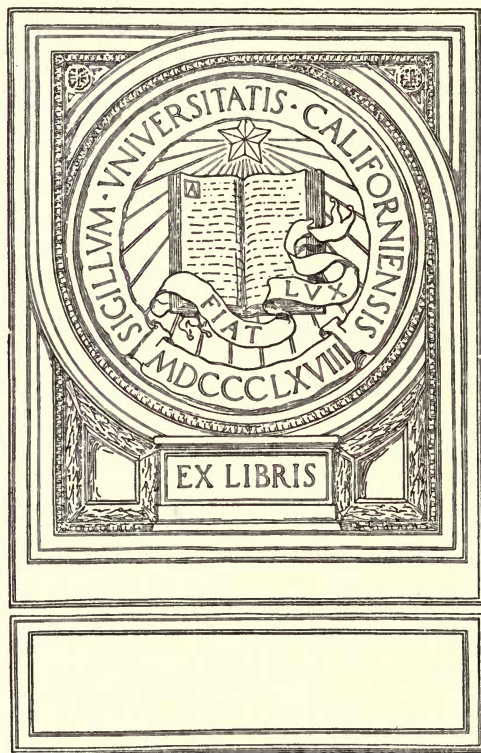


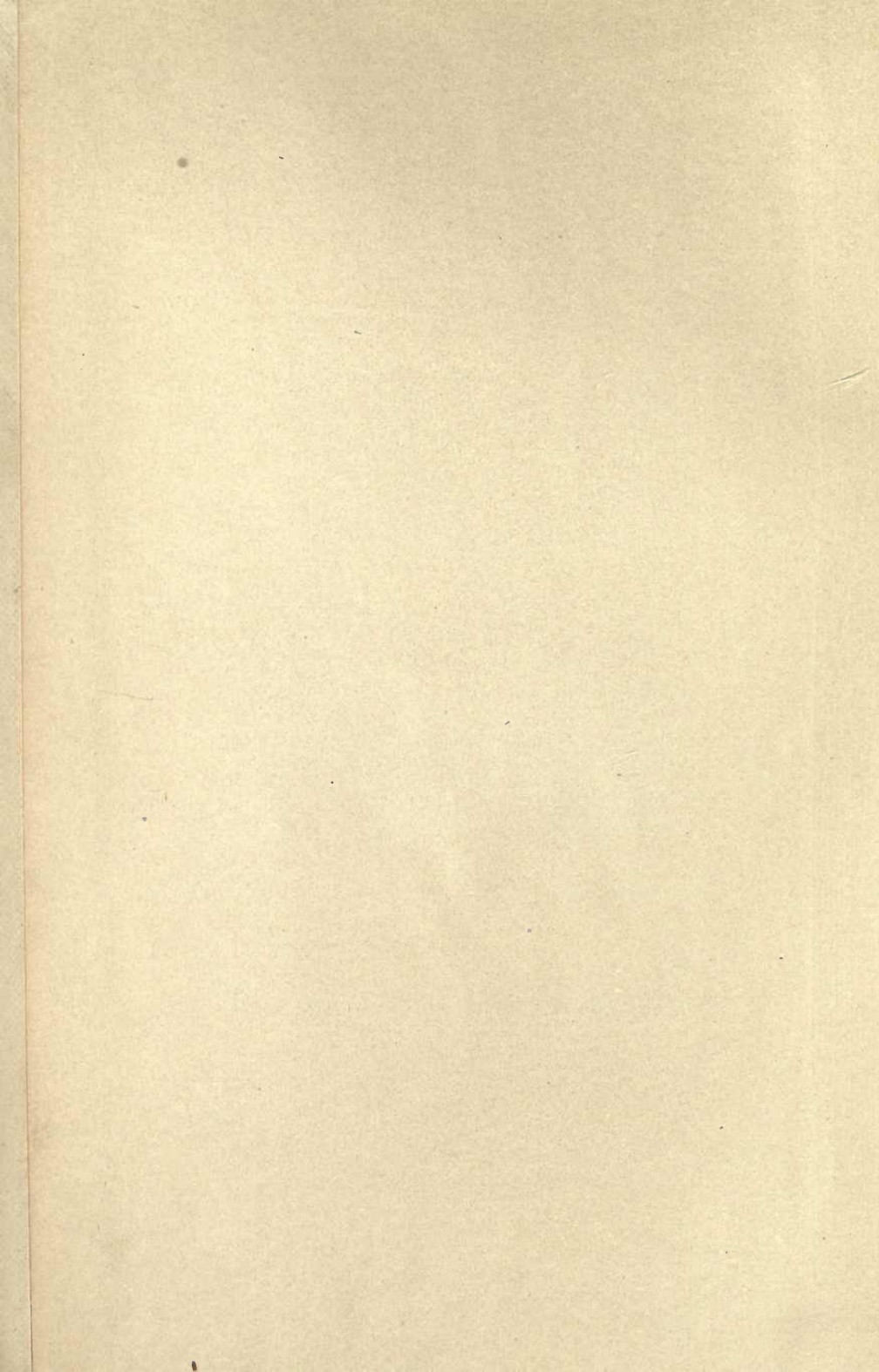


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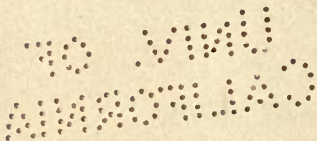
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PREFACE.

The rapid advance in the industry appertaining to mechanical appliances for locomotion on common roads seems to need a better representation than it has yet had in book form, especially in its relation to the automobile industry in the United States.

It is hoped that the numerous inquiries in relation to motors and vehicles that have been received by the author will find a fair and satisfactory reply in the pages of this work.

Then there need be no apology for the publication of a work to meet the wants of seekers for information in this new line of industry which exemplifies a new phase in the ways and means of a people for gratifying their desires for new modes and economies in travel for pleasure or business.

In the development of new modes of power resources and in the improvement of well-known powers for automobile uses, is involved a vast business aspect and comparatively a new departure in business lines.

There has been as yet but little published in book form that has proved satisfactory to the general reader or inquirer on the subject of the mechanism and motive power for common road locomotion.

The technical press in the United States seems to have been the only source of information and illustration in regard to this newly developed industry, and to this the author is much indebted for details and illustrations.

It is proposed in this work to bring the practical working details of the horseless vehicle as clearly as possible to the understanding of the general reader.

Personal inspection and critical examination of the mechanism of the motive power and running gear is the best method of arriving at the facts as to the operation and durability of so important an element as their power factor.

To some extent this has been afforded and has contributed much to the detailed description that has been given and illustrated in this work. A free reference to patent illustration and description does not always give a true conception of a mechanism that becomes a manufacture after a patent has been issued; improvements and changes suggested by trials and experience take the place of the patented exhibit, when the patented feature in a measure is greatly changed and sometimes lost.

The theoretical consideration of power and its mathematical expressions are so fully treated in technical works on steam, explosion motors, electricity and compressed air, that a repetition of such topics in this work will not, it is thought, increase its interest for the general reader or for the user of the automobile.

GARDNER D. HISCOX.

May, 1900.

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Chapter I.

INTRODUCTORY.

HORSELESS VEHICLES

AUTOMOBILES AND MOTOR CYCLES

CHAPTER I.

INTRODUCTION.

With the recent advent in force, of motor vehicles under their various synonyms of horseless carriage, automobile, auto-cars, and motor-cycles, in a list in which the roots auto and moto enter into many names designating the specialties of manufacture in Europe and in the United States, comes the search by the curious to find the true history of progress in the development of self-propelled vehicles.

Wheels as a rolling device have been in use for more than four thousand years with oxen and horses as their propelling power for transportation. The only improvement during the past four hundred years has been in the art design of the vehicles, and only during the past two centuries has thought been given to other means or powers of vehicle propulsion.

The spirit of invention and improvement seems to have taken a movement among thinking minds in the fourteenth

century and was thus early expounded by that philosopher in mechanics, Roger Bacon, in the following prophetic words:

"We will be able to construct machines which will propel ships with greater speed than a whole garrison of rowers, and which will need only one pilot to guide them, we will be able to propel carriages with incredible speed without the assistance of any animal, and we will be able to make machines which, by means of wings, will enable us to fly in the air like birds."

The first indication of the application of a mechanical device for the propulsion of vehicles seems to have begun in the sixteenth century in a vehicle propelled by springs, built in Nuremberg, Holland, by Johann Haustach. The spring motor fever raged at times during the passing centuries and seems to have culminated in the United States a quarter of a century since as spring-stored power for street railway cars and vehicles. Its life for such work was short. Its true sphere is a lasting one through the centuries for the storage of power for time service.

Wind sails for vehicle propulsion was a common sight in Holland away back in the palmy days of the republic and have since been seen on our Western prairies, but no permanent success has resulted from this power for vehicle propulsion.

The first effort at propelling a vehicle by steam seems to have been made by a Jesuit missionary, Father Verbrast, in the thirteenth century, probably using the re-action wheel of the Heron type that had apparently laid dormant for more than a thousand years.

It was a steam propelled vehicle, with a motor of the reciprocating type, that made its advent with the early progress of the steam engine for power purposes that was the

forerunner of the thousands of self-propelled vehicles that have as it seems sprung into useful operation during the last decade of the nineteenth century.

Steam traction vehicles for haulage, for drays, for plowing and for passenger service have advanced steadily in Europe and in the United States, even extending to many other countries.

The advent of the internal combustion motor soon gave a new phase to the self-propelled vehicle, and gave a further impulse to its use as a pleasure carriage.

The electric motor and the storage battery seem to have followed in due time to form the triad of powers that will give the horseless vehicle all the probable elements of success in every avenue of usefulness.

The gasoline motor was first used for vehicle propulsion with success about 1888, but was proposed at an earlier date by Lenoir in France. The electric motor and storage battery soon followed and came into use within the last decade of the nineteenth century.

The patents in the United States for motive power and running gear date back to the beginning of the century in small numbers, increased in the decades from 1860 to 1880, and in the last decade of the century swelled up to a total of about 275. The earlier patents that expired previous to 1886 covered nearly all the essential features of the present construction.

It appears from published data that in Europe there are now well over 7,000 owners of automobiles. Many of these own more than one vehicle, so that perhaps the number of vehicles could be put at 10,000. Of the 7,000 no fewer than 5,600 are in France. The general idea has been that in France the interest was centered in Paris, but this is erroneous, there being of the 5,600 no fewer than 4,541 scattered

all through the departments. In France, moreover, there are 619 manufacturers of automobiles, not including makers of detail parts, 998 of them, 1,095 repair shops, 3,939 stores for oil, gas, etc., and 265 electric charging plants and "posts." For the remainder of Europe the figures are far from complete, but it would appear that there are 268 owners of automobiles in Germany, 90 in Austro-Hungary, 90 in Belgium, 44 in Spain, 374 in Great Britain, 111 in Italy, 68 in Holland, 114 in Switzerland, and 35 in Russia, Denmark, Portugal.

No such figures as these are at present obtainable for the United States, and if we put the number of automobiles in this country at 700 it will probably be an exaggeration. The number of makers actually at work or organizing is probably more than 100. Fortunately for our credit, as an inventive and enterprising nation, the first year of the new century ushers in with every promise of a great outburst of activity in the manufacture of automobiles of every description.

American constructors of gasoline motor vehicles have from the beginning aimed to regulate speed through the motor and to reduce the speed gears to one or two, obtaining all intermediate speeds by increase or diminution of the charge. In many of the French and American vehicles intermediate speeds are obtained by varying the tension of driving belt or other friction devices, and it is to be noted that the very latest French construction tends in the same direction as our own, viz., toward speed regulation by the motor. This tendency is universal, and it is only because the necessity of striking out in that direction was appreciated in the United States from the beginning that American constructors to-day may be considered as far, if not farther, advanced than their competitors in other countries where automobile experience is of much older date. When

the speed changes in gasoline vehicles are under consideration, it should also be remembered that the momentum of a vehicle in motion always serves to efface all abruptness in the transition from a higher speed to a lower one or the reverse.

Steam seems to have taken the lead as the source of power for the horseless vehicles in England and France, with varying success, dragging slowly along with the progress of the steam engine for nearly a century, yet hampered by popular and governmental prejudice, obstructive laws and bad roads, which even in this enlightened decade has not been entirely cleared away. Official restrictions are still retarding the progress of the automobile in the United States; but are fast disappearing in Europe. During the past half century, the improvement of common roads has made great progress in France, Germany and England, so that at the present time France has taken the lead in good roads and is equally in the lead in the manufacture of automobiles.

In England the agitation in the interests of good roads started more than a half century since, with only steam traction interest as the principal mover. Single-handed it battled for road improvement with but slow progress against popular prejudice and obstructive regulations and laws. The advent of the explosive and electric motors for vehicle propulsion, added other and powerful impulses in the agitation for good roads, and with the pressure from the vast bicycle interest the quadriad of forces has come together with a combined power that will, we hope, make road improvement a foregone conclusion and a necessity in this and all other countries of progressive instincts. With good roads in the United States the automobile industry should soon forge to the front in legitimate activity.

The motor vehicle contests in France, England and the United States during the past half dozen years, have done much to wake up an interest in the good roads movement and with their improvement the automobile will take its proper place in our every-day locomotion; but we do not fear its supersession of the horse.

Of the automobile contests that have been a source of encouragement in the improvement of both vehicles and roads, may be mentioned the French trial races from Paris to Rouen in 1894, and from Paris to Bordeaux and return in 1895. These were followed by the Chicago trial races in the fall of 1895, which was won by a German automobile, the Benz, brought over as a sample by Mueller & Sons, of Decatur, Ill. A year later the Chicago *Times-Herald* organized a contest with an offer of \$5,000 in prizes for a 54-mile run. A large number of automobiles of foreign and American make were entered. The three modes of power were represented.

As the time approached for the run one after another of the contestants excused themselves as not being ready, which resulted in two vehicles making the start. The German gasoline vehicle of Mueller & Sons was alone to finish the race. This proving unsatisfactory, a further contest was made up for a later date, which, unfortunately, brought a very bad condition of the road, but resulted in prizes for various kinds of showing in power, endurance and ease of management to the Duryea Motor Wagon Co. (gasoline), H. Mueller & Sons (gasoline Benz motor), a Roger-Benz (gasoline motor-cycle), the Sturgis Electric motor-cycle, the Morris & Solom electrobat, G. W. Lewis (gasoline motor-cycle), Haynes & Apperson (gasoline motor-cycle), the Hertel (gasoline motor-carriage), and the Hornby-Akroid (gasoline carriage). Nothing of this character beyond a few individual

runs and an exhibition, that has attracted special attention, has been done in England. In Germany, while the motor-carriage industry has been developed to a large extent, we hear of no well contested trials similar to those in France and in the United States, having been made.

In June, 1896, an automobile contest was made in New York from the City Hall to Tarrytown on the Hudson and return, under the auspices of the *Cosmopolitan Magazine*, which seems to have started a fresh impulse in American automobile industry. This contest was won by the Duryea gasoline motor-wagon. These contests and subsequent exhibits and trials have resulted in the formation of the American Automobile Club, now numbering over 200 members, with its headquarters in New York City. This with the L. A. W. interest should become a vast force in the interest of good roads.

A general interest and enquiry has already been aroused all over this country in regard to automobile possibilities, and for information as to the constructive details and action of the various motive powers of the self-propelled vehicles.

France has so far taken the lead in the development of the automobile as a pleasure carriage. The reason for that is not far to seek. Paris, where the automobile is carrying everything before it, is in a superlative degree the city of good roads. Asphalt pavements, kept in perfect order and smooth as a billiard table, offer tempting inducements to automobile constructors and riders. Every variety of design and device for self-propulsion can be tested under the most advantageous conditions. If easy running, with good loads and high speed, cannot be attained on the Paris boulevards, then it is impracticable anywhere. Prizes have been offered to stimulate invention and races arranged to test the devices offered.

To a great extent, what is true of Paris applies in nearly equal degree to the other large cities of France, and to the roads connecting them. Long runs can be made with the assurance of finishing the perfection of good roads the entire distance. If, as is frequently the case, automobiles break down or fail from exhaustion of motive power under such conditions, it should be through no fault in construction or in ineffectiveness of the motive power when subjected to the test of long journeys, for this is common to all methods of travel.

Following in the contest methods for invigorating constructive and perfect action in all parts of a vehicle and its power, the great contest in France in 1897 has been most prolific in results in the improvement of its weak points.

In the Paris to Dieppe contest no less than 69 entries were made. Fifty-five started in the race, and a finish was made by more than one-half the starters. A successful and continuous trip of 1,000 miles from Warsaw, Russian Poland, through Germany and Belgium to Paris by an automobile built by Peugeot, in 10 days, and the late run of a Winton from Cleveland to New York, a distance of 707 miles, in $47\frac{1}{2}$ running hours, counts largely in favor of the future stability, durability and ease of control in the vehicles of the new motor age.

It is now fairly demonstrated that the horseless vehicle can be driven long distances over medium good roads at average speeds of 14 miles per hour, and for touring parties this leaves the horse drag far in the shade for care and expense.

The automobile fever has set innumerable inventors at work on motors of various kinds, while many bona-fide companies have been formed for real work in producing automobiles for the market, and many more who are not inven-

tors, or even manufacturers, that have organized away up in the millions for apparently the sole purpose of hoisting upon capitalists a worthless stock.

There seems to be but three kinds of motive power that are taking the lead, viz., steam, internal combustion and electric motors, each of which has its adherents or is specially suited to its own sphere of action or special field of usefulness. As for compressed air, the radius of action for road vehicles is somewhat limited, and although it has been tried in England and some experiments made in the United States, it has not as yet made much progress.

In railway propulsion it has taken a fairly solid base for useful work, having been in use in Europe and the United States during the past twenty years.

In mining traction and for stationary and portable motor work it has taken a leading and important position as a motive power.

Carbonic acid gas has as yet failed to give satisfaction, owing to the great sacrifice of pressure from its liquid state required to bring it within the limit of the working strength of a motor.

Acetylene gas is somewhat expensive, and, although but slightly experimented with for vehicle power, it is yet to be developed as to its radius of usefulness in automobile work.

Liquid air is out of the question for motor power.

The present year may be said to be a crucial one in the development of the automobile into permanent lines of design of motors, running gear and bodies best adapted to each of the kinds of motive power.

When you first sit in a motor carriage and feel yourself being carried over the ground with no horses in front of you, it produces a pleasurable sensation. As you become more accustomed to it, the feeling grows to one of delight

and lastly you are completely "carried away" with it. You experience only half the joyous possibilities of a motor carriage when riding as a passenger. The other half, we have learned, is the driving. When you have the steering-lever in your hand and can speed ahead at your own pleasure by simply pressing a button, or lever; when you wish to increase, or lessen the speed, or to make a quick run with a neighbor, then it is truly a new and delightful sensation. The vehicle of this type is so easily and safely controlled that one soon acquires the feeling of perfect confidence in himself and the motor. You can stop so suddenly, turn so abruptly, or go backwards almost as quick as thought.

Happy should be the owner of an automobile.

While the over enthusiastic journals and newspapers are harping on the passing of the horse, it may justly be claimed that an incompetent driver of horses may cause as much damage as one on an automobile, but as men have been driving horses for several thousand years it is fair to presume that the green hands in the business are fewer than those in the art of steering a motor carriage. If we are about to change to a new mode of locomotion, this is a good time to begin demanding a certain amount of skill and knowledge on the part of the man at the lever. The fee for examination in cities should be nominal, and the board of examiners should be made up of engineers and experts in such machinery. There is no reason why the license feature should be any more of a hardship than it is for drivers of public vehicles. It is certainly desirable for the general public that none but competent men be allowed to manipulate the new vehicles, especially for the next few years, while the horse is becoming reconciled to the new order of things.

In providing for the limit of speed allowed to automobiles

there is no reason why the regulations should be any more severe than those now in use to prevent fast driving with horses. Reckless speed—with horses, bicycles and automobiles alike—is chiefly a matter of place and time. A speed that is perfectly safe on an empty street might deserve arrest of the driver in a crowded park. An arbitrary limit of some kind must be set, but its enforcement, as in the case of bicycles, will have to be left largely to the discretion of police officers. The licensing of the drivers will be a far more effective check upon reckless speed, for one or two offenses of this sort can be made the occasion of taking away a driver's license. The ordinance now in force in Paris should be a useful model for the proposed measure in the cities of the United States.

The pleasure carriage is essentially an article of luxury, and it has required hundreds of years of use and the talents of the most skilled to bring it to its present perfect condition, and riders will demand of automobiles the same freedom from noise and the same ease of motion that they get with the horse-drawn vehicle. Cabs and other public conveyances, as well as vehicles for freight purposes, must be provided with positive, reliable power, one that is quick to respond to the calls made upon it, and one that will give the best results with the lightest possible weight; one, too, that is simple, effective and economical. Capital stands ready for bona-fide investment in stages and trucks as well as in pleasure vehicles, just so soon as motor builders can guarantee their motors to do what is required of them.

The advantages and disadvantages of the three kinds of motive power for vehicles may be briefly stated for the consideration of all interested in the operation of the horseless vehicle.

The advantages of steam power may be safely assumed to

be, first, absence of vibration when standing or running; second, light weight and simple transmission; third, fuel and water easily attainable; fourth, perfect control over all speeds forward or backward.

Its disadvantages are chiefly, first, municipal obstructions in regard to the use of steam power; second, practical knowledge required in the care and operation of steam power; third, injury to boiler and loss of steaming power by incrustation (which may be remedied by second requirement); fourth, length of time to get up steam, a few moments only; fifth, required watchfulness of water level and operation of the burner, whether automatic or not.

The advantages with internal combustion motors are, first, absolute safety from fire or explosion; second, moderate weight in proportion to power; third, economy in fuel and its ready purchase on the road; fourth, freedom from municipal obstruction as to kind of power; fifth, its operation easily learned.

Its disadvantages are, first, more or less vibration according to design of motor; second, motors must be started by hand through a lever or by crank, although this is not required in some motors; third, complexity of change speed gear and its operation.

In the electric storage battery system, the advantages are, first, a simple and direct transmission from a reversible rotary motor; second, ease of operating the motor for all speeds forward and backward; third, freedom from vibration at all times and from noise except possibly at very high speed; fourth, no preparation required for starting; fifth, freedom from anxiety in regard to the motive power and its care; sixth, ease of recharging the batteries from a local current plug in the vehicle stable. Its disadvantages are, first, its limited radius of distance from the source of supply, say

from 20 to 40 miles hence, only available in cities or towns having electric stations, or to a limited extent from country electric stations; second, excessive weight and short life of batteries, in proportion to load carried; third, excessive cost of power when charging current has to be purchased. For local operation where a gasoline motor electric plant is used for house lighting, the economy is apparent.

Already the tendency at this stage in the progress of manufacture of automobiles of all kinds of motive power is to meet the desire of owners and operators of these vehicles for great power and fast speed. This should be guarded against as tending to encourage road racing, which is not desirable in a pleasure carriage and should be confined to models for racing on suitable tracks or speedways. No one thinks of driving a horse up a hill at a full trot; a slow walk seems to satisfy most driving tourists. Then why should a motor vehicle be overloaded with machinery and itself made heavier to accomplish excessive speed either on the road or in hill climbing. This idea is especially pointed for family comfort on the road and for touring. Where is the pleasure of rushing through the country at break-neck speed with eyes riveted upon your machine gear and losing the scenic beauty of travel?

This is most applicable to the man of business who owns an automobile and wishes to derive relief from business cares and vexations by a pleasurable drive in a vehicle that gives confidence in its simplicity of running gear and ease of management. The cost is also in favor of simplicity of construction as well as a point with the purchaser. If for recreation, freedom from the thought of complicated parts and movements and the vexation of finding defects while on the road are most necessary conditions in the design of the horseless carriage. Let the lovers of racing sport

only hold the reins of the fast automobile and enjoy its dangers.

There is much improvement yet to be made in all the modes of generating and applying power to the motor machinery as well, also to the reduction of weight and parts without losing the required strength for the proper work of the vehicle.

With steam-propelled vehicles the steering and speed movements appear to be reduced to the most simple and direct terms. It is the boiler and burner that are in the progressive stage of automatic control; but automatic devices, like other complex devices, require watching to give confidence in their action, and therein lies its principal trouble. The speed control is faultless.

The internal combustion or explosive motor system has its advantages and its failings. A self-starting motor with one cylinder is not yet available for vehicles unless the motor is previously turned to the proper position for a forward impulse.

With two cylinders the conditions are better and with three or four cylinders with consecutive impulse the requirement for self-starting seems to be satisfactory. For any number of cylinders the lever and pawl starting device operated from the carriage seat has proved satisfactory and desirable. The devices for changing the motor speed by varying the charge or by mischarge, work well above the minimum speed at which the motor will run, say about 200 revolutions per minute, and from this to 800 or as claimed by some builders, 1,000 or more revolutions per minute, the direct control is in most cases satisfactory; but this does not cover the requirement—a forward and reverse low speed is necessary,—and at least one maximum speed beyond the capacity of the direct motor speed seems

also necessary and an intermediary speed is largely in use. This involves a complication of gears and gear movements that seem to be the only drawback to a most satisfactory application of this motor power for vehicles. It adds complex changes of gearing to the operating movements with its buzz in high speed and adds many parts to be oiled, cleaned and watched for loose joints from the jar of the running gear.

With the electric motor there seems to be the most freedom from care of all the motive powers. The driving is fully as simple as with the steam motor with its direct application to the carriage wheels, few parts to cause apprehension and any incidental derangements easily found and remedied with but a small practical knowledge of the wiring connections.

The weight and life of the storage batteries are the chief consideration for the usefulness of the electric motor vehicle for touring or long journeys. The improvements in storage batteries of late seem to have largely reduced the shortcoming of this system, and extend its radius of operation within reasonable limits of weight, to about 100 miles for pleasure automobiles and to about 40 miles for heavy or delivery wagons. The increase of electric light plants in the cities and principal towns throughout the United States make it possible to arrange touring routes for electric motor vehicles for extended circuits, and thus enable this quiet and easily managed power to become available for long journeys.

The arrangements for steering vary largely in detail and may be divided into three distinct methods.

First, by pivoting the axle at its centre and operating its function by a screw or geared sector operated by a hand-wheel. This was one of the early devices and was found

clumsy and undesirable. It has found its best practical use in both forms in road rollers and traction engines. In a road roller that we have examined, the traverse nut and screw are operated by the engine with a double-clutch and lever, which overcomes the difficulty of turning the broad-faced roller by hand.

The hub pivot is in general use with hand-lever connections for light vehicles and hand-wheel connections for the heavier class.

An improvement in placing the pivots in the central plane of rotation of the steering wheels has entirely removed the hand shock by the direct lever connection, and has given to the automobile quadricycle the bicycle facility for steering. This is one of the most desirable conditions in the guidance of motor vehicles. The swiveling of the steering axle in the vertical plane is the most general in use and preferably to any arrangement of an elastic frame, whether the elasticity is in the metal bars or jointed fittings.

Of resilient tires the pneumatic is the one which gives the best results. Instead of the entire weight of the vehicle having to be raised over any intervening obstruction, or crushing it into the roadway, or when passing over a soft surface the wheel sinking in such a manner that it must either crush down or surmount the incline in front of it, the pneumatic tire, on the contrary, absorbs or swallows up, so to say, either entirely or partially, the obstruction, and thus obviates the necessity for the lifting of the wheel and vehicle, or at any rate greatly reduces the height through which such lifting action must take place. Not only is an obstacle more easily surmounted in this manner, but, furthermore, the tire obtains a better grip. The striking of any obstacle which may be situated on the one or the other side of the actual contact point on the wheel base is also to

a large extent taken up by the cushioning action of a pneumatic tire, and the pressure exerted through the spokes is greatly reduced in consequence of this reduction in side thrusts. In the case of the steering wheels this is an advantage of great value, inasmuch as it enables them to be maneuvered with a greatly reduced expenditure of energy, and renders their operation a far easier matter.

It seems, therefore, that for the lighter class of vehicle, and especially those fitted with pneumatic tires, lever steering is the most suitable, as being the quickest in action and the simplest. But for the heavier vehicles and those which are not fitted with resilient tires, wheel-steering gear is practically a necessity.

In the design and construction of the automobile one thing has been apparently lost sight of that will be greatly missed, and that is storage space. Under the seat and back of same in the buggy of the doctor or the country parson there was room for a hamper of provisions for the picnic party, a grip of the traveler or some supplies for the needy. In the light runabout of the contractor or jobber the same space gave him accommodation for tools or samples, and in the carriage in general such space, out of the way of the occupant and always at hand, has been looked upon as a necessity. This space in the automobile is occupied by the driving mechanism, and when on a touring trip the baggage is necessarily piled upon the carriage in a manner that suggests a moving day. Space for grip or baggage is one of the things in order of improvement in automobile construction.

There is nothing of importance that we are waiting for to add to the automobile. No startling inventions are called for, and none probably are coming to solve the motor problem. All the mechanical essentials have been devised seemingly complete and ready at our hand.

It is the combination and adaptation of well-known details that is needed to perfect the automobile mechanism, rather than pure invention. Many of the detailed parts have been brought into practical use within the past few years and are held under patents to the detriment of progress in automobile construction on the best lines of mechanical design.

The bicycle has throughout its marvelous development been preparing the way for a vastly greater vehicle than itself. The tubing, the wheels and tires, the ball bearings, the sprocket and chain, the steel for every part, and the numerous products of automatic machinery have contributed to the perfect action of this elegant and speedy adjunct to the human motor. Time and trial with the modern means of manufacture will eventually bring weight and power to their respective limits in the later vehicle for strength and speed. The enthusiastic designer of automobiles may be led to ignore or forget precisely what is really needed, and purchasers may not realize exactly what they want. We want, perhaps, least of all for a pleasure carriage, a racing machine. Speed records will never establish permanently any type of vehicle or motor.

The typical horse, that has been such a valued helpmate of man, is not the racehorse. Neither is the making of long runs over rough roads the thing alone to be kept in sight in designing the vehicle. Thousands of horses, especially around our cities, never go more than ten miles from home, and never see a piece of rough road. Let the roads, to some extent at least, be smooth for the vehicle, and let not all the concessions be made by it. Let us first try to produce serviceable, ever-ready and easily-managed automobile vehicles that will run upon good roads without costing too much, either at first or for repairs, and let us use them and find pleasure and comfort and convenience in them upon

our good roads and for comparatively short runs, and when this service is fully established improvements will follow rapidly, until we will be able to go everywhere and do everything with them. The roads will be smoothing themselves to entice the automobile farther and farther from home, until it becomes ubiquitous.

We may expect progress in the development of the automobile in several directions at once. We may build the highest types of pleasure vehicles first, for wealth and leisure to enjoy, the racer for the sporting community and from that we may meet the larger service of the more numerous classes, with the motor bicycle and tricycle; while, on the other hand, we may speed up and lighten the traction engine, transforming it successively into the auto-truck and the delivery wagon, until the developing types shall meet and fully cover all requirements.

Chapter II.

HISTORICAL.

THE PERIOD OF THE PROGRESS OF STEAM MOTIVE
POWER.

CHAPTER II.

HISTORICAL.

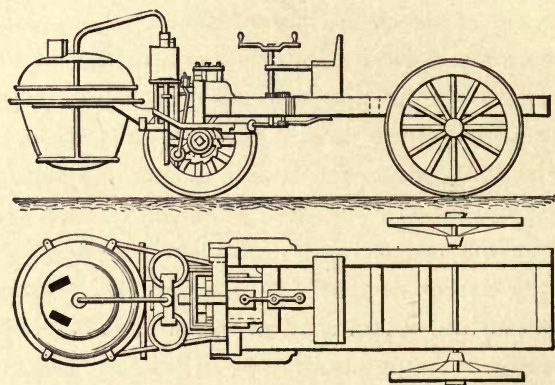
THE PERIOD OF THE PROGRESS OF STEAM MOTIVE POWER.

The horseless vehicle seems to have had a conception with the dawn of steam power, for Roger Bacon predicted the coming power of steam in road and marine propulsion.

The dream lay dormant for a few centuries, with an occasional spasmodic repetition and day dreams of roading, sailing and flying, until the dawn of the patent period, when, in 1618, Ramsey foreshadowed road traction in a steam engine patent. Spring power had already been tried in Germany, and wind power for driving vehicles was being used to considerable extent on the flat plains of the Netherlands.

Still slumbering, steam-road propulsion took a suggestion from Sir Isaac Newton about 1680 of a road wagon with a steam boiler with a rearward jet of steam blowing against the air, and which was claimed to have been accomplished before this time by Father Verbiest, a missionary at Pekin, China, by placing an æolipile with jets playing upon a revolving winged wheel geared to the wheels of a car. Nearly a century later but little progress had been made further than conjectural projects for road locomotion. Following the slow progress of the steam engine by Papin, 1698, Savery and others, Dr. Robinson in 1759 suggested to Watt the application of the steam engine for road carriages, but Watt was too busy to give it attention, and the idea slumbered with him for twenty-five years. The pro-

ject was revived in successive years by Dr. Darwin and Boulton, Watt's partner, ending only in suggestions. Moore and Small kept the subject in agitation, and together, with Edgeworth, brought the period of the ideal horseless carriage down to 1770 in England. Meanwhile automobile propulsion was making ideal progress on the continent, and in 1769 Cugnot had constructed a running steam wagon. It was in reality a tricycle, the front single wheel being driven by a pair of cylinders acting upon a crank shaft and geared by ratchets to the wheel shaft.



FIGS. 1 AND 2.—CUGNOT'S SECOND ROAD WAGON, 1770.

The boiler and engine overhung the forward wheel, which was also the steering wheel.

This, the first actual horseless vehicle, made a speed of $2\frac{1}{4}$ miles per hour, and was appreciated in military circles as a wonderful machine until it displayed erratic conditions by running into fences and walls.

Not daunted by these accidents, Cugnot, under patronage of the minister of war, built an improved and more powerful road wagon which was finished in 1770. It is still pre-

served in the Conservatoire des Arts et Metiers in Paris, France.

The improved road locomotive, as it was then called, consisted of a rear frame supported on two wheels, pivoted to the forked frame and bearing frame with steering sector of the 50-inch driving wheel, upon which the boiler and engine rested. The copper boiler had an internal furnace with two small copper chimneys passing up through the top of the boiler.

It had two single-acting cylinders with pistons connected to occillating arms with pawls acting on ratchet wheels fixed to the driving wheel axle. Thus each stroke of a piston made a quarter revolution of the driving wheel.

This roadster showed overloading on the single driving wheel and came to grief by overturning in rounding a corner.

In England, the fire of practical work in road locomotion slumbered with an occasional fanning by Murdock, Watt and Symington, which culminated only in working models. About 1786, Sadler of Oxford, England, was experimenting in the application of steam to road vehicles, when he was cautioned that Watt's patent covered the principles of the application of steam power for the propulsion of road vehicles. This seems to have stopped progress for awhile in England—although advocates and inventors were never out of the field.

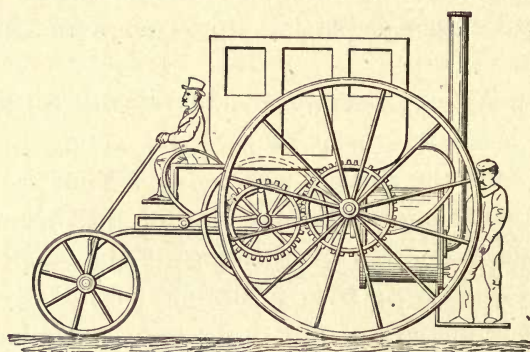
In the United States, Oliver Evans seems to have been the first to advocate and obtain privileges in Pennsylvania and Maryland, to operate steam road wagons about 1787. His venture resulted in a combined boat and road wagon built in 1805.

Charles Dallery, in France, followed in Evans' example with a small steamboat on wheels.

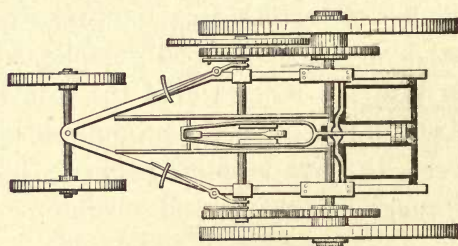
Nathaniel Read, Warren, Mass., patented a road steam

carriage in 1790. Nothing further than a working model resulted.

Trevithick made a further advance by building and running a steam road carriage in 1802. After experimental runs in and out of London, it was finally dismantled and the engine sold for mill use.



Elevation.



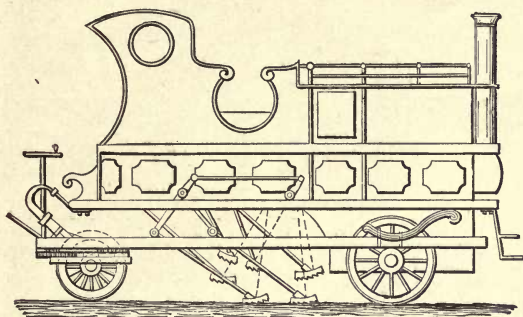
Plan.

FIGS. 3 AND 4.—TREVITHICK'S STEAM
ROAD CARRIAGE, 1802.

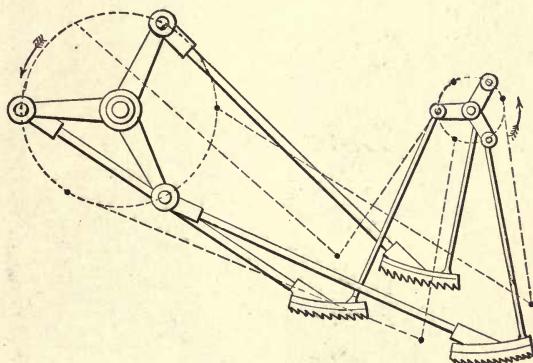
Road locomotion seems to have slumbered during the war period in Europe, with a few spasmodic efforts in the way of patents issued to Griffith, Brown, Burstall, Hill and others from 1821 to 1824. Some of these patents covered the push-foot idea which was probably derived from

the duck-foot paddles of the early years of steamboat experiments, of which Fig. 5 is an example of Gordon's Walking Carriage, which, after several years fruitless trials, was abandoned as an impractical system.

The movement, it will be seen, was made by a push-foot



Elevation.



Plan of Movement.

FIGS. 5 AND 6.—GORDON'S FOOT-PROPELLED
STEAM CARRIAGE, 1824.

connection from a three-throw crank-shaft and the lifting and dropping of the feet by a smaller three-throw crank-shaft revolving in unison with the larger one.

Griffith built a steam carriage about 1822, in which the

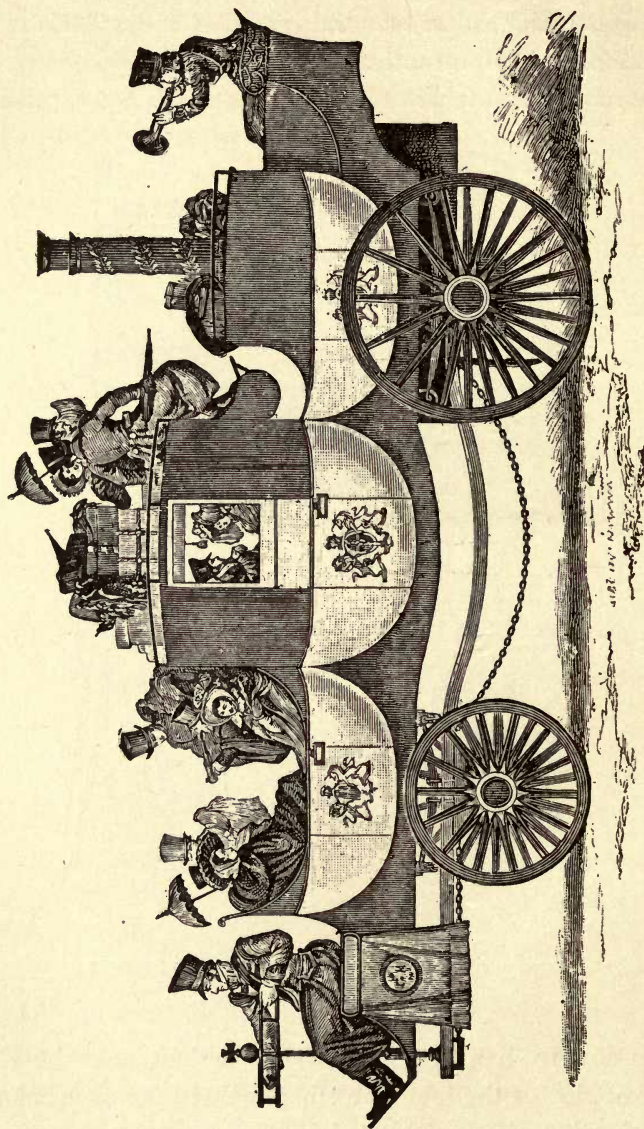


FIG. 7.—JAMES STEAM COACH.

exhaust was to be condensed in thin metal tubes exposed to a circulation of air. It never had a road trial.

In the Burstall & Hill carriage an attempt was made to make all the wheels drivers by a fore and aft shaft with bevel gears. It could make but a four-mile speed and after a few trials, various changes were made resulting in detaching the boiler from the main body upon a pair of drag wheels. It was not a success. The first road coach that seemed to have been run with any success in England was built by W. H. James, patronized by Sir J. Anderson, in

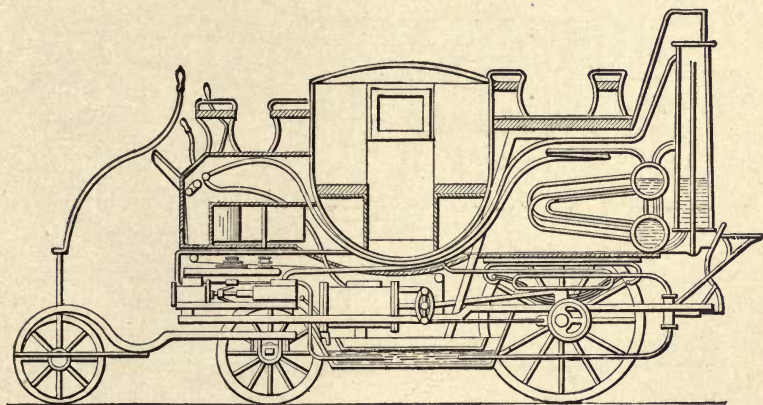


FIG. 8.—GURNEY'S STEAM CARRIAGE.

1829. This was a regular coach in form and attained a speed of 15 miles per hour. James built a number of steam carriages and tractor engines.

Several patents in England and the United States followed this period, with a few spasmodic trials on the road in England. Summers and Ogle, in England, built steam carriages with drop-tube boilers, similar to those now used on American fire engines, advancing the construction to enable a speed of 24 miles per hour.

Sir Goldsworthy Gurney commenced building road loco-

motives about 1822 with improved methods derived from the experience and failure of contemporaries. Some of his coaches and carriages were run for passengers and hire on the public highways.

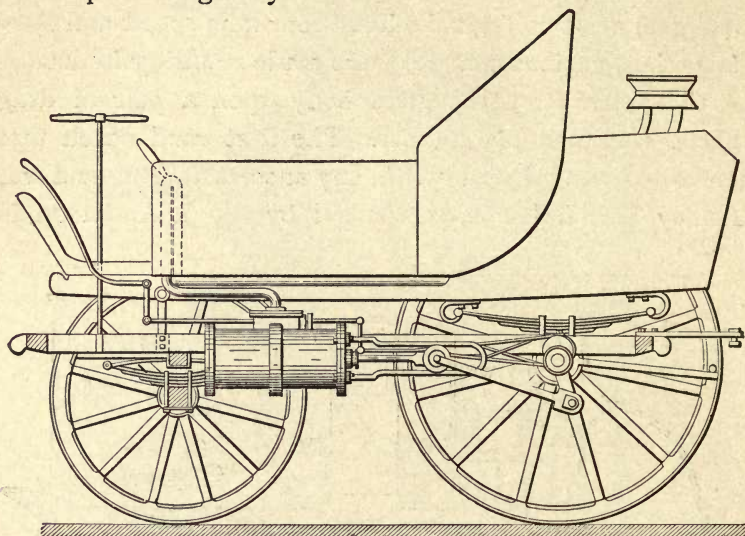


FIG. 9.—GURNEY'S STEAM CARRIAGE, MODIFIED.

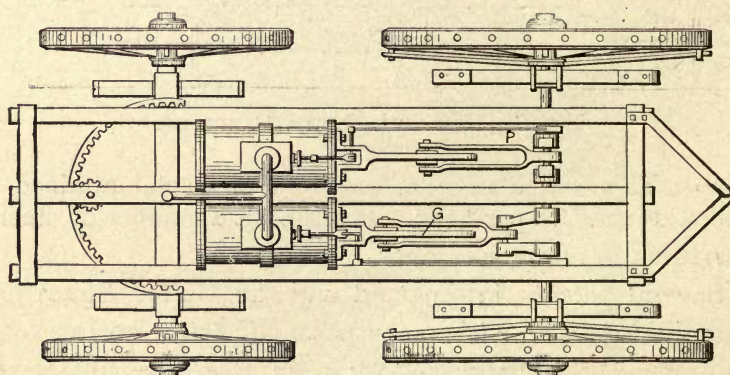


FIG. 10.—GURNEY'S STEAM CARRIAGE—PLAN.

He met with severe opposition from the authorities by high tolls and obstructions, and finally abandoned the business.

In Fig. 8 is shown one of Gurney's steam carriages in elevation with an independent steering wheel, which was soon abandoned as impracticable.

In Fig. 9 is an elevation of the modified carriage, and in Fig. 10 a plan of the running gear.

Contemporaneous and following Gurney's trials, Hancock seems to have made considerable advance in the construction of boilers and engines suitable for vehicles, a number of which were built extending over the time from 1837 to 1840, carriages, omnibuses and tractors being seen on the roads

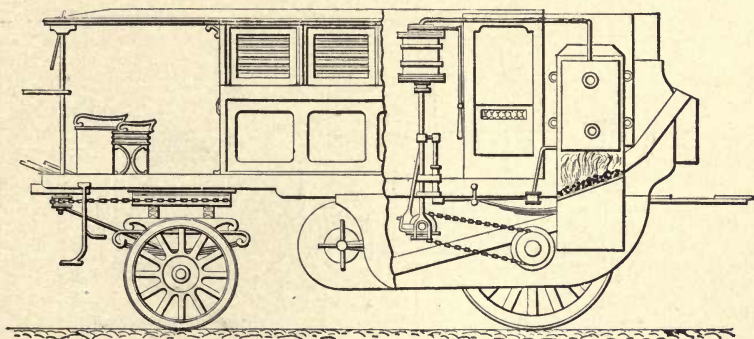


FIG. 11.—HANCOCK'S STEAM OMNIBUS, 1839.

about London. One of his styles of omnibus is shown in Fig. 11.

In this type of vehicle the vertical tubular boiler with magazine fuel feed and a blower was brought into use to control the steam. The chain and sprocket gear with inverted engine, all indicating an advance towards more modern economies.

Hancock's vehicles seem to have taken the lead in England during this period, forming lines of steam omnibuses from London to Islington, Paddington, Stratford and much within the city. Speeds of 10 to 12 miles per hour was the practice and about 20 miles as a spurt on the best roads.

The decade, 1830-1840, was an era of flotation of companies for road locomotion in England, the schemes being mostly promoted by speculators who had, perhaps, nothing better than worthless patents on which to base their claims for public favor.

Colonel Maceroni, an Italian resident in England, with Mr. Squire, patented a vertical tubular boiler which was a rapid generator and capable of a working pressure of 150 pounds. A steam carriage was soon built, described to be

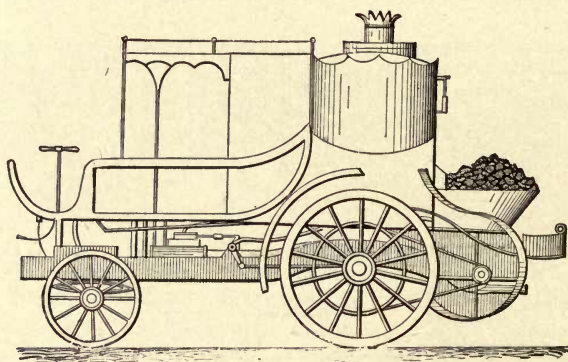


FIG. 12.—MACERONI AND SQUIRE'S STEAM COACH, 1834.

a simple and efficient machine with an average speed of 16 miles per hour. This carriage plied daily between Paddington and Edgware for several weeks, and during a run aggregating 1,700 miles required no repairs.

Fig. 12 shows the general appearance of Maceroni's vehicle with the chain and sprocket connection from the engine shaft to the driving wheels.

It was a nine-passenger vehicle and driven from cylinders $7\frac{1}{2}$ by $15\frac{3}{4}$ inch.

One of Maceroni's steam carriages was run in Paris, and one in Belgium, in 1834-5.

Maceroni was starved out by frauds, and a general steam

carriage company undertook to construct carriages involving his patents, by other parties.

We notice but one carriage, a steam drag, running in Paris previous to 1840, made by Deitz.

J. Scott Russell, in England, built a half dozen steam coaches in the latter part of this decade and operated them in Scotland and in London. Opposition by the turnpike companies was still rampant and culminated in the destruction of one of his coaches. Fig. 13 represents one of J.

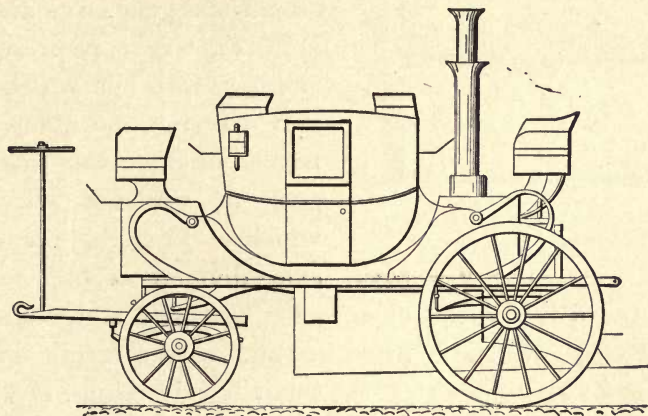


FIG. 13.—J. SCOTT RUSSELL'S STEAM COACH, 1834-1840.

Scott Russell's coaches which continued on the roads until about 1857.

The compensating gear appeared about 1834, invented by Roberts, of Manchester, which appears to have involved the principles of many following devices for relieving the strain on the driving wheels when rounding curves. A common name in England for this device was "Jack in the Box," so named probably from its hidden mechanism. It superseded the claw clutches that had been previously used; illustrations of which are shown in the details in other chapters.

The principle forms of compensating gear in use at this time, apart from the wheel ratchets are represented in Figs. 14, 15 and 16. A central through shaft had the cranks keyed on at right angles. The differential bevel wheels on a cross arm or frame were fastened on the central shaft.

The wheels and counter bevel gears were fixed on sleeve shafts running freely on the central shaft and abutting against the shoulders of the cranks and gear cross arm.

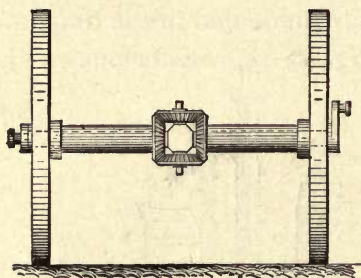


FIG. 14.—OUTSIDE CRANK DIFFERENTIAL GEAR.

In Fig. 15 is represented another form in which the arm carrying the differential bevel pinions was made a gear or sprocket wheel, in which *E D*, is the revolving axle divided at the center.

A is the driving gear or sprocket, attached to a frame or "Jack-box," which is fitted to and moves freely on the axle and carrying with it the small bevel pinions, *B*, which may be one but preferably two, to more perfectly balance the mechanism. The bevel pinions, *C C*, are fixed one to each section of the shaft.

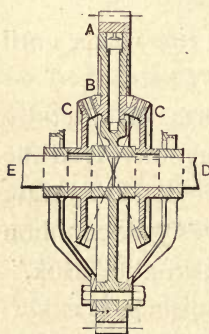


FIG. 15.—DIFFERENTIAL DRIVING GEAR.

This differential gear as used on a traction engine is shown in Fig. 16.

This form is also applicable to a crank connection and reducing gear for any form of vehicle.

One wheel and one bevel gear are fixed to the axle. The other wheel with its bevel gear runs loose on the axle. The driving-spur gear, with its differential pinions, runs freely on the sleeve of the fixed

bevel gear. The long pin serves to lock the loose wheel to the driving-spur gear, making the locked wheel take a positive motion, and locking the differential system for a straight run.

Hill and Anderson were still ardent promoters of the steam coach industry, and several companies were operating coach routes in England, when, from 1840 to 1857, an interreg-

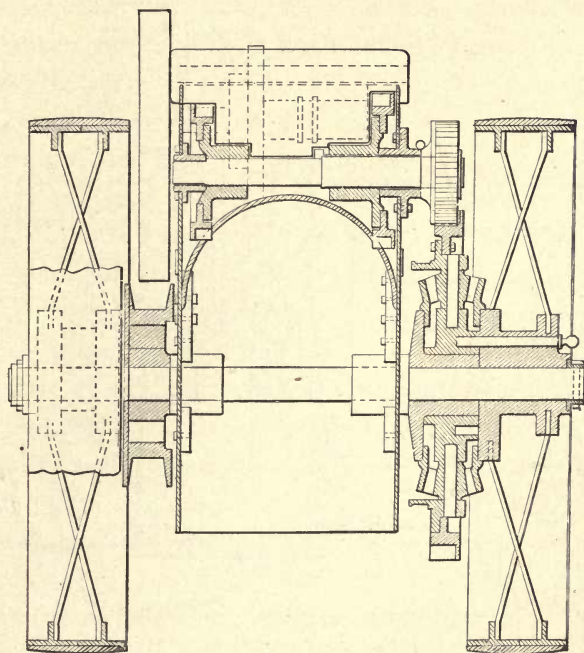


FIG. 16.—DIFFERENTIAL GEAR ON TRACTION ENGINE.

num seemed to have fallen upon this industry for several years, when a revival seems to have commenced in England, France and the United States. The steam vehicle construction previous to this time seems to have drifted almost entirely toward large coaches of capacity for from 12 to 20 passengers.

In the United States the lighter carriages for private use had their first trials in a small steam carriage built by J. K. Fisher, in New York, in 1853, having two cylinders, 4 by 10 inches, and a water-tube boiler. This carriage attained a speed of 15 miles per hour on good roads.

Richard Dudgeon built a small steam carriage with two cylinders, 3 by 16 inches, that made a speed of 10 miles per

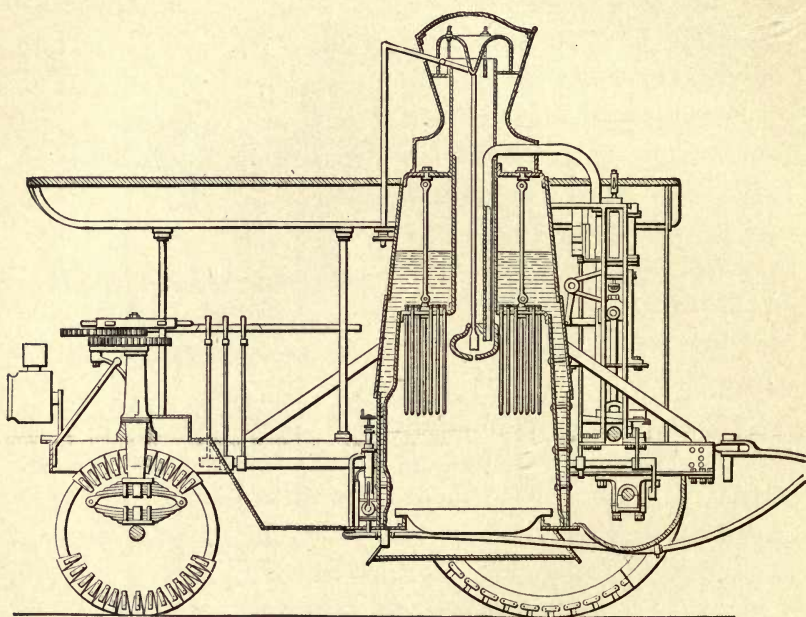


FIG. 17.—RANSOME'S TRACTION STEAMER.

hour. It was destroyed in the New York Crystal Palace fire in 1858.

Progress was very slow in the United States, while in England road locomotives and traction engines seems to have taken the lead, and a large industry sprung up for foreign demand.

The use of steam on common roads in both England and on the Continent seems to have drifted away from passenger

traffic and more to traction vehicles, some for drawing passenger coaches. One of the many traction engines, of various types of this decade, 1860 to 1870, is shown in Fig. 17.

This road steamer, it may be seen, had a vertical drop tube, or what was named in England the Field boiler. The cylinders were 8 by 10 inches, with crank shaft geared to 6-foot driving wheels. The boiler had 11 square feet of grate and 177 square feet of heating surface. The wheels had India rubber sectional tires, with linked shoes. Speed, 7 to 10 miles per hour.

In 1873, Loftus Perkins exhibited at the International Exposition, South Kensington, England, a novel steam road wagon with three wheels. A single broad rubber-tired wheel in front and two trailing wheels. The engine, boiler, and all the machinery was placed on a frame encircling the single driving-wheel, and turned with it in steering the vehicle. This construction seems to have gone back a hundred years, for it was much after Cugnot's ideas in Fig. 1. The advance was in a compound engine, $1\frac{3}{4}$ by $3\frac{1}{4}$ by $4\frac{1}{2}$ -inch cylinders, working with 450 pounds steam pressure, with an engine speed up to 1,000 revolutions per minute.

The vehicle drew a small truck or tender on which was an atmospheric condenser made of very small thin tubes which not only condensed the steam but rendered its operation practically noiseless. It was in use for two or three years, and had sufficient power to draw a loaded coach 21 miles in three hours, including stops. The boiler was one of Perkins' high pressure tubular type.

Mackensie, in England, built and operated a steam brougham in 1874, driven by two cylinders, $3\frac{3}{4}$ by $4\frac{1}{2}$ inches, with sprocket chain gear and change gear for two speeds. He used a drop tube or Field boiler 2 feet in diameter, 4 feet high, working at 135 pounds pressure.

Steam road enterprise for pleasure carriages seems to have taken the back seat from this on for several years until the petroleum and electric industry gave a new impulse to road locomotion.

A few spasmodic efforts still continued, however, in Europe and in the United States. Lee and Larned built a steam-propelled fire engine in New York in 1863. John A. Reed built a steam wagon in 1863 and operated it on the Western prairies. Frank Curtis, of Newburyport, Mass., built and ran a steam buggy in 1867.

Carrett, Yarrow, Hayball, Tangye, Todd and others built and operated steam road carriages of improved forms and machinery in England in the decade following 1860.

Steam road locomotion, however, continued to improve in its application to industrial uses for haulage and steam plowing in Europe and the United States. The steam road roller became a most important element in road improvement and a source of power in the building of good roads. It has now become a necessity for road building and repairing, employing large numbers in every civilized country.

Chapter III.

STEAM AUTOMOBILE MOTOR APPLIANCES.

BOILERS AND BURNERS FOR STEAM MOTOR VEHICLES—THE
NEW SERPOLLET STEAM MOTOR.

CHAPTER III.

STEAM AUTOMOBILE MOTOR APPLIANCES.

It was not until 1889 that steam traction on roads resumed a new phase in the direction of vehicles for pleasure. In the decade previous to this date the English road laws and the opposition of turnpike companies appear to have almost extinguished road steam locomotion in England. It was to have a new birth in France, under more liberal road laws and regulations.

In M. Serpollet was developed the spirit of evolution for the horseless carriage, which in his hands made rapid strides. With the development of the explosive and electric motor industry, the spirit of progress became epidemic in France and rapidly spread throughout the Continent, England and the United States.

M. Serpollet's boiler was a marked innovation towards lightening the source of power, and the flash boiler seemed to take on a useful form, although the principle had been tried before and failed to meet the requirements.

In Fig. 18 is represented one of the steam tricycles of M. Serpollet.

His first boiler did not have the fuel magazine, and is shown in vertical section, Fig. 19, and in horizontal section in Fig. 20.

The flash coil generator, Fig. 21, at first made of $1\frac{1}{2}$ inch lap-welded iron pipe, flattened and coiled as in Fig. 21, and

afterward of steel or copper pipe, corrugated, as shown in the cut. The elongated aperture within the coil was about

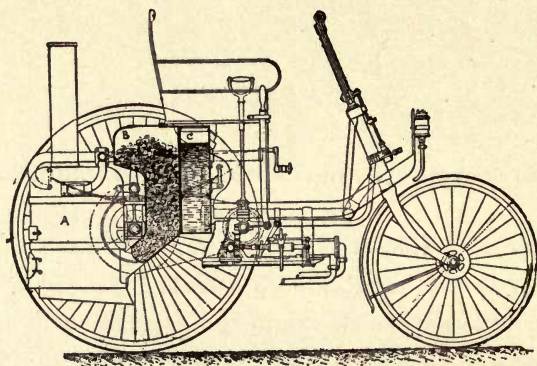


FIG. 18.—SERPOLLET'S STEAM TRICYCLE.

$\frac{1}{8}$ of an inch wide. It was placed above the fire, as shown at A, Fig. 19.

They were tested at 1,500 pounds per square inch to insure safety at any probable pressure, a working pressure

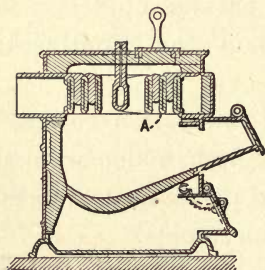


FIG. 19.

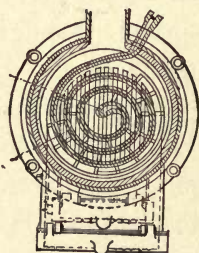


FIG. 20.

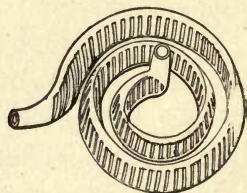


FIG. 21.

THE SERPOLLET STEAM GENERATOR.

of 300 pounds being the practical limit. For a larger generator two coils, one above the other, were placed over the furnace and their ends connected so that the water injection was first through the lower coil.

In this method of generating steam there is no valves between the boiler and engine; the injection pump works constantly while the vehicle is running, and the amount of water fed to the boiler is regulated by a three-way cock operated by a convenient handle for directing the required amount of water to the boiler, the excess returning to the tank through the third port in the cock.

The feed pump could also be started by hand for the first charge. For stopping the motor, the water was shut off from the boiler.

Incrustation was not found in this type of generator with ordinary clean water; the high velocity of the water and steam through the narrow spaces was found to sweep any sediment clean from the surface and to discharge it through the cylinders and exhaust.

The evaporated power of one coil was reported to be equal to 40 pounds of water, or more than one boiler horse power, with a grate surface of 108 square inches.

This looks somewhat surprising, yet a record of 15 miles per hour with two persons on the tricycle was frequently made.

The Serpollet boilers were further increased in power for larger vehicles by changing the form of the tubes, as shown in Figs. 22 and 23, and nesting them in series, as shown in Fig. 24, and stacking, as in Figs. 25 and 26.

The furnace, Fig. 25, shows a longitudinal section, and Fig. 26 a cross section, showing the fire door and the cold air inlets above the fire, operated by a sliding damper for admitting cold air over the fire when the vehicle is standing. This being the plan of boiler used in the larger vehicles, had a furnace composed of fire brick tiles, set in a framework of special channel and tee forms of iron to hold the tiles securely, and the whole was encased in a sheet-iron box lined with asbestos.

FIG. 24

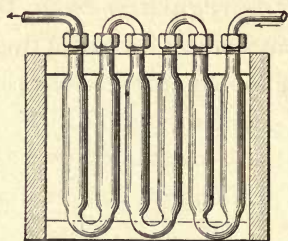


FIG. 23



FIG. 22

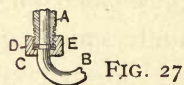
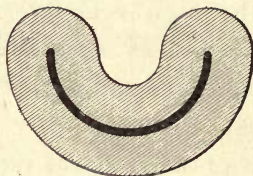


FIG. 27

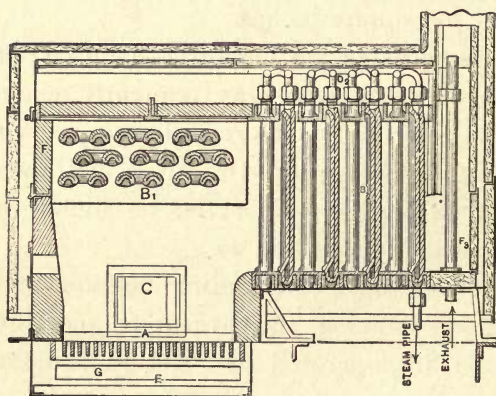


FIG. 25.

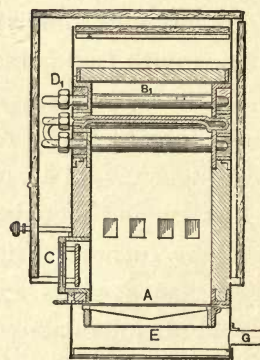


FIG. 26.

ELEMENTS OF THE SERPOLLET BOILER.

Further improvements were made by substituting gasoline or kerosene burners, one of which is shown in Fig. 28, in which the inlet at *J* received the oil under a low pressure by compressing the air in the oil tank sufficiently for overcoming the friction in the burner coil and maintain a vapor pressure at the jet for a full fire and governed by a cock in the oil pipe for reducing the flow of oil and the intensity of the fire.

The oil entering at *J*, passes into the coil, *S*, becomes vaporized and passes down through the end of the coil, *j*, into the base, *B*, and up through the central burner tube, *C*, through the slotted nozzle, *O*. A plug at *b*, and the screw closure at the top of the burner nozzle, can be removed for the purpose of cleaning the burners. The air passes up through the arms of the base, *B*, as shown in the

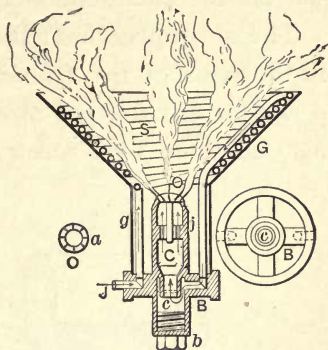


FIG. 28.—LANGUEMARE BURNER FOR KEROSENE OIL.

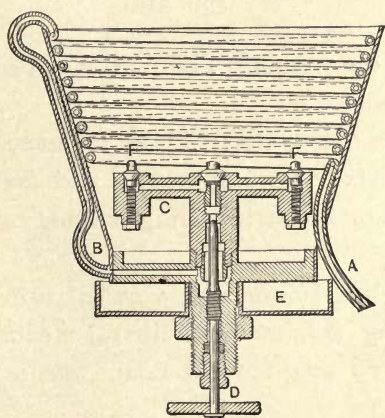


FIG. 29.—IMPROVED LANGUEMARE BURNER.

side diagram, and mingles with the vapor at the base of the coil. A small cup placed below the burner, charged with alcohol, served to heat the burner and lower part of the coil sufficient for starting the burner with oil.

An improved and larger burner by M. Languemare is illustrated in Fig. 29, which has a central valve

to control the vapor flow close to the burner tips—a very good arrangement, as the oil or gasoline that may be in the fluid state in the lower part of the coil may be checked from feeding the burners more readily than by a valve in the feed tube, *A*. The valve wheel, *D*, is operated by ratchet wheels and chain connection with the seat.

The cut represents a five-tip burner. The four tips, *F F*, in the arms of the frame are adjusted by screwing up or down for any desired size of aperture. The central tip is also adjusted by a screw, but is hollow, with side holes, to

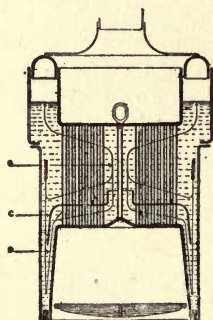


FIG. 30.

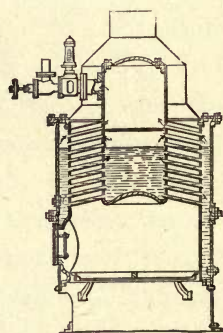


FIG. 31.

allow the vapor to pass to the outer tips. The cup, *E*, is for starting the burner with alcohol.

Other forms of these burners are in use. Those for gasoline require much less coil surface for vaporizing and are made in helical nests of three or five, with straight sides or cylindrical casings.

In Fig. 30 is shown an English submerged vertical tube boiler with interior circulating deflectors; a liberal steam and water level surface and well adapted for coal, coke or gasoline burner.

De Dion and Bouton, in France, made several models of boilers for vehicles, one of which, Fig. 31, is a vertical boiler

with an outside water space connected to an inside water cylinder by inclined tubes, with a diaphragm across the inner cylindrical shell between the two upper rows of tubes for producing dry steam by circulating the steam generated in each compartment through the upper tubes.

This boiler is especially applicable for coal or for a gasoline torch furnace, which can be fixed to the grate lugs.

Another form of boiler, made by the De Dion-Bouton

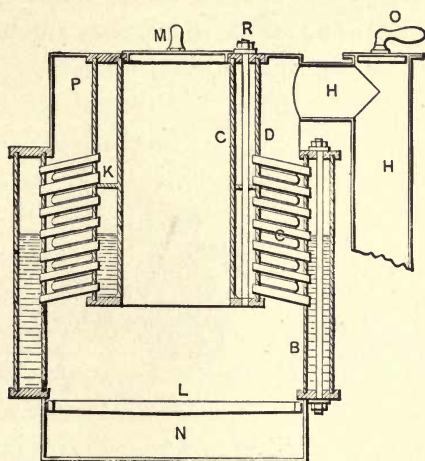


FIG. 32.—DE DION BOILER.

Co., is of the magazine type, derived from Fig. 31, in principle, but with an annular central shell and down draft smoke pipe, illustrated in Fig. 32.

This boiler, it will be seen, has every other vertical section of tubes closed at their outer end and expanded in the outer sheet of the inside section of the boiler, while the alternate tube sections are expanded in both sections of the boiler.

The magazine, *C*, is closed by an air-tight cover, *M*, and the draft regulated by the sector cover, *O*. The end

joining of the two pair of cylindrical shells, it will be observed, are made by annular grooved plates held by through bolts, in the author's opinion, a not very reliable construction for a high pressure boiler.

The boiler of the steam fire engine, made by the Gould Manufacturing Co., Seneca Falls, N. Y., Fig. 33, is a type of the vertical tube system with a water fire box and submerged tubes. Its conical smoke chamber and central smoke pipe gives this type of boiler many advantages in having the water line above the tubes and a large steam space so desirable for this class of boilers.

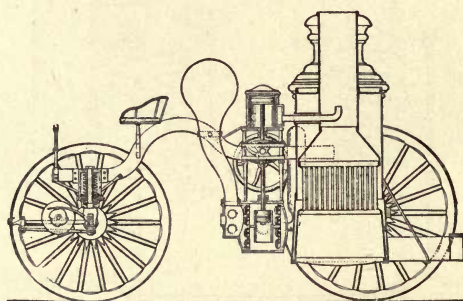


FIG. 33.—THE FIRE ENGINE BOILER.

It is the general type of boiler used in England for traction engines, trucks, road rollers and other heavy steam vehicles. In the United States the horizontal or locomotive form of boiler is largely in use for road rollers and traction engines.

BOILERS AND BURNERS.

In Fig. 34 is illustrated a boiler made by the Clarkson & Capel Co., London, and used with the burner, Fig. 35, on their four-ton dray.

The tubes in this type are only inclined from the horizontal enough to make a free circulation. The conical fire box

has a large heating surface and receives the first impact of the flame.

In Fig. 35 is illustrated the Clarkson & Capel burner. The oil enters the vaporizing coil at the bottom turn at *E*, as shown by the dotted line; is vaporized by the flame of the burner and the vapor carried through a continuation of the coil to the needle valve chamber at *J*.

The spindle of the needle valve, *N*, is pivoted to the arm of a rock shaft that extends to the outside of the mixing chamber, *T*, and connects by the arm, *L*, and the lever, *L'*, to the burner spindle and valve for regulating the flame at *E*. A cross bar at *B* guides the spindle, which

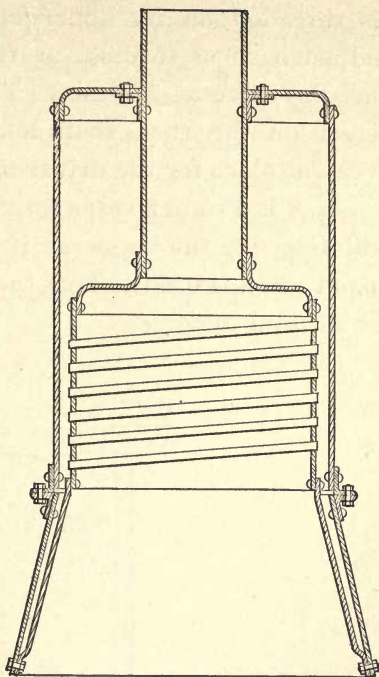


FIG. 34.—THE C. & C. BOILER.

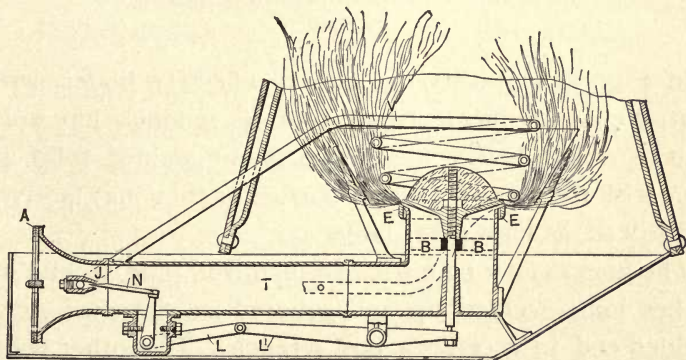


FIG. 35.—THE C. & C. BURNER.

is threaded on its upper end to allow the valve to be adjusted so as to close at the same time that the vapor needle valve at *J* closes. The valves are operated by a lever on the rock shaft and a link extending to a convenient place for the driver to handle.

At *A* is a rotary valve for regulating the inflow of air for diluting the oil vapor as it passes along the tube, *T*. A hand torch is used to heat the vaporizing coil before the oil is allowed to enter.

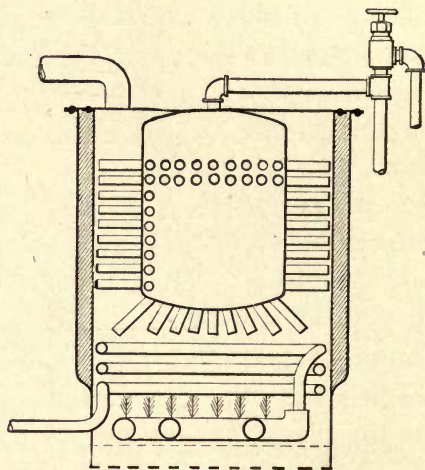


FIG. 36.—THE EXTERNAL FINGER
BOILER.

In Fig. 36 is illustrated a very effective boiler, with a central chamber made from eight or ten-inch lap welded iron pipe, with both heads drawn in and welded solid, as is done with the compressed air bottles or they may be riveted and calked, as with other boilers.

The fingers may be made of $\frac{3}{4}$ -inch iron pipe, from 4 to 5 inches long, welded up and squared or flattened on the welded end to receive a box wrench. The other ends to have the standard pipe thread.

The casings may be made of No. 12 sheet iron, covered with asbestos and enclosed in a thin sheet iron case.

The fuel evaporating coil may be made of $\frac{3}{8}$ iron or copper pipe, and connected to a burner frame, as in Fig. 36 and Fig. 37. The boiler, Fig. 37, is made of steel boiler plate with water leg and internal finger tubes made in the same manner as above described. It may have an outside case of thin sheet iron with asbestos packing on the cylindrical part.

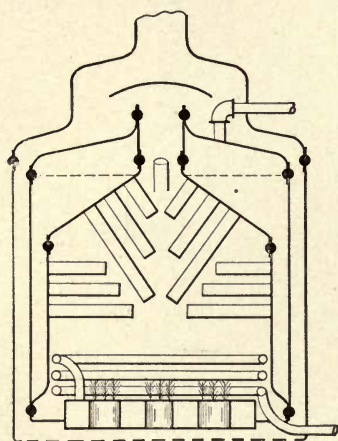


FIG. 37.—THE INTERNAL FINGER BOILER.

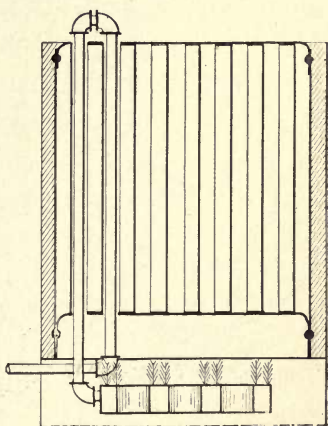


FIG. 38.—THE VERTICAL TUBE BOILER.

The boiler, Fig. 38, with a shell made of copper, No. 10 wire gauge, and heads of $\frac{1}{4}$ -inch sheet steel, flanged and riveted to the shell, illustrates a good practice for small boilers.

The diameter for 4 horse power should be 15 inches by 15 inches in height. The heads should be laid out for 350 copper tubes $\frac{1}{2}$ -inch diameter, No. 14 wire gauge, cut to project $\frac{1}{8}$ -inch beyond each head and expanded by a suitable Dudgeon expander and the ends flanged out.

The vaporizing tube, as used in the Stanley system, enters under the edge of the shell, extends up through one of the tubes and down through another tube to the burner case. With this arrangement, a separate air jet must be used to start the boiler, after which the heat of the boiler is sufficient to vaporize the gasoline in the pipes within the boiler tubes.

The jet burner, Fig. 39 is a hollow casting consisting of two rings with connecting necks, the upper surface having from 60 to 75 holes about $\frac{1}{32}$ of an inch diameter, through

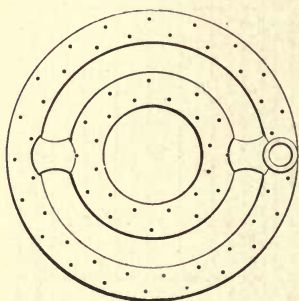


FIG. 39.—JET BURNER.

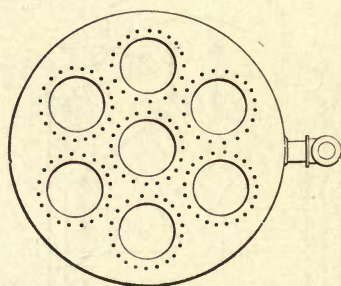


FIG. 40.—JET BURNER.

which the vapor meets the air drawing through the spaces within and around the rings.

The jet burner, Fig. 40, may be made with two disks of $\frac{1}{8}$ -inch steel plate with the edges flanged over to shut tight with a $\frac{1}{2}$ -inch space and brazed, with a collar for connecting the vapor pipe. The holes for air feed may be laid out and drilled in one head before the heads are brazed, which makes the drilled head the template for drilling the other head. The size of the holes must be made to exactly fit the selected size of the steel tubing from which to make the thimbles to fill the holes and to be expanded and the edges flared to make a secure joint. The size of the thimbles may be $\frac{3}{4}$ or

1 inch, and the number may be from 10 to 30, to suit the size of burner required. The jet holes should be $\frac{1}{32}$ -inch in diameter and in number suited for the size of the boiler from three to five hundred. One thousand holes, $\frac{1}{32}$ will only equal the area of a $\frac{5}{16}$ -inch pipe.

BOILERS AND ENGINES FOR STEAM MOTOR VEHICLES.

In Fig. 41 we illustrate a multiple vertical tube boiler.

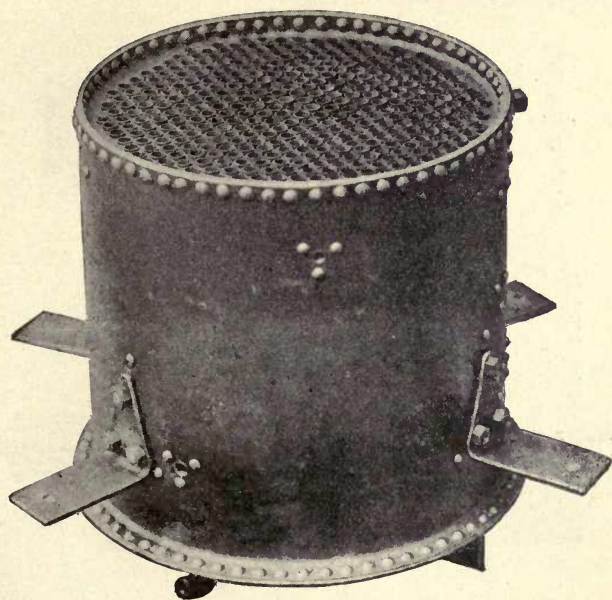


FIG. 41.—THE MILNE & KILLAM BOILER.

made by Milne & Killam, Everett, Mass., who are now building boilers, burners, regulators and engines, with complete equipment for steam motor carriages.

The vehicle boiler here illustrated is the stock pattern supplied to vehicle manufacturers, weighs complete but 130 pounds. It is 15 inches in diameter and 15 inches high, and will generate steam under normal pressure for 4 horse power. It is built with a steel shell and has 380 copper

tubes, each 14 inches long, giving a heating surface of 56 square feet. The working pressure is 140 pounds, and each boiler is tested at 350 pounds. The boiler is covered with asbestos and aluminum. It is fitted with dry steam pipe, water glass fittings, gauge cocks and blow-off pipe, holes for water feed and steam gauge connected; also a multiple tube cylindrical burner 15 inches diameter, 5 inches deep, with automatic gasoline regulator.

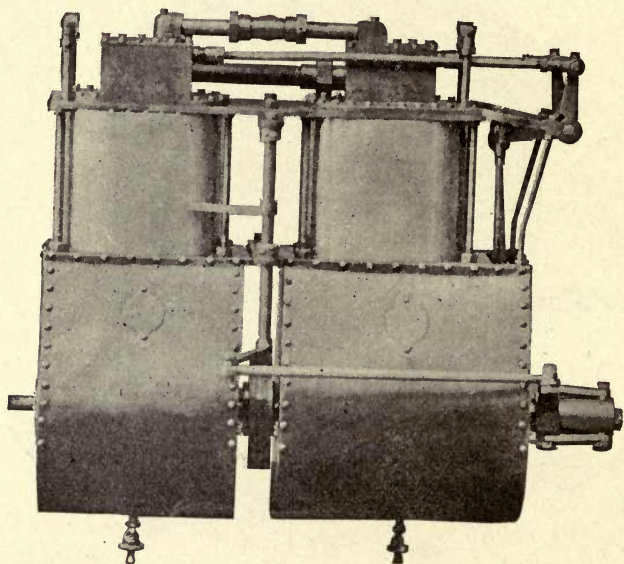


FIG. 42.—FOUR-CYLINDER SINGLE ACTING ENGINE.

The engine, Fig. 42, furnished with the boilers of this company are very compact and are models of concentrated energy. They develop on extreme call 6 horse power, although they develop but 4 horse power with the usual boiler pressure of 140 pounds per square inch.

It is of the four cylinder, single acting, reversible type and runs in oil in a draft-proof case; perfectly balanced and noiseless. Four cranks set at 90° from each other, gives a

perfect balance, and do away with all vibration. What is meant in this engine by "single-acting" is, that steam is admitted to one end of the cylinders only, therefore, the pressure on the working parts is always in one direction, which prevents any noise or pounding.

The engine is hung or suspended by the top, permitting it to swing fore and aft to allow for adjustment of the driving chain. This arrangement also does away with any fore and aft strain on the engine or rear axle that would occur if the engine was stationary while going over rough roads. The steam pipe is so arranged that no strain is brought upon it by fore and aft movement of the engine.

