America's First Gasoline Automobile

By J. FRANK DURYEA*

THE decade of the '80's may be considered as that in which, for the first time, all the knowledge and things necessary to the construction of a gasoline automobile were present in this country. Oil wells, first drilled in 1858, were furnishing the derivatives kerosene and gasoline. A few gas engines came into use, operating on the Otto four-stroke cycle. Gas producers were in use, making from gasoline a gas suitable for these engines. Ball bearings and rubber tires became common on bicycles. Friction clutches, belts, chains, and gears for transmitting power were well known. Differential gearing had been used on tricycles. The self-propelled trolley car came into use, and experiments were made with steam road vehicles like the one shown in *Fig. 1.*

EUROPEAN DEVELOPMENTS

Given initiative and these conditions, the appearance of the automobile in America could not be long delayed. However, conditions in Germany were even more favorable, for there, in 1876, Dr. N. A. Otto had constructed the first four-cycle gas engine, and in the next seven or eight years machines of this type had begun to attract much attention there. Knowledge of these engines no doubt spurred Gottlieb Daimler and Carl Benz to action, for Daimler started work at Cannstatt in 1884, and Benz at Mannheim in 1885.

Daimler's first engine had a single vertical cylinder (see *Fig. 2*), but he soon started building two-cylinder engines, of a narrow "V" type, using hot tube ignition and a tank type carburetor. These engines were operated at a high speed for that time, but since both pistons were connected to the same crank pin, there was considerable vibration. They were not throttled to obtain variable speed, but were held to approximately constant speed by governor control of the exhaust valve action, working on the well-known "hit-and-miss" principle, whereby the engine received either a full charge or nothing.

Daimler, in 1885, built a motor bicycle (see *Fig. 3)* and later one or more quadricycles. I have no information as to the number built, but one of these quadricycles was shown at the Columbian Exhibition in Chicago during 1893. It had no front axle, but the front wheels were steered by bicycle-type front forks. This was the first gasoline-engined vehicle shown in America, but if my impression of it was correct, there was little about it to inspire in one a desire to possess it. However, this may also be said of the first Duryea, now in the National Museum, which is shown in *Fig. 4.*

Among those who contributed to the development of the automobile, Carl Benz deserves a high place. In the years following 1885 he built some very satisfactory vehicles (see *Fig. 5*). His first United States patent was issued in June, 1888, and showed a single front wheel for steering, a single-cylinder horizontal engine with vertical crankshaft, and belt and pulley transmission to a jackshaft, from which sprockets and chains drove each rear wheel of the vehicle. Here Benz early disclosed the progress he was making.

In 1889, the *Scientific American* published an illustration of a later Benz car. This was a four-wheeled vehicle with Akerman steering knuckles and was, I believe, substantially as far advanced in design as were the three Benz cars that took part in the *Times-Herald* Race at Chicago in 1895. Therefore, I would say of this 1889 Benz that it was probably the first really desirable and usable gasoline-engined car in Europe, just as the car which I designed in 1894 and drove to win the Chicago race in 1895 was the first really usable car built in America (see *Fig. 6*).

Charles Duryea and I were together in 1889 at Rockaway, New Jersey, and, as we always read the *Scientific American,* I am sure that we saw the illustration above mentioned, for I have always said that we knew something of the work of Benz before we ever started work on the first Duryea car.

EARLY DURYEA DEVELOPMENT

The Duryeas were Illinois farm boys, used to all kinds of farm machinery with belt, chain, and gear drives. Our imagination had been fired by the power and speed of the railway locomotive. During the '80's we had seen steam threshing-machine engines, drawing their heavy grain separators from farm to farm. We had become engine-minded, and as early as 1883, at the age of 14, I had made crude plans of a belt-driven steam vehicle.

In 1888, after graduating from high school, I joined Charles at Washington, D. C., and took up machine work, while Charles was building a model of his Sylph bicycle (shown in *Fig. 7*). That summer we took our first ride

*Based on a talk before the Horseless Carriage Club of Los Angeles.

