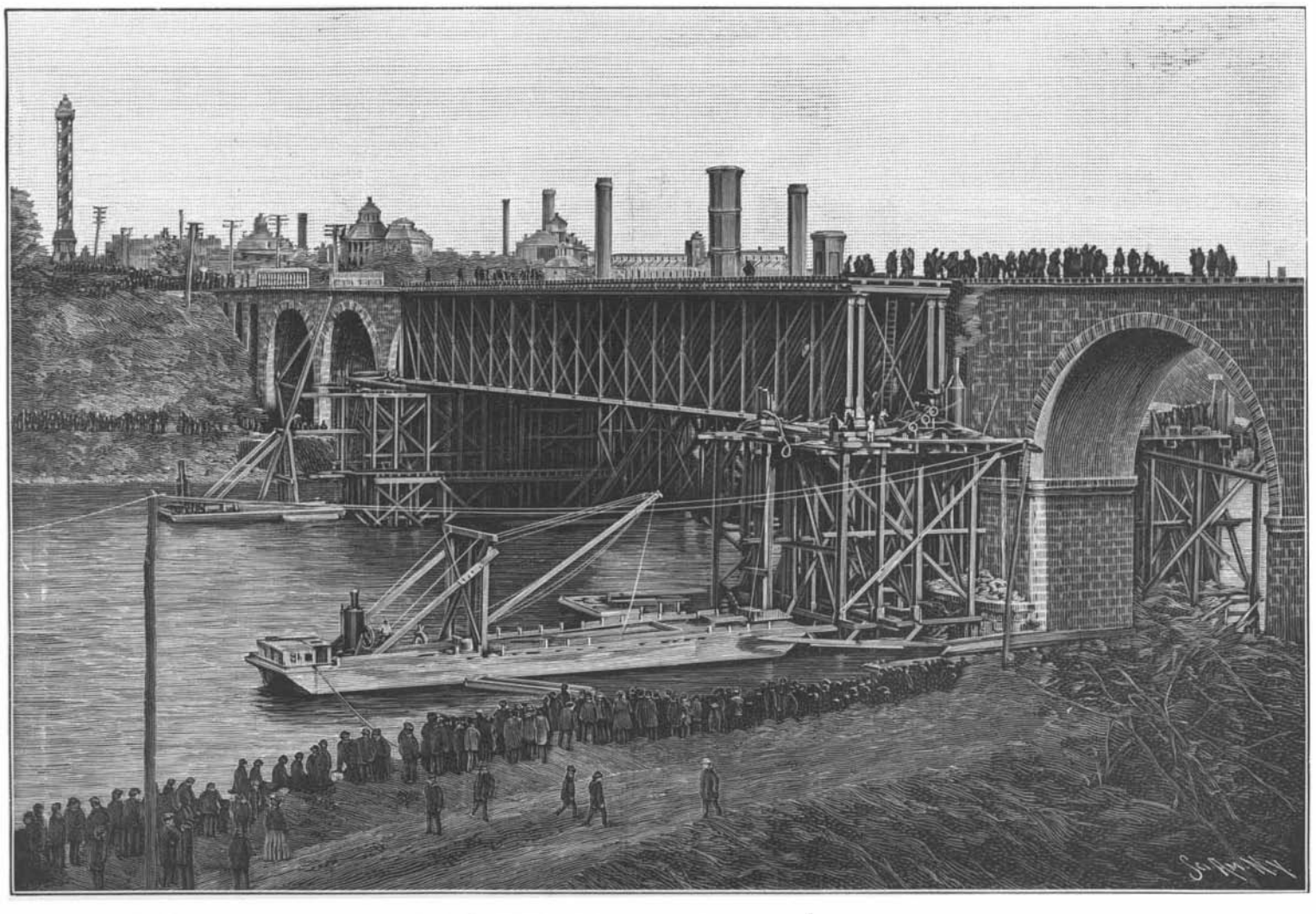
One cannot go through an establishment such as the Eclipse Bicycle Company's and see the close work, rigid inspection of all parts, the vast number of labor saving machines, and not be impressed with the great skill and care, and the elaborate plant, required in the construction of the modern bicycle.