THE NEW SERPOLLET STEAM MOTOR.

The new steam motor of Leon Serpollet is designed much on the same principles of the straight line double cylinder gasoline engines. It is illustrated in Fig. 43 in part sectional elevation, plan view, end view and a section of the compression sub-piston and inlet port at the lower right hand corner of the cut.

It was designed for using the superheated steam generated in the flash boiler.

Steam is admitted by valves at the end of each cylinder, which are operated by cams on a secondary shaft geared to the crank shaft. The exhaust for each cylinder is by a port opened by the piston at the forward end of its stroke, as shown on the left hand cylinder in the elevation figure of the cut.

By this arrangement the steam is only exhausted during the moment of the end of the impulse stroke. The steam remaining in the cylinder is compressed on the return stroke in the whole space up to the inlet valve. The supplementary plunger piston moving in the neck of the inlet

passage is longer than the piston stroke; it is hollow, with side ports at about half stroke.

The operation is, then, that the return stroke of the piston compresses the steam remaining in the cylinder and inlet pipe until one-half the return stroke is made, when the ports in the sub-piston close and the compression in the cylinder is rapidly increased, making a strong cushion of steam in

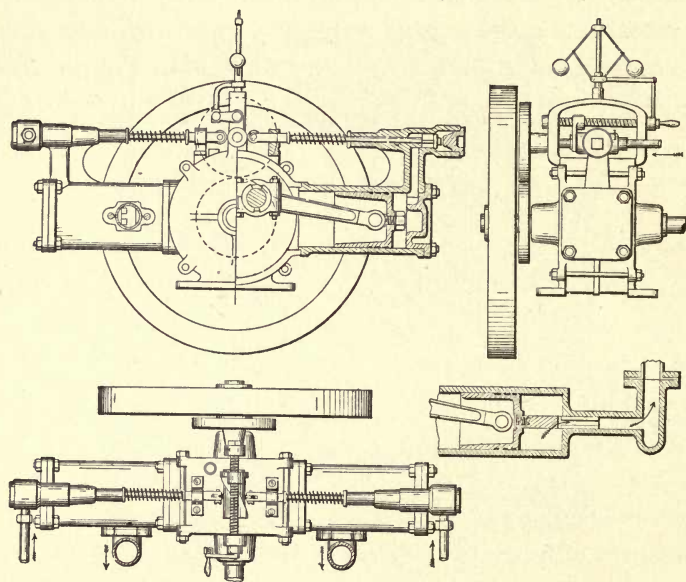


FIG. 43.—THE SERPOLLET COMPRESSION ENGINE.

both the cylinder and inlet pipe. The inlet valve then opens, letting in a charge of high pressure and temperature steam; not against the full area of the large piston, but against the area of the sub-piston and following it until the small side ports open and the compression of the large piston is partly exhausted by expansion, when the inrush of the high pressure steam gives a powerful impulse during the middle of the crank stroke.

CARE OF AN AUTOMOBILE BOILER.

The amount of steam required for a vehicle engine should not be much greater than for other small engines of slide valve type. The variable cut-off from the reversing link motion, with the probable leakage in valves and piston, for a light runabout using an average of one and a half indicated horse power at a fair traveling speed of 10 miles per hour, should use no more than 35 pounds of water per horse power hour. For a 30-mile trip this would be 105 pounds or about 13 gallons, which will be a small storage capacity for such a vehicle, and may admit of a much larger storage, say for a 50 mile trip. The gasoline or oil storage for a 30-mile trip should be 16 pounds, or say 3 gallons—or for a 50-mile trip, 5 gallons. If a surface air draft condenser is used and mineral oil used to lubricate the cylinder the scaling of a boiler may be considerably delayed, and with a small portion of caustic soda or any alkali added to the tank water if lime be present in any of its combinations, will prevent its adhesion to the boiler shell or tubes and can be blown out from the boiler at high pressure entirely clean, following a few minutes after extinguishing the burner. Every vehicle boiler should be provided with the means of quickly blowing out the contents whenever necessary. A further guard against fouling of the boiler may be provided by an elevated tank in the vehicle stable to catch and filter rain water, or for treating hard water with a solution of triphosphate of soda, which will coagulate the lime and allow it to settle, when the pure soft water may be drawn for the boiler.

Chapter IV.

SPECIALTIES IN AUTOMOBILE CONSTRUCTION.

THE COMPENSATING BEVEL GEAR TRAIN—A TWO PINION
DIFFERENTIAL GEAR—AUTOMOBILE TIRES—
ROLLER BEARING AXLES, ETC., ETC.

CHAPTER IV.

SPECIALTIES IN AUTOMOBILE CONSTRUCTION.

REVERSING GEAR BY THE ECCENTRIC.

A very compact steam motor gear for reversing is illustrated in Fig. 44. The wheel, *A*, carries the link lugs and is keyed to the crank shaft; *D* is the eccentric with a feather guide in the fixed wheel, *A*, and with a slot to allow it the required movement across the shaft. A link, *C*, is pivoted to the fixed wheel, *A*, and a bell crank link, *B*, is pivoted in the same manner on the opposite side with its Y-arms extending at right angles and hooked to pins on the sleeve, *E*. A yoke lever pivoted to the frame and traversing the groove in the sleeve, when at right angles with the shaft, brings the eccentric to a central position, and its movement either way sets the eccentric for forward or back motion of the engine, an equivalent of the link gear.

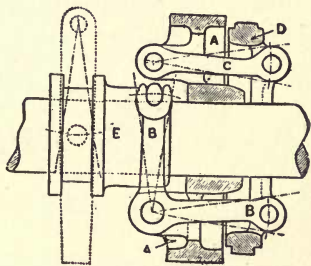


FIG. 44.—REVERSING ECCENTRIC.

THE COMPENSATING BEVEL GEAR TRAIN.

The principles pertaining to the motion of an interlocked bevel gear train allows of several differential conditions in its motions that are interesting in view of its almost univer-

sal and indispensable use as the compensating gear for differentiating the speed of the driving wheels when running on curves.

There are several different conditions that can exist with a train of this character; one of which is illustrated in Fig. 45. First, let the gear or arm, *A*, be fixed and both *B* and *M* free to turn. Gears *C* and *D* then act as intermediate bevel gears and *B* and *M* will turn at the same speed but in opposite directions. In the transmission of power from one gear to the other the force tending to

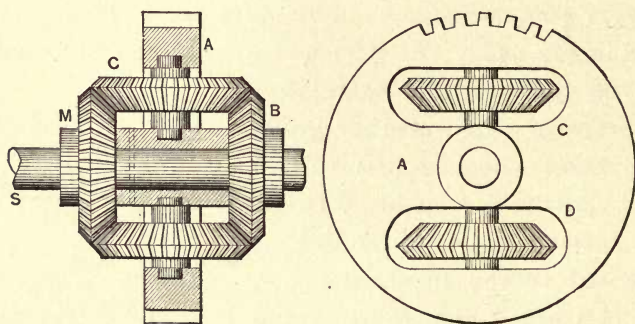


FIG. 45.—COMPENSATING BEVEL GEAR TRAIN.

rotate the gear or arm, *A*, is just half the force transmitted from *B* to *M*. Second, suppose *B* to be fixed and *M* to be driven from outside, gear *A* being free to revolve with its shaft. It is clear that *A* will make only one-half as many turns as *M* and in the same direction. Third, if *M* be fixed and *B* the driver, *A* will turn one-half as many times as *B* and in the same direction. Suppose both *M* and *B* to have independent motions and *A* to be free to revolve. If *M* and *B* move in unison in the same direction, they will simply carry *A* along with them. If one moves faster than the other, *A* will follow that one. If they have motions in opposite directions and at the same speed, *A* will remain station-

ary, and if either *B* or *M* moves faster than the other, *A* will follow that gear as before at a differential speed when they were turning in the same direction. The amount of motion of *A* will be equal to one-half the angular motion gained by either of the other gears.

These applications are numerous and varied, and in many instances results can be accomplished through their use that would be difficult, if not impossible, without them.

A TWO-PINION DIFFERENTIAL GEAR.

The simple differential gear, Fig. 46, is an English device used on motor tricycles. The wheel hubs are fixed to the outer ends of incased shafts. The inner ends are pivoted by universal joints to pinions at an angle of about 30° from the

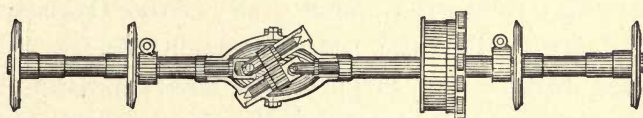


FIG. 46.—A DIFFERENTIAL GEAR.

axle and incased in a frame or box terminating in the hollow shafts with shoulders bearing against the wheel hubs. On one of the hollow shafts the sprocket wheel and friction brake pulleys are fixed.

The power is given to the inner axles by turning the hollow shaft and gear box in which the differential pinions are journaled, thus allowing a free differential movement of the two inner axles and wheels.

AUTOMOBILE TIRES.

The spring wheel was the unsuccessful forerunner of the rubber tire. A few trials on the early steam carriages proved their unfitness. When rubber tires were first devised there was no intention of putting them on anything except

bicycles. There had been, however, back in the '40's, a man named Thomson who constructed an inflatable tire of canvas and rubber and leather to put on a wagon, but he had no success with it. When tricycles and bicycles came into use it was found quite natural to shoe them with solid rubber bands and nothing else was done for a number of years, until in the '80's the safety bicycle was invented on account of the numerous accidents in riding the "ordinary;" and this safety bicycle was also shod with a solid tire. In 1886, Overman, of Springfield, made a rubber tire with a hole running through the center of it, just like a piece of tubing, with very thick walls, the hole enabling the walls of the tire to yield more to the inequalities of the road. The solid rubber tire, however, held its own until the season of 1890, there being but few "cushion" tires (as the Overman tire was called) put into use. Meanwhile in the late '80's, in England, Mr. Dunlop invented his inner-tube tire, which consists of a rubber bag in circular form provided with a valve to inflate it; this was covered by a rubber and canvas shoe to stand the attrition of the road. The Dunlop tire was first seen in this country in September, 1890, when a man named Laurie came over and won all the races because he had pneumatic tires. Tillinghast, of Providence, invented what is now called the single-tube tire, which was a one-body tire, holding itself the valve to inflate it and having the wearing body and the air-containing body all vulcanized into one integral whole. This tire was a good deal criticised, but Tillinghast persevered, and in two or three years the single tube tire made its way in the market and is in general use. It is only seven or eight years since pneumatic tires were put upon any vehicle except bicycles and tricycles. Their first appearance was on trotting sulkies, and from these vehicles they gradually crept on to road wagons.

It was not, however, until the automobile came to the front, along about 1894, that the pneumatic shoeing of large vehicles was adopted. There have been many attempts to make a satisfactory automobile tire. As yet no automobile tire is what it should be. No construction of canvas and rubber seems to be able to withstand the tremendous test of weight which is given it over the roads in this country. In France, with their better roads, they have better success. The driving mechanism of automobiles really requires a pneumatic tire, for a solid tire will shake most mechanism to pieces or disturb its action, especially in the case of electricity. At the same time the life of automobile tires, where there is much weight, is very short. The costly tires put on automobile cabs last something like three or four months, and as they are very expensive, the mileage required to keep such a cab shod is disastrous to economies. Figuring out the cost of tires against the cost of a horse, including his care and his wear and tear, it has been asserted that the horse costs less in feed than the tires on the vehicle. It may be said, however, that the pneumatic tire for heavy vehicles is still in an experimental stage. Just how much longer it will remain so is yet to be seen. At the present time substantially all automobile tires are single-tube tires, constructed according to the Tillinghast invention. On the lighter vehicles, tire life is much longer, and with care seems to fill the requirement.

The later inventions and combinations in their structure and internal elastic bracing points to their ultimate best forms of structure which will probably make the pneumatic tire satisfactory and a permanent wheel shoe for all purposes.

Since all automobiles must be equipped with rubber tires of one kind or another, and no one feature is of more vital

importance than the tires, it goes without saying that all users and owners of automobiles are on the watch for the latest and most improved make and style of rubber tire to be found. While it is true that rubber tires were used in Europe before they were in this country, it remained for an American inventor to produce the first real success in the way of rubber carriage tires. The method of applying the

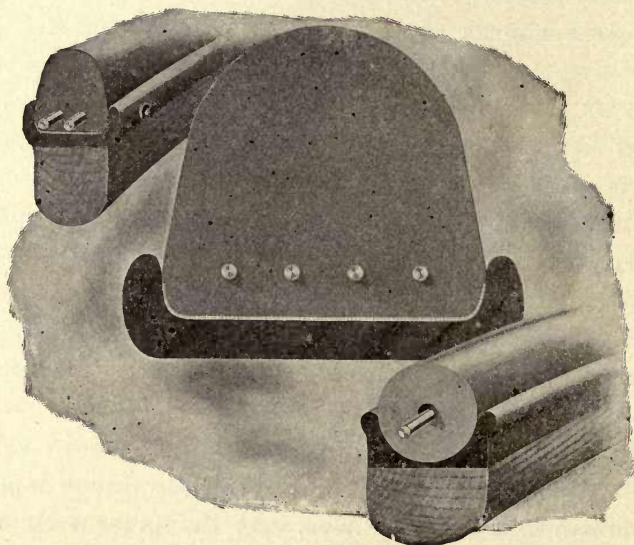


FIG. 47.—THE SOLID RUBBER TIRE.

English tire was faulty; in fact, it was necessary to make the tires so hard in order to keep them in the channels that the resiliency of the rubber was lost, and the most that could be said for the tire is that it was noiseless.

Fig. 47 shows a cross-section of a special automobile tire with four retaining wires. These wires are electrically welded in the channel, and the tension to which they are drawn is only limited by the size of wire used. These tires are known in the market as the Kelly-Springfield tire, made

by the Consolidated Rubber Tire Company of 40 Wall Street, New York City.

A feature that is not lost sight of by purchasers and owners of automobiles is that solid rubber tires give far less trouble and annoyance than any other style, and are fast growing in favor with the builders of automobiles.

ROLLER BEARING AXLES.

In Fig. 48 is illustrated the roller axle bearing, made by the Grant Axle and Wheel Co., Springfield, Ohio. It is claimed that the roller bearings are the most reliable of all the antifriction devices for automobile wheels.

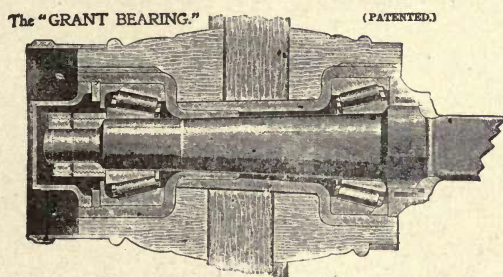


FIG. 48.—ROLLER WHEEL BEARING.

The bearing lines are long on the rollers, giving greater stability and wear longer than ball bearings.

They can be fitted to any wooden hub and are made for wire wheel hubs.

In Fig. 49 is illustrated a roller bearing for a motor axle or any shaft.

The cone rings being loose on the spindle, allow them to turn independently on the axle or shaft, so that in case the rolls should in any way become obstructed and lock, it would not lock the wheels, for the cones can revolve on the axle or spindle as in the plain box.

ALUMINUM IN MOTOR VEHICLE CONSTRUCTION.

Although aluminum and its alloys can never compete with iron or steel in cheapness for the required strength, yet there are other qualities which recommend it as an economical material in vehicle and motor construction. In its pure state it is light and workable in all forms, as castings, plates, sheets, rods and tubing.

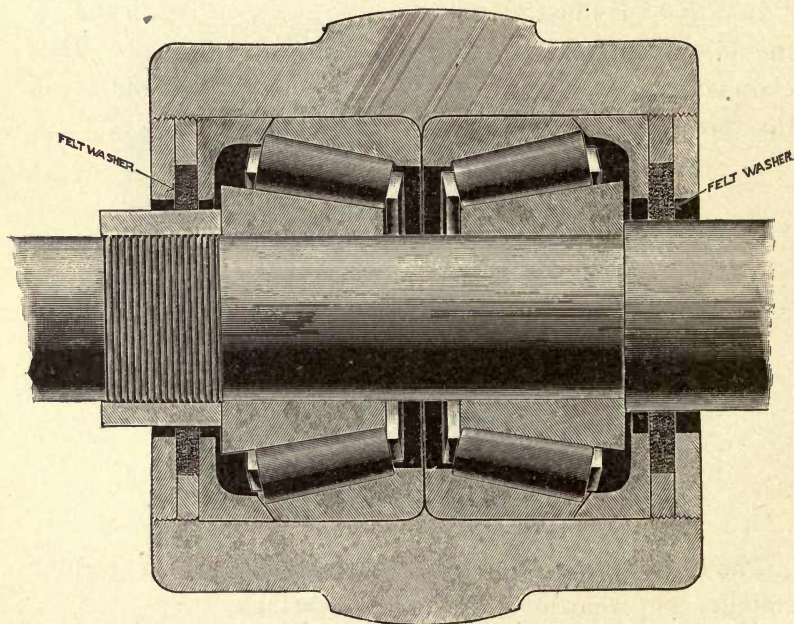


FIG. 49.—MOTOR SHAFT BEARING.

As no royal road for soldering this unique metal has been found, soldering should be dispensed with unless the conditions are favorable and the knowledge of its management at hand.

Riveting makes fairly good work and can be depended upon for body work on carriages. The alloys of aluminum with 10 per cent. tin are as easily worked as brass, harder

than pure aluminum and can be soldered in the ordinary way with pure tin as a solder. The alloys with copper are the aluminum bronzes with from 2 to 5 per cent. of copper, are strong and stiff for all machinery parts, are of less than half the weight of iron per bulk, are rust proof and with the harder alloys make good wearing surfaces for cylinders, pistons and journals.

The new alloy of aluminum and magnesium has made possibilities of a still lighter metal than aluminum for constructive purposes. Another alloy of aluminum with small percentages of tin and copper has the low specific gravity of 3.39 with high transverse and tensile strength, 32,000 and 40,000 pounds per square inch respectively. It is workable and may be made as hard as steel.

An alloy of aluminum and tungsten having a specific gravity of 2.89 and possessing great strength is in use by the De Dion & Bouton Co., in France, for frames and bodies of automobiles. An aluminum steam motor vehicle body has been made by the Porter Motor Co., of Boston, Mass.

Chapter V.

STEAM PROPELLED VEHICLES AND AUTOMOBILE CARRIAGES.

GOOD ROADS APPLIANCES—ROAD ROLLERS, TRACTION
ENGINES, TRUCKS, FIRE ENGINES—MOTOR
VEHICLES FOR HEAVY TRAFFIC—
VARIOUS TYPES OF STEAM
AUTOMOBILES.

CHAPTER V.

STEAM PROPELLED VEHICLES AND AUTOMOBILE CARRIAGES.

GOOD ROADS APPLIANCES.

In the improvement of our roads, the stone-breaker stands first in importance for producing the material, and the road roller gives the finishing touch.

These constitute the main expense in making and keeping our roads in repair. The road scraper, picks, shovels, and barrows belong to every community.

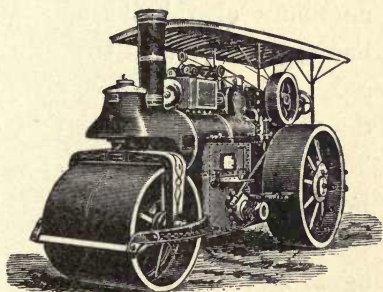


FIG. 50.—THE ROAD ROLLER.

Good roads are necessary not only for the success of the automobile, but for a better highway for all purposes. They may be said to be the foundation of civilization; for rapid and easy communication is a mode of education. The activities of a people keep pace with their means of communication. It is in evidence that civilization improves as the various phases of human activity are commingled by the better means of transport for business or pleasure, and what the railways have done in the long run, good roads will do for the by-ways. Let the interests of the League of American Wheelmen and the automobile clubs join as a

united force to push legislation, not only of States, but to push the good road interests with counties and towns, that the United States may soon rival its European models in good roads.

ROAD ROLLERS OF THE HARRISBURG FOUNDRY AND MACHINE
COMPANY, HARRISBURG, PA.

In Figs. 51 and 52 are represented the latest improvement in road rollers that are quickly convertible for picking the surface or for plowing roads for repairs. They are also used for rolling dam or reservoir embankments. They are built in sizes of 10, 12½ and 15 tons weight; these weights having been found most desirable for road work. This company also build special road locomotives, for heavy haulage and freight transportation. They are built to carry a steam boiler pressure of 150 pounds per square inch, have double cylinders, and can climb grades of 20 per cent. Their water tank and fuel bunker have a capacity for four hours' continuous work. For traction work the time capacity may be increased by additional tank and fuel storage. Every operative detail is centered convenient to the engineer on the platform at the rear of the boiler, over which a cab is placed.

The cuts show much of the constructive principles and methods of operation, making it unnecessary to detail the parts for control of the motion of these road rollers.

TRACTION ENGINE OF THE FRICK COMPANY.

The traction engines of American builders have varying features of novelty, all claiming good points of construction. The tractors built by the Frick Company, Waynesboro, Pa., have no exception in good points, which cover their universal use for hauling loaded vehicles, for plowing, road

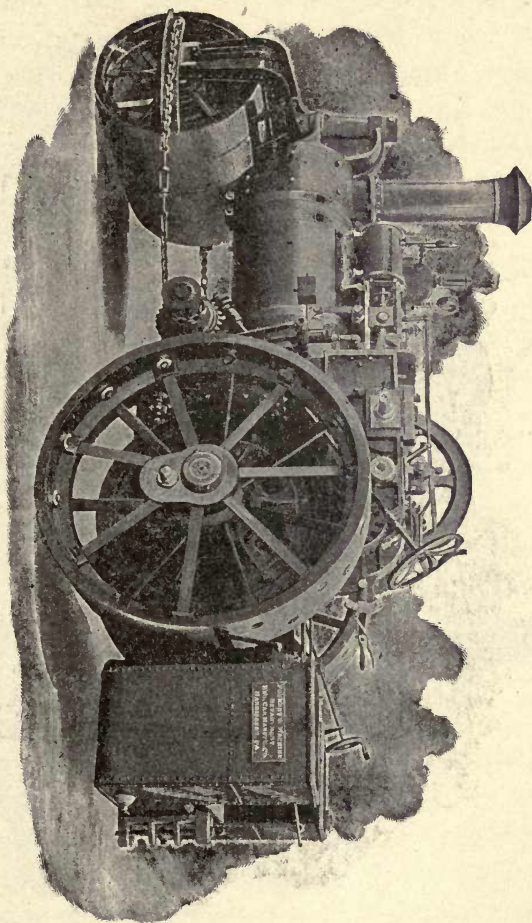


FIG. 51.—STEAM ROAD ROLLER OF THE HARRISBURG FOUNDRY AND
MACHINE WORKS, HARRISBURG, PA.

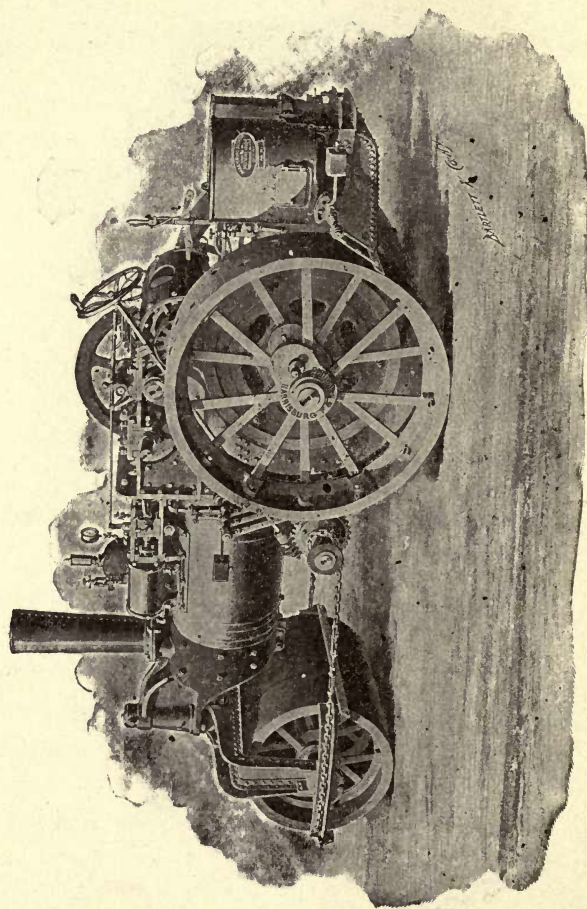


FIG. 52.—STEAM ROAD ROLLER—LATEST IMPROVEMENT FOR PICKING,
TRACTION PLOWING, AND ROLLING ROADS.

scraping, road rolling, and for portable power for all kinds of agricultural work.

In the constructive detail of these engines, the engine, gearing and main axle are mounted independent of the boiler, relieving it of the working strain of the machinery. Cushion main gear, for preventing shock; compensating gear with locking lever; elastic steering gear and a friction clutch in the fly-wheel, which gives the whole tension of the gear on down grades.

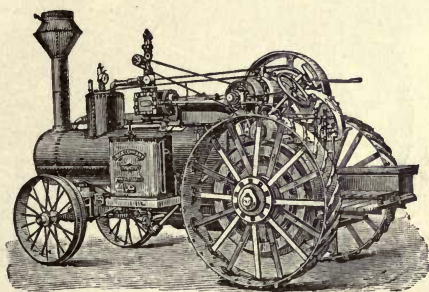


FIG. 53.—FRICK COMPANY TRACTION ENGINE.

The company build four sizes of their traction engines, from 10 to 17 horse-power, and from $4\frac{1}{2}$ to 7 tons weight.

A COMPOUND TRACTION ENGINE.

In Fig. 54 is represented a steam traction engine with compound cylinders set tandem, as made by Robinson & Co., Richmond, Ind., who build five sizes of traction engines with single cylinders, from 10 to 18 horse power. The transmission of power from the engine shaft is through a train of spur-gear and pinions to internal toothed spur-wheels fixed to each driving wheel. The through shaft for connecting both driving wheels has a compensating gear in the last spur-gear of the train.

The axle of the driving wheels is bent under the boiler

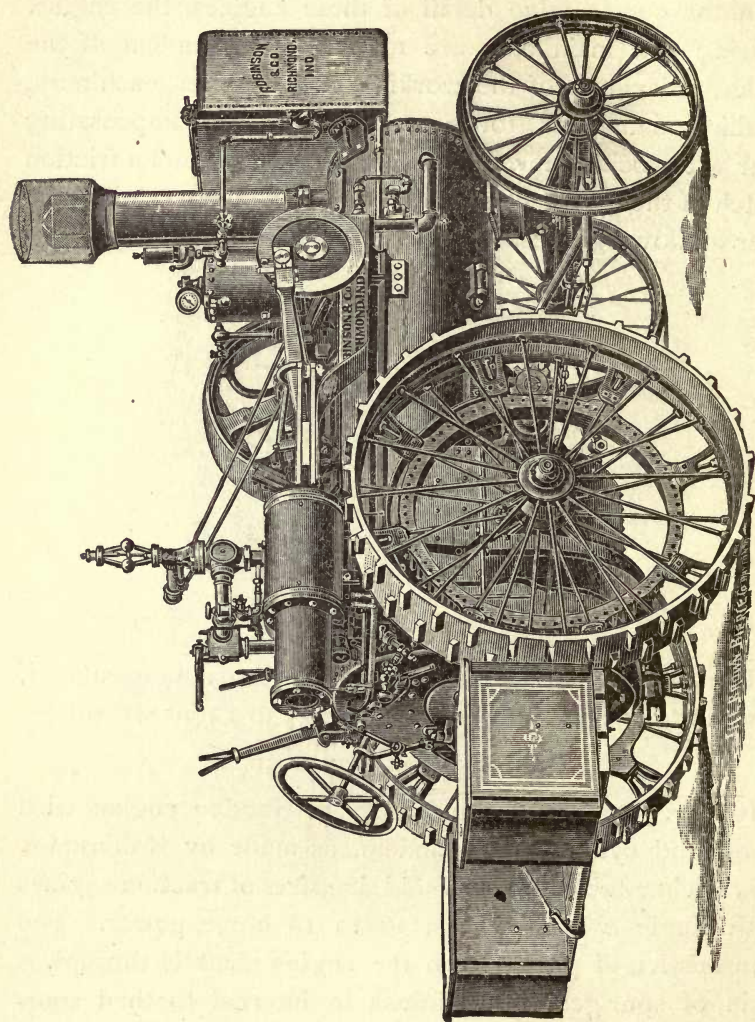


FIG. 54.—THE ROBINSON COMPOUND TRACTION ENGINE.

and mounted with springs in guide boxes riveted to the boiler shell. The vibrating motion of the wheels from roughness of the road is taken up by the springs vertically while the distance between the axle and driving pinion centers remain constant.

The slide valve is controlled by a reversing link and lever, which also sets the cut-off when power is required, as for running threshing machines, saws, etc. A friction clutch on the fly-wheel of the engine, operated by a link and lever under the hand of the driver, controls the engine with great power on down grades.

THE NEW BIRDSALL TRACTION ENGINE.

In Fig. 55 is illustrated the new Birdsall traction engine, built by the new Birdsall Company, Auburn, N. Y., who also build a road roller on similar lines of the traction engine.

The mounting of the boiler and engine is upon a through shaft at the rear of the fire box with coil springs upon the axle boxes and a frame to carry the driving pinion shaft.

A fore and aft driving shaft transmits the power from the engine with bevel gear, so that by its slight oscillation the springs are compensated. The differential gear is within the large spur-gear on the main shaft, and is provided with cushion springs to prevent shock when starting or reversing.

The traction wheels are of a novel construction; their face being made of angle iron lugs placed in reversed diagonals and riveted to angle iron tires.

The spokes are of flat iron, in basket form, and riveted to the flanged hubs and tires; a strong form of construction.

The open face of the driving wheels gives the engine greater power of pull on soft ground, and prevents sticking of earth clods on the wheel face.

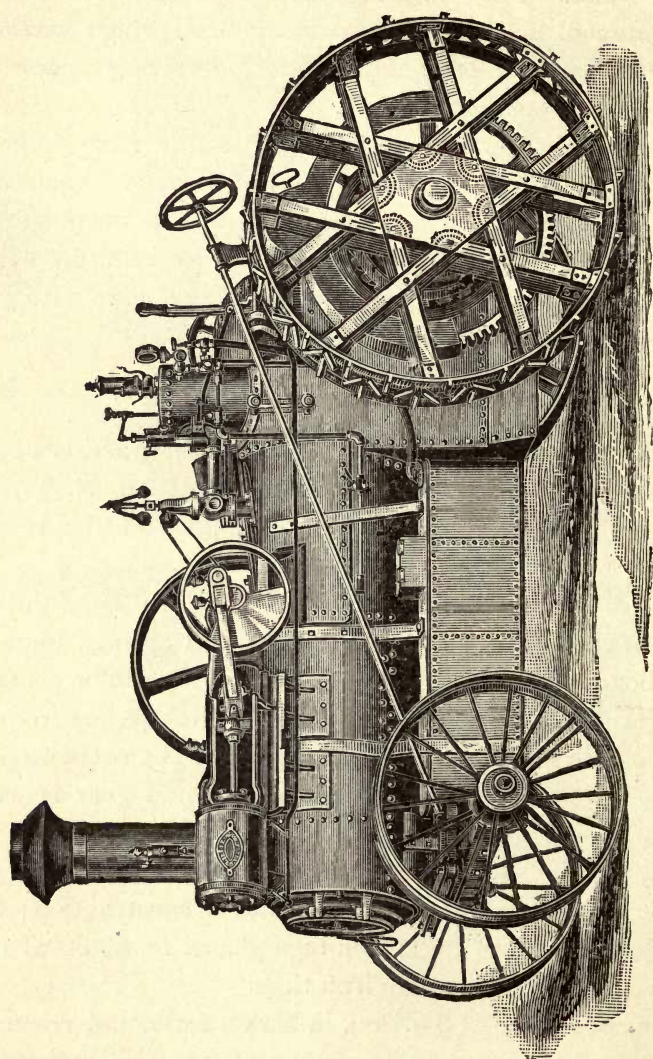


FIG. 55.—THE NEW BIRDSALL TRACTION ENGINE.

The forward axle is fixed horizontally to the boiler with brackets, and pivoted vertically for inequalities in the road or ground. The steering wheels are pivoted to the ends of the axles with arms and connecting link for the two wheels.

A worm gear sector on one of the pivot arms, operated by a rod and wheel at the rear end of the boiler near the engine levers, gives complete control of the engine to the driver on the platform.

MOTOR VEHICLES FOR HEAVY TRAFFIC.

The steam lorry, or dray, is attracting much attention in

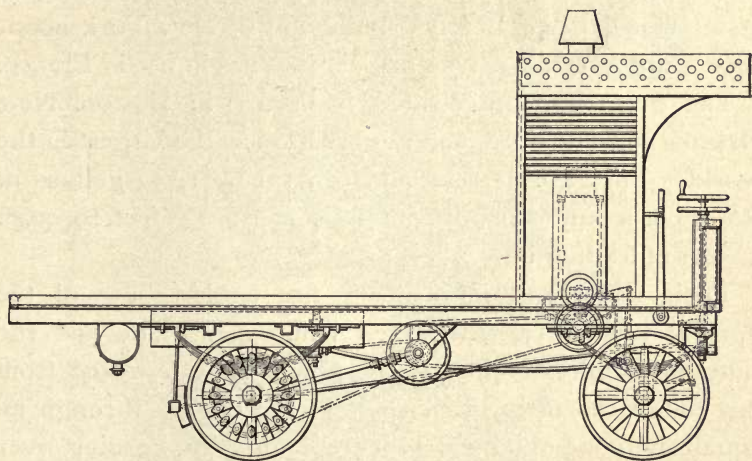


FIG. 56.—THE LEYLAND STEAM DRAY.

England, and a large number are in use in Liverpool and other large cities and manufacturing centers.

Their capacity for different sized drays range from 2 to $6\frac{1}{2}$ tons.

In Fig. 56 is illustrated the Leyland four-ton dray, the dimensions of which are: extreme length, 18 feet; width, 6 feet 5 inches; wheel base, 9 feet 11 inches; tread, 5 feet 3 inches; wheels, 39 inches diameter; height of platform,

45 inches; frame of steel; front tires, 4 inches wide; driving tires, 5 inches wide.

The boiler is of the vertical cylindrical tubular type, with a burner using kerosene oil with a vaporizer, consuming about $5\frac{1}{2}$ gallons of oil per vehicle mile with a four-ton load.

THE SELF-PROPELLED FIRE ENGINE.

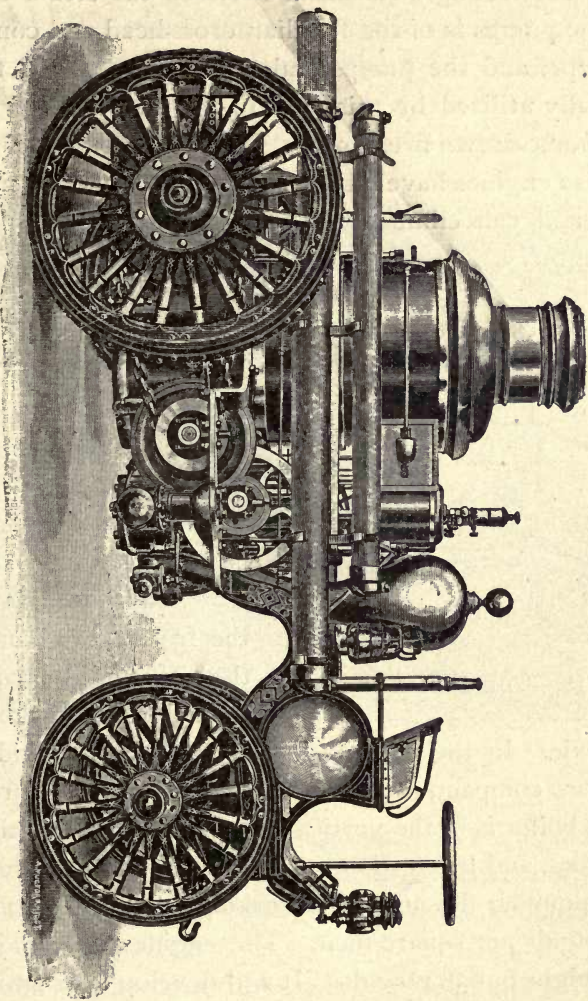
Fig. 57 illustrates the horseless fire engine built by the Manchester Locomotive Works, Manchester, N. H.

The steam-propelled fire engine is not a new idea in this line. Capt. Ericsson constructed a steam driven fire engine about 1840. Lee & Learned built one in New York about 1862. Many steam-driven fire engines are in use in France.

The fire engine illustrated is in use in Boston, New Orleans and Hartford, and are credited as the largest in the world. They are $8\frac{1}{2}$ tons, and can throw 1,350 gallons of water per minute to a horizontal distance of 348 feet, through 50 feet of leading hose.

Their boilers, as in ordinary fire engines, are of the upright tubular type, the shell being steel plate and the tubes of seamless copper. The power is transmitted from one end of the main crank-shaft of the engine, through an equalizing compound and two endless chains, running over sprocket wheels on each of the rear road wheels, permitting the wheels to be driven at various speeds when turning corners. The driving power is made reversible, so that the engine may be driven either forward or backward on the road at will. The steering of the engine is effected by means of a hand wheel at the front moving the fore axle through a system of bevel and worm gearing, so arranged that the constant exertion of the driver is not required to keep the vehicle in line on the road. By the removal of a key the driving power may be disconnected from the road.

FIG. 57.—THE AMOSKEAG AUTOMOBILE FIRE ENGINE.



driving gearing when it is desired to work the pumps with the vehicle standing still.

The connecting mechanism between the steam cylinders and the pumps is of the familiar cross-head and connecting-rod type, and the pumps and other parts are of the kind generally utilized by this firm in the construction of ordinary horse-drawn fire engines.

These engines have a speed capacity for twelve miles per hour, and can climb grades equal to any horse-propelled fire engine.

THE BALDWIN STEAM AUTOMOBILE.

In Fig. 58 is shown an outline of the steam surret and in

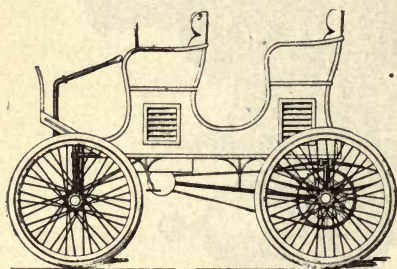


FIG. 58.—THE STEAM SURREY.

Fig. 59, the trap or dos-a-dos of the Baldwin Automobile Company, Providence, R. I.

The boiler in the surret is placed under the rear seat and the engine under the front seat; from which the driving by chain is extended to a sprocket on the

rear axle. In the trap or dos-a-dos the boiler and engine are more compact, are entirely enclosed and dust-proof.

The boiler is of the vertical tube type and contains some 300 tubes, and it is estimated that it will stand a pressure of 1,000 pounds, although the working pressure is but 100 to 125 pounds per square inch. The engine is steam-jacketed and weighs but 38 pounds. It will develop from 4 to 6 horse power, is reversible, and is fitted with nickel-steel valves and valve faces. The exhaust steam as it leaves the engine is conveyed to a patented combined condenser and cooler, and from there is returned to the water tank. In hill climb-

ing, where the steam used is considerable, the surplus passes through an ingeniously-devised muffler and escapes without noise. The exhaust steam also passes through a coil in the gasoline tank and raises the temperature so that a light pressure is automatically obtained without use of the hand pump.

The surrey and trap are both fitted with brakes and all

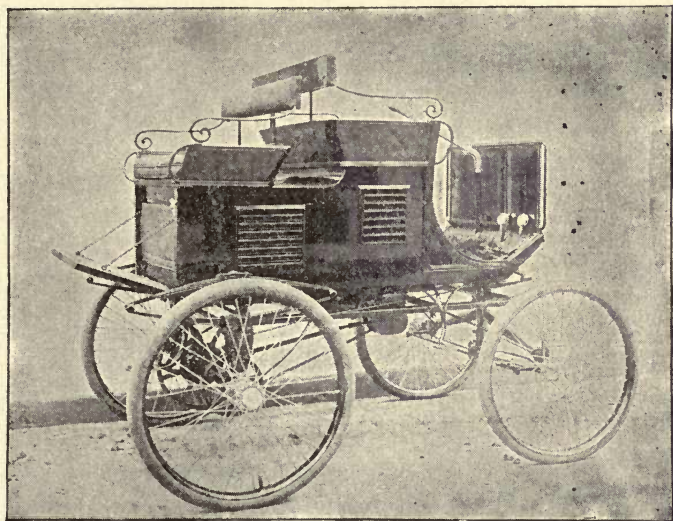


FIG. 59.—THE STEAM TRAP OR DOS-A-DOS.

accessories. The burner beneath the boiler is regulated by the boiler pressure. The tanks for carrying water and fuel, are so constructed that the contents will not be affected by the motion of the carriage.

To start the engine a hand pump is used to pump air into the gasoline tank to give the requisite feed pressure to the burner. A small receptacle is filled with wood alcohol (gasoline may be used) and after being lighted is set under the burner to give it the necessary initial heat to vaporize

the gasoline. The burners are lighted from this by the turning of a cock, and after a brief time to get up steam the vehicle is ready to operate.

Once started it requires no further attention beyond that required to see that the fuel and water supplies are not exhausted. The steam pressure regulates automatically by means of a diaphragm and valve the supply of fuel. In case the vehicle is left standing the supply of gasoline is cut off from one or two of the three burners as the steam pressure rises, and the third supplies merely enough heat to enable the vehicle to be started again at a moment's notice. The vehicle may be left a few minutes or hours without danger, with no consumption of water and only a very small consumption of fuel.

The engine is of the two-cylinder double-acting vertical variety. It is very carefully constructed and exceedingly light, and at the same time strong. The cylinders ($2\frac{1}{4}$ -inch bore and $4\frac{1}{2}$ -inch stroke) are set on the circumference of a circle struck from the center of the boiler and lie snug up against the latter, while the steam chest is located at an angle between the two cylinders, making a very compact arrangement. The clearance is small in the cylinder heads, the steam ports being wide but not deep. The exhaust ports are of ample size and open direct into a jacket surrounding the entire cylinder, giving at once an exhaust with little back pressure and a steam jacket for the cylinder.

The exhaust steam is carried from this steam jacket to the combined muffler and condenser and then passes through the fuel tank in the shape of hot water, maintaining a sufficient pressure in the tank (if the fuel be gasoline) to avoid the necessity of any hand pumping. Thence the hot water passes to the water cooler in the dashboard, composed of a number of horizontal tubes, through each of which the

water is compelled to pass before it is returned to the supply tank.

The feed water is automatically pumped from the supply tank to the boiler, but a hand pump is also provided for contingent use.

THE MILWAUKEE AUTOMOBILE COMPANY.

The carriages of this company, which is located at Milwaukee, Wis., are of the Stanhope or runabout style. The elevation of the Stanhope is shown in Fig. 60, and a plan of the running gear in Fig. 61. This company have adopted steam as a motive power as a well-trying and old servant and its ease of handling as well as its freedom from cumbersome transmission and reversing gear.

The frame consists, as will be seen, of a front and rear truss securely tied together by distance tubes, which contain universal joints. This entire structure is built of $1\frac{1}{4}$ -inch seamless tubing, strongly braced together, and has frame connections of steel of the best quality, riveted and brazed in place.

The front truss carries the front wheels and complete steering linkage. This apparatus enables a movement of 60° to be given the front wheels, which controls the carriage with ease at any speed, and which will turn it completely around in a 15 foot circle.

The rear truss carries the driving mechanism and rear wheels. A compensating gear is provided in the middle of this truss to allow for unequal speed of each rear wheel. The gears of this device are of crucible steel, while the axles are the best quality of open-hearth machinery steel, and the hubs are keyed on in the most secure manner. The main driving sprocket (which also carries the brake shoe) has 30 teeth, 1-inch pitch and $\frac{5}{16}$ inch wide.

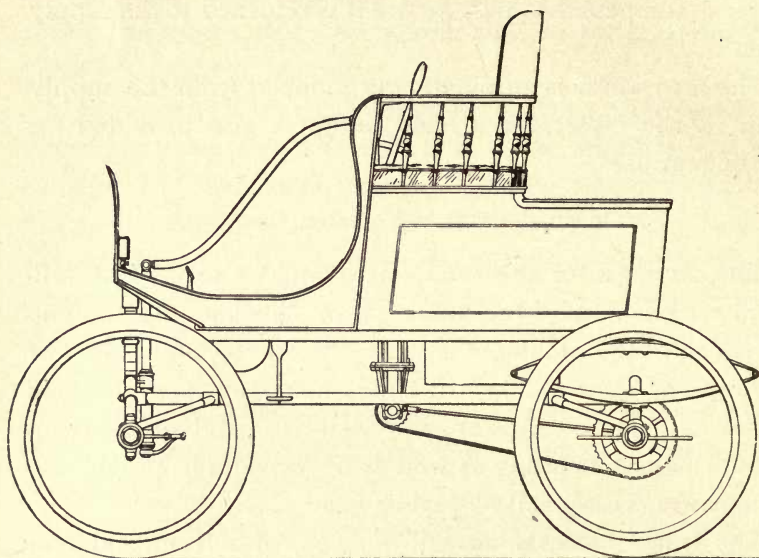


FIG. 60.—THE STEAM AUTOMOBILE.

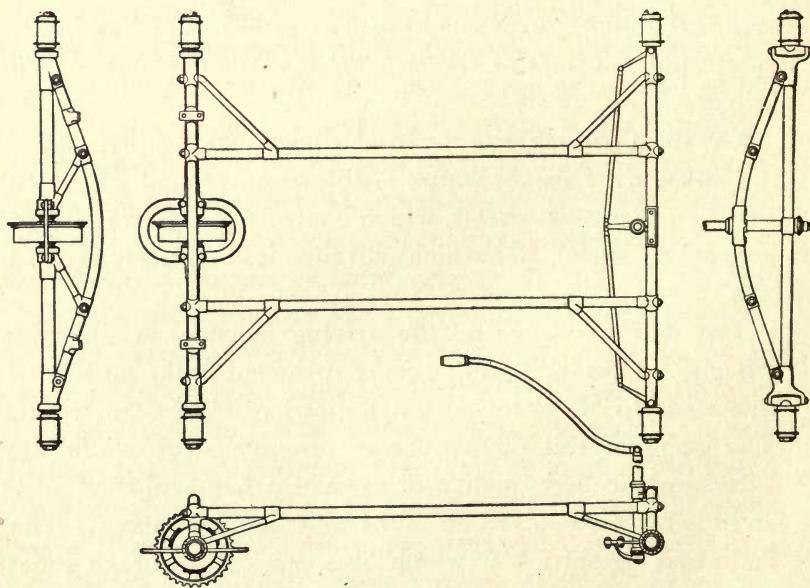


FIG. 61.—VEHICLE FRAME OF THE STEAM AUTOMOBILE.

The bearings throughout are of tool steel, hardened and ground to a finish. They have ball retainers, and are dust-proof.

Steam is generated in a vertical tubular boiler 12 inches high and 18 inches in diameter, containing 213 copper tubes. It is regulated automatically and has all of the appliances for safety and inspection. The gasoline fuel is contained in a tank of 3.7 gallons capacity, situated in the footboard, not shown in the cuts.

The water tank has a capacity of 15 gallons and surrounds the boiler. The exhaust passes through this tank. The engine is of the vertical, two-cylinder marine type, and runs at the rate of about 400 revolutions per minute at its highest efficiency, claimed to be between six and seven horse power. The power is transmitted by chain to the rear axle and gives the vehicle a maximum speed of 25 miles an hour. It will travel 10 miles on one gallon of gasoline and carries sufficient fuel and water in the tanks for 40 miles without replenishing.

The vehicle has a wheel-base of 58 inches and is fitted with 28-inch wheels, equipped with 2½-inch pneumatic tires. The running gear is made of seamless steel tubing with drop-forged connections throughout. The frame is braced and provision is made for allowing the wheels to adapt themselves to the inequalities of the road.

The operator sits on the right hand of the vehicle, steering with his left hand and controlling the steam valve and brake with the right hand and foot, respectively. He also has the reverse lever and pump valve within easy reach, while the water glass and steam gauge are conveniently located for occasional inspection. Owing to the automatic regulation the operator is required to attend only to the steering and throttle valve.

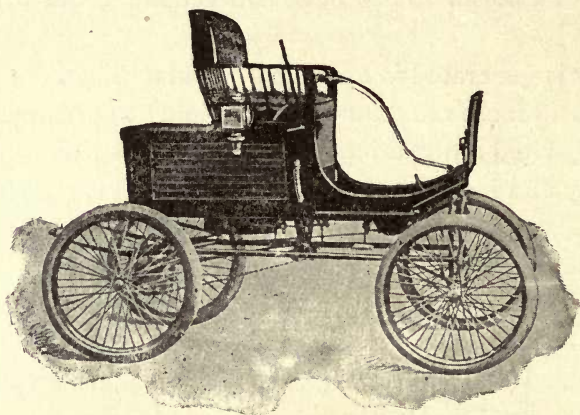


FIG. 62.—THE STANHOPE.

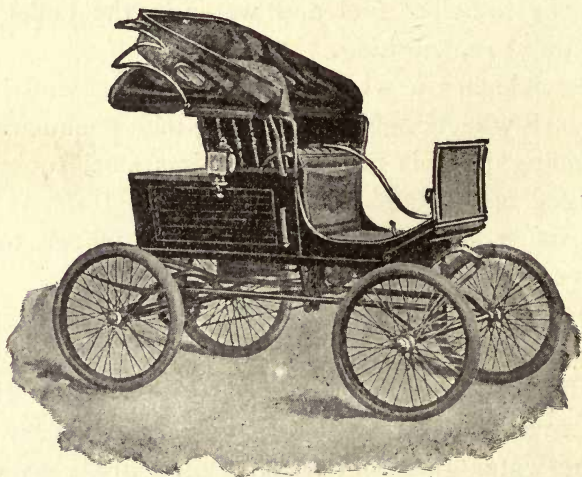


FIG. 63.—THE TOP STANHOPE.

STEAM PROPELLED VEHICLES, 101

The company also supply independently, running gear and steam parts.

STEAM AUTOMOBILES OF THE STANLEY TYPE.

Some of the most successful all-round steam motor carriages are now being built by the Locomobile Company, of America, whose works are at Newton and Westboro, Mass., with offices at No. 11 Broadway, New York City.

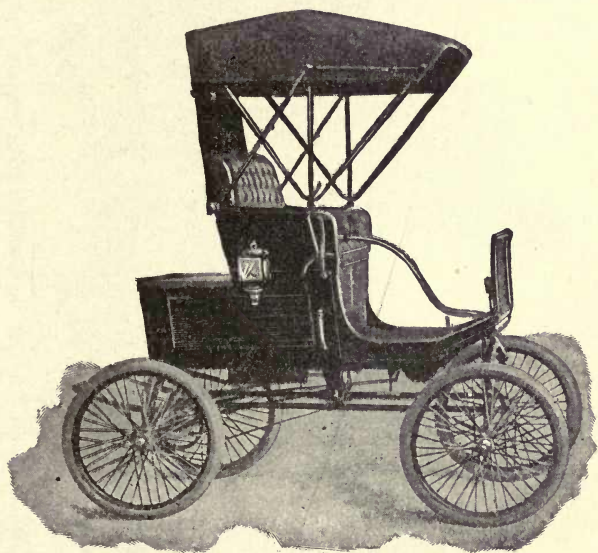


FIG. 64.—THE TOP STANHOPE.

In Fig. 62 is illustrated their Stanhope, or light runabout, and in Figs. 63 and 64 their top Stanhope suitable for family or physicians' use.

In Fig. 65 is illustrated their steam sarry, or touring wagon; a light and elegant vehicle for parties on long pleasure trips.

The wheels of these vehicles are constructed on advanced bicycle principles and of strength equal to their requirement

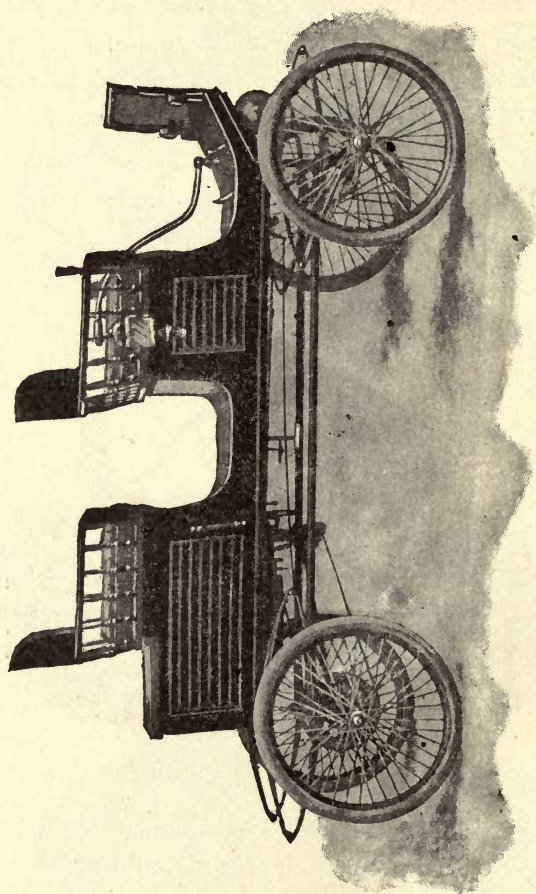


FIG. 65.—THE SURREY OF THE LOCOMOBILE COMPANY OF AMERICA.

of service. The lighter vehicles are provided with pneumatic tires $2\frac{1}{2}$ inches diameter, and with side lamps, cyclometer, bell and tools complete.

The running gear is of especial design and consists of steel truss, ball-bearing axles, with a double reach, mounted on four steel wheels, fitted with pneumatic tires. The rear axle is connected in the center by a compensating gear, which permits one wheel to move more rapidly than the other in making a turn. The front axle is stationary. The front wheels are connected by a swivel joint attached to the

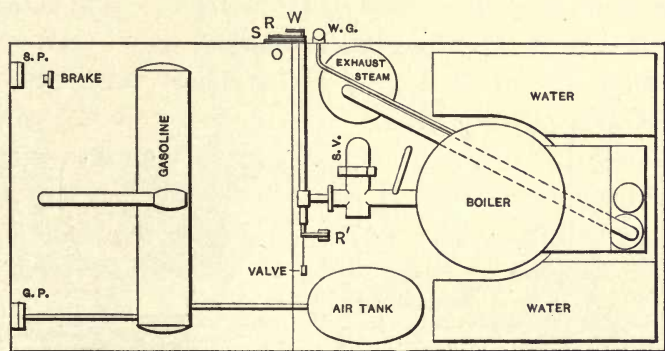


FIG. 66.—PLAN OF THE LOCOMOBILE.

steering gear. The steering lever is conveniently placed, assuring the positive control of the carriage with ease and quickness.

Behind the seat of the carriage is a small square opening into which the water is placed. It can be poured in with a hose, bucket, or any kind of a vessel and goes immediately into the water tank, which connects with the boiler. The tank has a capacity of 17 gallons, will run the carriage forty miles on ordinary roads and can be filled at any time or place at the rider's option. After the water is in the tank it is supplied to the boiler by a power pump connected direct

to the boiler and provided with a by-pass to the tank, giving the operator full and perfect control of the water supply to the boiler. The gasoline supply is automatically controlled and can be left with steam on, without any danger whatever.

The plan, Fig. 66, carries its own explanation generally. *W. G.* is the water gauge. The short lever, *R, R'*, operates the link motion. The small handle, *W*, opens the pump valve. The long handle controls the steam valve.

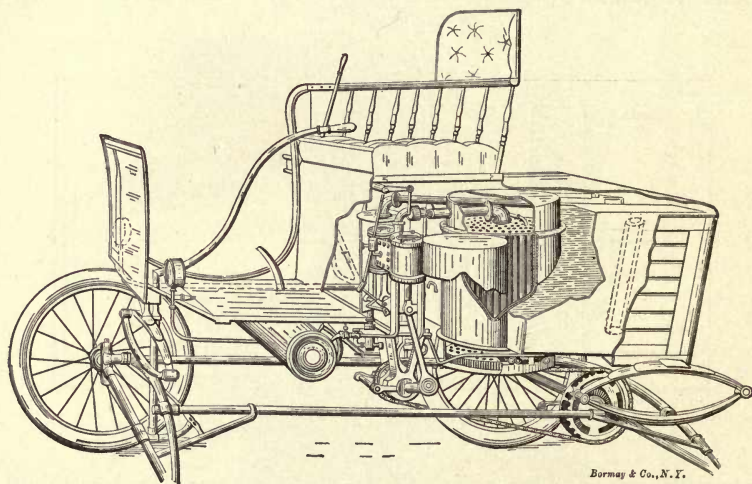


FIG. 67.—THE STANLEY SYSTEM OF THE LOCOMOBILE.

The elevation, Fig. 67, shows the position of the water tank, boiler, engine, air and gasoline tank, with part of the piping and operating devices.

The boiler is of an upright pattern, nicely fitting the space allotted for it, and contains forty-four square feet of heating surface. It is tested by cold water pressure to 750 pounds, and is provided with an automatic relief set to 170 pounds pressure, absolutely eliminating any danger whatever.

The shell of the boiler consists of a length of 16-gauge seamless, drawn, copper tubing, 14 inches in diameter by 14 inches deep. A half-inch flange is formed at top and bottom, to which the tube-sheets are riveted. A steam-tight joint is secured by brazing in the shell flange between the tube-plate and a steel ring on the under side of the flange, and riveting through. The boiler is then put in a lathe and two layers of piano wire are wound on the shell under a moderate tension. One-half inch copper tubes, to the number of 298, are then expanded into the two tube-plates. The boiler, as thus completed, has a total heating surface of 42 square feet. It is hydraulically tested to 750 pounds pressure and when ready to be put in place it weighs 105 pounds. It is covered with a thick layer of asbestos lagging, outside of which is an envelope of Russia iron.

The gasoline is carried in a copper tank, capable of holding three gallons, which is stowed beneath the foot board. The tank is kept under a pressure of 35 pounds to the square inch and is connected by a pipe with a reserve air tank. The air pipe leads in at the top of the tank, and a branch pipe runs to a pressure gauge in front of the dashboard. The gasoline is forced out of the supply tank through a pipe which leads to the bottom of one of the boiler flues, to which it connects. The oil flows up through the flue, then by means of a pipe across the top of the boiler to another flue, down which it is led until it emerges from the bottom of the boiler to the pipe, *A*, Fig. 68, where it may be controlled by two hand-operated needle valves, as shown in the regulator, Fig. 68. In passing through the boiler the gasoline is vaporized, and its admission to the burner is controlled by means of an automatic needle-valve, which is operated by the pressure of the water of the boiler upon the diaphragm at *B*, Fig. 68. The diaphragm is so

adjusted that when the boiler pressure exceeds 160 pounds, the valve will be closed, shutting off the supply of vapor. The regulating valve is adjusted by the spring shown near the diaphragm. The steam pressure is thus automatically controlled through the burner, which, when the boiler has once been started, requires no further attention on the part of the operator. In order to prevent the fire from going out altogether when the vapor is shut off, a bypass of very small cross-section is provided on the needle valve, which allows sufficient fuel to pass to keep the burner alight. The second needle valve, shown in the regulator, Fig. 68, is for

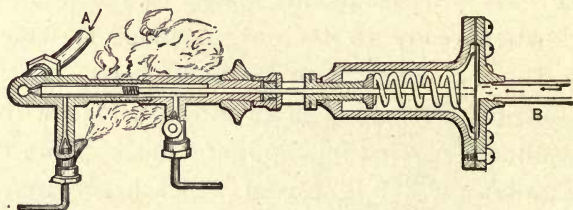


FIG. 68.—THE AUTOMATIC FUEL REGULATOR.

connecting a vaporizing pipe to be heated by a torch to start the burner before the boiler is hot enough to vaporize by the tube connections within it. The operation of the regulator valve is exceedingly prompt, and the device is one of the most pleasing among the many ingenious features of the locomobile.

The engine is located in front of the boiler and is secured to the frame of the body. It is shown so clearly in Fig. 69 as to need no detailed description. It is a remarkably well designed and built two-cylinder engine of the locomotive type with Stevenson link motion and ordinary D-valves. The cylinders are $2\frac{1}{2}$ inches diameter, 4 inches stroke, and valves set to cut off at $\frac{5}{8}$ stroke at the full movement of the links. The framing is of brass, and a

special feature is the fact that the engine has ball-bearings both on the crank pins and the crank-shaft bearings. The engines are bolted to the wooden cross bracing of the body near the cylinders, and the lower part of the engine frame is kept in place by means of a strut, which extends from the engine frame back to the rear frame of the carriage. The strut is provided with a right and left hand turnbuckle, which enables the slack of the chain to be taken up when necessary. To allow for the slight movement due to this adjustment, the steam pipe is connected with the top of the steam-chest by means of a U-pipe provided with expansion joints. The driving of the rear axle is effected by means of a twelve-tooth sprocket on the engine shaft and a twenty-four-tooth sprocket on the compensating gear-box on the rear axle.

The burner consists of a sheet-steel cylinder of about the same diameter as the boiler, and is carried, as shown in Fig. 67, immediately below the latter; within the outer cylinder is a smaller inner one, into which the vaporized gasoline is fed. It is provided with 114 short vertical copper tubes, which extend from the bottom of the burner, where they are open to the air, to the top plate of the vapor cylinder. The air passes in through these tubes, and at the top it meets the gasoline vapor, which issues from the cylinder through a large number of small holes

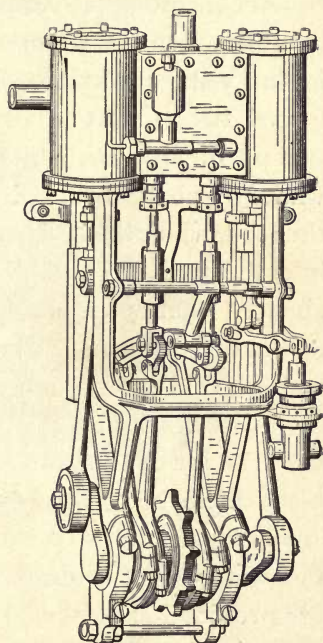


FIG. 69.—THE ENGINE.

around the air tubes, the vapor and the air commingling and burning with the familiar Bunsen flame, immediately below the lower tube-sheet of the boiler.

The boiler is fed by means of a little feed pump, which is operated from the cross-head of the engine. The water is led from the tank by means of a rubber pipe, and it may be cut off by a cock, before the check valve, which is just in front of the pump, is reached. There are three check valves in all between the water tank and boiler and they all work in the same direction. From the feed-pump the water is forced directly to the boiler. A pipe leads from the feed pump to a by-pass, which is worked by a lever, placed conveniently at the hand of the driver. By turning this lever the feed, when the boiler is full, can be thrown back directly into the tank. The boiler is supposed, normally, to carry about 8 inches of water above the tube-sheet, leaving 5 inches of steam space; but an inch or two either way in the water level is not of serious consequence, the boiler steaming satisfactorily even when there is only an inch of water over the lower tube-sheet. A water-glass on the outside of the vehicle body shows at a glance the water level. By arranging a mirror on the dash board, the driver can have the water-glass continually under his eye. Check valves are provided above and below the water-glass, so that if the glass should break there would be no rush of steam or water from the boiler.

On a level road, at a speed of 10 or 12 miles per hour, the steam is usually maintained at a pressure of 150 pounds to the square inch. The pop-valve is set at 240 pounds. In operating the locomobile, one is impressed with a sense of the reserve power of the boiler and engines, the carriage starting from rest with a wonderfully rapid acceleration, jumping to full speed, if desired, within a very few lengths.

This is the type of vehicle that ascended Mount Washington, 6,300 feet, in a run of 8 miles in two hours and ten minutes. It can climb a grade of 14 per cent. at 15 miles per hour. It has overcome, unaided, a grade of 30° without difficulty.

THE CLARK STEAM AUTOMOBILE.

In Fig. 70 is illustrated the steam dos-a-dos built by Edward S. Clark, 278 Freeport Street, Boston, Mass. It weighs about 1,200 pounds, with equipment, ready to run. Wire wheels, 30 and 34 inches diameter; pneumatic tires, 3



FIG. 70.—THE STEAM DOS-A-DOS.

inches diameter; the frame of steel tubing; front axle tubular; rear axle solid. Vertical handles for steering and operating the links, for all speeds and reversing, are placed in the middle of the seat, so that the operator may sit on either side of the seat. The band-brake lever is also in the middle of the foot-board, and can be operated from either side of the seat.

Fig. 71 represents the boiler, the shell of which is made of steel-plate No. 10 wire gauge. The heads are flange steel, $\frac{1}{4}$ inch thick, riveted to the shell and calked as in ordinary boiler practice. The boiler is 16 inches diameter, 14

inches high outside of tube heads, and 21 inches high, over all, from bottom of burner to top of hood. It contains 360 copper tubes $\frac{1}{2}$ inch diameter, weighs 140 pounds, and is suited for a double cylinder engine, $2\frac{1}{2}$ by 4 inches, running at 150 pounds boiler pressure.

The Clark engines are all double cylinder and of two models, in regard to their operating gear. The Class A

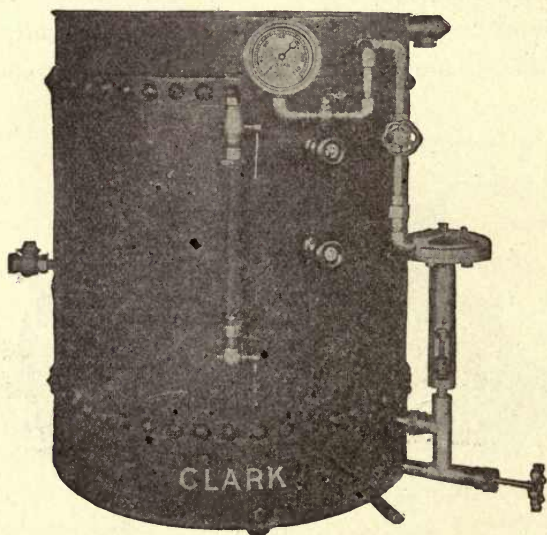


FIG. 71.—THE BOILER.

are built in four sizes, viz., $2\frac{1}{4} \times 4$, $2\frac{1}{2} \times 4$, $2\frac{3}{4} \times 4$ and 3×4 inches bore and stroke.

The cylinders are of close grain cast iron; the frame of steel and bronze; crank shaft a solid steel forging; cross-heads and all bearings of phosphor bronze; pistons of steel, with cast-iron spring rings.

The valves are operated by a small independent shaft geared to the crank shaft, and the engine reversed by a sliding sleeve on the valve shaft, which reverses the motion

of the slide valves. The pump for feeding the boiler is operated by an arm on the cross-head, as shown in the cut, Fig. 72. The weight of the engine, as shown in the cut, is 50 pounds.

Mr. Clark furnishes boilers with fittings, burner, regulator complete, as shown in the cut, and the engine, to parties

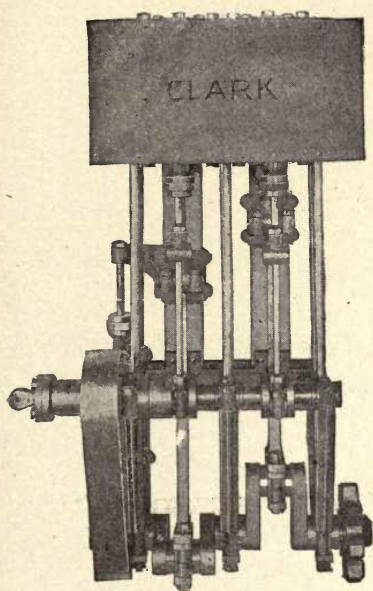


FIG. 72.—THE ENGINE.
CLASS A.

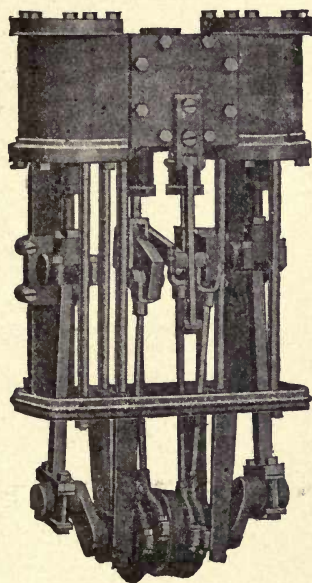


FIG. 73.—THE ENGINE.
CLASS B.

who wish to assemble their vehicles and motive power themselves.

The Class B engines, Fig. 73, of Mr. Clark's construction are built on the same lines and material as Class A, with the exception of the valve gear, which is operated by four eccentrics on the crank shaft connected to a pair of links, locomotive style. The driving sprocket is placed in the

center of the shaft between the eccentrics. The Class B are made in two sizes, $2\frac{1}{2} \times 3$ and $2\frac{1}{2} \times 3\frac{1}{2}$ bore and stroke. The smaller size engine, as shown in the cut, weighs 35 pounds.

Chapter VI.

HORSELESS VEHICLES WITH EXPLOSIVE
MOTORS.

CHAPTER VI.

HORSELESS VEHICLES WITH EXPLOSIVE MOTORS.

Almost as soon as the gas engine was successfully reduced to its present simplicity and reliable action, inventors began to apply it to road wagon propulsion. Lenoir, in France, patented the first explosive motor vehicle in 1860. Benz, in Germany, was one of the first to produce a successful motor wagon, which was publicly exhibited in Munich, Germany, in 1891.

Daimler, also in Germany, followed closely in the early years of the decade with improvements in explosive motors for marine and road propulsion.

The new power idea spread rapidly in France and England and, with the electric motor, now forms the three principal systems of road motive power so largely in use in all Europe and the United States.

A host of experimenters in France, among whom may be named Serpollet, Peugeot, Panhard, Lavassor, Kreiger, De Dion and Bouton, have contributed largely in perfecting the mechanism of the automobile and thereby giving it a distinctive reputation, upon which American inventors have widened its mechanical and economical adaptation for vehicle construction and motive power.

The Duryeas took up the experimental line in automobile motors in the United States, in 1886, and after five years of personal effort produced their first motor vehicle in 1891.

Others fell into the same line of experimental construction, so, that the beginning of the twentieth century has found the motor power greatly perfected in all its parts.

The introduction of solid and pneumatic tires has made a great advance in the comfort of riding and has contributed largely to the machine economy by the saving in wear and tear, from the excessive jar and vibration caused by the use of iron shod wheels.

The past decade, therefore, compasses the history of this branch of automobile work. The Benz wagon of its early date was not essentially different from its followers; being operated by a single four cycle cylinder, running at a high speed, reduced by belts to a counter shaft and by chain and sprocket wheels to the wagon axle. Since then the prime moving units have been duplicated in the explosive motor vehicle, and even three or four cylinders have come into use with most satisfactory results. Five cylinders give an almost constant impulse to the shaft and keep the motor in uniform motion, making it possible to dispense with the fly wheel, or to make it so light that its weight will scarcely effect the total weight of the running gear. Although the gasoline engine by its simplicity of construction and freedom from watchful care, as with steam, is better adapted for road wagon service, yet it has its faults of design to meet all requirements. In its present form it does not reverse and hence the necessity of somewhat complicated machinery for making its operation complete. With single cylinder motors, a high speed is necessary that the fly wheel may equalize the motion from a four or two cycle impulse. In spite of the few difficulties and inconveniences in operating a gasoline road wagon, it has as yet, but one real competitor for all-round service and for country-touring.

IGNITION FOR GASOLINE MOTORS.

The hot tube for ignition is not in general use, although it has done well with small platinum tubes in English and German motor vehicles and motor bicycles. The constancy of the heating jet seems to be quite as complex to guard from shifting air currents and to ensure a continual generation and flow of gasoline vapor for the burner as is the electric ignition system, which appears to be generally adopted in the later European and American motor vehicles. For a more special study of each system of ignition a reference to my work on "Gas, Gasoline and Oil Engines" is recommended, which also treats of the explosive technics of gasoline, vapor and air mixtures, and the management of explosive motors, with the theoretical considerations and formulas. Two kinds of sparking devices are in use. The separated electrodes, which require a jump spark from a single induction coil of the Rhumkorff type from a break device on the outside of the cylinder, and the single wire induction accumulator coil, with a wiping spark by break contact within the cylinder. Opinion is divided as to the merits of each method and their details of operation.

The secondary or jump spark, however, is not by any means so easy to handle. The insulation must be far more perfect, and even then in damp weather the spark will sometimes run along the surface of the external parts and thus miss the required "jump" in the explosion chamber. The points in the cylinder between which the spark should occur will become either at their tips or their bases covered with carbon deposit, which, acting as a conductor, again destroys the spark. Most of the various Rhumkorff coils, moreover, require a "vibrator" in the primary current, which is liable to get out of order. These troubles, bad

enough with one cylinder, become worse when two are in use, and the commutation becomes more complicated in consequence. This form of coil, as a rule, requires a battery and does not work so well with a self-induction dynamo, so that for automatic use both battery and dynamo may have to be used, a dry battery for starting and a dynamo generator for a continual current.

With the single wire or sparking coil with current from a live battery or permanent field generator, or other generator giving a nearly constant current that is broken by a wipe or contact sparking device within the cylinder, there are also troubles, resulting in mis-fires. The wiper or hammer must be actuated by snap devices on the outside of the cylinder and may be well regulated as to time and varied in its movement to delay ignition for motor speed change. Its troubles arise from the same carbon deposit that effects the electrodes with short circuit, and the wipers wear quite fast. A hammer contact is good, but has its noisy troubles.

The current for properly firing the charge should have an electro-motive force of at least ten volts; a weaker current will fire the mixture when all parts are clean, but much of the mysterious and unseen failures may be attributed to a weak current. The most suitable current gives a white or bluish-white spark, the red spark even, if large, is not reliable, whether a jump spark or a break contact. This essential feature should have means for easy observation in every electrically ignited motor, and should be the first to be examined when the motor stops from unknown cause. The amount of compression effects to a considerable degree the certainty of firing from the electric spark. The heat generated by compression, increases with the pressure, so that a spark that fails to ignite at 15 or 20 pounds compression will readily ignite at from 50 to 60 pounds compression.

Chapter VII.

ELECTRIC IGNITION DEVICES.

ELECTRIC BATTERIES—HOW TO CHARGE THE PRIMARY
BATTERIES—TO CHARGE THE BATTERIES—TO AMAL-
GAMATE THE ZINCS—THE ELECTRIC IGNITER—
ELECTRIC IGNITION COILS—AN IM-
PROVED ELECTRIC IGNITER.

CHAPTER VII.

ELECTRIC IGNITION DEVICES.

ELECTRIC BATTERIES.

When the Edison-Lalande battery is used for automobile work, it is not necessary to employ a sparking magneto or a generator, or any other device of this character, as the battery delivers a perfectly uniform current which is just as strong at the end of twelve hours work as at the beginning. This simplifies the electrical connections very greatly, which is a great advantage when it is considered that gasoline automobiles are handled by people having little or no electrical knowledge.

The Edison spark coil is the result of a large number of experiments to determine the most efficient shape and style for use on rapid-firing motors. It is a short, thick coil, which will give a hot, bright spark, and yet will have an instantaneous discharge. This coil, when used with the Edison-Lalande portable batteries, types Z or V, makes a perfect outfit for vehicles requiring electric ignition.

Fig. 74 illustrates the Z Edison-Lalande battery, which is suitable for sparking small-sized gasoline engines, size $4\frac{1}{2}$ by $6\frac{3}{4}$ inches, and has a capacity of 100 ampere-hours.

Fig. 75 illustrates the V Edison Lalande battery which is suitable for sparking the larger vehicle gasoline engines, size $5\frac{3}{4}$ by 8 inches, and has a capacity of 150 ampere-hours.

The elements employed in the Edison-Lalande cell are zinc, which forms the negative pole, and black oxide of copper (Cu. O), the positive pole of the battery. The exciting

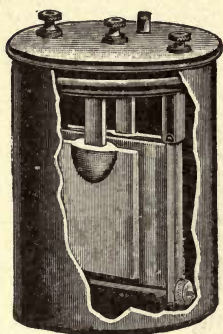


FIG. 74.—THE Z CELL.

liquid is simply a solution of caustic potash. The oxide of copper is obtained by the process of roasting copper turnings; the oxide is then ground into a fine powder and compressed into solid blocks, from which plates of a suitable size for the different cells are cut. These plates are suspended from the cover of the containing vessel (a porcelain jar), in a grooved copper frame, the sides of which are rigidly bolted to the cover by means of thumb nuts, one of which also serves as the positive pole of the battery.

On each side of the copper oxide element in the larger type cells (but only on one side in the smaller types) is suspended a rolled zinc plate. These zinc plates are fastened by a bolt to a knob on the cover. This prevents any movement in the relative position of the elements, and does away with the necessity of using vulcanite separators to prevent any short circuits occurring in the solution. The zincs are amalgamated, and as in most batteries, the zinc is attacked more vigorously near the top than

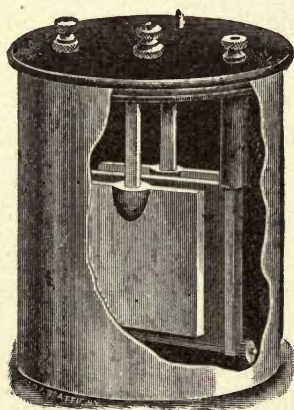


FIG. 75.—THE V CELL.

at the lower part of the plate. The zincs for this cell are made slightly tapering, the thick part being uppermost.

The exciting liquid employed in the battery consists, in

all types, of a 25 per cent. solution of caustic potash in water, or, in other words, of a solution of one pound of caustic potash in three pounds of water. When the circuit is closed and the cell is put in action, the water is decomposed, the oxygen forming, with the zinc, oxide of zinc, which, in turn, combines with the potash to form an exceedingly soluble double salt of zinc and potash, which dissolves as rapidly as it is formed; the hydrogen, liberated by the decomposition

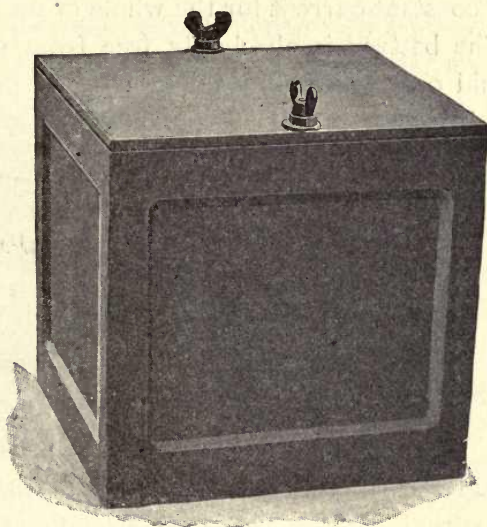


FIG. 76.—THE EDISON PRIMARY BATTERY.

of the water, reduces the copper oxide to metallic copper. A layer of heavy paraffine oil, three-eighths of an inch deep, is then added to keep out the air and prevent creeping. These batteries are manufactured by the Edison Manufacturing Company, New York City.

In Fig. 76 is illustrated an Edison four-cell primary battery suitable for motor ignition. It is connected in series and equal to an electromotive force of $7\frac{1}{2}$ volts.

A current of from 5 to 12 amperes can readily be drawn

from this battery. At a 5-ampere discharge it will give 250 Watt hours. It can be used for lighting carriages, where it will give three 3-candle power lamps for a period of eight hours.

This battery, which has permanent connections completely protected from the solution and placed at the bottom of the box, is free from deposits of every description, ready for use as soon as charged, and which gives a perfectly steady and constant current for the whole of the life of the charge. The battery is absolutely free from polarization and one fluid only is employed, rendering it practically a single fluid battery. It will operate either through a spark or a Rhumkorff coil, and as there is perfect depolarization there is no possibility of failure to spark.

It has an outside measurement of $8\frac{1}{2}$ by $8\frac{1}{2}$ by $8\frac{1}{2}$ inches and weighs, when charged, 20 pounds.

These batteries are furnished by the Edison Electric Light and Power Company, New York City.

HOW TO CHARGE THE PRIMARY BATTERIES. (FIG. 76.)

To Make the Solution.

Dissolve in an earthenware vessel six pounds nitrate of soda (Chili saltpetre) in one gallon of water and add slowly one gallon sulphuric acid; allow it to stand four or five hours to cool. This solution is used on the carbons and should be kept in a stoppered bottle. Do not *mix* it in a glass vessel, a bottle or in the battery. The heat generated may break glassware.

For the zincs, add one part by volume of sulphuric acid to fifteen parts of water.

To Charge the Battery.

Put in each porous pot the amount of nitrate of soda stated in the description of the battery; then fill the porous

cell with the strong solution to within one inch of the top; then insert the zincs in the outer cells and fill to top of zincs with the dilute acid. Place the rubber tray absorbent pad and lid in place and screw down tightly. The battery is then ready for operation. The dilute acid may be mixed in the box in case of necessity.

To Amalgamate the Zincs.

Clean the zinc by dipping it for a short time in dilute sulphuric acid (one part acid to ten of water), then with a rag rub it with mercury till it becomes brightly polished.



FIG. 77.—DRY BATTERY.

IGNITION BY DRY BATTERY.

Dry batteries are much in use for igniting the gas charge in explosive motors; especially where the dynamo generator is in use, when it becomes a valuable reservation against failure of the generator. For starting a gasoline motor it is always ready and are now made with lasting qualities and can be depended upon for continuous service. The dry battery, Fig. 77, here illustrated is made by William Roche, 42 Vesey street,

New York City, for gas engines and automobile motor ignition and much used as a reserve, or for initial ignition to the dynamo in starting the motor.

Their electro-motive force is from 1.35 to 1.65 volts, with from 8 to 22 amperes current. The gas engine cell is round, 7 by 3 inches. The automobile cell is 7 by 2 $\frac{3}{4}$ by 2 $\frac{1}{4}$, or made larger if desired.

ELECTRIC IGNITION DEVICES.

The sparking dynamo or electric generator with permanent magnetic field is illustrated in Fig. 78.

This dynamo igniter is constructed with a permanent magnet field and an armature of the drum type. It has self-feeding carbon brushes, and is self-lubricating, being provided with grease cups. The armature, being enclosed, is dirt, oil and moisture proof. It can be run in either direction, and if the fly wheel of the engine runs true, may be driven from a friction pulley bearing upon the same, or may be belted to the fly-wheel or any convenient shafting. The speed should be about 2,000. The Holtzer-Cabot Electric Company, Boston (Brookline), Mass., manufacture these dynamo igniters.

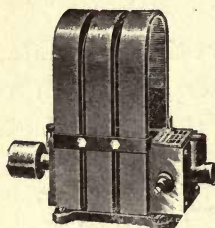


FIG. 78.—GENERATOR.

The sparking coil, Fig. 79, is of the Edison type. It is 9 inches long, with an iron wire core wound with six pounds of insulated copper wire, which enables it to give a bright, hot spark, even with a weak current, from the battery. They are furnished by the Edison Manufacturing Company, New York City.

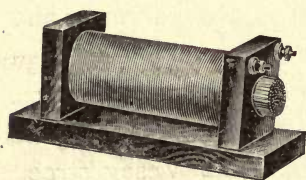


FIG. 79.—SPARKING COIL.

THE ELECTRIC IGNITER.

Electric ignition for gasoline motors, in one of its forms is in general use. The primary current may be from a wet battery made suitable for vehicle service; a wet or dry storage battery or from a dynamo generator with permanent magnets for the field.

Small generators with a current wound field, so made as to have a magnetic reserve, are also in use.

