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.'

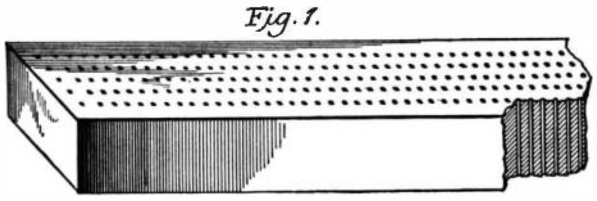
"Anybody who is familiar with the history of smokeless powder and the actual processes of manufacturing these powders knows that none of Mr. Hiram S. Maxim's inventions is being used to-day in the commercial production of any smokeless powder in the world.

"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.



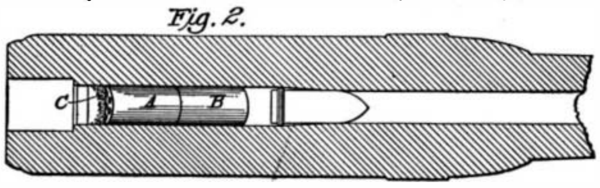
August 8, 1895, in which Hiram S. Maxim makes the following statement :

"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-

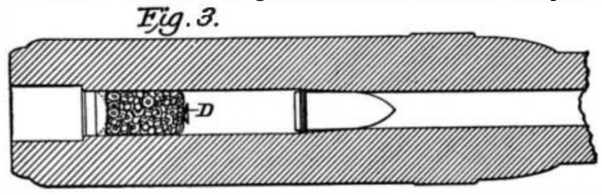
Fig. 2.



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

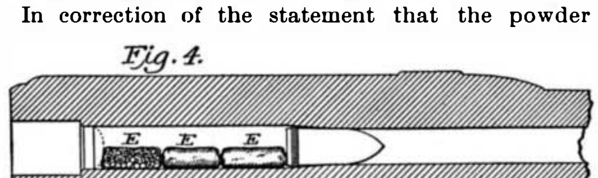
Fig. 3.



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.

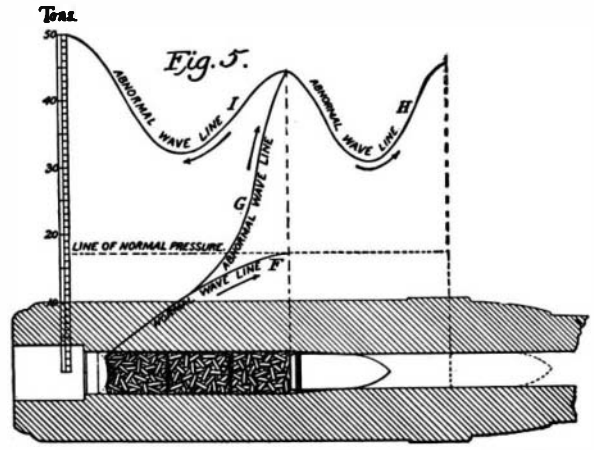
In correction of the statement that the powder

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 :

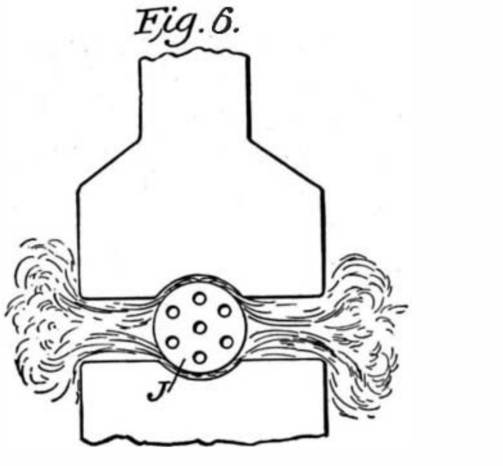
"Now, in regard to the packing or jamming of the powder in the bottle neck of the chamber, this is absolutely impossible. If two sticks of powder are placed in contact and lighted, the evolution of gas from their surfaces is such as to blow them apart. When a large gun is loaded with smokeless powder, 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.