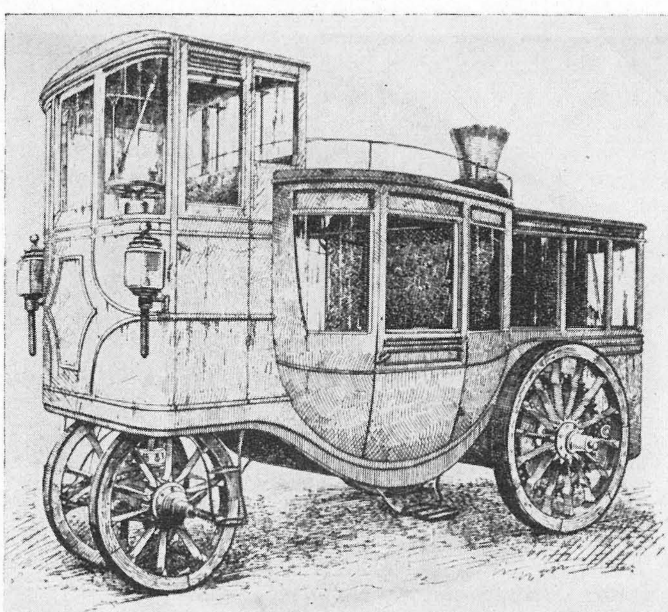
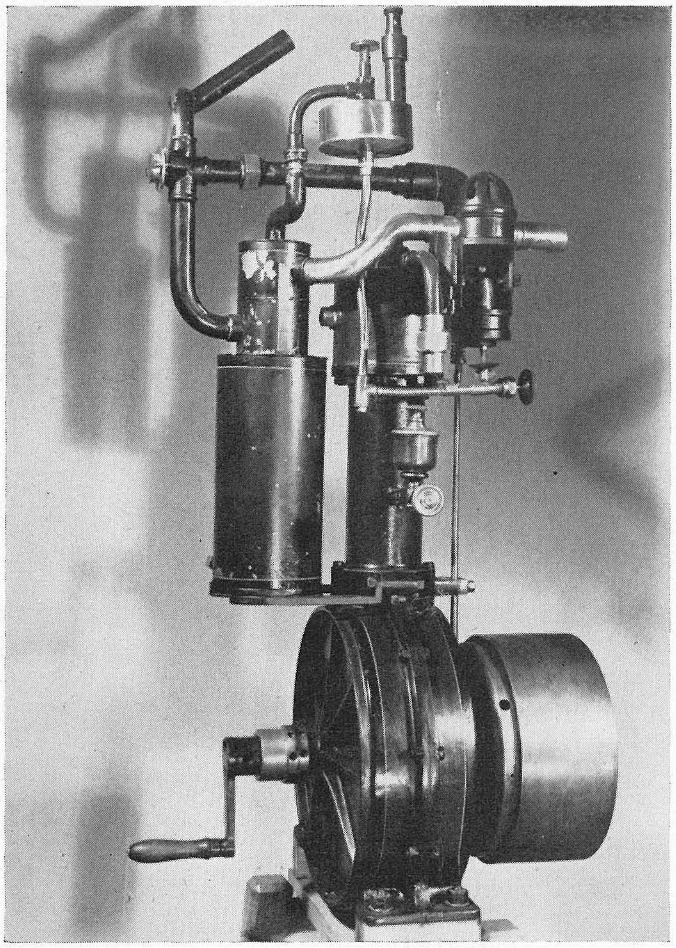


FIG. 1. The steam carriage of Charles Randolph of Glasgow, built in 1872. It weighed four and one-half tons ready for the road, and was probably the first entirely enclosed road vehicle. Note wheel steering and rear engine.



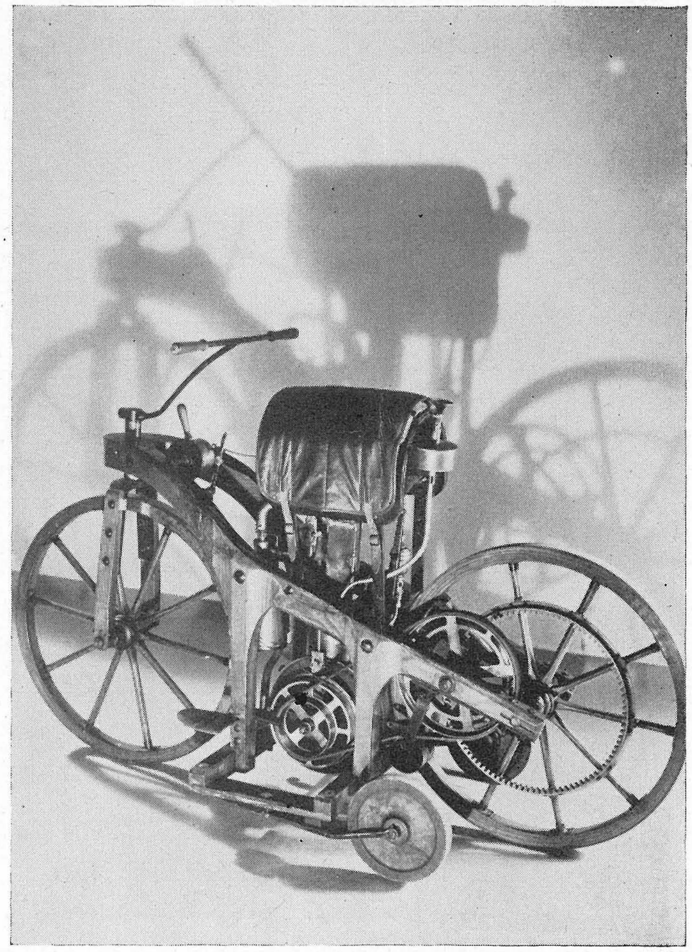


FIG. 2 (at left). Daimler's first single-cylinder vehicle engine, 1885. FIG. 3 (at right). Daimler's first vehicle, the first motor bicycle ever constructed (1885). It employed the second single engine, which he built as shown in FIG. 2.

together in a trolley car, and agreed that an engine-driven vehicle would be equally practical on the road. After a year at Washington we went to Rockaway, New Jersey, where Charles was having his bicycle made, and I engaged in tool work. Here, as at Washington, we regularly read the *Scientific American* and scanned the pages of the *Monthly Patent Office Gazette* for anything of interest.