In Fig. 80 is illustrated an ignition battery plant, in which the batteries may be two or three in series, connecting with the binding post, *P*, of the primary winding of the induction coil, *T*, and continued through the other binding post, *P*, to the breaker at *K*, which is operated by a break contact arm or cam on the reducing gear or shaft. The secondary winding of the induction coil is connected to the binding posts of the ignition plug, *P*, by the wires, *e, e*, and continued through separate insulating sleeves, *i, i*, terminating in the platinum points, *c, c*. The distance apart of the

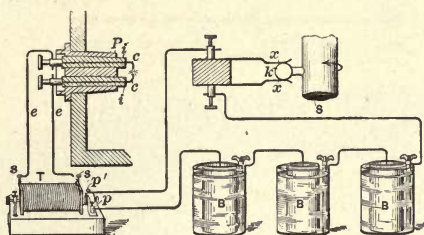


FIG. 80.—ELECTRIC IGNITER.

platinum points must be determined by the intensity of the battery and induction coil.

ELECTRIC IGNITION COILS.

The principles covering the construction of the jump spark coil having a secondary induction coil is not generally understood; we therefore illustrate in Fig. 81, the details of such a coil without a vibrator, and in Fig. 82, the same coil with the vibrator. The first shows the connecting arrangement as used by De Dion, of tricycle fame in France.

H, H, is the iron core generally made of soft wire.

The heavy line coil is the primary winding over the core. *P, P, M, M*, are the primary binding posts. The upper posts, *P* and *P*, are connected through the battery and switch. The lower posts, *M* and *M*, are connected through

the breaker on the reducing gear from the crank shaft represented at *N, F, D, G*. The upper post, *P*, and the lower post, *M*, are directly connected, making a complete primary circuit from the battery, *A*, through the switch, *J*,

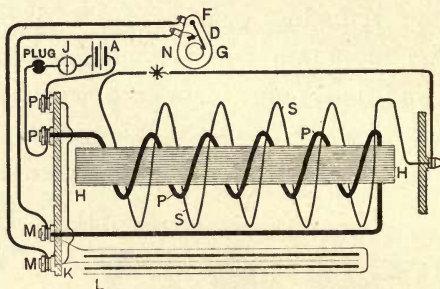


FIG. 81.—THE JUMP SPARK COIL.

and post, *P*, around the core and post, *M*, to the breaker at *D*, and through the lower post, *M*, and across by the upper post, *P*, to the battery.

The condenser, *L*, is composed of strips of tinfoil separated by paraffined paper.

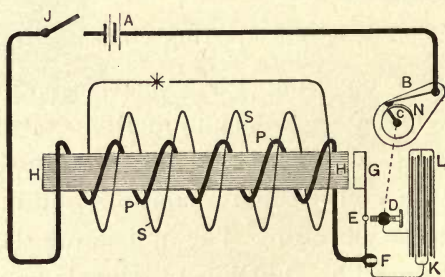


FIG 82.—JUMP SPARK COIL WITH VIBRATOR.

The strips of tinfoil are continuous or in series and are connected as a shunt across the contact breaker through the posts, *M, M*. The secondary coil of finer wire is wound

outside of the primary coil with each end terminating in the sparking electrodes in the cylinder.

The vibrating coil, Fig. 82, is the same in its parts and action with the coil, Fig. 81, with the addition of a spring vibrator shown at *F, G*.

The primary circuit is completed by the cross connection from *D* to *C*.

The passage of the current round the primary coil, excites magnetism in the soft iron core, *H*, which then attracts the block, *G*, on the spring, *G, F*, thus breaking the

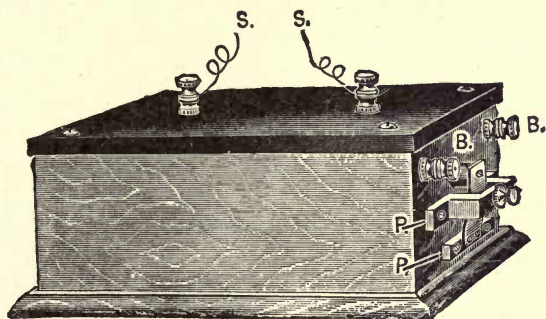


FIG. 83 —THE JUMP SPARK COIL IN A CASE.

circuit at *E*, and stopping the flow of current in the primary coil.

This action causes the core, *H*, to lose its magnetic force, and the block, *G*, in virtue of the spring on which it is mounted, flies back, and the circuit is remade at *E*. only to be broken again in the same manner. By careful adjustment of the screw in *D*, a very rapid make and break action may be obtained, which takes place many times while the commutator bar, *C*, is in contact with the spring, *B*, and during this period the passage of the battery current through the primary winding is rendered intermittent.

The induced secondary current also becomes intermittent,

and this secures a succession of sparks that insures a positive ignition.

These coils are made and mounted in a neat substantial case, Fig. 83, and can be used either with or without the vibrator, as shown. With battery giving a current of 4 to 6 volts a spark of 1 inch may be obtained from this coil. It is fitted with binding posts, ready to connect the wires. It is made by C. F. Splitdorf, 25 Vandewater Street, New York City.

AN IMPROVED ELECTRIC IGNITER.

In Fig. 84 is shown a new ignition plug of French origin designed by Bisson Berges et Cie, Paris.

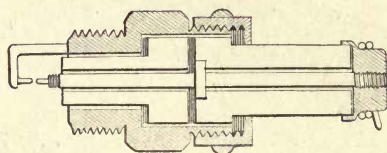


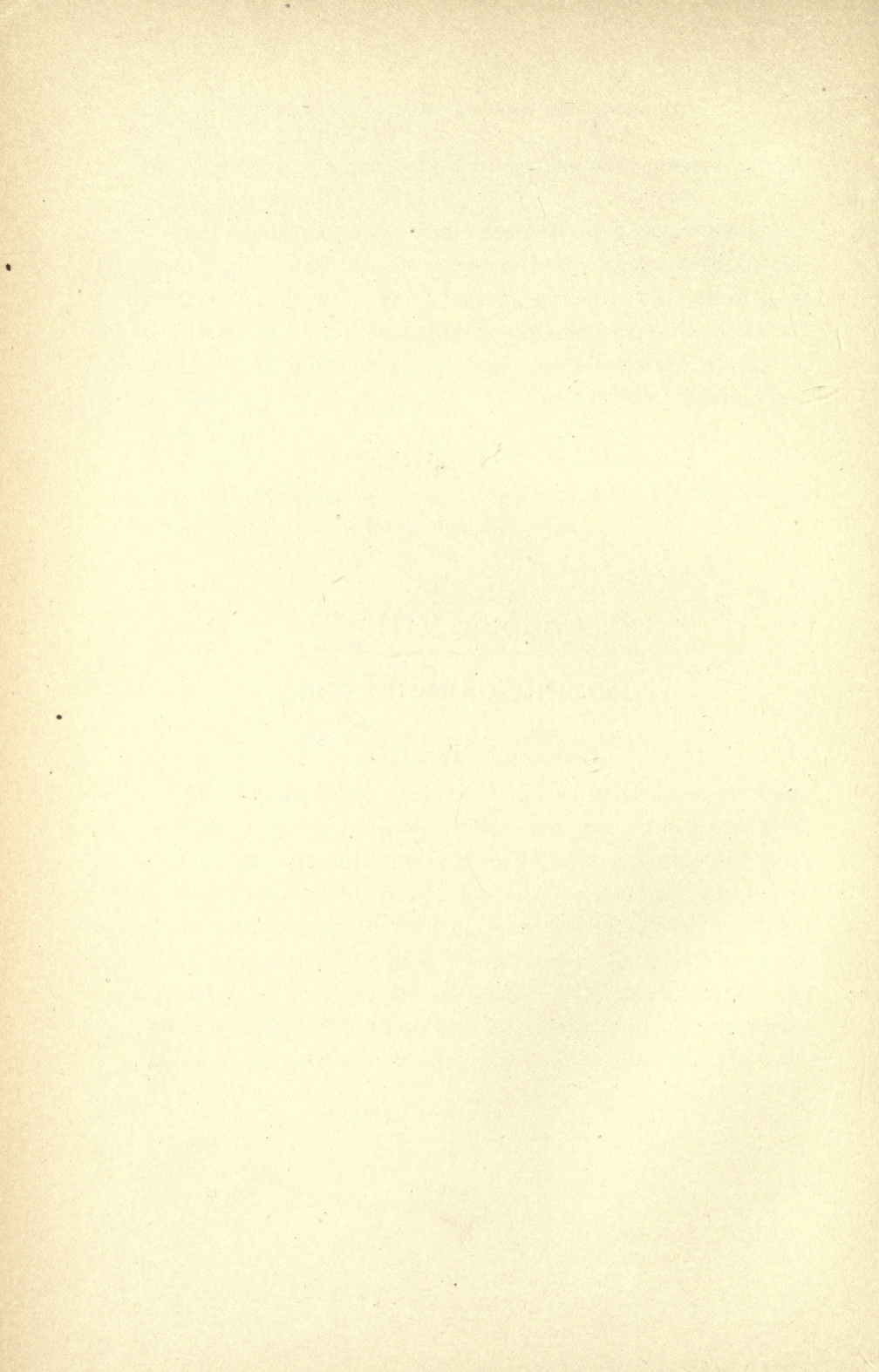
FIG. 84.—ELECTRIC IGNITION PLUG.

The plug and cap may be made of best brass or composition, with an extension piece cast on, or inserted with a platinum pin, opposite to which is a copper spindle with a fixed collar and a platinum point. The insulators may be of porcelain or of lava as made by the D. M. Steward Manufacturing Company, Chattanooga, Tenn. The packing may be of mica or asbestos. The thickness of the packing between the two lava or porcelain insulators makes an easy adjustment of the distance a part of the platinum tips.

Chapter VIII.

ATOMIZING CARBURETORS.

GASOLINE VAPORIZER.



CHAPTER VIII.

ATOMIZING CARBURETORS.

In Fig. 85 is illustrated a very simple atomizing carburetor, in which *F* is the cylinder port ; *E*, inlet valve ; *G*, exhaust

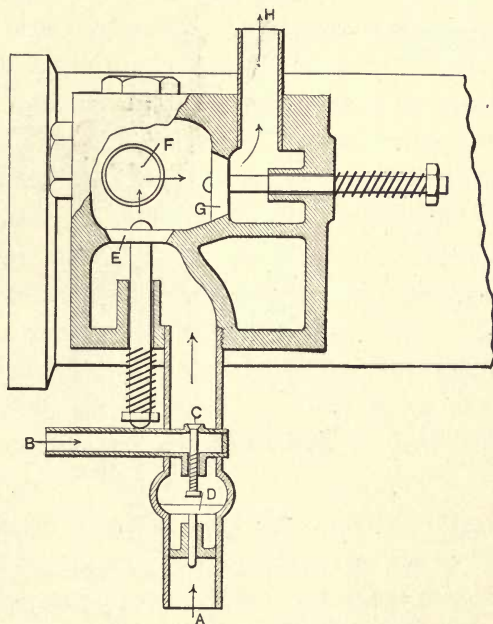


FIG. 85.—ATOMIZING CARBURETOR.

valve ; *D*, the air inlet valve, and *C* the gas or gasoline inlet valve. A controlling valve, or cock, should be put in the gasoline pipe, and the air inlet pipe should have an air

shutter for regulation of air intake. The gasoline and air inlet valves should be put together in separate fittings for a ready means of adjustment, and so arranged that the air valve, *D*, strikes the stem of the gasoline valve, *C*, at the moment of indraft of the piston. An additional regulating air inlet valve should enter the inlet chamber above the gasoline valve, *C*.

AN ATOMIZING CARBURETOR.

In Fig. 86 is illustrated a gasoline feed atomizing carbure-

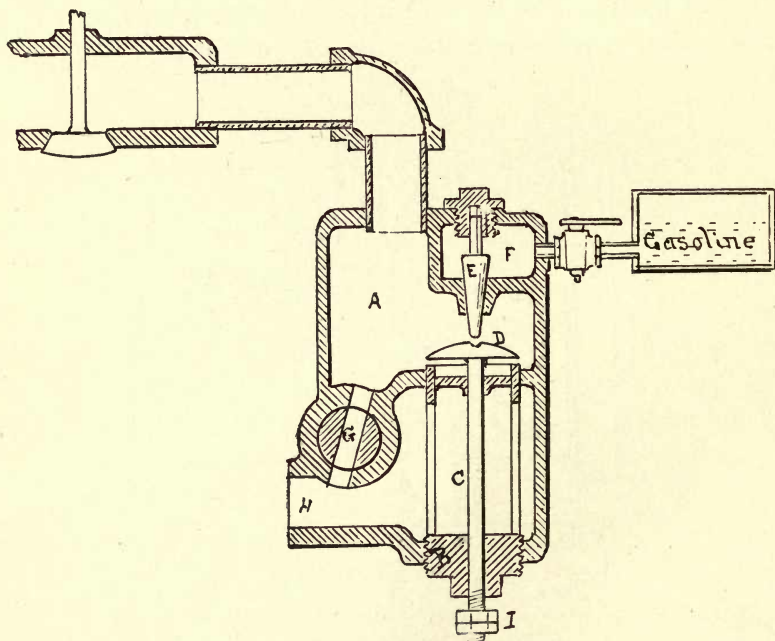


FIG. 86.—ATOMIZING CARBURETOR.

tor from a gravity or pressure flow to the valve box, *F*, with a regulating cock or valve, and a supplementary air valve at *G*, both under the control of the driver. The gasoline tank may be placed at a lower level with air pressure.

The inlet needle valve, *E*, is opened by contact with the

automatic air valve, *D*, which is lifted by the draft of the piston at the charging moment. *B* is a cage that forms the seat of the valve, *D*, and the guide for its spindle, *C*. At *I*, on the valve spindle, is a nut and lock nut by which to set the lift of the air valve, *D*. By attaching a lever to the spindle at *I*, the flow of gasoline to the atomizer may be controlled or closed without operating the valve between the valve chamber and the tank while running the motor.

THE LEPAPE CARBURETOR.

In Fig. 87 is illustrated the carburetor, made by M. H. Lepape, Paris, France. It comprises an outer cylindrical shell, with a cross bar and central valve chamber, with gasoline inlet and regulating valves, as shown in the sectional cut. The central cylindrical body provided with a chamber, *e*, which can be closed both at top and bottom by valves, the stems of which are respectively surrounded by coiled springs, *X* and *z*. The outer shell at its top is closed by a cap, *g*, through which passes an adjusting screw, *V*, engaging the stem of the valve, *z*. In the lower portion of the shell a bell piece is mounted, which is surrounded by wire gauze, *P*, through which heated air from the exhaust heater passes. The gasoline to be vaporized enters at *m*, beneath the valves. The explosive mixture finds its exit through the tube, *T*.

In inoperative position the lower valve is slightly raised from its seat by the upper valve, the two valve stems telescoping within each other. The movement of the stems is limited by stops, *e*. The valves being in this position the liquid will fill the chamber, *e*, by gravity or pressure from the gasoline tank. When the inlet valve of the motor is open the resistance of the wire gauze will cause the cap, *g*, to be depressed, and, likewise, its adjusting screw, *V*. The

upper valve stem will then be plunged into the chamber filled with liquid.

By this operation the lower valve will be closed, thus cutting off the communication between the supply reservoir and the chamber, *e*. As it continues to fall, the cap will force the valve stem, *f*, into the liquid contained in the chamber, *e*, and will cause it to displace a volume of liquid equal

to that of the immersed portion. The volume immersed and consequent displacement can be regulated to meet the requirements of the motor, by means of the adjusting screw, *V*, of the cap, *g*. By turning the collar, *d*, a supply of fresh air can be admitted to diminish the vacuum produced by the intake, and consequently to regulate the quantity of liquid which falls on the wire gauze, *P*, since this volume depends upon the degree of immersion of the stem. The liquid which falls upon the wire gauze is vaporized by the hot air and passes to the cylinder of the motor, mixed with air for regulating the mixture from the perforated shell and regulating cap, *d*.

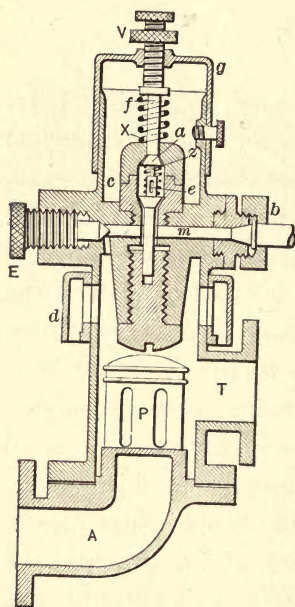


FIG. 87.—LEPAPE
CARBURETOR.

It therefore follows that the admission of a supply of cold air regulates the quantity of liquid which should pass to the cylinder, and the proportions of air and gas in the explosive mixture introduced within the cylinder of the motor.

The screw, *E*, serves to release any air from the liquid supply tube, and to permit a small quantity of liquid to flow,

in order to facilitate the starting of the motor. The device is claimed to give a perfect carburation without odor or smoke.

THE DAIMLER CARBURETOR.

The atomizing carburetor used on the Daimler motor is illustrated in Fig. 88. It is of the constant level type, in which a float, *B*, operates a pair of counterweight levers, *E*, and the valve spindle, *D*, to control the inlet of gasoline to meet the exact wants for the motive power.

At each charging stroke of the piston through the aspirating passage, *M*, the gasoline is drawn in a jet from the nozzle, *I*, and air is drawn at the same time from the primary air passage into the annular chamber, *H*, and under the drop tube, *F*, as shown by the arrows, and, passing the nozzle with great velocity and with the jet of gasoline strikes the deflector, *K*,

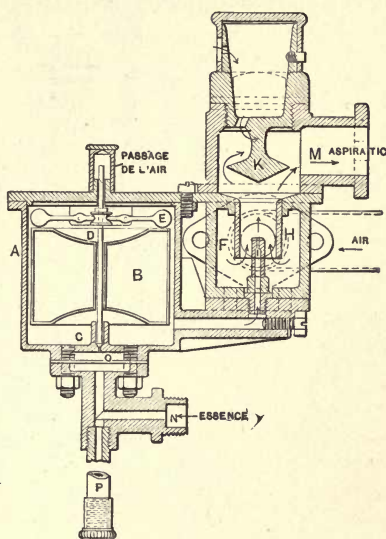


FIG. 88.—DAIMLER CARBURETOR.

where the gasoline is finely atomized and mixed with the air. A further aeration and evaporation of the atomized particles of the gasoline is made and regulated by the air inlet through the perforated cap at the top, which is graduated and may be operated by a handle and link from the driver's seat.

A cloth filter is inserted between the flanges of the chamber at *O*, and a cavity plug, *P*, serves for emptying the pipe and reservoir and for catching any particles of dirt that may

pass into the pipe. The cap over the valve spindle has a small vent hole and serves to relieve any pressure caused by the variation of the position of the float, *B*. The gasoline enters at *N*, by gravity or slight air pressure in the tank as desired.

THE ABEILLE CARBURETOR.

The carburetor, or rather atomizer, Fig. 89, is used on a French vehicle with the Abeille motor. It is a constant level feed atomizer, regulating its feed from a higher level

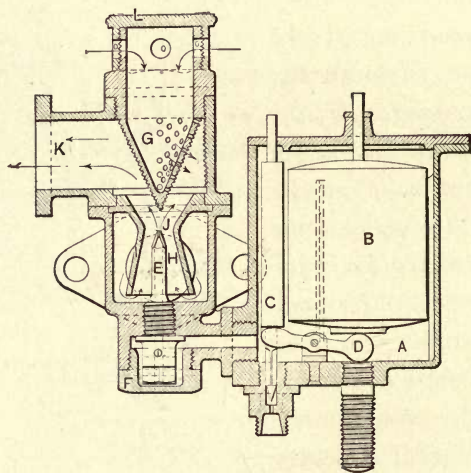


FIG. 89.—THE ABEILLE CARBURETOR.

reservoir, or tank, by means of a float, *B*, in the receiver, *A*, which, by its floating position, opens a small conical valve on the lower end of the spindle, *C*, through the operation of the lever, *D*. The spindle *C*, being a counterpoise weight to close the inlet valve when the float, *B*, exceeds the proper height. The level of the gasoline in the receiver is adjusted to stand just below the top of the jet nozzle at *E*. An inlet for air to meet the gasoline jet, *J*, at the neck of the double cone, *H*, is shown by the circular opening in the oval flange

behind the jet. The suction of the piston during the charging stroke jets the gasoline against the perforated cone in contact with the annular jet of air from below, where it is met by the regulated diluting air from the holes in the upper section of the perforated cone. The cap, *L*, has holes corresponding with the air holes in the inner section, so allowing of adjusting the area of the diluting air inlet by

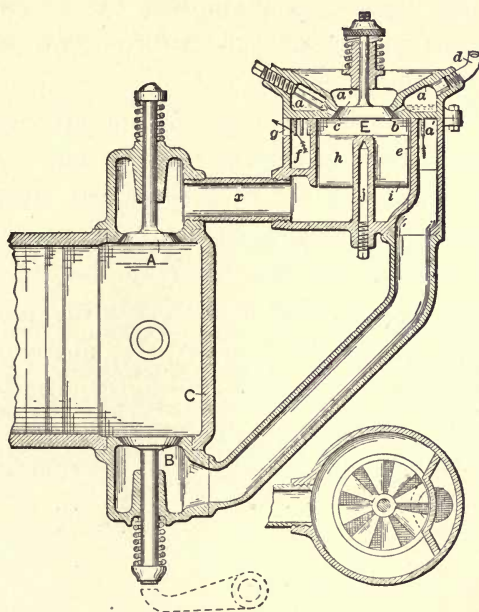


FIG. 90.—THE W. HAY VAPORIZER.

rotation on its screw thread. The jet nozzle can be quickly removed or adjusted by removing the plug *F*.

GASOLINE VAPORIZER.

In Fig. 90 is illustrated a vaporizer patented by Walter Hay, New Haven, Connecticut. It has some excellent features for perfecting the vapor and air mixture before it enters the cylinder. The gasoline enters the small annular

chamber, *a*, *a'*, through the pipe, *d*. Several small holes open from the annular chamber upon the central line of the valve seat of the inlet air valve *E*, some of which have screw needle valves for regulating the flow of gasoline. The inrush of air, when the valve opens by the draft of the piston, atomizes the inflowing gasoline and precipitates the atoms upon the deep wings of a fan, *h*, hung upon the central spindle, *j*; the fan is set in motion by the inrush of air, thoroughly stirring the mixture before it enters the pipe, *x*, leading to the inlet valve, *A*.

The horizontal section of the fan and chambers is shown at the lower right-hand corner of the cut. The exhaust valve, *B*, is opened by the rock shaft arm, dotted below in the cut, when the exhaust passes through the diagonal pipe and into the annular chamber *f*, surrounding the inner vapor and air chamber, imparting heat to both the inner chamber and the annular gasoline chamber *a*, *a*, and makes its final exit through the slotted apertures in the outer casing, as at *g*. The spindle casing at *i*, in the cut, should have a line across it to separate the fan hub from the spindle guide.

Chapter IX.

OPERATING DEVICES AND SPEED GEARS.

THE AUTOMATIC CLUTCH—THE COMPENSATING GEAR—THE
VARIABLE SPEED GEAR—A MOTOR TRICYCLE GEAR—
A FRICTION CLUTCH MOTOR CONNECTION—A
GASOLINE MOTOR STARTER—STEERING
WHEEL GEAR—MUFFLERS.

CHAPTER IX.

OPERATING DEVICES AND SPEED GEARS.

THE AUTOMATIC CLUTCH.

In Fig. 91 is illustrated an automatic clutch, to take the place of the usual compensating gear. The upper or ratchet

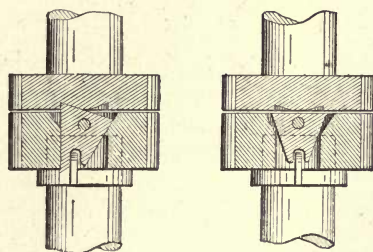


FIG. 91.—AUTOMATIC CLUTCH.

ring is made fast one to each driving wheel hub; the ratchet block is pivoted in the lower ring that is loose, having small motion on the shaft, which is stopped by keys. The small collar and key are fixed to the axle, so that on a straight run both pawl blocks bear in the forward teeth of the hub ring. When rounding a curve the outer wheel gains on the inner wheel, throwing the ratchet block into the position shown in the right hand section of the cut. This clutch drives in the same manner in backing a vehicle, making a great improvement over the old forward ratchets, and a very simple device as compared with the more complex compensating gear that requires a divided and sleeved axle.

It is the invention of R. F. Stewart, Pontico Hills, N. Y.

THE COMPENSATING GEAR.

The compensating gear, so essential to the driving mechanism of motor vehicles, and so difficult to make by amateurs, can now be purchased from the Boston Gear Works, Boston, Mass. Their details are illustrated in Figs. 92 to 95. The sleeve extension on the side is the friction pulley for the band brake. They are made in two sizes—8 inch pitch diameter, with sprocket teeth cut to order, with two

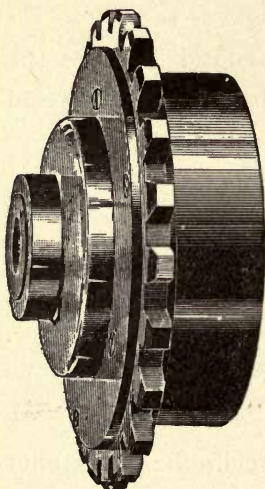


FIG. 92.—THE SPROCKET
WHEEL GEAR.

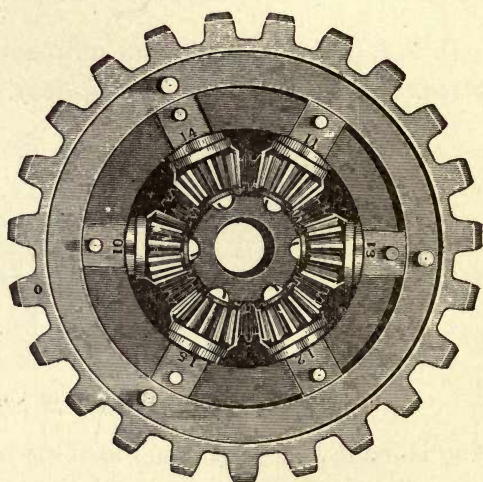


FIG. 93.—SIX-PINION
PLAN.

bevel gear wheels and three pinions, and with sprocket wheels, 10 inches diameter, with two bevel gear wheels and six pinions for heavy vehicles. The size and cut of the sprocket wheels, which are fastened with screws to the flanges on the rim, may be varied to order.

In Fig. 94 are shown the details in section of a single chain wheel, and in Fig. 95 the arrangement in section for a two chain wheel. The cuts are scaled to about one-third the size of the smaller gear.

The bevels, *L* and *C*, are secured respectively to the hollow shafts, *N* and *R*. These shafts, which are independent of each other, are reinforced by the tubing, *W*, which is held in place by means of the collar, *P*. The two bevels mentioned are driven by three pinions, *E*. The cut illustrates only two pinions.

When the power is applied to the sprocket wheel, *G*, it is

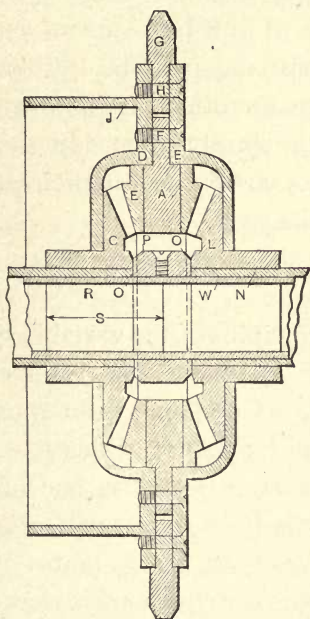


FIG. 94.—SECTION, SINGLE SPROCKET.

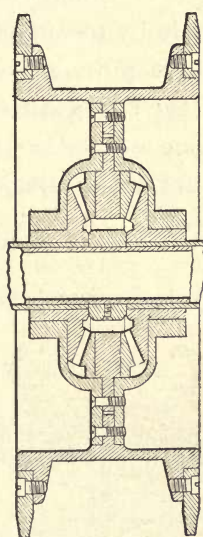


FIG. 95.—DOUBLE SPROCKET.

equally distributed to the bevel gears, *C* and *L*, by means of the pinion, *E*, and two other similar ones, which pinions in driving do not revolve on the stud, *A*. These pinions being loose on the stud, *A*, when one bevel offers more resistance than the other (as in the case of the vehicle turning a corner), it is obvious that the bevels can adjust themselves

according to the resistance offered, the rubber tires are therefore not injured by skidding.

D and *E* represent a section of case for holding the parts together.

J is a friction sleeve to receive the brake band.

As can be seen from the illustration, the shaft is in two parts, separated by a collar that is fixed to a reinforcing liner tube. When the power is applied to the sprocket wheels it is equally distributed to the bevel gears on the split shaft by means of the interposing pinions. When one gear offers more resistance than the other, as in turning a corner, the two gears can adjust themselves according to the resistance offered, as the pinions are loose on their studs, which are the driving parts of the gear.

THE REEVES VARIABLE SPEED GEAR.

In Fig. 96 is illustrated the principles of the variable speed gear as made by the Reeves Pulley Company, Columbus, Indiana, for motor vehicles.

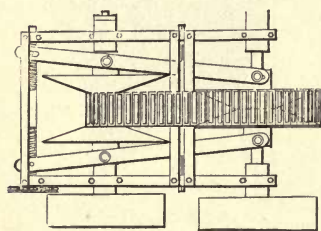


FIG. 96.—VARIABLE SPEED GEAR.

Variable speed is one of the important features in motor cycle design. Every motor cycle experimentalist knows that road conditions are constantly varying, and to meet these ever-

changing conditions it is absolutely essential to have a pliable speed device. This consists of two cones mounted on the motor shaft and two similar cones on the countershaft, both pairs being adjustable laterally on their respective shafts by the bar arrangement shown in the diagram, so that when the cones on the motor shaft are close together those on the countershaft are far apart and

vice versa, allowing locked adjustment at all intermediate stages. The specially constructed belt runs between these cones bearing upon the conical surfaces with the beveled edges of the belt only. When the cones on the motor shaft are forced together the belt is therefore expanded and forced to run on a larger circle around the shaft, while simultaneously the cones on the countershaft are separated, allowing the belt to contract so as to run on a smaller circle around the countershaft.

The belt is composed of a series of leather and iron strips, riveted on to a rawhide base, which enables a powerful grip on the edges without in the least kinking the belt. The central swivel bearings of the operating levers have a screw take-up to adjust the tightness of the belt. A double screw shaft, with a sprocket wheel and chain to a hand wheel, enables the driver to gradually change the speed.

This device is in use on gasoline automobiles built by the above company.

A MOTOR TRICYCLE GEAR.

A very compact gasoline motor and two-speed gear train is illustrated in Fig. 97. It is a French design, made by Dalifol & Thomas, Paris, France.

The main axle, motor and gear-box are bracketed from the tricycle frame shown across the top of the cut.

The motor, *A*, is in a vertical position and provided with air-cooling rib flanges.

The motor-shaft terminates in the female portion of a friction clutch *B*, the male part of the same *B'* being carried on the end of a shaft, *O*, in the same line. On this latter shaft are mounted two friction clutches, *C*, *D*, the male portions of which *C'*, *D'*, are controlled by a single lever, *K*, in such a way that only one of the clutches can be in gear at a time. For the high gear, the two parts of the clutch, *C*,

are brought into contact, the power of the motor being then transmitted through the pinion, *F*, to the large gear wheel, *E*, on the tricycle axle. For the low gear the lever, *K*, is pulled over to the opposite side, thus throwing out the clutch *C* and bringing the two parts of the clutch *D* into engagement, and by the same lever arm, *K'*, the ratchet clutch, *M*, is locked to drive the pinion, *J*, for the slow gear motion.

In this position the power is transmitted to the wheel, *E*,

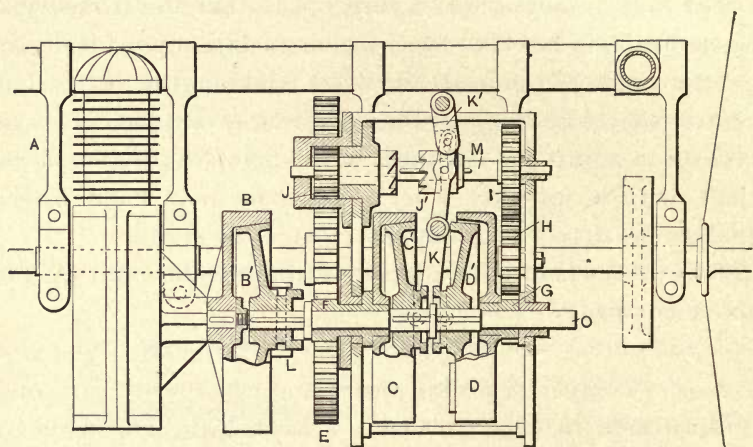


FIG. 97.—A TRICYCLE GEAR.

through the pinions, *G*, *H*, *I*, and *J*. The spur wheels, *F* and *J*, are always in mesh with the wheel *E*, they being so arranged that as one is driving the other runs free, and vice versa. The gear is entirely enclosed in a dust-proof case and the whole driving gear reduced to the smallest possible space, with its center of gravity at the driving wheel axle.

A FRICTION CLUTCH MOTOR CONNECTION.

A very compact and direct connection from a motor to the compensating gear of a vehicle is shown in Fig. 98. It is the subject of an English patent and shows a very compact arrangement of the operation of the friction clutch by a quick thread-screw and lever. *C* is an extension of the motor crank shaft, to which is keyed the friction pulley, *T*,

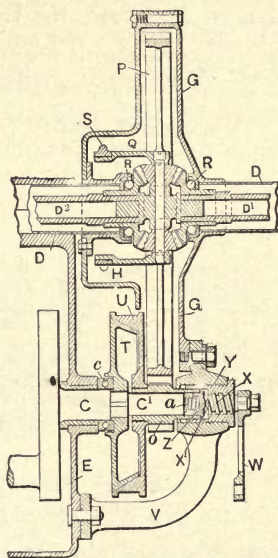


FIG. 98.—FRICTION CLUTCH CONNECTION.

with a ball bearing at *c* to counteract the thrust of the quick screw *X*, which is operated by the lever *W*. *U* is the matched friction pulley made fast on the pinion sleeve, *O*, with a cap bearing on the thrust-screw *X*. A small helical spring, *a*, between the end of the crank shaft and the pinion sleeve cap, pushes the clutch open. The pinion sleeve is feather keyed to the crank shaft *C*¹. *Y* is a nut screwed into the frame, *V*, forming a bearing for the outer end of the

pinion sleeve and for the thrust-screw bearing thread. The compensating gear and box is of the usual construction and well shown in the cut without reference to the lettered parts. It has ball bearings, as shown at *RR*, and forms part of the driven axle.

A GASOLINE MOTOR STARTER.

In Fig. 99 is illustrated a starting device, designed and made by Mr. Estcourt, in England, for the purpose of starting the motor by the driver without leaving his seat.

A starting wheel, *B*, with oblique saw teeth, is fixed on the motor shaft, *A*. A sprocket chain, *C, C*, is wound on a

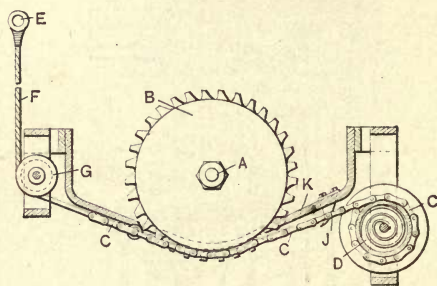


FIG. 99.—A MOTOR STARTER.

drum containing a coiled spring, *D*, so arranged as to rewind the chain with a stop, *J*, so as to allow it to hang free from the ratchet wheel when the finger loop at *E* is dropped to the eye in the vehicle floor—*G*, is a small sheave under the floor, in which the lanyard, *F*, runs—*K*, is a slotted plate with flanges, or guard, for guiding the chain. For starting, the driver takes the loop, *E*, or its handle, in hand, first drawing the chain in contact with the teeth of the wheel, makes a sudden pull to the extent of the unwinding of the chain, and as suddenly returns the handle to the floor, when the chain is wound up by the spring, and stopped just clear

of the sprocket wheel. If the motor does not start at the first effort it is repeated.

STEERING WHEEL GEAR.

In Figs. 100 and 101, we illustrate two of a number of designs for setting the steering wheels at right angles to the radius of their respective curves. When a vehicle is in the act of rounding a curve, it is imperative, in order to prevent side-slip, that the axes of all the wheels should radiate from one point; that is to say, assuming the axis of the rear wheels to be fixed, then prolongations of the axis of the two front wheels should intersect a prolongation of the axis of the rear wheels at one and the same point, and this should be

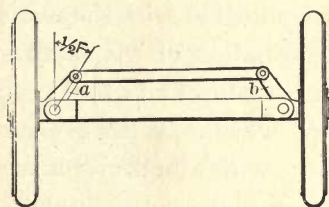


FIG. 100.—STEERING GEAR.

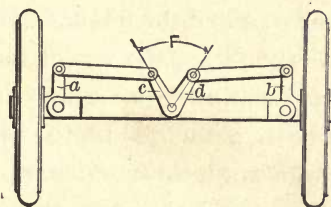


FIG. 101.—BELL CRANK STEERING GEAR.

the case to whatever extent the front wheels are turned. By swivelling the steering axle on its central bearing, it may readily be seen that the axle is in line with the radius of the curve that the vehicle is moving over, and that the plane of motion for each wheel is at right angles to the radius of the curve. With this arrangement of the steering gear, the wheels run perfectly free and do not crowd each other with side thrust and cause friction.

When the wheel pivots are placed near to or within the hubs, the axle in rounding a curve, is not parallel with the radius of the curve, the inner end taking a forward position and the outer end a backward position from the radius of

the curve drawn through the centre of the axle. It will then be readily perceived that the planes of the wheels do not coincide with the tangent of the curves on which they are running. Hence some arrangement of the controlling parts must be made to vary the planes of the wheel to meet the requirement of their respective radii. The amount of angular change in the relation of the planes of the wheels on a curve depends upon the length of the wheel base of the vehicle, and increasing therewith. In Fig. 100 is shown the ordinary method of giving the wheel on the inner curve a greater movement than the one on the outer curve, when a steering lever is pivoted to any part of the connecting link between the two pivot arms, *a*, *b*. The angle of the pivot arms with the plane of the wheels should vary somewhat with the width of the tread, the wheel base, and the radius of the smallest curve allowed for the vehicle to turn upon. The usual practice is about 30° to the plane of the wheel. With arms at right angle to the axle, as in Fig. 101, with a bell crank arm pivoted on the axle, the angle of the bell crank should be about 60° , or twice the angle, as in the first-mentioned arrangement.

MUFFLERS.

The suppression of the noise from the exhaust of gasoline and steam motor vehicles has been a matter of much comment and experiment, which has resulted in a few devices that have so modified the nuisance to both man and beast as to produce only a small hissing noise that is scarcely noticed by equine sensitiveness. A cylinder of about four times the capacity of the motor cylinder, made of sheet iron, and strong enough to sustain ten pounds pressure per square inch, is in common use. It may have two or three perforated disks fastened within and be covered with asbestos felt and an outer covering of duck or tin. The end of the cylin-

der opposite the exhaust entrance should also be perforated with an aggregate open area equal to four times the area of the exhaust inlet. The exhaust muffler box, or cylinder, is also made to contain a pipe for heating and vaporizing the gasoline, or for heating the charging air.

In Fig. 102 is illustrated a device, made of iron pipe and

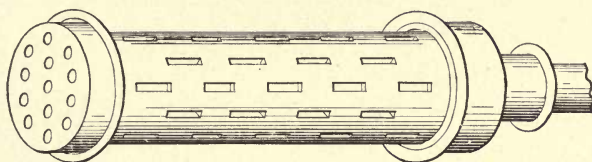


FIG. 102.—SINGLE TUBE MUFFLER.

ittings, which gives a very free flow to the exhaust. The exhaust pipe terminates at the enlarging socket. The slots in the pipe are cut in a milling machine as thin as practicable, and the cap may be also slotted or drilled, giving a total area of four or more times the area of the exhaust pipe.

Another form in which the final exit of the exhaust may

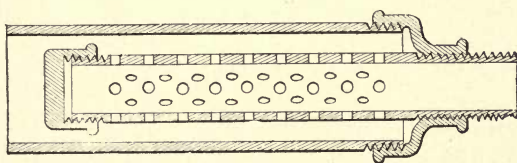


FIG. 103.—DOUBLE TUBE MUFFLER.

terminate close to the ground is also in use and has its advantages. It is shown in section, Fig. 103.

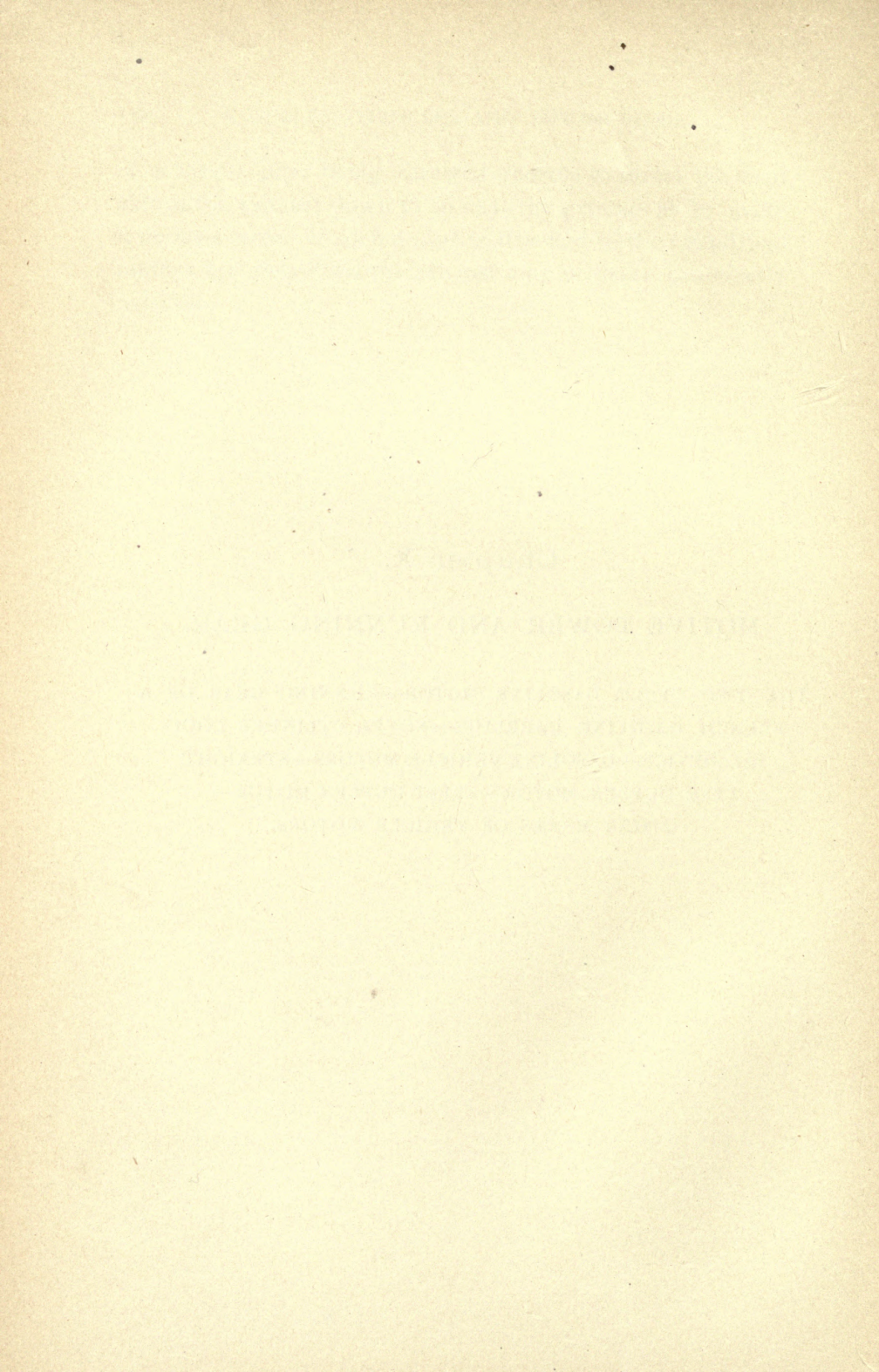
A tube or iron pipe one size larger than the exhaust pipe may be drilled with holes equal to four or more times the area of the exhaust pipe and closed with a cap or welded up at the end. An expanding socket tapped through will allow

of a larger pipe being screwed therein to direct the final exit of the exhaust down to so near the ground as to make it unobservable. If such a pipe is attached to the cylindrical muffler first described the exhaust may be made practically noiseless.

Chapter X.

MOTIVE POWER AND RUNNING GEAR.

THE TWO CYCLE GASOLINE MOTOR—RUNNING GEAR OF A
FRENCH GASOLINE CARRIAGE—NOVEL CYLINDER COOL-
ING DEVICE—GASOLINE VEHICLE MOTORS—STRAIGHT
LINE DUPLEX MOTOR—CREST DUPLEX MOTOR—
OTHER MAKES OF VEHICLE MOTORS.



CHAPTER X.

MOTIVE POWER AND RUNNING GEAR.

THE "YALE" TWO CYCLE GASOLINE MOTOR.

In Fig. 104 is illustrated the motor made by the Denison Electric Engineering Company, New Haven, Conn.

The motor is shown in parts that its construction may be more readily seen and described. They are built in suitable sizes for automobile, stationary and marine work. The sizes at present are a $3\frac{1}{2}$ horse power, with single cylinder, $4\frac{3}{4}$ inches diameter, 6 inches stroke. A 4 horse power, with double cylinder, 4-inch diam., $4\frac{1}{2}$ -inch stroke; also double and triple cylinder motors of the first named size. This company also furnish blue prints of these motors and parts in detail, suitable for working drawings.

The crank shaft is forged from the solid, and counter-balanced, is shown to the right; against it rests the rotary valve plate, *M*, which in use slips over the end of the crank shaft and fits loosely on a boss made to receive it. The plate, *M*, is driven positively by the small pin, *R*, shown on the left hand crank throw, and is spring-seated on the crank case cover, *C*, shown at left of fly wheel. As the crank revolves (in a spray of oil which gives perfect lubrication to all the moving parts), this plate, *M*, opens and closes the suction port, *S*, and transfer port, *A*, with absolute certainty, and also preventing the charge while being compressed in the

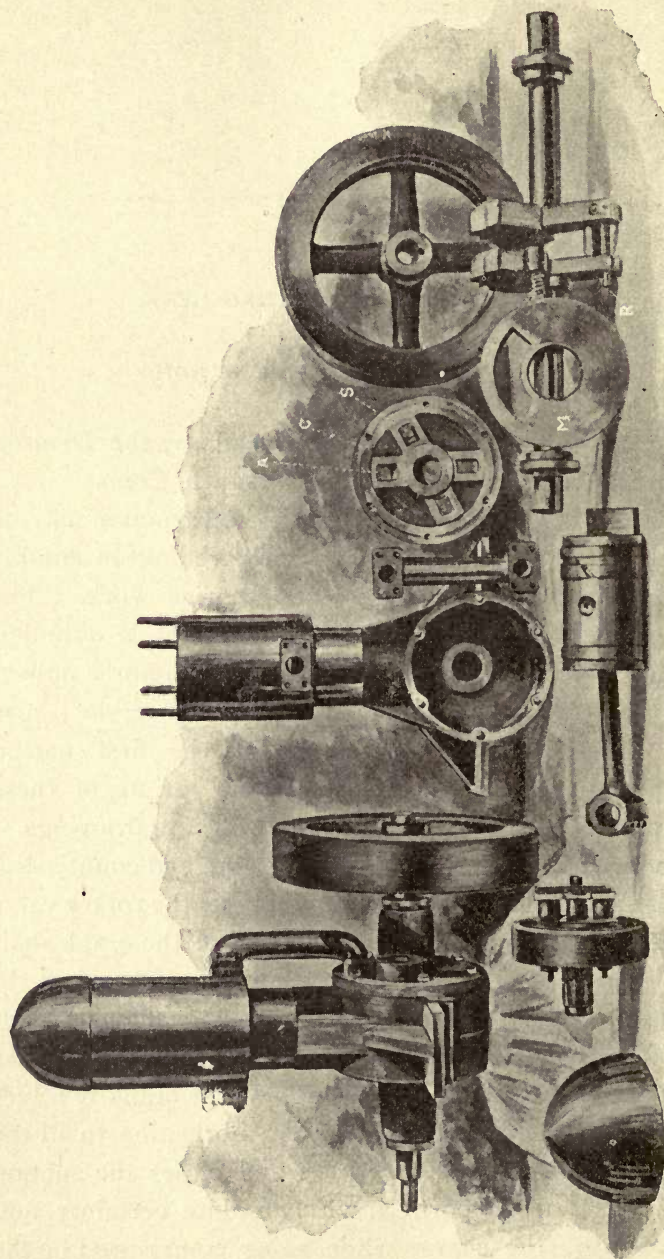


FIG. 104.—THE "YALE" TWO CYCLE GASOLINE MOTOR.

base, from blowing up the transfer pipe and around the sides of the piston, and out of the exhaust port, as the packing rings on the bottom of the piston cannot prevent this side leak. As soon as a piston wears even a small amount, this leakage is bound to take place, and is sure to produce loss of power, and even prevent the engine from running unless provision is made for preventing it. The rotary valve, *M*, is subjected to only nominal wear, as the compression in the crank case does not exceed fifteen pounds, and only the cold charge and oil come in contact with it. The valve, *M*, also is so arranged that it makes a perfect seat, and would continue to do so even should the crank shaft wear badly out of line. The remainder of the parts hardly call for further explanation. One feature of very great importance, however—the constant down-thrust—is in marked contrast to engines of the four-cycle type. In four-cycle engines the slightest lost motion in the connecting rod or bearings requires instant adjustment, otherwise the engine will pound itself, while in this engine, the thrust always being down, will not pound, and no damage will result even after parts and bearings are badly worn. Stuffing boxes are provided at the ends of bearings or baffle rings on the crank shaft, so the charge cannot leak out, no matter how much the bearing and shaft should wear.

The system of vaporization consists essentially of a supply tank, which is somewhat lower than the vaporizing receptacle, and a gasoline circulating pump, which, while the engine is running, pumps a small amount of gasoline into the receptacle which is attached to the air suction pipe. In order to make this reliable, the pump pumps faster than the gasoline is used, the surplus flowing back into the tank. This results in an absolutely even height of gasoline in receptacle, irrespective of vibration, and, as there are no

valves in this receptacle, there is nothing to get out of order.

The air is drawn into the suction pipe through openings, and siphons up the exact amount of gasoline, which is adjusted by a micrometer screw, and one adjustment only, is necessary for a given engine.

The speed of the engine is controlled by two throttling valves on one stem, operated by a hand lever. These valves so adjust the flow of air that the proper amount of gasoline is siphoned up so as to make a perfect explosive mixture under all conditions, whether light or heavy explosions, slow or full speed, hot, cold, damp or foggy weather. No change or adjustment is required from summer to winter running, as the explosive mixture is further mixed and also warmed, by the violent agitation it receives at the crank case, previous to its transfer to top side of piston, and subsequent compression before the explosion takes place. This method admits of the use of less volatile and cheaper grades of gasoline than can be employed where the carbureting system is used.

The sparker is of the make and break type, with an adjustable and instantaneous snap motion, which is worked from the outside of the cylinder by a connection from the eccentric which operates the gasoline and water circulating pumps. This type of sparker is found to be the most durable, the least liable to become over-heated, and the most economical of current. The adjustment or timing of the spark can be regulated to a nicety, while the engine is running; a convenience when engines are being adjusted to some special class of work, as the timing of the spark is a very important item in the efficiency and in speeding the engine. The sparker is so economical of current that almost any form of battery will answer; a good dry battery, or Samp-

son Batteries give excellent results, although we recommend the Edison Lalande Battery as more durable and satisfactory in the long run.

RUNNING GEAR OF A FRENCH GASOLINE CARRIAGE.

In Fig. 105 is illustrated the carriage gear made by Chesnay, De Falletane & Co., Dijon, France. The motor is of the air-cooled type, and set vertically in the fore box, which is also used as a seat.

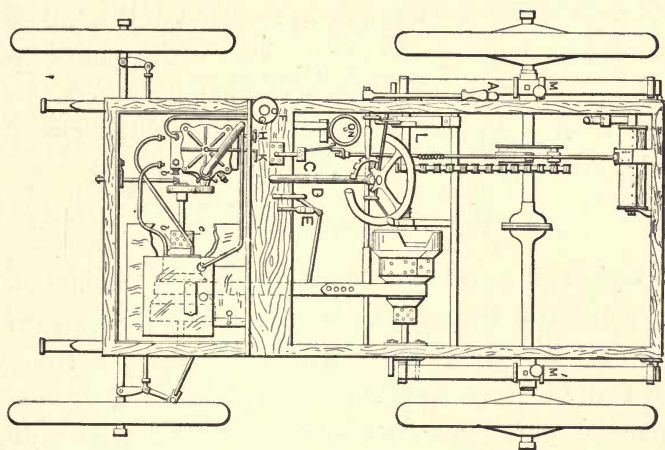


FIG. 105.—THE MOTOR VOITURETTE.

In addition to the rib flanges, the sprinkling cylinder cooling device, illustrated in Fig. 106, is used, and which also illustrates the vaporizing and air-mixing device. In the transmission mechanism four speeds are provided. The motor shaft is pinioned to a counter shaft, on which is mounted a four step cone pulley, connected by a single belt to a similar pulley on a second counter shaft. A belt-tightening pulley is controlled by a foot pedal. The difficulty of shifting the belt on step cone pulleys is overcome by coning the steps, so that the shifting fork will carry the belt from

one step to another with ease. As the tightening pulley is let go, the slack in the belt allows it to readily follow the shifting fork without strain.

From the counter shaft the power is transmitted by sprockets and chain to the rear axle, which is provided with a compensating gear. A friction clutch in the second counter shaft pulley is operated by a toggle joint link and the lever handle at *A*, at the side of the seat; its further movement operates a band brake on the second counter shaft. A band brake on the driving axle at the side of the sprocket is operated by the foot pedal at *C*. At *K* is the handles of the cylinder relief cock, and the index handle at *H*, sets the vapor and air mixer at *G*, as illustrated in the cut of the cylinder cooling device, Fig. 106.

NOVEL CYLINDER COOLING DEVICE.

In Fig. 106 is shown the method of cylinder cooling devised by the Borguignonne Automobile Company, of Dijon, France. By this arrangement a three horse-power motor could be kept sufficiently cool by the use of less than a gallon of water for a 200-mile run, thus largely reducing the weight of water otherwise stored in tanks and air-cooled coils. The cut shows the relative conditions of the system of using the heat of the exhaust for vaporizing the gasoline, and at the same time for producing pressure in the water tank to make an intermittent forced spray upon the wing flanges of the cylinder. In operation, the exhaust passes from the cylinder through the pipe, *B*, to the muffler tank, *O*, and from the opposite end turns down towards the ground. The pressure in the exhaust pipe is sufficient to force part of the exhaust through the small pipe, *D*, to the vaporizer at *B*, and using part of the heat of the exhaust at *F* to keep up the temperature in the vaporizer and transmit

a modified pressure to the water tank, *H*, through the small pipe, *J*. A double-barrelled cock, at *G*, acting as a diluter, is operated by the driver through two levers and link rods, which regulates the quantity and proportion of air and vapor.

The pressure of the exhaust in the water-tank, at *H*, which is located so that the water will not siphon over through the spray pipes, produces a spray flow with each exhaust through the nozzles at *V* and *W*, so distributed that the water will flow over the surface of the wing flanges.

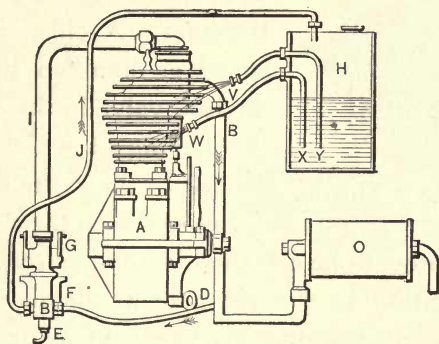


FIG. 106.—CYLINDER COOLER.

It is now well understood that the greatest economy and power in explosive motors is not derived from excessively cool cylinders, but better working effect and increased power can be obtained with cylinder temperatures near to the water-boiling point.

GASOLINE VEHICLE MOTORS.

The Lowell Model Company, Lowell, Massachusetts, manufacture small gasoline motors for tricycles and very light carriages. Fig. 107 is their three-quarter actual horse-power motor, which is of the two cycle compression type, having an impulse at each revolution and is reversible. The cylin-

der, which is of the ribbed or air-cooled type, is contained in one casting with the crank chamber, three-inch diameter by three-inch stroke of piston; extreme height, 14 inches;

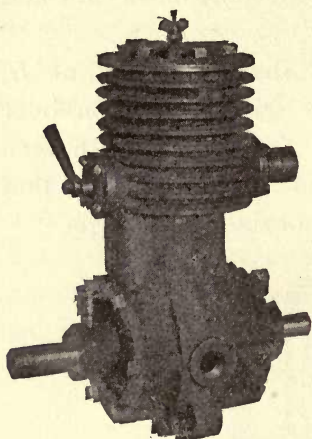


FIG. 107.— $\frac{3}{4}$ H. P. MOTOR.

width over bearings, $8\frac{1}{4}$ inches; length of shaft, 12 inches; weight, without fly-wheel, 46 pounds. If extreme lightness is required, aluminum is used in some of the parts, reducing the weight of the motor to 26 pounds, which is a desirable weight for bicycles and tricycles. A close regulation of speed is obtained by a specially devised valve in the transfer port, the handle of which is shown on the left of the cylinder in the cut.

Lugs cast on the crank chamber allow the motor to be attached in any desired position on a vehicle. Ignition is electric and its device is fitted for either the jump spark or a sparking coil, as desired.

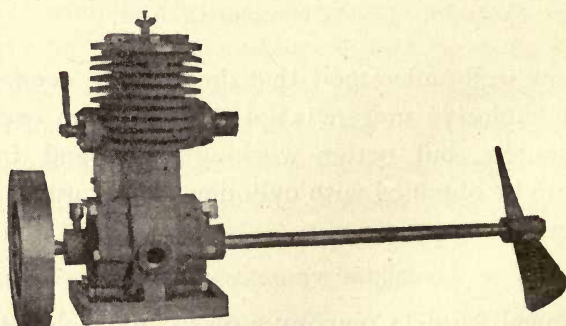


FIG. 108.—THE MARINE MOTOR.

A specially devised mixing valve is used by which the gasoline is atomized and vaporized to obtain the best results with variable charges for speed.

The company also furnish these motors with extended shafts (Fig. 108) for boats of light build from 12 to 14 feet long. When used for that purpose they are fitted with a base, thrust collar and wheel. They also furnish other sizes, with single and double cylinders, up to six horse power.

THE STRAIGHT LINE DUPLEX MOTOR.

Fig. 109 illustrates a form of gasoline four cycle motor of French origin, and now adopted, with modifications, in England and the United States by a number of motor carriage builders. The cylinders are offset just enough to allow of a double crank at 180° , so that ignition may take place at the same instant, thus almost entirely eliminating vibration; or ignition may be made alternately with a two cycle effect.

The cylinders are air-cooled by radial ribs, which are found efficient on the smaller sized motors for carriages and tricycles.

The Crest Manufacturing Company, Dorchester, Massachusetts, are building motors similar to this pattern with modified details for carriage and cycle builders.

To prevent an explosive engine from vibrating, it is not only necessary to perfectly balance all moving parts, but also to balance the explosive impulses. It is a well-known law of mechanics that "action and reaction are equal and opposite." When firing a gun the explosive force tends to propel it in the opposite direction to the projectile. The same action applies to the explosive engine; the force of the impulse tends to throw the cylinder and bed in the opposite

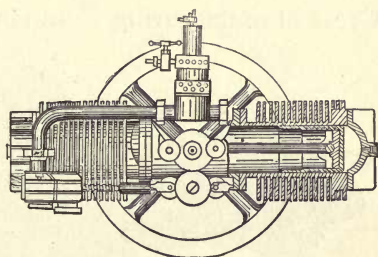


FIG. 109.—THE STRAIGHT LINE DUPLEX MOTOR.

way to that which propels the piston, and to cause it to kick or vibrate, imparting the motion to the carriage in which it is fixed. Now, if two cylinders be tied together with forward ends towards each other and opposite, an equal explosion taking place in each cylinder simultaneously, moving the pistons to meet each other, there will obviously be no kick or reaction of the cylinders and body of engine, because the impulse in one will be counteracted by the impulse of the other, but the impulses must be equal and take place exactly together.

THE CREST DUPLEX MOTOR.

The straight line duplex gasoline motor, made by the Crest Manufacturing Company, Dorchester, Massachusetts,

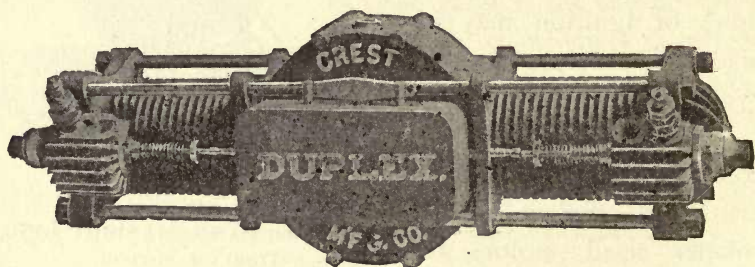


FIG. 110.—THE DUPLEX MOTOR.

is illustrated in Fig. 110. It is a well designed motor for carriages, weighing less than 92 pounds, and develops nearly 4 horse power. They also furnish a $2\frac{1}{4}$ -horse power motor for tricycles.

This motor is air-cooled by convection ribs on cylinders and valve chests ; is crank balanced, and is of the four cycle type, giving a crank impulse at every revolution.

The electric ignition is so arranged that a large variation in speed may be made by deferred sparking, and a division of power also may be made by the ignition in one cylinder

only, which makes this a very desirable motor for automobile vehicle power.

This company furnish drawings for complete running and power gear to customers preferring to assemble their own vehicles. They furnish the motor, induction coil, battery, vaporizer and muffler, with plans and instructions for light carriages of the runabout style that are suited to the wants of carriage builders or amateurs.

We illustrate the method of attaching the motor in Figs. 111, 112 and 113 for a two-seated tricycle and a buggy or runabout.

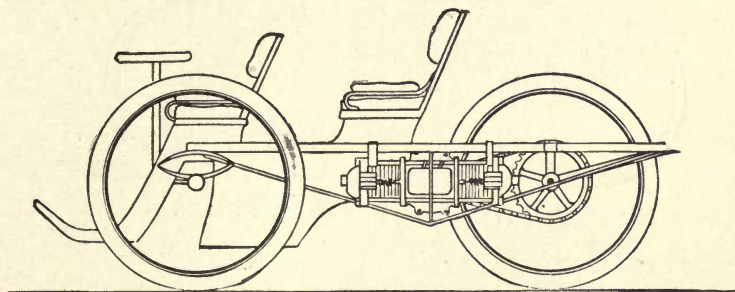


FIG. 111.—THE TRICYCLE DESIGN.

The cut of tricycle shown is the easiest and cheapest to construct, and it has but three wheels, has no differential gear, and the frame is of the most simple character.

The frame is of steel pipe, $1\frac{1}{2}$ inches diameter, No. 12 gauge; front axle, $1\frac{1}{2}$ inches diameter, 12 gauge, reinforced. The under brace is $\frac{3}{8}$ -inch rod, solid steel. The motor is attached direct to the driving wheel. There are two seats, one behind the other; there being less air resistance on this account.

The duplex 4 horse power will give all the power required for these types of vehicles.

The frame work of a carriage is built of steel tubing, $1\frac{1}{4}$

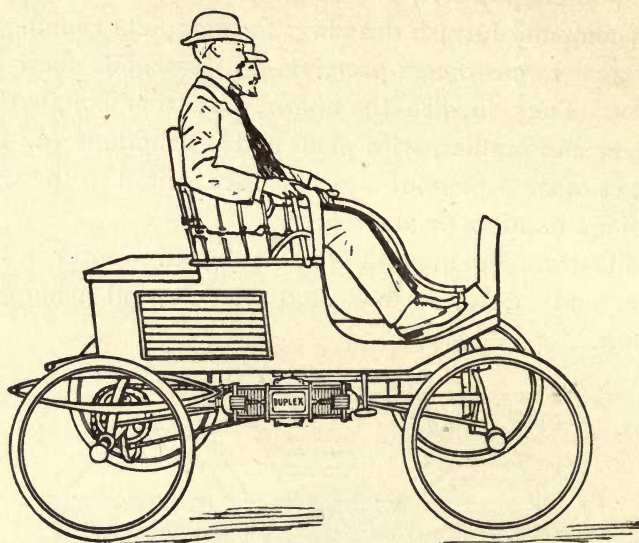


FIG. 112.—THE RUNABOUT DESIGN.

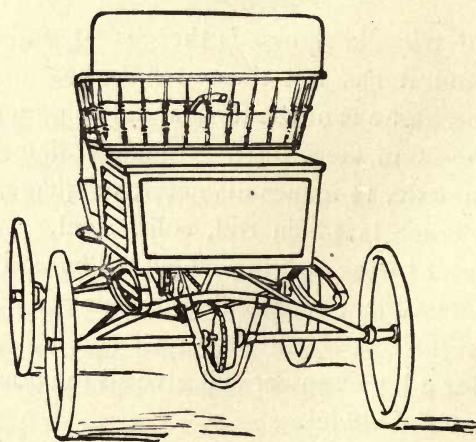


FIG. 113.—REAR VIEW.

inches in diameter, using No. 12 gauge. All joints should be pinned and brazed. Girder construction should be used, as it is well known that this method secures the greatest strength, with the least weight of material, and it is the

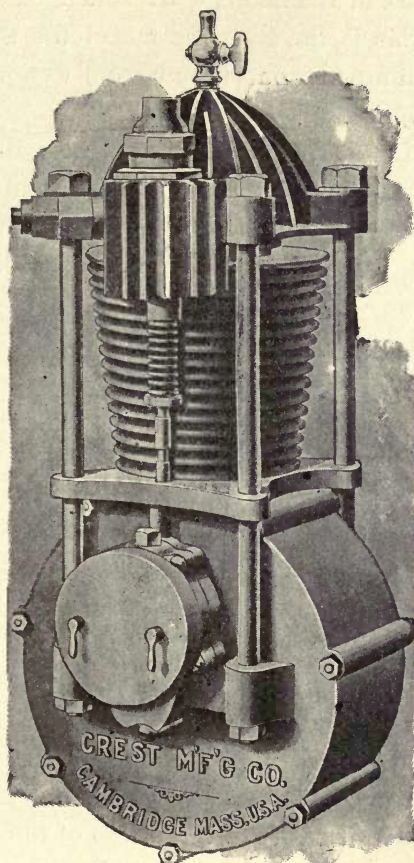


FIG. 114.— $2\frac{1}{4}$ H. P. MOTOR.

cheapest and simplest to manufacture. The frame can be reinforced at any point by cores of wood. All the diagonal and short braces are $\frac{3}{8}$ -inch steel tubing, 18 gauge. The rear axle should have all bearings of either the roller or ball

type of the most approved construction. The differential gear should be so constructed that a band brake can be used. The two main braces are constructed of ash or hickory.

The wheels should be either metal or wood rims, steel spokes, 28 inches in diameter, with 2-inch or 2½-inch pneumatic tires. This is the standard wheel for the light automobile, and can now be purchased from various dealers in automobile supplies.

The Crest Manufacturing Company also build a single cylinder, 2½-horse power motor, to be set in a vertical position, and designed on the same lines of construction as the Duplex, that is well adapted for tricycles or very light vehicles.

This is illustrated in Fig. 114. It will be noticed that both the duplex and the single motors have their cylinders, cylinder heads and crank chambers put together with four through bolts, which is a great convenience in separating the parts for cleaning or repairs, as also contributing largely to the lightness of construction so desirable in the motors for carriages.

VEHICLE MOTORS OF THE QUICK MANUFACTURING COMPANY,
PATERSON, N. J.

In Fig. 115 is illustrated the phaeton of this company, and in Fig. 116 the gasoline duplex motor, which is water jacketed, of the four cycle type, placed horizontally, having lugs, as shown, to attach it easily to the frame of the vehicle. The valves are operated by cams on a shaft across the cylinder heads, which is rotated at half speed by a chain from a sprocket wheel on the crank shaft. The spark-igniting device is operated by miter gears on the valve shaft.

The two-cylinder motor is of four brake horse power at 700 revolutions per minute.

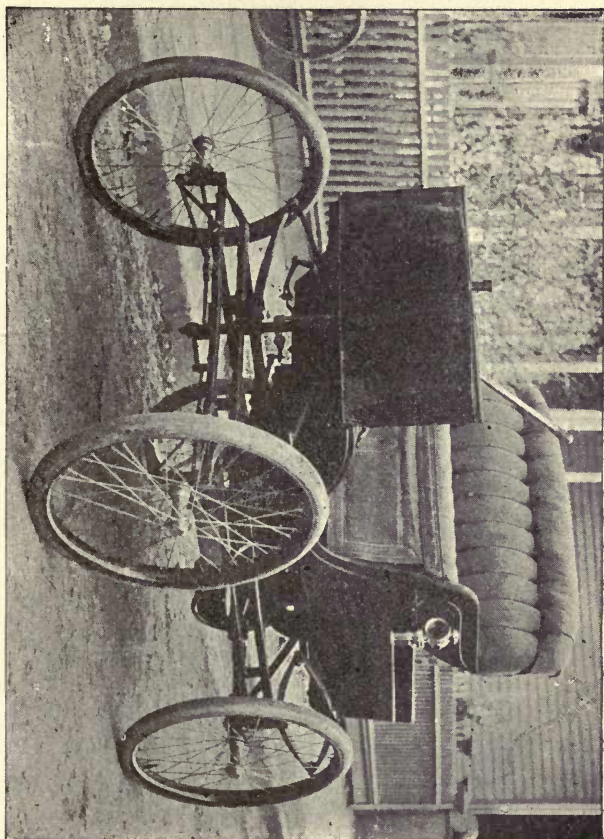


FIG. 115.—THE QUICK GASOLINE MOTOR VEHICLE.

Its dimensions, as shown in Fig. 116, are $27\frac{1}{2}$ inches long, 18 inches wide by 4 inches high, and weighs 249 pounds, and has an enclosed crank chamber.

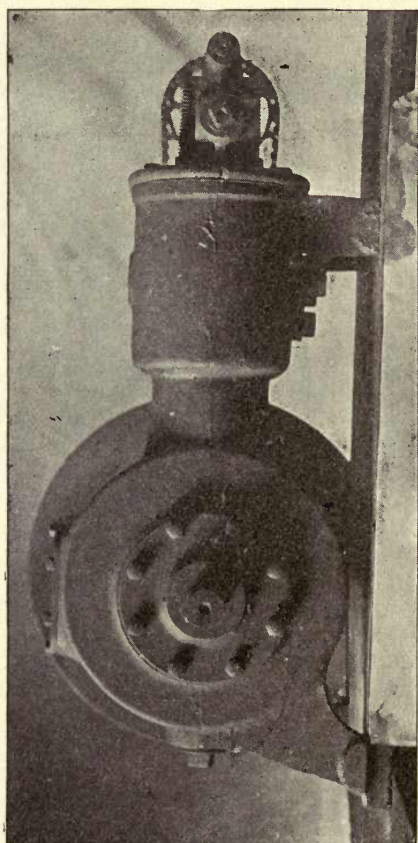


FIG. 116.—THE QUICK MOTOR.

This company build the motors and entire motor equipment for parties who desire to assemble their own motor carriage.

Chapter XI.

AUTOMOBILE BICYCLES AND TRICYCLES.

THE AUTOMOBILE BICYCLE—THE GASOLINE MOTOR BICY-
CLE—THE BOLLEE GASOLINE TRICYCLE—THE PY MOTOR
TRICYCLE—THE ARIEL MOTOR QUADRICYCLE—THE
AUTOMOBILE FORE CARRIAGE—THE PENNING-
TON MOTOR TRICYCLE—THE PENNINGTON
RACING TRICYCLE—THE DE DION-BOU
TON TRICYCLE—THE ORIENT QUAD-
RICYCLE, TRICYCLE AND TAN-
DEM—THE CANDA AUTO-
QUADRICYCLE.

CHAPTER XI.

AUTOMOBILE BICYCLES AND TRICYCLES.

THE AUTOMOBILE BICYCLE.

In Figs. 117 to 120 are represented one of the German gasoline motor bicycles, made by Wolfmuller & Geisenhof, Munich, Germany. A large number of bicycles of this type are in use in Germany and France. In ordinary appearance it is that of an ordinary wheel of the lady's type, with exaggerated dimensions. Upon looking at it, the eye is struck by two peculiarities. The hind wheel is not, like the front one, mounted with spokes, but is solid and formed of two disks; and the machine is lower than ordinary models. This peculiarity is justified by the resistance that it is necessary to give a wheel, light upon the whole, that is actuated by two pistons which sometimes furnish as high as 2 horse power. So the rider, seated on the saddle and his two feet placed at the sides of the frame upon stationary stirrups, has only to stretch out his legs to find the ground.

The steering is done as in the ordinary bicycle, and with so much the more ease and fewer chances of sliding, in that the center of gravity of the apparatus is placed much lower than usual. The total weight of the vehicle is, nevertheless, not great, since, when ready to operate for long stretches, it does not exceed 110 pounds. The speed is easily regulated at from 3 to 24 miles an hour by means of a

button placed under the thumb of the rider; the noise and odor of the motor are almost nil; powerful brakes render the cyclist always master of his machine, even in the steepest descents, and that, finally, so many valuable improvements are united in this vehicle, which has not yet reached its perfection, that it is bound to meet with success.

If we remove the covering plates from this bicycle, we first come across (Fig. 118) quite a complicated mechanical

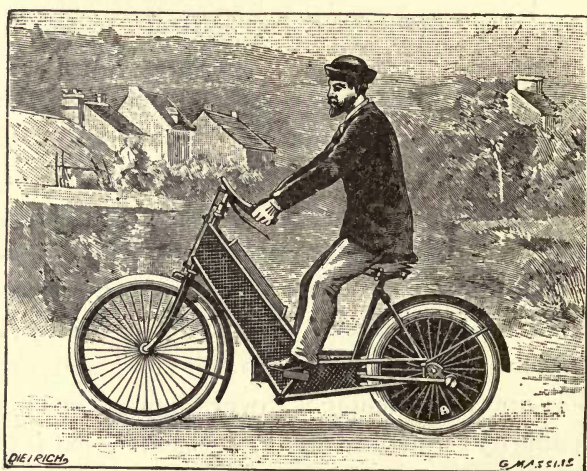


FIG. 117.—THE GASOLINE MOTOR BICYCLE.

apparatus, the too numerous details of which we have simplified for the clearness of description. The frame of the machine is formed of eight tubes, four on each side (*CD*, *DE*, *FG*, *GH*, for example, on the right side) connected by various crosspieces (such as *GD* and *EH*) that consolidate them. These tubes are brazed together as in bicycle construction, and are assembled by sockets, *D*, *G*, etc., in a tight manner, since they communicate with one another and serve for the circulation either of the water necessary for the cooling of the cylinders or of the oil to reduce friction.

The wheels are provided with pneumatic tires. The steering wheel, *B*, oscillates as usual around the axis, *CF*. The driving wheel, *A*, whose center is at *I*, is provided with a

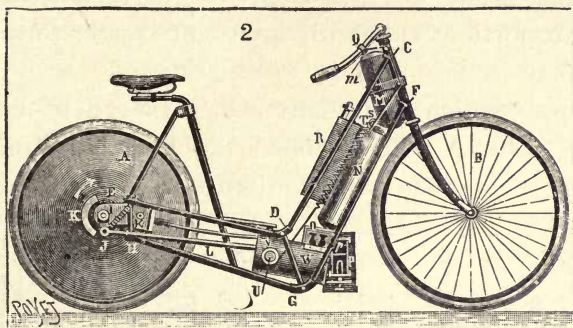


FIG. 118.—VERTICAL VIEW.

firmly fixed cam, *K*, the use of which we shall see further along.

All the essential parts are placed in the interior of the frame and are, consequently, protected against damages caused by a collision, fall, etc.

The gasoline reservoir, *M*, is located behind the head of the bicycle, and may be filled through the capped hole, *m*,

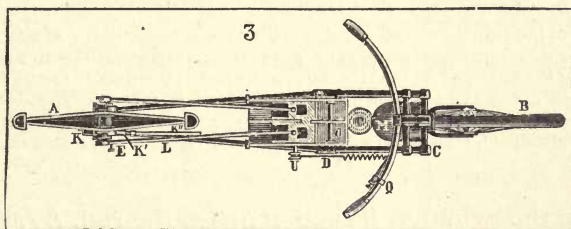


FIG. 119.—PLAN.

Details of the parts. Side and plan views. *A*, driving wheel; *B*, steering wheel; *C*, *D*, *E*, *F*, *G*, *H*, frame tubes; *M*, gasoline reservoir; *N*, evaporator; *O*, valve box; *P*, lamp and ignition chamber; *q*, ignition tube; *R*, water reservoir; *S*, cock for regulating the entrance of gasoline into the evaporator; *T*, funnel of the evaporator; *U*, regulator of water for cooling the cylinders; *V*, distributing mechanism; *W*, cylinders; *XY*, connecting rod, *K*, cam; *K'*, roller; *K''*, valve rod; *L*, piston rod.

with a quantity of liquid sufficient for 120 miles. The gasoline falls, drop by drop, into the evaporator, *N*, in passing through the cock, *S*, and the funnel, *t*. Through a simple mechanism, shown in Fig. 120 (4), the gas mixed with air in proper proportions enters the ignition chamber through the valves, *O*.

A lamp, *P*, which continually keeps at a red heat a small platinum tube, *p*, placed above the flame, produces the explosion of the detonating mixture. The piston is thus

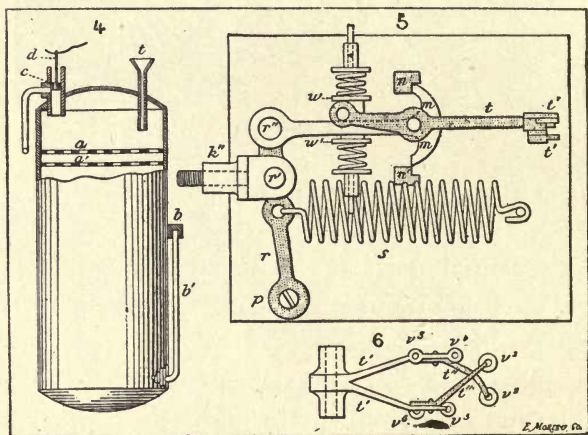


FIG. 120.—MECHANISM OF THE BICYCLE.

- (4).—Details of the evaporator—partial section: *t*, funnel for entrance of gas; *a*, *a'*, etc., gauze for accelerating evaporation; *b*, *b'*, tubes for entrance of the air; *c*, piston for admitting the mixture into the valve box; *d*, its rod. (5).—Details of the distributing mechanism: *K''*, extremity of the actuating rod; *r*, *t*, levers; *p*, *r'*, *r''*, joints; *s*, spiral spring; *w*, *w'*, supports of the spring; *n*, *n'*, stop block. (6).—Details of the various valves: *v¹*, *v²*, ignition valves; *v³*, suction valve; *v⁴*, *v⁵*, emission valves; *v⁶*, air valve.

driven in the cylinder, *W*, and actuates the rod, *LJ*, which is aided in its return motion by a powerful rubber spring, *EJ*.

As may be seen, the principle is not new, the details of its application alone possessing a real originality. The governing of the motor is, in fact, put at the disposal of the rider, in a very simple and certain manner. To the handle bar, to

the right, at the level of the thumb, is fixed a threaded piece, Q , which controls a cord running upon pulleys and connected with the cock that regulates the flow of the gasoline, the valve that admits the gas into the ignition chamber, and, at U , with the valve that allows water to flow from the reservoir, R , for cooling purposes. The opening or closing of these parts can be done gradually by the progressive screwing up or unscrewing of the threaded nut. The rider thus gradually accelerates or slackens the speed of his machine; but a sudden stoppage can also be effected through the freeing of a spring arranged around the regulating piece, and which, allowing it instantaneously to fall to the end of its threading, closes all the communications at the same time.

The most important control given to this handle-bar piece is that of the entrance and exit of the evaporator, N (Fig. 118). The latter is thus named because the gasoline falling drop by drop through the funnel, t , evaporates therein. A succession of gauze sieves, a, a' , placed one above another in the cylinder, offers therein the greatest surface of evaporation possible. The external air which, through its mixture with the gas, is to produce the detonating mixture, enters the cylinder through a capsule that prevents the suction of impurities and dust. The admission of the mixture into the valve chamber, is regulated by the piston, c , whose rod, d , is placed, like the gasoline cock, under the control of the rider. If, then, the latter completely closes the cock, he thus also closes the admission tube at the same time. The gasoline ceases to fall upon the gauzes, and the mixture to enter the ignition chamber, and conversely.

We have seen how the production of the mixture is obtained and rendered regular, and it now remains for us to remark how the mechanism of its distribution is made. The

ingenious mechanism here employed is designed to open the two admission valves at once, at the moment desired, and by the use of a single lever. The cam, K (Figs. 118 and 119), fixed upon the disk wheel, A , and carried along in its revolution, frees, in passing, the roller, K' , mounted upon a guide block that transmits motion to the valve rod. It is this rod that, at V , actuates the distributing mechanism, which it is impossible to represent in Fig. 118, and the principal details of which are shown in Fig. 120 (5 and 6). This mechanism is installed upon a plate that forms a cover for the cooling box of the cylinders. It is constructed as follows: The extremity of the rod, K'' , is jointed at r' with a lever, r , that oscillates around the fixed point, p , and is continuously brought back to its normal position by a spring, S , as soon as the passage of the cam, K , over the roller, K'' , has made it lose it.

The extremity of this lever, r , is jointed at r'' to another lever, t , whose extremity commands, at t' , the valves represented in Fig. 120 (6). At about its center, the lever t (5), is jointed again to a crosshead, m , and held upon it with hard friction by two spiral springs. This head engages with the blocks, n and n' , which are provided with corresponding notches. The central part of the lever, t , is thrust alternately against w and w' . On another hand, the levers, t' (6) carry at their extremity another small lever, t'' , which controls the valves, v^1 and v^2 , leading to the ignition chamber. Owing to this arrangement, the lever, t , of one of the cylinders causes, at the same time, the ignition in the conjoined cylinder.

If now, we suppose that the cam, K , carries along the rod, K'' , it will be seen that the lever, t , will recoil and carry with it one of the levers, t' . The crosshead, m , engages at the same time with the block, n , and compresses the

spiral spring which is located behind the piece, *w*. But as soon as the spring, *S*, acts, it brings the lever, *l*, to the front and causes the head, *m*, to engage at *n*, carrying with it the second lever, *tt'*, and reciprocally.

These points in the operation of the various parts are better shown in the following cuts (Figs. 121 to 126):

THE GASOLINE MOTOR BICYCLE.

In Fig. 121 is illustrated a side view and partial section of the present motor bicycle, made by Wolfmüller & Geisenhof, Munich, Germany. This is their latest improvement. It will be noticed that the water reservoir in this bicycle is placed over the driving wheel, acting also as a guard.