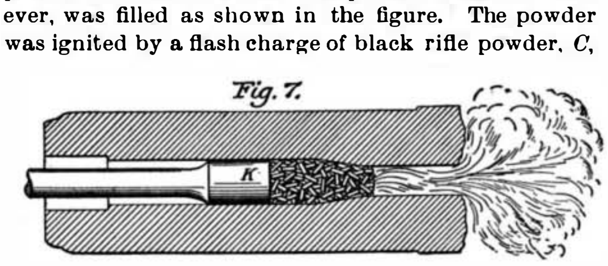


combustion would occur in the narrow neck of the powder chamber, exactly as I pointed out as having occurred in the 10-inch gun which burst. Also witness statement of Mr. Hiram S. Maxim in letter to Lieut. Meigs above referred to :

"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 mount much more rapidly, and the whole charge would again be thrown violently backward, to be again thrown forward by a greatly magnified rear pressure.

In the early experiments with prismatic powder in the United States, and which were very extensive, it was found that a charge but partially filling the powder chamber, as shown at *D*, in Fig. 3, would produce very high and erratic pressures, sometimes mounting to seventy or eighty thousand pounds to the square inch; whereas, if the powder were divided and put into three bags, lying end to end, as shown at *E*, *E*, *E*, in Fig. 4, a low and uniform pressure was always the result. The conclusion was that the charge when employed in the shape shown in Fig. 3 was ignited, it was thrown violently forward, more or less crushed, and again backward, setting up violent wave actions of the products of combustion resulting in very high pressure.

When the charge in the 10-inch gun which burst was ignited, it tended to rush forward like a rocket, to follow the projectile out of the gun, but the impacting of the forward end of the charge into the contracted neck of the powder chamber and against the projectile crushed a portion of the grains, and increased the rapidity of combustion enormously, so that the pressure, instead of mounting on the normal wave line, *F*, shown in Fig. 5, rose to an enormous height, on a line something like *G*. This was followed by a wave of reaction on lines something like *I* and *H*, the projectile having in the meantime moved some distance forward. The wave, *H*, impacting upon it, although it rose very high, did not rise to the height of the wave, *I*, which, impinging upon the stationary breech block, and aided by the accelerated combustion of the powder under its influence at the rear, rose beyond the strength of the gun, blowing out the breech with great violence.

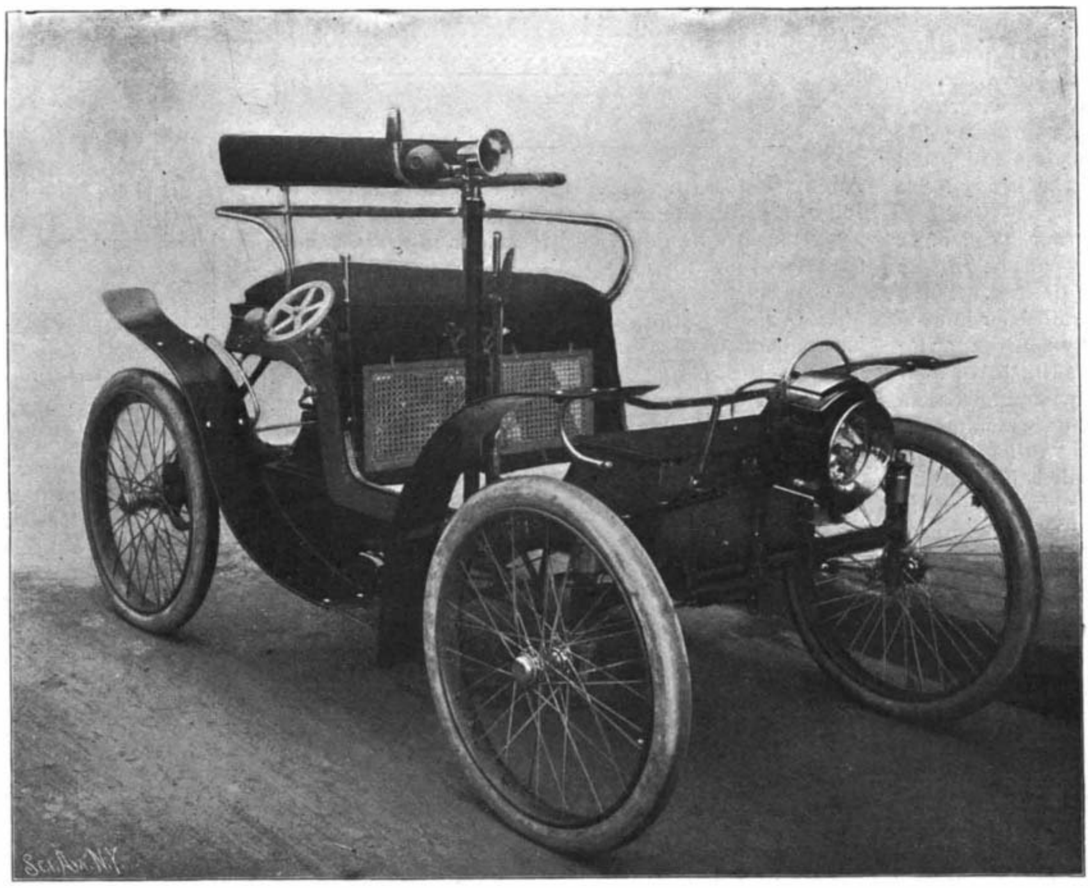
As an illustration of the erroneous claim that the powder grains would not be crushed because not capable of being brought in actual contact, let us refer to Fig. 6. Suppose a powder grain, *J*, were to be ignited on the anvil of a steam hammer. When the hammer descended, it would not come in contact with the burning grain. This would be impossible, yet I think no one will doubt that the grain would be crushed all the same.

