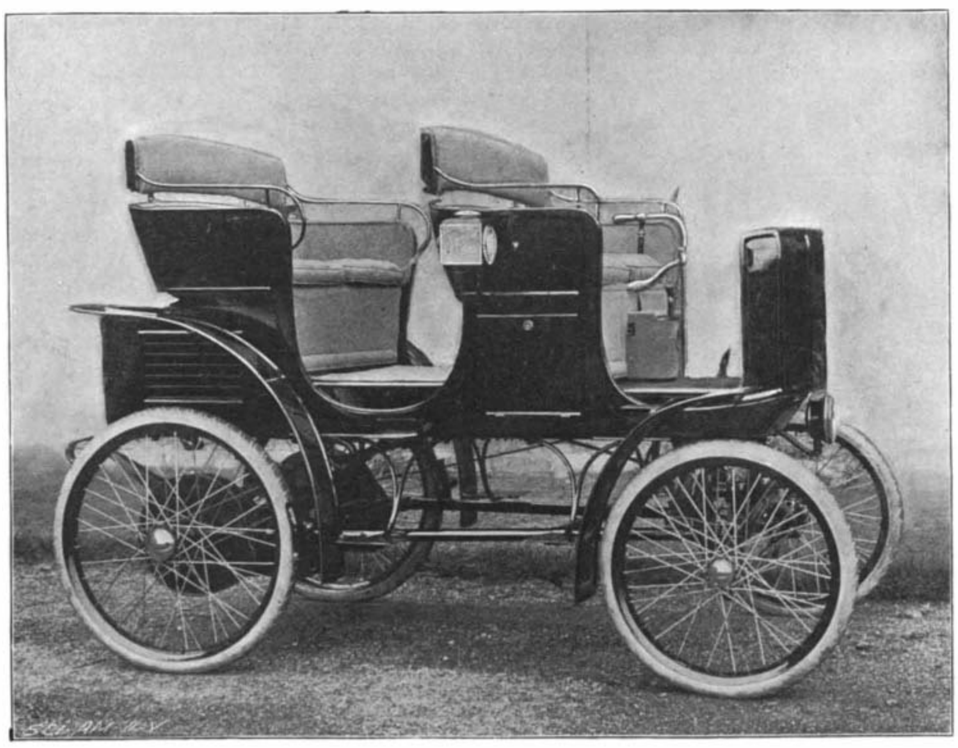
weight to the side toward which it is desired to go. The front wheel is also turned in this direction, and the tendency to fall is counterbalanced by the constant travel of the points of contact of the wheels with the ground in the direction of inclination. Equilibrium is thus maintained during the turning. When it is again wished to go straight, either the weight is shifted to the opposite side (by leaning) or the front wheel is turned still sharper, as in restoring the balance.

In examining the mechanics of the more difficult features of bicycle riding, it is necessary to consider with more particularity the laws governing the action of the front or steering wheel. The front wheel is mounted on an axle which supports a fork whose stem has a bearing in a rearwardly inclined position in the head of the frame. The fork curves forward as it approaches the axle. If the stem were vertical and the fork straight, the axis of the stem would meet the ground at the point where the wheel rests on the ground. The inclination of the fork stem, however, causes its axis to pass in front of the point of contact of the wheel and ground, thus producing the effect of the caster wheel, such as is used on furniture. The curve in the fork brings the point of contact of the wheel closer to the axis of the stem, and, without destroying the caster action, increases the sensitiveness of the steering wheel. The chief effect of the caster construction is that the point of contact of the wheel, by dragging behind the axis of the stem, exerts a strong tendency to keep the wheel pointed in the direction of motion of the bicycle.

If the stem axis be kept in the vertical plane through



COLUMBIA TWO-SEATED "SURREY" MOTOR CARRIAGE.

the axle, there is no tendency of the wheel to turn to the side when the stem is inclined laterally. When, however, the stem is not kept in this vertical plane and is inclined toward a given side, the wheel turns toward that side until its axle is in the vertical plane passing through the stem. The reason for this lies in the tendency of every body that is free to move to seek the position in which its center of gravity is lowest. In such a position of the wheel, the distance from its center to the ground is less than its radius.