After a year and a half at Rockaway, Charles moved his bicycle work to the Ames Manufacturing Company at Chicopee, Massachusetts, and I soon followed, again taking up tool-making and mechanical drawing. At Chicopee we spent much of our spare time in discussion of mechanical matters of interest to both of us and, in the summer of 1891, because, I believe, of some further reference to the work of Daimler or Benz, we started reading books on gas engines with the idea of building a motor vehicle.

It was not until the late fall or early winter of 1891 that Charles took the steps that led to our starting work on the first Duryea car, for at this time he came to me and announced that he had just the engine and transmission that we needed for the vehicle we had talked of building. He then described a free piston engine, as suggested to him by C. E. Hawley, and an unusual form of friction transmission which I think was probably never used before or since. I at once contended that both these ideas were highly experimental and their use questionable, but Charles went ahead and had Ames Company draftsmen make illustrative sketches of the idea, as applied to a democrat spring wagon. The only working drawings made were for a part of the friction transmission and a part of the body of the engine. These drawings were made in the winter of 1891 and '92 but it was not until March, 1892, that Charles met Erwin F. Markham and arranged for a conference at which Mr. Markham agreed to put up one thousand dollars to build the first car.

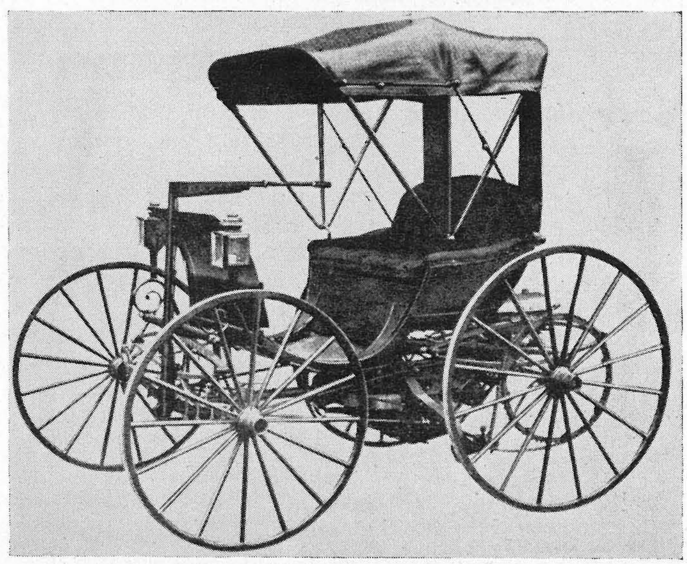


FIG. 4. The first Duryea, with the second engine. This car may be seen at the Smithsonian Institute.

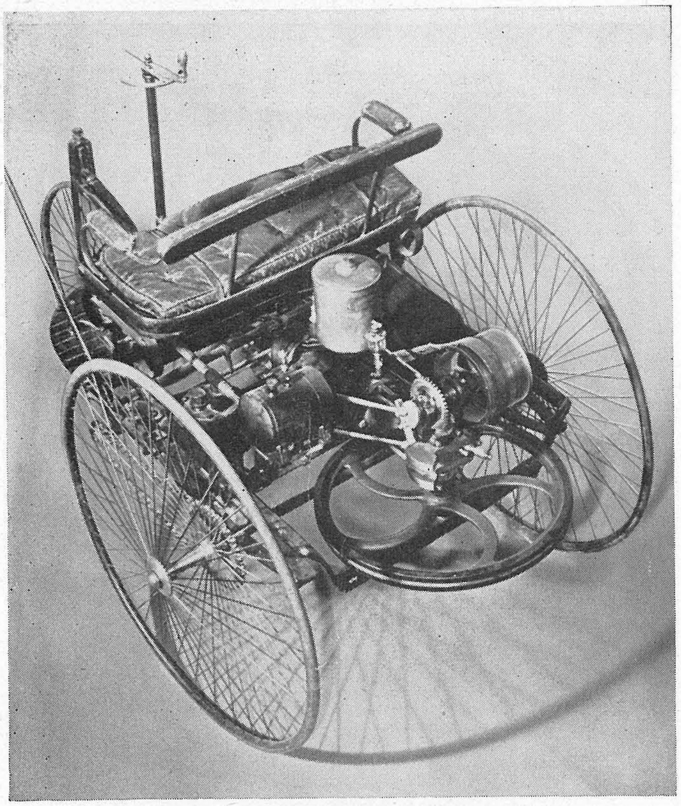


FIG. 5. Benz's first car, a three-wheel, single-cylinder tricycle with belt transmission adapted from lathe practice. This drive was retained until 1902.

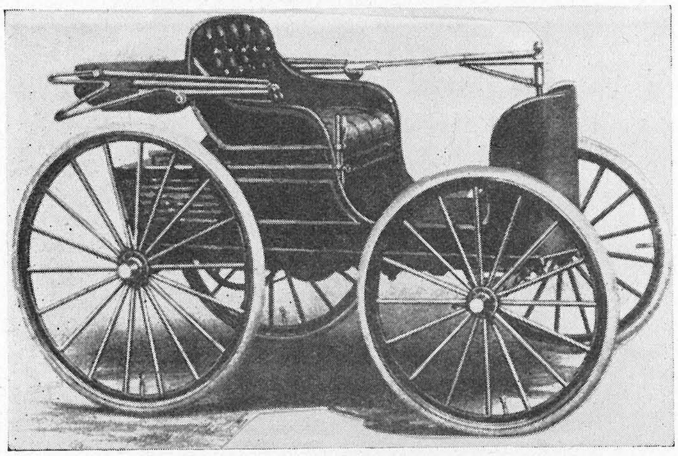


FIG. 6. The Duryea "Chicago car," winner of the first race in America, Thanksgiving Day, 1895.

