driving wheel, for the reason that the latter all settled down to a common size of 28 inches; but as the introduction of the chain drive enabled the speed of revolution of the driving wheel to be increased over that of the cranks, thereby increasing its circumferential speed, it was decided to designate the bicycle by the effective diameter of the rear wheel as thus secured. The increased circumferential speed of the wheel is obtained by placing a larger sprocket on the crank axle than on the rear wheel; for the rear sprocket (with its wheel) will run just as much faster as the front sprocket is larger than itself. Thus, if there are 24 teeth in the front sprocket and 8 in the rear, it is evident that, by the time the 24 teeth of the front sprocket have engaged and drawn forward the chain, the chain will have engaged and drawn forward 24 teeth on the rear sprocket, and to do this it must have rotated the 8-tooth rear sprocket three times. Now, this will cause the 28-inch rear wheel to travel over a distance equal to three times its own circumference, or equal to the single circumference of a wheel three times as large as itself, or 84 inches in diameter. Since this effective diameter is due to the chain and sprockets, it is spoken of as "gear," and a bicycle with an effective driving wheel diameter of 84 inches is known as an 84-gear wheel.

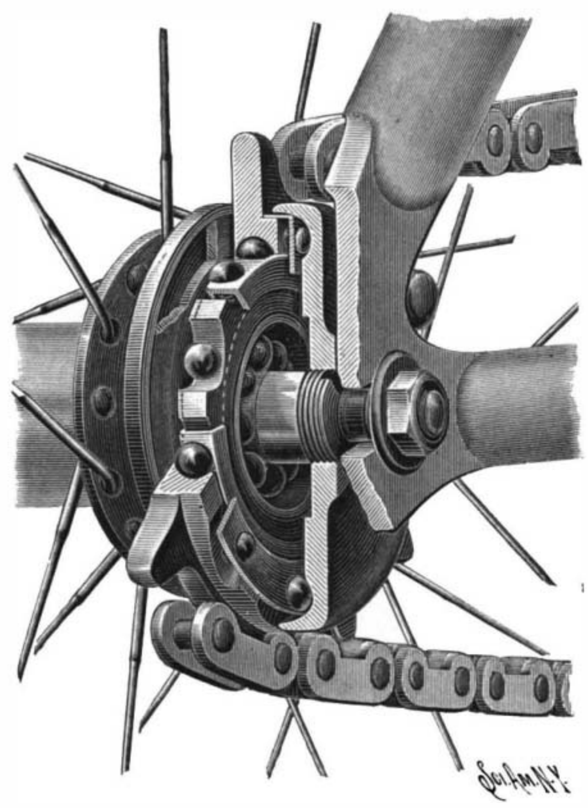
It is evident, then, that since the diameter of the rear wheel is constant, the gear depends solely upon the relative size of the sprockets employed, and is found by the simple formula, $G = \frac{D \times F}{R}$, where G = the gear; D the diameter (28 inches) of the rear wheel; F the number of teeth in front sprocket and R the number of teeth in rear sprocket. Thus 84 gear can be obtained by a 21-tooth front and a 7-tooth rear or a 30-tooth front and 10 tooth rear. The gear of a bicycle, then, is the diameter of a circle whose circumferential length is equal to the distance traveled by that bicycle in one revolution of the cranks.

It is largely the possibilities of "gear" that make the safety so incomparably superior to the ordinary bicycle. Formerly one was restricted to what he could stretch, and only a tall man could negotiate a 60-inch wheel. Now a child's wheel is geared to 60, and many women are riding wheels of 76 to 84 gear. Gears of 96 to 105 are not infrequently met with on the road, and there is one famous rider in paced races who has won his reputation on a wheel geared to 120 inches. It is the great distance covered in proportion to the speed of pedaling that constitutes the charm of the high gear, at least as far as the imagination is concerned; for that frailty of human nature which expresses itself in a desire to get "something for nothing" will not down, and asserts itself in all kinds of places and at unexpected times. In riding a high gear there is a sense of getting out of the machine something more than we put in—even though mechanical orthodoxy tells us this cannot be—and there is no denying that, under favorable conditions of grade and wind, a day's journey can be made with less fatigue on a high than a low gear.

Of course, we all know that the total work done by a rider in propelling the same wheel over the same stretch of road, under identical conditions, never varies, whatever may be the gear employed. If I ride a 25-pound wheel a mile on the turnpike with a gear of 60, I do a certain amount of work; and if I ride the same wheel over the same mile in the same time with 120 gear, I do the same amount of work. In the latter case I turn my cranks more slowly, but I have to exert just as much more pressure upon them as their speed of rotation has decreased. If, with a view to reducing the pressure, I double the length of the cranks, then my feet must travel twice as far in a circle twice as large. Since work at the cranks may be regarded as pressure multiplied by distance, the total amount of work I do will be the same, whether I exert heavy pressure on short cranks moving in a small circle or light pressure on long cranks moving in a large circle.

Since in riding the same distance at the same speed, on the same wheel, the total work is the same, whatever the gear and whatever the length of the cranks, the question arises, What is the best gear to use? The answer is that, The gear must be determined by the physical and temperamental make-up of each individual rider. If we were to pick out a dozen men, and start them out to walk a hundred yards, we would find that no two of them took the same length of step. Some would fall into a long swinging stride of 36 to 40 inches, while others would trot along with little mincing steps of 18 to 24 inches. The speed might be the same, but the length of stride would be that which each individual had unconsciously found to be agreeable to his own idiosyncrasies of physique and temperament. So with the question of gear and crank length. Some riders will get the best results with high gear and long cranks, others with low gear and short cranks, while a rider of the writer's acquaintance uses on the road a 104 gear with a 6½ crank, and will ride all day without any apparent distress. As a rule, tall men should use high gears and long cranks, a 6-foot rider being able to negotiate a 7½-inch crank with as little bending of the knee (a fruitful source of weariness) as a 5½-foot rider using a 6½ crank.