Applying this law to the construction of the bicycle, the inclination of the stem axis tends, when the frame is vertical, to turn the steering wheel across the frame. As the frame is tipped further the wheel turns toward the front until, when the frame lies on the ground, the wheel is practically in line with the frame. The wheel turns to the side toward which the frame leans, and this is because the axis of the stem, passing to the rear of the axle, leaves the center of gravity of the wheel in its front.

There are, therefore, two forces acting on the unrestrained steering wheel. First, there is the caster action, which tends to keep the wheel in line with the frame; and, second, there is the tendency of the wheel to turn to the side toward which the frame is inclined and throw the axle into the vertical plane passing through the stem axis. The position which the wheel takes is one due to the resultant of these two forces.

In riding straight ahead with the steering wheel unrestrained, if the balance is lost, the steering wheel, owing to the inclination which the stem axis thus receives, turns in the direction of fall and carries the line of contact of the wheels with the ground laterally until it has passed under the center of gravity of the rider and wheel, when the frame either remains straight or inclines in the opposite direction. In the latter event the steering wheel again automatically restores the balance.

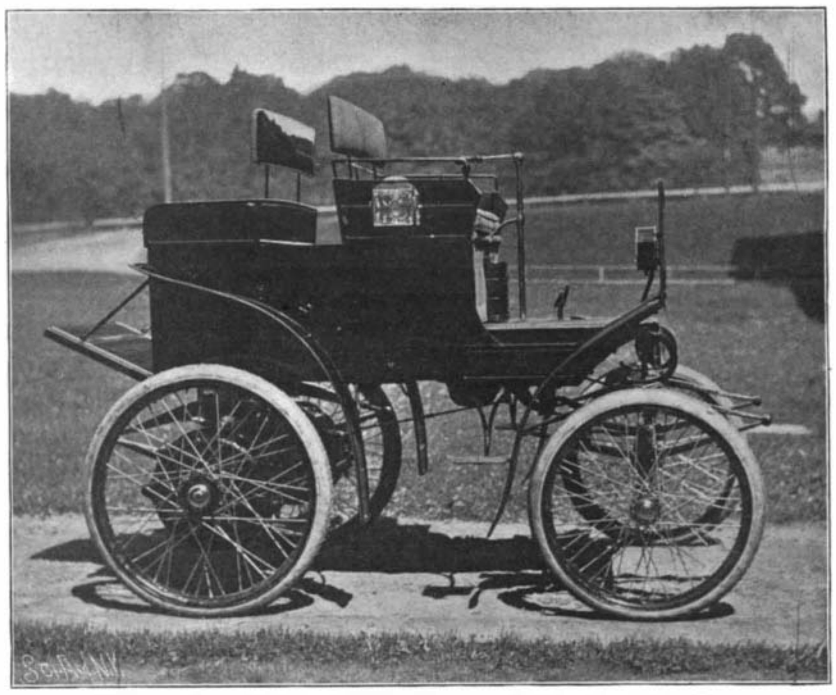
If the rider, when running with hands off, desires to turn to one side, he leans to that side; and the steering wheel turns itself in the same direction. When the turn has been made, the rider leans in the opposite direction until the front wheel has again placed itself in line with the frame.

The acts thus far enumerated are commonly performed; but the feat of riding backward is much more difficult and rare. That this can only be done by manipulation of the steering wheel will be apparent from the following considerations:

In riding backward with the steering wheel free, the point of contact of this wheel drags and seeks to move, relative to the frame, away from the direction of travel. It accordingly approaches the stem axis, turning the wheel across the frame. The steering wheel remains in this position, because it is the position of lowest center of gravity, and because the point of contact cannot go beyond the stem axis. Owing to the position of the center of gravity of the steering wheel in front of the stem axis, the wheel will fall to the side toward which the frame is inclined and will cause the head to run away from the direction of fall, instead of in the same direction as the fall, as it does in riding forward. It is therefore apparent that the bicycle cannot be ridden backward when the steering wheel is allowed to control itself.

