LABORATORY TESTS OF THE BICYCLE.

There is probably not a machine in the world that works on such a small margin of safety as the bicycle. It has been estimated that the safety "factor" is only about 1¼ in the lightest machines, and while this is probably too low an estimate, it is certain that, when a powerful 200-pound rider is climbing a steep hill, or worse, coasting down a hill whose surface is rough and lumpy, the margin of safety must be a very narrow one—narrow, that is to say, compared with that allowed in other forms of mechanical construction. Thus the bridge builder provides sufficient steel in the various members to insure that the heaviest possible loads that can come upon them will not strain the metal above from 20 to 30 per cent of its elastic strength, and even in designing structures that are subject to quiet or static loads, the material is not strained beyond 33 per cent of its strength; that is to say, the parts are made not less than three times as strong as is necessary to bear the greatest stress that will be put upon them.

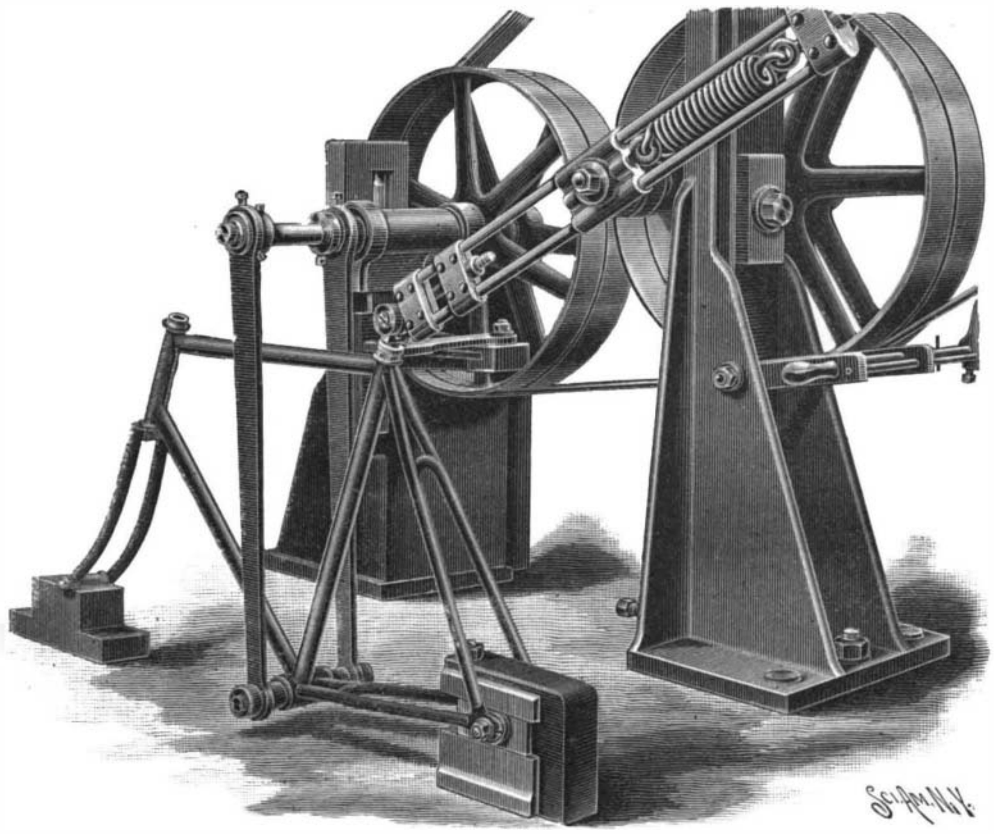
We cannot calculate the maximum stresses of a bicycle with the nicety with which they can be computed in engineering structures and in the heavier classes of machinery. The conditions of use and abuse are so various—the hard use of a powerful but cautious rider being less severe than the abuse of some reckless boy—that the only way in which the proper strength for a wheel can be determined is by trial, and by a careful selection and test of the materials of which it is constructed. If an engineer were told to work out the strain-sheet of a bicycle in the same way as he would that of a railway bridge, taking the possible maximum stresses due to the work of heavy and powerful riders upon rough and hilly roads, and proportioning his parts so that the metal should not be strained above 10,000 to 15,000 pounds to the square inch, the wheel built from such a strain-sheet would be as heavy as the primitive boneshaker of thirty years ago.

A comparison of the bicycle considered as a means of transportation with a railway car brings out the remarkable fact that it takes forty-six times as much dead weight of material to carry a man on the railway as it does on a wheel. For a modern coach carrying sixty people will weigh about 70,000 pounds, which is at the rate of 1,167 pounds to the passenger; while a modern bicycle will weigh only 25 pounds. If we take the Pullman car as an example, the disparity is yet more striking; for here we have only twenty-four passengers carried on a car weighing 100,000 pounds, or say 2 tons to the passenger. In this case the car weighs 167 times more per passenger than does the bicycle.