As I was the more competent mechanic of the two, it had been understood that if a start was made I should have charge of the work, and I went with Charles to see Mr. Markham and later to locate a suitable workshop. Following this, a secondhand phaeton was bought, into which the parts would be fitted. Starting early in April, 1892, construction proceeded through the summer, for it was a new line of work and I had much designing and drafting to do.

With perhaps the most difficult parts of the car, such as carburetor, hot tube ignition, and a method of controlling the engine and transmission yet to be designed, Charles moved to Peoria, Illinois, leaving me full responsibility for carrying on the work and, in return, assuring me of a share in the project. Thus, although disappointed that I had not been included at first, I now became one of the partners. Illness contracted in October stopped all work until January 1, 1893.

Having designed and built for the engine hot tube ignition and a crude spray carburetor, I attempted to start the free piston engine, only to find that it would not give regular power impulses. Our backer, Mr. Markham, threatened to withdraw, and to forestall this action, I eliminated the free piston feature of the engine by pinning the two pistons together, and hastily constructed a little device on the side of the engine to cause the exhaust valve to function properly. I have a model of this little contrivance at Madison, Connecticut.

This crude makeshift engine was now operative, but had very little power and could not be used with the phaeton body set in place over it without first the addition of a special hand starter and some method of remote control for the engine. But with these things added, it would still be a makeshift and the engine was therefore never completed far enough to enable us to use it to drive the car on the road, for Mr. Markham and I decided to discard it.

A NEW DESIGN

I then designed and built a new engine with a cast water jacket, hand starting device, timer gears to operate the exhaust valve, electric ignition, a spray carburetor, a muffler, and finally, a governor—to avoid the necessity of remote control for the engine. The Bowden wire method of remote control was not then known. None of the above features had been used in the first engine except my spray carburetor.

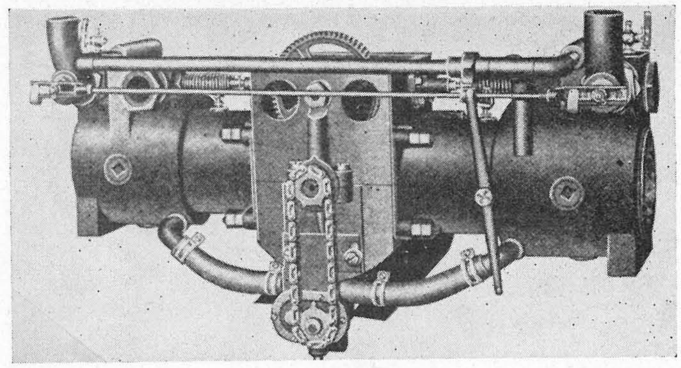
Since the working parts had been supported by a rigid framework connecting front and rear axles, I arranged to support this framework at a single point on the front axle, thus providing a three-point support for the engine and transmission and avoiding distortion due to uneven roads.

This first Duryea car was first driven on the road on September 21 or 22, 1893, as shown in the *Springfield Evening Union* of September 22, 1893. The engine gave no trouble, but because of its friction transmission the car was barely operative, and I was never able to give a demonstration to a possible investor. Charles's engine had been a failure, and now his second principal feature —the friction transmission—was also a failure.

After a few weeks of testing, Mr. Markham decided to quit. Refusing to accept this action as final, I designed a new transmission of gears and friction clutches, and confidently offered to build it on my own time if Mr. Markham would meet material and shop expense. He accepted, and I built and installed this transmission in the car. The *Springfield Union* of January 19, 1894, describes my first trip with this successful transmission. This car, with my engine and transmission, is the Duryea car now in the National Museum at Washington, D. C.

With the first car nearing completion, I started, about

FIG. 7. Advertisements for Charles E. Duryea's "Sylph" cycles appeared in various popular magazines during the latter part of 1892 and in 1893.