Our artist has shown in the accompanying sketch



THE TREBERT COASTER AND BRAKE.

how the gear increases the effective diameter of the driving wheel, raising it from 28 inches to as much as 120 inches in the case of one rider already mentioned. As a matter of fact, our fastest racing men are using a wheel from 2 to 3 feet larger than the largest locomotive driving wheels used in this country. Another interesting point brought out in the sketch is that the modern bicycle has increased the locomotive powers of man to such an extent that to cover as much ground at each step in walking as he does at each stroke of his pedals, he would have to be a giant fully 35 feet in height. It was found, by measuring the number of steps taken by several employes in walking 150 feet down the SCIENTIFIC AMERICAN office, that the average stride is 2½ feet in length, or 5 feet for two steps. Now two "strokes" of the legs of a cyclist on a 120 gear wheel would carry him a distance of 31½ feet; and, supposing the step is roughly proportionate to the height, our giant would have to be about 35 feet tall, and to make the maximum speed of between 35 and 40 miles an hour accomplished on the 120-gear wheel, he

THE VICTOR AUTOMOBILE CARRIAGE.

would have to step as frequently as a person of ordinary stature walking at a brisk rate.

A FRENCH firm has undertaken the manufacture of a new metallic curtain for the Opera House at Besançon. The curtain is to be lowered after each act or in case of great danger. It is 60 feet wide and 54 feet high and is to be composed of aluminum sheets 13 feet long and 29 inches wide and 1/16 of an inch thick. The total weight will be 4,000 pounds. If such a curtain were made of sheet iron, it would weigh 11,000 pounds.

THE TREBERT COASTER AND BRAKE.

Since the introduction of the automatic coaster and brake, improvements in construction have constantly been made which have increased the efficiency of the device to such an extent that the old plunger brake is beginning to disappear. Among the latest types of these brakes is the Trebert brake, made by the Trebert Automatic Coaster and Brake Co., of Syracuse, N. Y.

The brake in question comprises essentially a friction-disk secured to the hub of the rear wheel, a clutch on the disk, and a clutch on the rear sprocket-wheel. The two clutches are provided with inclined surfaces upon which balls, held in place by retaining rings, roll. The balls on the disk-clutch serve to lock the sprocket and clutch together when the wheel is in motion; and the balls on the sprocket clutch serve to bind the sprocket against the friction-disk in order to stop the wheel.

When the chain of the bicycle is pulling forward, the balls on the disk-clutch will also move forward and ride up their inclines, thereby locking the clutch and sprocket together so that both rotate with the wheel. When the rider desires to coast, he applies a slight back pressure to the pedals, thus causing the balls on the disk-clutch to roll down their inclines in order to release the sprocket from the clutch and to permit the wheel to rotate independently. When the rider wishes to stop, he applies a further back-pressure to the pedals, thereby causing the balls on the sprocket clutch to ride up their inclines and to bind the sprocket and friction disk so tightly together that the wheel is prevented from turning.

The brake, besides giving the rider full command of his wheel and enabling him to hold his feet stationary upon the pedals for the purpose of coasting, possesses the additional advantage of being readily applied to any wheel without the necessity of remodeling or changing the frame.

THE VICTOR AUTOMOBILE.

While we are considering hydrocarbon and electric vehicles, it must not be forgotten that there are also on the market excellent motor carriages driven by steam, and we take pleasure in presenting an engraving of the "Victor automobile," which is a steam wagon entirely automatic in its regulation, made by the Overman Wheel Co., Chicopee Falls, Mass. When the word steam is used it naturally brings to mind a certain uneasiness, but users of the Victor automobile need have no anxiety, for the boilers are tested and insured by the Hartford Steam Boiler Insurance Company, each boiler being tested by the expert of this well known company and a certificate given as to the test. The boiler is truly automatic, the water being fed into the boiler automatically with absolute precision. Thus the user will be relieved from the point which is the chief difficulty of putting steam in the hands of laymen. The pressure on the fuel tank is also regulated automatically. The fuel tank holds enough common gasoline to go fifty to one hundred miles, and gasoline is readily obtainable in every village. It also holds water enough to run twenty-five miles, and a collapsible soft rubber bucket enables one to get water at any place. The engines are of three and one-half horse power and the boiler capacity is five horse power. The machine is geared according to the roads and hills, and it is capable of running from a speed which is slower than one would walk to its maximum speed, which would ordinarily be about twenty miles an hour.

Infection by Speaking Tubes.

The speaking tube is an excellent means of infection, and The London Lancet has recently issued a note of warning concerning them. These tubes are practically unventilated except when in use, and when the person using them speaks, the moisture in the air which he exhales condenses on the sides of the tube, so that the products of respiration remain for the benefit of the next persons using the tube; and it is little wonder that the telephone is recommended in preference to the speaking tube by sanitarians. It is quite possible for tuberculosis or other diseases to be spread by speaking tubes; for it is necessary for the person in calling to place his lips in actual contact with the mouthpiece at the near end to make the whistle sound at the far end.

TUNNELS under the Thames at London are multiplying rapidly. Hardly has the Blackwall tunnel been open when another at Rotherhithe is projected. It is to be 30 feet in diameter—3 feet more than the Blackwall tunnel. It is to be a mile and a quarter long. The total work will cost about $7,000,000, but nearly $4,000,000 of this will go for the approaches.