Let us see what can be done by manipulation of the steering wheel. If perfect balance could be maintained, the bicycle would travel in a straight line and no trouble would occur. In actual practice, however, the bicycle is always falling either to one side or the other. Suppose it to fall to the right side. The driving wheel, which is now the front wheel, being inclined to the right, will travel in a curve toward the right, as does a coin when it is rolled freely across the floor. The driving wheel is consequently going in the proper direction to carry the line of contact under the center of gravity and restore equilibrium. If, then, we turn the steering wheel so that it travels to the right, the bicycle will travely bodily in the direction of fall, and if this takes place more rapidly than the center of gravity travels laterally, equilibrium will be restored.

The secret of recovering the balance in riding backward lies in turning the steering wheel in the opposite direction relative to the direction of travel of the machine from that in which it is turned when riding forward. Having once learned to turn the handle-bar one way in riding forward, it is very difficult to turn it in the opposite direction merely because the bicycle is traveling backward.



COLUMBIA TWO-SEATED "DOS-A-DOS" MOTOR CARRIAGE.

COLUMBIA MOTOR CARRIAGES.

The three motor carriages herewith illustrated were chosen from the many styles of automobile turned out by the Pope Manufacturing Company as being thoroughly representative of the work done in the motor carriage department of this firm. In every case the motive power is electricity, the company being of the opinion that in the present state of the art electricity, while not without its limitations, fulfills more of the necessary conditions of a successful motive power than the steam or gas engine.

The storage electric motor is clean, silent, free from vibrations, thoroughly reliable, easy of control, and produces no dirt or odor. While it is not so cheap nor of such mileage capacity as some other forms of motor, it is certainly not extravagant in proportion to the service rendered, and its capacity has been proved to be more than equal to the demand of the average city or country vehicle. The greatest demand for an efficient automobile comes, not from people who wish to take long tours through the country, or whose business calls them to any considerable distance from an electric charging station, but from surgeons, expressmen, and those private citizens who wish to keep a carriage, but cannot afford either the space or the cost entailed in providing a team, stable, and coachman.

In order to secure data as to the necessary mileage to be provided for in the storage batteries, the Pope company had cyclometers attached to the conveyances of several individuals who were engaged in occupations in which the automobile would prove serviceable. The investigation showed that the average mileage was 18 miles per day, and except in one case the maximum mileage did not exceed 25 miles. Accordingly, batteries are furnished for the motors that have a capacity of 30 miles per day on level roads and 25 miles on the ordinary grades of a New England city. These figures are, of course, modified by conditions of mud, snow, or rocky roads. The batteries can be charged from any 110-volt direct current circuit such as is used in city lighting. Where current of a higher voltage or the

COLUMBIA DOUBLE-SEATED "PHAETON" MOTOR CARRIAGE.

alternating current is used the company supply, at moderate cost, a small portable and practically automatic transformer. To charge the batteries from empty to full takes three hours, and the average cost, where current is taken from the city mains, is 60 cents, and the company claims that the average cost of running on a carriage when using current taken from a public station is one cent per mile.

The frame is built of steel tubing manufactured at the Hartford establishment. The wheels are proportioned to meet the specially severe strains of motor carriage service, the front wheels being ordinarily 32 inches in diameter and the rear driving wheels 36 inches. The tire , 3 inches in diameter, are of the Hartford single-tube type, and are provided with a roughened "herring-bone" tread to improve the adhesion. The walls of the tube are of great thickness, and one set of tires has already run 2,500 miles without the need of repairs. The wheels are fitted with ball bearings designed to meet the heavy loads and stresses of the automobile.

The carriages have a maximum average speed of 12 miles per hour on the level, and they can be run at lower speeds of 6 and 3 miles an hour if desired. These speeds are based upon the fact that 8 miles per hour is the legal limit in most cities. The person operating the carriage sits on the left hand side, as this is the convenient side for seeing the wheels of any passing vehicle and judging the distance. The controller, which moves through four positions, from "stop" to "full speed," is at the left hand, and the steering handle is held in the right hand. The brake and reversing lever are operated by the left foot. The brake consists of a bronze band which is tightened over an iron drum on the rear or driving axle. A warning electric bell is carried on each carriage. It is rung by pressing a push button placed in the end of the controller handle already mentioned, and a meter is conveniently placed in sight of the operator, by which he can read at sight how much of the battery power has been used.

EXPLOSION OF A TEN-INCH GUN AT SANDY HOOK.

MR. HUDSON MAXIM REPLIES TO MR. HIRAM S. MAXIM.