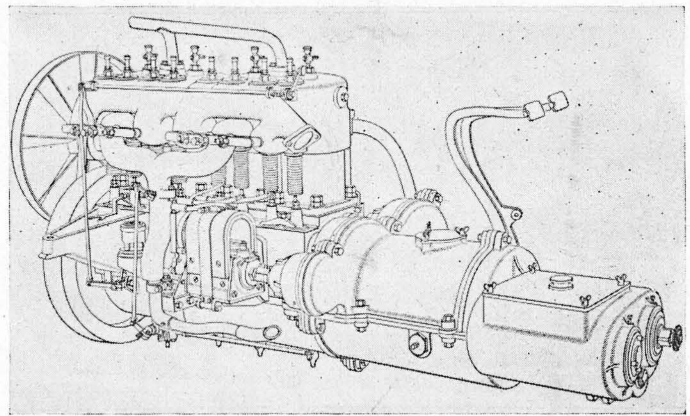
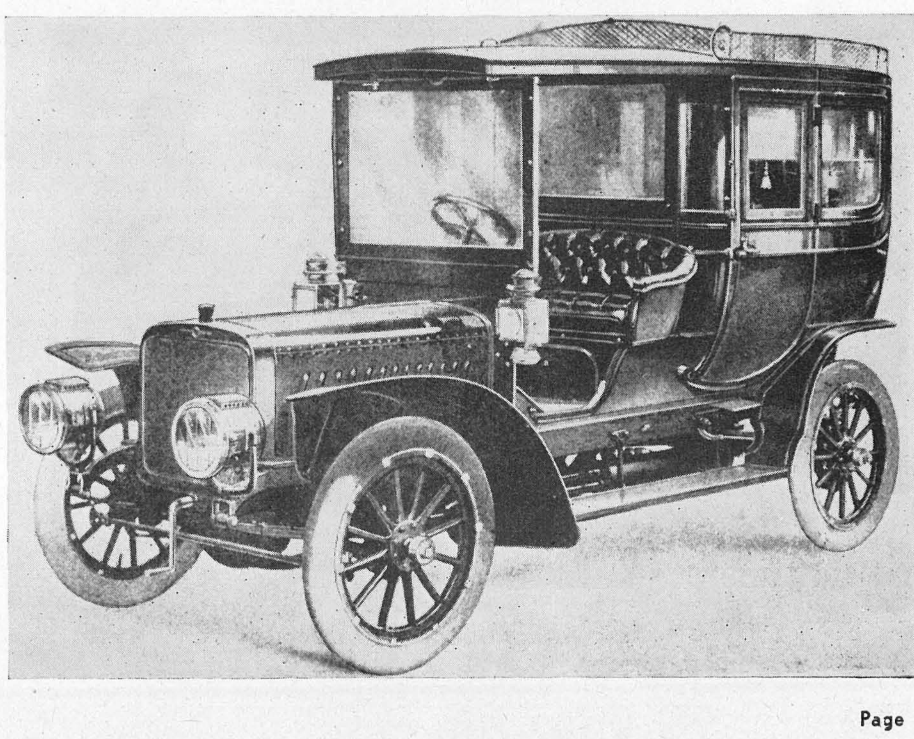


FIG. 8 (at left). The third Duryea (1896). FIG. 9 (upper right). The two-cylinder engine of the 1903 Stevens-Duryea. FIG. 10 (lower right). The four-cylinder unit power plant of the 1905 Stevens-Duryea.

January 1, 1894, to design a second car. Mr. Markham was unable to finance the work further and, as I had been without salary for a month and a half, it was necessary that I quickly find new capital. Borrowing to live, and working earnestly, I had, in March, completed plans for the new car. These plans showed a piano-box side bar buggy, with a two-cylinder, two-cycle motor, and my transmission of gears and friction clutches, all well concealed in the body. A live rear axle with ball bearings, and wheels with all-metal hubs, were shown; also ball bearings for the transmission shafts.

With these plans in hand I was able, late in March, 1894, to induce Henry W. Clapp to agree to finance construction of the car, and work was started in April. This car was operative early in December, 1894, and was repeatedly driven rapidly around the empty top floor of the factory building. The motor was a trifle irregular because of faulty electric ignition, but, believing the motor faulty, I converted it from two-cycle to four-cycle in January and February, 1895. The irregularity continued and was traced to a weak spark, and promptly corrected.

The car was painted and, with wheels equipped with cushion tires, was placed on the road late in March,



AT RIGHT:
FIG. 11. The first six-cylinder Stevens-Duryea, 1905.