The frame of the machine is formed of four parallel tubes, two upon either side, connected with the main journal boxes of the rear or drive wheel, and united at their forward ends with two pairs of oblique tubes connected by cross bars at the top, and carrying the steering head, in which is received the shank of the front fork, as in an ordinary bicycle.

Between the two pairs of horizontal bars are secured two motor cylinders, formed in one casting and provided with a water jacket. The cylinders contain pistons connected by piston rods with the crank on the main shaft. The bearings of the crank pins, as well as the bearings of the main shaft, are rendered nearly frictionless by the use of balls, as in the bearings of an ordinary bicycle. The cylinders are single acting, and the cranks, which are on opposite sides of the rear wheel, are parallel, and extend in the same direction. The motors work on the four cycle principle, and are so timed as to give one effective impulse for each revolution of the drive wheel.

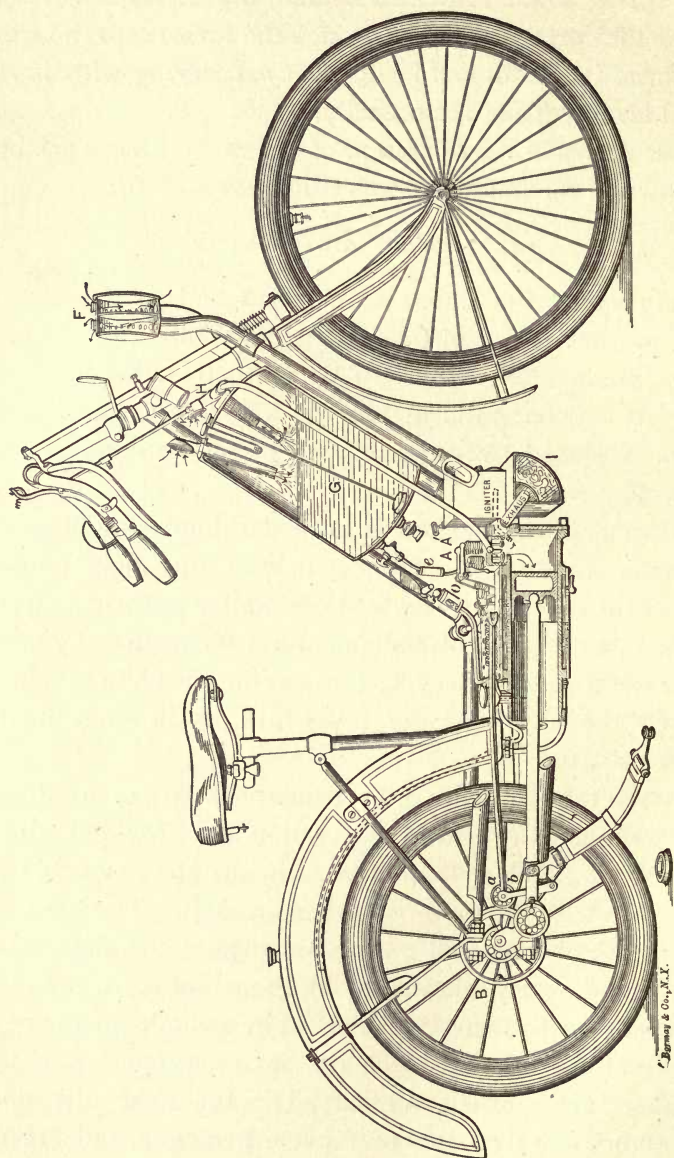


FIG. 121.—THE GASOLINE MOTOR BICYCLE.

Wolfmüller & Geisenhof, Munich, Germany. The latest pattern.

The gasoline is contained in the reservoir, *G*, Fig. 121, supported by the oblique tubes at the front of the machine. This reservoir is connected directly by the small pipe, *e*, with the burner which heats the ignition tube. In the top of the reservoir, *G*, is inserted a screw-capped filling tube, *f*, Fig. 122, the lower end of which is covered with wire gauze.

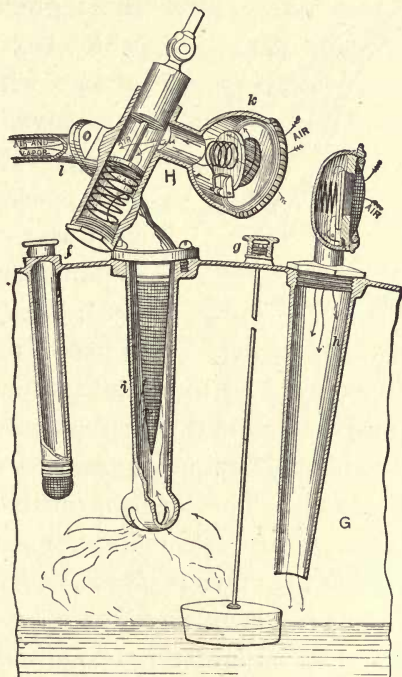


FIG. 122.—THE VAPORIZER.

To the top is attached a screw-capped nipple, *g*, through which extends a wire, having on its lower end a cork float, by means of which the depth of the liquid in the reservoir is ascertained.

A conical air supply tube, *h*, projects into the reservoir, and is provided at the top with a hood, through which air enters into the reservoir. The hood is furnished with a

check valve, which keeps the tube closed, except when a partial vacuum is formed through the action of the motor. The tube, *i*, projects into the reservoir, and is provided with a hollow spherical lower end, in which is formed a transverse slot. In this tube is inserted a wire or gauze cone,

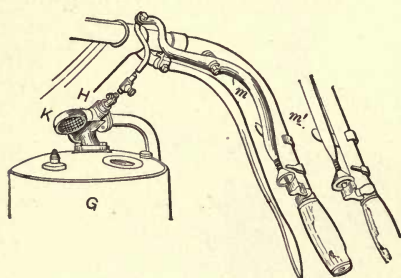


FIG. 123.—HANDLE BAR AND VALVE CONTROLLER.

connected at the top to the regulating valve, *H*, which latter also communicates with an air supply valve, *k*. The regulating valve, which is thin, is arranged to slide over the opening which communicates through the pipe, *l*, with the sup-

ply side of the valve casing. The proportion of gasoline vapor and air conveyed to the motor depends upon the position of the valve, *H*, and this is regulated by the lever, *m*, pivoted to the handle bar and connected with the valve, *H*, by a rod (Fig. 123). The lever, *m*, at its free end has a latch which is arranged to pass under a lug projecting from the handle bar when the valve is closed, and when the lever

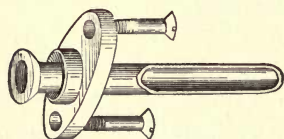


FIG. 124.—THE TUBE IGNITER.

is released to open the valve, the regulating cone screwing on to the end of the lever rests against a finger projecting from the handle bar, and serves to adjust the position of the valve by engagement with the finger as it is screwed

along the threaded end of the lever.

The ignition of the charge is effected by heating the nickel tubes projecting about $2\frac{1}{2}$ inches from the rear ends of the cylinders into the ignition box. In this box is placed

a heating vapor burner, receiving its vapor from the vertical tube at the side of the box, which contains a wick saturated with gasoline supplied from the reservoir. The tubes extend into a fire clay chamber, in which are loosely placed three nickel spirals below the tubes, for distributing and retaining the heat. The heating burner, arranged in this way, effectively heats both nickel tubes, thus insuring prompt and regular explosions. The ignition tube is provided at its inner end with a flange which is clamped in place by a yoke. The lower oblique tube on one side of the machine conveys air to the burner, and the oblique tube on the other side serves as a chimney for carrying the products of combustion from the burner. These tubes terminate in a compartmented hood, *F* (Fig. 121). The front being the inlet and the rear the outlet from the ignition box.

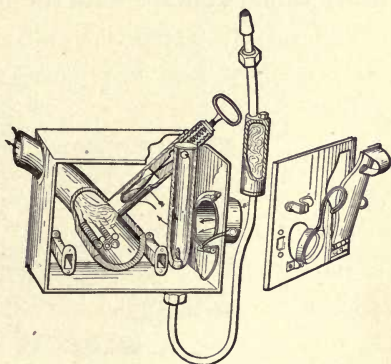


FIG. 125.—THE IGNITION BOX.

On the top of the cylinder, above the explosion chamber at the rear of the piston, is a valve chest containing two pairs of poppet valves, one pair to each cylinder. The valve chest is furnished with two separate chambers, one for the supply of the explosive mixture, the other for the escape of the exhaust, and the valves are held to their seats by spiral springs surrounding their stems, as shown. The valves which admit the explosive mixture are provided with light springs, so that when the pistons move forward the valves open inward automatically ; but the exhaust valves are furnished with heavier springs, which hold them to their seats

at all times except when they are depressed by the valve operating levers, *A*, *A'*.

These levers are made to open their respective valves in alternation by the peculiar combination of levers shown more clearly in Fig. 126. Upon the side of the rear or drive wheel is secured a cam, *B*, upon which presses a roller, *a*, carried by the arm, *b*, jointed to the lower side bar. A rod connected with the arm, *b*, is jointed to one end of the lever, *C*, the opposite end of which carries the hook, *D*. To the hook, *D*, is pivoted a three-armed lever, *F*, which is held in frictional contact with the hook by a strong spiral spring.

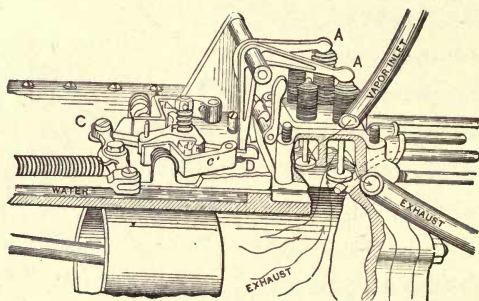


FIG. 126.—PISTON AND VALVE GEAR.

Pivoted to the top of the cylinders are two arms, *c*, *c'*, which are pressed toward the center of the cylinder by springs. The forward projecting arm of the lever, *F*, is capable of bearing against the free end of one or the other of the arms, *c*, *c'*. The shorter arms of the lever, *F*, are alternately brought into engagement with studs, *d*, *d'*, projecting from the top of the cylinders. The angled arms, *A*, *A'*, are pivoted on a rod supported by ears projecting from the cylinders, and their downwardly projecting ends are engaged in alternation by the hook, *D*. This action of the exhaust mechanism controls the machine.

The exhaust escaping through the exhaust valve is taken to a hood, *I*, made in the form of a hollow quarter cylinder, which is divided into two compartments by a perforated curved partition. The exhaust pipe enters into the smaller compartment and the larger compartment is filled with asbestos cord. The convex surface of the hood, *I*, is perforated. The asbestos cord serves as a muffler which deadens the noise of the exhaust.

Over the drive wheel is supported a curved water tank which is connected with the water jacket surrounding the cylinders, and the circulation of water serves to prevent the overheating of the cylinders. Strong elastic bands are connected with the connecting rod and with an arm mounted on a rock shaft at the top of the cylinder. These elastic bands may be put under tension to assist in starting by means of a screw at the top of the frame, which is operated by a crank and miter gear. The oil for the lubrication of the cylinders is contained in the upper oblique tube of the frame, and is fed to the cylinders by a sight feed, *o*.

To start the motor cycle, the reservoir, *G*, is partly filled with gasoline; the door at the back of the ignition box is opened and the burner for heating the ignition tube is started by giving it a preliminary heating by means of an alcohol torch. As the door at the rear of the ignition box is opened for this purpose, the air supply pipe is closed automatically by means of a connection with the rear door. When the tubes are red hot the valve, *H*, is opened, the rubber bands are put under tension and the machine is moved forward by the operator until an explosion occurs, when he mounts the machine and proceeds on his way. The proportion of the supply of air charged with gasoline vapor and pure air is regulated by the valve, *H*. By man-

ipulating the cone on the lever, *m*, the supply of explosive mixture, and, consequently, the speed of the bicycle is regulated. When fairly under way, the tension of the rubber bands is released.

The action is as follows:

The forward motion of the piston draws in the explosive mixture through the valve, *H*. On its return, it compresses the explosive mixture in the explosion chamber behind the piston, and a portion of the mixture is forced into the hot tube, where it is ignited, forcing the piston outwardly, giving the propelling impulse. The return stroke of the piston expels the products of combustion through the exhaust valve, which is opened by the cam, *b*, at the proper moment through the agency of the roller, *a*, and the hook, *D*, as already described, and the cylinders operate in alternation, thereby giving one effective impulse for each revolution of the drive wheel. To stop the machine, it is only necessary to close the valve, *H*, and apply the brake in the usual way.

The engine cylinders are $3\frac{9}{16}$ inches in diameter, with a stroke of $4\frac{5}{8}$ inches. The supply and exhaust valve apertures are $\frac{1}{2}$ inch in diameter. The gasoline reservoir is 13 inches long and $7\frac{1}{2}$ inches in diameter. The driving wheel is 22 inches in diameter and the steering wheel is 26 inches in diameter. The pneumatic tires are made specially large and heavy to support the weight of the machine and rider. The wheel base is 4 feet; weight, when in running order, 115 pounds.

The reservoir contains a supply of gasoline sufficient for a run of 12 hours. Speed from 3 to 24 miles per hour.

THE BOLLÉE GASOLINE TRICYCLE.

The elegant little tandem tricycle, Fig. 127, built by M. Leo Bollée of Mans, France, has figured largely in the French trial races. It differs somewhat in design from others in having a closed seat in front of the rear driving wheel, giving a most comfortable position for the driver.

The slight elevation of this vehicle gives it a perfect

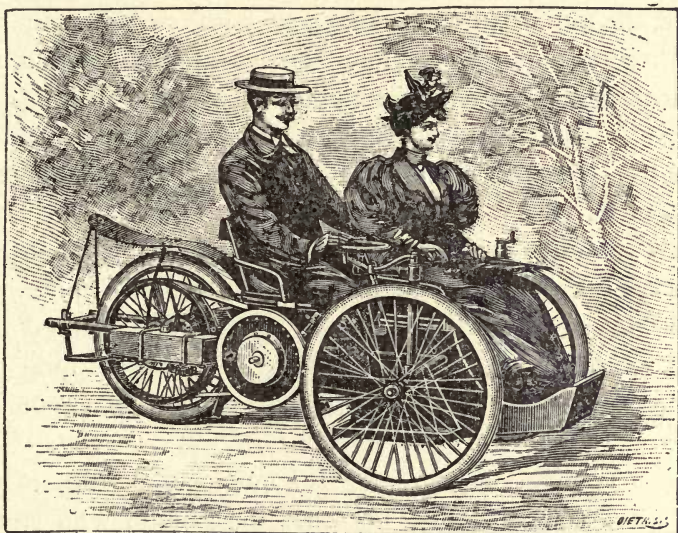


FIG. 127.—THE BOLLÉE TANDEM TRICYCLE.

stability, since its center of gravity is 16 inches above the ground. Its wheel base is $3\frac{1}{2}$ by 4 feet.

The steering is by the forward wheels with knuckle joints on the axle and jointed spindles extending upward at the sides of the forward seat, with arms and links attached to a steering wheel at the right of the driver.

The motor is of the four-cycle type with an unusually long stroke for carrying the expansion as far as practicable, and is rated at two horse power at 800 revolutions per min-

ute, at which speed the vehicle runs at the rate of 27 miles per hour.

The driver with his right hand steers the vehicle by the hand wheel, while with his left hand he holds a vertical lever which controls all the movements for regulating the running. By pushing the lever the belt is tightened to start the vehicle, after the motor has been started by the flywheel or a crank. By turning the handle of the lever to the right or left the motor is thrown into gear with one or another of the three speeds. By pulling the lever back beyond the vertical loosens the belt and applies the brake.

This vehicle weighs but 350 pounds in running order, and from its great speed for so small sized vehicle, was christened in Paris as the *road torpedo*.

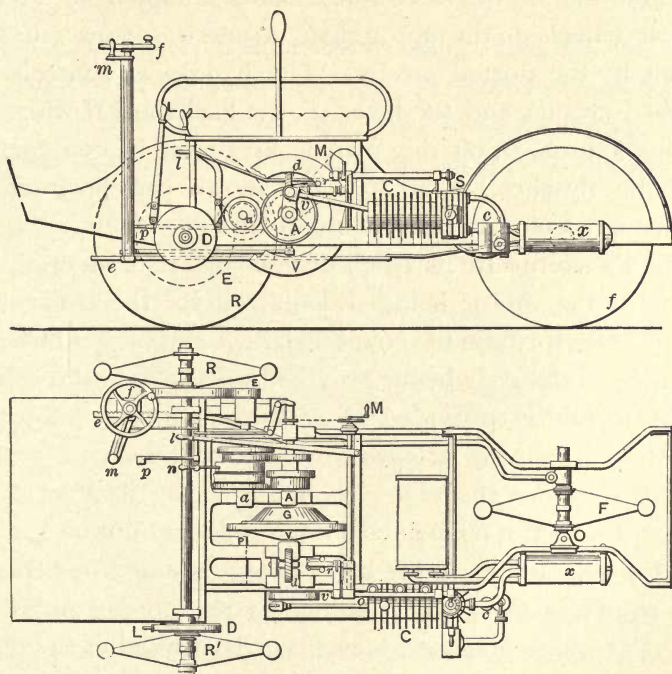
This vehicle, in 1896, was not claimed as a new invention, but rather as an assemblage of the best vehicle and motor conditions of the day for a very light, easily handled and swift roadster. All three wheels are mounted upon ball bearings and provided with Michelin removable pneumatic tires.

The accompanying figure gives an accurate idea of the Bollée tricycle. As may be seen, the person who sits in front does not aid in the steering of the vehicle. The steersman sits behind, his feet resting on each side upon a platform provided with a straw mat. He merely has to move his foot backward in order to press the lever of a powerful brake, whose block is tangent to the circumference of the driving wheel.

We may add that it carries a supply of gasoline sufficient for a trip of 72 miles, that it may be run at an expense of scarcely more than a cent a mile, and that the price of it is low enough to place it within the reach of persons of moderate means.

THE PY MOTOR TRICYCLE.

In Figs. 128 and 129 are illustrated a vertical and plan view of a motor tricycle that has lately been put on the market in France by the Compagnie des Automobiles du Sud-Ouest, of which M. André Py, the designer of the vehicle, is the manager. As will be seen from the illustrations, the



FIGS. 128 AND 129.—THE PY MOTOR TRICYCLE.
VERTICAL AND PLAN VIEWS.

vehicle has three wheels, and has seating accommodation for two riders, back to back. The motor, *C*, is of the single cylinder horizontal type, provided with radial disks for cooling purposes, and tube or electric ignition. It is capable of working up to 3 horse power. It is located on the left-hand side of the frame, with the explosion chamber at the

rear. The exhaust valve, *S*, is controlled by a small longitudinal shaft, actuated by worm gearing, *d*, from the motor shaft, *A*. A centrifugal governor, *r*, is mounted on the shaft and prevents the exhaust valve being opened when the speed of the motor becomes excessive. The muffler is located at *x*. Three forward speeds of 5, 10 and 15 miles and one backward motion are provided, these being obtained by a series of gear-wheels on the motor shaft, *A*, and the countershaft, *a*, shown by the dotted circles. The handle, *m*, controls the forward speeds, and the lever, *L*, the backward motion. A friction clutch, *G*, on the plan is arranged in conjunction with the flywheel, *V*, so that the motor can be instantly thrown out from the transmission gear.

The Py voiturette is front driven and rear steered, the power of the motor being transferred to the front road wheels, *RR*¹, through the counter shaft, *a*, and the gear wheels, *E*, a differential gear being provided on the opposite side at *D*. A handle is provided at *M* for putting the motor in operation, by means of sprocket wheels and chain, with a friction clutch on the motor shaft. Steering is effected by the hand wheel, *f*, connected by the rack and pinion gear, *e*, with the rear wheel, *F*, the latter being mounted in a special way, shown in the plan, by being pivoted on one end of its axle at *O*, which is moved forward or backward at the other end by the link rod and rack. A lever, *l*, controls a band brake on the differential gear, while a foot pedal, *p*, actuates two band brakes on the intermediary shaft, *a*. All the transmission gear is arranged under the seats, where is also located the gasoline storage tank, which has a capacity of four gallons. The vehicle is 9 feet long and 4 feet 8 inches in width, while the seats are only 4 feet above the ground. The center of gravity is quite low, making an easy mount and a safe vehicle as a business runabout.

THE ARIEL MOTOR-QUADRICYCLE.

The method of converting a motor tricycle for one person to a quadricycle for two persons, by removing the steering wheel and attaching a fore carriage with two wheels and seat, is one of the novelties brought out by the Ariel Cycle Company (Limited), of Birmingham, England, and is illustrated in Fig. 130.

The front wheel of the tricycle being removed, the arms extending from the under carriage are then fastened to the back axle sleeve of the tricycle; two tubes extending from the arms just mentioned have to be secured to the bottom

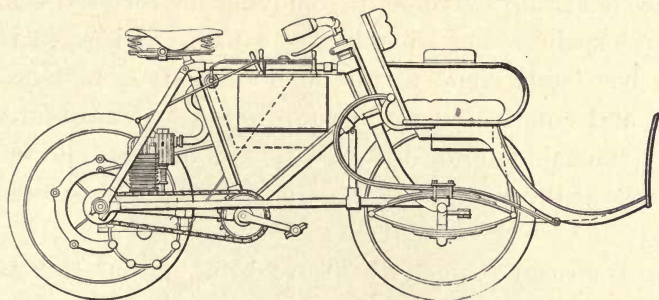


FIG. 130.—THE CONVERTED TRICYCLE.

frame tube of the tricycle by means of a clip and bolt. These three clips are all that is necessary to manipulate, and the change from tricycle to quadricycle can be made in about half an hour. The body is carried upon a set of C and elliptical springs, thus giving perfect suspension. Mud guards are provided to the side wheels, and an apron fitted to the dashboard enables the passenger to be carried well protected from wind, dust and mud. The steering is controlled by the rear rider, and is arranged in such a manner that in taking a corner the inside wheel is not parallel to the outside wheel, the two being tangent to circles having the same center, which center is on the line of the axle of the

back wheels. By this system friction is avoided, and the motor is not called upon to perform unnecessary work. The extreme length of machine, including the attachment, is 7 feet 7 inches, and width on the outside of the tricycle wheels, 3 feet 5 inches.

The running gear is very similar in detail to the De Dion and other tricycles described further on.

THE AUTOMOBILE FORE CARRIAGE.

A novel combination of the motive power with the steering wheels, making an independent driving power that can be attached to any carriage by removing the forward wheels, axle and springs, and substituting a fore carriage in their place, has lately come to public notice. It is of German origin and comes under the name of the "Kuhlstein-Volmer" detachable motor or fore carriage, and has been in use in France as the Pretot motor carriage. It is illustrated in Fig. 131.

The American company who are bringing out this automobile is the Automobile Fore Carriage Company, Astor Court, New York City.

The points claimed for it are: That it can be attached to almost any of the old horse-drawn styles of vehicles, and that one motor can be used for a half dozen different vehicles. In fact, it is virtually a motor horse, to be harnessed to any vehicle at will. The driving machinery, consisting of a four-cycle gasoline motor, with cone pulleys and belt-change speeds, is enclosed in a rectangular box or housing, central over the forward axle, and is attached to the foot board of a carriage by a fifth-wheel or bearing plates, the upper one of which may be bolted to the frame of the carriage, while the under one forms part of the housing. The two plates can turn one upon the other by means of a circle of rollers, and

the lower plate has a circular rack formed upon it which is engaged by the pinion of the steering shaft, which shaft is carried by the upper plate, and is placed conveniently to the right hand of the driver. The fore carriage motor is maintained in its proper vertical alignment by a strong, hollow pivot block, which extends upwardly from the lower bearing plate through a deep collar in which it turns in the

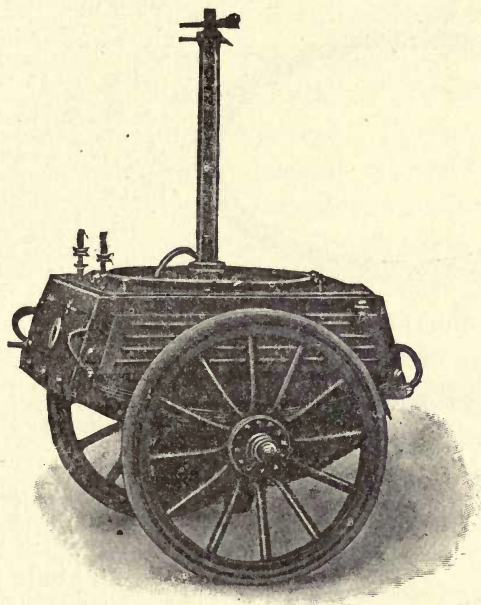


FIG. 131.—THE AUTOMOBILE FORE CARRIAGE.

upper plate. The whole construction is sufficiently stiff and strong to transmit the tractive effort of the motor to the body of the vehicle without racking the frame of the latter. The operating levers are carried up through the central pivot block, and are arranged conveniently in front of the driver.

The roller bearing fifth-wheel applicable to the fore carriage is here illustrated in its parts.

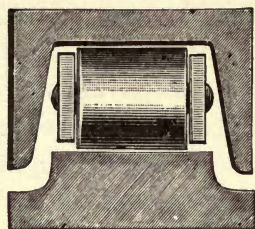


FIG. 132.—ROLLER BEARING.

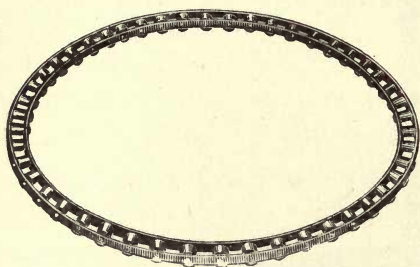


FIG. 133.—ROLLERS AND FRAME.

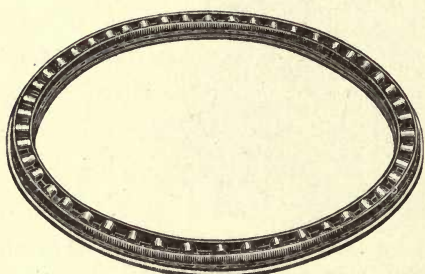


FIG. 134.—ON LOWER RAIL.

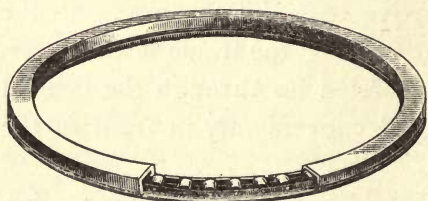


FIG. 135.—TOP CHANNEL ON.

Fig. 132 is a section showing the lower rail, a roller between its cage rings and the channeled top ring, closing over the friction rollers and cage to hold them concentric and to shut out dust and grit.

Fig. 133 shows the rollers enclosed between the rings and held in place by spindles.

Fig. 134 shows the roller system resting upon the bottom plate.

Fig. 135 the top channel ring in place with a section out in the cut to show the rollers.

The roller bearing fifth-wheel is suitable for all kinds of vehicles requiring a fifth-wheel. They are manufactured by Christian Nielson, 745 Third avenue, Brooklyn, New York City.

THE PENNINGTON MOTOR TRICYCLE.

The illustrations, Fig. 136, shows an elevation, and Fig. 137, a plan of a tricycle for four persons, as built at Coventry, England.

It has the most compact form for its carrying capacity of any motor vehicle as yet brought out. Its weight is about 280 pounds, with dimensions allowing it to pass readily through ordinary doorways. A two-cylinder motor, acting on cranks at 180° , gives a fair balance for a four-cycle impulse. A center line fly-wheel, with double chain and sprocket wheels, transmit the power to the rear wheel. The front wheels in independent sockets are operated by rods extending to the arms at the bottom of the handle bar axle.

The speed, controlling and steering gear is operated by the driver on the rear seat by the vertical lever and the bicycle arms. The bicycle pedals and chain connections with the motor counter shaft give the driver perfect control in starting and stopping independent of the brake. The vehicle is started by means of the pedals by the driver after the passengers are seated, thus obviating the disagreeable vibration when the vehicle is standing.

The pedal shaft sprocket has a silent ratchet, so that the driver can use the pedals for a foot rest and be always ready to help the motor on a severe upgrade. Great ease and comfort is derived from the easy spring saddles and large-sized pneumatic tires.

The gasoline is stored in the elevated tank from which the motors are supplied. Electric ignition is used.

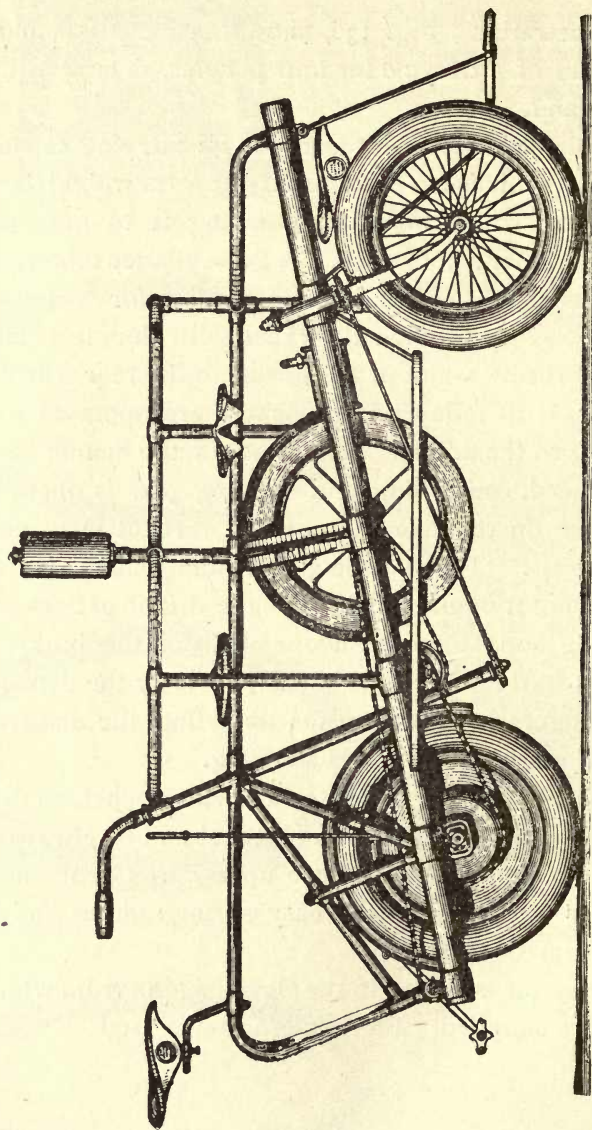


FIG. 136.—PENNINGTON MOTOR TRICYCLE—ELEVATION.

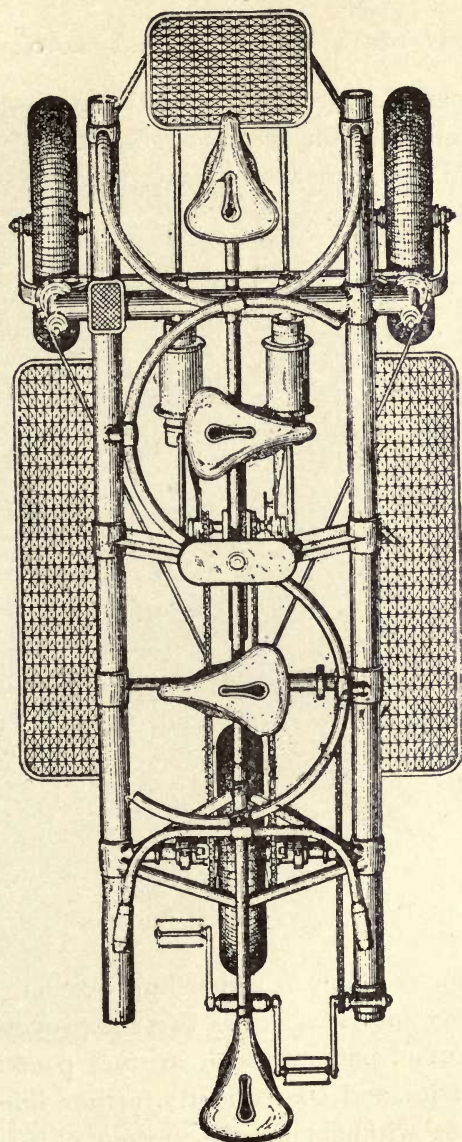


FIG. 137.—PENNINGTON MOTOR TRICYCLE—PLAN.

THE ANGLO-AMERICAN RAPID VEHICLE COMPANY.

THE PENNINGTON & BAINES GASOLINE MOTOR VEHICLES.

This company has brought to the United States a number of motor vehicles of the gasoline motor type. They are of English build, and somewhat heavier than the same style of vehicles built here.

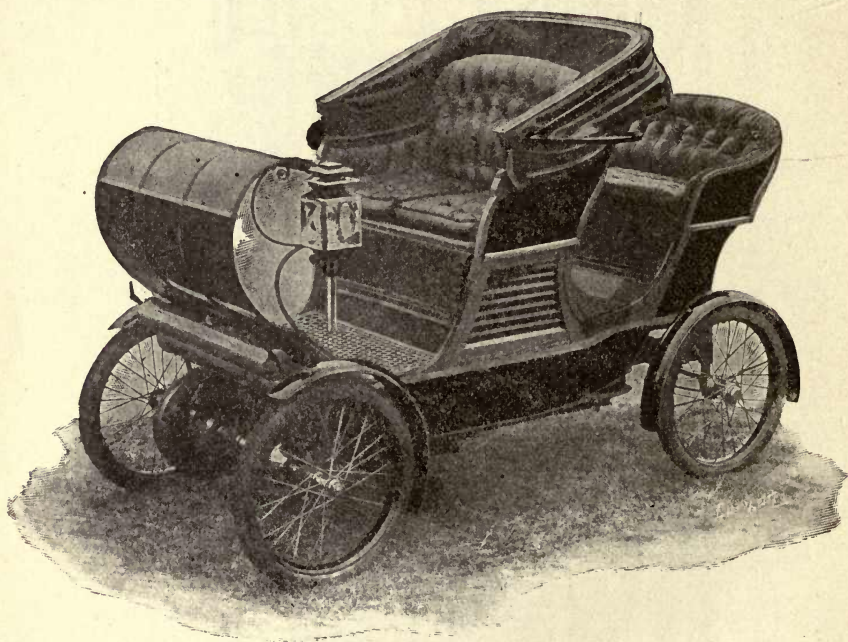


FIG. 138.—VICTORIA DE LUXE.

There are many points in which improvements have been made in these vehicles; some of these improvements forming the subject of patents which are yet pending in some foreign countries, and consequently further information on these points is withheld for the present. It is generally known, however, that in the Pennington motor the use of a carburetor is avoided, and yet, because of the method

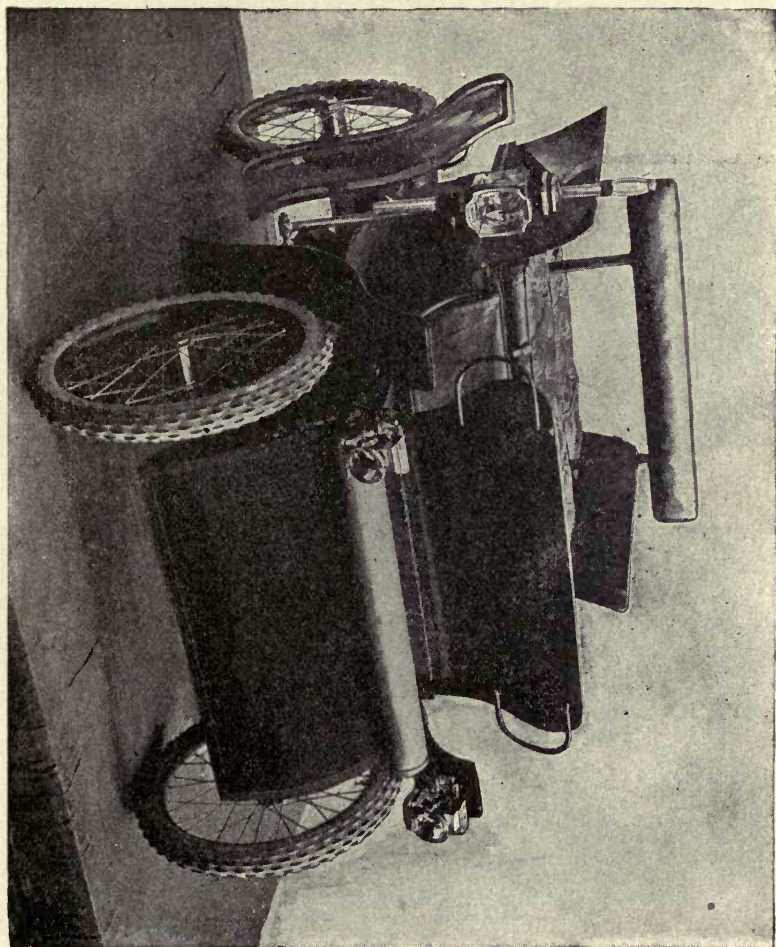


FIG. 139.—THE "UNIVERSAL," OR DOG-CART.



FIG. 140.—A PENNINGTON RACING TRICYCLE.



FIG. 141.—A SNAP SHOT—FORTY MILES AN HOUR ON A CURVE.

employed for feeding the gasoline into the cylinder, not only is perfect combustion secured, but every drop of gasoline is utilized, and the maximum power is developed from the amount of the hydro-carbon consumed.

The power is conveyed from the motor to the front axle of the car by either belt or rope, which can be tightened, if needed, even when the carriage is running, and without

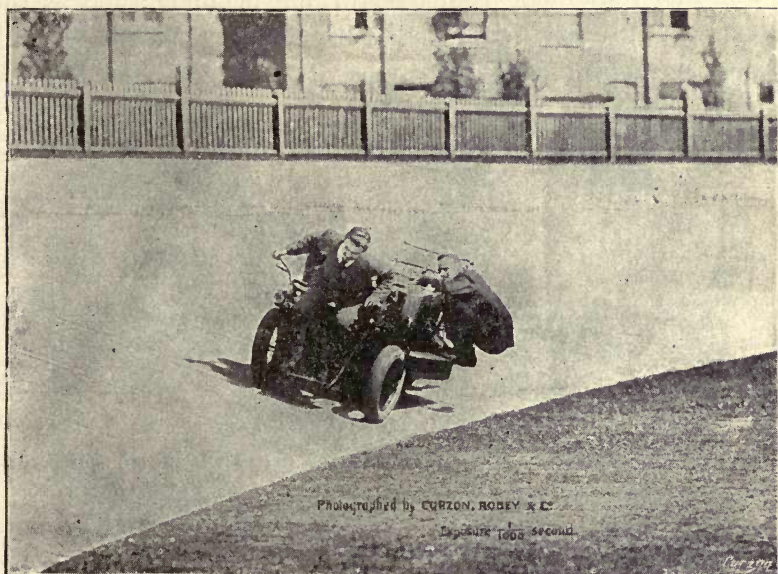


FIG. 142.—COUNTERBALANCING CENTRIFUGAL FORCE.

stopping the vehicle. Motor carriage drivers, who have been troubled with a slipping belt, and whose only remedy was to stop the carriage, cut a piece out of the belt and splice it up again—an operation occupying with most people twenty minutes to half an hour—will appreciate the advantage of being able to take up any slack in the belt instantly.

Besides the positive speeds obtained by changing the gears, any intermediate speed can be obtained by the regu-

lation of the gasoline supply, it being passed to the motor from the tank in which it is stored through a needle valve, and a quarter turn of the valve handle, conveniently placed within reach of the driver's hands, will decrease or increase (depending on which way it is turned) the gasoline supply, and the result on the motor is instantaneous.

With the Pennington vehicles the makers confidently claim absolute immunity from overturning accident; and as the center of gravity is only some few inches from the ground, and the wheel base being long, it is almost impossible to upset; indeed, the stability is so great that the vehicle can be swung round in a narrow road when going at high speed,—a feat which would be impossible in a heavy vehicle standing high from the ground. The steering is effected by means of the back wheels, the front wheels being driven, and this is a reversal of the usual practice for which certain advantages are claimed. The steering, for instance, greatly tends to prevent side-slip, and a complete circle can be made with these vehicles in a radius of about ten feet.

These racing tricycles have been much in use in England, where motor cycle racing has been in extensive vogue.

THE DE DION-BOUTON TRICYCLE.

One of the most popular motor vehicles for a single rider, in France, is the De Dion-Bouton tricycle, of the hydro-carbon motor type. It has found its way to the United States, and will, no doubt, for its lightness, speed and ease of management, become a leading light vehicle here.

In Fig. 143 is illustrated a general rear view of the tricycle, and in Figs. 144 and 145 an outside view of the four-cycle air-cooled motor.

In Fig. 146 is shown the details of the motor and the method of its operation.

The tricycle is provided with pedals, sprockets and chain for starting and as a means for returning home, if by accident the motor becomes inoperative, or as a help in ascending steep grades. The motor is journaled upon the sleeve of the main axle, as shown by the brackets, Fig. 144, and connected to the lower member of the frame by a link. It

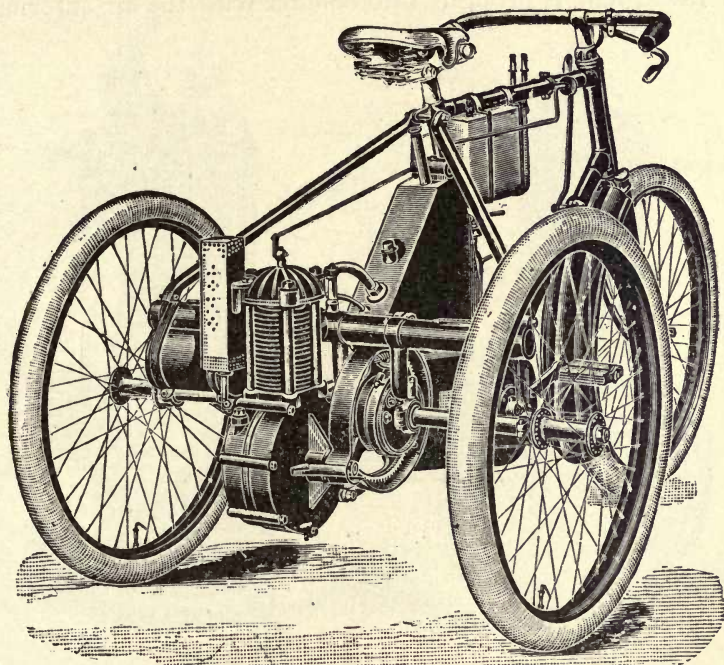
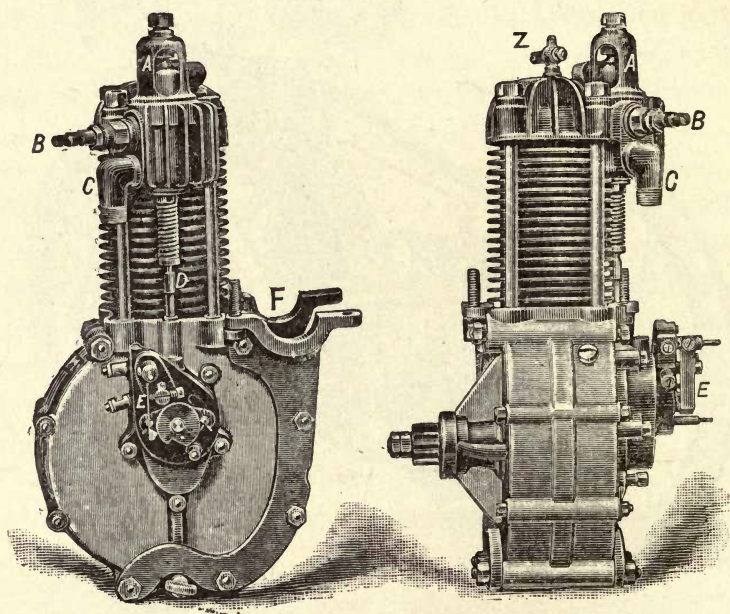


FIG. 143.—THE DE DION-BOUTON TRICYCLE.

is geared to the differential gear train by a pinion for the proper speed, which is regulated by the vapor and air inlet valves operated by and connected to the small handles shown on the upper cross bar of the frame. Referring to the motor, Figs. 144 and 145, *A*, is the charge admission valve; *B*, the electrode plug; *C*, exhaust pipe; *D*, rod and spring of the exhaust valve; *E*, electric contact breaker. A

handle on the front frame operates the relief cock, *Z*, to admit of a free movement of the piston when starting and when pedaling without the motor power.

The action of the motor will be seen by referring to the diagram shown in Fig. 146. To the left is the vaporizing chamber or carburetor, in which the gasoline contained in the lower half is brought into contact with the air entering



FIGS. 144 AND 145.—THE DE DION-BOUTON MOTOR.

by the tube, *A*, and made to pass between the horizontal plate, *B*, and the surface of the liquid; the carbureted air then rises, as shown by the arrows, and enters the double valve, *C*, shown below in detail, by which it is mixed with an additional quantity of air, which enters by the orifice, *D*, at the top; the mixture then passes to the motor by means of the tube, *E*. The admixture of air and vapor is regulated by the handle on the left in the small diagram, while the

handle at the right regulates the flow to the motor cylinder.

The float serves to indicate the level of the gasoline in the carburetor by means of a rod which passes through the tube of admission; and the tube itself is arranged to slide up and down in order to maintain a constant difference between the

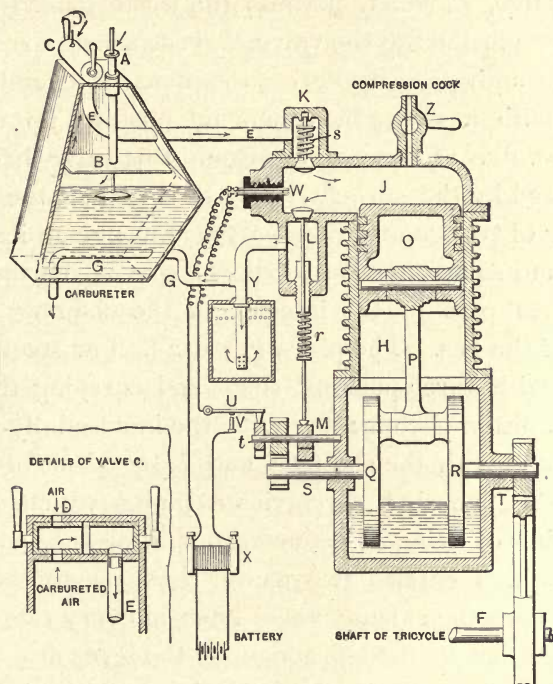


FIG. 146.—DETAILS OF MOTOR.

horizontal plate and the surface of the liquid, this plate being attached to the lower end of the tube. In order to avoid the cooling of the gasoline by evaporation, it is warmed by means of the tube, *G*, through which passes a portion of the hot exhaust gas escaping from the motor.

The cylinder, *H*, of the motor is of cast steel, with projecting flanges which serve to increase its radiating surface and

prevent overheating; above is the chamber, *J*, in which the explosion of the gas takes place; at the top of the chamber is the valve, *K*, which admits the gas coming from the carburetor; the valve is normally closed by means of the spring, *S*, whose pressure is regulated so as to allow the valve to open upon the descent of the piston. Opposite is the exhaust valve, *L*, which permits the waste gases to escape after the explosion; to the valve, *L*, is attached a rod which passes through the cover of the exhaust chamber and engages with a cam, *M*, which, by pushing up the rod, opens the valve at the proper instant, this valve being normally closed by the spring, *r*. At *W* is shown the ignitor, consisting of two copper rods passing through an insulating bushing, and so arranged as to allow a spark from the induction coil to pass in the interior of the chamber for the ignition of the gas. The piston, *O*, is a hollow steel casting provided with three packing rings, and carrying the wrist pin. The piston is connected with the inclosed fly-wheels, *Q* and *R*, and with the shafts, *S* and *T*, by means of the piston rod, *P*. The shaft, *S*, carries a pinion which engages with another of twice its diameter, operating the small shaft above, *t*, which carries two cams; the cam to the right serves to open the exhaust valve once in every two revolutions, while that to the left acts upon the lever arm, *U*, carrying the contact, *V*, of the induction coil, by means of which a spark is caused to pass at *W*, thus igniting the gas contained in the chamber of the motor.

This induction coil is operated by four dry batteries. From the preceding description the action of the motor will be readily understood. When the piston descends, it produces a vacuum in the top chamber, by the action of which the valve, *K*, opens, admitting the detonating mixture from the carburetor; when the piston rises, it compresses this gas

and the valve of admission closes. At the instant of the second descent of the piston the cam actuates the lever, making contact with the induction coil, upon which a spark passes, causing an explosion of the gas, which pushes the piston with sufficient force to cause it to pass twice through the same position; when the piston rises after its descent, it compresses the residual gases of explosion, and at this instant the cam, *M*, lifts the exhaust valve and the gas leaves the motor by the exhaust pipe, *Y*. When the piston redescends, this valve closes and the upper valve opens, as before, to admit a fresh supply of gas and so on.

The discharge box, or muffler, is shown attached to the exhaust pipe, *Y*, in the diagram, and at the left of the cylinder, in Fig. 146. The two series of perforations in the muffler produce almost a noiseless exhaust.

The maximum speed of the tricycle is 24 miles per hour, and grades of 8 to 10 per cent. may be mounted without the aid of the pedals.

The Waltham Manufacturing Company, of Waltham, Mass., sells the product of De Dion-Bouton & Co. in the United States, and in addition to selling the regular machines now manufactured by De Dion-Bouton & Co., they will import the De Dion motors, and make a complete line of "Orient motor cycles and motor carriages." They are now building tricycles, trailers and attachments, tandems and a light carriage.

VEHICLES OF THE WALTHAM MANUFACTURING COMPANY,
WALTHAM, MASS.

The illustration, Fig. 147, shows the Orient quadricycle, which in principle and mechanism is the same as their tricycle, and shows the detachable parts for conversion into a quadricycle fitted. This machine meets the requirements of

those who want a small light automobile for two, and one that is well adapted to all kinds of road use.

It is built on sound mechanical lines, and of very rich finish. The extra wheel that is supplied can be easily fitted to convert it into a tricycle.

These vehicles comprise a line of gasoline-propelled automobiles which have recently been placed on the market by the Waltham Manufacturing Company, Waltham, Mass., of Orient Cycle fame. Their mode of propulsion is by the

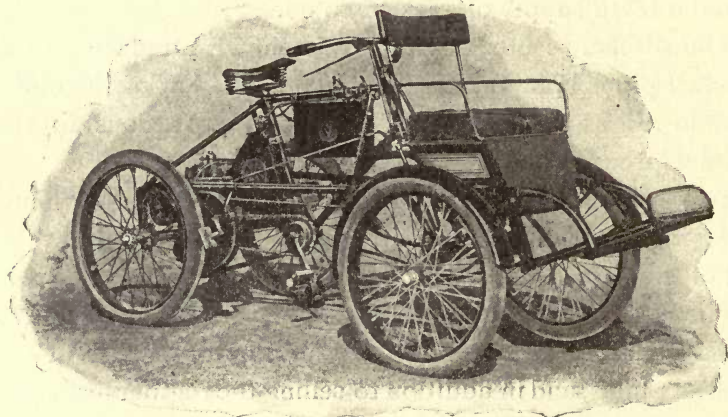


FIG. 147.—THE ORIENT QUADRICYCLE.

French De Dion-Bouton motor, which represents a large percentage of the total number of tricycle motors in use and their popularity is explained in their own simplicity. They are not only simple in construction, but very inexpensive to run, and the result obtained seem to give the best of satisfaction.

The principle of this motor is as follows: The vapor that rises from the gasoline in the carburetor, and with a mixture of air, is sucked into the motor by the piston. At the moment the charge is compressed by the return of the pis-

ton, an electric spark, which is worked automatically, and receives its current from the induction coil and small dry battery, explodes the gas, and the piston is forced into action. Upon its return the gases of combustion are expelled, and then a fresh charge enters as before. The radi-



FIG. 148.—CHANGING THE RIG.

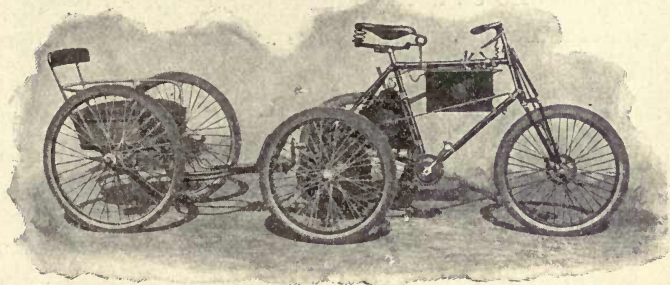


FIG. 149.—TRICYCLE AND TANDEM-TRAILER.

ating flanges on the motor cylinder serve to throw off the heat, and thereby eliminates the use of a water jacket.

The cost of feeding a motor of this kind is quite small. A gallon of gasoline will supply power for about 50 miles, and can be obtained at almost any place.

The popularity of the motor tricycle in Europe served as the best introduction it could receive into this country ; and

it is now classed among our leading styles of automobiles. Among its many good features is that it can be converted into a tandem quadricycle by simply removing the front wheel and substituting the fore wheels and seat, which are furnished with the combined vehicle; or else a trailer can be attached if desired.

The motor being placed below the rear axle brings the weight of the machine, which is proportionately distributed, close to the ground, and thereby insuring the greatest safety. The carburetor, battery and other parts are placed in convenient positions in line of the frame, and the rider has full control of the machine in his left hand, where a simple turn of the handle-bar grip connects and disconnects the current.

With a little assistance from the rider by the use of the pedals, steep hills can be ascended without difficulty, and the pedals can also be used to increase the speed.

The general arrangement of the motive power is shown in Fig. 146.

Fig. 148 shows the facility of arranging the detached running gear and seat forward from the motor, and in Fig. 149 is shown the trailing attachment of the second seat and wheels following the tricycle.

THE CANDA AUTO-QUADRICYCLE.

In the design of this unique motor vehicle, the running gear differs somewhat from the French and English models of the De Dion tricycles. It is built by the Canda Manufacturing Company, Cartaret, N. J.

It is, as illustrated in Figs. 150, 151 and 152, a most convenient tandem rig for two persons, one in front in a comfortable buggy seat; the other on the saddle, steers the vehicle and controls the gasoline motor.

The central frame, which carries the saddle, is of steel tubing, constructed on bicycle lines, to which is affixed the steering handles and the pedals for starting the vehicle. Outside of this a curved frame of angle iron connects the front and rear sections of the vehicle, forming a light and stiff structure.

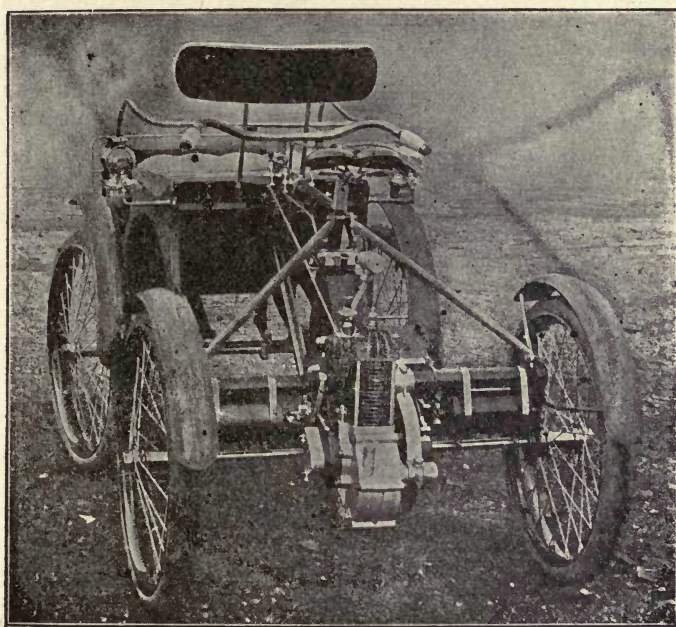


FIG. 150.—REAR VIEW OF THE AUTO-QUADRICYCLE.

The quadricycle tracks 36 inches in width, with a 46-inch wheel base, and measures $7\frac{1}{2}$ feet in length over all.

The wheels are 26 inch diameter, of the tangent spoke tension type, with $2\frac{1}{2}$ -inch pneumatic tires. When charged ready for service it weighs 350 pounds.

The motor is of the four-cycle type, with air-cooling flanged cylinder mounted just back of the rear axle and geared direct to the differential gear box. A band brake is

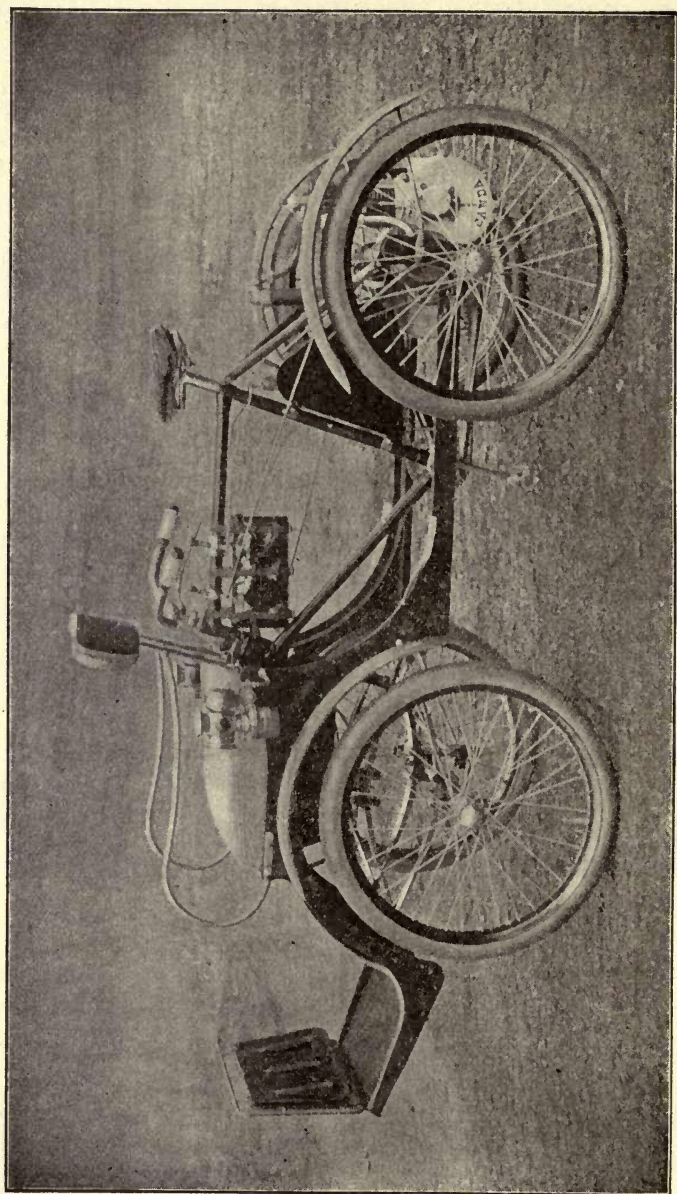


FIG. 151.—THE CANDA AUTO-QUADRICYCLE.

controlled by a lever under the handle bar. The motor is of $1\frac{3}{4}$ horse power, and controlled by varying the charge, giving speeds of from $2\frac{1}{2}$ to 25 miles per hour. The general details of the motor management are similar to the De Dion-Bouton tricycle, illustrated in Fig. 146.

The steering is by rod connection from the handle bar

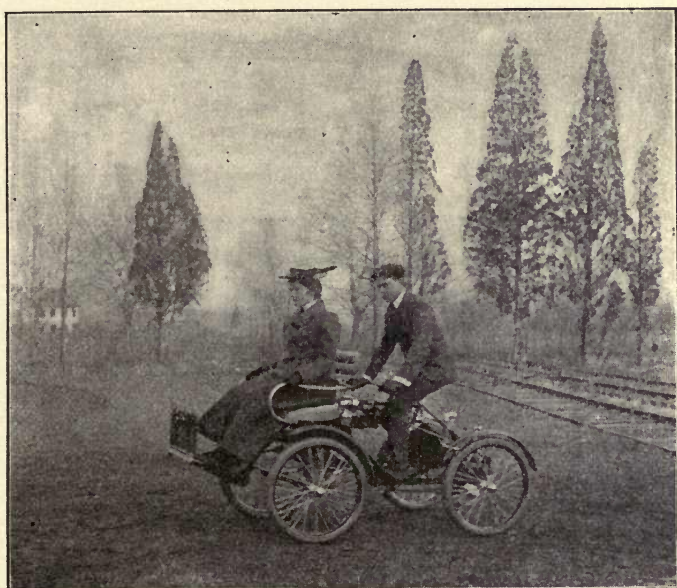


FIG. 152.—THE AUTO-QUADRICYCLE ON THE ROAD.

spindle to the arms of the front axle pivots at the hubs of each wheel.

Chapter XII.

GASOLINE MOTOR CARRIAGES AND VEHICLES.

THE BOULEVARD SURREY—THE PETTER GASOLINE CARRIAGE—
THE BERGMAN MOTOR CARRIAGE—THE CLEMENT GASO-
LINE VEHICLE—VEHICLES OF THE INTERNATIONAL
MOTOR WHEEL COMPANY—THE WALTERS SIN-
GLE DRIVING WHEEL—THE UNDERBERG
VOITURETTE—MOTORS AND VEHICLES
OF THE AUTOMOBILE COMPANY OF
AMERICA—THE GROUT GASO-
LINE MOTOR CARRIAGES.
THE SINTZ GASOLINE MOTORS AND VEHICLES—THE MUELLER
MOTOR CARRIAGES—THE HERTEL MOTOR CARRIAGES—
THE WINTON MOTOR CARRIAGES—VEHICLES OF THE
AUTO-CAR COMPANY AND THE PITTSBURG MOTOR
VEHICLE COMPANY—VEHICLES OF THE DUR-
YEA MANUFACTURING COMPANY, SPRING-
FIELD, MASS.—VEHICLES OF THE
DURYEA MANUFACTURING COM-
PANY, PEORIA, ILL.—THE
GENERAL POWER COM-
PANY AUTOMOBILE
MOTOR.

CHAPTER XII.

GASOLINE MOTOR CARRIAGES AND HEAVY VEHICLES.

The more substantial automobile vehicles for pleasure and park riding, for touring and for heavy traffic—the coach, delivery wagon, the omnibus and the truck—are fast taking a leading place in our larger cities, and, as in England and on the continent, their expanding usefulness is noticeable throughout the country. The doctor, in either city or country, can now step into his buggy, ready harnessed, and be off; can make his round of calls in the quickest time, and does not even mind a long drive that would jade a horse. The fire chief reaches his call in less time than ever before. The ambulance is always ready for the start, and makes quick time on its call. The cab, omnibus and truck can now stand upon the street with no one to watch the horses. The stand is unfouled, and cleanliness follows their tracks. Each of the kinds of motive power is cleanly in its habits, and as each has its special radius of power and endurance, their progressive march of usefulness will go on and find their great calling as sure as has been the progress of our railways. Good roads must lead the way—the rest will soon follow.

Horseless vehicles will become the feeders to our railway systems, and thus the network of communication will become complete, and the old horse stages will be but a memory of the past.

Breaking away from our transient reverie and getting back to solid facts, we sketch the French park wagon for four passengers, with a rear elevated seat for a driver.

The motor is placed beneath the driver's floor, and the middle seat turns over as shown by the dotted lines, for examination of the motor and speed gear. A panel also can be opened under the driver's seat to give a full view of the operating mechanism. These vehicles are largely in use in

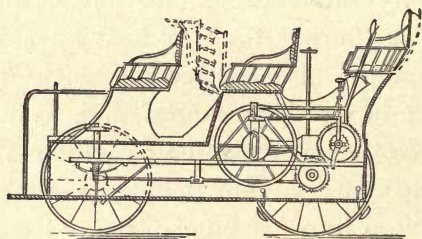


FIG. 153.—THE BOULEVARD SURREY.

France for riding parties, and will soon be seen and appreciated in the United States.

THE PETTER GASOLINE CARRIAGE.

An English design of a motor carriage plan and driving gear is illustrated in Fig. 154, and the gasoline motor in Fig. 155. The motor is placed over the driving axle. From the crank shaft a sprocket wheel and chain transmits the power to a friction sprocket, *E'*, running loose on the counter shaft and pressed by the double friction disks, *F, F*, by the operation of a push rod through the hollow counter shaft and bell crank lever, *W*, terminating in a handle at the right of the carriage seat.

A second handle, *M*, changes the speed by moving the clutch to one or the other of the sprocket wheels, *N* and *K*.

A brake, *V, V*, is operated by a cross shaft and a handle at

G. The exhaust is controlled by the lever, *D*, and a cam on the reducing gear. The low speed gear, *L*, has an overrunning ratchet at *R*. The motor is of one horse power at 200 revolutions; cylinder, $3\frac{1}{2}$ inches diameter, 6 inch stroke, of cast iron, $\frac{1}{2}$ inch thick at the combustion end. The outer shell is of thin metal driven over the cylinder flanges.

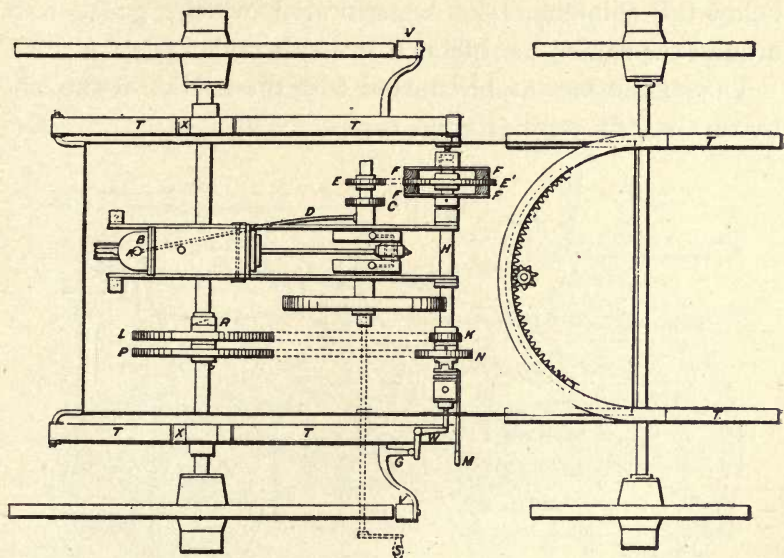


FIG. 154.—PETTER CARRIAGE GEAR.

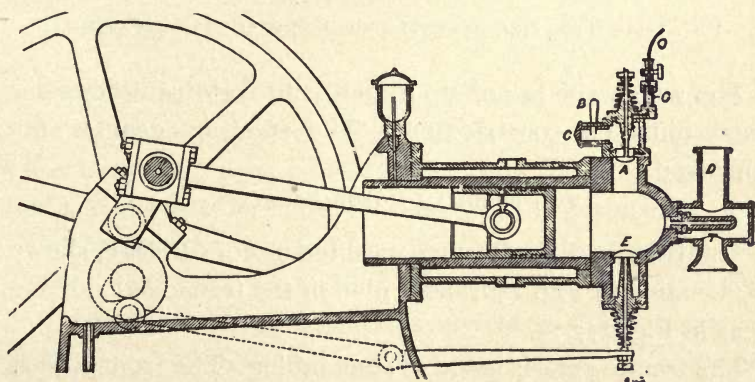


FIG. 155.—PETTER MOTOR.

The crank shaft of the motor is bored for an oil recess and plugged ; it holds oil for a day's run.

The gasoline gravitates to the inlet valve, *A*, through the perculator, *G*, and atomizes by the air drawn in through *B* by the suction of the piston. The ignition tube is of platinum, heated by a gasoline vapor jet, in the flaring recess below the chimney, *D*. A perforated or wire gauze box around the flame jet protects it from air rush.

The engine has to be started with the friction brake off, by turning the crank, *S*, Fig. 154.

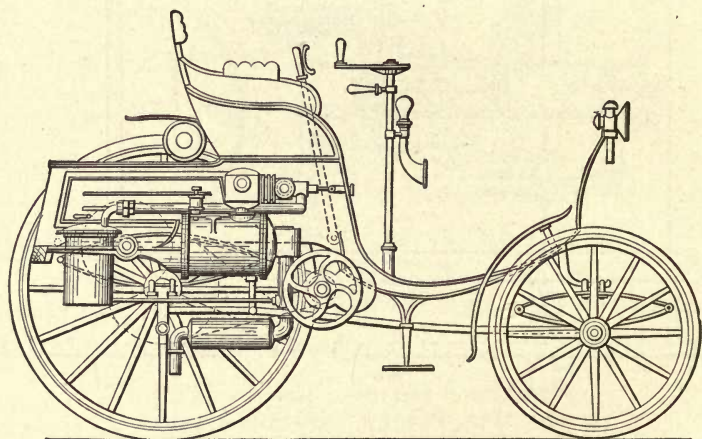


FIG. 156.—THE BERGMAN MOTOR CARRIAGE—ELEVATION.

The whole rig is not up to date, but yet furnishes some good hints on construction. The steering gear is not approved.

THE BERGMAN MOTOR CARRIAGE.

The Bergman is a German gasoline motor carriage, shown in elevation in Fig. 156, and a plan of the frame and running gear in Fig. 157.

The frame work is made of steel tubing. The front wheels are 28 inches diameter, with pneumatic tires ; rear wheels,

40 inches diameter, with solid rubber tires. The cylinder, which occupies a central position, is 5 inches diameter, $6\frac{1}{2}$ -inch stroke, developing 4 horse power at 400 revolutions per minute, and is of the 4-cycle type. The cylinder is cooled by a circulation of water from rectangular tanks on each side of the carriage, as shown in the plan, Fig. 157. A drum on the crank shaft is belted to a fast and loose pulley on a counter shaft, with a change speed gear. The top crank in front of the seat is for steering; the handle just beneath it for operating the change speed gear and for shifting the belt. A

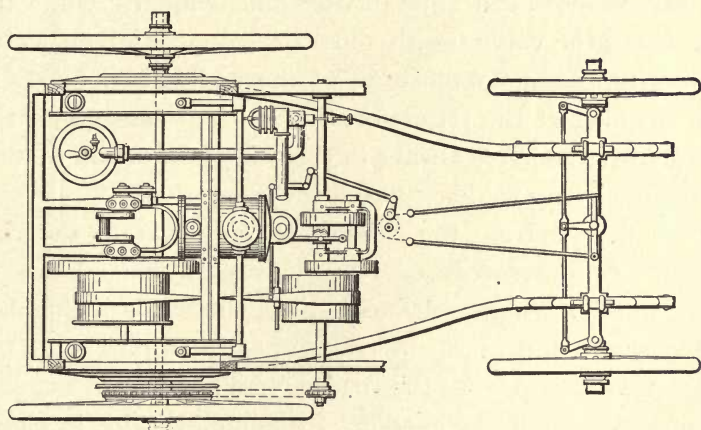


FIG. 157.—THE BERGMAN MOTOR CARRIAGE—PLAN.

small button in front of the seat operates the needle valve in the mixer, the air being drawn in through a spring valve in line with the button on left side of the seat. The gasoline tank is at the rear left side, and encloses the carburetor.

The carburetor, hanging from the rear left corner of the vehicle, contains a controlling mechanism adjusting itself automatically under all conditions of road, so that a constant mixture is supplied to the motor. This consists of a vessel containing gasoline, and suspended on levers inside a recep-

tacle. The vessel is counter-balanced by weights on the levers, or arranged as a float, provision being made for an admission valve for the liquid, an inlet for the air, and a float for effecting the admixture of the air and gas, at approximately the same height above or below the level of the liquid. This vessel may be placed on a spring for retarding its downward movement, and closing the valve when the vessel receives an excess of liquid. The valve regulating the inlet of the liquid is pressed on its seat by a spring mounted on an extension of the valve spindle, which, when the valve closes, can slide further independently while the disk keeps the valve tightly closed. A double mixing valve secures the even composition of the explosive mixture at each opening of the regulator, the width of passage for the gas mixture, which is always in the same proportion to that for the air, being regulated by a revolving slide.

A small pipe from the exhaust carries heat to the carburetor to counteract its cooling by evaporation.

The muffler hanging beneath the cylinder, is a chamber enclosing the end of the perforated exhaust pipe, with an outlet pointing down to the road bed. The lever at the side of the seat is the brake handle. A pneumatic whistle hangs on the front of the steering spindle.

THE CLEMENT GASOLINE VEHICLE.

In Fig. 158 is illustrated the outlines of a French gasoline motor carriage of very light weight, 575 pounds, and in Fig. 159 an outline section of the motor. The carriage frame is made of thin steel tubing, shown at *A*, Fig. 158, carried on leaf springs fixed to the rear axle at *L*, and swiveled on the forward axle at *K*. The rear axle is carried in a fork with a swivel at *Q* to equalize inequalities in the road, and to prevent torsion in the tubular frame on which the carriage body

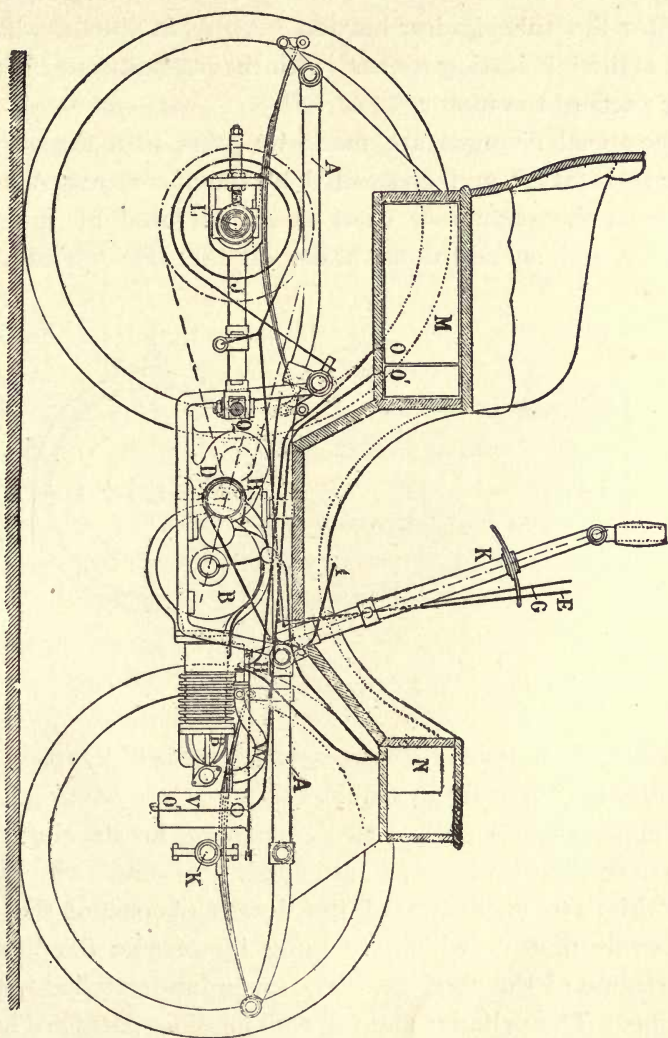


FIG. 158.—THE CLEMENT GASOLINE MOTOR CARRIAGE.

rests. A gasoline tank under the seat, *M*, supplies, through independent tubes, *O* and *O'*, the fuel for the motive power, and for the tube igniter burner. At *N*, in the dash-board box, is the lubricating oil can, with tubes leading to the running parts of the motor.

The speed changes are made by gears in a three-speed gear train at *D*, and controlled by the lever, *E*. A strap brake on the secondary shaft at *H*, operated by the foot pedal, *I*, and an additional brake on the axle operated by

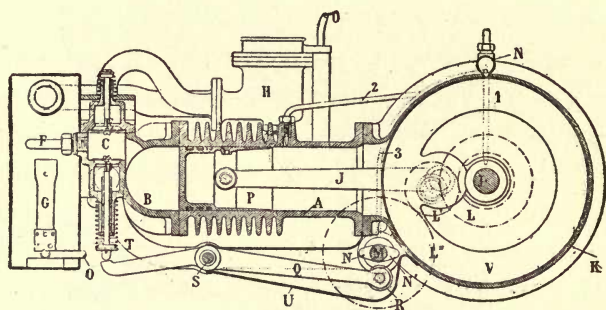


FIG. 159.—THE CLEMENT GASOLINE MOTOR.

the lever, *G*, controls the carriage. Speeds of 4, 10, 15 and 20 miles per hour are available.

The lever handle, *K*, has two movements for steering, with the controlling levers, *E*, *G*, attached.

In Fig. 159 is illustrated the details of one of the two four-cycle motors which are hung in a frame fixed to the tube frame of the carriage. The cylinder is ribbed for air cooling. The cylinder and internal moving parts are lubricated by oil dash in the closed crank chamber. A vibrating lever, *Q*, operated by a cam on the reducing gear shaft controls the motor by the exhaust, the motion of which is uniform, and not regulated by the inlet charged.

The special feature of this motor is the carburetor, *H*, through which the exhaust is passed, heating and vaporizing the charge drawn in through the pipe, *O*, and an automatic valve where it is mixed with warm air drawn from the pipe connection with the Bunsen burner case above the platinum ignitor, *F*. The Bunsen burner, *G*, has a vaporizer. The other lettered parts are in evidence by inspection.

VEHICLES OF THE INTERNATIONAL MOTOR WHEEL CO.—302 WEST FIFTY-THIRD STREET, NEW YORK CITY.

The novel single-wheel motor here illustrated is the invention of Mr. J. W. Walters, New York City.

As a class it is somewhat unique as encompassing the speed gear within the single driving wheel.

The device consists of a rubber tired wooden wheel, actuated by a two-cylinder gasoline motor, that is suspended on one side. On the other side two gasoline tanks that supply the fuel are held in position. The motor acts upon the wheel by means of a loosely mounted pinion meshing into a gear upon the wooden wheel. A clutch mechanism, the lever of which is within reach of the driver on the wagon, enables the latter to stop and start the vehicle at will. Owing to the novel nature of this invention a complication of machinery is avoided. It requires no backing mechanism. By simply reversing the motor-wheel with the steering bar and starting the motor, the vehicle runs backward.

Fig. 160 shows the motor wheel attached to a carriage, with the steering and motor-operating handle in its proper position.

A side view of the motor wheel, Fig. 161, shows the two motors of the four-cycle type, at right angles, driving a pinion on the axis of the wheel which meshes in a pair of spur gears for operating the valves. A friction clutch transfers

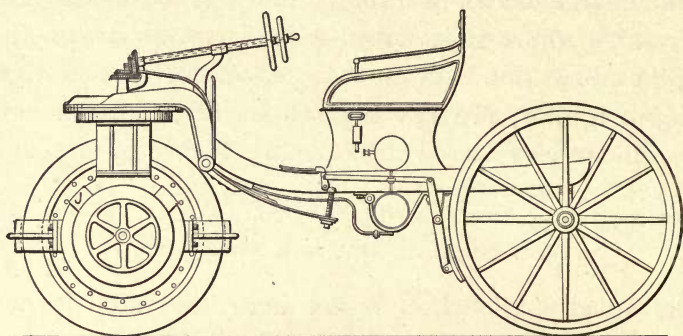


FIG. 160.—THE WALTERS SINGLE DRIVING WHEEL.

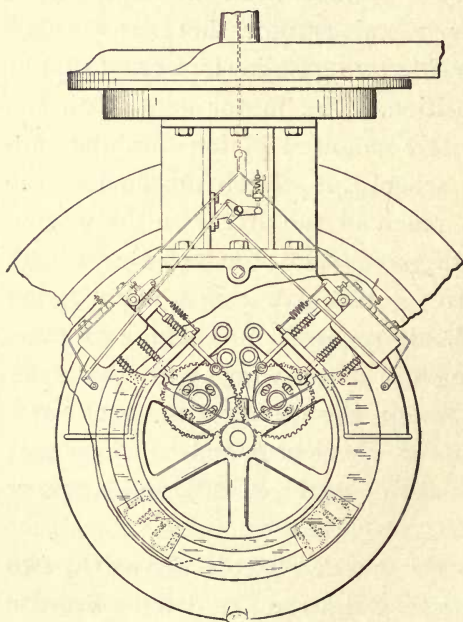


FIG. 161.—THE DRIVING WHEEL.

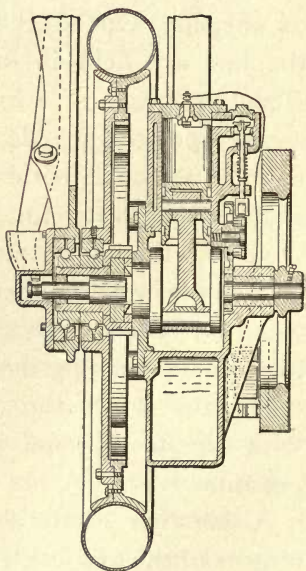


FIG. 162.—SECTION OF MOTORS AND WHEEL.

the motor power to the wheel through a set of spur gears meshed in an internal geared wheel forming part of the driving wheel.

In Fig. 162 is detailed a section of the motor and wheel.



FIG. 163.—THE MOTOR WHEEL.

The valve gear is on the side next the fly-wheel and the speed gear on the center line of the wheel.

In Fig. 163 is illustrated the general appearance of the motor wheel standing independent of the vehicle, and in Fig. 164 its attachment to a delivery wagon.



FIG. 164.—THE DELIVERY WAGON—INTERNATIONAL MOTOR
WHEEL CO.

THE UNDERBERG VOITURETTE.

This is a French gasoline motor carriage or double-seated phaeton design, built by M. E. Underberg, Nantes, France.

The elevation in Fig. 165 and the plan in Fig. 166 represent the leading details. The forward reverse seat is for one person, and on the opposite side from the driver's seat, thus giving a clear view forward for the operator. The motor is a single cylinder Gailardet pattern with radial ribs for air cooling, and is set vertically at *M*, over the front

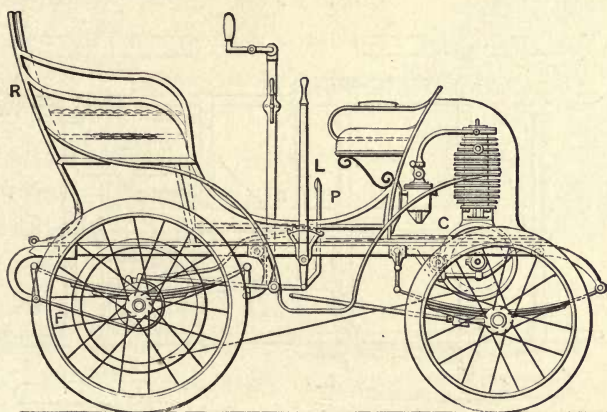


FIG. 165.—THE UNDERBERG VOITURETTE—ELEVATION.

axle in the plan, having a free circulation of air for cooling the cylinder.

The carburetor, *C*, is of the constant level type, atomizing the gasoline by indraft of air by the suction of the piston. The gasoline tank being placed under the rear seat, is high enough to allow of a flow to the carburetor by gravity. The motor is pinioned to a spur gear on a counter shaft, *A*, Fig. 166, carrying four gears; one of which is in constant gear with a spur wheel on a second shaft, *B*. The three gears on the counter shaft are fastened on a feathered sleeve,

controlled by the bell crank, *C*, and the hand lever at *L*, Fig. 165.

A pulley on the second shaft at *P* carries a belt to a pulley on the compensating gear of the rear axle. The pulleys have guard flanges. The rear axle is so hung that by levers and links, the foot pedal, *P*, Fig. 165, is made the means of making the belt loose or tight, thus obviating the use of a friction clutch for starting the motor.