To the Editor of the SCIENTIFIC AMERICAN :

In your issue of May 6, 1899, appeared a long article signed "Edmund J. Ryves" and another signed "Hiram S. Maxim." All who are familiar with Hiram S. Maxim's style of expression will be able to identify both communications as the work of the same author.

My brother Hiram, in his letter, states that I did not assist him in his early experiments on smokeless powder in England. The same statement is also made in the Ryves article. I have letters in my possession signed by Hiram S. Maxim in which he states that I did assist him very materially in those experiments, which I shall publish in the next issue of the SCIENTIFIC AMERICAN SUPPLEMENT. I am glad that he now claims that I did not assist him in those experiments, because this refutes his previous claims that the inventions which I have patented were on ideas acquired by me from him while assisting him in his experiments.

He also states that an examination of the patents will show who the patentee really was. I will also state that an examination of the patent records will show which of us, Hiram S. Maxim or myself, is the inventor of the most important inventions now used in the commercial manufacture of smokeless powders. The following is a list of my British smokeless powder patents: No. 18,682 of 1894; No. 8,569 of 1895; No. 11,299 of 1895; No. 16,311 of 1895; No. 16,861 of 1895; No. 16,862 of 1895; No. 16,858 of 1896; No. 15,499 of 1897; No. 7,178 of 1897.

The following letter from Dr. Robert C. Schupphaus will explain itself and throw considerable light upon the matter under discussion here.

"Charlottenburg, Germany, September 17, 1898.

"Hudson Maxim, Esq., New York city :

"Dear Sir : Your letter of August 30 was received, telling me of the statements made by Mr. Hiram S. Maxim about smokeless powders, and his claims to being the inventor of important methods and processes, and his further assertion that many of the important features of the Maxim-Schupphaus smokeless powder originated with him and were taken from him.

"I have been long aware that he was making some such claims. In fact, in the fall of 1896 I was told in London, by Mr. Albert Vickers, that he had understood from Mr. Hiram S. Maxim that all the important methods employed by us were taken from him, and that they were his inventions. Mr. Hiram S. Maxim was forced to acknowledge before Mr. Albert Vickers, in my presence, that any such conclusion in regard to the Maxim-Schupphaus powder as Mr. Vickers might have arrived at through remarks of his was false, and that not a single feature of this powder originated with him. I have in my possession a letter addressed to me and signed by Mr. Albert Vickers, for Vickers Sons & Company, Limited, dated London, November 2, 1896, which closes as follows :

"'We undertake not to manufacture this powder without having made an arrangement satisfactory to yourself.'

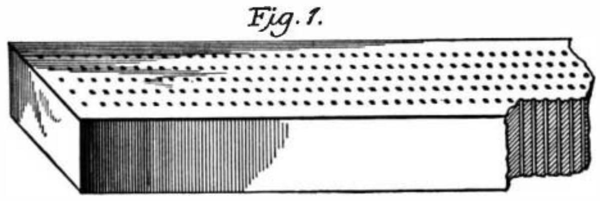
"Anybody who is familiar with the history of smokeless powder and the actual processes of manufacturing these powders knows that none of Mr. Hiram S. Maxim's inventions is being used to-day in the commercial production of any smokeless powder in the world.

"You may give any publicity you wish to this letter in order to meet the unfounded claims made by Mr. Hiram S. Maxim and also to show that, as we stood together and shared the work and the trials in the production of the Maxim-Schupphaus smokeless powder, there is now no disposition on the part of either of us to rob the other of the full measure of credit deserved, and we stand together in sharing the credit as we did in sharing the work. Sincerely yours,

(Signed) "ROBERT C. SCHUPPHAUS."

One such letter, referring to his first smokeless powder experiments, was addressed to Lieut. J. F. Meigs, Engineer of Ordnance, Bethlehem Iron Works, Bethlehem, Penn., dated 32 Victoria Street, London, S. W.,

Fig. 1.



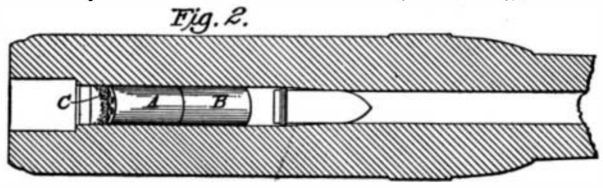
August 8, 1895, in which Hiram S. Maxim makes the following statement :

"My brother Hudson assisted me in my experiments for several months."