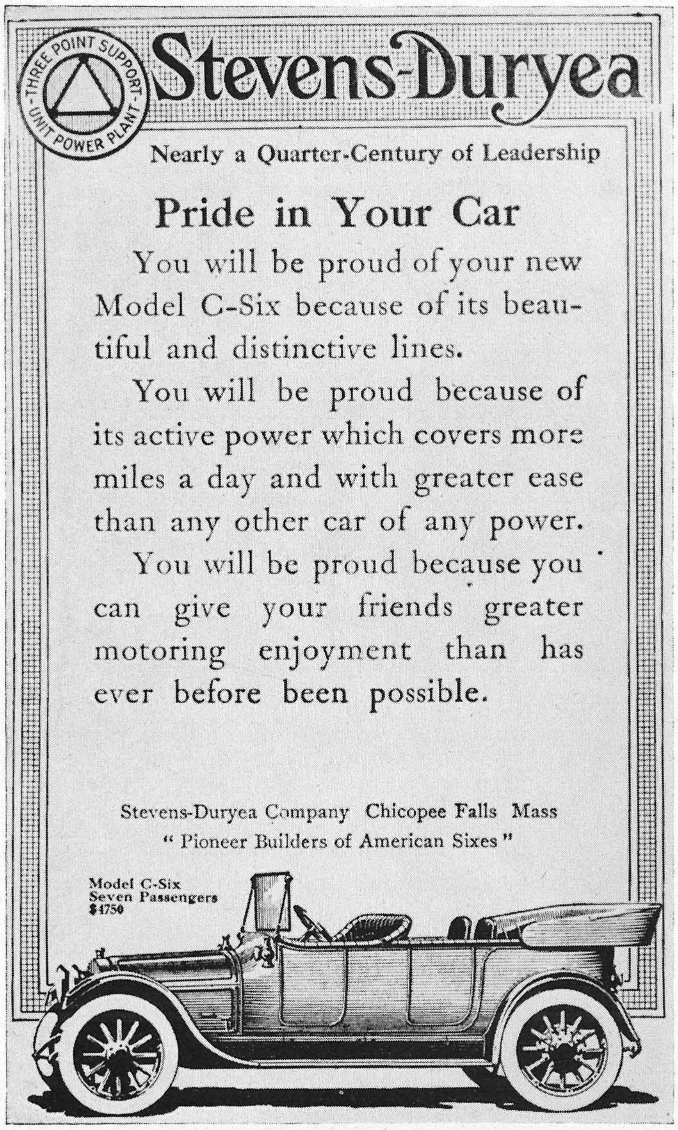


FIG. 12. A 1913 model, Stevens-Duryea. It was equipped with an air starter to which the engine responded immediately.

1895. From this time it was in use nearly every day of the spring and summer, giving demonstrations to build up the interest necessary to enable us to organize a company.

After many demonstrations with the car had been given throughout the summer, the Duryea Motor Wagon Company was organized at Springfield, Massachusetts, in September, 1895, with George H. Hewitt president and T. W. Leete treasurer. In recognition of my work of designing and building the car, I was made a director and employed as chief engineer in charge of design and production.

Driving this car for the Duryea Motor Wagon Company, I won America's first race, sponsored by the Chicago *Times-Herald,* and run on Thanksgiving Day, November 28, 1895. The course was from Chicago to Evanston and return; the distance, 54 miles. Much snow fell the day before the race and, of nearly 80 entries, only six appeared at the start. Two of these were electrics and three were foreign Benz cars; the Duryea was the only American gasoline car in the race.

Of the six starters, but two finished, and these were the Duryea, driven by me, with Arthur W. White of Toronto, Ontario, as umpire, and a Benz, driven by Oscar Mueller of Decatur, Illinois, with umpire Charles B. King of Detroit. After a trying day, the Duryea finished ahead of the Benz, by an hour and 35 minutes, winning first prize of two thousand dollars. The Benz was driven across the finish line by umpire Charles B. King after the driver had fainted from exhaustion due to pushing the car through the drifted snow. Charles B. King was the first to build a car in Detroit, and later built the King automobile.

SIGNIFICANT FEATURES OF DESIGN

Since the "Chicago winner" was the first really desirable and usable American car, I shall now list some of its more important features, and I may say that I was the first to use these features in an American automobile:

1. An engine with electric ignition.
2. A pump to circulate water for cooling the engine.
3. A spray carburetor for the engine, with constant gasoline level.
4. A pump to supply gasoline for the carburetor.
5. A transmission having three speeds and reverse, in which power was transmitted through toothed gears by setting a friction clutch.
6. Ball bearings for the transmission shafts.
7. A rear axle having differential gears and rotating axle shafts to drive the rear wheels of the car.
8. Ball bearings for the rear axle shafts.
9. Concealed mechanism.
10. Pneumatic tires—built to my specifications by Hartford Rubber Works.

All of these features are to be found in the automobile of today. None of them were to be found in Charles Duryea's partly completed plans for the first Duryea car. However, following Charles's departure for Peoria, Illinois, I designed for the first car a spray carburetor, electric ignition, and a gear and friction clutch transmission.

I may say further that the Benz cars imported from Germany in 1895 contained but three of these 10 features, namely, electric ignition, ball bearings on a transmission shaft, and partly concealed mechanism.

The "Chicago winner" was the second Duryea car, but after formation of the Duryea Motor Wagon Company, I designed a third car, which is shown in *Fig. 8.* Thirteen cars of this design were finished and the greater part sold during 1896. Driving one of these, I won America's second race on Decoration Day, May 30, 1896. This race was sponsored by the *Cosmopolitan Magazine,* and was from New York to Irvington on the Hudson and return, a distance of 52 miles. Another of these cars was loaned to Barnum and Bailey, and for a time was shown daily in their ring and street parades.

After making some changes in still another of these 1896 machines, I took it to London and on November 14, 1896, drove it in the London-to-Brighton Liberty Day Run, which celebrated the repeal of the English four-miles-per-hour law. Mr. Herbert Thrupp of Thrupp and Maberly, noted London carriage-makers, rode with me, and I have his affidavit that we were first to arrive in Brighton.

Late in 1896 I made for the Duryea Company the fourth Duryea car design. In this I used an electric generator, for ignition without batteries, and a float-feed carburetor. These features are shown in my patents for which application was made on November 7, 1896, and June 14, 1897. I believe that these are also "firsts."