To carry this illustration a little farther, let us suppose that a large number of grains be placed in a hollow cylinder with a contracted opening similar to that of the powder chamber and bore of a gun, as shown in Fig. 7. Let us ignite the charge and instantly bring forward with great violence a steam plunger, *K*; would not some of the powder grains be crushed into fragments in being pushed forward into the contracted space?

A similar condition certainly existed in the 10-inch gun that exploded, only the powder charge was thrown forward and compressed in, to the narrow space with enormously greater violence than could possibly be effected with a steam plunger.

In closing, I will add that "collodion" cotton is not employed in the Maxim-Schupphaus smokeless powder, and never has been, as stated in the said article. Neither is the soluble guncotton which we do employ unstable. Soluble guncotton is now made which is as stable as tri-nitro-cellulose and contains nearly as much nitrogen. There is, furthermore, hardly any difference in the explosive value of our gelatin guncotton and tri-nitrocellulose. The powder charge did not detonate in the 10-inch gun which burst, as only the breech mechanism was blown out. The body of the gun was not disrupted. Had the charge detonated, the entire rear portion of the gun would have been blown to fragments.

The charge which burst the 10-inch gun was ignited at the rear. Had it been ignited simultaneously throughout, there would not have been any excessive pressure. The Maxim-Schupphaus multi-perforated cylinder which has been adopted by the United States government is not in any sense a failure, but the biggest kind of a success. I recommend transversely perforated grains, because I believe them a still greater improvement. Nevertheless, the present multi-perforated cylinder only requires proper loading to give perfect results. The same is equally true with cordite and all other forms of gunpowder. The powder which burst the 10-inch gun had undergone no chemical change whatever.



FRONT VIEW OF THE DECAUVILLE PETROLEUM MOTOR-CARRIAGE.

The United States government would not have benefited by the suggested "interchange of experiments." The experiments conducted with the Maxim-Schupphaus powder in this country have been very exhaustive, and the results attained with it are far superior in every respect to anything that has been produced elsewhere in the world, and there have been fewer accidents.

Results of experiments with multi-perforated cylinders have shown greater uniformity in velocities and pressures under all circumstances than have been attained by any other form of powder in the world. In many instances, the velocities and pressures during a large number of shots have been practically as uniform as the instruments could measure. The United States government will not abandon multi-perforated powder grains, but instead, other governments must soon follow the lead of the United States in the use of the multi-perforated smokeless powder.

In confirmation of the above statements about the ballistic value of the Maxim-Schupphaus powder, I refer to the report of the Chief of Ordnance of the United States Army, of 1896, page 197. After dwelling upon the numerous advantages of this form of powder, the conclusion is reached that:

"All things considered, the perforated cylinder or disk proposed by General Rodman many years ago, and recently revived in the Maxim-Schupphaus powder, appears to me to be the most suitable and promising form for the colloidal smokeless powders."

HUDSON MAXIM.

219 West Thirty-fourth Street, New York.

THE DECAUVILLE MOTOR-CARRIAGE.