The crank handle for steering is at the right side of the

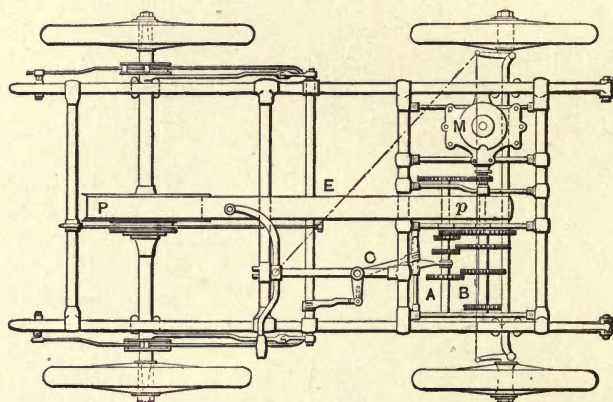


FIG. 166.—THE UNDERBERG VOITURETTE—PLAN.

seat and linked under the carriage body to the arms of the pivoted wheel axles. The vehicle weighs six hundred pounds, has an average speed of fifteen miles per hour, and will climb a grade of eight per cent. under the slow speed. The frame is made of steel tubing, 1½ inches diameter, and suspended on springs. Wheels have pneumatic tires and ball bearings. Electric ignition by induction spark is regulated by a side handle on the steering lever.

MOTORS AND VEHICLES OF THE AUTOMOBILE COMPANY OF AMERICA.

The motors of this company have been heretofore known as the "American Motor," built by the American Motor Company, 32 Broadway, New York City.

The new organization is at the same location. They supply motors for all purposes, stationary, carriage and marine, the smaller sizes with either ribbed or water cooled cylinders. The motors of this company are made with single cylinders of one and two horse power and as duplex motors of two and four horse power for vehicles; all of the four-cycle compression type. The smallest ribbed air cooled motor weighs 50 and the 2 horse power motor of the same type weighs 75 pounds, without flywheels. All their motors are crank encased with aluminum. The vertical water jacketed motor, Fig. 167, is $3\frac{1}{2}$ horse

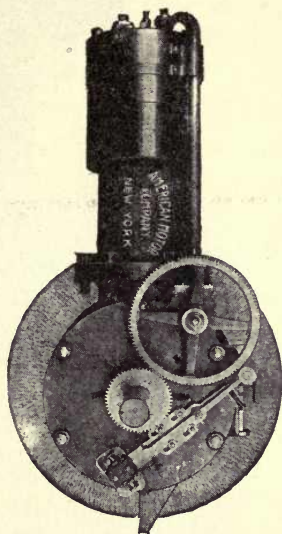


FIG. 167.—VERTICAL MOTOR.

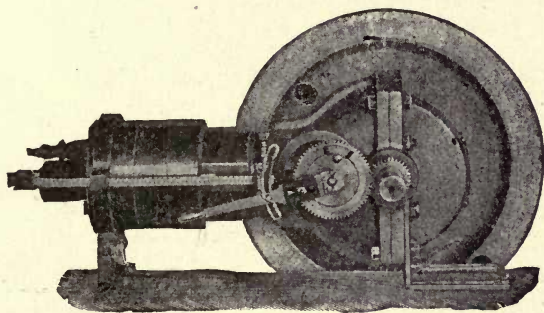


FIG. 168.—HORIZONTAL MOTOR.

power and the horizontal water jacketed motor, Fig. 168, is $1\frac{1}{2}$ horse power. This is the smallest that is made of this

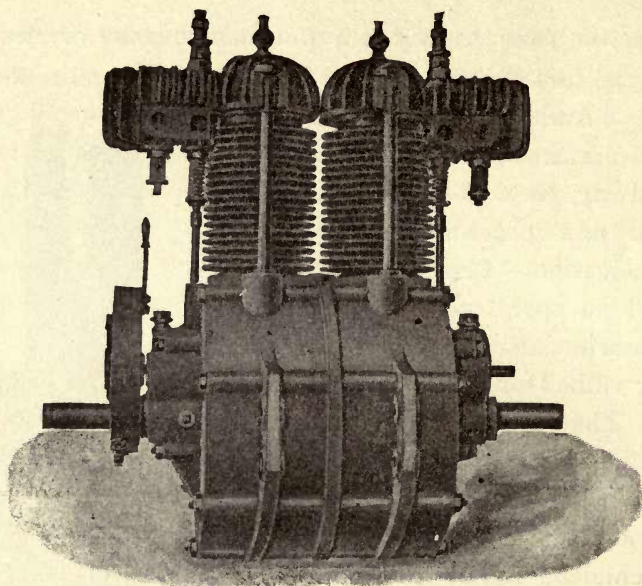


FIG. 169.—DUPLEX AMERICAN MOTOR.

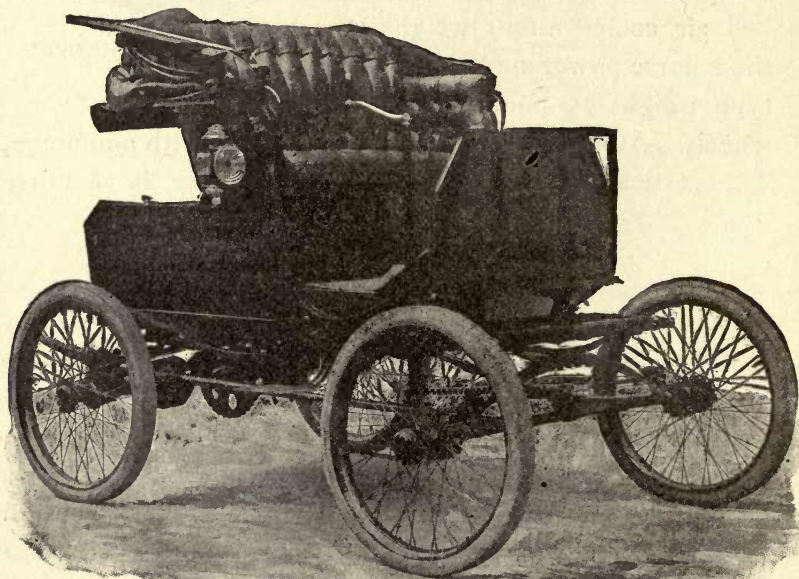


FIG. 170.—STANHOPE OF THE AUTOMOBILE CO. OF AMERICA.

type for vehicles. The lever centered on the reducing gear is for varying the time of the exhaust for controlling the motor.

The duplex air cooled motor, Fig. 169, has also an aluminum crank case, and is a very light motor for a carriage. The motors are regulated both by variable charge and by delayed electric ignition. Fig. 170 represents their Stan-

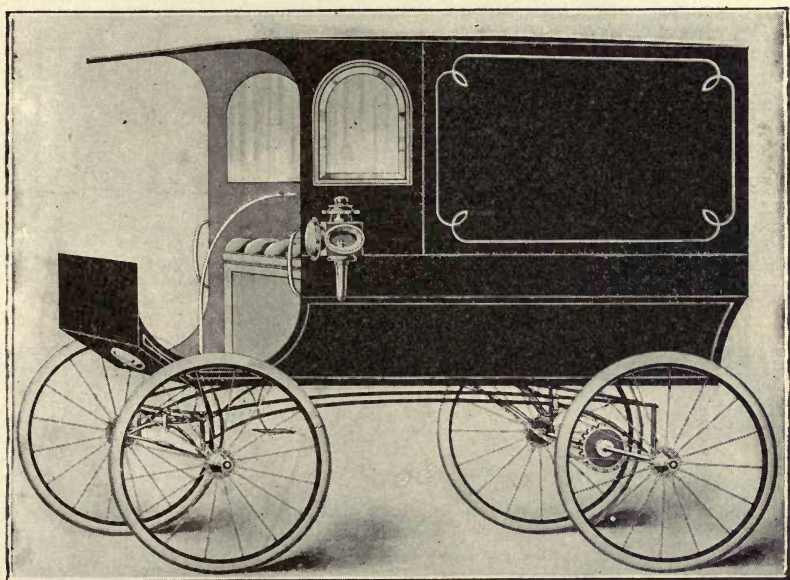


FIG. 171.—THE GASOLINE MOTOR DELIVERY WAGON.

hope, one of the newest and most approved styles on the market.

THE GROUT GASOLINE MOTOR CARRIAGE.

In Figs. 171 to 175 are illustrated a line of automobile carriages as built by Grout Bros., Orange, Mass.

The motors of these carriages consist of two cylinders, four-cycle compression type, neatly enclosed in a case and

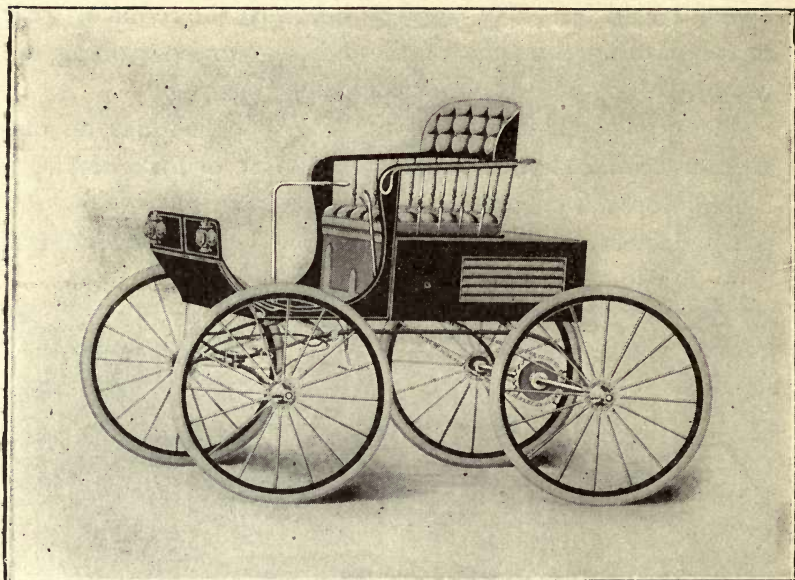


FIG. 172.—THE TWO-PASSENGER TRAP.

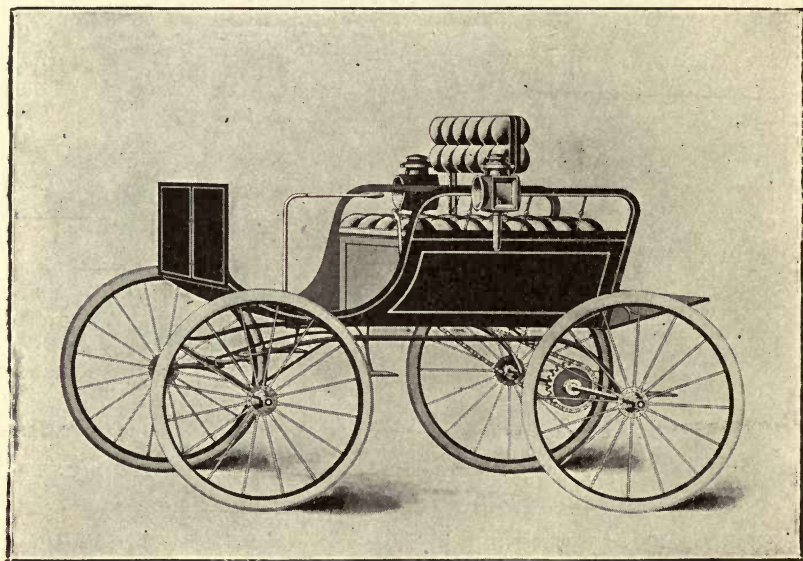


FIG. 173.—THE FOUR-PASSENGER TRAP.

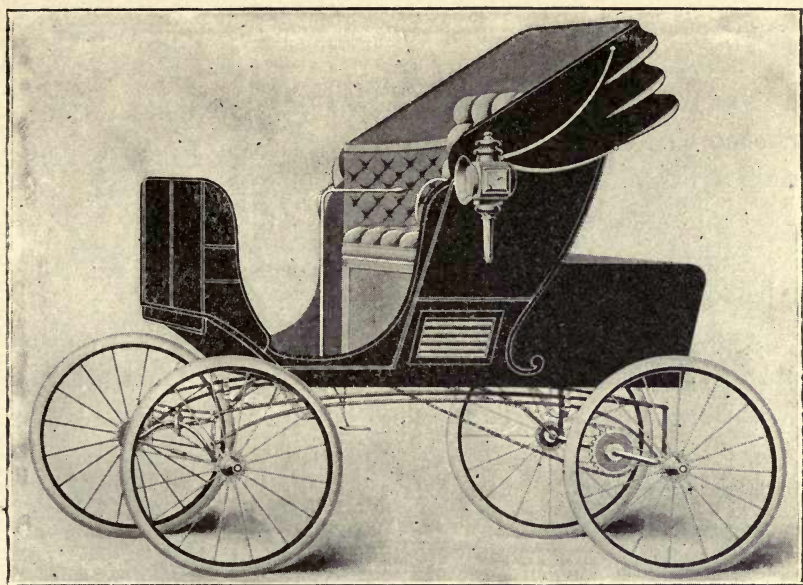


FIG. 174.—THE STANHOPE.



FIG. 175.—THE STANHOPE—QUARTER VIEW.

of about six horse power or sufficient for the weight and use of each vehicle.

The two passenger trap, as are the other vehicles, are furnished with electric side lights with a current from the ignition dynamo which sparks the motor and also furnishes current for an electric alarm.

Variable speeds from both motor charge and speed gear give ranges from 4 to 18 miles per hour.

The lighter vehicles have a single steel tube frame strongly made with braced joints at the fittings. The wheels are made with solid hubs, steel rims, wood spokes and steel sockets. Tires, 34 x 3 inch pneumatic or solid tires when desired. Tread, 56 inches; wheel base, 63 inches. Weight from 1,000 to 1,400 pounds, according to style.

Ball bearings on the lighter vehicles.

Delivery wagons are also a product of this company of which the illustration, Fig. 171, is a representation. They also propose to build steam carriages if desired.

THE SINTZ GASOLINE MOTORS AND VEHICLES.

The Sintz Gas Engine Company, Grand Rapids, Mich., have adapted their motors to vehicle service. In Fig. 176 is illustrated carriages, omnibus, inspection and a street railway car, as operated by their motors.

The motor is of the two-cycle compression type, with enclosed crank and piston connections. It is a valveless gasoline motor, with electric ignition by a finger brake sparking device in the head of the cylinder. In Fig. 177 is shown the cylinder with the piston at the end of the down stroke.

The upward stroke draws the mixed charge into the crank chamber. The downward stroke compresses the charge in the chamber, and into the space around the lower end of the cylinder of sufficient amount to force an explosive charge

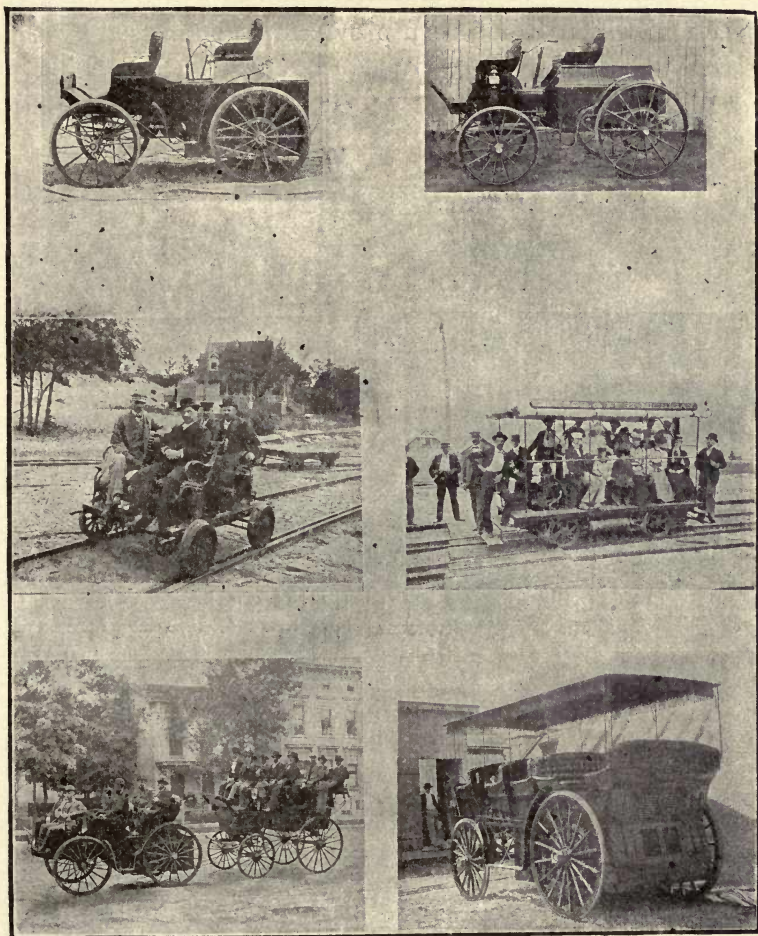


FIG. 176.—THE SINTZ MOTOR VEHICLES.

into the cylinder when the descent of the piston opens the inlet port and closes the charging port shown at the lower end of the cylinder. The charge is made by the expansion of the gasoline and air mixture contained in the annular space into which it had been previously compressed by the descent of the piston.

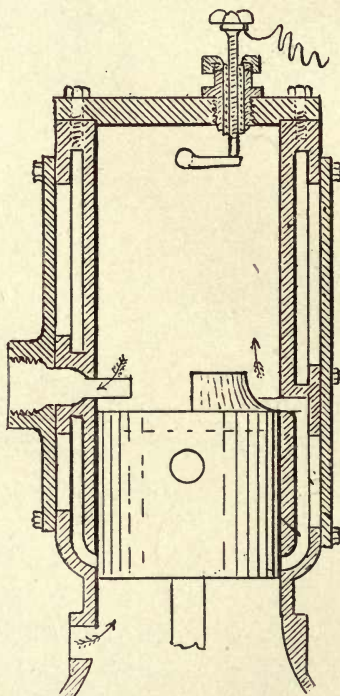


FIG. 177.—SINTZ CYLINDER.

The exhaust port on the opposite side of the cylinder, as shown by the arrow, is opened by the descent of the piston before the charging port, giving the relief to the cylinder pressure just before the inlet port opens. The lip on the piston deflects the incoming charge up and against the ignitor, thus insuring a fresh charge at and around the sparking finger at every revolution.

THE MUELLER MOTOR CARRIAGE.

In Fig. 178 is illustrated the motor carriage of the Mueller Manufacturing Company, Decatur, Ill.

It is in style a trap or dos-a-dos, with wood spoke wheels and pneumatic tires, and is an improvement on the "Benz" model, brought out from Germany.

The frame of this carriage forms a continuous tube for

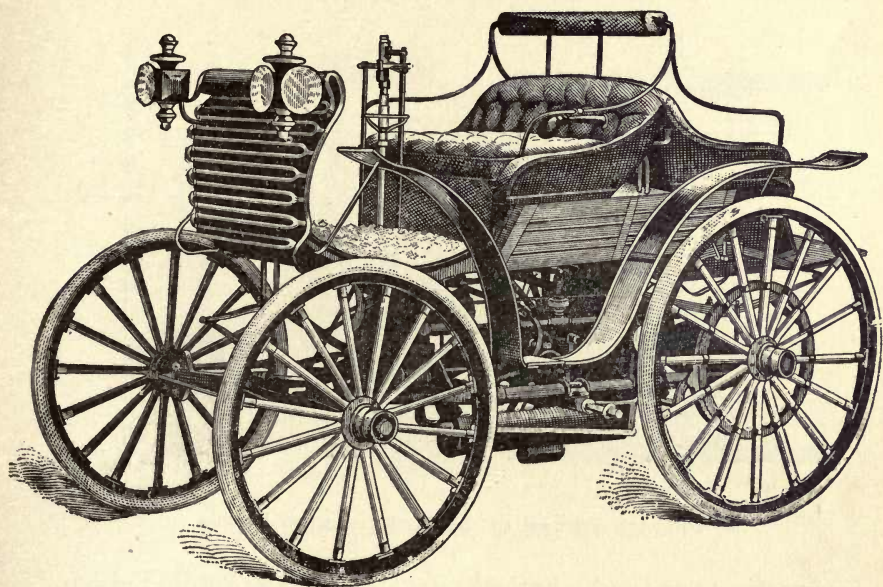


FIG. 178.—THE MUELLER TRAP.

cooling the water circulation and is plugged between the two pipe connections to the water-jacketed cylinder, so that the circulation is continued through the cylinder jacket and the cooling coil on the front of the dash-board, as shown in the cut. A small tank suspended between the front part of the frame holds the surplus water supply. The motor, which is single, of the four-cycle compression type, is bracketed

THE HERTEL MOTOR CARRIAGE, BUILT BY THE OAKMAN MOTOR VEHICLE COMPANY, GREENFIELD, MASS.

In Figs. 180 and 181 are illustrated a rear and front quarter view of one of the lightest hydro-carbon motor vehicles on the market, its weight averaging 500 pounds. The steering gear is peculiar to this vehicle, being a pair of bicycle wheels supported in bicycle forks, the right hand one being jointed to a steering handle extending to the seat. At the

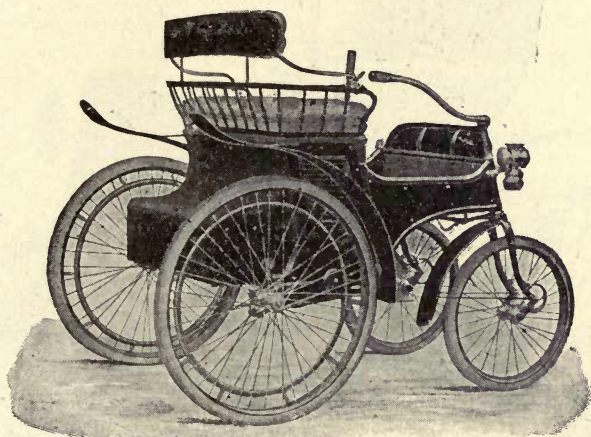


FIG. 180.—THE HERTEL RUNABOUT.

junction of the fork and socket of each steering wheel is an arm projecting to the rear, and these arms are joined by a link rod, thus making a simple and perfect movement of each wheel from the steering handle.

The steering wheels are made to assume automatically a direct line course by a helical spring and check-chain connection between the arms, making the link connection, so that if the steering handle is dropped from the hand the carriage will run straight forward, and will not turn out of its course.

The steering wheels are not hung directly to the forks, but are on short links, pivoted to the ends of the fork prongs, and held in position by curved springs, so that the wheels will take inequalities in the road or override obstructions without transmitting the jar to the body of the vehicle.

The power is obtained from a double cylinder gasoline motor, $3\frac{3}{8}$ -inch by $4\frac{3}{4}$ -inch stroke, of $2\frac{1}{2}$ horse power.

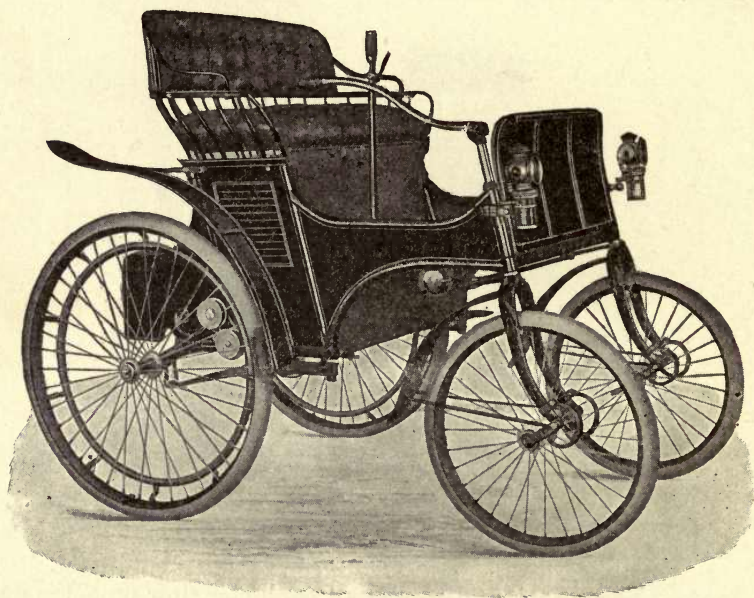


FIG. 181.—THE HERTEL MOTOR CARRIAGE.

Its crank shaft is geared to a high-speed driving shaft, with universal joints and elastic V shaped friction pinions that mesh in a driving rim fastened on the inside of each rear wheel.

A muffler for each cylinder deadens the sound of the exhaust. One of the mufflers is arranged to heat the air for vaporizing the gasoline.

The fly wheel is on the high speed shaft, thus enabling

the required regulating duty from a light fly wheel. By the manipulation of the single motor lever, the operation of turning over the motor for starting, the locking of the friction gear, regulation of the speed by the quantity of the charge, an increase of power on up grades and the wheel brake motion is obtained by a few movements of the left hand on the handle of the lever.

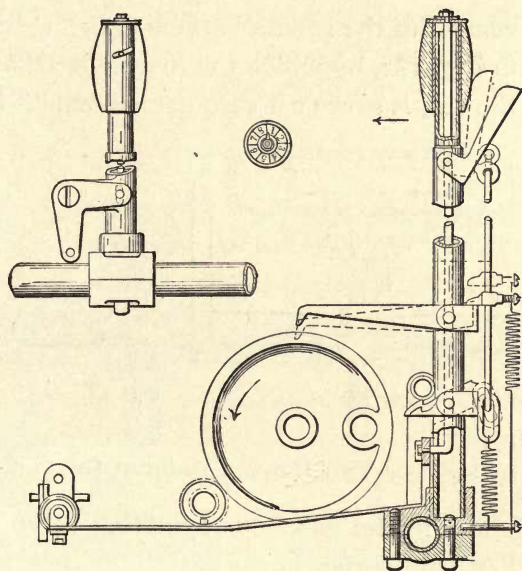


FIG. 182.—THE HERTEL CONTROLLING GEAR.

A small generator running by belt from the high speed shaft furnishes the current for electric ignition with a storage battery reserve. The vehicle carries a gasoline charge for a run of 75 miles. Maximum speed 20 miles per hour.

In Fig. 182 is illustrated the controlling and starting gear of the Hertel motor, consisting of an operating lever with a central rod having a vertical motion controlled by a pin on the vertical rod traversed by a helical slot in the handle.

The handle having a rotary motion with an index on top to gauge the position of the charging valve. The helical slot is shown in the handle at the right. The small hand clip when closed upon the handle lifts the rod linked to it and the stop on the starting pawl, when the pawl drops into the teeth of the geared crank wheel and a fore and aft motion of the lever starts the motor in motion ; at the same time a twist of the handle by the hand opens the gasoline regulating valve by the movement of the rod and attached bell crank, shown at the left in Fig. 182, by which the long lever shown at the bottom of the cut, is given a horizontal movement that oper-

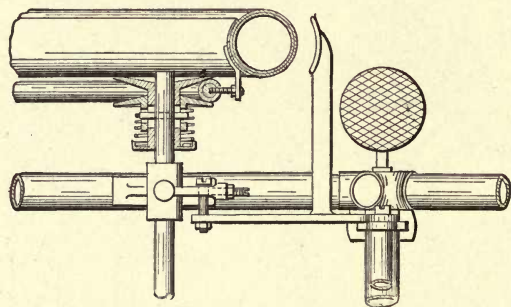


FIG. 183.—THE HERTEL DRIVING GEAR.

ates the plunger in the gasoline regulating valve shown at the lower left hand corner in the cut.

The same movement of the hand clip also releases the small hook pawl from the lever of the rock shaft which makes contact of the V driving pulley with the friction rim of the vehicle wheel, thus allowing the motor freedom to start. When the motor is started the hand clip is released ; the springs draw the rod down, throws up the starting pawl and locks the hook pawl in the arm of the rock shaft controlling the contact of the V driving pulley with the wheel rim of the carriage. The mechanism of the driving pulley is shown in Fig. 183. On one end of the counter shaft is a link

connecting it to the rock shaft arm and the brake, which is also operated by an extreme backward movement of the hand lever.

One-half of the V driving pulley is fixed to the shaft, the other half is closed by a spring, so that for slow motion and a hard pull for up grades a strong pressure forward on the handle bar presses the contact of the V pulley well towards its center and thereby increases its pressure and power.

For applying the brake a backward pull of the hand lever releases the contact of the driving V pulley and brings the brake arm in contact with the wheel tire.

THE WINTON MOTOR CARRIAGES.

In Fig. 184 is illustrated a line of the hydro-carbon motor carriages of the Winton Motor Carriage Company, of Cleveland, Ohio, in which a "Fire Chief's" fast wagon takes the lead followed by two phaetons and a line of delivery wagons. In Fig. 185 is illustrated their latest design of a phaeton, and in Figs. 186 and 187 two models of their delivery wagon. The long run of a Winton phaeton from Cleveland, O., to New York in May, 1899, seems to have established the stability of the Winton type for hard work on rough roads. The enduring qualities of its motor and running gear was proved by the trip of over 700 miles in $47\frac{1}{2}$ hours running time, averaging nearly 15 miles per hour, and making at times 25 miles per hour.

Many improvements in the details of the motor and running gear have been made during the past year towards simplicity and automatic adjustment of parts, ease of access, balancing of motor and convenience in handling that has brought the "Winton Vehicles" to the front among all of the automobiles.

In the delivery wagons, as also in the lighter carriage

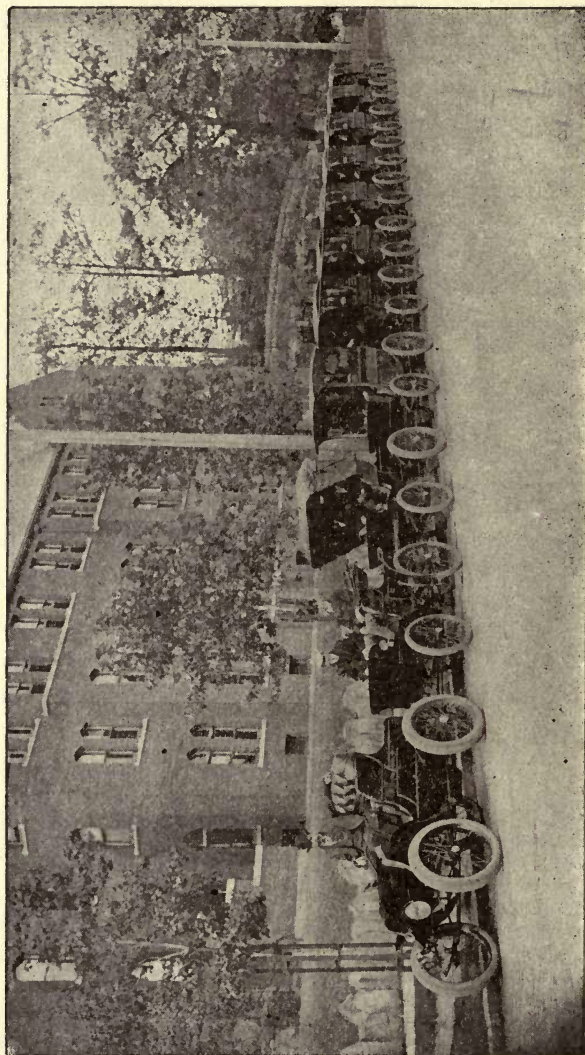


FIG. 184.—A LINE OF WINTON AUTOMOBILE CARRIAGES.
A Fire Chief's Fast Wagon, Two Phaetons, and Line of Delivery Wagons.

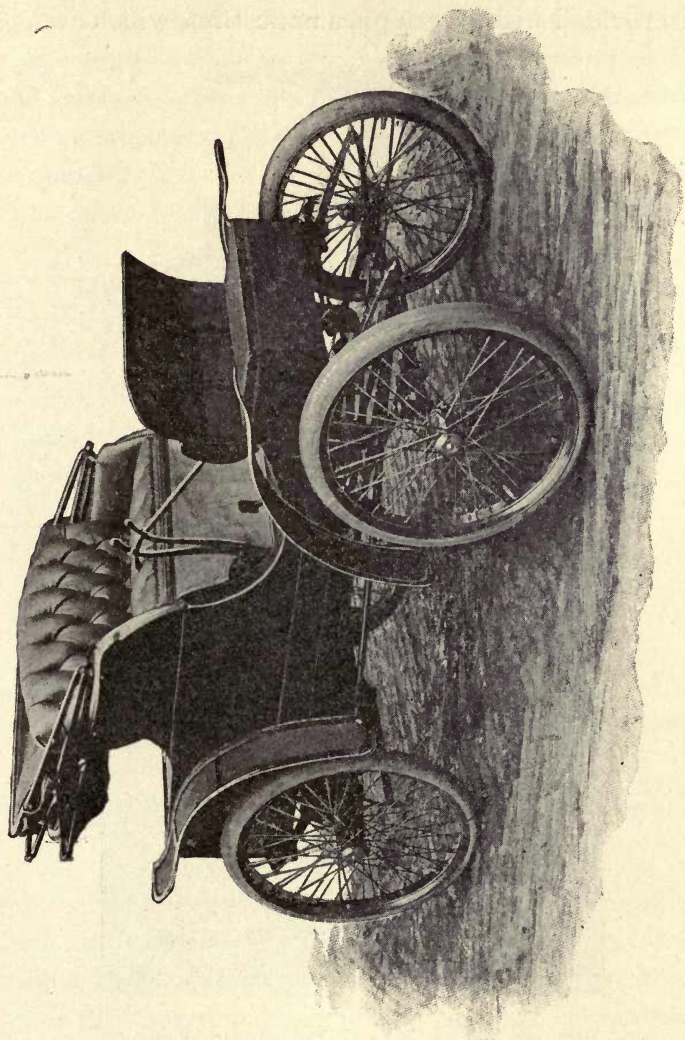


FIG. 185.—THE WINTON PHAETON.

the driving mechanism is snugly concealed in the body of the vehicle. The wheels are 32 inch diameter front and 36 inch rear. provided with 3-inch pneumatic tires, which are prac-

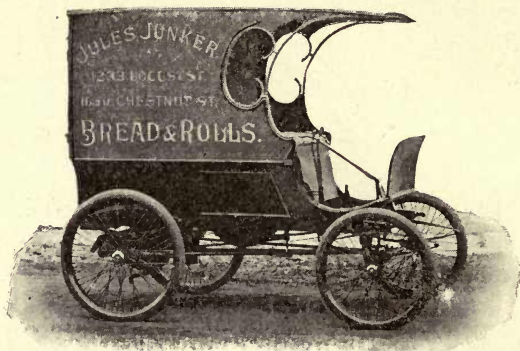


FIG. 186.—THE LIGHT DELIVERY WAGON.



FIG. 187.—THE HEAVY DELIVERY WAGON.

tically puncture-proof. Ball bearings are used at all important points, thus securing the greatest possible freedom from friction and wear.

In Fig. 188 is illustrated the general plan of the running gear, in which it will be readily observed that the main driving speed, as well also, the intermediate and backing speeds, are operated by friction disks through the operation of two hand levers. A third hand lever being used for steering, all placed convenient for the driver on the right hand side of the vehicle.

The brake pulley is placed on the counter-shaft, with its

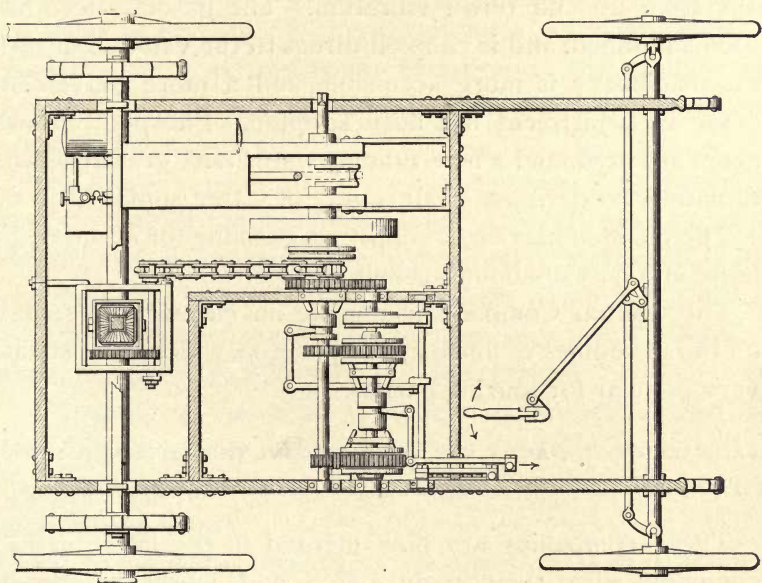


FIG. 188.—THE WINTON RUNNING GEAR.

brake strap operated by an arm on a supplementary shaft, which also carries the arm that operates the motor friction disks, so that by a single movement from the vertical to the rear of the operating hand lever the motor is disconnected and the brake applied. The other hand lever being used for change speed and backing. The motor which is of the single hydro-carbon type is well balanced to give the vehicle freedom from vibration, and which, by the gasoline charge

control, has a variable speed from 200 to 900 revolutions per minute, thus giving easy grades in changing the speed of the vehicle.

Among the improvements that have been lately put on the new Winton carriages may be mentioned an automatic oiler, oiling all bearings, and iron composition, instead of bronze boxes. Instead of working on an arm, as in the earlier vehicles, the counterbalance now works in a direct line, obviating up and down vibration. The gasoline feed has been simplified, and is coupled direct to the valve stem. All the machinery is more accessible, and a more convenient mode of adjustment has been adopted. Phosphor bronze gears are used, and a new tubular water tank greatly assists radiation, rendering a small supply of water sufficient.

The phaeton carries a supply of gasoline for a run of 75 miles at a cost of about one-half cent per mile.

The Winton Company also make an elegant top surrey on the same lines of finish as the phaeton, which will become very popular for touring parties.

VEHICLES OF THE AUTO CAR COMPANY AND THE PITTSBURG MOTOR
VEHICLE COMPANY.

These companies are now merged in the latter named company, with their main office and works at Swissvale, Pa.

In Fig. 189 is illustrated their top buggy, or runabout, a light running vehicle, highly finished, and well adapted for a physician or business man. Weight, 500 pounds.

In Fig. 190 is illustrated their park trap, an elegant vehicle for ladies' use. It is handsomely upholstered, and has a graceful and finished design. It weighs 800 pounds.

This company also make a delivery wagon of light and neat design.

The motors are of the four-cycle type, two in number, placed end to end, on cranks 180° apart, thus balancing all parts of the motor and eliminating the usual vibration of single cylinder motors.

The cylinders of the light carriages are ribbed and so placed as to receive a free circulation of air for cooling the cylinder. The motors of the heavier vehicles are water-jacketed and connected to a water tank under the foot-board, which is perforated with 50 1-inch copper tubes, so arranged as to condense the water vapor in the tank, and to keep the water at the proper temperature for cooling the cylinders. The cooling water is circulated by a small centrifugal pump.

The power is transmitted from the engine shaft direct to the rear axle by chain and sprockets. The rear axle sprocket contains the differential gear, and a brake-band wheel, with an additional brake on the motor shaft, which is controlled by the same lever that controls the speed of the motor; the other brake is operated by a foot pedal.

The speed of the motor is further regulated by delaying the time of ignition, which is by the electric spark from a small generator, which also charges a storage battery for starting the motor.

When the motor reaches its full speed the storage battery connection is automatically changed when the surplus current recharges the battery.

All parts of the motor not exposed to heat are made of aluminum, thus making the motor as light as it seems possible for this type of prime mover. A special slow speed gear is provided for hill climbing, which is quickly thrown in, and allows of the full power of the motor to be used for the steepest road grades at a slow speed of the vehicle. An indicator card from this motor shows faultless lines of com-

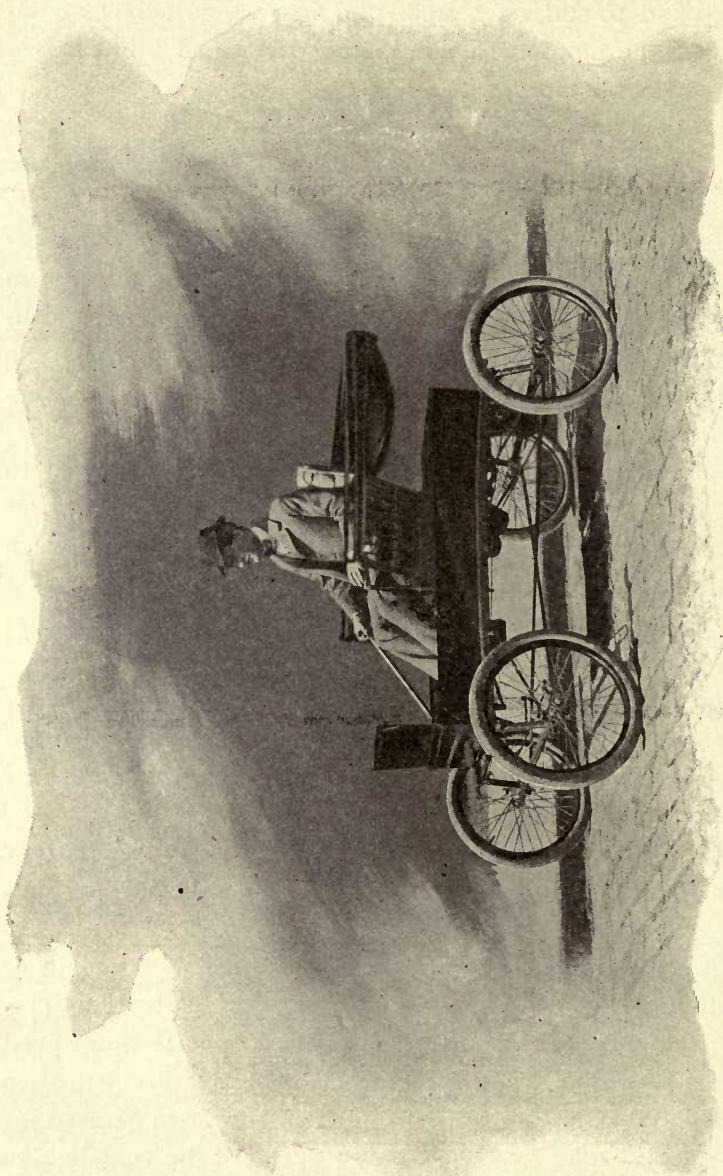


FIG. 189.—THE RUNABOUT OF THE PITTSBURG MOTOR VEHICLE COMPANY.



FIG. 190.—THE PARK TRAP OF THE PITTSBURG MOTOR VEHICLE COMPANY.

pression and expansion. Compression, 75 pounds; ignition pressure, 250 pounds; exhaust, 20 pounds.

VEHICLES OF THE DURVEA MANUFACTURING COMPANY,
SPRINGFIELD, MASS.

In Fig. 191 is illustrated the speedy automobile that won prizes in England in 1896, and in the Cosmopolitan race in New York. The vehicles of this company are operated by two or three-cylinder gasoline motors, with belts and clutch change gears on a counter shaft, with sprocket and



FIG. 191.—ONE OF THE WINNERS.

chain transmission to the compensating gear box on the bisected driving axle.

The frames of the vehicles are made of steel. The wheels have wood spokes, with $2\frac{1}{2}$ -inch pneumatic tires, 30 inch front, 34 inch rear wheels; speeds, variable, 5, 10 and 20 miles per hour, and can reach 30 miles per hour on asphalt roads. The motors are independent, so that a disabling of one does not disable the carriage. These vehicles have a tank capacity for 8 gallons of gasoline, sufficient for more than a 100 miles run.

MOTOR VEHICLES OF THE DURYEA MANUFACTURING COMPANY,
PEORIA, ILL.

The gasoline motor vehicles of the Peoria Company seem to have had a marked success in their endurance and speed qualities, as shown in the results of the Chicago *Times-Herald* race in 1895, the Cosmopolitan race in 1896 and the Liberty Day run in England against the winners in the French races. The low three wheel vehicles or tricycles are the favorite



FIG. 192.—THE DURYEA RUNABOUT.

styles made by this company, and seem to meet all objections. It is light, quickly mounted and carries sufficient power for the medium roads of the country, even in snowy and muddy weather.

In Fig. 193 we illustrate two of their three wheelers, plowing through a 10-inch snow, and in Fig. 194 the same style of vehicle pushing its way through Illinois mud. In Fig. 192 is illustrated the same style of vehicle mounted

with two forward wheels to suit the taste of parties that think two wheels are better than one for steering or for appearance.

The Park tricycle or motor trap with canopy top, Fig. 195, is made with two or with one seat as desired. The single steering wheel is light, clean and less complicated, less



FIG. 193.—THE DURYEA IN SNOW.

in the way in mounting, and can be handled more easily and quickly than two wheels.

Fig. 196 is an outline plan of the vehicle and location of the mechanism.

The motor is placed horizontally under the front seat, and consists of three cylinders $4\frac{1}{2} \times 4\frac{1}{2}$ inches, with a flywheel 16 inches diameter weighing 80 pounds; the motor complete, including fly wheel, weighs 200 pounds, and is of 6-horse power.

A single feed pipe supplies all three cylinders at head of motor. A single exhaust chamber, lying on top of the cylinders, carries the gases to a single muffler. A single insulated wire carries the electric current for sparking. A single set of cam shaft gears operates all the valves and sparkers. A single water jacket and water tank keeps the motor cool; while the added parts to make three



FIG. 194.—THE DURYEA ON A MUDDY ROAD.

cylinders are duplicates of the parts required in a single cylinder.

A fuel tank under the front floor carries sufficient ordinary stove gasoline for one hundred to two hundred miles' driving, while the water tank under the rear seat insures the motor against overheating.

The motor is throttled like a locomotive, and speeds from

three to thirty miles per hour may be had on good roads by a simple turn of the wrist. For mud or hill climbing a special power gear on the motor shaft is provided, giving three times the power at one third the speed, either forward or backward as desired.

The controlling lever centrally placed gives absolute con-



FIG. 195.—THE DURVEA PARK TRICYCLE.

trol of the vehicle in one hand and by either rider. The lateral swing of the lever steers, twisting the handle, throttles the motor, while a vertical motion starts and changes the speed. These movements are as easy as guiding a saddle horse, and their effect upon the vehicle is instantaneous, so that these machines are much safer, although driven at high speed, than horse vehicles.

The central foot brake gives further ability to stop, and a heel pedal operates the reverse or back motion. The total weight is but about seven hundred pounds empty, and the large power is sufficient to drive the vehicle over any roads passable by ordinary traffic.

In their lighter vehicles a starting stirrup is used by the foot, which by pushing downward starts the motor, thus avoiding the soiling of the hand in applying a crank to the

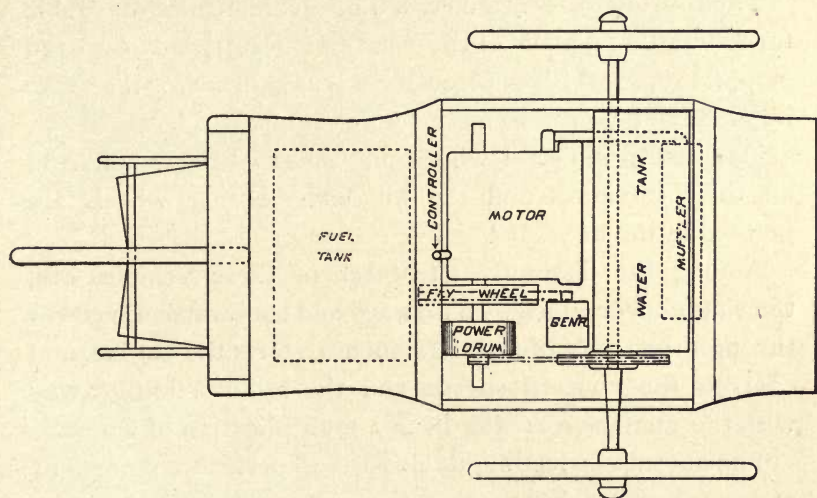


FIG. 196.—THE DURVEA MOTOR WAGON PLAN.

motor shaft. In the larger vehicles a crank is used. The electric ignition is obtained direct from a generator driven by a belt from the fly wheel. A mixer or atomizer under the control of the hand on the steering lever controls the speed of the motors by the quantity of charge admitted to the cylinders.

In Fig. 196 it is noted that the reversing gear is contained in the power drum, and the differential gear is in the large sprocket wheel on the axle.

VEHICLES OF THE DETROIT AUTOMOBILE COMPANY, DETROIT, MICH.

This company has brought out a line of gasoline motor vehicles that make a complete outfit for all the wants of automobile work for pleasure or business. Fig. 197 illustrates their Runabout.

The general outline and finish of all their vehicles are designed with similar parts and the running and motor gear are interchangeable on all the light carriages.

The touring cart is a convertible vehicle most desirable for its kind. In place of the rear box for parcels or hand grip, its removal gives place for a trunk, or a seat may take its place and you have a stylish dos-a-dos.

The suspension steel wheels and rubber tires are alike in all their carriages and the forward steering wheels are pivoted at the hubs.

Among the distinctive features of these vehicles are, the single lever which by a forward and backward movement through the space of about 12 inches, starts the engine, and controls the forward speeds and the backup, doing away with the confusion arising from a multiplication of levers.

The automatic feeding device gives perfect combustion at any speed, leaving no odor from unconsumed gases.

A perfectly balanced engine, with absolutely no vibration.

A device, actuated by a button under the foot, which controls the speed, which may be varied from a slow walk to about 40 miles per hour, for the pleasure vehicles.

An absolutely new sparking device, which is positive, never fails, and is practically indestructible.

Every part is encased and is dust and water proof.

No chains or belts of any kind. the driving gear being connected direct to the rear axle, through the compensating gear.

A flexible yet rigid frame.

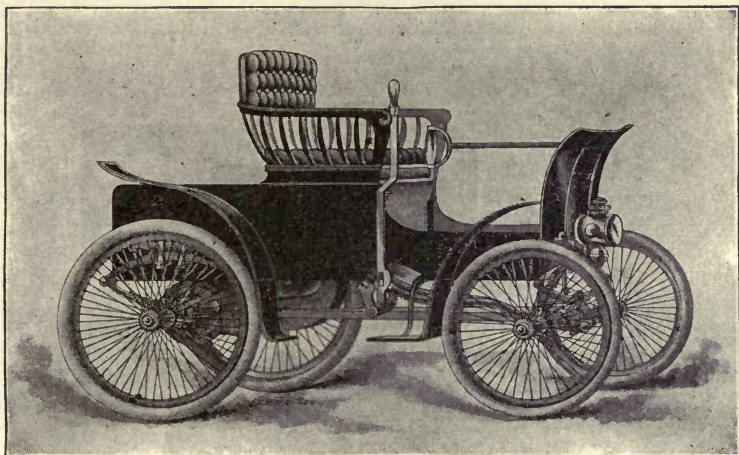


FIG. 197.—THE RUNABOUT.

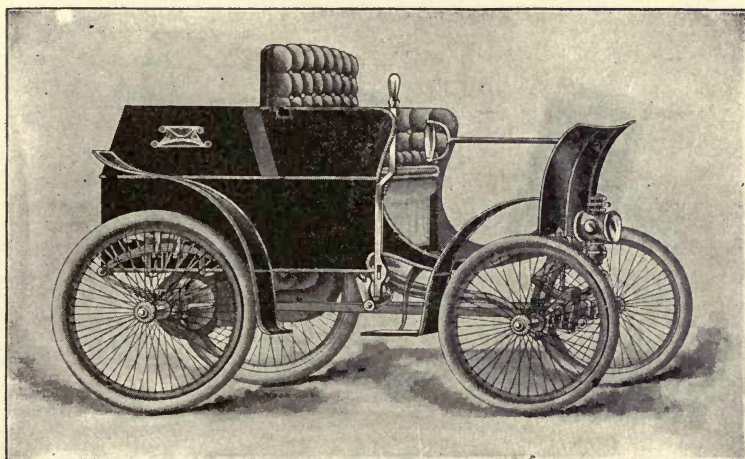


FIG. 198.—THE TOURING CART

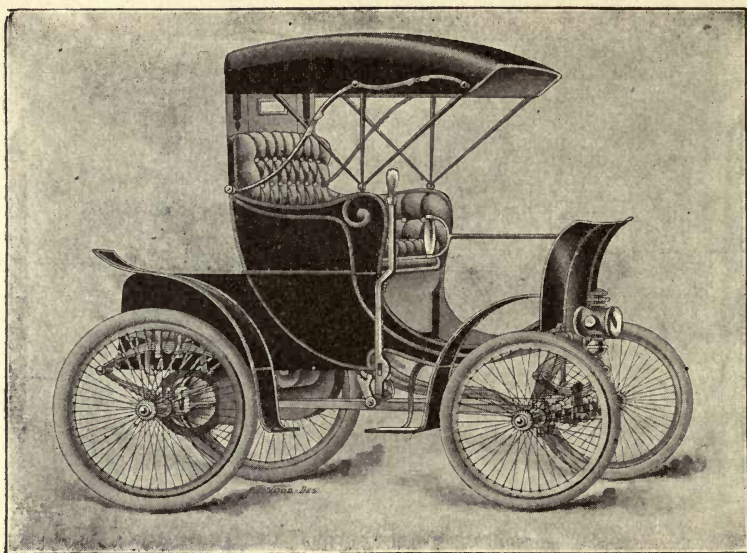


FIG. 199.—THE TOP PHAETON.

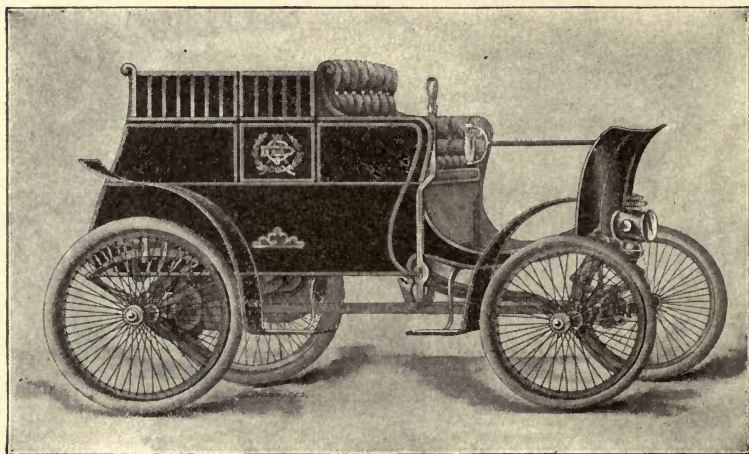


FIG. 200.—THE TRAP.

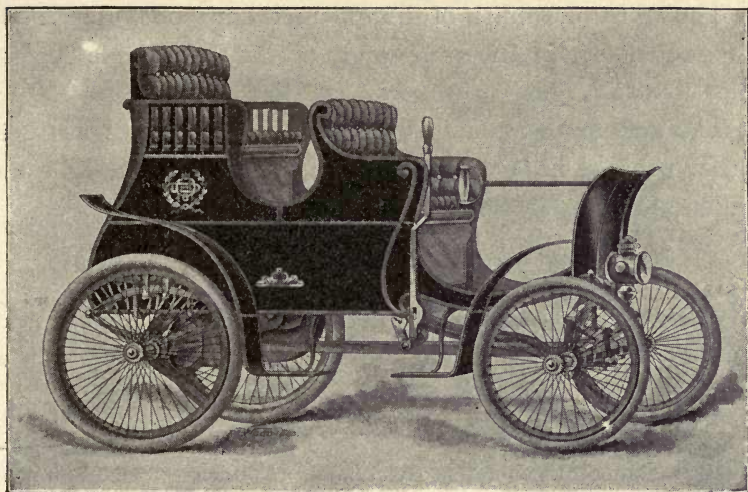


FIG. 201.—THE SURREY.

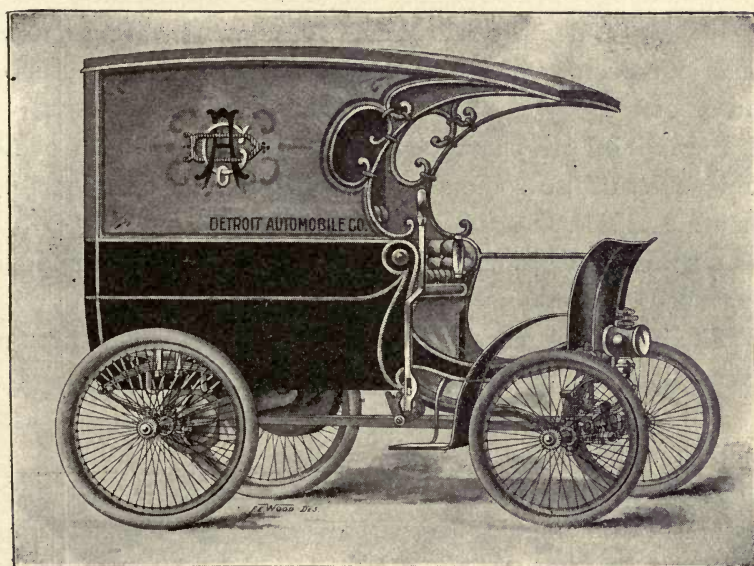


FIG. 202.—THE DELIVERY WAGON.

The style and finish of these vehicles are most acceptable to good taste in the purchasers of the automobile type of pleasure carriages.

The delivery wagon is built on the same lines as their other vehicles in motor and running gear, and is a light and quick moving vehicle for light trade.

THE GENERAL POWER COMPANY AUTOMOBILE MOTOR.

The general public is now becoming familiar with the relative advantages, as well as the limitations of each special type of motor used in automobiles.

A recent occurrence in India calls attention to the form of fuel commonly used in internal combustion motors. The *Autocar* stated that a recent consignment of "petrol" or naphtha automobiles was refused admission to India by the British Customs authorities, in consequence of the alleged danger attending the use of the required fuel.

It is not difficult to determine what qualities are required in a satisfactory fuel for internal combustion engines for automobiles.

Engines of this character, in order to be generally available, must utilize some form of liquid fuel that is obtainable in all localities.

The fuel adopted must be a low cost one, if the automobile is to be commonly used for commercial purposes.

The ideal fuel should have the highest possible thermodynamic value per given unit of weight.

Although last named, safety is an element of the first importance in a fuel intended for universal use.

To recapitulate, the perfect fuel for vehicles of all kinds (1) must be obtainable everywhere; (2) must be liquid in form; (3) must be low cost; (4) must have the highest possible thermodynamic value; (5) must be safe.

Only one such fuel exists. It is that safe product of petroleum prepared for illuminating purposes, and known commercially as mineral oil, called in some parts of Europe, paraffine, and known throughout America as kerosene.

The following table shows its superiority over other well-known forms of stored energy :

DYNAMIC VALUE OF UNIT WEIGHT OF VARIOUS SOURCES
OF POWER.

A good battery will store	15,000 ft. lbs. per lb. battery.
Liquefied air expanded from 2,000 lbs. down to atmospheric pressure, under ideal conditions, would develop	139,100 ft. lbs. per lb. air.
Coal of 14,600 B. T. U., used in a steam plant of 12½ per cent. efficiency, would yield	1,408,000 ft. lbs. per lb. coal.
Petroleum oil of 20,700 B. T. U., consumed in an explosive engine of 30 per cent. efficiency, would yield	4,794,120 ft. lbs. per lb. oil.

Thus it will be seen that one pound of petroleum or refined kerosene oil used to produce power in an internal combustion oil engine develops far more mechanical energy than an equal weight of any other medium, either for producing or storing power.

In consequence of the wastefulness incident to all small steam engines, the fuel required for a steam wagon for a trip of 50 miles, will cover five times that distance when used in an internal combustion motor.

It requires 35 pounds of liquefied air, and more than 300 pounds of storage battery to equal the power obtainable from one pound of kerosene oil, costing about one cent. As a reservoir of power, one gallon of oil is superior to one ton

of storage battery. If air could be compressed to liquefaction and supplied gratuitously to consumers the extra cost of storage and transportation would render it inferior in economy to commercial mineral oil. In fact, kerosene is simply gaseous solar energy, having the capacity of liquefying at ordinary temperatures.

Domestic kerosene of 120 degrees Fahr. flash and 150 degrees Fahr. fire test has a specific gravity of about 0.785, and one gallon will equal $8.33 \times .785 = 6.539$ pounds. B. T. U. per gallon = 135,357.

Petroleum and all its products possess practically the same calorific value per pound weight. The weights of the different products vary, and consequently the calorific value is not uniform per gallon, but it is uniform per unit of weight. The best authorities give the heat units in a pound of petroleum as 21,000. At 60 degrees Fahr. 86° Baume gasoline weighs 88.4 ounces per gallon. In other words, the calorific value of a gallon of 86° gasoline is to the value of a gallon of kerosene oil as 88.4 is to 104, therefore gasoline has 18 per cent. less value, gallon for gallon, for fuel purposes than kerosene oil.

It is thus evident that even where gasoline is obtainable and safety ignored, the selling price per gallon should be 18 per cent. less than kerosene in order to produce power at the same cost as kerosene. Thus, if kerosene can be purchased at 10 cents per gallon, gasoline should be purchasable at 8.2 cents per gallon in order to compete.

It is well known, however, that gasoline is always higher in price than kerosene, though lower in thermal units.

The General Power Company, of 100 William Street, New York, is making a specialty of employing the "Secor" method of utilizing oil of high fire test for motors for all power purposes.

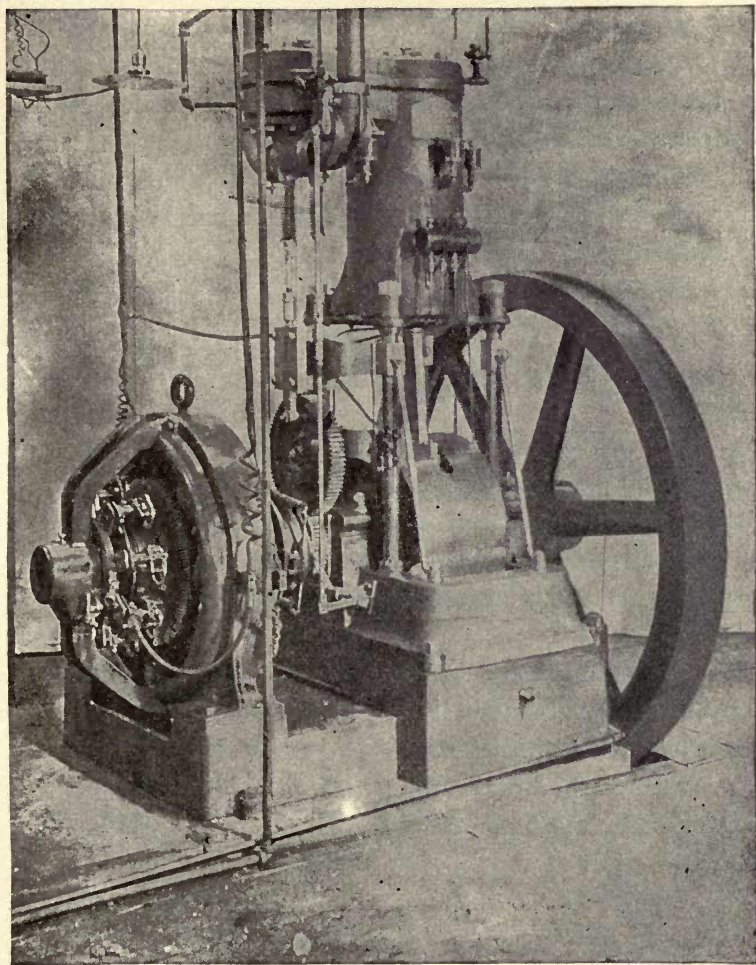


FIG. 203.—THE KEROSENE MOTOR ELECTRIC PLANT.
SECOR SYSTEM.

A recent successful adaptation of their system to electric lighting is the oil-electric motor for isolated plants.

The baffling problem of complete combustion of heavy oils is practically solved, the exhaust being as colorless as from a perfectly-adjusted gas engine. Careful tests show that the direct connected electrical plant furnished by the General Power Company possesses the following features, viz.: reliability, durability, saving of weight and space, low cost of operation, ability to maintain uniform voltage without fluctuation, and perfect combustion.

The freedom from vibration, and the capacity for using ordinary illuminating oil—inherent features of this system—at once challenges the attention of those interested in automobiles.

At the urgent request of several prominent American manufacturers of automobiles, who foresaw the greatly enlarged sphere of usefulness open to an internal combustion motor, embodying the "Secor system," the General Power Company undertook the production of an automobile motor.

The Secor automobile motor embraces three distinctive features: (1) it burns kerosene; (2) it is reliable in operation; (3) it is free from vibration.

In regard to the first feature, it should be stated that perfect combustion is maintained through an extreme range of speed as well as of power.

The importance of the second distinctive feature of this system can scarcely be overestimated. The erratic behavior, and uncertainty of operation of internal combustion motors is greatly exaggerated when such motors are applied to automobile use. Inevitable atmospheric changes, resulting in variation of humidity and temperature, not infrequently have an unpleasant effect on internal combustion motors.

Referring to the third special feature in the Secor automobile motor, absence of vibration, it is well known that the ordinary methods of balancing either stationary or marine engines are entirely inadequate when applied to automobiles.

In a wagon there is no foundation whatever. Again the vibration appears to be increased by the unavoidable conditions affecting an automobile.

Inasmuch as it is impossible to supply a firm foundation to a carriage motor, it became necessary to devise a mechanical arrangement which would absolutely eliminate the recoil or shock incident alike to the cannon and the reciprocating engine, caused by unbalanced pressure.

So far as a cannon is concerned, if the bore were continuous from end to end, and the charge placed *between* two cannon balls of equal dimensions and weight, each equally free to move in opposite directions, the recoil of the gun itself would be *nil*.

The problem of exactly balancing the stresses of a reciprocating engine is more difficult, however, by reason of the change from pressure on the piston to torque on the shaft.

The Secor balanced motor is a successful solution of the problem of suppressing vibration by balancing all stresses caused by the expansion of the gases within the cylinder, as well as those stresses caused by the kinetic change from reciprocating to rotary movement, and the stresses due to centrifugal effect.

The method embodied in the Secor system retains the advantages of enlarged radius of travel and high speed of carriage of the internal combustion motor, in combination with the safety and absence of vibration of the electrically driven vehicle, using at the same time a form of condensed power—kerosene—available in all lands.

Chapter XIII.

ELECTRIC MOTIVE POWER FOR VEHICLES.

THE ELECTRIC BROUGHAM—A FRENCH VICTORIA—THE JEN-
ATZY DOG PHAETON—THE KRIEGER COUPE—THE JEAN-
TAUD CAB AND COUPE—THE PATIN DOG CART—THE
BARROW ELECTRIC TRICYCLE—VEHICLES OF THE
UNITED STATES AUTOMOBILE COMPANY—
ELECTRIC BROUGHAMS AND CABS.
VEHICLES OF THE GENERAL ELECTRIC AUTOMOBILE COM-
PANY—THE ELECTRIC AUTOMOBILE AMBULANCE—THE
WAVERLY ELECTRIC MOTOR VEHICLES—THE COLUM-
BIA ELECTRIC VEHICLES—AUTOMOBILES OF THE
AMERICAN ELECTRIC VEHICLE COMPANY—
VEHICLES OF THE RIKER ELECTRIC
VEHICLE COMPANY—STORAGE BAT-
TERIES AND GENERATORS.
THE WILLARD AUTOMOBILE BATTERIES—THE CARE OF AUTO-
MOBILE STORAGE BATTERIES—PRIMARY BATTERIES FOR
ELECTRIC VEHICLES—AN ELECTRIC AUTOMOBILE
CHARGING AND REPAIR STATION—THE HYDROM-
ETER SYRINGE—THE “MULTUM IN PAR-
VO” CARRIAGE LAMP—AN ELECTRIC
AUTOMOBILE TOY.

CHAPTER XIII.

ELECTRIC MOTIVE POWER FOR VEHICLES.

The wonderful development of electrical appliances within the past few years, for power purposes, and their great economy, adaptability, and usefulness in that line, as shown by the universal adoption of electricity for the propulsion of street railway cars also clearly demonstrates the superiority of electricity as a convenient and easily controlled power for motor vehicles, which are now becoming so popular.

While the well-known trolley car takes its power through the overhead or underground wires and conductors from an inexhaustible source of electricity, the motor vehicle is limited to the charge or amount it can carry, in consequence of the fact that it is intended to travel in places and over roads where there is no continuous outside supply of electricity. Hence the means of storing electricity economically in the form of batteries is now one of the problems which is undergoing development.

New ideas are constantly being worked out, and it is confidently expected improvements will continue by which greater efficiency will result. At present changes have been made in the construction of storage batteries whereby a surprisingly large quantity of active material is put into a small space, and this accounts for the neater appearance electric motor vehicles now possess over former designs. It is also a fact that the aggregate weight of battery for

the amount of current discharge obtained is less than formerly.

The factor of weight is one of the features in electric vehicles that practical men are working to overcome, and it is said that whenever a storage battery or a system of storing the electric current is invented by which the weight of the battery is greatly reduced, there is certain to be an impetus given to electric motor vehicle industry such as has never been thought of.

One of the essential requirements in a motor vehicle is that the reserve power shall be instantly available for a brief period of time, as, for example, when heavy grades are met with. In a storage battery this condition is perfectly met, the increase of current demanded being readily given off and accurately measured by the ampere meter, so that, by observing the latter, while traveling on an apparently level road, one can detect slight grades by the varying position of the ampere needle.

The battery may be considered as an elastic equalizer capable of giving off, in an instant, the amount of current needed at various times and emergencies. This makes electricity an ideal power for vehicles, for it eliminates the complicated machinery of either steam, gasoline or compressed air motors, with their attendant noise, heat and vibration. It is not only serviceable as power, but also as light at night.

The electric vehicle, since its inception, has had scarcely a decade of years, in which to bring it to its present efficient development. It has been an evolution, gradual, though rapid; for many have contributed to its success, which has finally placed on a firm basis one of the leading dreams of the early inventors and engineers on the possibilities and outcome of the rotary motor. This achievement in the line of electric power can hardly be overestimated. Number-

less inventors and engineers have struggled, toiled and finally passed with the solution of the enchanted problem of rotary motion almost within their grasp in other lines.

It remained for the electric motor to give the final and complete solution. A rotary motor with no oscillating or reciprocating parts has at last been developed. It delivers torque, pure and simple—constant and regular, and has a capacity measured by its size, and an efficiency measured by other motors, nothing short of wonderful. The motor was simply ideal.

At first much was said to the effect that this motor was not a prime mover; but that it had been hitched to a primary power. Its system of connection with the prime source of power is at once so complete, and its association so intimate as to perform more acceptably and economically than the prime mover itself, and as compared with the smaller sources of power, its economy back to the fuel, even at miles distant, was found to be superior.

The fact that the electric motor is a rotary motor, contributes to the success of electric motor driven systems to a degree difficult to overestimate. Our compressed air advocates, compelled, as they are, to use a multiplicity of reciprocating parts as motors, have made a step backward, and are certainly in the rear in this, as in other features of their system.

The electric automobile coming upon the scene at this time falls heir to many of the rich results worked out in connection with tramway traction. There are many who go so far as to predict that the younger claimant will displace the former methods, especially in the lighter class of street service, and this, doubtless, will be the case to a large degree in the near future.

Electric railways are rapidly reaching out with wider

radii of operation and heavier and heavier equipment, and the automobile will doubtless have wide use as supplemental to the heavier systems. In fact, co-operation has already been proposed in a number of instances. Its great flexibility and independence of track render it the ideal urban conveyance.

As the perfection of the electric motor gave the first impetus to electric tramway traction, so the point now reached in the perfection of the storage battery will yield equal results in the field of the electric automobile. The past three years have advanced the art remarkably, and drawn to it the attention of both skill and capital, and results have followed.

The perfected storage battery presents some remarkable features. It even rivals the electric motor in its fitness and special adaptability to the automobile problem. Its very large reserve power at instant command; its entire freedom from danger when fully charged; its almost constant pressure throughout its capacity; its recently developed capacity for quick charging; and ease with which charge may be obtained in almost any hamlet in the country, are among its advantages.

Tests of the principal types of storage batteries in use in Europe as published are trustworthy as to their specific capacity at their various rates; but their stability is not always assured under the severe vibration due to vehicular traffic. Improvements are in order, and progressive towards an enduring stability in the electric storage battery.

Fortunately materials are at hand and systems of developing the plates are now being perfected that will render them thoroughly reliable and commercial to a degree commensurate with reasonable requirements.

THE ELECTRIC BROUGHAM.

In Fig. 204 is illustrated an electric brougham or cab, in which the driver's seat is forward, as in the older style of cabs. The battery is placed beneath the cab floor, with a

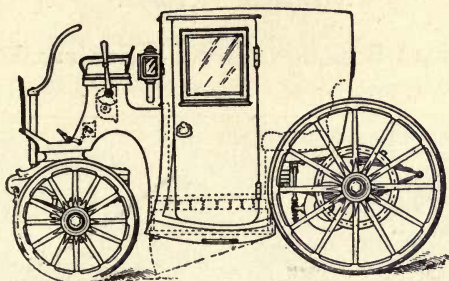


FIG. 204.—ELECTRIC BROUGHAM.

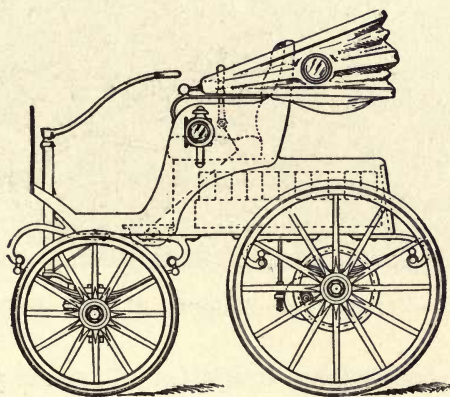


FIG. 205.—THE PHAETON.

drop floor to carry the battery trays. The motors are geared to spur wheels on the hubs, a French design.

The style of automobile mostly in use in Europe and the United States is the phaeton, without or with a top, and which in many vehicles, are made removable to suit the conditions of the weather. Others are also provided with a

temporary seat and foot-board attachable at the rear, forming, practically, a dos-a-dos, thus, with a single vehicle, a convertible all-round establishment may be made a great convenience for a family, a physician or business man.

A FRENCH VICTORIA.

The Victoria of Bouquet, Garcin & Schivre, Paris, France,

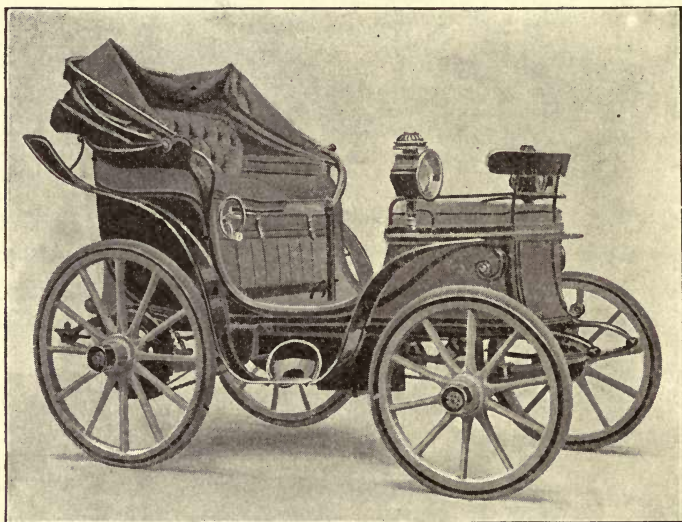


FIG. 206.—VICTORIA OF BOUQUET, GARCIN & SCHIVRE.

is an elegant and stately design for a private pleasure carriage. It is illustrated in Fig. 206.

It has a steel frame attached to the running gear by elliptic springs, and is arranged for interchangeable bodies.

The complete vehicle weighs 2,200 pounds, while the battery weighs but 770 pounds, and is placed in the seat box over the forward wheels. The motor weighs 88 pounds, is rated at 4 horse power, and located beneath the seat over the driving wheels. It is geared to an inter-

mediate shaft, with differential gear, and the power transmitted to the carriage wheels through chains and sprocket wheels. The speed has seven changes up to 15 miles per hour.

The carriage has a total run of 60 miles on a single battery charge.

THE JENATZY DOG PHAETON.

This vehicle, built by the Société Générale des Transports

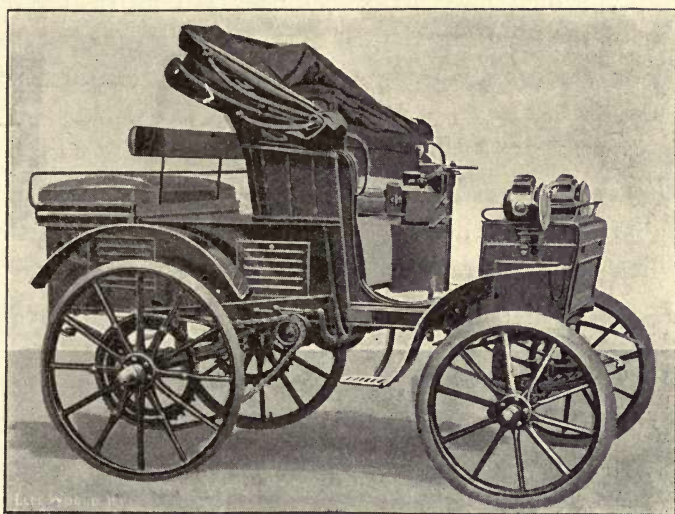


FIG. 207.—JENATZY DOG-PHAETON.

Automobile of France, is a utility accommodation for two to five persons. The extended box at the rear provides for a temporary seat, and encloses one battery and an open type motor, series wound and rated at 4 horse power, with speed regulation for $3\frac{1}{2}$ and $7\frac{1}{2}$ miles per hour. The battery is in two groups, connected in parallel for the low speed, and in series for the higher speed. In line with the armature shaft, a second shaft is connected to it by a universal joint, which shaft carries two loose pinions meshing in gears keyed to the

differential gear shaft that carries the driving sprockets. A clutch between the loose pinions, which are of different sizes, changes the speed for two rates, thus making four speeds in all.

The battery is in two groups of 22 cells each, one of which is under the driver's seat, and the other at the end of the box extension.

The steering is by the forward wheels, which are pinioned at the ends of a fixed axle. The pedal controls the band brakes on the differential gear axle, and a lever operates a wheel or emergency brake, not shown in the illustration, Fig. 207.

THE KRIEGER COUPÉ.

This French carriage is a novelty in the method of placing of the motors, which are fixed on the pivots of the front steering wheels, and geared direct to a spur wheel fixed to the hub of each steering wheel. The motors are four pole, two of which are series wound and the others shunt wound.

It would seem that the position of the motors attached wholly to the steering pivots would injure them by excessive vibration, but lengthy trials have proved that the pneumatic tires were fully equal to the required protection.

The various conditions of grouping the batteries and the field winding give armature speeds from 200 to 1,200 revolutions per minute, with carriage speeds up to 12 miles per hour.

In going down hill the motors act as generators feeding back to the battery.

Fig. 208 is an outlined front view, showing the position of the electric motors, and Fig. 209 is a photo engraved view of the coupé.

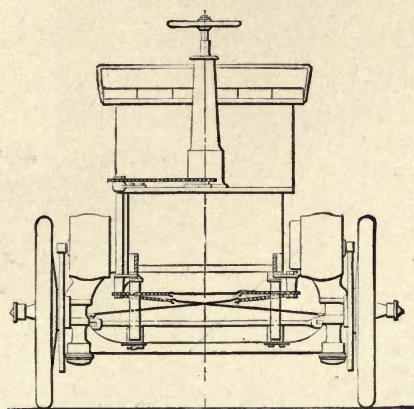


FIG. 208.—KRIEGER COUPÉ.

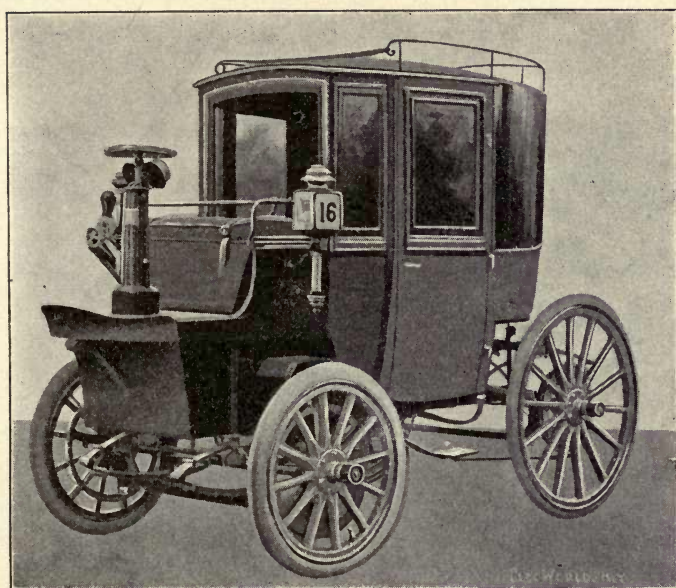


FIG. 209.—THE KRIEGER COUPÉ.

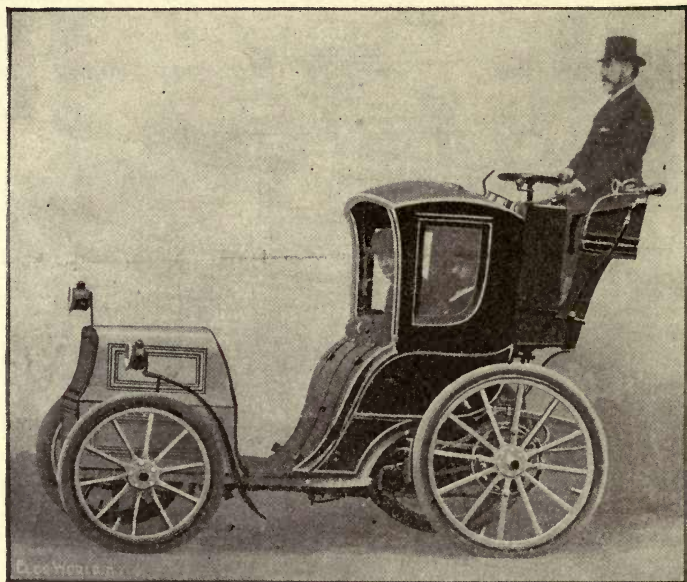


FIG. 210.—THE JEANTAUD CAB.

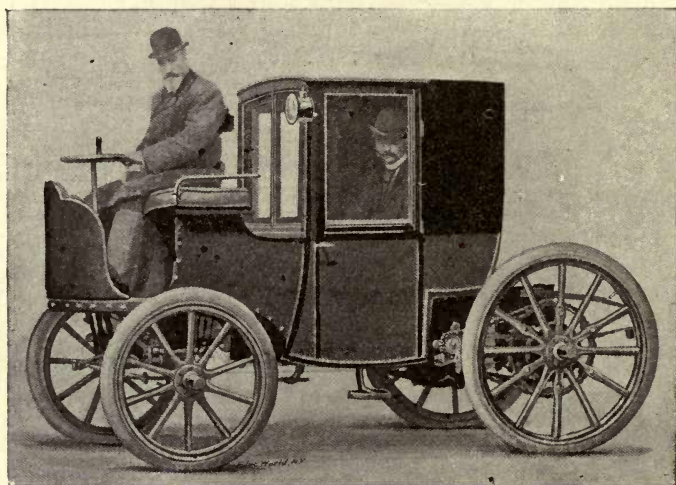
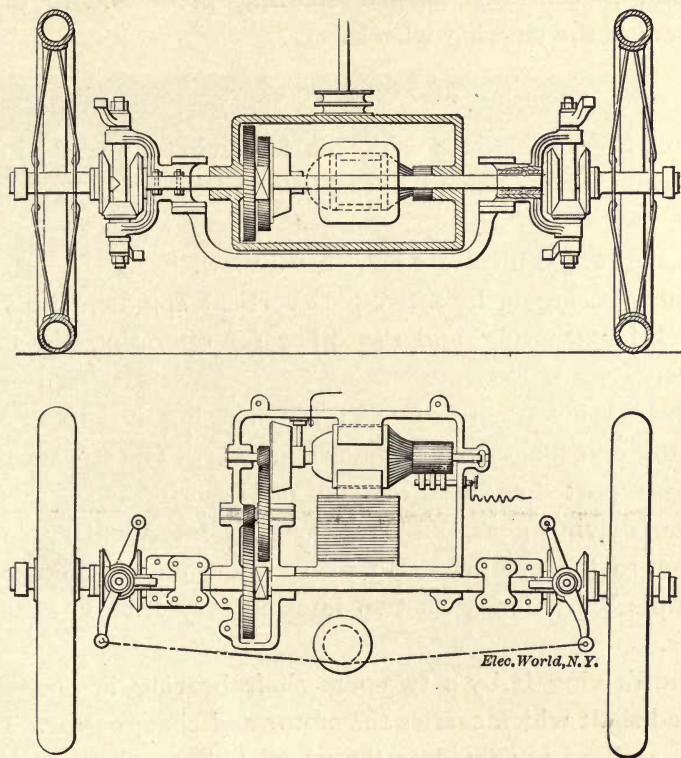


FIG. 211.—THE JEANTAUD COUPÉ.