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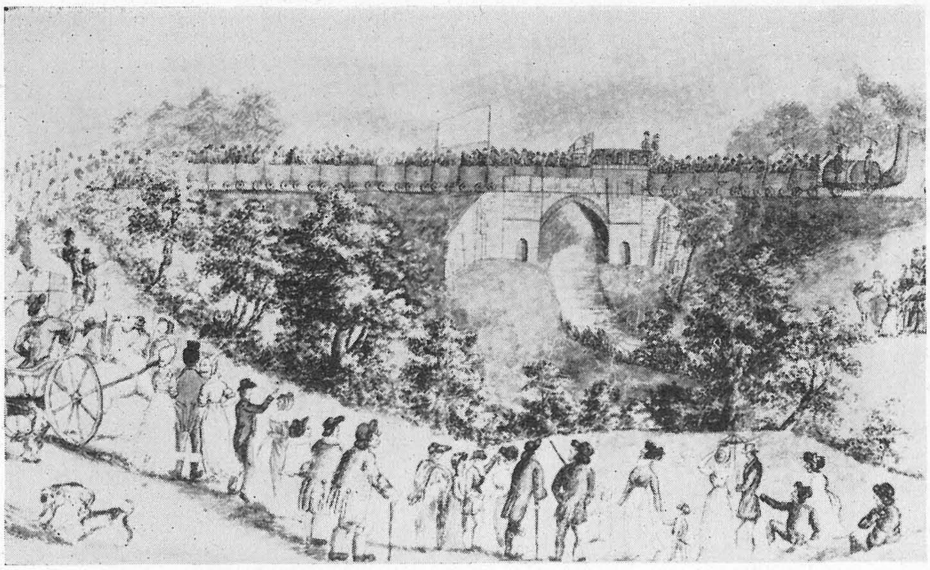

AT LEFT:

FIG. 3. Inauguration of the first public railway, September 27, 1825.

Railway led to his employment in the construction of the Liverpool and Manchester Railway, the first great line and the one which established the railway system as truly successful. In 1823, also anticipating a demand for engines, he and his son Robert, with the backing of Pease, opened in Newcastle the first locomotive works in the world. "This establishment was the chief seat of practical locomotive development for the ensuing twenty years, and a training ground for locomotive engineers."[3]

The Stockton and Darlington Railroad was the first public steam railway in the world. At the opening, on September 27, 1825, a train of 34 vehicles, making a gross load of about 80 tons, was drawn by one engine driven by Stephenson with a signalman on horseback in advance. The train moved off at the rate of from 10 to 12 miles per hour and attained a speed of 15 miles per hour on favorable parts of the line. The locomotive, appropriately called "Locomotion," was built by the Stephensons at Newcastle. It weighed about seven tons, developed about 10 horsepower, and hauled a load of from 60 to 70 tons at an average speed of five miles per hour.

Fig. 1 reproduces a full-length portrait of Stephenson by John Lucas. It is taken from the well-known engraving by T. S. Atkinson. The section of the Liverpool and Manchester Railroad across Chat Moss, a bog some 12 square miles in extent, is shown in the background.

Fig. 2 shows the "Locomotion" mounted on a pedestal in front of the Darlington North Road Railway Station, where it was placed with suitable ceremonies in June, 1857.

Fig. 3 is reproduced from a drawing by Dobbin in the Science Museum, London. It portrays the opening of the Stockton and Darlington Railway. As Jeans wrote 50 years later, many curious recollections of the opening ceremony were preserved by those who were present. "One can scarcely even now meet with a man or woman of advanced years between Auckland and Darlington, both inclusive, who did not assist in the opening celebration. It was commonly reported at the time, and has since been handed down as a reminiscence of the event, that the whole of the inhabitants turned out to witness the advent of the 'iron horse,' save and except two old ladies whose infirmities or prejudices, or both combined, prevented them from rendering so marked a need of homage to the new era. Great excitement prevailed among the spectators as the engine came in sight. Excitement in many minds took the form of disappointment when it was found that the locomotive was not built after the fashion of a veritable four-footed quadruped, some of the older folks expecting to see the strange phenomenon of an automatical semblance of a horse stalking along on four legs. But everybody admitted that the performance of old 'Locomotion' was wonderful in its way, and vigorous cheering greeted its approach."[4]

3. *Handbook of the Science Museum*, loc. cit.
4. J. S. Jeans, *Jubilee Memorial of the Railway System* (London, 1875), pp. 71-72.

America's First Gasoline Automobile

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I took this car to London in June, 1897, and there became acquainted with the Honorable C. S. Rolls, later of the famous Rolls-Royce car. Mr. Rolls frequently rode with me, both as passenger and driver, and in July, 1897, wrote an article for the English magazine *Automotor*, in which he praised the flexibility of the engine and stated that the car was free from most of the objectionable features of other makes.

LATER DEVELOPMENTS

With manufacture started in 1901 at the J. Stevens Arms and Tool Company in Chicopee Falls, Massachusetts, the first Stevens-Duryeas had a two-cylinder engine, shown in *Fig. 9*, and three-speed transmission, located in the body beneath the driver's seat. These cars were profitably sold for three years, but, seeing the growing influence of foreign design, in 1903 I designed a four-cylinder motor, placed forward under a hood with a shaft drive to a bevel gear in the rear axle. For the engine I designed a multiple-disk, dry-plate clutch, and arranged to bolt the engine crankcase, clutch housing, and transmission housing together as a unit. This we called the "unit power plant" and a diagram of it appears in *Fig. 10*. The car was finished in 1904 and shown at the New York show in January, 1905. A year later a company now prominent in the industry exhibited at the New York show an exact copy of the chassis of this Stevens-Duryea car, and later the unit power plant, with multiple-disk, dry-plate clutch, became substantially standard for the industry.