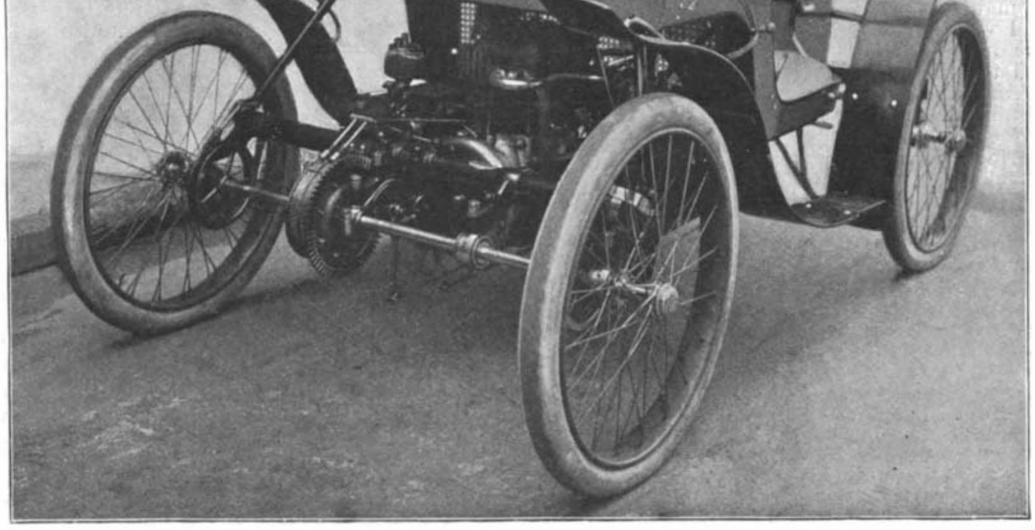
In the 1898 automobile race from Paris to Amsterdam, a distance of 1664 kilometers (1023 miles), the first prize in its class was won by the Decauville "voiturelle," in fifty-four hours.

The Decauville carriage is driven by a two-cylinder, four-cycle gas engine of the Otto type. The motive agent employed is naphtha, contained in two vaporizing-chambers or carbureters of a capacity to enable the carriage to run fifty miles without replenishing its supply. The air admitted to these chambers forms, with the naphtha vapor, an explosive mixture which is conducted to the cylinders. As in the De Dion-Bouton motor tricycle, the naphtha is prevented from cooling by evaporation, by conveying a part of the hot, exhausted gases through a small tube passing through the carbureters. The two cylinders of the motor have external flanges or ribs so as to obtain a large radiating surface and to prevent overheating. The mixture of air and gas is exploded by means of an electric spark. The pistons are single-acting trunk-pistons, which drive the rear axle of the carriage by means of gearing.

The engine, as before mentioned, is of the four-cycle type. When a piston descends, the intake is opened and the explosive mixture of air and vapor is admitted into the cylinder. When the piston rises, the intake closes and the gas is compressed. Just as the piston is about to descend for the second time, an electric spark explodes the gaseous mixture and drives the piston suddenly down. On the following up-stroke the exploded gases are exhausted. When the first cylinder is in its third period (that of explosion), the second cylinder begins its first period (that of admission), so that the two pistons act alternately on the motor shaft.

The accompanying illustrations represent two views of the automobile. Beneath the front edge of the carriage-seat three small levers are mounted, which, by means of connecting mechanism, respectively control the admission of gas to the cylinders, regulate the time of ignition, and control the compression. Like all gas engines, this motor must be started by hand; for which purpose a crank wheel is mounted on one side of the carriage. A lever mounted below the crank wheel on the side of the carriage controls the admission of air to the vaporizing chambers, and, therefore, regulates the carburization. By means of a pedal in the floor of the carriage and a long lever mounted in front of the driver's seat, the motor can be thrown in and out of gear with the rear axle.

The carriage is provided with two changes of speed and is steered by means of a handle bar in front of the seat. The automobile weighs about 500 pounds and has a maximum speed of 20 miles per hour. This handsome vehicle has recently been imported to this country by Mr. P. Cooper Hewitt, of New York, and it is now being tested.



REAR VIEW OF THE DECAUVILLE PETROLEUM MOTOR-CARRIAGE.

IN three years the cost of running an Atlantic steamer exceeds the cost of construction.