THE NEW STEEL SPAN READY FOR TRANSFERRING TO PLACE.

A RAPID BRIDGE RENEWAL.

A remarkable record for rapid bridge renewal was made by the engineers of the Pennsylvania Railroad Company on Sunday, October 10, when a large iron structure on the busiest part of that road was taken away and a new span put in its place in the remarkable time of nine minutes. This feat was performed on the bridge which crosses the Schuylkill River, carrying the tracks of the New York branch over that beautiful stream just above Girard Avenue, Philadelphia. The approaches of this structure are of the most substantial stone work, and a long metal span stretches across



A RAPID BRIDGE RENEWAL—THE OLD SPAN REMOVED TO TEMPORARY FALSEWORK.

SCIENTIFIC AMERICAN

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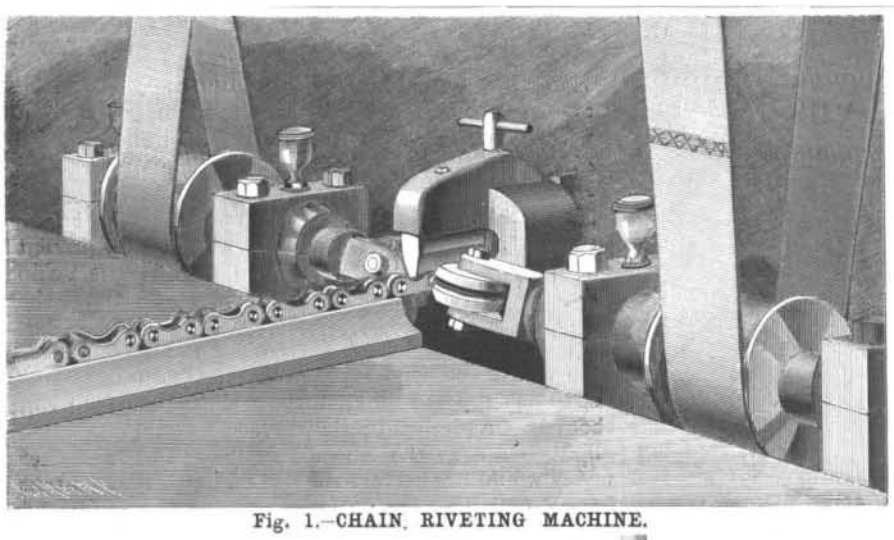


Fig. 1.—CHAIN RIVETING MACHINE.