A six-cylinder car, shown in *Fig. 11*, was added to the Stevens-Duryea line in 1906 and after that sixes became the company's principal product. These cars were a source of very satisfactory profits to stockholders, but they were all high-priced cars, ranging from $2,500 for the four-cylinder car of 1905 to $6,500 for certain later models. A seven-passenger, six-cylinder model appears in *Fig. 12.*

By 1915, it had become clear to me that mass production methods would eventually spell the doom of the high-priced car. I was in ill health at the time, and, having received an excellent offer from the Westinghouse Company for our plants in Chicopee Falls and Springfield, I accepted the offer and retired. This move I have never regretted.

Testing and Metering in Natural Gasoline Operations

(Continued from Page 12)

The equipment now almost universally employed for measuring gas volumes is the orifice meter. Its operation is based upon the principle that the rate of flow of fluid is a function of the pressure drop caused by the presence of a suddenly restricted opening or orifice of known size inserted in the line.

For every combination of pipe size, orifice size, flowing pressure, and temperature and specific gravity of gas, a given differential pressure across the orifice corresponds to a definite rate of flow of gas through the line. Tables are available for relating these quantities.

Of the factors named above, pipe size of course remains constant. The size of orifice may be varied at will simply by removing one orifice plate and inserting another. The specific gravity of the gas from a particular source is usually so nearly uniform or changes at such slow rate that periodic determinations of this property are adequate. Temperature is either taken daily at a time representing average conditions, or, where large volumes of gas are involved, it may be recorded continuously. Continuous records of both line pressure and differential pressure are usually made on clock-operated charts attached to the orifice meter. These charts are usually changed daily.

The charts are sent in to a field office, where the pressures indicated on them are averaged. From carefully kept records of the other conditions existing at each meter, the corresponding volumes of gas are computed with the aid of the tables mentioned above.

Fig. 4 is a photograph of a number of orifice meters installed on gas lines from gas-oil separators in which fluid from individual wells is separated into wet gas and crude oil streams ahead of the natural gasoline plant. *Fig. 5* is a picture of a number of orifice meters located inside a natural gasoline plant to measure streams entering or leaving processing equipment.

METERING LIQUIDS

Orifice meters are applicable to the measurement of liquid flow as well as gas flow and are widely employed for this purpose in natural gasoline operations. Typical locations are on lean oil streams to absorbers, feed and reflux streams to fractionating columns, etc.

On the other hand, orifice meters are less reliable in determining rates of flow of volatile liquids than in measuring the flow of gases and vapors. Accordingly, while they have been widely used for operating control purposes, they have been considered unsuitable for measuring volumes of finished stocks produced at natural gasoline plants. For this service, positive displacement meters of the general type used in domestic water and gas service are often employed. The use of meters on finished product streams makes possible the observation of rate of production without the necessity of accumulating large quantities of highly flammable liquids in gauging and shipping tanks in the plant area where boilers and gas engines might present an ignition hazard.

As has been the case with most industries, there has been tremendous technological progress in the last 25 years in the natural gasoline industry and the related liquefied petroleum gas industry, which actually developed from infancy to maturity during that period. Improvements in metering and testing methods have contributed effectively to that progress.

The Month in Focus

(Continued from Page 3)

government. This report can be obtained from the Government Printing Office for 30 cents.

November 13, 1945

To the Members of the
Senate Committee on Commerce
and the
Senate Committee on Military Affairs

Gentlemen:

We have a feeling of deep concern regarding the pending legislation on federal aid to science. We share the belief of the sponsors of this legislation that expansion of our scientific work can yield returns of great benefit to the nation.

The manner in which this aid is administered is vital to the success of any program undertaken. We have studied this matter, and we transmit to you our considered opinion on the two administrative plans which you now have under discussion.

It is our belief that the top authority in the proposed National Research Foundation should rest in a board or commission of scientists and laymen chosen by the President on the basis of interest in and capacity to promote the purposes of the Foundation, and not in a director who would be aided by a board with only advisory duties. The responsibilities of the top authority will be so great and the fields to be covered are so extensive that only a broad and representative board of most able men could effectively assume this responsibility and authority.

We believe that the Foundation can achieve its objectives better by grants to institutions for the support of broad fields of scientific research and scientific education than by contracts for research on specified and closely limited problems.

We believe that the Foundation should not supervise or direct research activities of other government agencies, and should not have the duty of surveying these activities, but should arrange for suitable interchange of information between government agencies and research men carrying on work with the support of the Foundation; and that officers of other government agencies should serve *ex officio* on certain advisory panels of the Foundation, such as Advisory Panel to the Division of National Defense, but that no such *ex officio* members should serve on any board or commission of this Foundation to which authority is delegated.

Recognizing the great need of study of human relationships, we believe that the Foundation should provide suitable support for the social sciences and humanities as well as for the medical and natural sciences, that the social sciences and humanities should be suitably represented in the membership of the board or commission, and that provision should be made for scholarships