THE JEANTAUD CAB AND COUPE.

In Fig. 210 is illustrated the Jeantaud cab, and in Fig. 211 the Jeantaud coupé, as built by M. Jeantaud, Paris, France, and in Figs. 212 and 213 are represented an elevation and plan of the running gear of a Jeantaud coupé, but is not the



FIGS. 212 AND 213.—THE JEANTAUD RUNNING GEAR.

arrangement shown in the cab and coupé, Figs. 210 and 211, which are driven by chain and sprocket wheels on the differential gear shaft.

This allows of a fixed axle and eliminates the complication of a differential gear on a revolving axle. For these carriages a bipolar motor of $3\frac{1}{2}$ horse power, with shunt and

series field coils, are used, which gives speeds from 3 to 11 miles per hour. The 44 battery cells weigh 880 pounds. The elevation and plan of the driving and steering gear, Figs. 212 and 213, is peculiar, as the transmission is through a set of three bevel gears at each side in order to get around a centrally located steering pivot and to make drivers of the steering wheels.

THE PATIN DOG CART.

This French electric vehicle is somewhat a novelty in its general appearance, and in the transmitting and regulating gear.

In Fig. 214 is illustrated a general view.

The steering is by a two-part vertical spindle, with one wheel for steering and the other for operating the controller.

The side lever, with a latch, is for changing the speed gear, and the rear longer one is the brake lever. The storage battery is reported as a new one, but not described.

The driving gear, Fig. 215, has one intermediary spur, geared to the compensating gear. The motor pinion is a multiple V friction, with two intermediary friction change gears.

The driving is by a two-part shaft bearing in an offset a fixed shaft which carries the motor and change gear. The brake pulleys are fixed to the wheel hubs, and the springs clipped to the offset shaft.

The offset shaft or bar is opened horizontally into an oval to receive the compensating gear, having one each of its beveled gears fixed to the inner ends of the driving shafts, which are also journaled to bearings on the oval part of the offset shaft.

The motor shaft is supported by arms from the field poles,

and carries a rimmed pulley, concentric with which are three or four loose fitting leather rings (Fig. 216). Two other pulleys of different diameters carry gears and are mounted on an oscillating frame, so that the gears are at all times in mesh with the main gear of the differential casing, while either of the pulleys themselves can be brought

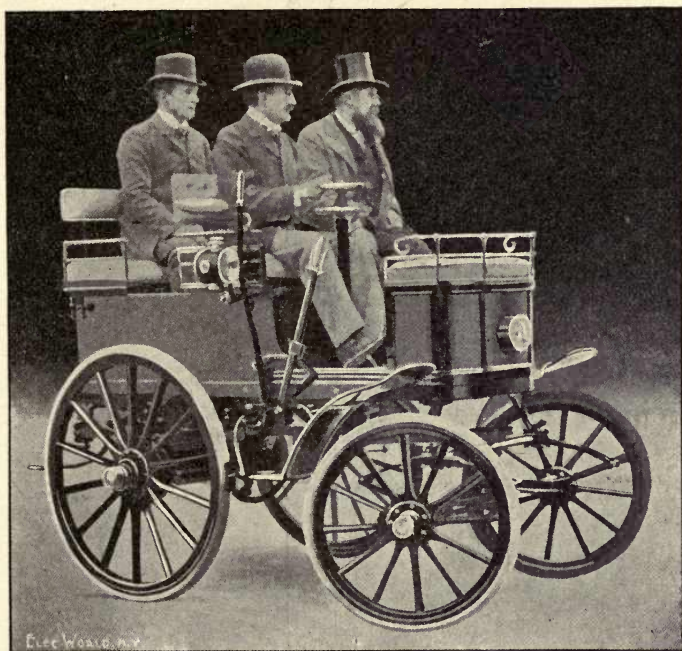


FIG. 214.—THE PATIN DOG CART.

up hard against the leather rings on the motor pulley, being driven by the friction therewith.

The frame of the friction change gear is pivoted on the driving shafts, and carries two pinions that are in constant mesh with the spur wheel of the compensating gear, shown by the large radius dotted line. The friction pinion of the

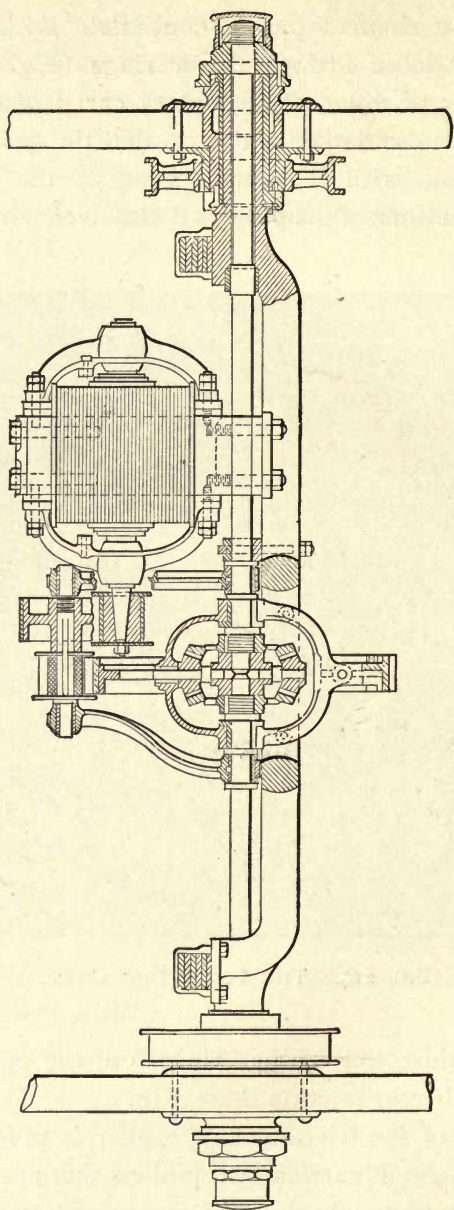


FIG. 215.—THE DRIVING GEAR OF THE PATIN DOG CART.

motor is shown within the triangular space of the frame; the link rod being pivoted to a lug on the frame.

This rather complicated arrangement makes it possible to change the speed-reduction ratio, or to throw the load on the motor after the latter has attained full speed. In this way a sudden pull can be obtained of much greater intensity than the motor would otherwise be capable of. There is no danger of breaking gear teeth, as the gears never separate.

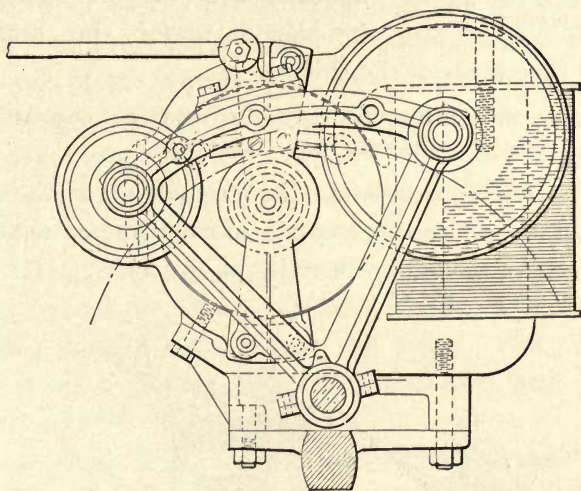


FIG. 216.—THE CHANGE SPEED GEAR.

The motor is series wound, and further speed variations are obtained by changing the number of field windings by the intervention of a controller. The usual band and shoe brakes are present, and the reverse connection is also used as a brake.

THE BARROW ELECTRIC TRICYCLE.

A novelty in electric appliances of power for operating a light vehicle is found in the Barrow tricycle (Fig. 217).

In this vehicle the motor is carried on the fork of the steer-

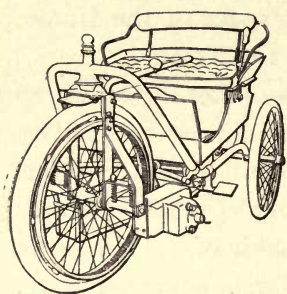


FIG. 217.—BARROW
TRICYCLE.

ing wheel, which has an internal toothed spur gear in which the pinion of the motor meshes.

The storage battery is placed under the seat of the vehicle and wired to the motor with a flexible loop at the fork swivel. A vertical motion of the steering handle operates a brake. The controller is placed under the seat and operated by a lever at the side.

VEHICLES OF THE UNITED STATES AUTOMOBILE COMPANY,
ATTLEBORO, MASS.

In Fig. 218 is represented a new departure in the design and arrangement of the electric motive power which has many points of advantage worthy of notice.

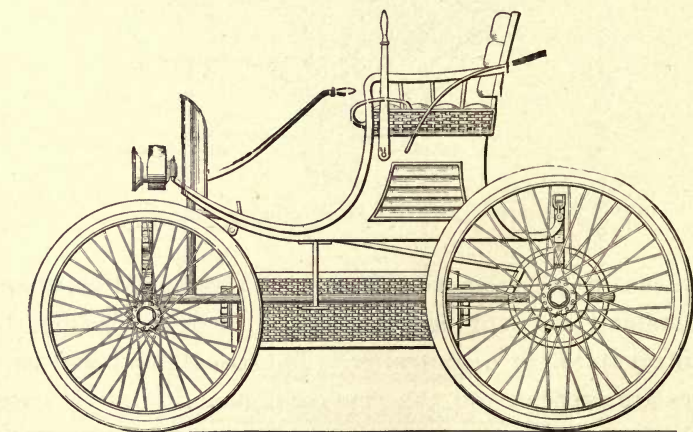


FIG. 218.—THE ELECTRIC VICTORIA.

The outline of the carriage body conforms more to the usual forms of the present style of the horse vehicle. but if extended at the rear gives room for storage so little thought

of in motor vehicles. The battery is suspended underneath the carriage body, thereby getting the centre of gravity low. The carriage body is suspended on light, independent springs.

The electric motor is mounted in the centre line of the rear shaft. No compensating gear is used. The motor is of a new construction, in which both the field and armature revolve, one of the driving wheels being fastened to the field and the other to the armature, giving the necessary flexibility in rotation of the wheels. The brake, which is applied to the hubs of the wheels, is of the ordinary band type.

The weight of this carriage is about 2,000 pounds, the accumulator weighing 1,120 pounds. The accumulator consists of 40 cells, giving about 80 volts when fully charged. The motor shaft revolves about 1,000 turns at the highest speed, carriage being geared to 71. The carriage has three forward speeds, of three, six and twelve miles, and two backward speeds of three and six miles. One charge is sufficient for a 30-mile run. It is provided with volt and ammeter combined.

The steering is by lever connections with hub pivoted gear. The wheels are of the wire suspension type with three-inch pneumatic tires.

ELECTRIC BROUGHAMS AND CABS.

The electric broughams and cabs of the Electric Vehicle Co., now extensively in use in the City of New York, are operated by two electric motors, one to each forward wheel with its pinion meshed in an internal spur gear attached to each wheel.

The axles are both fixed and attached to the vehicle body by springs, the rear axle carrying the steering gear, which is of the knuckle type, and operated by the lever in front of the driver's seat.

The wheels are novel—being composed of sheet iron disks, dished with their convex sides outward and closing on a wooden rim on which is fixed a crescent steel rim to receive the tire.

Fig. 219 represents a very clear front view, and Fig. 220 a side view in outline of the brougham.

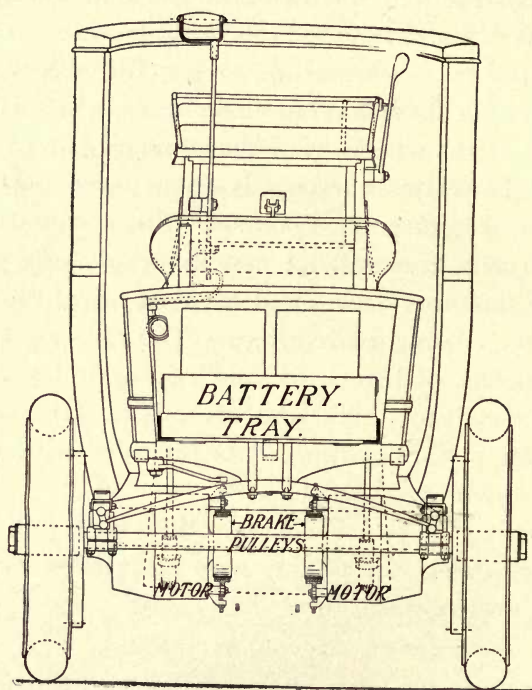


FIG. 219.—THE BROUGHAM—FRONT.

Beneath the driver's seat, laid horizontally, is the controller, with its lever rising on the outside and at the left of the driver.

The brake is operated by a lever and catch-rack through pull rods with levers below the body of the brougham, to a pair of pulley straps with friction on pulleys fixed to the

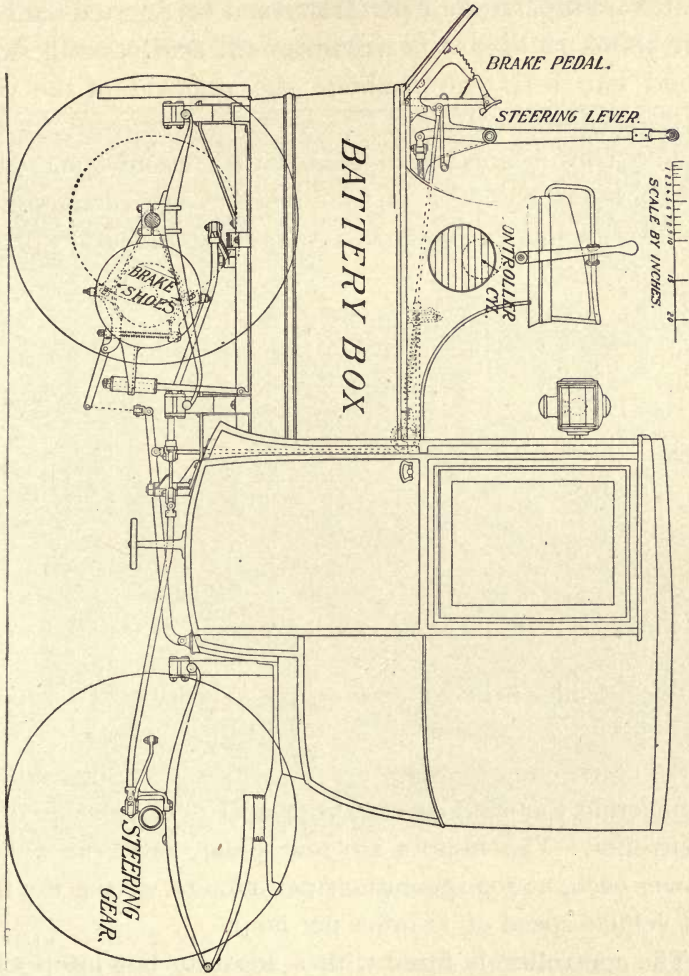


FIG. 220.—THE BROUGHAM—SIDE.

motor shafts. The motors are held by a spring link to the body of the vehicle.

The battery jars are of hard rubber, within which the plates are separated by perforated and corrugated hard rubber sheets to lessen the splash of the acid—and the whole fitted into a tray to facilitate the removal of the whole battery at once.

The tray is lined with lead, with a waste spout which prevents any spilled acid from injuring the carriage. The battery equipment complete weighs about 1,200 pounds.

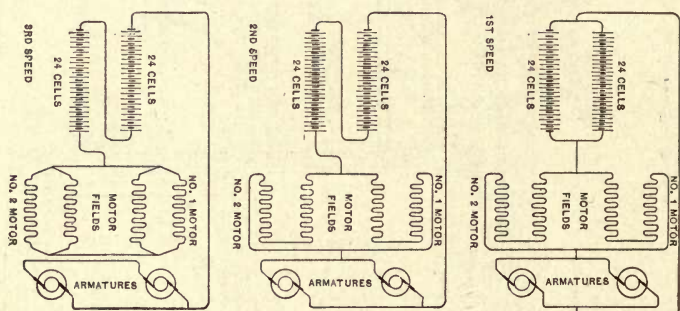


FIG. 221.—DIAGRAM OF BATTERY AND MOTOR CONNECTIONS.

The controller is arranged for three speeds, with a reversing switch.

An emergency switch is also provided to be operated for connecting the main current in case of derangement of the controller. The motors are four polar, rated at 2 horse power each, at 700 revolutions per minute, giving the highest vehicle speed of 12 miles per hour.

The controller is fitted with a separate but interlocking reversing switch, so that the three speed positions apply to either forward or backward running. No magnetic blow-out is used with this controller, and each contact is made doubly certain by the use of two independent contact fingers

in each division. The speed variation is obtained by means of a division of the battery into two groups, which may be placed in series or multiple, the third or highest speed being obtained by a rearrangement of the series field coils of the two motors from a series to a multiple combination



FIG. 222.—THE HANSOM CAB.

(see Fig. 221). In the main circuit there is also what is called an emergency switch, in such a position that the driver can strike it with his heel and open the main circuit in case for any reason the controller becomes inoperative.

The batteries are placed beneath the driver's seat and over

the driving wheels, thus throwing the greatest weight upon the drivers. The panel doors in front, beneath the foot board, make a most convenient entrance to the battery box for changing the batteries, which consists of 48 cells of chloride accumulators of the motor vehicle type.



FIG. 223.—THE HANSOM CAB.

The Hansom cabs of the New York Electrical Vehicle Company have been placed in a firm foothold of patronage, and with the improvements suggested by experience may be considered a fixture in New York cab service.

They are illustrated in Figs. 222 and 223.

VEHICLES OF THE GENERAL ELECTRIC AUTOMOBILE COMPANY,
PHILADELPHIA, PA.

In Figs. 224 and 225 we illustrate some of the vehicles built by this company.

The phaetons for physicians and pleasure riding are in design between a doctor's carriage and a Stanhope, consisting of a seat for two persons, with handsome upholstery and cushions side and back. The battery compartment extends under the seat and backward, with a drop-hinged door at

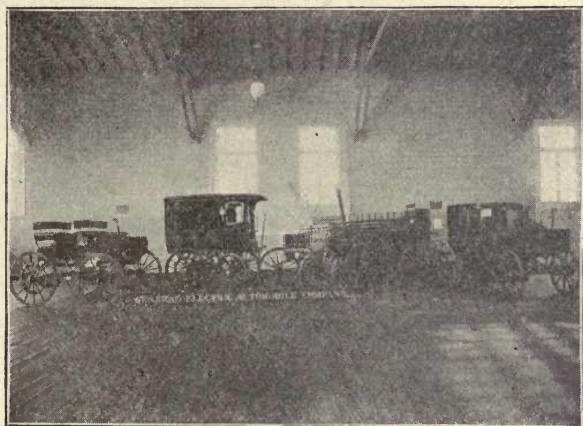


FIG. 224.—VEHICLES OF GENERAL ELECTRIC
AUTOMOBILE COMPANY.

the rear. Handsome lamps, both for electric light and candles, are provided on the sides of the body. The running gear consists of two large rear and two smaller front wheels, all of wood, and having solid rubber tires. The front axle-tree is carried upon springs secured to special iron extensions from the body, and the wheels are turned for steering by knuckle joints or side pivots, and moved by a steering lever extending upward through the body near the dasher, and leading backward toward the seat. The rear axle is also

fixed and carried by a similar set of springs. The wheels are all furnished with ball bearings. These vehicles are designed to give a light-weight effect, and rich yet simple design.

The brougham is but very little larger than ordinary types of fine carriages of this class. In general design it does not differ materially from the best styles of Rogers or Brewster makes, with the exception of the front running gear,



FIG. 225.—GENERAL ELECTRIC AUTOMOBILE COMPANY
DELIVERY WAGON.

which is made similar to that of the phaeton, but heavier. In this vehicle the knuckle-jointed axle or individual wheel pivot is preferred instead of the fifth-wheel because of lightness, cheapness, quicker steering and improved design. The front wheels are smaller than the rear wheels, as is customary. The axle boxes are provided with roller bearings. The eye is not offended by any abnormal changes in design

from that it is accustomed to seeing, the company believing that any radical changes in design should come by degrees to avoid public aversion to riding in objectionably conspicuous vehicles. The motors are located under the rear portion of the body and geared to the large rear wheels. The batteries are placed within a compartment under the floor of the body, but so shielded and worked into the structure of the carriage that it is not perceptible. This result is secured by having a false floor and making the doors fit down over the sides of the battery compartment. The front projection upon which the operator's seat is located is arched in form, just as in the modern brougham, and the controller is placed out of view under the seat. The battery compartment has the bottom hinged to drop on the forward end, and permits the batteries and the trays to be withdrawn or inserted. When in position the bottom is raised and locked in place. The construction makes the vehicle somewhat shorter geared than a horse brougham of the same size.

The electrical equipment of these vehicles consists of the following: There are 44 cells of battery coupled in such a manner that for all normal work the cells are maintained in series, but for certain work, as in mounting very steep and short grades, or starting exceptionally large loads, the cells may be temporarily arranged in two sets, and these put in parallel. The batteries are automatically coupled up with the motor circuits on the vehicle, through the media of contact switches, by simply sliding the trays into the compartments. While the batteries are adapted to be removed from the vehicle for charging, sockets are provided for attachment plugs, so that the batteries may be charged while in place, and these plugs are so constructed that it is impossible to make a wrong connection or reverse the polarity.

The motors are two in number and develop 2 horse power each on normal running, but may be worked up to twice that power at 800 revolutions per minute for a considerable period without excessive heating. They are four-polar, with the armature shaft carried in roller bearings, and operate on eighty volts. The field windings are divided into two coils, so that those of each motor may be thrown in series or multiple. The motors are hinged to the rear axle near the outer ends thereof, and are supported from the vehicle body. The armature shafts extend close to the wheels, and are fitted with pinions of $3\frac{1}{2}$ -inch diameter, working on annular gears of 22-inch diameter, fastened to the spoke arms. The gears are of phosphor bronze and carefully cut. The ratio is 1 to 6.28.

The controller is placed under the floor of the phaetons, and under the operator's seat on the box in the broughams, and is operated by a hand lever. It is of the series-multiple type, adapted to give four speeds and one brake position. The first notch puts the two motors in series with the field-magnet coils also in series. The second notch maintains the armatures in series, but with the two sets of field coils of each motor in each multiple. The third notch throws the two motors in parallel, but connects the two field coils of each motor in series. The fourth notch maintains the motors in parallel, but also throws the two field coils of each motor in parallel. The brake is set by moving the controller lever the other way, and throws the fields and armatures all in series on a short circuit, causing the machines to act as braking dynamos. This is only resorted to in case of emergency or in descending steep grades. A foot brake is provided when desired for ordinary uses. In all of the working notches, one to four, of the controller the batteries are connected with all of the cells in series, giving a maxi-

num voltage of 88. On the fourth or parallel notch the speed is 19.8 miles per hour. In addition to the series-multiple controller there is an electric switch for throwing the battery cells in two series of 22 cells each, and these two in parallel with each other; and this is employed in connection with the parallel arrangement of the motors, namely, the third and fourth notches when the internal resistance and counter electromotive force is lowest. This connection is only used in starting heavy loads or climbing steep grades.

In addition to these switches for controlling the speed and braking there is a separate hand-controlled switch to reverse the armature connections for running backward. In the phaeton these various switches and the controller lever are arranged at the left-hand side of the seat and extend up through the side rail and in convenient reach. This enables the operator to sit on the side adjacent to the middle of the road, and to see more clearly for steering and avoiding collision with passing vehicles.

The delivery wagons are provided with a fifth-wheel steering gear on the front wheels, controlled by a small hand wheel on horizontal axis and operating through gearing a worm or tangent screw, which works in a worm gear segment fixed to the pivoted axle. This method of steering delivery wagons is preferred, because by it the axle is always locked, and excessive strains and jars cannot come upon the operator. It is found by experience that this steering gear works most satisfactorily. It furthermore enables the most approved customary type of spring-body support to be employed, which is deemed advisable, and especially so for vehicles required to carry heavy loads. The batteries are arranged in trays, and placed within a compartment under the rear of the body, and furnished with a spring floor to reduce the jarring upon the battery when traveling over

rough roads or crossing railroad tracks. The wheels are fitted with anti-friction bearings, and the rear wheels are independently driven by separate motors. The wheels are of wood, with solid rubber tires.

THE ELECTRIC AUTOMOBILE AMBULANCE.

The electric automobile ambulance shown in Fig. 226 was built by F. R. Wood & Son, of New York City, for St. Vincent's Hospital. It is handsome in appearance, being well finished. The openings are all inclosed with beveled plate glass windows, which open or close with ease. The vehicle is steered from the front wheels, and is propelled by two 2-horse power motors, which are suspended on the rear axle. The current for the motors is supplied by 44 cells of storage batteries, and it is managed by a controller placed under the seat entirely out of view. This controller permits of three speeds ahead, 6, 9 and 13 miles per hour, and two speeds to the rear, 3 and 6 miles per hour. The radius of action of the ambulance is 25 to 30 miles.

The Wood pedestal gear is used, making it possible to have the body low, which is essential in an ambulance, and adds to its appearance. All the fore and aft bending strain on the springs is relieved by the pedestals sliding vertically up and down on the pedestal box. The driver is in immediate communication with the surgeon by the aid of a speaking-tube. The inside trimming is of leather, and the bed slides out, and being caught by irons, stands out parallel with the sidewalk, thus enabling a patient to be placed upon the bed without the necessity of being jolted, which is inseparable to the use of stationary beds. The inside and outside electric lights are of ten-candle power each. The mountings are all of brass.

The ambulance service in our American cities is the

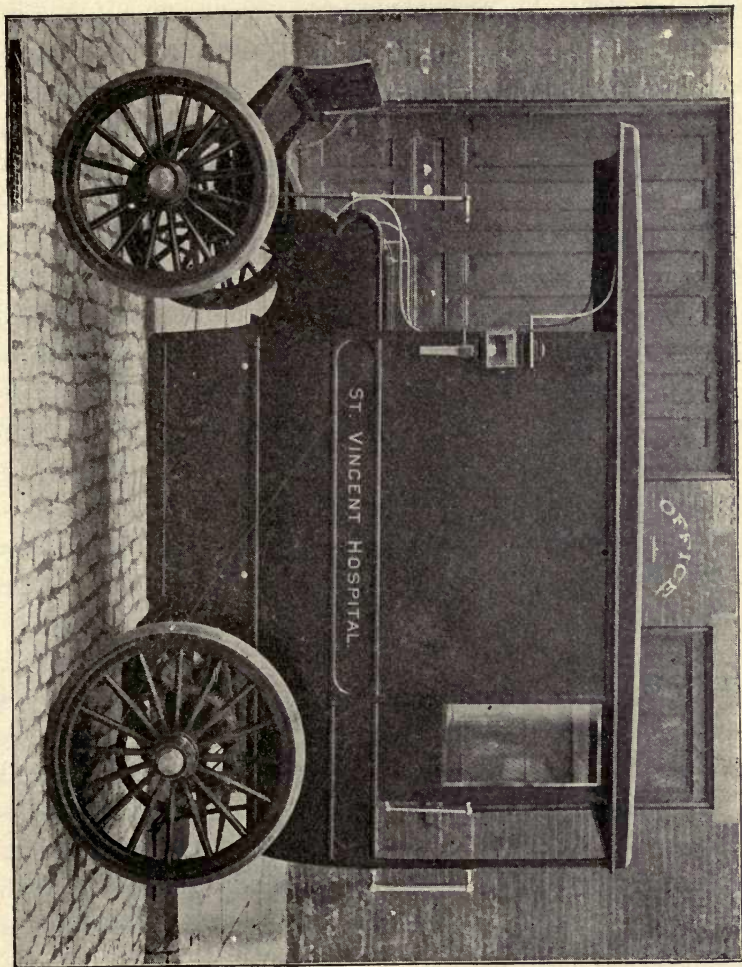


FIG. 226.—THE ELECTRIC AUTOMOBILE AMBULANCE.

model one of the world, so that it is little wonder that we are to have what is probably the first electric ambulance, certainly the one we illustrate is the first ever built in the United States. There are many reasons why an automobile ambulance has marked advantages over the horse vehicles. It is capable of greater sustained speed, and when the destination is reached no care has to be paid to the steaming horse, and both surgeon and driver can devote their attention to the injured person. Accidents to ambulances are of frequent occurrence, owing to their speed and their right of way, but electric vehicles can be stopped in their length. Every second is of importance to an injured person, and speed and ease of riding will undoubtedly soon make them a great favorite among hospital authorities. Another feature of interest is the lower cost of maintenance. An ambulance is usually idle twenty or more hours out of the twenty-four, and this gives ample time for charging the batteries. There is no time lost in hitching up, and the stable may be in the hospital proper, without the dangers of stable odors.

THE WAVERLY ELECTRIC MOTOR VEHICLES.

We illustrate, in Figs. 227, 228 and 229, the electric motor carriages of the Indiana Bicycle Company, Indianapolis, Ind. The bicycle experience of this company has enabled them to build their carriage frames largely on bicycle principles, with cold drawn steel tubing and brazed joint fittings, giving a rigidity to the frame not to be obtained with riveted or screwed joints. The wheels are wire spoked for light vehicles and with ball bearings. The motor is of the multipolar type, and is rigidly hung to the running gear. The motor shaft is geared directly to the two rear wheels. Each rear wheel is made to revolve independently of the other by compensating gears upon the motor shaft.

Three sizes of motors are used according to the weights of the vehicles, viz., one and one-half horse power for the runabout, two and one-half for the phaeton and Stanhope, and three and one-half horse power for the delivery wagon.

The battery consists of 44 non-polarization cells varying in capacity from 60 to 125 amperes; the lightest weighing about 9 pounds per cell.

They are arranged in four trays of eleven cells each, and are charged with a 110-volt current.

A Wattmeter is placed convenient for observing the discharge of the battery, enabling the operator to see at a glance the amount of energy in store. A lever for starting and regulating the speed is placed at the left side of the seat and connected with the controller beneath. A push button on the top of the controller lever gives the reverse motion.

Each vehicle has five speeds forward and three backward; the forward speeds varying from three to fourteen miles per hour.

The steering is by a lever and shaft linked to the pivoted arms of each wheel, giving an easy and natural motion for the hand in guiding the vehicles. A band brake on the periphery of the compensating gear drum is operated by the foot on a pedal on the floor of the vehicle.

A safety lock switch is provided to prevent meddling when the vehicle is left alone.

Their runabout, Fig. 227, is intended for two persons, but has an emergency seat for two more. It is finished in elegant style, weighs about 1,200 pounds, and has a radius of 35 miles to one battery charge.

The Stanhope or phaeton, Fig. 228, is a most convenient and comfortable carriage for touring or for a physician. It has a $2\frac{1}{2}$ horse power motor, with suitable battery for a

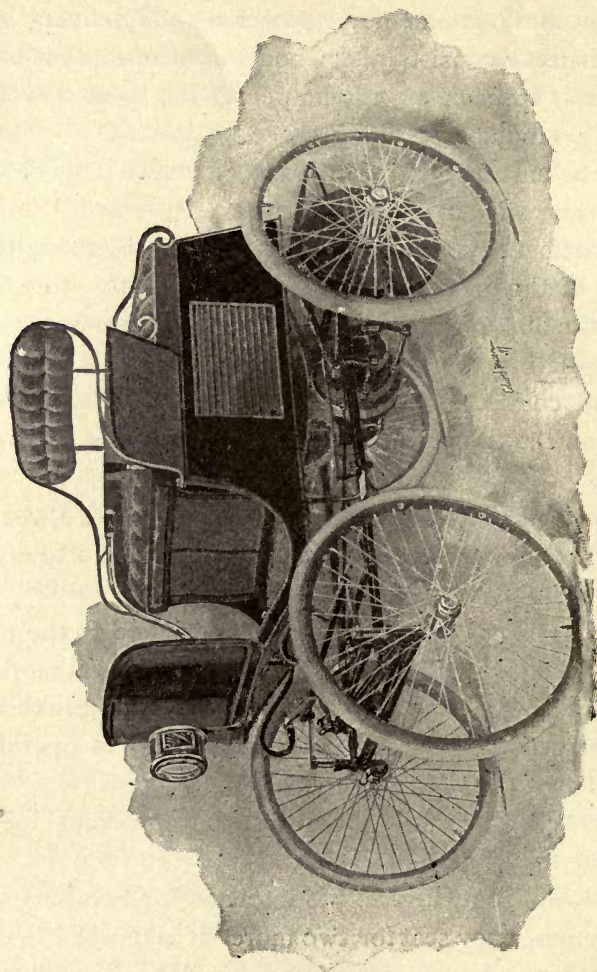


FIG. 227.—THE WAVERLY RUNABOUT.

radius of 40 miles, with a speed of from 12 to 14 miles per hour.

Fig. 229 is a combination wagon for parcel delivery, with a running gear and frame similar to the Stanhope, and of the same power. The parcel hood is removable, as shown in the lower right hand corner of the cut, when a very styl-

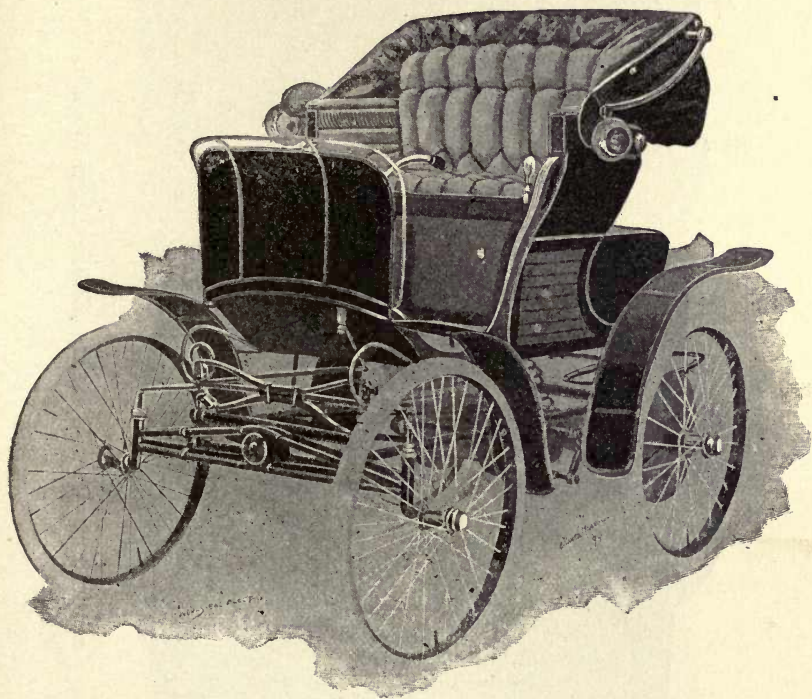


FIG. 228.—THE WAVERLY PHAETON.

ish runabout or pleasure carriage is at hand, as shown in the upper right hand corner of the cut.

This company also make a brougham, equipped with a $3\frac{1}{2}$ horse power motor and a 44-cell battery of 120-ampere hour capacity. It is a stylish carriage, with a removable rear seat, and for winter use is provided with an electrical heater.

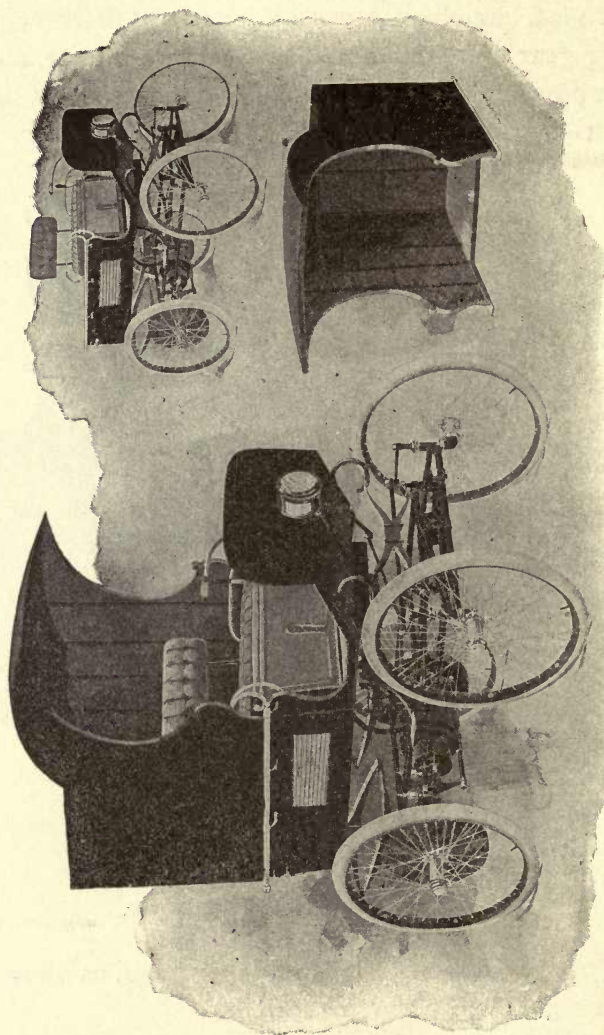


FIG. 229.—THE WAVERLY COMBINATION WAGON.

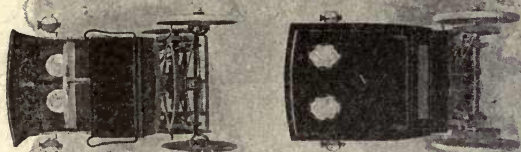
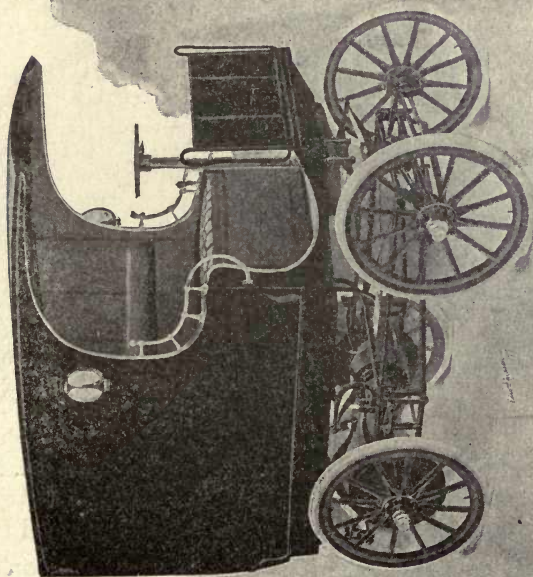


FIG. 230.—THE WAVERLY DELIVERY WAGON.

Fig. 230 illustrates the Waverly merchandise delivery wagon, a heavier and more powerful vehicle than usual, with a $3\frac{1}{2}$ horse power motor, and a radius of 40 miles, with a speed of from 8 to 12 miles per hour. The wheels are strong, of the wood spoke pattern, with pneumatic tires.

THE COLUMBIA ELECTRIC VEHICLES.

Prominently among American motor vehicle builders may be mentioned the Columbia and Electric Vehicle Company,

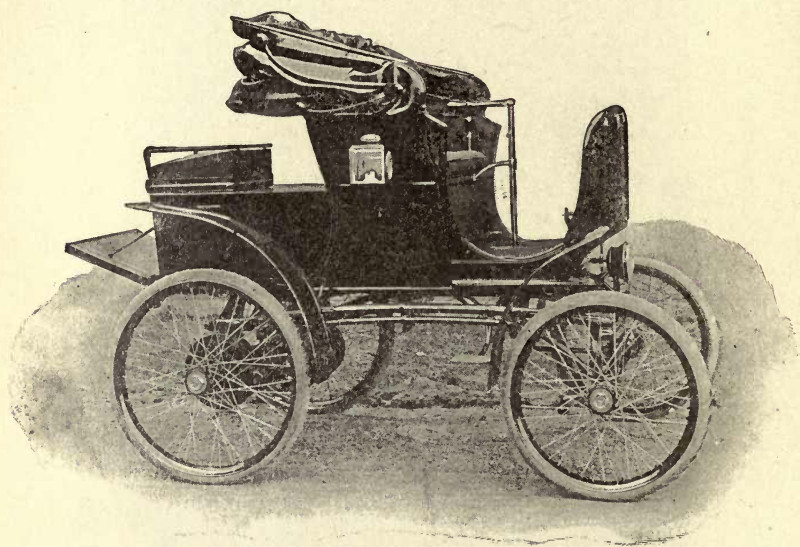


FIG. 231.—COLUMBIA ELECTRIC PHAETON, MK. III.

Hartford, Conn., whose vehicles are manufactured for the Electric Vehicle Company, 100 Broadway, New York City. This company, by virtue of long continued experimentation in the direction of mechanical road traction, has been able to place upon the market vehicles which from the very first have been commercially successful, and have proved popular.

Among these, the first style of carriage produced, known

as Mark III., Fig. 231, has come to be generally recognized as almost a standard type of American electric vehicle. This carriage, in its latest design, is a hooded phaeton, with detachable rumble behind. It is superbly finished in black, with panels of green, and upholstered in dark green wulfin cloth. The body is mounted by means of transverse springs on a rectangular frame of steel tubing, from which is hung, just ahead of the rear axle, a single 25 ampere motor, which

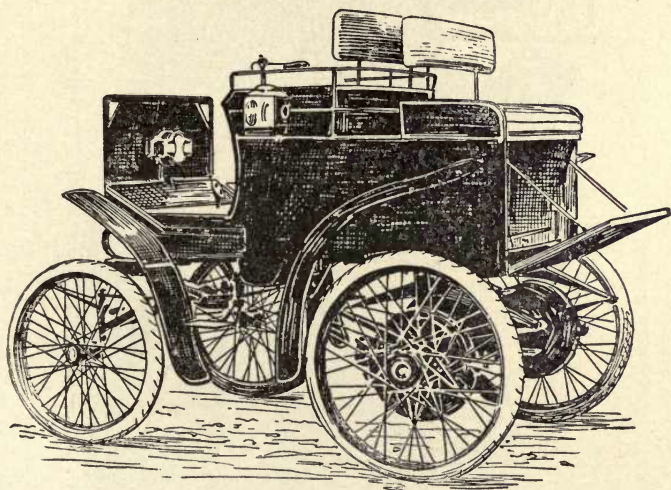


FIG. 232.—COLUMBIA ELECTRIC DOS-A-DOS, MK. VI.

in turn is connected through the customary balance gear to two driving shafts terminating in pinions, the latter meshing with external gears attached to the wheels. The wheel base of this carriage is $65\frac{1}{2}$ inches; the gauge, 54 inches. The wheels are of wire suspension type, 32 and 36 inches in diameter, equipped with 3-inch pneumatic tires. Steering is effected by means of the usual individually pivoted front wheels. By the manipulation of the controller handle at the left of the operator, three speeds ahead, equivalent to 3, 6 and 12 miles per hour, and two backward speeds may be

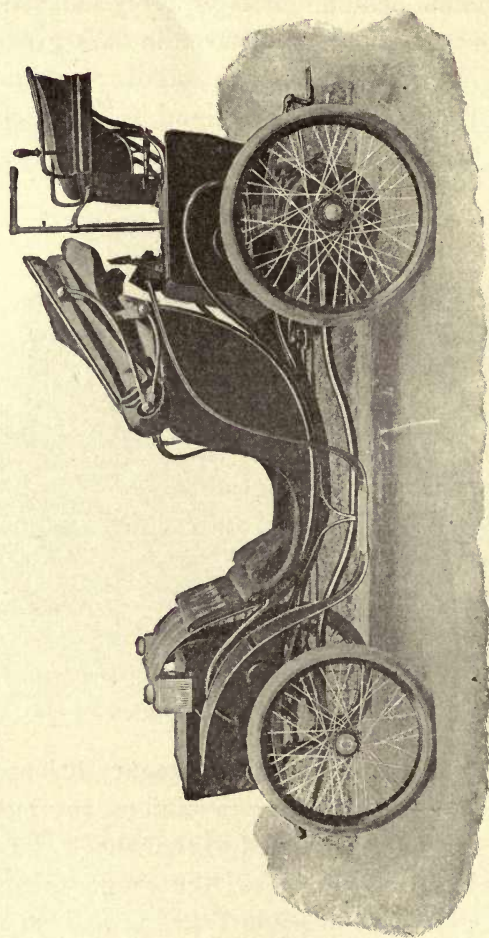


FIG. 233.—COLUMBIA DAUMON VICTORIA.

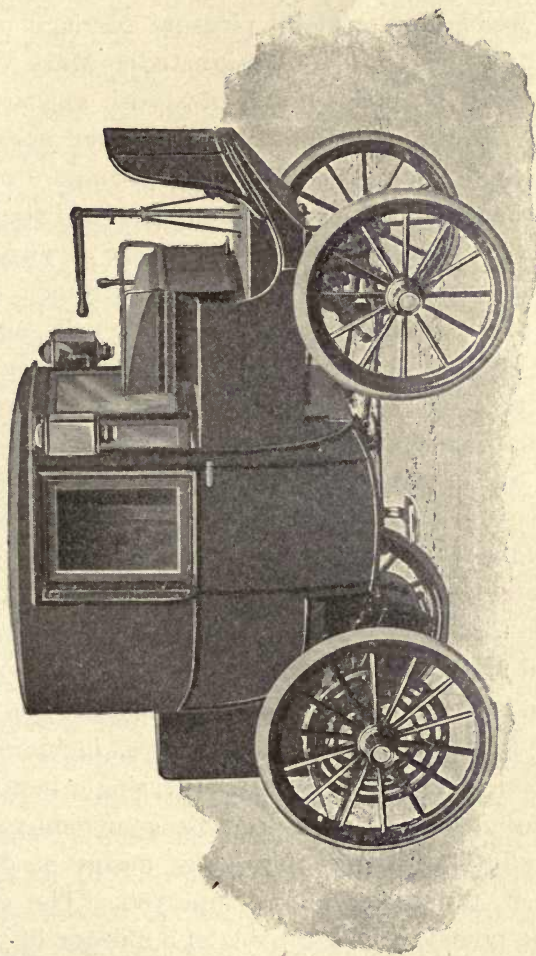


FIG. 234. —COLUMBIA BROUGHAM DE LUXE.

obtained. The battery, consisting of 44 chloride cells, has a capacity of 75 ampere hours at a three-hour rate, giving a mileage of 35 miles over ordinary roads. The total weight of the finished vehicle is 2,570 pounds.

Another well-known style of pleasure carriage, made by this company, is the dos-a-dos, designated as Mark VI., Fig. 232. The body of this vehicle, of stylish appearance, is mounted by fore-and-aft elliptic springs, over axles which are connected by rear bars. A single 30-ampere motor is employed, connected through a balance gear and single gear reduction to the rear wheels. The latter are of wire, 32 and 36 inches in diameter, and provided with 3-inch cushion pneumatic tires. The battery consists of 44 cells, and when discharged in three hours will furnish 90 ampere hours, equivalent to a mileage over ordinary roads of 35 miles. The maximum speed is about 11 miles per hour.

In the Mark VI., Daumon Victoria, Fig. 233, a somewhat radical departure from the lines usually followed in motor vehicle building has been made. The battery is carried in the Daumon boxes, one-half directly over the front axle and half over the rear axle. The vehicle is operated from the driver's seat at the rear, the passengers being thus enabled to obtain an unobstructed view ahead. This seat also accommodates a footman. The usual features, including individual pivotal steering by front wheels, single motor operating, through balance gear and single gear reduction, and controller, affording three speeds by means of different groupings of the battery, are employed. The carriage weighs 3,250 pounds, and is capable of a mileage of 30 miles per charge, and the maximum speed of $11\frac{1}{2}$ miles per hour.

Their delivery wagon is built with a special view to severe city delivery service. The finish of the main panel is black, the center panel velvet brown, and the lowest panel maroon.

The wheels are of wood, 36-inch forward and 42-inch rear, and are equipped with 2½-inch Kelly solid tires. The two axles are braced to the body by means of jack bolts, no reaches being used. The 40-ampere motor, spring suspended just ahead of the rear axle, has bolted to it at each end a cast iron housing, completely enclosing and protecting the balance gear and other working parts, and normally develops about 3½ horse power. The battery compartment, containing 44 cells, is depressed several inches below the merchandise compartment, allowing a carrying space of approximately 4 feet by 3½ feet by 6 feet clear, and designed to carry a total dead load of 1,000 pounds. The average mileage per battery charge is 2½ miles.

The Mark XI., Brougham-de-luxe, Fig. 234, intended for private use, is finished and upholstered in accordance with the most approved usage. It is rear driven by a single 40-ampere motor, the construction used being similar to that employed on the delivery wagon described above; steered by means of the front wheels from a driver's seat ahead, and controlled by the usual three-speed controller and foot-operated band brake. Half of the battery of 44 cells is placed beneath the driver's seat, and half carried in a compartment above the rear axle. The cells used have a capacity of 100 ampere hours, and propel the carriage about 28 miles per charge, the maximum speed being about 12 miles per hour. Wooden wheels, 36 and 42 inches in diameter, are used, provided with 2½-inch Kelly solid rubber tires. The interior is finely upholstered with the best materials, and equipped with the most modern conveniences of urban travel, including coach clock, reading light, driver's signal, etc.

Two other popular styles of vehicle are the small Victoria, Fig. 236, and Runabout, Fig. 237, termed Mark XII. The

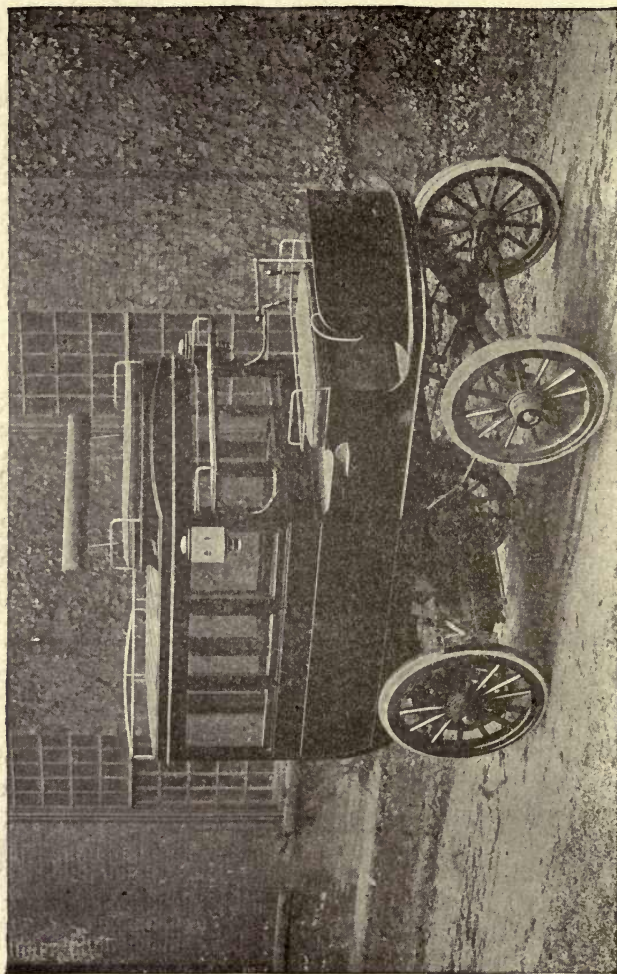


FIG. 235.—COLUMBIA OMNIBUS, MK. XI.



FIG. 236.—COLUMBIA VICTORIA, MK. XII.

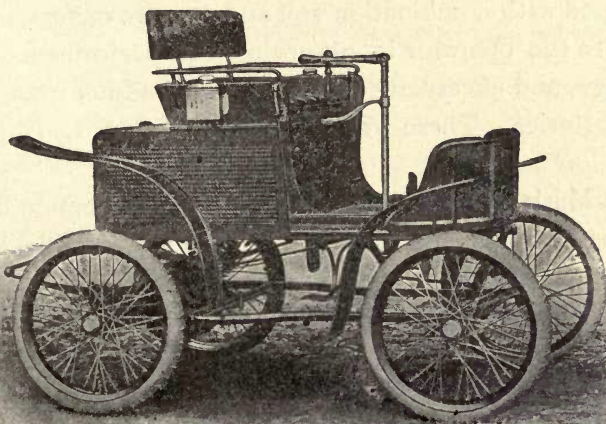


FIG. 237.—COLUMBIA RUNABOUT.

two carriages are similar in point of running gear and electrical equipment, but the bodies are dissimilar, conforming to two well-known existing types of horse-drawn vehicles, the Victoria being intended for ladies' pleasure and park driving, and the runabout for general business and pleasure driving. Both are comfortably upholstered and finely finished,—the former in a bright automobile red or dark green,—the latter in dark green. These vehicles are equipped with 28-inch wire wheels, front and rear, provided with 3-inch pneumatic tires. The short wheel base of about five feet, and their comparatively light weight, make them very easy of manipulation, while their mileage of about 30 miles per charge renders them available for a variety of purposes where a small carriage is required. The single motor, rated at 20 amperes, is swung from the rear axle, and uses current from the battery of 44 cells, located in the carriage body, and furnishing about 45 ampere hours. Three speeds, $3\frac{1}{2}$, 7 and 14 miles per hour are provided. These carriages, together with all vehicles produced by this company, are equipped with combination volt and ampere meters, of great value to the operator in observing the performance of the carriage, and effectually preventing an undue exhaustion of the batteries. These vehicles weigh about 1,900 pounds each.

The Mark XI. Omnibus, Fig. 235., will accommodate ten passengers inside and three on the top seat outside, besides the occupants of the driver's seat. The inside compartment is entered from the rear by means of two steps, and is upholstered in dark green leather, with morocco finish. The windows are provided with silk shades, and the work is finished in cherry, ash and whitewood. The interior is equipped with electric lamps, signal buttons, and other modern conveniences. The wheel base of this vehicle is 8 feet, and the

wheel gauge $5\frac{1}{2}$ feet. The wheels are 36-inch front and 42-inch rear, and are equipped with $3\frac{1}{2}$ -inch Kelly solid rubber tires. Steering is accomplished by means of a lever, standing normally parallel to the driver's seat, and capable of a forward and backward movement. The customary foot-operated band brake is used, supplemented by an auxiliary tire brake applied to the rear wheels by a hand lever at the driver's left. The motor used, delivering normally $3\frac{1}{2}$ to 4 horse power, but capable of temporary loads much greater, is bolted to housings containing the differential gear and other running parts, and is spring-suspended to relieve its supports of sudden strains. This omnibus has made over ordinary roads and hills a mileage of 32 miles on a single charge, and is capable of a speed of slightly over 9 miles per hour.

This company is continually producing new types of vehicles, of which the larger number are electrically propelled, although several varieties of gasoline carriages have already been built.

AUTOMOBILES OF THE AMERICAN ELECTRIC VEHICLE COMPANY.

We illustrate seven of the vehicles of this company who are now located at 134 West 38th street, New York City. The runabout top buggy for two persons, Fig. 238, with pneumatic tires; motor, $2\frac{1}{2}$ horse-power; wheels, with wooden spokes, 34 and 36 inch diameter.

The break, Fig. 239, for four persons, with a motor of 4 horse power; wheels with wooden spokes, 34 and 36 inch diameter, and pneumatic tires.

The Dos-a-Dos, Fig. 240, for four persons. Motor, 4 horse power; wooden spoke wheels, 34 and 38 inches, with solid rubber tires.

The mail phaeton, Fig. 241, for four persons. Motor, 4

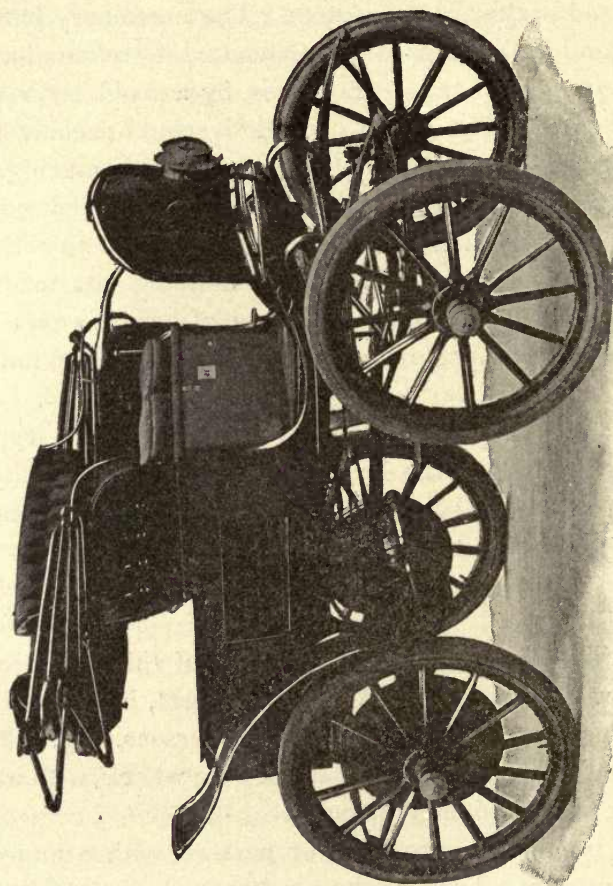


FIG. 238.—THE RUNABOUT TOP BUGGY—AMERICAN ELECTRIC
VEHICLE COMPANY.

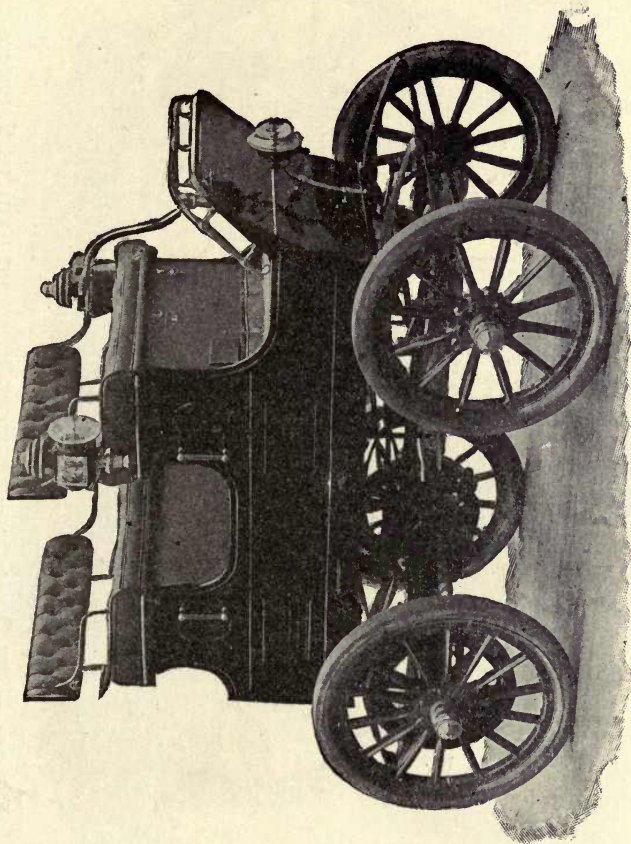


FIG. 239.—THE BREAK—AMERICAN ELECTRIC VEHICLE COMPANY.

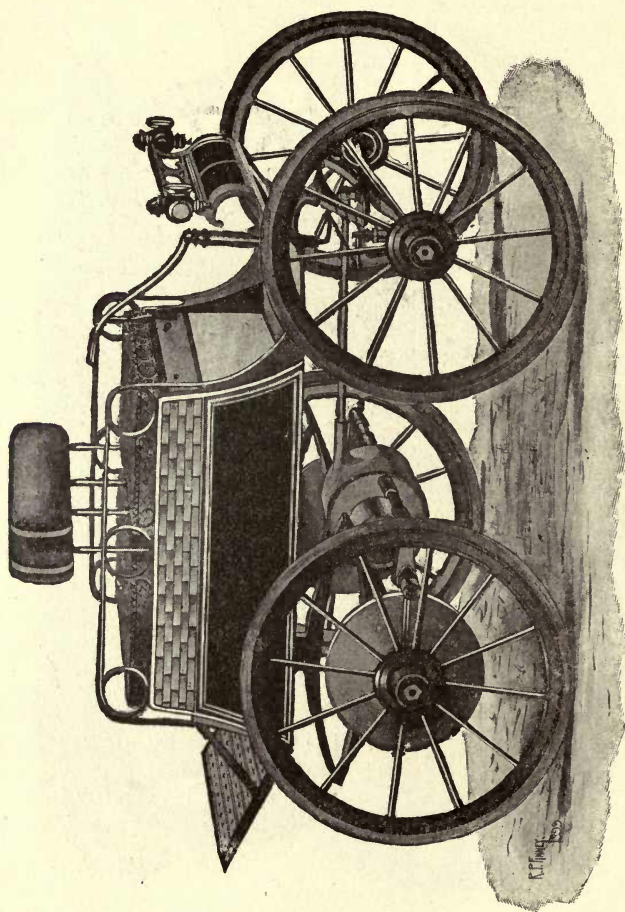


FIG. 240.—THE DOS-A-DOS—AMERICAN ELECTRIC VEHICLE COMPANY.

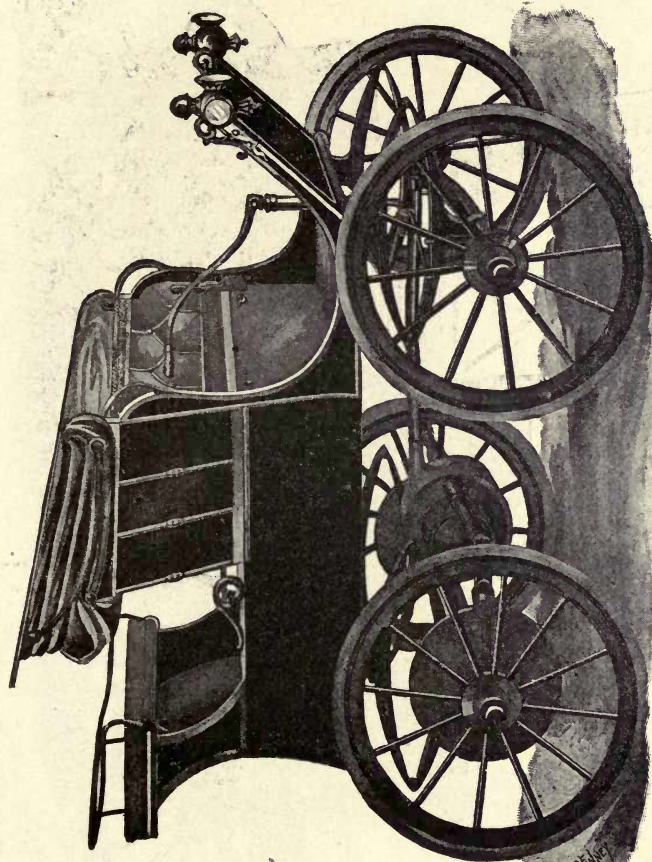


FIG. 241.—THE MAIL PHAETON—AMERICAN ELECTRIC VEHICLE COMPANY.

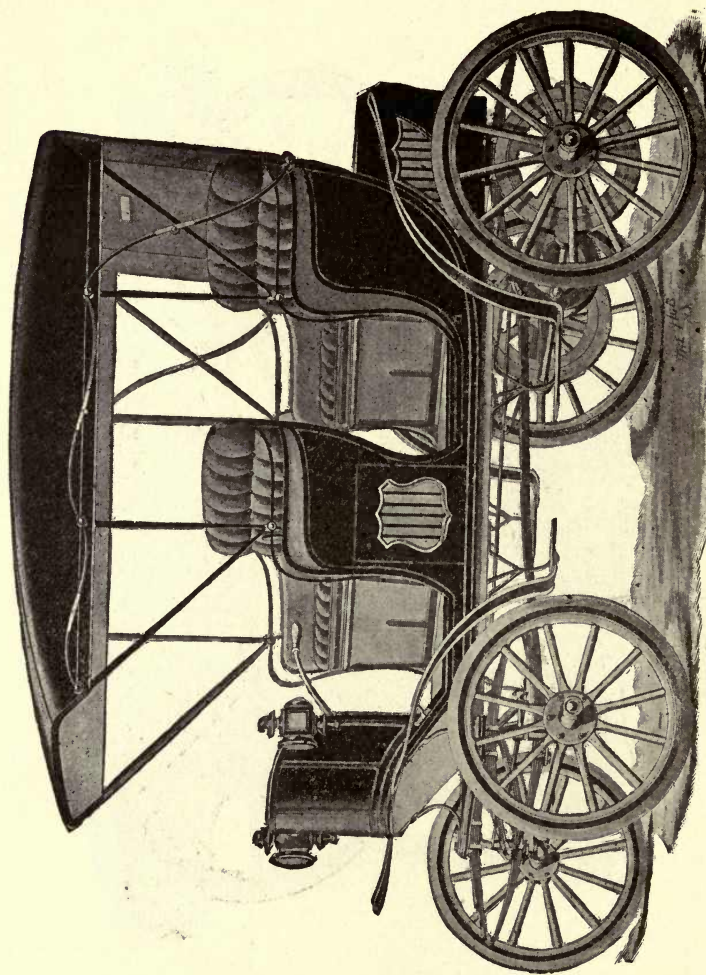


FIG. 242.—THE TOP SURREY—AMERICAN ELECTRIC VEHICLE COMPANY.

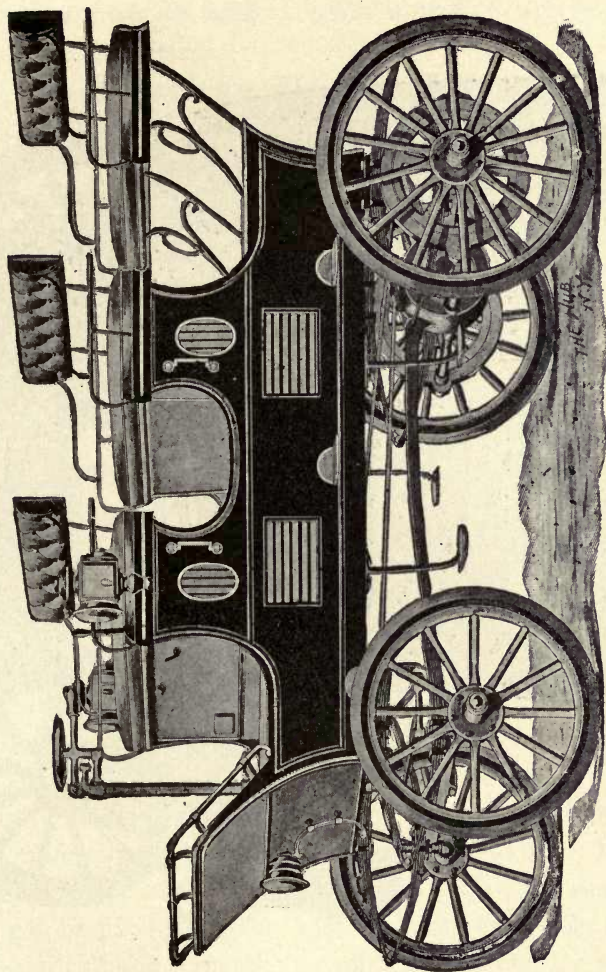


FIG. 243.—THE SIX-PASSENGER BREAK—AMERICAN ELECTRIC VEHICLE COMPANY.

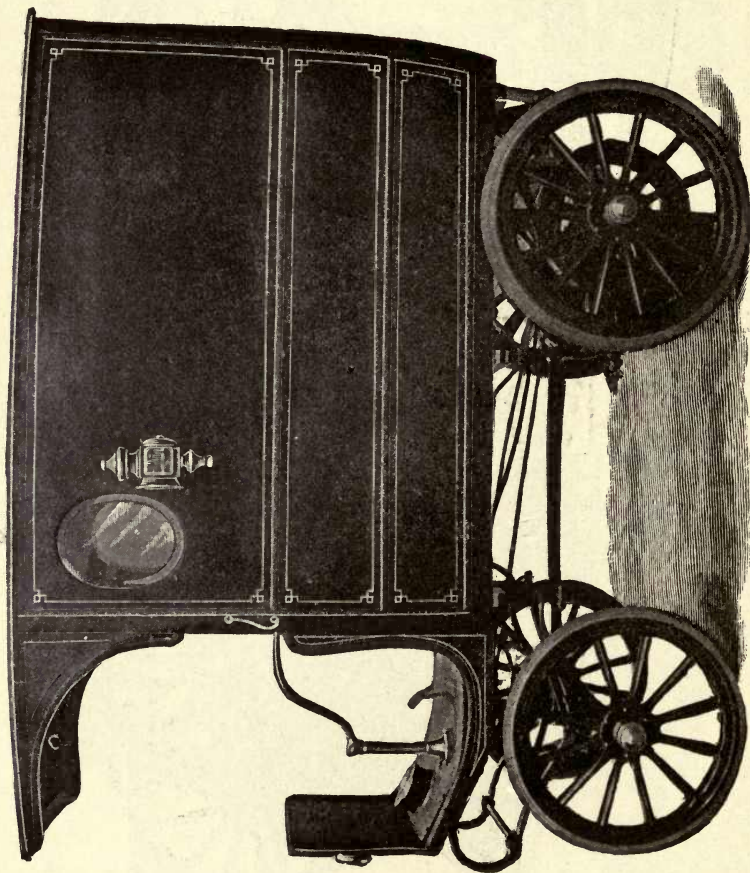


FIG. 244.—THE DELIVERY WAGON—AMERICAN ELECTRIC VEHICLE COMPANY,

horse power ; wheels, with wooden spokes, 34 and 38 inches, with solid rubber tires.

The top surrey, Fig. 242, for four persons. Motor, 4 horse power ; wheels, with wooden spokes, 34 and 38 inches, with solid rubber tires.

The six-passenger break, Fig. 243. Motor, 5 horse power ; wheels, with wooden spokes, 34 and 38 inches, with solid rubber tires.

The delivery wagon, Fig. 244, 8 feet long, 44 inches wide, 48 inches high inside. Wooden spoke wheels, 34 and 36 inches, with solid rubber tires.

The feature of the American Company's construction, a construction that it was the first to use, is the single reduction motor with hollow armature shaft and a single motor equipment. By this hollow shaft construction all need of a divided driving shaft is done away with to give greater strength at this essential point. This company is the pioneer in its line and, always in the lead, it is now making a better vehicle than ever before. The storage battery used has reached the up-to-date limit as a combination of powerful, light and compact design and construction.

One charging will run a vehicle 35 to 50 miles ; very few private carriages would ever be subjected to such a test.

The cost of running is about one cent a mile. The batteries can be recharged in the carriage, and in about three hours' time, shutting off automatically when filled. Where a direct current is not available, or where a large independent plant can be used to advantage, as with a private lighting plant, the running expense per mile can be greatly reduced. The vehicles are furnished with a combination meter, by means of which the operator estimates the mileage capacity yet remaining in storage.

The storage batteries consist of 42 accumulators in hard

rubber cells, tightly sealed, with lug connections burned together. Only the best rolled lead is used, and the motor is a combination of power, capacity and durability with light, compact construction.

The maximum speeds of the vehicles vary according to their purpose, and can, in each case, be regulated to meet the demands of the road—two to twelve or fifteen miles an hour. This is controlled by a lever convenient to the operator's left hand. Powerful band brakes, operated by a foot lever, hold the carriage quickly and firmly on any grade. With his right hand the operator uses the steering lever, the slightest pressure of which is sufficient to place the vehicle exactly where he desires. A ball-and-socket connection prevents the vibration of this lever in his hand. Differential gearing adjusts the speeds of the rear wheels in turning corners. To reverse the motion of the carriage requires but the turn of a little lever at the driver's seat. This is small enough to carry in the pocket, and when removed cuts off the current, thus, so to say, tying up the vehicle. The motive power makes available brilliant electric lamps which add to the safety and beauty of the family carriage, while the electrically illuminated wagon sign, now made possible, recommends itself at once to business men.

VEHICLES OF THE RIKER ELECTRIC VEHICLE COMPANY,
ELIZABETHPORT, N. J.

The Riker system of electric power for vehicles is illustrated in the phaeton, Fig. 245, and the Victoria, Fig. 246, each having tangent wire spoke wheels, 32 inches diameter front, and 36 inches diameter rear, which are the driving wheels.

A single $1\frac{1}{2}$ K. W. motor is enclosed in a tight metal case; one side is clamped firmly to the axle casing, the other side is loosely secured on a vertical rod, but clamped between

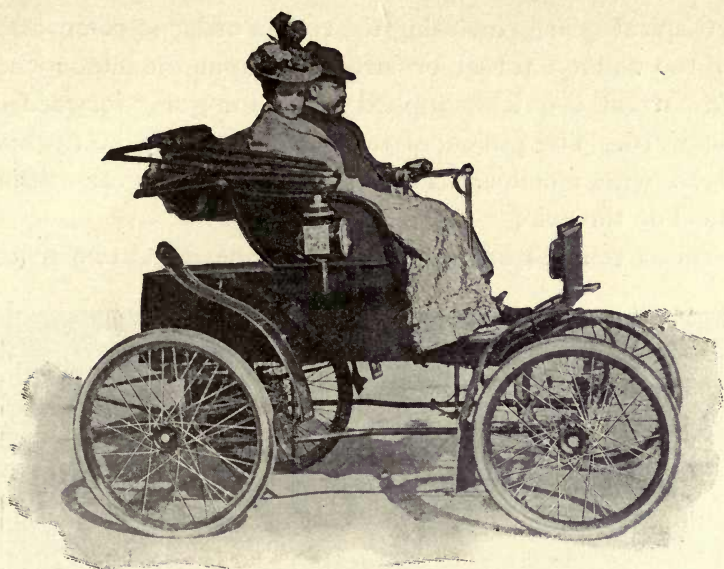


FIG. 245.—THE PHAETON.

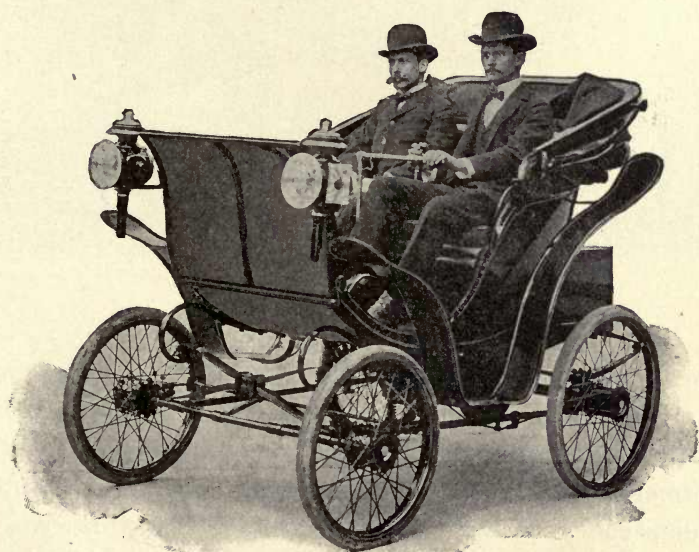


FIG. 246.—THE VICTORIA.

two spiral springs inclosing the rod in order to compensate for the sudden thrust or strain put upon the motor when the current is quickly applied, either for going forward or backward. The pinion of the motor is made of rawhide edged with metal, and meshes into the large gear driving wheel on the axle.

These vehicles have three speeds ahead and two to the

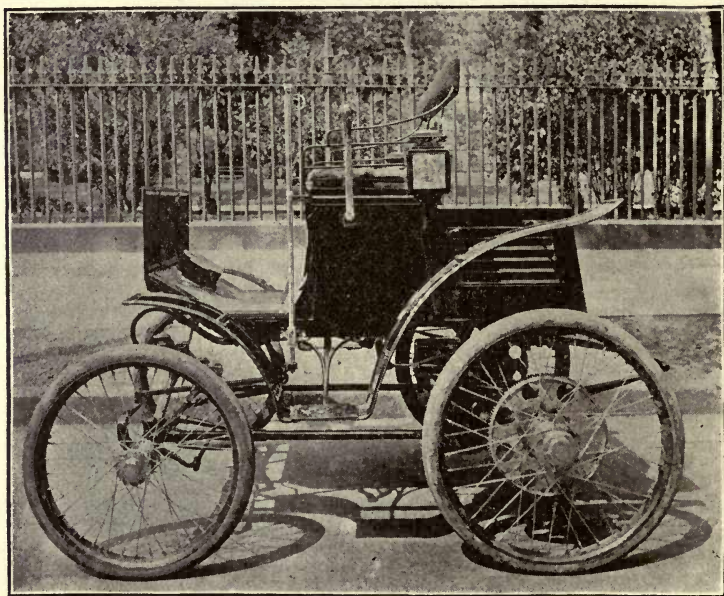


FIG. 247.—THE RUNABOUT.

rear, with a maximum speed of 12 miles per hour, and a total mileage of 25 miles with one charge. They are provided with electric side lights, a combination ammeter and voltmeter in sight on the dashboard. Weight about 1,800 pounds each. Wheel base, 63 inches; tread, 50 inches.

The Runabout, Fig. 247, is a lighter vehicle, with 28-inch front, and 32-inch rear wheels; base, 50 inches; tread, 48

inches; weight, 1,300 pounds. Two motors, of $\frac{3}{4}$ K. W. each, are geared to a spur wheel on each hub, having three speeds forward and two to the rear. A maximum speed of 10 miles per hour, with a total mileage of 25 miles per each charge.

Electric side lights, a combination volt and ammeter completes the rig.

The Dos-a-Dos, Fig. 248, has the same general dimensions

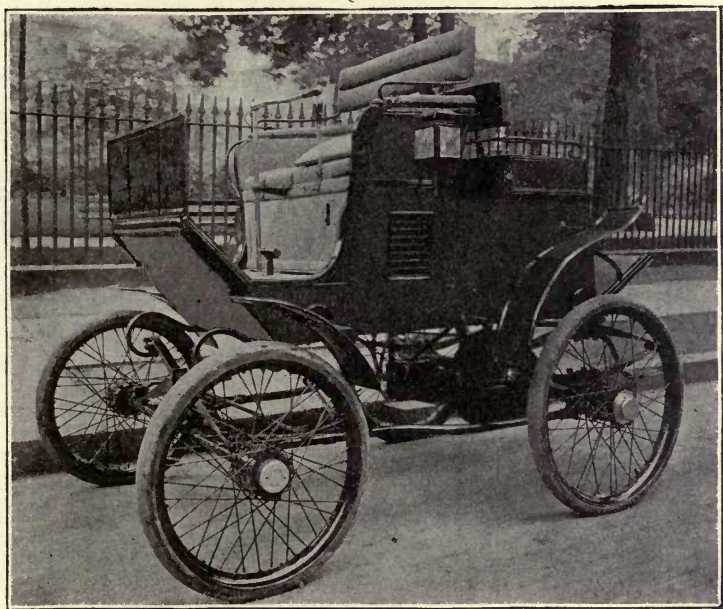


FIG. 248.—THE DOS-A-DOS.

of running gear as the phaeton and Victoria, with a 56-inch tread, and weighs 2,500 pounds.

It is driven by a 2 K. W. motor with the same speeds and mileage as the phaeton.

The Surrey, Fig. 249, is built on similar lines of running gear; a longer wheel base, 74 inches, and tread, 56 inches. They are operated by a 2 K. W. motor, controlled for four

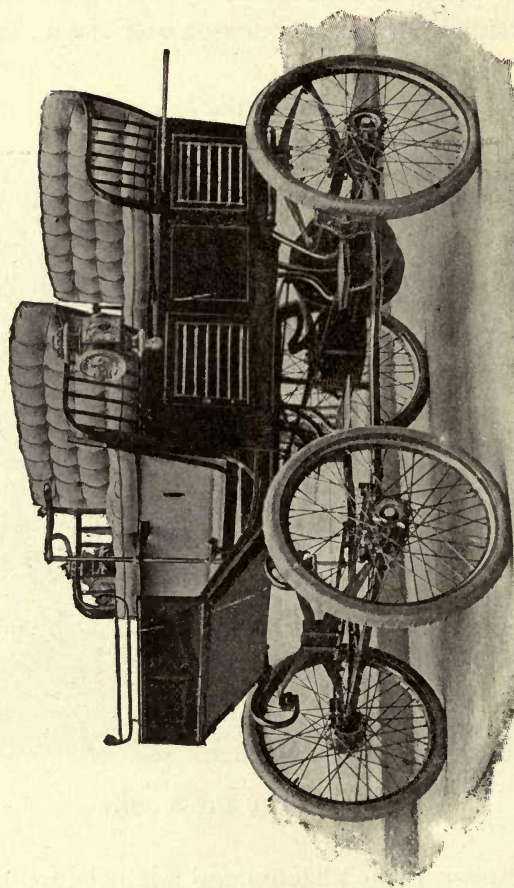


FIG. 249.--THE SURREY.

speeds ahead, and two speeds to the rear. Their maximum speed is 16 miles per hour, with a total mileage of 25 miles.

The storage battery is in two parts, one under each seat, consisting each of two crates or boxes, containing, in the whole, 44 Willard storage cells, size $3\frac{3}{4} \times 5\frac{9}{16} \times 9\frac{1}{8}$ inches high, with a total weight of about 950 pounds.

The Brougham and Demi coaches, Figs. 250 and 251, have



FIG. 250.—THE BROUGHAM.

depressed frames to accommodate a low floor; solid rubber tires on wood spoke wheels; a suitable and strong construction for their weight, which is 4,000 and 4,200 pounds, respectively. Wheel base, 80 inches; tread, 59 inches. Each vehicle has two motors of 2 K. W. each, with the same controller speeds as stated before, and with a total mileage of 25 miles. Maximum speed, 10 miles per hour.

The Theater bus, Fig. 252, is a still more substantial and weighty vehicle, having $2\frac{1}{2}$ -inch solid tires on wood spoke wheels, 36 and 44 inches in diameter, with a 66-inch wheel base. Tread, 58 inch front; 68 inch rear. Weight, 5,500 pounds. A carrying capacity of 13 passengers and driver. Electric lights within.

Two motors of 2 K. W. each, geared direct to large spur

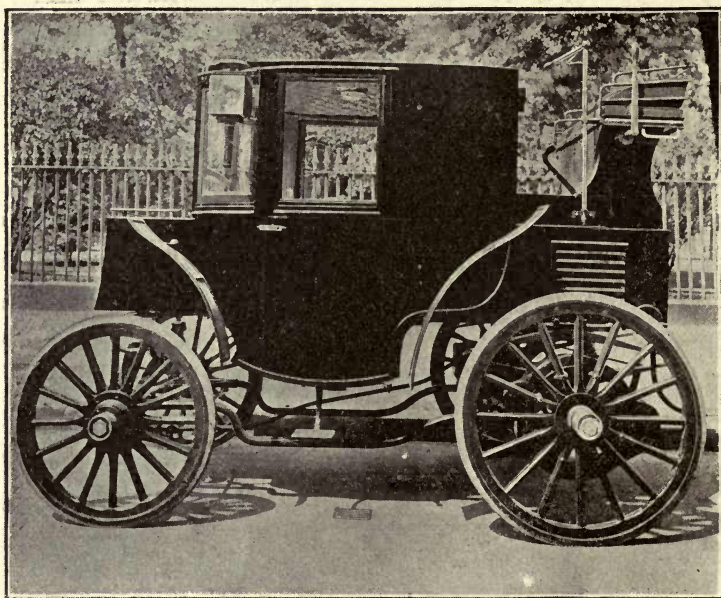


FIG. 251.—THE DEMI-COACH.

gears on the hubs, are controlled at the same speeds and mileage as the Brougham and Demi coach.