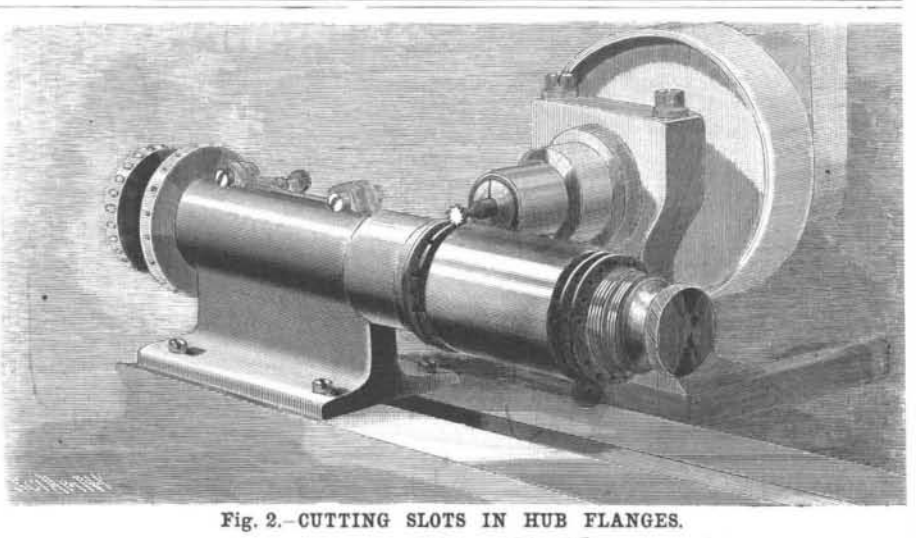
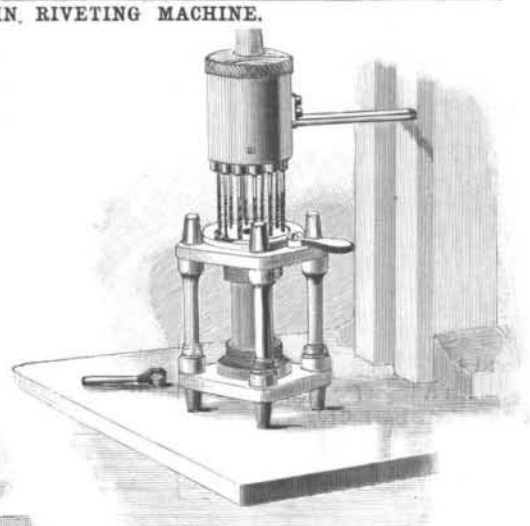


Fig. 2.—CUTTING SLOTS IN HUB FLANGES.



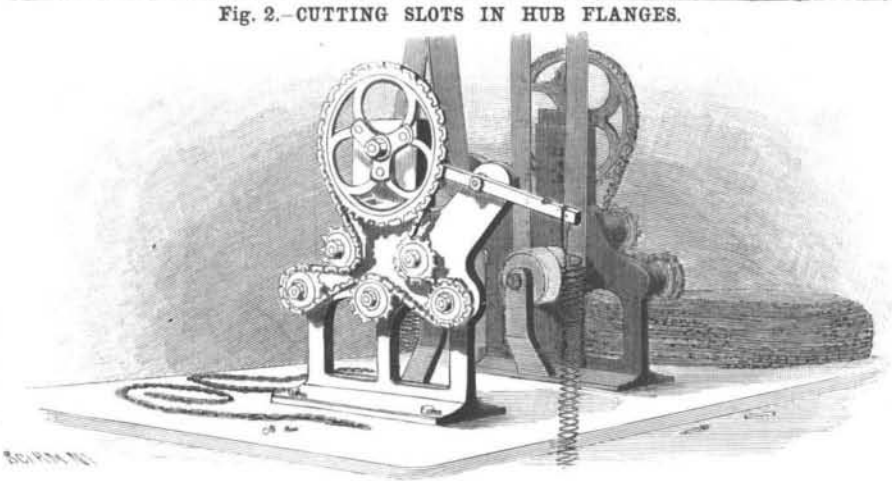


Fig. 4.—CHAIN LIMBERING MACHINE.