In the article signed "Edmund J. Ryves" a statement is made to the effect that the company could not get some of the Maxim-Schupphaus smokeless powder for tests in England, owing to the fact that it was found impossible to make it stand the British stability test. In regard to this, I will refer to Mr. Hiram S. Maxim's remarks on the stability of this powder from his letter to Lieut. Meigs, which will appear in the next issue of the SCIENTIFIC AMERICAN SUPPLEMENT. He says that, according to his own tests, the Maxim-Schupphaus smokeless powder stood twice as long as British cordite.

Last year I sold to Sir William Armstrong, Whit-

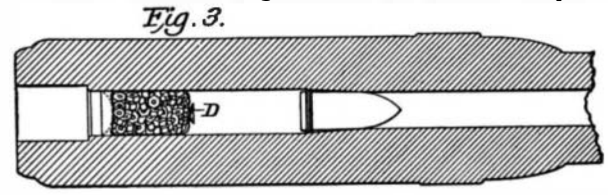
Fig. 2.



worth & Company, eight hundred pounds of Maxim-Schupphaus smokeless powder. They encountered no such difficulty.

It is also stated that: "Mr. Hudson Maxim attributes the disaster to the charge being driven forward into the narrow neck by the pressure, where the grains of powder were jammed together, and an exaggerated illustration is shown with the grains of powder driven forward and jamming in the neck of the chamber. Now, as a matter of fact, in all large guns of modern make, the chamber is very little larger than the bore, the chamber not being bottle-necked to any considerable extent. Mr. Hudson Maxim proposes as a remedy that long bars or sticks of powder should be employed extending the entire length of the chamber, and that these sticks should be transversely perforated. Had the artillerists of the world, who have been experimenting during the last eight years with smokeless powders, exchanged the results of such experiments, it would have saved a great deal of trouble and pre-

Fig. 3.

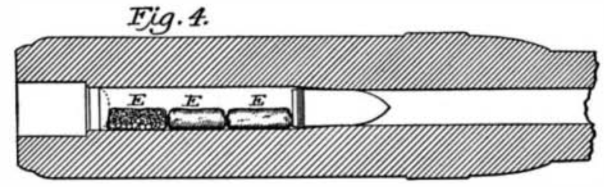


vented a considerable loss of life. This multiple-perforated smokeless powder was tried in my presence over two years ago."

Now, as a matter of fact, the tests which he refers to as having been made in his presence were with ordinary cordite, very irregularly and badly perforated with ragged transverse holes. What I had advised was rods especially made, like that shown actual size in Fig. 1, and 18 inches long and rectangular in form, multi-perforated with small rectangular holes regularly spaced, so as to provide uniform burning thicknesses between the perforations. Furthermore, the cordite which was used was a waste lot which could not be sold for service purposes. It was split up into numerous fissures and cracks throughout as a result of imperfect squirting or by drying.

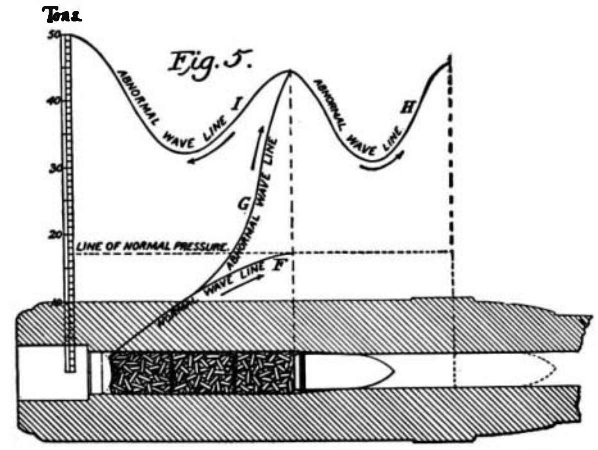
In correction of the statement that the powder

Fig. 4.