Size of gear.	Gear used for	Distance covered in two strokes or one revolution of the cranks compared with distance covered (5 feet) in walking two steps.
120	Paced racing	31 ft. 4 ins
105	High gear for road riding	27 ft. 6 ins
88	Sprint racing	23 ft
80	Ordinary gear for road riding	21 ft
68	Lady's wheel	17 ft 9 ins
Two steps	Walking	5 ft

From these considerations it is evident that the light weight of the bicycle can only be maintained by the most careful inspection of materials and workmanship, and in the case of all the standard bicycles it is safe to say that this inspection is very carefully made. Every lot of stock is subject to tests in the testing department, which, by the way, is coming to be recognized as an indispensable part of all large American establishments in the engineering and kindred trades, and the finished parts and finished machines are in some cases put to special tests to determine their strength and running qualities.

We present an illustration of one of many testing machines installed in the laboratory of the Pope Manufacturing Company. It is used for trying the strength of the frame, and it is designed to reproduce as far as possible the actual stresses to which a frame is subjected when put to hard usage on the road. The principal stresses are those due to the weight of the rider applied at the top of the seat-post tube and the alternate transverse bending stress due to the pressure on the pedals. The frame is mounted upon two blocks, one under each hub as shown, the crank-hanger being left unsupported. The stresses due to the weight of the rider are reproduced by means of a short-throw crank driven by a pulley, and a spring connecting rod, as shown, one end of which is clamped to the seat-post, while the crank engages a sliding head which is attached by a powerful spiral spring to the other end. The rapid rotation of the crank thus imparts a series of cushioned blows whose effect on the frame is similar to that due to the speed of the machine, inequalities of the road, the pneumatic tires, and that part of the rider's weight which is on the saddle.



MACHINE FOR TESTING BICYCLE FRAMES.

The crank-shaft stresses are applied by means of two connecting rods, one on each side of the frame, which are driven by eccentrics set at 180° and carried on a second pulley-driven shaft. The stroke of the eccentrics is of course very short, merely sufficient to bring a heavy bending stress alternately on each side of the crank-hanger. One machine out of every lot is placed in this instrument of torture, and if, after it has been merrily thumped and wrenched for a stated length of time, its tubing is true, brazing sound, and the whole frame in line, it is considered that no fair usage on the road can ever break or distort it.

One must confess that, interesting as the various departments of a bicycle factory undoubtedly are, the most fascinating plant is to be found in the department of tests, for here we see the fruition of the labor of the whole establishment. That all-absorbing question as to the respective ease of running of a chain and a chainless wheel is here determined to absolute demonstration on an ingenious device known as a float dynamometer. The wheel is mounted at the side of a tank of water in which are two separate floating platforms. On the first platform is mounted an electric motor, on the other a friction brake. The motor is connected by a universal joint shaft with the axle of the bicycle, and the friction brake is similarly connected with the shaft of a pulley upon which the rear or driving wheel of the bicycle runs. It is evident that the power given out by the floating motor will be in part absorbed by the internal resistance of the bicycle, the rest being returned at the floating brake.

The tangential reaction of the motor will cause the float on which it is carried to tilt over; similarly, the pull of the brake will tilt the brake float. If, now, the tilting in each case be corrected by moving a sliding weight on a horizontal graduated arm, the readings of the two arms will show respectively the power given to the bicycle by the motor and the power returned to the brake from the bicycle. The difference will represent the loss by friction in the bicycle. If a chainless and a chain wheel be tested in the same apparatus, their respective efficiency can be determined with the greatest accuracy.

It is found that, with the gears new and perfectly clean under light loads, there is practically no difference in efficiency between the Columbia chain and chainless wheels, but, as the load is increased, the chainless wheel begins to show a gain which grows rapidly as the load is still further augmented—a result which shows the bevel gear to be superior to the chain gear for hill climbing, and superior to it in all cases where the chain has "stretched" or is fouled with grit or dust.

BICYCLE GEAR—WHAT IT IS AND WHAT IT DOES.

Those of our readers who were bicycle enthusiasts in the days of the old "ordinary" will remember that a wheel was designated by the diameter, in inches, of its driving wheel, which varied from 48 to 62 inches, according to the length of leg of the rider. Thus we were wont to speak of the respective merits of our 50-inch Rudge, or 54-inch Victor, or 60-inch Columbia, as the case might be. The diameter of the driving wheel was the most variable element, and hence it was chosen as the designating feature.

With the introduction of the rear-driven safety it was no longer possible to grade the wheels according to the diameter of the

BICYCLE GEAR AND ITS EQUIVALENTS.

A safety geared to 120, in one revolution of the crank, covers the same distance as that covered by one revolution of an ordinary wheel ten feet high, or two strides of a man thirty-five feet high.