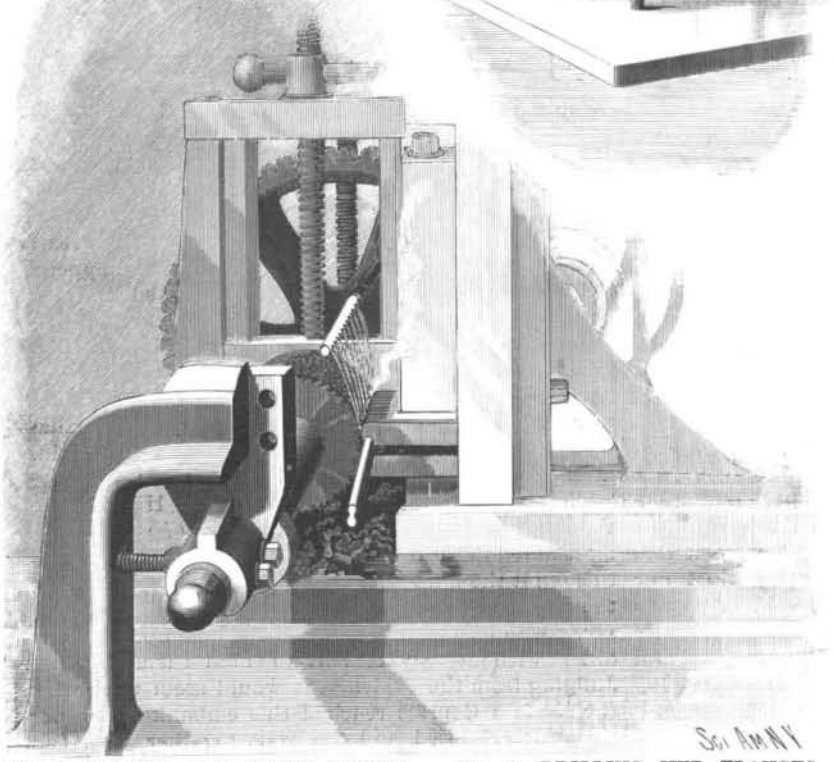


Fig. 5. SAWING OFF CHAIN BLOCKS. Fig. 3. DRILLING HUB FLANGES

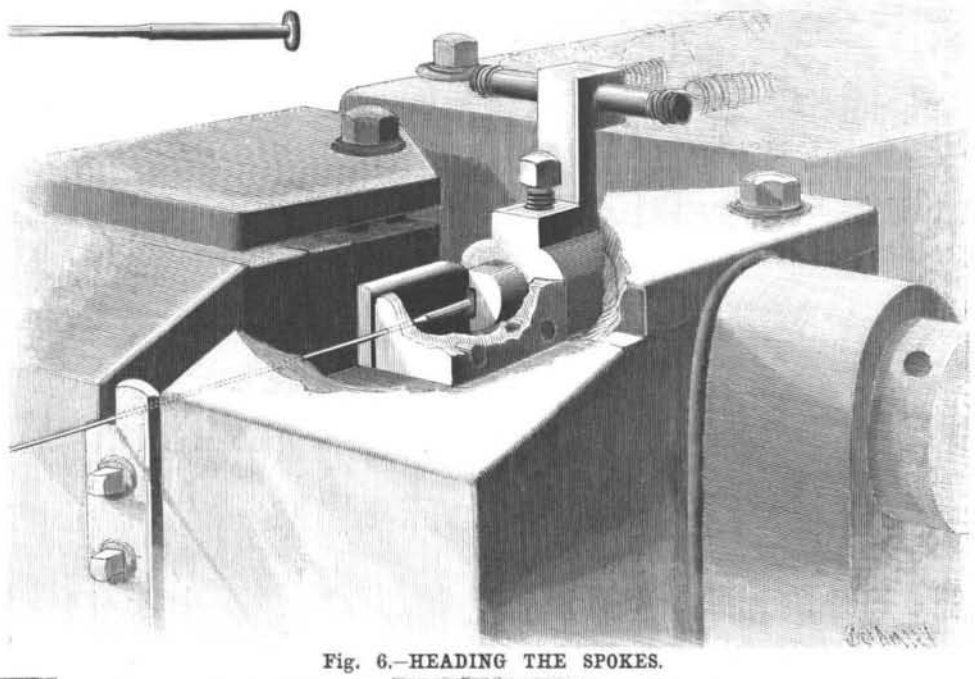


Fig. 6.—HEADING THE SPOKES.