chamber in all large guns of modern make is very little larger than the bore, I will call attention to the fact that with the 10-inch gun which burst, the powder chamber was a little more than one-third larger in cross sectional area than the bore, so that a body which would pass freely through the powder chamber would have to be compressed one-third in order to pass through the bore. This is sufficient to account for all I have claimed. I will also quote the following paragraph :

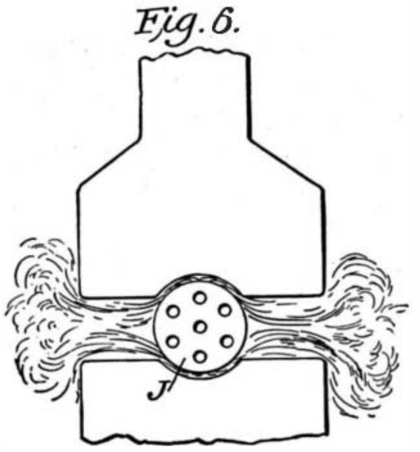
"Now, in regard to the packing or jamming of the powder in the bottle neck of the chamber, this is absolutely impossible. If two sticks of powder are placed in contact and lighted, the evolution of gas from their surfaces is such as to blow them apart. When a large gun is loaded with smokeless powder, the bundle of powder does not by any means fill the chamber. In a 10-inch gun there is at least three inches space above the powder charge. . . . Suppose, for the sake of argument, that the powder should be pressed together in the chamber, it would instantly be thrown back again, because the nearer the powder is together, the higher the pressure and the faster it burns."



Diagrams are shown with an attempt to prove that, owing to the rapid evolvement of gases from the surface of the burning grains, they could not be jammed into the forward end of the powder chamber or crushed ; and it is stated that "no amount of pressure will bring two pieces of burning powder into actual contact," and that powder grains in a gun automatically space themselves, contact being rendered impossible, and that 100 tons pressure to the square inch would not force two pieces of burning powder together.

Let us examine this logic. It is not necessary that the grains of powder should come into actual contact in order to produce the jamming, crushing, and bursting effect described by me. The very fact that the pressing together of burning powder grains causes them to be still more strongly forced apart, accords with, instead of being contrary to my claims ; for, from that very reason, a higher mounting of pressure and more rapid

Fig. 6.

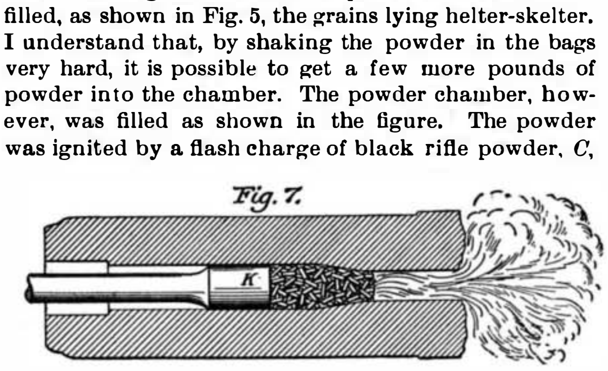


combustion would occur in the narrow neck of the powder chamber, exactly as I pointed out as having occurred in the 10-inch gun which burst. Also witness statement of Mr. Hiram S. Maxim in letter to Lieut. Meigs above referred to :

"With a soft and semiplastic powder in long rods, like the British cordite, it sometimes occurs that the explosion produces a wave action, driving the soft and plastic powder, while still burning, into the forward end of the chamber of the gun. . . ."

There was not, as stated in the Ryves article, at least 3 inches space above the powder charge ; 141 pounds of powder was employed, considerably more than the normal charge. The entire powder chamber was filled, as shown in Fig. 5, the grains lying helter-skelter. I understand that, by shaking the powder in the bags very hard, it is possible to get a few more pounds of powder into the chamber. The powder chamber, however, was filled as shown in the figure. The powder was ignited by a flash charge of black rifle powder, *C*,

Fig. 7.



placed at the rear. Now, to arrive at a correct understanding of what probably occurred, let us suppose that two solid cylinders of powder filling the powder chamber were to be employed, as shown in Fig. 2, and a flash charge, *C*, employed to ignite them. They would be thrown violently forward into the narrow neck of the powder chamber, and the forward one would be crushed, and although the pressure at the rear of the first grain would be rapidly mounting, still the pressure in the confined space about the fragments of the forward grain would cause the pressure to