The Delivery Wagon, Fig. 253, is of a half ton capacity, in addition to driver and delivery man. Weighs 3,600 pounds. Has 2-inch solid tires on wood spoke wheels, 38 and 42 inch, with a wheel base of 68 inches, and 59-inch tread. The two motors are 2 K. W., each geared to spur

wheels on the hubs. The speeds are three ahead and two to rear, with a maximum speed of 9 miles per hour, and a total mileage of 30 miles.

The Riker Company also build a truck, Fig. 254, in which the battery is carried in an enclosed box beneath the floor of the vehicle. They are driven by two 3 K. W. motors, geared to spur wheels on the rear axle hubs.

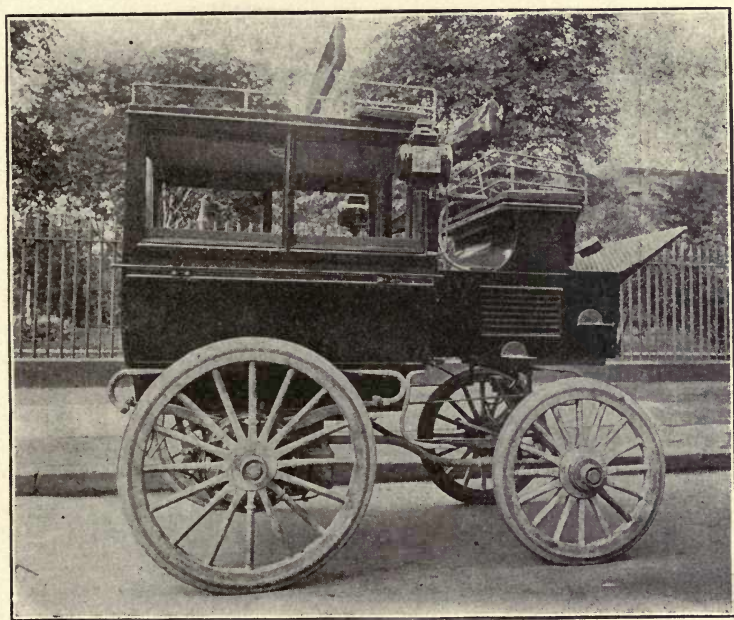


FIG. 252.—THE THEATER BUS.

In the lighter vehicles driven by a single motor, the rear axle is constructed in two parts. One is a solid axle attached rigidly to one rear wheel, while the other end is connected by a differential gear in the hub of the other wheel with the tubular driving axle, both being encased in a stationary tubular axle and run on roller bearings. The solid and tubular axles both revolve together ordinarily, except when

turning curves; then, by means of this gear, one may rotate slower or faster than the other. Such construction permits the vehicle readily to turn small circles and curves.

Fig. 255 represents a Riker delivery wagon hub deep in the snow; they have proved themselves fully equal to horses in a snowstorm.

In the wiring of the Riker system the insulated wires lead

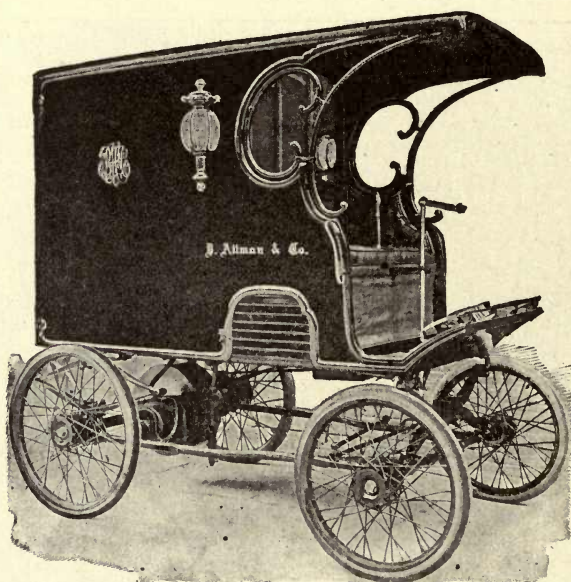


FIG. 253.--THE DELIVERY WAGON.

from the terminals of the battery to the controller located under the front seat just ahead of the battery, which controller is in the form of a cylinder having a number of contact plates on its surface separated by insulating material on which bear brass springs severally connected with the battery in such a way that in one position of the cylinder only a few cells will operate, or in another so that they will be arranged in parallel, or in another in series, or in another for reversal of the direction of the current.

On the left hand end of the controller cylinder is a small cogwheel which meshes with a segment gear forming the lower end of the reciprocating controller lever standing in a vertical position between the cushions and the seat. The movement of this lever forward rotates the cylinder and puts on the current of varying degrees of quantity and intensity, according to the speed desired. There is a ratchet

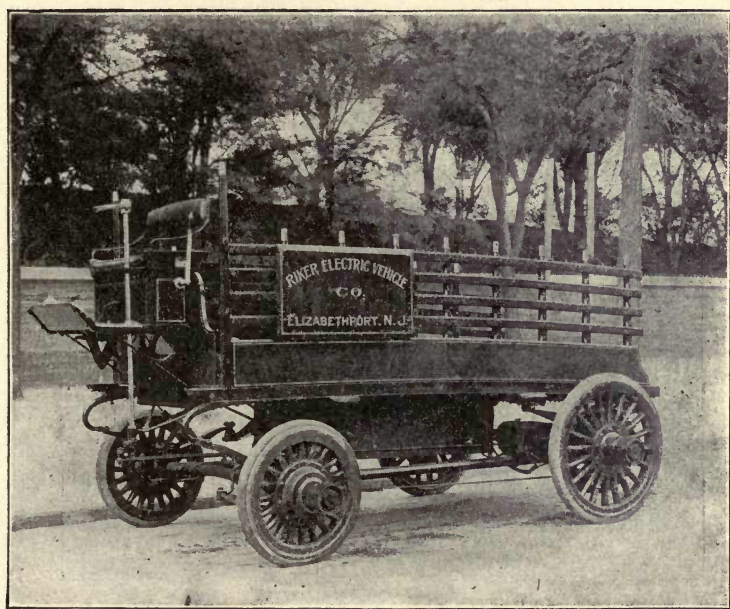


FIG. 254.—THE TRUCK.

wheel adjoining the pinion of the cylinder on which a spring pawl acts as a temporary friction lock, holding the cylinder in whatever position it is placed, yet yielding to the motion of the lever when forced forward or backward by the hand.

Pushing the lever forward one notch, or click of the spring below, gives a very slow speed of 2 to 3 miles an hour; to the second notch, 6 to 7 miles an hour; to the third notch, 10 to

12 miles an hour; to the fourth notch, 15 miles an hour. By drawing the lever back to the vertical position the current is thrown off. Running the length of the lever is a latch rod terminating at the upper end of the handle. To reverse the current for backing, this rod is pressed downward with the thumb at the top of the handle, which permits the controller to rotate in the opposite direction. Two different speeds



FIG. 255.—THE DELIVERY WAGON IN SNOW.

for backing may be used. Thus one lever is used for a forward or backward movement. The driver sits on the left hand side of the seat, operating the driving lever with the right hand and the steering lever with the left. The steering shaft rises vertically through the bottom of the carriage, just in front of the driving lever, and is hinged so that the upper part can lie in a horizontal position, either to the right or the left.

An electric push button is inserted in the handle connected with a signal electric bell, attached to the underside of the bottom of the carriage, at the front. The signal is sounded by pressing the button with the thumb of the left hand. Under the left hand end of the front seat is a special safety switch for completely cutting off the current. At the opposite end is another switch for the electric dash lamps observed on each side. Beside this switch is a three-knife switch which is turned down for charging.

The vertical steering shaft is connected underneath the carriage by a crank and rod with one end of an interior movable hollow hub, around which the front wheel runs on ball bearings; the hub is pivoted on its interior to the carriage frame. Another connecting cross rod extends from this hub to the same style of hub on the opposite side. So that the movement of one hub by the steering shaft operates the other in the same direction, both moving parallel to each other. This enables the steering to be done very easily.

The carriage frame which supports the springs is built of strong steel tubing, well braced and jointed. The foot brake lever projects slightly above the floor, and has side notches for holding the lever in any position it may be placed. From this lever under the carriage, the brake rod extends to a band brake wheel secured on the rear tubular propelling shaft adjoining the large gear wheel, also keyed on the same shaft. To exclude dust, these are covered by a metal casing.

An additional safety hand brake is provided, the lever of which will be seen just inside the front seat of the surrey, Fig. 249. By the side of the main gear and within the same case is a pulley on which acts a band brake, besides which shoe or spoon brakes are also fitted to the rear tires.

The "Jack-in-the-Box," differential, or compensating gear, to give its various names, is located inside one of the cylindrical hubs, its four intermediate bevel pinions being driven by a sleeve from the main gear meshing with the motor pinion. This gives a solid inner axle clear from this hub to the hub of the other wheel, instead of an axle divided at the compensating gear, as is the case with most other vehicles. Ball bearings are used in the lighter vehicles and roller bearings in the heavier. The steering is effected by the usual hub pivot arrangement, the pivots being placed, however, within the hollow hubs of the forward wheels. These pivots are vertical, and with cone-shaped ends. A proper increased deviation of the inside wheel when turning is obtained by the non-parallelism of the pivot cranks.

Perhaps the most interesting features of these vehicles are the ingenious details of the controlling mechanism. The ordinary cylindrical controller under the seat is used, giving by means of a series-multiple combination of the batteries three speeds forward and two to the rear. In the main circuit is an automatic circuit breaker, which opens in case the motor is given more than 400 per cent. overload. This is reset simply by restoring the controller handle to the off position. On the footboard or dashboard is a combined voltmeter and ammeter, showing at all times the pressure of the cells and the load on the mechanism. An automatic switch in the charging circuit prevents the connection of the batteries with the wrong polarity, and cuts off the batteries when fully charged.

The electric tricycle is rather interesting, as it is one of the lightest vehicles yet developed and weighs only 800 pounds. It has a 4-foot wheel base and a 4-foot tread, with wheels 28 inches in diameter, fitted with 2½-inch pneumatic tires. The motor is rigidly suspended, meshing

directly with a gear on the hub of the single rear wheel, the steering being effected by the usual forward hub pivots. The motor is rated at 1 horse power at 40 volts, and weighs about 60 pounds, the gear ratio being 8 to 1.

In Fig. 256 is represented the running gear of the Riker system of electric vehicles. The frame is of steel tubing with

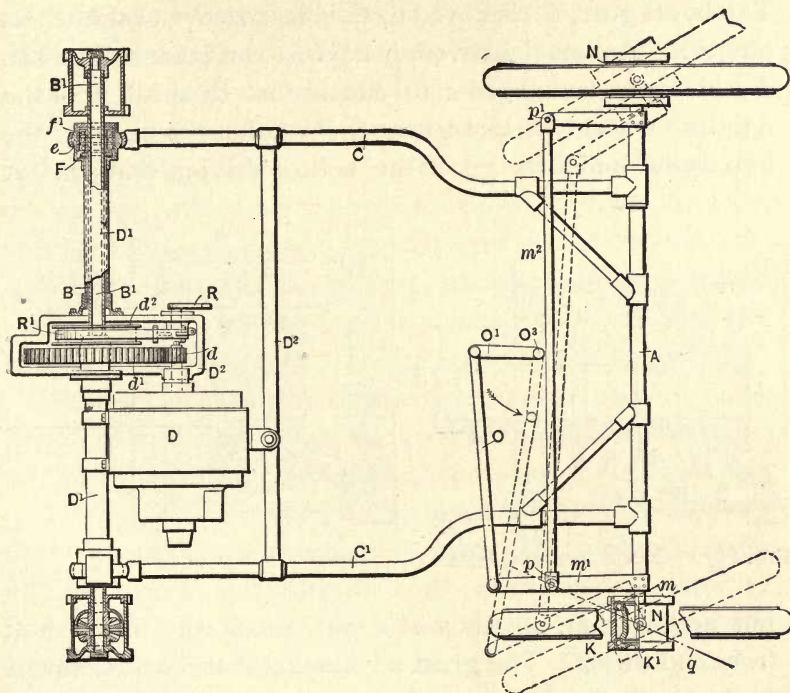


FIG. 256.—THE RIKER RUNNING GEAR.

ball bearings on the hollow driving shaft, which extends from hub to hub with the compensating gear in one of the hubs. The motor, *D*, is pinioned to the spur gear and band brake pulley, which are keyed to the hollow shaft. The motor and gear box are attached to the sleeves, *D*¹, which enclose the hollow shaft and connect with the tubular side bars, *C*, *C*¹. The cross bar, *D*², serves to bind the side bars, and as a sus-

pension bar for the motor. The steering is a novelty, as the pivot is located within the hubs and in the plane of the center bearing of the wheels.

The compensating gear, Fig. 257, is within the hub, has its yoke carrier, G , G , made fast on the hollow driving shaft, B , and carries with it the two bevel pinions on the studs, g^1 . The bevel gear, G^1 , is keyed to the inner sleeve of the wheel hub, H . The bevel gear, G^2 , is keyed to an inner solid shaft, B^1 , which extends across to and is fast to the hub of the opposite wheel. A loose flange, H^1 , holds the shell of the hub to the end bearing of the hollow driving shaft, B . A

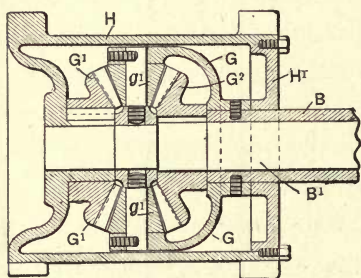


FIG. 257.—COMPENSATING GEAR.

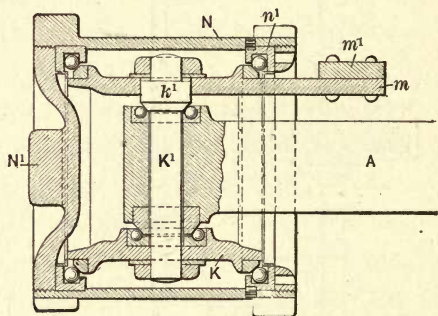


FIG. 258.—PIVOTED HUB.

nut and washer, not shown in cut, retain the inner shaft from end thrust. The great advantage of this arrangement is, that both the hollow and the central solid shaft extend across from hub to hub, forming a strong axle, and avoiding the weakness and trouble given by a divided axle.

In Fig. 258 is illustrated another feature of the Riker system, the center-pivoted steering wheel. The front axle, A , is rigid, with its end encased by a cylindrical box, K , and pivoted thereto by the vertical bolt, K^1 , with a shoulder, k^1 , supported by ball bearings. The cylindrical box, K , carries the wheel hub, N , in ball bearings. An extension of the

cylinder through the open end of the hub terminates in the steering link connections.

STORAGE BATTERIES AND GENERATORS.

The storage battery is no doubt destined to occupy a permanent place as a propelling power in all electrically driven automobiles. A large number of people interested in stored power are looking forward to a revolution in the generating power of storage batteries, and it is the opinion of many that the long-looked-for, light weight, high capacity battery will soon be discovered. It is also the opinion of many that the storage battery art is new; which of course is not true, as the invention of the storage battery was contemporaneous with that of the dynamo electric machine. Storage batteries which have been invented, placed on the market and failed are numerous.

There are probably but few articles of manufacture which permit of so many variations in regard to mechanical structure or capacity. Within the last few years there have been vast improvements made, not so much in regard to capacity as to perfection in mechanical details. The successful automobile battery of to-day does not have near the capacity that some of the earlier types had, but the durability of the same is many times greater.

A storage battery could be put in some of the present types of carriages that would operate the same for a distance of 200 miles on one charge on a level road. Any manufacturer of storage batteries, or any expert in the storage battery business, can furnish a battery having extremely high capacity and light weight, with consequent short life; therefore, all new and wonderful statements in regard to inventions in the storage battery line should be thoroughly investigated before being accepted as the real thing, but a

thorough investigation cannot be made in a few days. Almost any kind of a battery will give good satisfaction for a few months, but the battery which will last several years is the one which is desirable.

A battery can be made of one-fourth the weight of the present standard type of vehicle batteries, and still have the same capacity; it must be borne in mind, however, that it is not possible to make a battery of high capacity having long life. A battery to have long life must have a certain amount of weight, and the makers of batteries which are used the most have placed this weight at a point which will allow of good durability.

To illustrate how light a battery might be made, we make a comparison between the present type of battery, which is most in use, and a battery made several years ago. The present type of battery gives about seven amperes per pound of positive plate; a battery made by Fitzgerald, in England, gives a capacity of 16 ampere hours per pound of plate. In making this into a battery by substituting zinc for the negatives the battery could be made one-fourth the weight of the present standard type. This battery, however, would be extremely short-lived, and would not be durable enough to be commercially successful.

Going further into the automobile, it is not the battery alone which makes a successful automobile, for much depends on the motor, controller, bearings and also the wiring of the different parts. A drop of one or two volts has often been found in the controller alone. All wiring in an electric automobile should be of generous size. For a carriage weighing 1,500 pounds, it should not be less than No. 4 wire. All controller contacts should be made with large surfaces, and all surfaces ground to a perfect contact. The knife-switch principle is undoubtedly the best to use on a con-

troller, as this allows the above-named advantages to be obtained.

As to the proper generator to use for charging a set of batteries for automobile use, we would suggest that, where the straight 110-volt incandescent current is not at hand, a $2\frac{1}{2}$ horse power generator, wound and speeded for 120 volts, will charge a set of 40 or 44 batteries in series easily with a 25-ampere current. A 110-volt generator cannot sustain 25 amperes after the batteries are over one-half charged, or when the counter electro-motive force of the batteries has reached to two and four- to five-tenths volts per cell; that is, the cell shows by the voltmeter 2.5 volts. The amperage will drop down to about 10 amperes. This may not be an objection if time is of little importance, but if the desire is to hasten charging and sustaining the current to about 20 to 25 amperes a 120-volt generator is needed. This forcing process is not approved, as much energy is absorbed in generating heat rather than the chemical changes necessary to the active material.

In order to charge one of our electric carriages in the manner which is considered the most expeditious and economical, a current is required which at a voltage of between 110 and 115 will give from 30 to 46 amperes, depending on the size of the carriage and the capacity of the storage battery in it. Accordingly, if an owner of an electric automobile wishes to install an independent plant for the purpose alone of charging the vehicle, he would need a generator of a capacity of at least 3 kilowatts driven by a gasoline motor of 4 horse power. Such a motor, or perhaps one slightly larger, if properly installed, will furnish an electric light system for a country house, as well, also, to charge the storage battery of the family carriage.

THE WILLARD AUTOMOBILE BATTERIES.

In Fig. 259 we illustrate a single cell of the Willard type for an automobile carriage battery. They are manufactured by Sipe & Sigler, Cleveland, Ohio.

The general value of the storage battery is dependent up

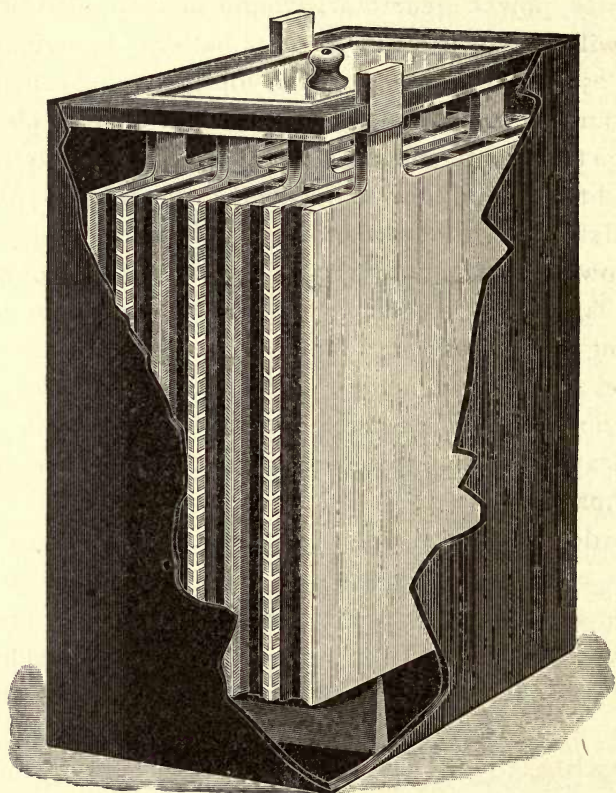


FIG. 259.—THE WILLARD CELL.

on the character and construction of the plates of which the elements are composed; and in this is found much of the merit of the Willard storage battery. The Willard plate, including the terminal, is constructed from a single sheet of pure rolled lead, every part of the finished product remain-

ing integral with the original plate. On either side of the sheet of lead there are formed thin leaves or shelves about one-fourth inch wide and one thirty-second inch thick. These leaves remain attached to a web or support in the center, and incline upward with a curve at an angle of about 20 degrees, thus forming a uniform cup-shaped opening between them.

The active material is produced by electro-chemical means, uniformly on the surfaces of all of the leaves, and on the surfaces of the web until the interstices are filled.

A special advantage in this automobile battery is found in the inclination of the leaves, by which the active material is held in place, as in automobile service this feature practically overcomes the washing action due to the movement of the electrolyte in the cells during the operation of the vehicle.

This battery is composed of the plates already described encased in a special design hard-rubber jar with a glass cover. The plates are separated from one another by an improved hard rubber separating sheath, which is corrugated, ribbed and slotted in such manner as to create absolutely no extra internal resistance in its use, and at the same time to so effectively separate the different elements as to entirely eliminate any probability of short circuits, thereby avoiding all abnormal disintegration. The voltage of these batteries is high, 2.6 volts per cell at full charge. They should not be discharged below 1.5 volts per cell.

Each cell is covered by a glass plate, which permits an examination of the interior of the cell at all times and keeps in view the electrolyte, which is of the utmost importance in batteries used for this purpose, as in cells without the glass cover, great damage frequently occurs by the unnoticed evaporation of the electrolyte below the tops of the plates.

In Fig. 260 is illustrated a nest of storage batteries of the Willard type, consisting of 40 cells in four trays, with their binding posts for connecting them with the controller. They are equal to a total voltage at full charge of 104 volts, and at minimum discharge at a total of 60 volts.

Among the cautions and directions sent with the batteries are the following:

On receipt of battery, charge to 2.6 volts per cell at the eight-hour rate.

Be sure that the electrolyte covers the plates at all times and in all cells.

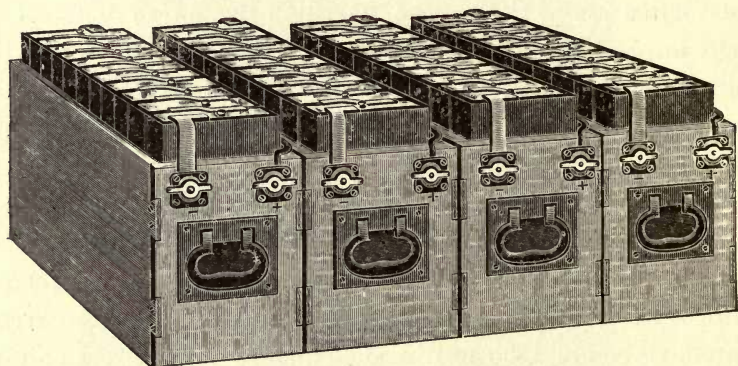


FIG. 260.—THE 40-CELL BATTERY.

Always open carriage body while charging the battery.

Never light a match near the battery while charging.

Never spark the battery while charging.

Always recharge promptly after using the carriage.

Avoid heating the cells in charging.

Do not charge beyond 2.6 volts per cell at the eight-hour rate.

Overcharge for twelve hours at the low rate once each month.

Replenish electrolyte for loss in ordinary use with 10

parts water and one part sulphuric acid. When loss is due to spilling in shipment use four parts water and one part sulphuric acid.

Handle trays carefully—a short drop may break a cell.

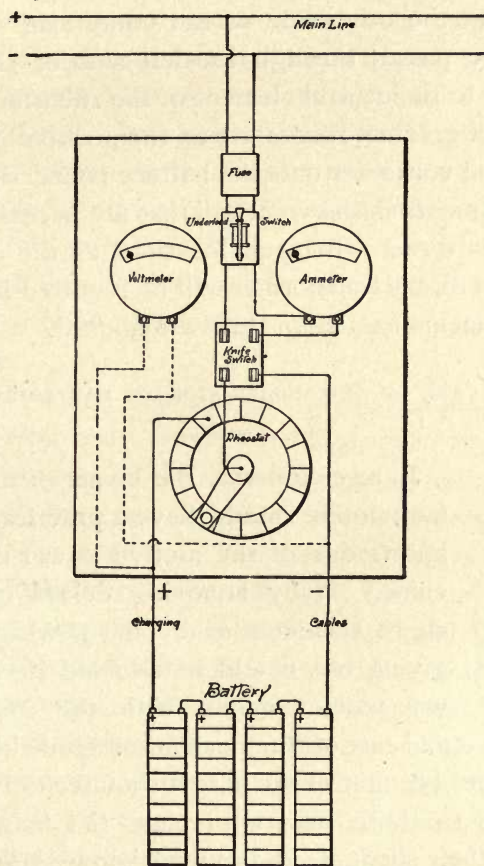


FIG. 261.—ARRANGEMENT OF SWITCHBOARD FOR CHARGING THE WILLARD AUTOMOBILE STORAGE BATTERY.

A more complete and detailed direction for the management of these batteries is given in a booklet which may be obtained by addressing the manufacturers.

In Fig. 261 is illustrated a switchboard for charging an

automobile battery from an electric lighting line, consisting of a fuse, an under-load switch connecting the negative current through the ammeter and double knife-switch to the negative pole of the batteries, which are connected in series. From the other side of the under-load switch the positive wire passes through the left side of the double knife-switch to the central element of the rheostat and from its element of greatest resistance to the positive pole of the battery. The voltmeter cuts the battery connections.

The instruments as shown are all that are necessary where the current is direct. In such locations as the current is alternating, a rotary transformer will be required in addition to the instruments named on this switchboard.

THE CARE OF AUTOMOBILE STORAGE BATTERIES.

BY T. D. BUNCE.



In a general way the owner of an electric automobile should have a practical working knowledge of the motive power of his machine. Many annoying delays caused by slight accidents or by the power suddenly giving out would be avoided if the driver was more familiar with the construction and care of the mechanism within his vehicle.

Perhaps a brief account of the care it should receive will be of assistance to those who appreciate the benefits they derive from their silent steed, but who know little or nothing about its make-up or needs.

The makers' directions should be followed in every particular as long as the battery operates successfully under normal conditions, and the maximum voltage can be obtained after the charge. When it is first seen that these conditions cannot be secured, it is better to consult a specialist

in storage batteries, as there is no source of power so liable to injury by neglect as the automobile storage battery.

The battery usually consists of from 40 to 44 cells, identical in construction. Each cell does its proportion of work, and when one is out of order, it means not only the loss of the work of this cell, but the throwing of the additional work on the others, as well as the ultimate destruction of the disabled one. It is now possible in New York City to call at a charging station, have your battery tested and a report made as to its condition on blanks especially prepared for this purpose. If any defect is found it may be remedied at once, or the defective cell or cells removed and repaired without interfering with the operation of the automobile.

It is rarely found that all the cells are at the same voltage, especially after they have been discharged to any extent. It is frequently found that a battery giving its full voltage at the start will have one or more cells drop down as soon as the current is turned on. The cause of this trouble cannot be found without removing the cells from the vehicle and discharging them at the same rate as that used in the motors and by testing each cell with a low-reading voltmeter.

The customary method of burning the connections together is not considered advisable, as it involves the necessity of sawing them apart to remove a defective cell, and reburning it in place again. In addition to this, the batteries of an automobile require frequent cleaning, and a more convenient method of doing this should be provided.

The oxides from the plates of a battery begin to deposit as soon as it is put in service, and, although space is provided for the deposit, some of it will collect on the ribs in the bottom of the cells and between the plates. This will cause more or less loss of charge if the battery is left stand-

ing for any great length of time before again using it. The agitation of the battery while in use has a tendency to stir up the deposit, so, that much greater capacity can sometimes be obtained immediately after a charge than after the battery has stood over night. It is, therefore, advised to always charge the battery for at least a short time before going out, as this will not only replace any loss, but it will have a tendency to stir up or remove any oxide that has become deposited. The writer has known batteries to do their full amount of work when used shortly after being charged, but ran out in half the time when left standing over night.

Too much reliance should not be placed on the open circuit voltage of the battery either before or after discharge, as the maximum voltage will be given by a set of batteries that has only a small percentage of the electrolyte left in the jars. The maximum voltage would be reached on charging sooner than with the full amount of acid. A defective battery will often give its full voltage when being charged and often hold it for sometime afterward, but on being called on for power it drops to a lower tention.

The working voltage is the best measure of the battery's condition. In the majority of automobiles the different speeds are obtained by various groupings of the cells. This only permits of the voltmeter showing the voltage being used at the time, and it requires the controller to be placed at full speed to get the total working voltage. If, on starting out, it is possible to run a short distance at full speed on a level stretch of road, the voltage should be noted. On returning at the same place and under the same conditions take the voltage again. In this way a good comparison can be made.

The batteries should frequently be removed from the automobile, and the interior of the body cleaned with water

in which a liberal quantity of washing soda has been dissolved. This neutralizes any acid that may have been spilled and causes quicker drying. The battery trays should be treated in the same way. When thoroughly dry they may be painted and replaced. It is especially recommended that provision be made to charge the cells out of the wagon, so that the testing of acid, cleaning, painting, etc., may be done without loss of time. The electrolyte does not require renewing so long as the cells are in working order, but a sufficient quantity must be kept in them to cover the top of the plates about one-half an inch.

The specific gravity of the acid is a reliable test of the condition of the cells. They should all read uniformly. The Beaume scale hydrometer is generally used. In this connection attention is called to the hydrometer syringe, illustrated in Fig. 263, as an almost indispensable instrument for these tests and for other purposes.

PRIMARY BATTERIES FOR ELECTRIC VEHICLES.

Many inquiries have been made as to the possibilities of using primary batteries for motor vehicles. We hear of no successful trials with wet batteries, and the consensus of opinion is that such batteries are out of the field for locomotive power.

We learn that a very light and elegant carriage has been built in England for the Queen of Spain, and supplied with dry batteries with a capacity for being recharged without going to a charging station. The batteries are said to weigh but 225 pounds, and claimed to generate sufficient energy to run the carriage at a speed of 10 miles per hour. The lighting of the carriage lamp is also provided for by the battery current. We can as yet only consider it as a royal toy.

THE FUTURE OF THE ELECTRIC AUTOMOBILE.

Anyone who is familiar with the condition of the art and with the character of the product of the various types of motor vehicles, cannot doubt the wide field that the electric motor vehicle will cover. There is no doubt but the steam and the gasoline vehicle will each have its field of usefulness, and while the same will be comparatively large, in fact enormously large, yet they will in no wise compare with the field that must be covered by the electric vehicle. In reviewing the comparative merits of the several types of vehicles named, the first general division will be dependent upon the ability of the vehicle to perform the required service under the existing conditions of roads and streets. This division will leave to the steam and gasoline vehicles the entire field covering exceedingly bad roads, such as predominate in some parts of the country territory. It will leave the field found in cities, and in such parts of the country as reasonably good roads prevail, to the competition of the three types of vehicles, and it is within this territory that the enormous sales will be made during the next decade, as it is within this field that the automobile is entirely and thoroughly practicable, and it is also within this field that are found the thousands of purchasers ready, willing and capable of paying for an automobile.

In determining the comparative merits of the several types of automobiles in the field last named, the following chief features will be considered and will be found to be of importance in the order in which they are named.

FIRST.—Safety to the operator and occupants. In this important feature it is apparent that the electric carriage is entirely without an equal, as there is no possibility of any damage resulting from the use of boilers or explosives, as nothing of the character is used in connection with the

electric carriage, nor could the slightest damage result to one from any shock that might be produced from the battery, as the voltage used in any motor vehicle is not above 88, which would have no ill effect whatever. The possibility of damage from explosion of boiler or of gasoline, is, of course, apparent to anyone.

SECOND.—The care and ease of operation. In this again the electric carriage is entirely superior to either of the others. Anyone can operate it without previous practice or technical knowledge, and the care is so simple that any coachman of moderate intelligence can perform this service. It must be apparent again to anyone in the slightest degree familiar with either of the other types of vehicle that no one except an expert can be relied upon to operate them, and care for them, and that great damage may result by trifling errors in connection with their operation.

THIRD.—Possible prohibitory legislation. In this there is no possible objection that can be made to the electric carriage, for it is at all times free from any possible objections. This again is not true of the other types of carriage, and there is some probability of prohibitory legislation against these types, as they certainly come under the police regulations as given to municipalities, by State legislatures. It may well be said to be a matter worthy of police surveillance, in which not only the convenience, but the safety of the public is interested in the matter of danger from possible explosions of boiler or other explosives, as well as to the odor and vapor emitted from these types of vehicles.

Imagine the condition that would prevail if the present vehicles of a city were replaced by these types, and you have before you the importance of a vehicle which is entirely free from danger of explosives and from odor.

FOURTH.—General elegance. In this feature, again, the

electric carriage stands entirely alone ; no uncleanness, no vapors, no odors, no vibrations, no heat, no oil, and practically noiseless. Neither of the other types of carriage can be said to be free from the above objectionable elements ; some of them especially annoying, all of them disadvantageous.

FIFTH.—Convenience. In this feature again the electric carriage stands at the head of the list ; for, by the simple insertion of a charging plug when the carriage is driven into the barn, it will take care of itself, and be ready for operation when wanted. It is unnecessary to await the generation of steam, as in a steam carriage, and unnecessary to perform the difficult operation of starting the engine by hand, as in the case of a gasoline carriage.

SIXTH.—Economy. In the cost of the production of energy required for the operation of the various vehicles, the electric carriage is probably a trifle more economical than either of the other types named, but the whole cost for the energy of operating an electric carriage is so far below the cost of operation by horse power, and it is so trifling a matter, that we regard this of the least importance of any feature named when connected with an article so expensive as a motor vehicle must necessarily be, and in which the other features are of so much greater importance than the mere matter of a trifling economy. The advantage of the electric vehicle in this respect is, however, very great, for as stated in a previous clause, the electric vehicle may be operated by a woman or child with perfect security, while an experienced attendant must always accompany either of the other types of vehicle.

Again the repairs on an electric carriage will be far less than on either of the others, owing to the very much greater amount of mechanism employed in either of the other car-

riages, and also to the vibrations to which the same are subjected. Thus it will be seen, by comparing the various important features of the three types of vehicles, that the electric vehicle is destined to cover this field practically alone.

AN ELECTRIC AUTOMOBILE CHARGING AND REPAIR STATION.

The automobile charging and repair station, illustrated in Fig. 262, antedates the automobile industry by a number of years, having been established in 1891 for the manufacture, charging and general care of storage batteries of every description. With the advent of the automobile, the Storage Battery Supply Co., No. 239 East 27th Street, New York City, has increased its capacity for this class of work. Its facilities for the repair of automobile batteries are unsurpassed. A well trained force of men are constantly employed, and are ready day or night to make any repairs. It is a most convenient station for charging the batteries of private electric automobile carriages.

THE HYDROMETER SYRINGE.

The specific gravity of the acid of a storage battery plays an important part in its efficient working, and frequent tests are necessary to determine its condition.

Before the containing jars of the cells were reduced to the small compass necessary in an automobile, it was customary to have a hydrometer floating in the solution where there was plenty of room for its free adjustment to the variation in strength of the electrolyte, and an easy reading could be made.

That this is impossible in the tightly built automobile cells is apparent, and to overcome this difficulty the hydrometer syringe, illustrated in Fig. 263, was designed. By

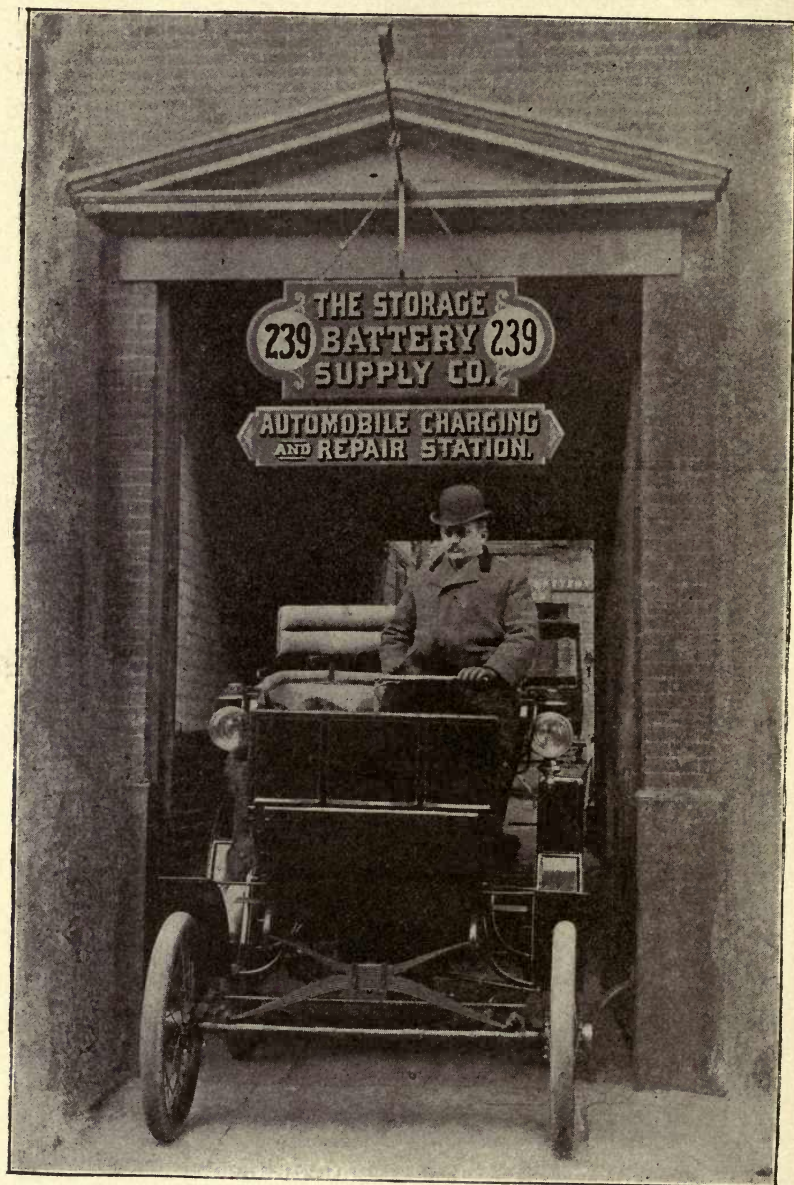


FIG. 262.—THE CHARGING STATION.

slightly compressing the bulb and inserting the slender tube through the vent hole in the cover of the cell, sufficient acid may be drawn up to float the hydrometer within the large glass tube and the reading made at once. The acid is returned to the same cell, and the reading of the next is made. The laborious method of drawing out sufficient acid by a syringe, and taking its strength in a separate vessel, is avoided, as well as the general uncleanliness of this method.

The hydrometer syringe more than accomplishes this purpose, as it may also be used to add fluid to the cells, or it may be used in the preparation of the acid solution. It is manufactured by the Storage Battery Supply Co., of New York City.

THE "MULTUM IN PARVO" CARRIAGE LAMP.

The fixture illustrated in Fig. 264 is more than worthy of its name. The limited space in the interior of a carriage does not admit of the usual form of incandescent lamp bracket with a projecting bulb. This compact arrangement, known as the "Multum in Parvo" lamp, is laid against the roof of a carriage or other vehicle, thereby lighting the interior in the most desirable manner without interfering with the free movements of the occupants. The lamp has a specially molded bulb that is suspended on springs

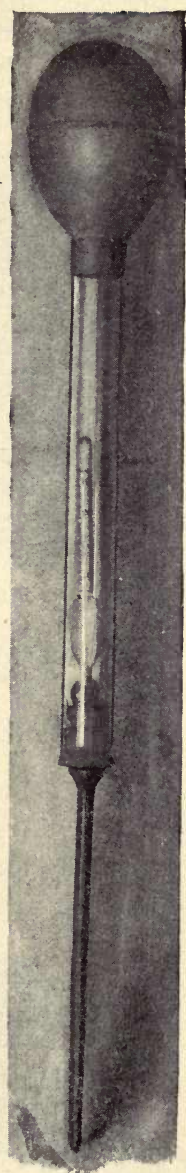


FIG. 263.—HYDROMETER SYRINGE.

in front of a silver-plated reflector. The whole is covered with a bent and beveled plate glass cover that may be engraved in any manner, if desired. A switch is placed in

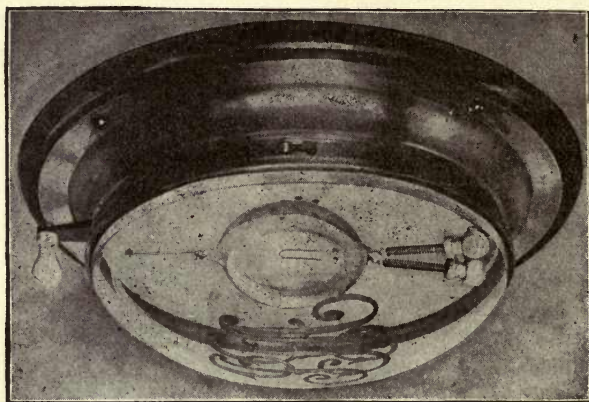


FIG. 264.—THE INSIDE ELECTRIC LAMP.

the back. Modified forms of this lamp are used as a dash headlight, or for side lamps. It is manufactured by the Storage Battery Supply Co., New York City.

AN ELECTRIC AUTOMOBILE TOY

Is a fancy in reality for the amusement of children, and sometimes may amuse those of older years. It is illustrated in Fig. 265, and manufactured by the Knapp Electric and Novelty Co., 125 White Street, New York City.

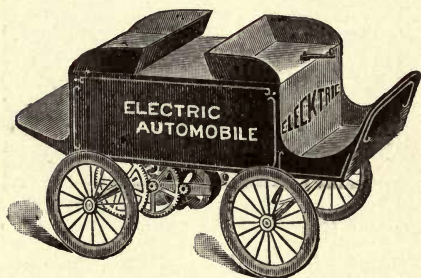


FIG. 265.—AUTOMOBILE TOY.

Those familiar with the subject are fascinated with this production in miniature, and the ever-increasing class of knowledge seekers will find it a wonderful source of

information and gratification. It teaches, amuses and gives great pleasure. As an electrical and scientific piece of mechanism it is unsurpassed.

Two dry cells of regular size, easily procured from any electrical supply house, are fastened in the body of the wagon and overcome the objectionable feature of acids in batteries.

Continuously, the battery will drive the wagon about five hours, but by using a few minutes only each time, its radius of usefulness will be largely extended with one pair of batteries.

The motor and double reduction gears are placed under the body and drive the rear wheels. The front axle is pivoted and the lever may be turned to any angle.

The body is beautifully enameled in green with gold trimmings, and fitted with a starting switch.

Length, $12\frac{1}{2}$ inches; width, $6\frac{1}{2}$ inches; height, $7\frac{1}{2}$ inches; diameter of wheels, 3 inches; size cells, $6 \times 2\frac{7}{8}$ inches.

Chapter XIV.

HOW TO BUILD AN ELECTRIC CAB, WITH
DETAIL DRAWINGS.

CHAPTER XIV.

HOW TO BUILD AN ELECTRIC CAB.

Scale $\frac{1}{2}$ inch to the foot.

The working drawings, Fig. 266, are those of a cab suitable for summer use, and are especially intended to illustrate the design of the side elevation, together with the position of the different mechanical features which belong more particularly to an electric motor carriage. The design is a combined illustration in four parts; the central figure (1) is an elevation of the complete cab; the left side (Fig. 2) is a half elevation, front view; the right side (Fig. 3) is a half elevation, rear view; the under side (Fig. 4) is a half plan view; at the top (Fig. 5) is the plan of the sector gears of the steering bar and their movement. To provide for these new designs it was necessary to cut loose from the prevailing idea of the arrangement of this class of motor-electric, and proceed by another path to bring the work up to that standard of high-class carriage building which the vehicle as a mode of travel deserves, and to make it a pleasure carriage, rather than a machine or engine. The effect of beauty is the predominating force which influences the carriage maker; that other factor, strength, will in the meantime assert itself.

The length of the cab is 9 feet 4 inches; the height is 7 feet; the width, 5 feet 4 inches. The body is mounted on iron curved frames bolted to the four elliptic springs

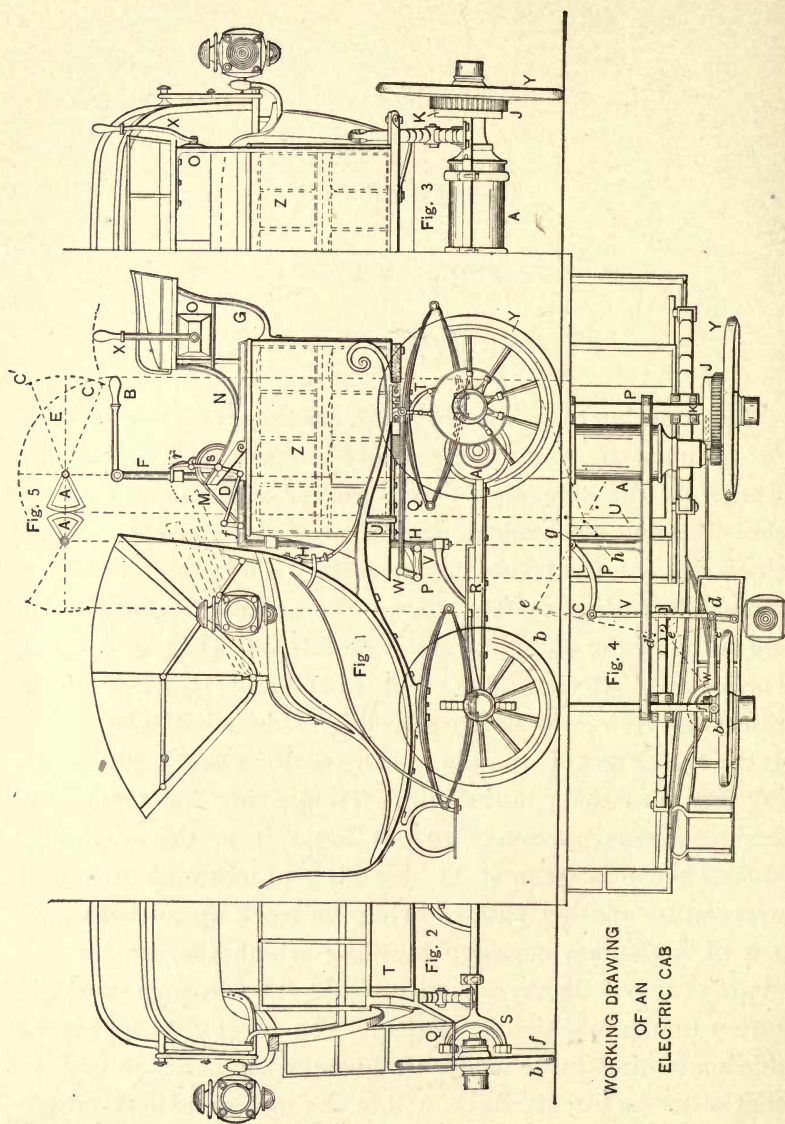


FIG. 266.—HOW TO BUILD AN ELECTRIC CAR.

Scale 1/8 inch to 1 foot.

and to the rocker of the body. The rockers are reinforced with an iron edge plate, screwed to the inside surface from the dash to the lazy back, $2\frac{1}{2}$ inches wide and $\frac{1}{2}$ inch thick, as shown by the straight line, *T* (Fig. 2), of the front views of the design (Fig. 1). The iron pumphandle-shaped side bars are provided with solid forged flaps, which rest on each elliptic, and are secured by $\frac{3}{8}$ -inch bolts. The front end of the battery caisson, *Z*, is supported by iron loops forged onto the pumphandle bars, which pass under the rockers and floor, and are secured by *T* bolts to the rocker. A bar of ash is let into the bottom, which in turn holds up the floor that the cells rest upon. This is the front bar of the three which compose the support for the floor of the battery trays, which are made of hard ash, and must be seasoned (kiln-dried). The top of the battery chest is made of dry birch, the grain of the wood running lengthwise of the box, composed of three pieces screwed onto the framing and covered with a paste of white lead and varnish, glue not being suitable for the fixing of the boards. The battery caisson is not fixed to the body; the space separating them is utilized for the passage of the steering and brake rods used in guiding and stopping the carriage. Upon the back end of the chest is mounted a driver's seat on iron braces, *G* and *N* (Fig. 1). The seat frame is provided with two compartments; on the near side is the controller, *O*; on the off side a box provides for a kit of tools, the controller taking up the space of 18 x 7 x 5 inches. The handle bar, *X* (Fig. 1) and *X* (Fig. 3), operates machinery for starting, stopping and regulating the speed of the motor, *A* (Figs. 1, 3 and 4). By this means the electric current generated from the batteries, *Z*, is controlled by wires which connect the controller with the motor. The motor shaft is operated upon the driving wheel, *Y*, with a 2-inch cog

meshing into a 14-inch toothed cog, *J*, clipped to the spokes of the driving wheel, *Y*. The motor is fixed to the 2-inch rear axle by means of the perch plates, *R* (Fig. 1). The bottom plate forms the clip yoke, which receives the threaded stem formed on the top perch plate, shown by the letters *PP* (Figs. 3 and 4). The inside nut is threaded to a $\frac{7}{16}$ -inch bolt. These plates hold the motor to the axle in rings. The other ends of the perch plates are likewise coupled to the front axle. The perch is made of hickory, the ends of which butt the axle at the front and the motor at the rear.

The top plate of the perch is bridged to receive the steering bar, *V*, which is pivoted to the arm, *W*, at *d* (Fig. 4), and to the fork brace, *L*, at *C*. The movement is crosswise from *d* to *d'*, of the outside knuckle, and from *c* *c'* of the inside knuckle joint. This distance is $10\frac{1}{2}$ inches, this being necessary in order to obtain an angle to the rim of the front wheel, *b*, of 45 degrees, from *b* to *c'* along the dotted line, *W* (Fig. 4). When the handle bar, *B*, of the steering gear (Fig. 1) is moved aside 7 inches from the center, *E* (Fig. 5), to *C'*, the bar, *L*, by means of the segments, *AA* (Fig. 5), will move to the point of the pivot, *g* (Fig. 4). When this handle bar, *B*, is moved to the right the carriage will be turned to the left side, which result is expected by the driver, as all turns are made to the near side when the driver has the right of way. If we bridge the perch at *R* (Fig. 1) we increase the rigid support of the motor to the axle. The perch is stronger than it would be if the plate was an unbroken line.

Our drawings are to a scale, and the mechanic can follow the idea, the size of the wheels, springs, and axles can be measured, and so far as the position of the motor, the battery, the controller, the steering gear and brake are con-

cerned, they are the same as in nearly all electric propelled carriages; the shape of the motor may be different, but the method of turning the driving wheel, *Y*, is present in every case, and as a general thing the axles are coupled together with two or three perches, but this is not the only method used. Some are without rigid perches and some perches may be pivoted. The brake is as important to a motor carriage as the steering gear, and the means of using it must be within convenient distance of the driver's right foot; it is therefore placed to the right of the upright steering rod, *F* (Fig. 1). The brake is shown in the side elevation (Fig. 1), and when set so as to clutch on the disc, *K*, impedes the turning of the driving wheels. This clutch is therefore constructed on both driving wheels alike; the lever, *r* (Fig. 1), is pushed with the foot ahead. This lever is pivoted at *S*, and connected to the rod, *D*, which is pivoted to the upright rod, *f*, then from this point a flat rod 5-16-inch thick by $\frac{1}{8}$ -inch wide is connected to the 1-inch round cross rod, *P* (Fig. 4), and shown at *P* (Fig. 1), as pivoted at *V* (Fig. 1). Then the flat bar, *Q*, is pivoted at *W* to the cross rod *P''*, which at the back end is pivoted to the clutch *T*, which finally is pivoted to a band of brass fixed to the axle, hinged in two parts and separated when the brake is off with a spring, which keeps the band from contact with the edge of the revolving disc, *K*, fixed to the cog wheel, *J*. We have seen brakes fixed in this way, but do not endorse them. We think it better to fix the support of the brake clutch lower down and make the supporting braces fast to the end of the motor, in close proximity to the disc, *K*.

The drawing shows a step, with a wing at its rear over the front wheel, which makes a convenient entrance, especially from the sidewalk; it is about 7 inches high. In riding the passenger can see ahead, which is an important

advantage in favor of this design, and the suggestion is offered that for park and seaside resorts the design is an appropriate one. The line, M (Fig. 1), is the slope which the top of the box has that covers up the cogs and rods connected with the brake and steering gear, but left exposed on the drawing to enable us to show the construction of the pivots, the rods and the connections.

H is a bar that braces the perches crosswise; it may be bolted to the plates or welded on; the latter occasions the most work, but has by far the best appearance, and for this, if for no other reason, it should be welded, and if we resort to smooth forgings all the way through, the appearance of the finished carriage will repay the extra expense. To leave the ends of the bars, either wood or iron, unfinished will prove in the end more expensive than to round or chamfer them, or to finish with scroll finish in regular carriage form.

This last is the best that can be devised, and then the painter can stripe them and the appearance cannot be adversely criticised. The clumsy appearance of the motor carriages has done much to injure them. If carefully designed at the outset, they can be made to look light and graceful, no matter how heavy the whole carriage may be. If we take, for instance, the spring bar over the hind spring and cut a scroll on the end to project over the spring, as shown in Figs. 1 and 3, and let the flap of the pumphandle side bar extend out upon it, with the edges of the iron rounded off, we will have a good looking piece of work. We must secure the top, or the back end of the wing to the body, or to some other support in that vicinity, and the shortest distance to the point of fixture is generally the one selected for this purpose. We fix the stay of the wing to the brace H' , and bolt this to the pumphandle side bar and the body, and solid to this brace H . We turn off the stay

to take the bottom of the wing, which is bolted. The bolts are first put in through the square hole in the iron of the wing and driven in so as to make a tight fit, the head being countersunk so as not to show on the top of the leather when filed up in good shape. It makes a good job, and one that is not expensive. The work will look as though it was intended to be so, but, on the other hand, if we put the matter off until the job is ironed, and as a last thing begin to calculate where and how to fasten it on, then the trouble and expense will begin and a nice piece of iron work will be spoiled, because of the bolt being just where it can be seen. These small things look well; they are noticeable more than the axles, and they can be turned to add much to the appearance of the work. The point to keep in sight is to work in the regular carriage making way, or better, but not worse. If there is a machinist who can iron off a motor carriage better than the carriage smith irons off his victoria or brougham, then he can iron anything from a locomotive to a sulky, and this includes all that is heavy or light.

The foregoing remarks on the iron and wood work of the motor carriage are suggested by what we have seen, and they are intended to improve the construction of the carriages in this country. They are already strong enough, they are already heavy enough, and they are big enough, but the work is crudely done. It is rough, it is not symmetrical, the irons do not taper, are not correctly swaged, the offsets are not carefully executed, and the setting of the axles is contrary to those rules long established for the construction of the dished wheel and tapered arm. If we dish the wheel we must plumb the spoke, and if we plumb the spoke we must taper the spindle. We cannot do one without doing the other two, for if we desire to avoid the friction of the box and axle we must have the spindle parallel to the

ground, and if the spindle is not horizontally set, then the box will crowd either the nut or collar. If we do not dish the wheel it will not stand up for its expected time. The wheels look better when flared out at the top, as shown on the drawings. There is no mechanical problem in the fact that the wheels are driven by a cog wheel that is clipped to the spokes, as in casting this toothed wheel the angle which the flare of the wheel creates can be made upon the pattern. Any mechanic will admit it is of no consequence what this angle may be. The teeth of the cog wheel, *J*, can be set to the flare of the wheel, called in the carriage shop the swing of the wheel, and mesh with the one fixed to the shaft of the motor. This will be done as time is given to the work. We know that the front and hind wheels are set to a vertical instead of an inclined plane, and the result is that the wheels appear to lean in at the top, and if set to a vertical line the weight which they carry will spring a $2\frac{1}{2}$ -inch axle, so that the axle will off at the top of the collar and on at the bottom of the point of the spindle. These are the facts, and the best mechanic in America cannot change them. Every carriage maker knows this to be true, and this applies to any wheel that has a tapered spindle. It is impossible to taper a spindle and then use a straight or vertical rim, and prevent the above trouble.

We are indebted to the courtesy of "The Hub" for this design and description.

Chapter XV.

THE GENERAL MANAGEMENT OF MOTOR VEHICLES OF ALL KINDS.

SPECIAL MANAGEMENT OF VEHICLE MOTOR POWER—STEAM
MOTOR VEHICLES—EXPLOSIVE MOTOR VEHICLES.

CHAPTER XV.

THE GENERAL MANAGEMENT OF MOTOR VEHICLES.

Never put on the brake before turning off the power, except in pressing emergency. This is a source of economy in power and wear and tear of machinery.

Never cross a railroad track, or defective place in a street or road, with the full power on, and, if possible, at very moderate speed, under the momentum of the vehicle.

If a vehicle has two brakes, a band and a tire brake, always use the band brake first and every time, except in emergencies of danger. A tire brake wears and injures the tires.

Do not think that a motor vehicle with any kind of motive power is as intelligent as a horse. Horses can be sometimes trusted and know the road.

Never forget yourself and start a vehicle with the brake on. It is a loss of power and may cause breakage in the driving gear.

Never try to jerk a vehicle out of a rut or mud-hole by throwing on the high speed power. If it does not move by the slowest motion gear, which should always be the strongest for up grades, an investigation should be made and help given. Horse-drawn vehicles are sometimes in the same predicament.

In steering, a driver is not expected to grip the steering lever or wheel with nervous anxiety. A hard steering gear is out of the question in good models of automobiles.

Too many operations attached to the steering handle are not desirable ; they lead to confusion, and may be the cause of mistakes. Let one hand do the steering alone, with as few unimportant attachments as possible, is the experience derived from a mechanical view of the conditions of automobile driving.

As much care should be exercised in running over road obstructions with the horseless vehicles as with those drawn by spirited horses ; there is no dash business over obstructions or a bad condition of the road.

When coming to a stop at a curb or on the road, it is desirable to shut off the power some time before reaching the stopping place, and move up to the stopping place by the momentum of the vehicle,—applying the brake only at the last moment. This is one of the first things that an automobile driver should learn by practice. It saves power and mileage, and makes a graceful manœuvre in coming to a stop.

Reversal of the power and motion of a vehicle while speeding is dangerous, and even at moderate speed is undesirable, and should never be done unless sudden danger makes it necessary. It strains the motive power and may cause a breakdown. In all ordinary driving the vehicle should come to a gradual stop by timely shutting off the power, and then, if need be, applying the brake for a stop, and reverse from a standstill.

Finally, it should be the first work of a purchaser or driver of an automobile vehicle, whether its driving power be steam, an explosive motor, electricity or compressed air, to become familiar with every part of its mechanism and of its working details—the whys and wherefores of every movement—before an attempt is made to run the vehicle on a street or road. It is recommended that the driving wheels be

blocked up by the shaft and the whole manipulation of the driving power be gone through with in all its details before venturing upon the road.

This will give confidence and pleasure on the first trip out.

SPECIAL MANAGEMENT OF VEHICLE MOTOR POWER.

STEAM MOTOR VEHICLES.

The action of steam is so direct and its control so simple that but little can be said that will cover the machinery details of all of the builders of steam driven automobiles.

The point principally to be watched and cared for, apart from the general management already described, is the water feed of the boiler. The boiler feed pump, as operated by the engine direct or from the vehicle shaft, does not feed the boiler with water in proportion to the steam used under the varying conditions of the road or the grade.

On an up grade or bad road the speed of the vehicle is labored and slow, and more steam is used than on down grades and smooth roads.

In the one case the pump does not meet the requirements of the boiler, and the boiler loses water. In the other case the shorter throw of the link lessens the quantity of steam used and the pump gains on the boiler water level. In some vehicles an equalizing regulation is provided by means of a three-way cock with a lever connection by which the driver can control the work of the pump by diverting part of the water back to the tank. A frequent watch on the water gauge is necessary; although, when once a person gains experience, the condition of the road largely helps to remind him of the time to increase or decrease the boiler feed. In some vehicles a supplementary pump is provided that requires but the pressure of a button or the movement of a

lever to regulate the water level. Again, this auxiliary pump is made automatic by a differential expansion apparatus, so constructed that when the water in the boiler falls to a fixed point, steam displaces the water in the regulator and its expansion through a lever opens the throttle of the auxiliary pump and thus keeps the water in the boiler within proper limit.

The earlier burners were lighted by a match applied to the vapor of alcohol or gasoline in a cup under the burner. Others use an alcohol torch for heating a small vaporizing pipe which gives a blow-pipe jet for heating the principal vaporizing coil, or for heating the boiler, until it is hot enough to vaporize the gasoline in the vapor pipe passing through the boiler tubes. A later device is to light the gasoline vaporizing from the jet burners by a spark from a dry battery. This is done by a push button at the seat. This provides for entirely shutting off the burner when the vehicle stops for a short time.

In other steam vehicles a pilot burner of small size is kept ignited when the vehicle is at rest, which keeps up steam ready for a quick start. The general regulation of the burner is by control of the amount of flow of the gasoline from the pressure tank.

The air pressure in the gasoline tank should be kept as uniform as possible, in order that the flow of gasoline to the burner should not vary beyond a reasonable limit.

In order to control the air tank pressure it should never be more than two-thirds full of gasoline, so that the air space may be large enough to give sufficient elasticity to the air pressure, that it will not rapidly fall as the gasoline is used.

In some vehicles a separate air tank is used and automatically pumped up by an independent steam pump. With

the large size of the air tank the pressure on the gasoline will scarcely vary more than one or two pounds in an hour, which is indicated by the air gauge on the dash board.

Four gauges are desirable on a steam propelled vehicle : a steam pressure gauge, an air pressure gauge, a gasoline indicator and a water gauge. The first three named are placed in a cluster on the dashboard and are easily observed.

The water gauge at the side and beneath the seat is not so readily observed ; but when a little experience has been obtained in regard to the rate of change in the water level in the boiler under the action of the boiler feed pump, no apprehension may be felt that requires a look at the gauge oftener than for a 3-mile run.

With an auxiliary and automatic pump, the water gauge needs but very little attention.

Every vehicle should be provided with an electric light behind the water gauge and in front of the three gauges on the dashboard. A dry battery is sufficient for this, or a small storage battery may be used for the gauges and side lights of the vehicle. Cleanliness of the motive power, gear, and attention to the oiling of the running parts should require no attention on the road ; this should be done in the stable, and should receive more attention than, we fear, is given by owners and drivers who have no mechanical proclivities. The same treatment of your carriage and horses will soon disable a valuable rig.

EXPLOSIVE MOTOR VEHICLES.

The special attention required for running a gasoline motor vehicle is quite different from what is needed in a steam motor vehicle. More levers are required to be manipulated, or when many movements are concentrated in

the steering lever, more attention must be directed to the various devices to be operated by the steering hand in order to avoid mistakes and not do the wrong thing.

The ways and means for operating the explosive motor, and the necessary change gears vary so much in the various vehicles in use, that a detailed study of the construction and operation of any one needs to be made by a purchaser under instructions from the manufacturer.

The same general management is required as noted on the first pages of this chapter. The only gauges to be observed are the ones showing the quantity of gasoline in the tank, or an air-pressure gauge where the position of the tank requires pressure for raising the gasoline to the vaporizer, for which a hand pump is usually provided for occasional use. As the pressure in the gasoline tank is constantly changing by the increasing area of the air space, the air pump needs a few strokes occasionally to keep up a moderate pressure to raise the gasoline to the vaporizer. The methods of ignition are not alike in the vehicles of different manufacturers, and should be made a special study under their instructions. A part of the running regulation in some vehicles is derived from delaying the ignition, and in others by varying the explosive charge, and yet others by both methods. Each is controlled by a special handle or lever manipulation, which requires special instructions suited to each design.

The change gear also varies so much with different manufacturers that no definite details of their operation can be given other than by reference to their construction and operation as given in the body of this work.

Chapter XVI.

COMPRESSED AIR POWER FOR VEHICLES.

CHAPTER XVI.

COMPRESSED AIR POWER FOR VEHICLES.

The use of compressed air for railway propulsion has now been on trial for nearly a quarter of a century, with but small advances in its adaptability beyond the limited terminals of local road lines, and for factory and mining traction.

The bar to its early success seems to have been wholly due to the initial low pressure in the storage tanks, which was limited to from 300 to 600 pounds per square inch, until the beginning of the last decade, when high pressure air service, for motive power, began to receive attention. The first trials of compressed air at from 2,000 to 3,000 pounds pressure per square inch was in railway work, and has reached a successful issue.

The first trials of high pressures for road carriages did not give satisfactory results in England, but its application as a motive power for heavy vehicles has made a fair progress, and is now in successful operation in France. A delivery wagon is reported to be in operation in Paris, having a storage capacity of 18 cubic feet of compressed air at a pressure of 4,200 pounds per square inch.

The air is delivered from the high pressure steel bottles by a differential valve, and reheated in a steel coil by a gasoline burner to an amount to double its volume under a varying working pressure of from 25 to 50 pounds per square inch, as needed. The cost of reheating the air for this vehi-

cle is about one pound of gasoline per hour, when running at ordinary speed.

In the United States, the American Air Power Company, the International Air Power Company, and the New York Auto Truck Company are pushing the interest of compressed air for vehicle propulsion with a line of practical experiments to demonstrate the feasibility of compressed air vehicles for street haulage and for ordinary truckage. These companies are operating under the Hardie and Hoadley-Knight patents.

A runabout wagon has been constructed by Mr. C. D. P. Gibson for the Air Vehicle Company, with an air engine weighing but 36 pounds, and with compressed air storage capacity of six cubic feet at 2,500 pounds pressure per square inch, the vehicle, storage and motive power weighing 670 pounds. The working pressure is reduced to 150 pounds through a differential valve, and the air reheated. Thus, a single storage charge should give out one horse power for five hours, and cover a distance of from 20 to 30 miles in such a vehicle. Thus the possibilities of compressed air for individual use lie in the ability to obtain a charge at some high pressure air station, or to operate a small oil engine power and high pressure compressor with, perhaps, a high pressure reserve tank for contingencies.

For trucks or traction wagons operating on short circuits, the problem of the practicable service of compressed air for vehicle power is most encouraging. For shop and yard work requiring short circuits with facilities for recharging at several points from pipe-line air hydrants, the problem has been practically solved; and we illustrate in Fig. 267 a shop truck built by and operated in the works of the American Wheelock Engine Company, Worcester, Mass. The upper hand wheel is on the steering spindle; the lower hand wheel

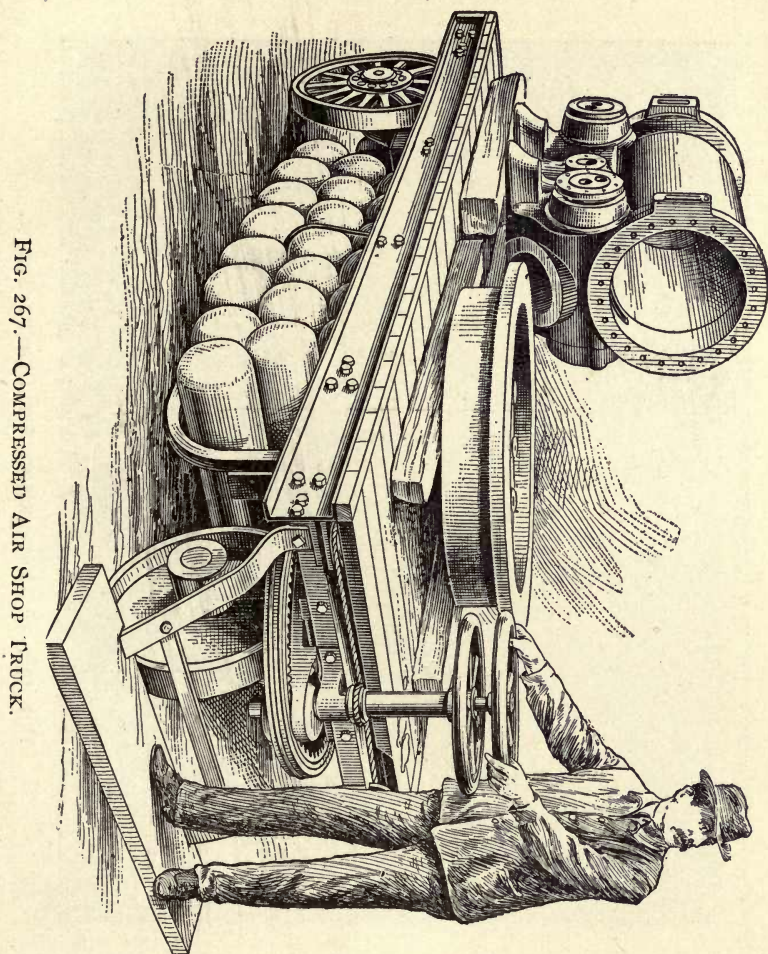


Fig. 267.—COMPRESSED AIR SHOP TRUCK.

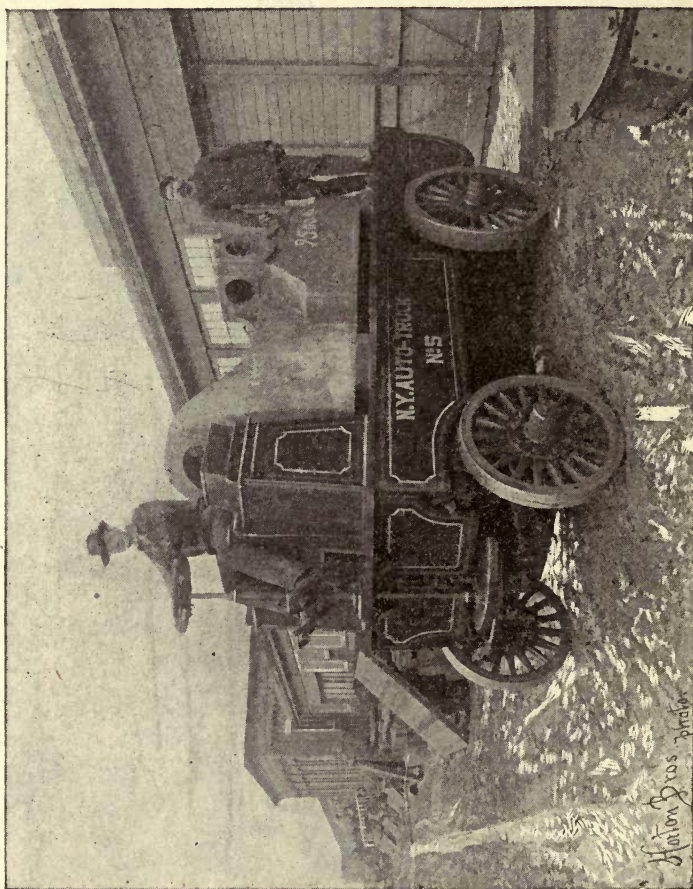


FIG. 268.—A COMPRESSED AIR STREET TRUCK.

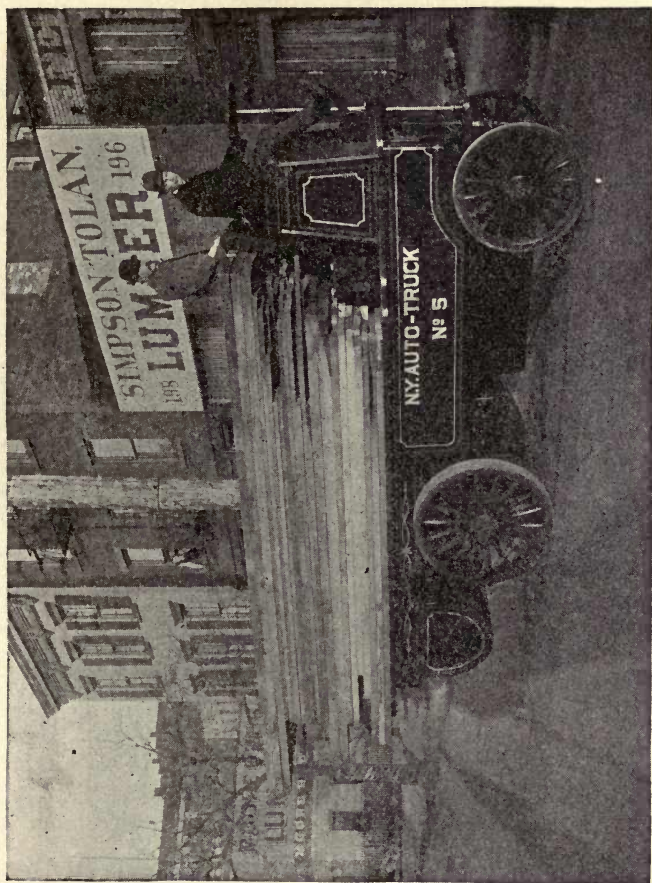


FIG. 269. --A COMPRESSED AIR STREET TRUCK UNDER A LOAD OF LUMBER.

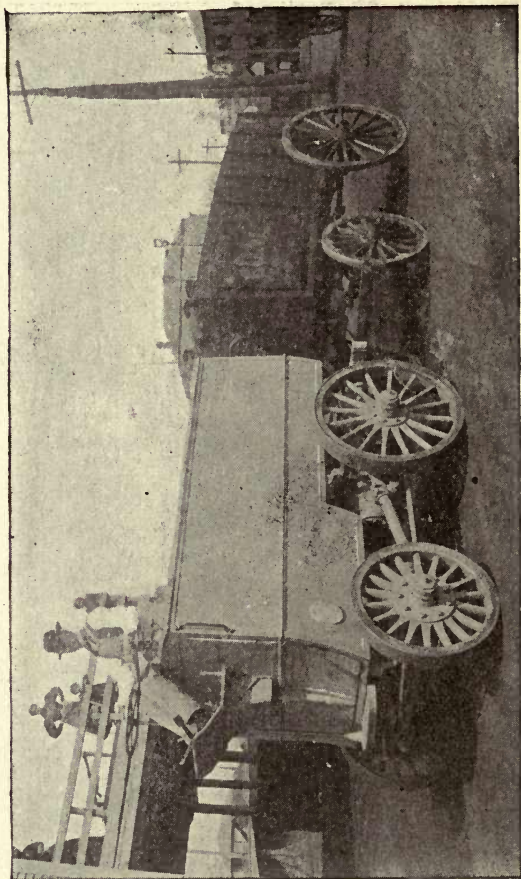


FIG. 270.—A COMPRESSED AIR TRACTION TRUCK WITH A TRAILING COAL WAGON.

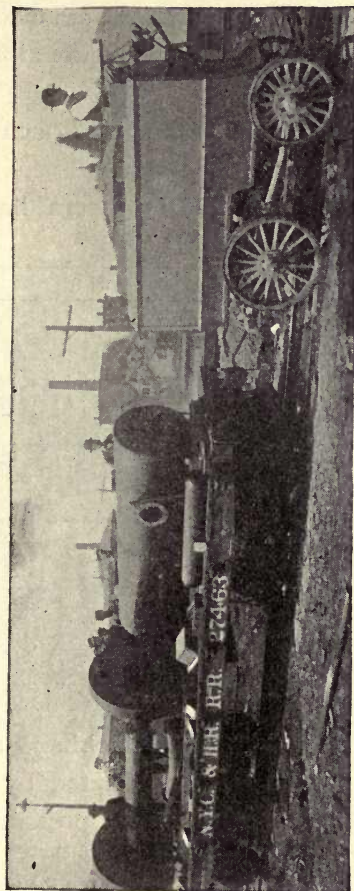


FIG. 271.—A COMPRESSED AIR TRACTION TRUCK MOVING A LOADED PLATFORM CAR.

is for operating the motive power by a lanyard connection to the link valve gear. The throttle is governed by a lever which is opened by the operator pressing his knee against it and is closed by a spring. The motor drives both rear wheels through a differential gear, and, when working under ordinary conditions, uses about 75 cubic feet of free air per mile.

It will move a load of ten tons, and occupies a space of 4 feet wide by 15 feet long.

Fig. 268 illustrates a truck for general haulage used at the

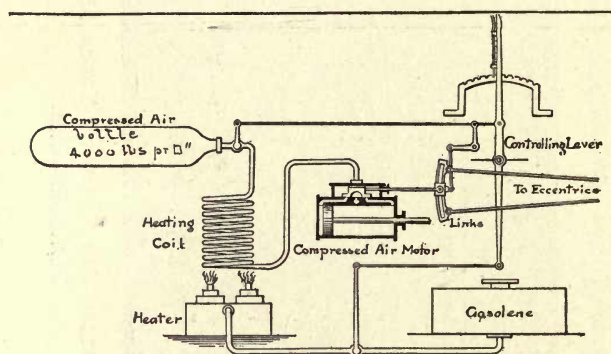


FIG. 272.—THE REHEATING OF COMPRESSED AIR WHEN COOLED BY EXPANSION FROM HIGH PRESSURE STORAGE.

Worcester works for shipping machinery and hauling supplies. In this truck the air is reheated by passing through a hot water tank charged to a high pressure.

In Fig. 269 is illustrated the same kind of truck loaded with lumber and in use in New York City, and in Fig. 270 a compressed air traction wagon hauling a coal wagon.

In Fig. 271 is illustrated the same traction wagon hauling a flat car loaded with machinery from the works, acting the part of a switching engine.

Fig. 272 is an ideal diagram of the operating parts of a

compressed air motor gear with the reheating device. Compressed air trucks and traction wagons are also used at the works of the International Power Company, Providence, R. I.

AN AUTOMATIC ELECTRIC AIR PUMP.

A most desirable adjunct of the automobile carriage house

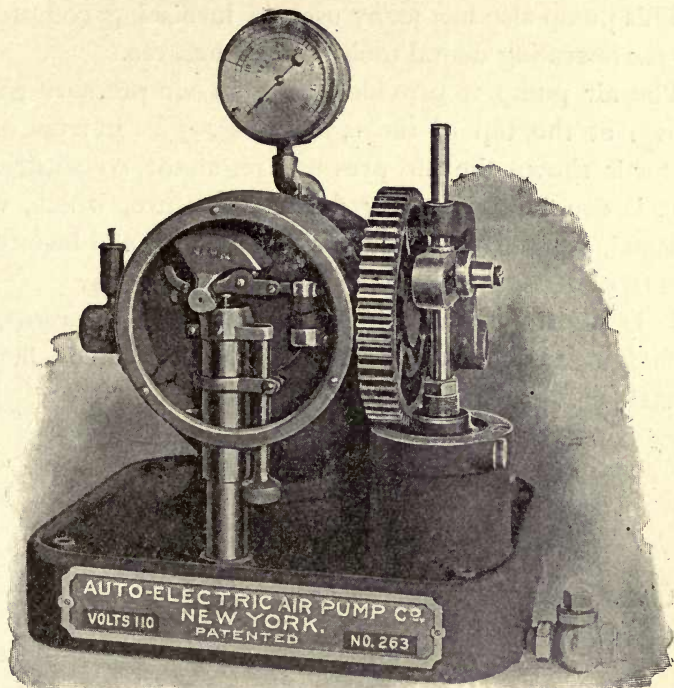


FIG. 273.—THE AUTOMOBILE AIR PUMP.

has been brought out by the Auto-Electric Air Pump Co., of Rochester, N. Y., and No. 39 Cortlandt Street, New York City. The electric motor and air pump are set upon a base 8 x 10 inches, and stands 10 inches high. Its pumping power is derived from an electric motor of six horse power geared to an air pump of a capacity of $2\frac{1}{4}$ cubic feet of free air per minute, at 100 revolutions of the crank per minute, at any

desired pressure for automobile or bicycle tires. The motor operates from a 110-volt continuous or alternating current, and will also operate from a nearly full charged automobile battery, thus putting the pneumatic tires in full tension before starting, and by this means save much tiresome work for the operator.

This pump also has many uses in furnishing compressed air for operating dental tools, air brushes, etc.

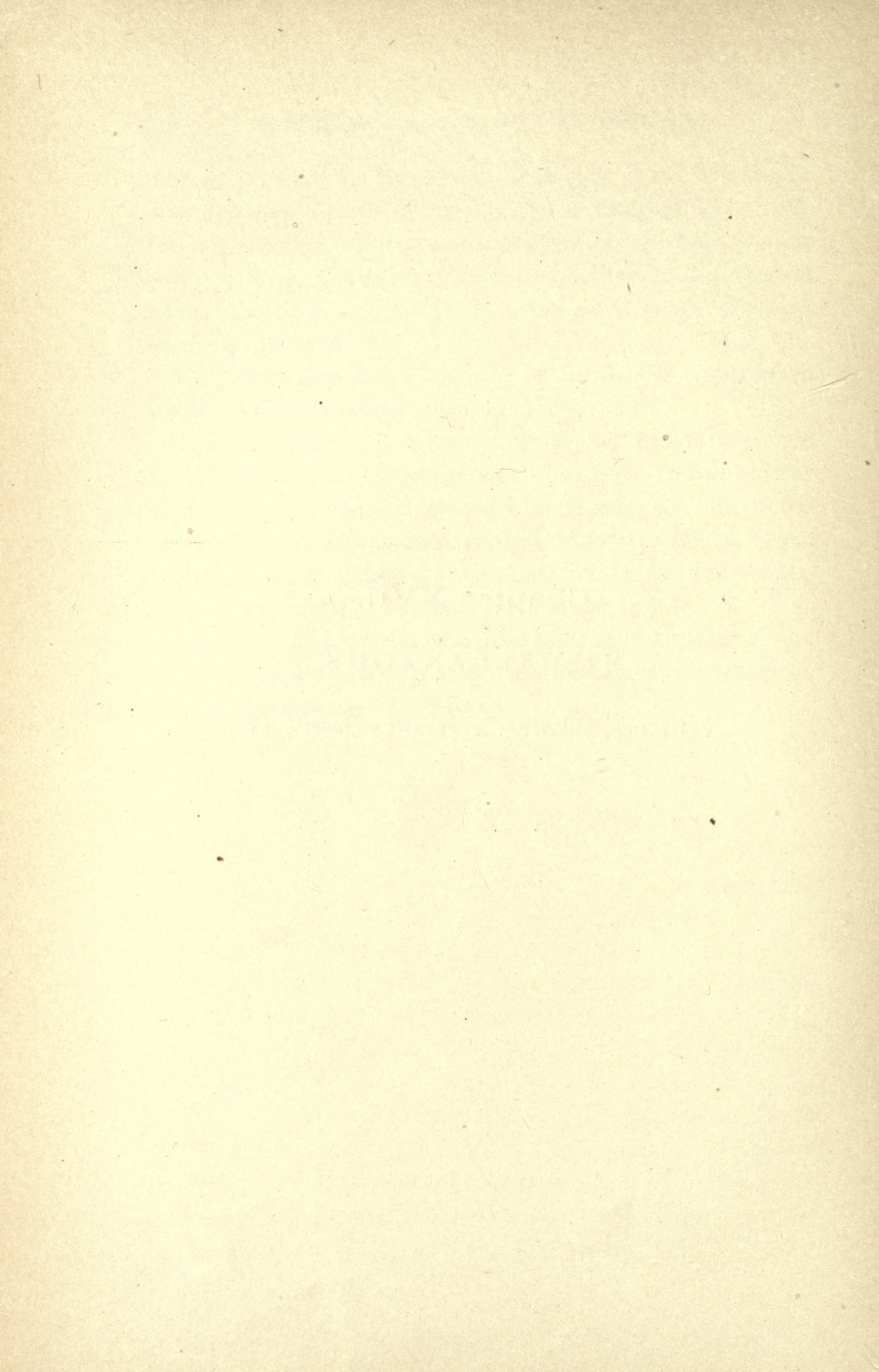
The air pump is provided with an air pressure gauge, shown at the top of the motor, Fig. 273. In front of the motor is shown the air pressure regulator, so constructed that it can be set to any desired pressure, which, when reached, a small delicately arranged piston and lever operates to switch off the current and stop the motor.