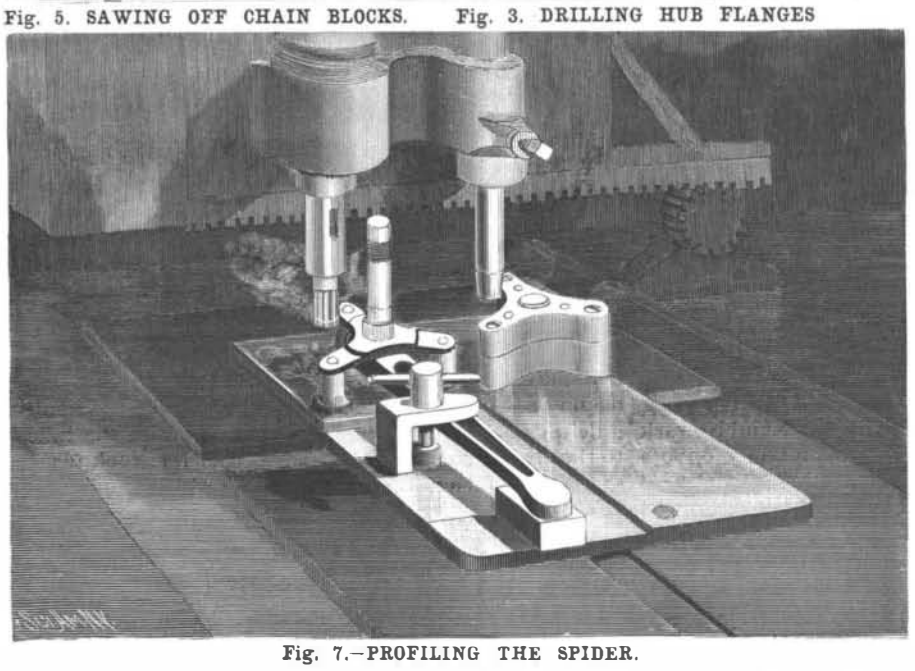


Fig. 7.—PROFILING THE SPIDER.

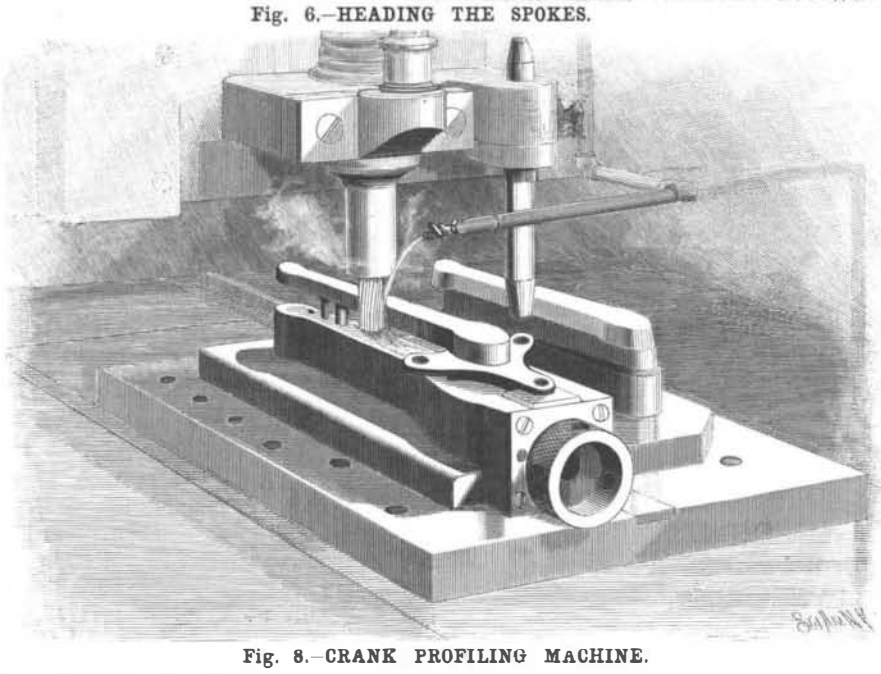


Fig. 8.—CRANK PROFILING MACHINE.

THE PLANT OF A MODERN BICYCLE FACTORY.—[See page 292.]