It is certainly a very compact and neat apparatus, and should occupy a place in every automobile stable where an electric current can be obtained.

Chapter XVII.

MISCELLANEOUS.

VEHICLES, MOTORS, APPLIANCES, ETC., ETC.



CHAPTER XVII.

MISCELLANEOUS.

THE VICTOR AUTOMOBILE.

Improvements in the elements of control seem to have no stay, and the latest production of a steam automobile carriage in which the watchfulness of the driver on the operation of the motive power is almost eliminated, has been brought out by Mr. A. H. Overman, of Chicopee Falls, Mass. It is illustrated in Fig. 274.

In the Victor automobile the fuel may be gasoline or kerosene.

The vertical tubular boiler is made entirely of steel, a seamless shell with heads, and tubes of ample strength. Inspected and insured by the Hartford Steam Boiler Insurance Company.

A pair of vertical is engines enclosed in a case free from dirt and run in an oil bath.

A heater utilizes the exhaust for heating the boiler feed-water—the residue exhaust is air condensed.

Water is supplied to the boiler automatically while running by a pump driven from the moving parts; when the vehicle is standing the pressing of a button starts an auxiliary pump for bringing the water up to its proper height. In addition, there is an automatic boiler supply regulator consisting of a differential expansion bar which is composed of

brass tubes and a solid steel bar. Any accidental drop in the water level below a minimum safe point, steam displaces the cold water in the regulator and the expansion of the brass tube operates a lever that opens the steam throttle of an auxiliary pump and the proper water level is quickly restored.

In case all the boiler feed devices should become

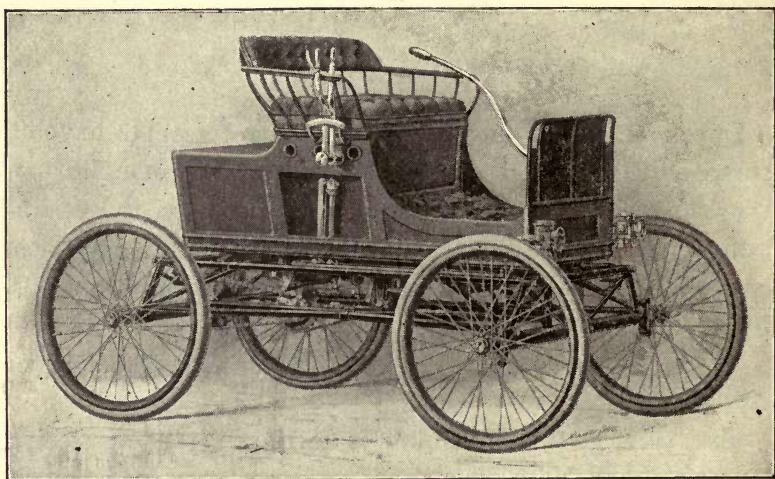


FIG. 274.—THE VICTOR AUTOMOBILE.

deranged, a fusible plug at a stated low water level will melt and blow out the fire in the burner.

A sight gauge indicates the quantity of gasoline in the tank at all times, and an automatically operated air pump keeps an even pressure in the tank.

The gauges for steam and air pressure and fuel supply are located in plain view on the dash board, and are electrically illuminated at night by operating a push button on the steering handle.

Another notable point is that the vehicle is self-locking, or

ties itself, when the driver leaves his seat. A spring lever beneath the panel of the seat shuts and locks the throttle valve when the driver rises from the seat, and the vehicle cannot be started until the driver is again seated. In operation there are only two things to keep in mind, the steering and the link valve lever on which the hands rest as easily as in driving a horse.

In fact the Victor is conceded to be the advanced automobile of the new century. In all its parts other than above enumerated it is of the most approved construction of the later models.

A KEROSENE MOTOR CARRIAGE.

In Fig. 275 we illustrate a surrey built by the New York Kerosene Oil Engine Company, No. 31 Burling Slip, New York City, who have become owners of the patents of Feodor C. Hirsch for the United States, France, England and Canada. The motors are of the four-cycle compression type, using common kerosene oil as their power fuel.

There is no doubt in the future prospect of kerosene as a safe and available fuel for explosive motors, and the constant improvement being made in details of motors for its use, seems to indicate its growing expanded use for motor vehicle power as well as for launches and yachts. It is the safest and cheapest power fuel available for these purposes.

The motor as shown in Fig. 276 is separated from its base for carriage use. It has no special ignition device; the bulb shown on top of the cylinder is connected with the cylinder head and receives the charge of kerosene oil for each impulse and vaporizes it on the instant ready for mixing with the air charge, drawn in by the piston. For starting the motor a lamp or torch is used for from 6 to 8 minutes to heat the vaporizing bulb to the proper temperature for vaporizing the oil, which, with this heat and the heat of

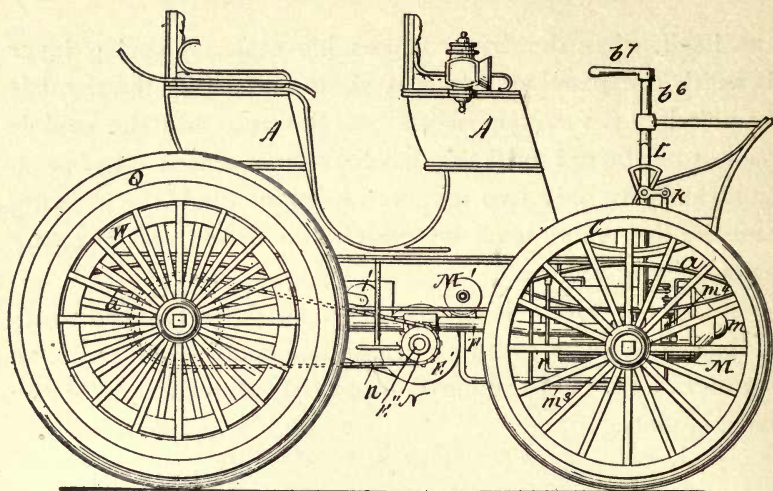


FIG. 275.—THE KEROSENE MOTOR SURREY.

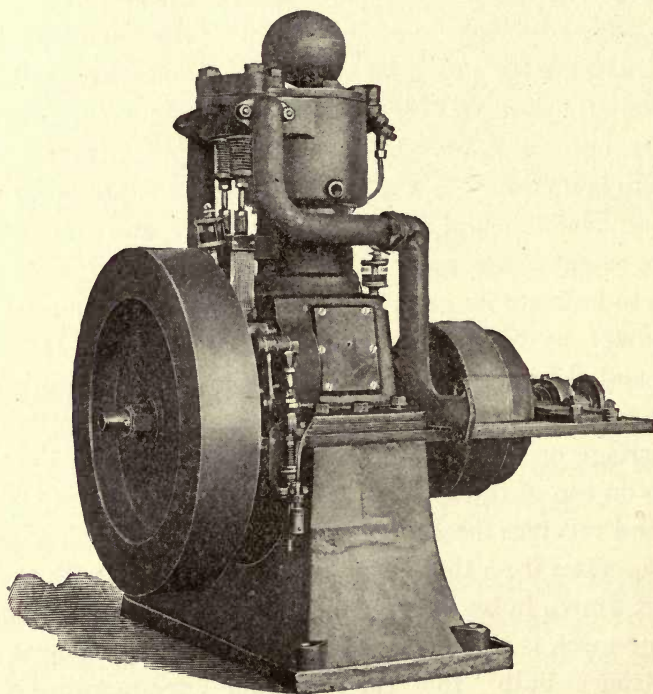


FIG. 276.—THE KEROSENE OIL MOTOR.

compression at the return stroke of the piston raises the temperature to the explosive point. This gives an impulse to the piston and its repetition continues the action of the motor.

It will be easily understood that by injecting the oil into the hot air a fraction ahead of time before the piston reaches the end of its stroke, the following advantage is obtained :

No condensation of the gas can take place against the cylinder wall, as the piston has swept the whole cylinder, and, nothing but pure air being drawn into the cylinder, which is compressed into the combustion chamber before the oil is injected.

The great field for industrial and marine work is now so broad, and the use of the motor vehicle is beginning to be so thoroughly appreciated, that a simple motor that can be run without an engineer, or expensive battery and ignition apparatus, is sure to be the one wanted, and kerosene from its general use will occupy a prominent place in all these fields, more especially in that of the horseless vehicle.

THE LANCASTER AUTOMOBILE.

In Fig. 277 we illustrate an automobile carriage designed by Mr. James H. Lancaster, 95 Liberty street, New York City. It is of the explosive motor power class of the phaeton style, with a vis-a-vis fore seat.

Mr. Lancaster has brought together in the design of this carriage and its motive power the best up-to-date mechanical devices for economy and efficiency for a compact and speedy vehicle.

By one lever only, the ingenious and efficient speed-gearing yields at will to any of the four varying rates of forward speeds and one backward, and yet they merge impercepti-

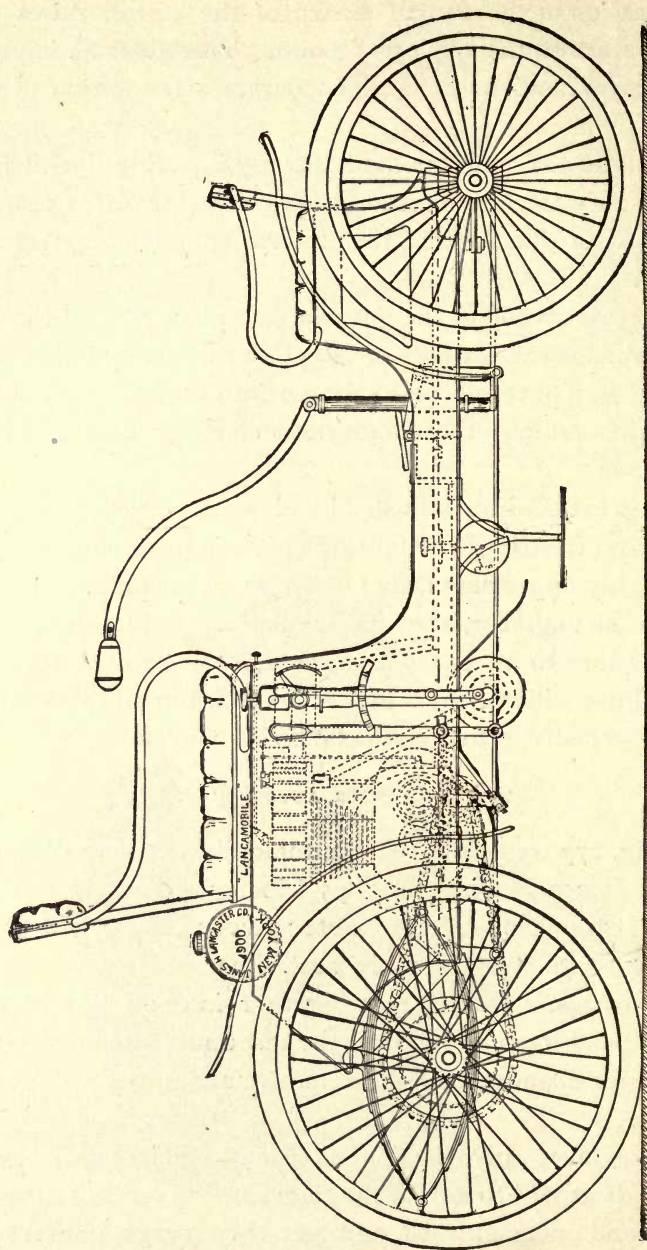


FIG. 277.—THE LANCAMOBILE.

bly from the slowest to the highest limit desired. All lubrication is entirely automatic. Not only the carriage but the entire mechanism is carried on springs, thus avoiding jarring and injury to it. This increases its durability, and also gives greater comfort to the riders.

A novel and perfect gasoline and air mixer effects great economy in fuel and ease of control. It is not effected by atmospheric changes and its means of regulation is simple and accurate. The rear axle being in one piece, greater strength and rigidity is ensured. Starting the "Lancamobile" motor is easily and instantly effected without the driver leaving the seat.

The "Lancamobile" steering and speed mechanism can be controlled by a child, and the absence of vibration, noise and smell makes gasoline now available without its many previous disadvantages. Speeds range from three miles to thirty per hour. The construction of frame and mechanism is such that almost any style of body can be attached to it.

AN EXPERIMENTAL SHOP.

In Fig. 278 we illustrate a model gasoline motor of a half-horse power made in "The Franklin Model Shop" of Parsell & Weed, 129 and 131 West 31st Street, New York City. The motor parts are made on a wrought iron frame suitable for attaching to a light vehicle. The details of this motor are fully described and illustrated, with the tools and methods of construction for amateur instruction, in their book on "Gas Engine Construction."

Messrs. Parsell & Weed have had considerable experience in gas and gasoline engine construction, and in their Franklin Model Shop they have an establishment which is well equipped with the best modern machine tools, and, with a corps of intelligent and experienced workmen, they are

prepared to do all kinds of fine work, models, and for building automobile engine parts, vaporizers, etc., to order from inventor's own designs. Their drafting department is also

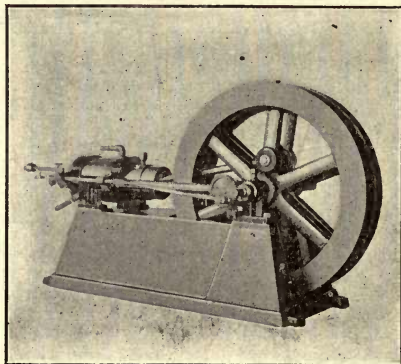


FIG. 278.—THE MODEL MOTOR.

available for the production of working drawings from customer's sketches.

A COMBINED MOTOR AUTO-TRUCK.

In Fig. 279 we illustrate a novel combination of a gasoline and an air motor truck, built by L. J. Wing, 95 Liberty Street, New York City.

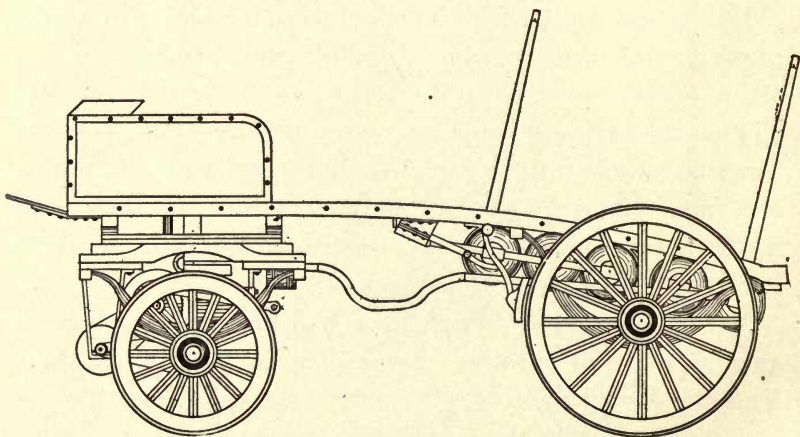


FIG. 279.—COMBINED MOTOR AUTO-TRUCK.

The initial power in this system is a gasoline double-cylinder motor ; very compact, reliable, and of large power for heavy work. This motor has the outer end of each cylinder arranged as an air-compressor. This gives an abundance of compressed air for starting the motor and for working air brakes—similar to steam engines, for blowing a whistle or as auxiliary power for climbing grades, starting heavy loads, etc.

As shown in the cut, the power is attached to the front wheels through a jackshaft having compensating gears. With this arrangement of the parts the driver is enabled to turn the vehicle at right angles for turning in narrow streets, while at the same time he has the full strength of the common wagon.

The power plant can be attached to any truck or wagon by removing the front wheels, axle and lower half of fifth-wheel and substituting the power plant. Then by putting on the storage tanks, air-brakes, etc., the old horse truck becomes a practical and reliable auto-truck, capable of doing a greater amount of transporting at less cost than by horses and occupying but one-half the room on the street. It does not soil the street as the horse does, and never gets tired or sick.

The arrangement for steering, stopping and starting are all made very strong, but these operations are done mechanically and require but little power on the part of the "Moteer," in fact, this wagon has less labor for the operator than the small electric carriages.

The exhaust has been arranged so as to remove the objectionable feature of the gas engine.

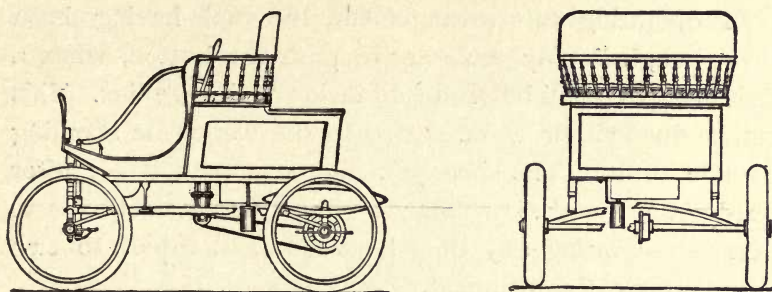
Mr. Wing has had many years' experience in machinery, and was the first one in the East to make the gas engine a success as a marine power.

AUTOMATIC IGNITER FOR STEAM VEHICLE BURNER.

For purposes of convenience, as well as economy, the most successful types of steam vehicle are constructed with a boiler heated by a gas flame, such being produced by employing the heat of the boiler itself to vaporize liquid gasoline. In starting the boiler, when cold, some portion of the fuel supply pipe is first heated, and when it has reached the required temperature the supply of liquid gasoline under air pressure is turned on, and becomes vaporized or turned into a gas in passing through the heated pipe; it issues through the burner under the boiler, where it may be ignited. For purpose of economy, in both fuel and water (as well as preventing over or dangerous pressure) when stops are made along the road, various automatic devices have been invented and applied to this type of automobile, by which the gas supply is diminished, or even cut down to a taper or pilot flame. As, however, the bottom of the burner is pierced with many holes in order to supply air to the burning gas, sudden gusts of wind will frequently extinguish the flame when so turned down, and, indeed, it often occurs that the fire when turned on to its fullest extent, with the vehicle under way on the road, will be suddenly blown out. In the latter case, it is necessary to stop the vehicle and relight the fire.

In order to overcome this annoying disadvantage, an electric re-igniting device has been devised and put upon the market by the A. L. Bogart Company, of 123 Liberty Street, New York City, which is particularly simple in construction, number of parts and method of applying. It consists of a spark-producing device contained in a cylindrical metal case, five inches long and three inches in diameter. Projecting from the upper side of this case is a stem surmounted by platinum sparking points, one of which is automatically

movable. This instrument, known as the igniter, is suspended by means of an iron brace screwed fast to the bottom of the vehicle in such manner that the sparking points pass up through one of the air tubes in the bottom of the burner and project within the same just above its upper surface. Figs. 280 and 281 represent the igniter as attached to



FIGS. 280 AND 281.

the steam vehicle known as the Locomobile, the first being a side and the second an end view of the same; portions of the framework are represented as being broken away in order to show the igniter plainly. Fig. 282 is a diagram of the igniter and its electrical connections, on a larger scale; the dotted lines between the igniter, button and battery box indicate the wires connecting the same. The push button is usually placed at the right hand side of the driver, preferably near the starting lever. Two cells of dry battery are contained in a neat cylindrical case, three inches in diameter and fifteen

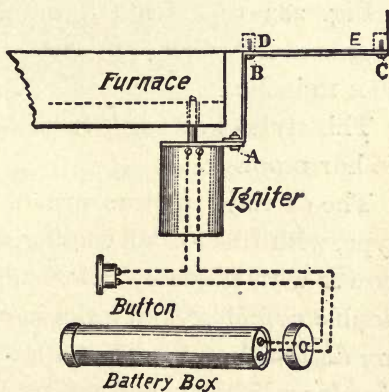


FIG. 282.

inches long, which is provided with a cover and may be placed in a tool tray, under the foot board. The connecting cord as supplied by the manufacturers is a double strand, twisted together, having three ends, one to be attached to the igniter, one to the button, and the other to screw posts in the battery box.

In operating this arrangement, the fuel having been turned on, it is only necessary to push the button, when a lighting spark will be produced inside of the fire box. This can be done either while seated in the wagon or standing outside of it. The heat remaining in the boiler after putting out the fire is sufficient to vaporize the fuel so as to permit re-igniting any time from one and a half to two hours after extinguishment.

VEHICLE MOTORS OF THE MALTBY AUTOMOBILE AND MOTOR
COMPANY.

The Maltby Company, who are located at No. 12 Clinton Street, Brooklyn Borough, New York City, furnish gasoline motors with water-jacketed and rib-cooled cylinders for bicycles, tricycles, carriages and launches.

Fig. 283 represents a water-jacketed, two-cycle launch engine of three horse power,—height, 22 inches; floor space, 20 x 12 inches.

This style of motor is furnished in sizes of $1\frac{1}{2}$, 3, 5, 6 and 10 horse power.

The carriage motors are of the four-cycle compression type, with ribs for air cooling, and sizes of one and two horse power with single cylinders and of four horse power with double cylinders and a single crank case. All their motors are designed on the most approved principles of construction for reliability, and are provided with a peculiar electric ignition device that varies the time of sparking.

In Fig. 284 is illustrated the ribbed and air-cooled motor of the carriage type.

When placed in a carriage, or on a tricycle, the feet shown in the cut are replaced by brackets direct to the vehicle frame. The crank case is made of aluminum, which contributes to the lightness of the motor, which for two horse power only weighs 53 pounds.

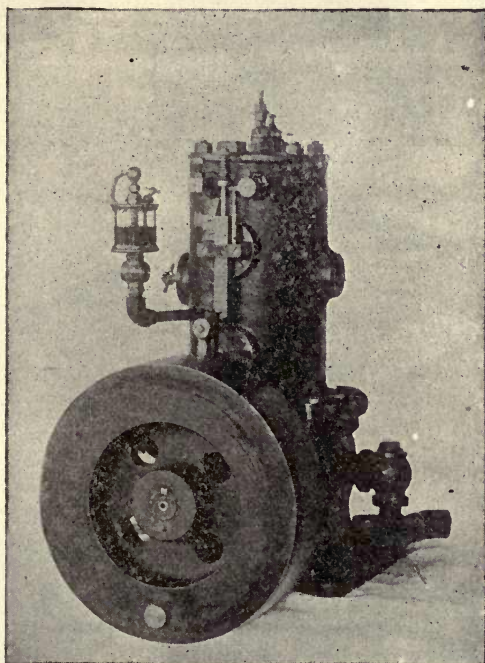


FIG. 283.—WATER-JACKETED CARRIAGE MOTOR.

In Fig. 285 is shown some of the principal parts of the carriage motor. The crank case, uncovered, with the reducing gear, cam and guide for operating the exhaust valve. The two bolts that hold the motor parts together, the piston, cylinder, and cylinder head, which is also ribbed, and the sparking push rod, which operates by contact with the

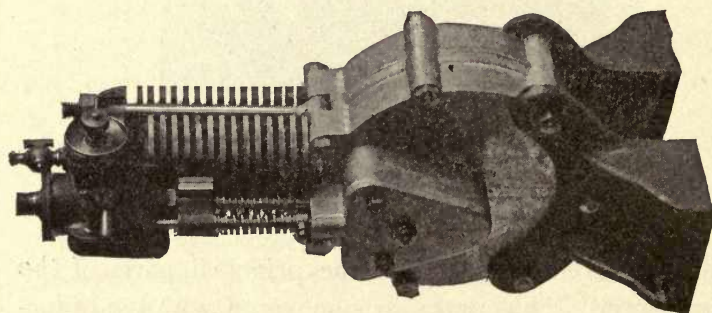


FIG. 284.—THE AIR-COOLED
MOTOR.

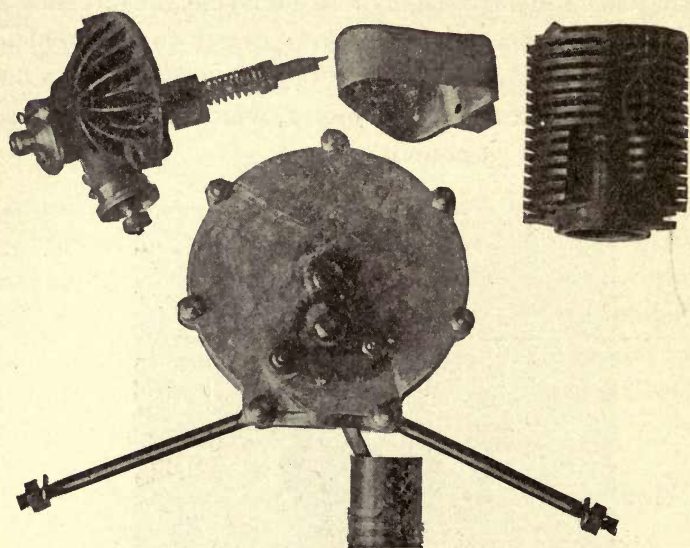
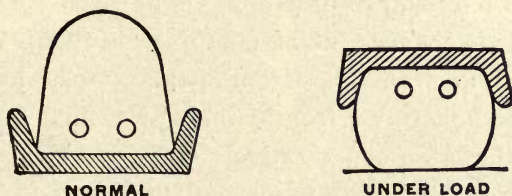


FIG. 285.—PARTS OF THE CARRIAGE
MOTOR.

piston. The bicycle motor of one horse power is made on the same lines as above, and weighs but 25 pounds.

THE LANGMUIR TIRES.

This tire possesses certain features which are not embraced in other makes of solid rubber tires. It has been the theory of inventors of solid rubber carriage tires that it was essential to have the rubber fill the channel before the load was put on, and this feature has been carried out in all tires that have come to our notice, with the exception of "Langmuir's," and the inventor of this tire seems to have conceived the idea that, in order to make a successful tire, it was necessary to make a radical departure from the old



FIGS. 286 AND 287.—LANGMUIR.

forms and methods of applying the tire, and we observe that he has made his tire so that there is a "V-shaped" space between the rubber and the flanges, and, in talking with the inventor, we learn that this is the primary base of their claims, and being of this shape they contend that they had a very resilient rubber tire, due to the fact that the entire weight of the vehicle comes on the base of the channel, and, as the rubber compresses laterally when under load, it fills the channel, and in this way the entire amount of rubber in the tire is brought into use, whereas, with the tires that fill the channel before the load is applied, there is quite a percentage of rubber that is not in use, for the reason that before the load is put on it fills the channel; consequently,

being encased within the sides of the flanges, that portion which is not encased spreads out over the sides of the channel, so that a person is riding only on the amount of rubber above the sides of the channel, whereas in the "Langmuir" the entire amount of rubber is brought into service.

In applying the "Langmuir" tire no superfluous rubber is used, as the tire is cut the same length as the circumference of the wheel, plus three times the depth of the rubber, using the same principle as applied in cutting iron or steel channels, and by so doing the matter of compression is eliminated, the results being that the tire will not open at the joint, will not break at the wire holes or cut at the base, and the harmful tendency of creeping is eliminated. The reason for creeping is on account of compression that is necessary to be used to keep the tires from opening at the joint. The tires are manufactured from $\frac{3}{4}$ inch to 3 inches in diameter, and, although a comparatively new article in the field, a great many of them are in use and have given satisfaction in every instance.

These tires are manufactured by the Revere Rubber Co., 59 Reade Street, New York.

AUTOMOBILE TIRES.

We illustrate, in Figs. 288 and 289, a lately-patented tire of novel construction, having much of the elastic properties of the pneumatic tire, without its troubles.

In Fig. 288 is shown a section of the tire for light vehicles. The open central space gives the tire great elasticity, and the form of its fastenings allows of a compressive hold of the tire on the wheel, instead of a tension or pull of the tire around the wheel, as with other methods of fastening.

The principle of compression is a saving one on the wear and tear of the tire. A cut, or puncture, has no disposition

to gap and extend the damage by the stretched condition of a tire; but, on the other hand, closes up and presses together by the longitudinal compression in this method of tire mounting.

If a tire becomes seriously cut or damaged from accident, a piece may be cut out and a new piece put in, thus saving the entire loss of a tire. This tire does not creep.

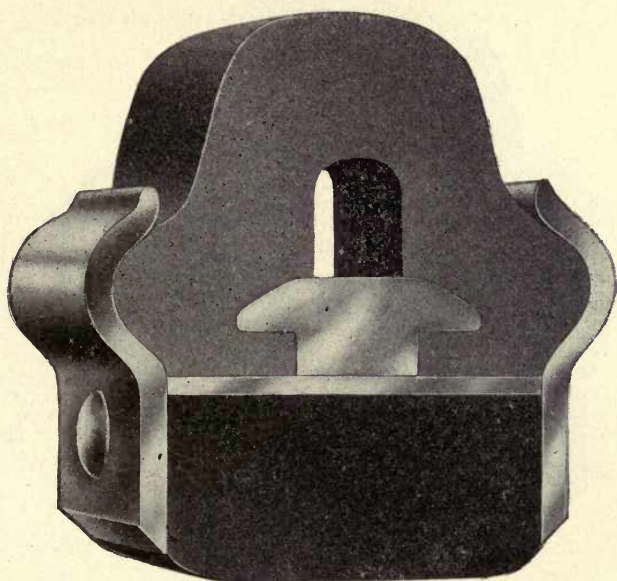


FIG. 288.—THE ELASTIC SOLID TIRE.

The central T-shaped band is fastened to a band tire, or directly on the felloes by bolts or pins. The outside grooved bands are bolted to the felloes by through bolts, making a firmly stayed and strong wheel. The rubber tires are moulded in rings for set sizes, or in straight lengths suitable for any size wheel, or for repairs.

In Fig. 289 is shown the solid tire for heavy vehicles, made

upon and subject to the same general principles of construction as the first named, but with a capacity for carrying much heavier loads.

Their durability is equal to the wear of the solid rubber down to the edges of the grooved supporting bands. They cannot be jerked off the wheel in railway ruts.

They are designated as the "compressed double-locked

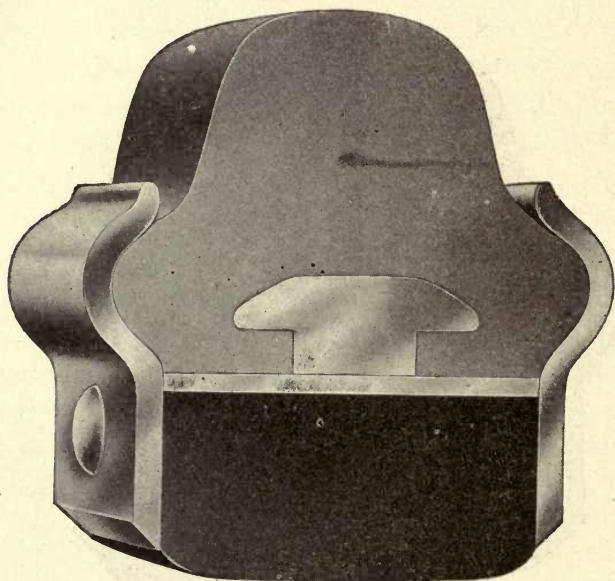


FIG. 289.—THE SOLID TIRE.

automobile tire," and are made by Dewes & Whiting, No. 243 Centre Street, New York City.

AUTOMOBILE LAMPS.

In Figs. 290 and 291 we illustrate a kerosene automobile lamp, made by the R. E. Dietz Company, 60 Laight Street, New York City. The need for a lamp that will not jar or

blow out under any conditions of road travel has been met by the Dietz Company, who have produced a lamp with a strong light, with chimney draft, that is reliable for automobile service, and will burn 24 hours with one filling. It burns with a clear white flame of 20 candle power, and lights up the road for a distance of 200 feet or more.

The lamp is compact and handsome in design, resembling, in a measure, the locomotive headlight, and is provided with an internal conical reflector of a peculiar form, which concentrates and focalizes the entire volume of light and throws it directly ahead.

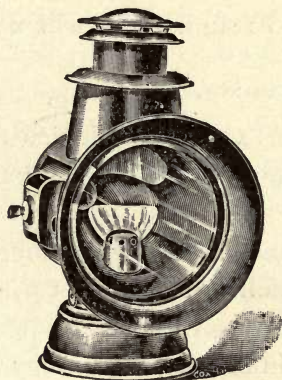


FIG. 290.—THE DIETZ
LAMP.

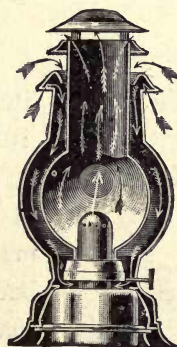


FIG. 291.—AIR PASSAGES
OF LAMP.

The front of the lamp consists of a beveled, moulded lens made from the best quality of lead glass, set in a flaring front door.

At the back is set a small lens of ruby glass, by means of which, when the lamp is in position at the side of the dash, a brilliant point of crimson light is seen from the rear.

The reflector is made of rolled silver-plated copper.

The flaring front is made of a highly polished non-tarnishing white metal.

The lamp embodies in its construction the well-known tubular principle; the sides being double form an air chamber, the cold air being drawn into the outer chamber at the top descends to the burner, and the hot air and products of combustion escape through the central passage.

The operation of the lamp can be readily seen by Fig. 291, the arrows showing the circulation of the air, and, as all the air that feeds the flame, or goes to the burner, passes through these chambers, no wind affects its burning. By means of this circulation fresh air is continually supplied to the burner, and a perfect combustion is the result; the lamp emitting a clear white flame devoid of smoke or odor, and one that the jarring incident to rough roads will not extinguish.

BALL BEARINGS.

In Fig. 292 we illustrate a ball separating device made by the Sartus Ball Bearing Company, 618 Broadway, New York City.

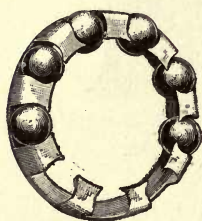


FIG. 292.—SEPARATORS.

The use of a ball retainer and separator in any kind of machine, running on ball bearings, has been proved, by severe and frequent tests, that friction in bearings is thereby reduced to a minimum, and that retainers and separators give the easiest running ball bearings.

It is a known fact that the rolling ball, even under great pressure, produces very little friction, and it is friction alone that causes wear. As the ordinary bearings in cycles, without exception, wear out in a comparatively short time, it proves, in the most positive manner, that the balls in these bearings, during use, do not always roll freely, but necessarily slide at times. Sliding of the balls has been proven by experiments.

The only proper way to test friction in bearings, is to put a weight of say 200 pounds on the wheel running on ball bearings, and revolve it. The spinning of a suspended wheel does not speak for the excellence of its bearings, but the revolving of the same under pressure, which it also undergoes as a part of a cycle or vehicle, with its driver, only determines the amount of friction generated.

The arrangement, Fig. 293, illustrates a simple device for testing the amount of friction in ball bearings, and to better explain said device, the parts of the illustration are marked with letters as follows:

A *A* is a bicycle hub on its fork, *E*.

B is a belt running under the hub and over a pulley fastened to a shaft.

E is a fork slightly changed to accommodate this method of illustration, but answering the purpose of the ordinary fork in a bicycle.

F is a 200-pound weight attached to the lower end of fork, *E*, and corresponds in this illustration to a rider on a bicycle.

From the foregoing it will be readily understood that when shaft, *D*, and pulley, *C*, revolve, hub, *A*, will also rotate on its bearings, and, as it is under the pressure of a 200-pound weight, it revolves under the ordinary conditions of bicycle riding.

As it is an accepted fact that friction will always cause more or less heat, it must be granted that the greater the friction the more heat; consequently, as an additional test, assume the wheel to travel at 300 miles an hour, the amount of friction of the loose ball bearings could readily be ascer-

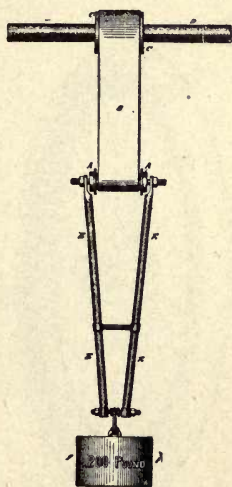


FIG. 293.—THE TEST.

tained by the amount of heat shown by the cones, cups and loose balls. Trials of long runs of cycle hubs in this kind of test has shown the decided value of the Sartus ball retainer.

AUTOMOBILE TIRE PUMPS.

Something which every owner of an automobile needs is a tire pump. Probably the best stationary hand lever pump is made by the Gleason-Peters Air Pump Company, 40 West Houston Street, New York. It is made from

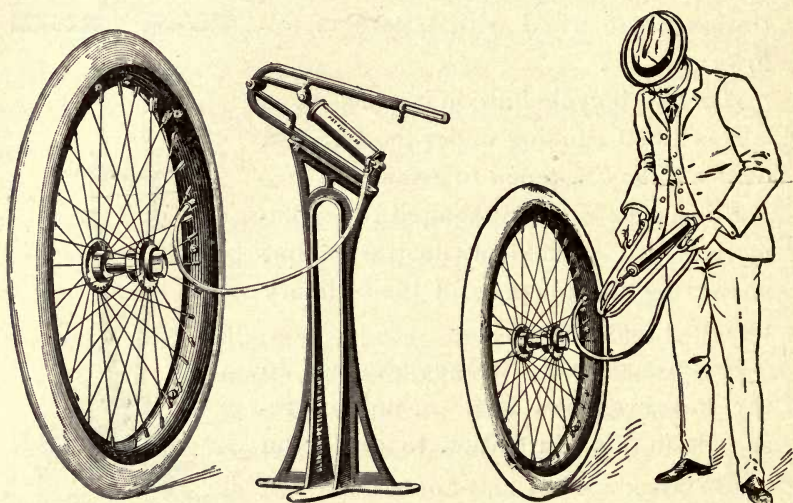


FIG. 294.—TIRE PUMP AND FRAME. FIG. 295.—OFF THE STAND.

malleable iron, can be operated by hand, is attached to a fixed support and possesses all the advantages of that class of pump known to the trade as lever pumps. Another important advantage is that whether portably held in the hand or affixed to a support, the best possible results are attained, as the leverage on the piston rod increases as the resistance on the piston increases, thereby securing the powerful leverage of the well-known "toggle-joint" principle as the piston finishes its stroke.

This pump is particularly adapted to automobiles, and is said to be the only hand pump that will give a pressure of 400 pounds to the square inch.

This company also makes power pumps for manufacturers of automobiles.

The illustration, Fig. 294, represents the pump on a slotted stand, which also serves as a bicycle holder.

In Fig. 295 is illustrated the pump detached from the stand and operated in the hands like a common bellows.

The direct hand pump, Fig. 296, is made from heavy seamless brass tubing and has malleable iron base, ball check valve and spade handle. This is a very powerful foot pump and is light in weight. All joints and connections are soldered, and the pump is designed to be carried about in the vehicle, and will make a pressure of over 250 pounds per square inch.

THE AUTOMOBILE BELL.

One of the most important attachments to the horseless vehicles, automobile or motor cycle, is the sweet-toned signal of alarm. It should be strong and penetrating, as well as quick in action.

The "Ideal bell" is constructed on an entirely new principle, which makes it suitable to be operated with electric light current as well as battery current. All the works are included under the gong, making a very attractive bell. (In the new construction the bell is also made dust and water proof.) It also gives a much stronger ring than the old style; this is accomplished by means of the circuit breaker. In all

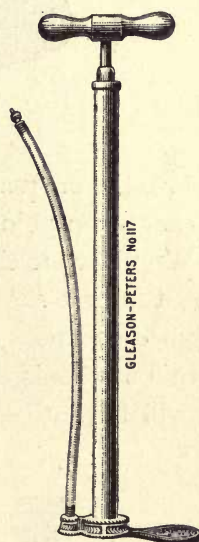


FIG. 296.—BICYCLE PUMP.

vibrating bells made heretofore the circuit is always broken before the armature comes in contact with the magnet, losing thereby the strongest part of the magnet's attraction, but in this one the armature has to come in contact



FIG. 297.—THE "IDEAL BELL."

before the current is broken, which makes the hammer give a very strong blow to the bell.

We illustrate the details of this bell in Figs. 297, 298 and 299, the first showing the outside and its complete closure from dust and water, and the latter the details of the internal mechanism, which is of more than ordinary interest. It will be noticed that the current comes through binding

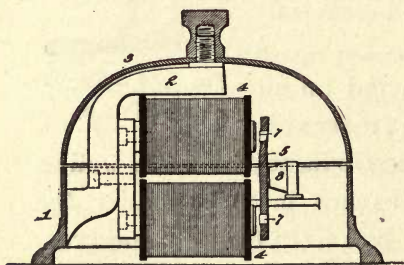


FIG. 298.—BELL SECTION.

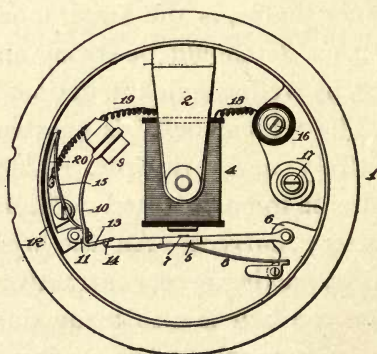


FIG. 299.—ITS OPERATION.

post, 16, then to the magnet wire at 18, then out at 19 to insulated bracket, 20, which holds the hammer lever, 10, then through contact, 13, to contact, 14, on armature bar, 6, so that when the armature bar, 5, is attracted and comes in contact with the magnet the momentum of the lever hammer breaks the circuit, and when the hammer rebounds the contact is again made, causing it to keep on vibrating as long as the circuit is closed. It will be noticed that by the manner in which the armature and hammer is pivoted,



FIG. 300.—A GOOD LUBRICANT.

there is a good rubbing contact, making it unnecessary to use platinum, although silver is used, so that when the bell is not used for a long time it will not corrode. These bells are manufactured by David Rousseau, 310 Mott Avenue, New York City.

LUBRICANTS FOR AUTOMOBILES.

The want of a lubricant for bearings and chains of motor carriages and motor cycles that does not choke up journal boxes and chains with graphite, which cannot be cleaned off

or even touched with hands without imparting the blacking nuisance, has brought out a new compound paste that is free from objections and easily cleaned from bearings or chains. It is free from mineral or gummy substances, and is especially adapted to the requirements of ball bearings.

It is made by Wm. P. Miller's Sons, 100 Greenpoint Avenue, Borough of Brooklyn, New York City.

BRASS AND COPPER GOODS.

Manufacturers of automobiles and amateurs will be interested in knowing where they can secure a superior quality of seamless drawn copper tubes, $\frac{1}{16}$ inch to 16 inches diameter, of any thickness required. The U. T. Hungerford Brass and Copper Co., New York City, have made a specialty of seamless drawn copper tubes for boiler tubes, and the size that is generally used by manufacturers of automobiles who are now placing their machines on the market measures $\frac{1}{2}$ inch outside diameter by No. 21 Stubs gauge, or $\frac{1}{32}$ inch thick, cut in lengths to suit the size of the boiler. These tubes are finished especially to give the greatest possible strength with the least possible weight. The extra large sizes of tubing, from 13 inches to 16 inches, are used for the shell of the boiler, and are made in thicknesses from $\frac{1}{16}$ inch up to $\frac{1}{2}$ inch, according to the requirements of the case. Seamless drawn brass and copper tubes are also used in vehicles driven by gasoline motors for conducting pipes, connections, etc., and anything in this line can be procured from the above mentioned concern.

They carry a full line of sheet copper, sheet brass, rods, wire, etc., and have just issued a stock catalogue showing full line carried in their New York warehouse, No. 12 Worth Street, which we believe will be invaluable to builders of automobiles, and will be sent to anyone on application.

The above company also manufactures an automobile oiler, as illustrated in Fig. 301.

The spout is so arranged as to be easily drawn out of the oil well, extending $3\frac{1}{2}$ inches beyond it, thus rendering it possible to reach any part of the automobile motor or running gear.

To close the oiler the spout is pushed back over a rod attached to the spout, acting as a valve, thus preventing the escape of oil.

As a precaution against leakage the screw head is packed solid with leather washers, making it absolutely impossible for the oil to pass through it.

AUTOMOBILE GEARING AND ITS MANUFACTURE.

One of the essential elements in automobile construction is a smooth running gear.

This can only be obtained with perfect tools for cutting the teeth of the gear wheels and pinions, so that

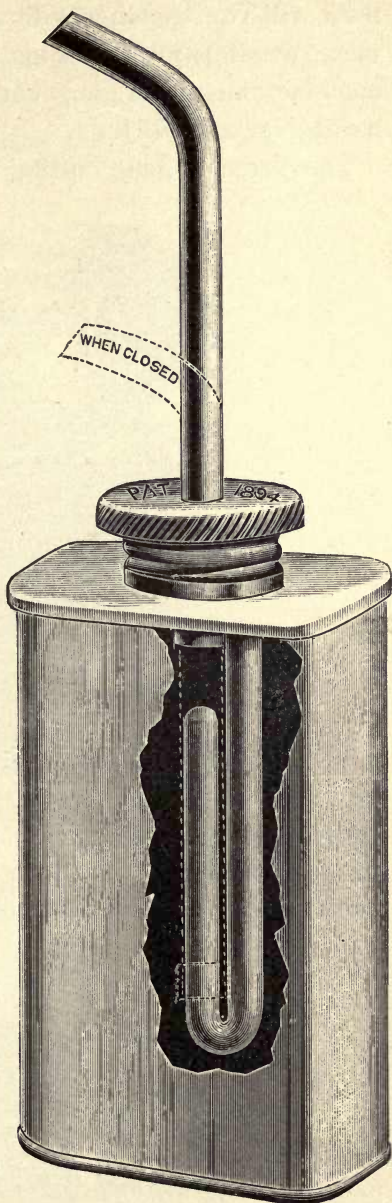


FIG. 301.—THE OILER.

they will run together without noise or jar. With this in view, we illustrate, in Figs. 302 and 303, a gear cutting machine and radial gang cutters made by Gould & Eberhardt, Newark, N. J.

The system of gang cutting the teeth of gear wheels is one

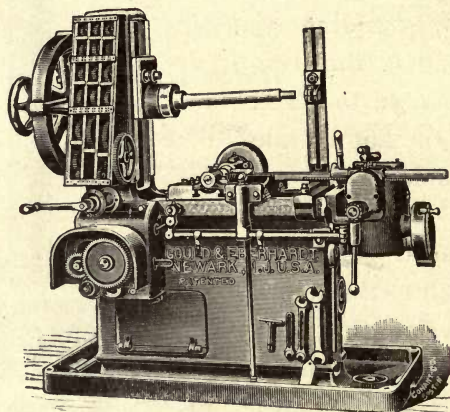


FIG. 302.—GEAR CUTTING MACHINE.

of the modern innovations in the saving of time in the operation of mechanical work.

Messrs. Gould & Eberhardt not only build the machinery, but are prepared to cut any kind of gearing for experimenters or builders of automobile motors and speed gears.

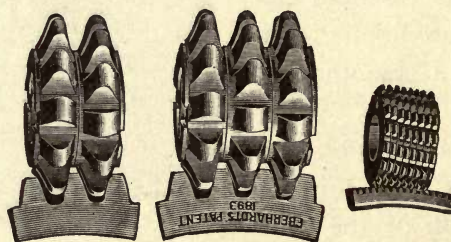


FIG. 303.—THE GANG CUTTERS.

THE AUTOMOBILE MACHINE SHOP.

The rapid advance in the manufacture of horseless vehicles, automobiles, and motor cycles has caused to be made special machinery of precision for finishing the parts of their motive power and running gear.

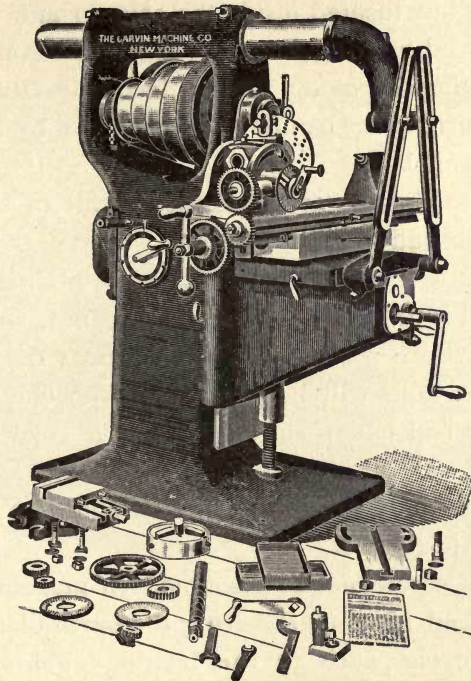


FIG. 304.—UNIVERSAL MILLING MACHINE.

We illustrate three of the most interesting machines of this class in Figs. 304, 305 and 306, as made by the Garvin Machine Co., Spring and Varick Streets, New York City.

The Universal milling machine embodies the most advanced design of this class of tool, and is advantageously adapted for cutting automobile gears, pinions, sprocket wheels, and for milling the brackets, levers, and other sur-

face work. It is also adapted for making the parts required for the construction of horseless carriages. Power feeds are provided in all directions, and all of these feeds are started and stopped by one hand lever at the front of the knee.

Special attention is directed to the feed mechanism. The change gear box located inside the column affords eighteen changes of feed, ranging from .003 to $\frac{1}{4}$ inch advance per revolution of spindle, and any desired feed is instantly obtained by simply turning the handle to correspond to the number on the index disk.

All of these changes are available for all of the feeds, in any direction, and in all positions.

A new feature of this machine is a stationary elevating screw which is provided with a rotating nut, so that when the machines are placed on cement floors or in fireproof buildings no hole will be required. The elevating nut is fitted with a ball end thrust, giving it a very easy movement.

Micrometer dials, graduated in thousandths, are provided on all the adjustments.

The turret screw machine is a modern machine tool especially designed for manufacturing the parts of automobiles and motor cycles, such as the bearings, gears, boxes, and other parts required to be bored, turned, faced, and threaded.

It has a very large capacity automatic wire feed mechanism for making the ball-bearing cups and cones from the bar. The machine has ample power for the heaviest kind of work. The regular friction-gear spindle is back-gear at a ratio of 8 to 1. In addition to this, the face plate is also back-gear at a ratio of 14 to 1.

The turret has large hexagonal faces, so that universal

turning tools can be rigidly secured, enabling them to make heavy and accurate cuts. The holes in the turret are $2\frac{1}{2}$ inches in diameter, and a bar of this size can be passed through the turret in line with the spindle, thus enabling any length of piece to be turned.

The power feed is positively arranged with change gears, one of which is provided with an adjustable slip friction, so

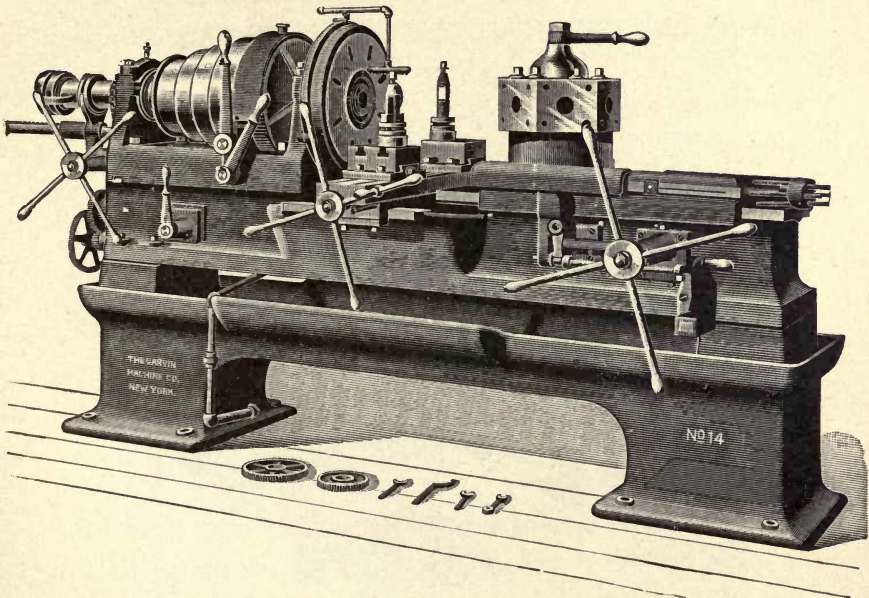


FIG. 305.—THE SINGLE TURRET SCREW MACHINE.

that no injury can happen to the tools in case they become dull or otherwise incapable of cutting.

A separate set of feeds is provided to give the proper pitches for screw cutting. Changes can be instantly made from the regular feeds to the screw-cutting feeds by simply throwing a lever at the side of the head stock.

The machine is provided with independent stops, so that tools of different lengths can be used in the turret.

The gap in the bed enables large gear and sprocket wheels to be turned, and the large combination oil pan and cabinet base provide means for saving and separating the oil from the chips.

The automatic pump furnishes a copious supply of lubricant to the cutting tools when required.

The double turret screw machine is a form of machine

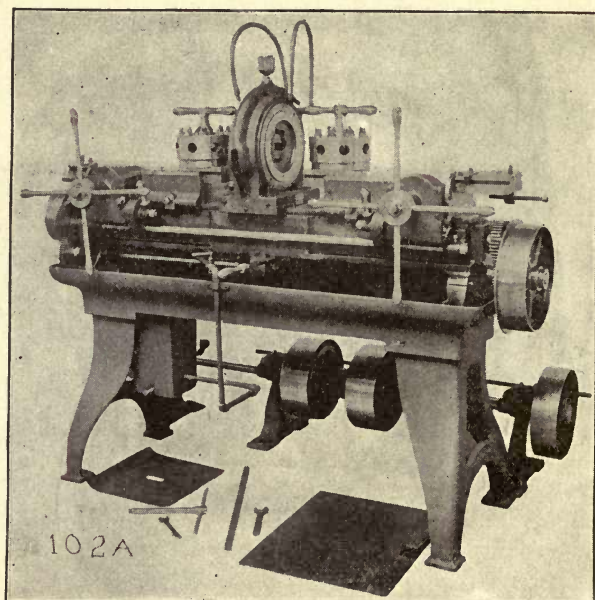


FIG. 306.—THE DOUBLE TURRET SCREW MACHINE.

brought out to meet the demands required in the construction of horseless carriages. It is particularly adapted for making pieces that require operation on both ends, such as wheel hubs, shells, change gear boxes, and similar work.

The machine is so arranged that the tools can be in operation on both ends of the piece simultaneously, thus saving a large amount of time; also enabling the piece to be com-

pleted at one setting, and insuring both ends of the work being finished in the same concentric plane.

The work being handled only once, all loss of time and inaccuracies due to rehandling are avoided.

The center chuck is driven by gearing, and revolves in anti-friction bearings thoroughly protected from chips and dirt.

The turrets are independent of each other, and are each provided with pan, and also power feed, with ample changes for the different classes of work.

These machines are built in several sizes to cover the range of work required on small motor cycles, automobiles, and trucks.

MOTORS AND VEHICLES OF THE HASBROUCK MOTOR COMPANY.

The Hasbrouck Motor Co., whose factory is at Piermont, N. Y., and office at No. 20 Nassau Street, New York City, are builders of gasoline motors and automobile carriages, trucks and delivery wagons, in connection with their business of building launches and yachts with gasoline motive power.

Their motor is in line with the latest and best design of one, two, four, six, eight, and ten horse power for immediate delivery, and higher powers to order.

The company are now building a modified Stanhope phaeton, Fig. 307, to carry two persons, with top and storm curtains—a complete and thoroughly up-to-date touring carriage, fitted with a six horse power gasoline motor that is absolutely odorless, and in which the vibration usual in gasoline motor vehicles has been entirely eliminated.

The economy in fuel is the best that has yet been obtained, the motor requiring but one-tenth of a gallon of gasoline per horse power per hour.

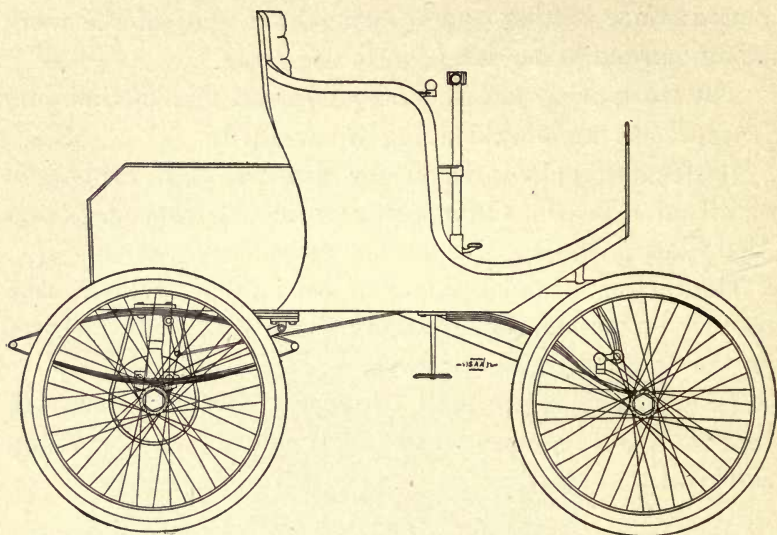


FIG. 307.—THE HASBROUCK MOTOR CARRIAGE.

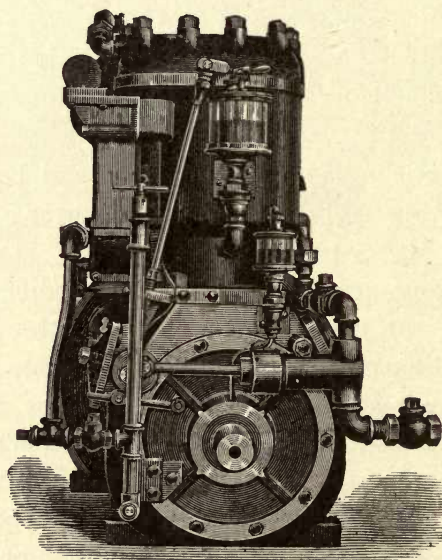


FIG. 308.--THE HASBROUCK MOTOR.

Their automobile carriage can be operated by any intelligent person, and is under perfect control in all its movements.

Its speed is gauged from one mile per hour to as fast as one may care to go, and the power is sufficient to climb a grade of 20 per cent. at from three to six miles per hour.

In Fig. 308 is illustrated the Hasbrouck motor.

A GASOLINE VEHICLE MOTOR.

In Fig. 309 we illustrate a compact and well made motor with air-cooled cylinder, made by the Smith Motor Co., 56 Morris and Essex Railroad Avenue, Newark, N. J. These motors are a specialty for automobile vehicles and tricycles; they are of the four cycle type with electric ignition and vaporizing device of the most approved pattern.

Three sizes are now in course of manufacture: $1\frac{3}{4}$ horse power motor that weighs 40 pounds, as shown in the cut, Fig. 309; a three horse power motor, same pattern, weighing 85 pounds, and a six horse power motor, weighing 110 pounds.

The cylinder, cylinder head and valve chamber are enclosed in a system of air-cooling ribs, that are fully equal to controlling the temperature and contribute to the neat appearance of the motor. The vaporizing device is attached to the top of the valve chamber, forming a fixed part of the motor.

By an arrangement of the internal passages in the cylinder, the products of combustion are swept clean from the cylinder after each impulse stroke and the regulation of speed is made both by variable charge and delayed electric sparks, all controllable by the operator.

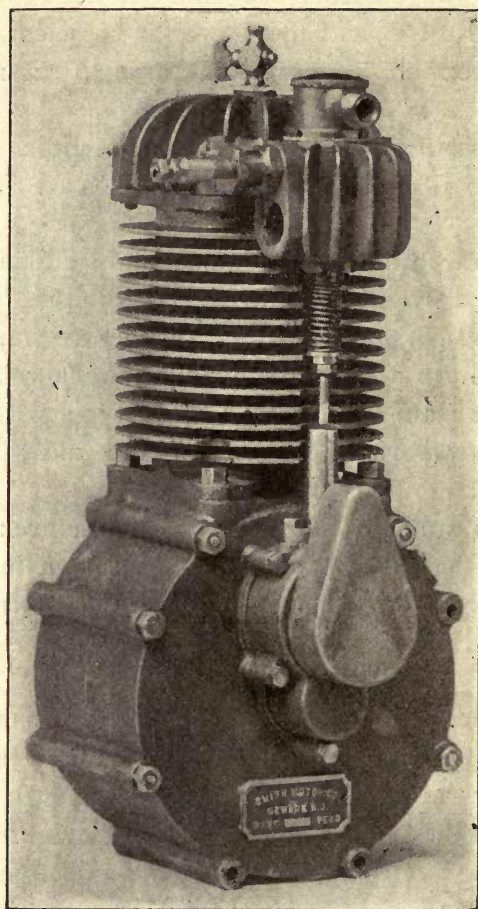


FIG. 309.—THE SMITH MOTOR.

COMBINED KEROSENE OIL ENGINE AND AIR COMPRESSOR.

In Fig. 310, we illustrate a novelty in an air compressor operated by kerosene oil.

The application of the explosive motor to the compression of air for all purposes is of recent date, and will eventu-

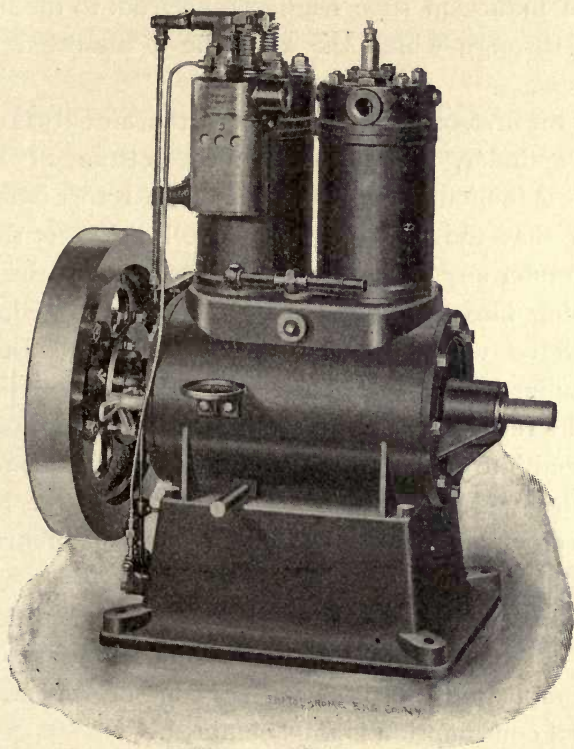


FIG. 310.—THE MERRILL KEROSENE OIL MOTOR
AND AIR COMPRESSOR.

ally become of great importance as an easily installed and economical method of obtaining compressed air for raising water by the Merrill system, but also to furnish air under pressure for any purpose.

The engine is of the vertical four-cycle compression type,

having an isolated retort at the side of cylinder, wherein vaporization and ignition are automatically effected, without the aid of electric batteries, igniters, or hot tubes.

Kerosene is contained in the base of engine and is supplied by a pump to an induction valve on top of retort, having an induction tube leading therefrom to the bottom of retort, through which the kerosene is admitted at the proper time.

During the first, or intake stroke of piston, air only is drawn into the cylinder, and kerosene into bottom of retort, wherein it is immediately vaporized. The retort is so proportioned that the kerosene vapor will not more than fill the same under any condition, thereby preventing the vapor from passing into the cylinder and condensing against the water-jacketed walls, which would cause great waste and serious fouling.

Upon the return, or compression stroke, the air in cylinder is forced into the vapor in retort, producing a combustible mixture which very readily ignites from the heated walls of retort, as soon as the piston ends the compression stroke.

The volume of air in the cylinder is always considerably in excess of that required by the vapor in the retort to form a combustible mixture; perfect combustion and economy in fuel consumption is thus obtained.

The kerosene is supplied to the retort against no pressure, but is largely assisted by the suction of piston, thereby relieving the pump of excessive duty. The pump is operated by a variable eccentric disc controlled by a fly-wheel governor, which mechanism supplies the kerosene in direct proportion to the load.

The governor also insures a positive delivery of kerosene. If the pump fails to deliver a proper quantity, the resulting

decrease of power and speed is immediately accompanied by the action of governor, which increases the stroke of pump, making up the deficiency and instantly effecting the recovery to normal speed. This result would not be obtainable if the pump had a fixed stroke.

By this arrangement no adjustments of the air or kerosene supply (which might be improperly handled by unskilled persons) are required.

The successive combustion of variable charges within the retort at the proper time, tends to keep the retort more uniformly heated, than if the charges were occasionally omitted; the speed of the engine is also more regular.

In fact, the regulation and the variable pressure effect within the cylinder of this engine is analogous to the operation of an automatic cut-off steam engine.

Special kerosene engine air compressor and generator units of direct connected types will be built, by which the owner of a country place can light his residence, supply it with water, and charge his electric automobile or launch.

The air compressor combination may also be used by manufacturers or at central stations for inflating automobile tires.

For automobiles and launches, multiple cylinder engines of modified designs to meet existing conditions will be built, together with a full line of pneumatic pumping machinery, by the Merrill Pneumatic Pump Co., 141 Broadway, New York.

DROP FORGINGS FOR THE AUTO-BUILDER.

It pleases us to become a class of clearing-house for the introduction of automobile parts. When these parts have particular merit, are the product of careful designers and practiced manufacturing methods, we may claim for them more than common attention.

Iron your vehicle for safety and wear first; then evolve graceful form combinations. We picture steering front axle parts, drop forged from stiff, strong steel. Both the pivot arm and yoked bed embody artistic outline, are forged to require the minimum of machine finishing, and must find favor among builders of first-class horseless carriages, etc.

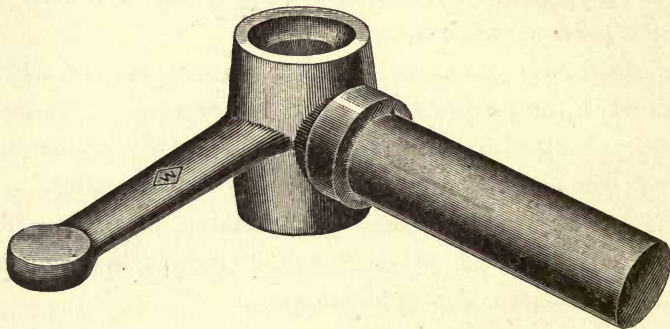


FIG. 311.—THE ARM, JOINT AND AXLE.

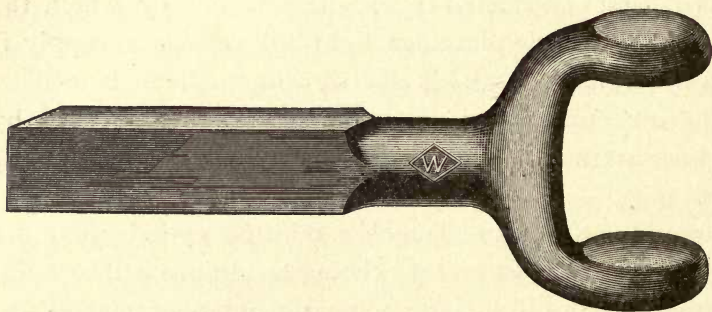


FIG. 312.—THE Y AND AXLE BAR.

Valve stem and connecting rod end forgings will interest the auto-engine builder. J. H. Williams & Co., Brooklyn, N. Y., are about to issue a catalogue describing these, with steering axle, crank shaft, and other stock drop forgings. The entire book will be interesting. The endeavor to excel has so marked the efforts of this well established concern that scant opportunity to further commend is created.

CONTINUOUS CURRENT VOLT-AMMETER

For Testing Storage and Primary Batteries.

To keep a storage battery in good condition and to prevent break-downs as well as expensive repairs, each cell should be tested from time to time by a low reading volt-meter capable of indicating tenths of volts.

In this way, cells which are not in good condition can be detected by their voltage being lower than the others, and attended to at once, before the trouble has become so serious as to necessitate expensive repairs.

The users of gasoline vehicles with sparking devices operated by storage batteries, will also find a low reading volt-meter invaluable, as such an instrument will indicate the fall in the voltage which occurs as the battery approaches exhaustion.

This will enable one to tell when the battery should be re-charged.

When a sparking device is operated by a primary battery, tests with a low reading volt and ammeter will enable weak cells to be detected and replaced.

This instrument has three scales, reading as follows: from 0 to 3 volts in tenths, 0 to 30 volts in units, and 0 to 10 amperes in fourths. Thus the readings of three instruments are combined in one, adapting it perfectly to battery testing.

The division of the 3-volt scale are tenths of a volt, making the instrument applicable to testing storage batteries.

The different readings are obtained by inserting a plug in the proper one of three marked holes in the end of the instrument. In this way the various readings are easily

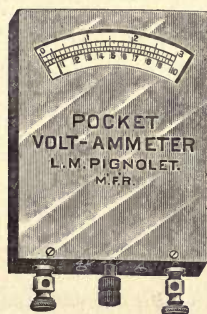


FIG. 313.—TEST-
ING VOLT-AM-
METER.

and quickly made, as no connections have to be altered at the binding posts.

These volt-ammeters are of the permanent magnet type, and have a high electrical resistance. Louis M. Pignolet, manufacturer, 78 Cortlandt Street, New York.

TEMPERED COPPER CASTINGS.

For electrical work, the want of perfectly pure copper castings is much felt, and many inquiries have been made as to where pure copper and copper tempered with a small percentage of alloy or with phosphorous to an amount that will make it the best metal for electrical conductivity, and yet hard enough for the commutators of dynamos and electric motors, can be obtained.

Phosphor-copper and phosphor-copper alloys are largely coming into use for antifriction purposes, and for special parts in electrical work, where ductility, conductivity, and hardness are required, and can now be readily obtained.

There are two or three well-known old-established firms in this country now manufacturing copper castings, which, upon being analyzed, show themselves purer than commercial pig copper, as they subject the copper to a special refining process before it is cast.

These firms furnish tempered copper castings absolutely free from blowholes, and their castings upon examination are found to be stronger and tougher than ordinary pig copper, the crystals showing a harmonious union and entirely alike. They can be forged at certain heats and are very serviceable for antifriction purposes.

Tempered copper castings are manufactured by E. A. Williams & Son, 105 Plymouth Street, Jersey City, N. J.

AN AUTO-CYCLE CHEMICAL ENGINE.

The growth of invention of apparatus for "coping" with fire goes steadily on. With it has come the invention of the Dolfini Auto-Cycle Chemical Fire Engine.

In its construction it is made to resemble a double tandem bicycle, thus having four wheels and saddles for four riders; the application of each rider's propelling power is so placed that it makes such propulsion far easier than riding an ordinary bicycle; the inventor also places a motor on the engine which drives it at the maximum speed of 30 miles an hour, or on an average of 20 miles in the same time. The inventor in the construction of this motor has aimed at perfection and has used nothing but the highest grade of workmanship, regardless of expense; he has used the best carbon steel forgings, special iron and best quality of phosphor-bronze being used. It has simplicity, cleanliness and is almost noiseless in operation, while starting and regulating is easy and reliable. The electric ignition is perfect. The exhaust is carried off without odor; no flame is used, and the motor can be started instantly. So if the men fail, the motor can be depended upon. This harmonious combination of the two best known inventions of this present time, viz.: the bicycle and the automobile, was given the name Auto-Cycle Chemical Engine. The tank contains two substances, namely, an acid and sodium carbonate in water, which when brought into intimate mixture develop a gas called carbon dioxide, in the presence of which combustion is impossible. The pressure is developed by the gas and the solution is sent with great force to the desired location of the fire.

They are built by A. W. Dolfini & Co., 332 Classon Avenue, Brooklyn.

THE UPTON TRANSMISSION GEAR.

This transmission is especially designed to meet the requirements for connecting the engine (gasoline or steam) to the rear axle of the carriage, and while very neat and compact in form, is mechanically correct, giving a strong and efficient gearing that will positively do the work with very little appreciable wear. It is illustrated in Fig. 314.

From its external appearance it will be readily noted that the inner mechanism consists of a train or trains of spur gearing, and this in fact, is the case.

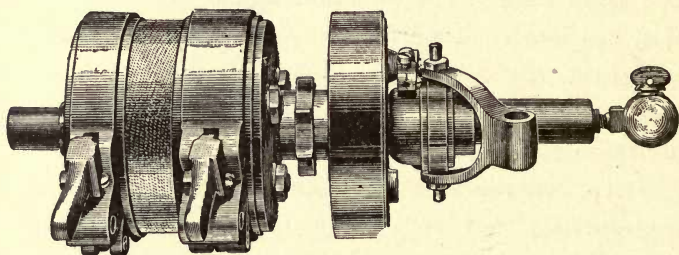


FIG. 314.—TRANSMISSION GEAR FOR AUTOMOBILES.

In the operation three band brakes and a friction clutch perform the different functions. By compressing the brake on the middle ring, the slow speed ahead is obtained. Throwing in the clutch at the right gives the fast speed. A brake applied to the single disk furnishes an emergency brake, should the ordinary brake fail to operate. A reverse movement to the sprocket is obtained by applying a brake to the left hand disk.

The positive performance of its different movements is, with this gearing, the object sought and obtained.

This transmission gear is made by the Upton Machine Co., No. 17 State Street, New York.

A MOISTURE-PROOF VENEER FOR VEHICLE BODIES.

Nothing adds so much to the finish and accepted appearance of a park carriage, a phaeton, or Victoria, as the application of natural wood surface to the panels or the dashboard, or of any part in which the wood grain can be developed with artistic effect. Heretofore veneering has not been successful because moisture from exposure and washing soon deteriorated and separated it from its backing. The difficulty has been obviated in a method of backing veneers of all the fancy woods by a special waterproof glue that resists the action of the weather and of washing processes, and brings veneered work to the front for ornamenting our finest carriages and automobile vehicles. This new phase in carriage building has been brought out by The Seguire-Axford Veneer Co., Jersey City, N. J., to whom we advise builders of automobiles to address for full information. The same company also manufactures automobile bodies to order.

THE BALL BEARING QUESTION.

In Fig. 315 we illustrate a ball bearing steering knuckle, and in Fig. 316 a wire wheel hub on the Baker ball bearing axle, with the steering knuckle also with ball bearings.

Manufactured by the United States Ball Bearing Co., Townsend Building, Broadway and Twenty-fifth Street, New York City.

In this age of horseless vehicles the question of ball bearings is one of great value, not only to the builders, but to the users of such vehicles.

No one doubts the value of a properly made and constructed ball bearing axle. Everybody recognizes that ball bearings greatly reduce the friction; greatly relieve one who owns or operates vehicles of much annoyance and trou-

ble; they greatly relieve horses from excessive draught; greatly curtail the expense of vehicles if propelled by either electricity, gasoline, or steam; greatly add to the riding comforts of a vehicle, and prolong the life of the same. It has remained, and to a certain extent still remains, for those who have gone into the question for the purpose and with the determination of learning just how a ball bearing axle should be made, and to ascertain what are the best mechanical principles upon which the same should be constructed in order to give to it antifriction qualities, durability, and sim-

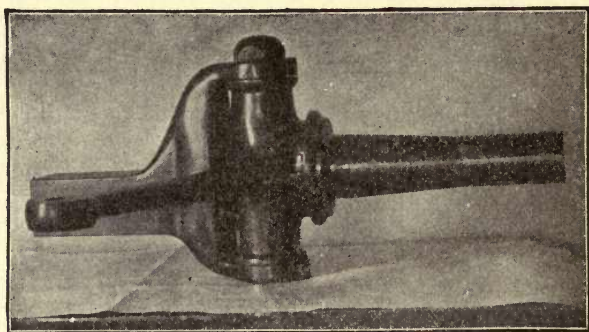


FIG. 315.—KNUCKLE JOINT AND AXLE.

plicity, to demonstrate that ball bearing axles are not only as practical on wagons designed and built for heavy weights as on vehicles for light weights, but productive of much greater results.

A ball bearing axle in which the cones and races are not ground and in which the balls are not absolutely uniform in roundness cannot be properly called an antifriction bearing. To be antifriction, these parts must be so smooth as to produce the least possible resistance. Grinding is the only process by which such surfaces can be obtained.

Ball bearing axles which have hollow or grooved cones

and hollow or grooved races (sometimes called ball cups) are much more objectionable than many imagine. Grooved cones and cups have a construction which prevents perfect rolling with the balls; the balls slip or slide over such grooved surfaces and the result is sliding friction. One would scarcely believe that there is so much less friction in a ball bearing with straight, slanting cones and right-angled races, or what is termed a three-point bearing, than there is in a ball bearing with grooved cones and cups.

With the balls confined upon straight slanting cones and in cups whose walls are at right angles to each other, the

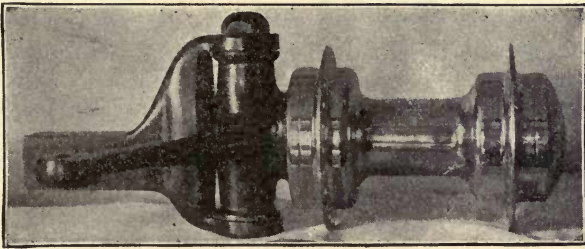


FIG. 316.—WHEEL HUB AND KNUCKLE.

balls touch at three points, each point being equidistant from the axis of the balls. In the three-point bearing the balls revolve at all times with the greatest facility, and sliding friction is eliminated.

It seems apparent that there is a great deal more friction in roller bearings and round grooved and annular grooved ball bearings than there is in a three-point ball bearing with straight slanting cones and cups with right angle walls.

Friction is a force which tells in mechanisms as well as in the economies of business. The object of any antifriction axle is to eliminate this friction as far as it is possible, and

one which fails to do this, whether it be ball or roller bearing, cannot properly be styled an antifriction bearing.

Men, when they use horses—while the horse should be considered just as much, if not more, than the mere question of dollars and cents—do not think or realize how much it is costing them to operate a vehicle without a properly constructed and made antifriction axle. But when they substitute either gasoline, electricity, or steam power for the horse, and they have to pay for every bit of power used to propel the vehicle, they will soon take notice of the force of friction in connection with their vehicle. When a man realizes that it is going to cost him more to propel his vehicle which has plain, ordinary axles, or an improperly constructed ball bearing or roller bearing axle, than it will if it had a properly constructed ball bearing axle, he is not going to hesitate as to which one of the vehicles he purchases.

Chapter XVIII.

LIST OF THE UNITED STATES PATENTS ON
AUTOMOBILES AND RUNNING GEAR.

CHAPTER XVIII.

PATENTS

Issued in the United States on Automobiles and Running Gear.

— 1856 —

Bradley, G., Driving Gear..... 16,044
Robinson, J., Steering Gear..... 15,820

— 1859 —

Bailey, J. H., Vehicle Gear..... 26,466

— 1860 —

Long, R. H., Steam Vehicle 26,911

— 1861 —

Fisher, J. K., Steam Vehicle.. 32,991

— 1864 —

Leky R. H., Motor Vehicle..... 42,203

— 1867 —

Hake, L. H., Motor Vehicle..... 62,264

— 1870 —

Sabin, I. A., Steam Vehicle.....104,888

— 1871 —

Craig, T., Motor Wheel115,786
McKinley, J. B., Motor Vehicle.....111,761

— 1872 —

Coe, L. W., Elec. Vehicle.....123,809

— 1873 —

Ball, D. H., Traction Engine.....130,997

— 1874 —

Cowles, E. P., Steering Gear.....154,846
Steel-Austin, Running Gear.....157,884

— 1875 —

Milliken, W. H., Motor Vehicle.....163,681

— 1876 —

Lauck, J. M., Steam Vehicle.....183,177
Stickney, A. B., Motor Wagon..... 178,809

— 1877 —

Cornish, B. F., Road Engine.....191,407
Carr, J. C., Road Engine.....195,702
Monnot, C. B., Motor Wheel.....197,485
Snyder, G. T., Road Engine.....197,423
Wade, J. W., Steam Wagon.....189,977

— 1878 —

Hicks, B. C., Road Engine.....206,176
Hussey, W. L., Road Engine.....207,524

— 1879 —

Harris, O. C., Steam Wagon.....222,352

— 1880 —

Clardy, J. W., Steam Wagon.....227,096

— 1881 —

Elfers, A. H., Steam Wagon.....244,117

— 1883 —

Finney, J. R., Elec. Vehicle.....270,186
Fox, E., Elec. Vehicle.....281,859
Freeman, I. S., Steam Vehicle.. . . . 282,299
Long, G. A., Steam Tricycle.....281,091
Woolsey, J. S., Steam Vehicle.....285,942
Young, F. E., Motor Tricycle282,022

— 1884 —

Troy, D. S., Pneumatic Vehicle.....300,290

— 1885 —

Troy, D. S., Exp. Motor Tricycle.....317,893

— 1886 —

Rogers, N., Motor Vehicle.....359,017
Russell, L. E., Motor Vehicle.....341,858
Self, W. R., Steam Vehicle.....345,327
Worrell, S. E., Steam Vehicle....346,974

— 1887 —

Ballard, J. H., Steam Vehicle.....365,788
Field, S. D., Electric Vehicle.....375,346
Tasker, S. P. M., Pneumatic Vehicle..364,450

— 1888 —

Benz, C., Motor Vehicle.....	{ 386,798
	{ 385,087
Daimler, G., Motor Vehicle.....	376,638
Faure, C. A., Elec. Vehicle.....	383,561
Knight, W. H., Elec. Vehicle.....	{ 382,990
	{ 383,229
Stevens, W. L., Elec. Vehicle.....	394,734

— 1889 —

Griscom, W. W., Elec. Vehicle.....	{ 406,833
	{ 408,231
	{ 408,232
Griscom, W. W., Vehicle Motor.....	408,233
Huntington, F. A., Motor Vehicle....	411,196
Main, W., Motor Vehicle.	{ 407,095
	{ 407,093
Peckham, E., Vehicle Gear	417,938
Perry, W. P., Elec. Velocipede.....	415,790
Potter, J., Vehicle Motor.....	408,430
Smith, H. B., Steam Tricycle	398,548

— 1890 —

Adair, J., Elec. Vehicle....	421,887
Grant, A. W., Vehicle Gear.....	429,681
Henderson, J. W., Elec. Vehicle.....	432,237
	{ 418,893
	{ 424,207
	{ 425,076
Hunter, R. M., Elec. Vehicle.....	{ 432,136
	{ 434,148
	{ 441,305
	{ 441,565
Ingraham, Elec. Vehicle.....	428,917
Jasper, W., Elec. Tricycle.....	426,384
Libbey, M. A., Motor Vehicle.....	438,010
Marshall, A. C., Steam Vehicle	438,168
Mather, A. C., Vehicle Motor.....	442,985
Overman, E. V., Vehicle Gear.....	420,606
Possons, N. S., Elec. Vehicle.....	434,949
Quinn, J. W., Motor Vehicle	431,993
Sperry, E. E., Speed Gear.....	{ 434,097
	{ 434,098
Wynne, F., Elec. Vehicle.....	419,094

— 1891 —

Dewey, M. W., Elec. Vehicle.....	{ 464,246
	{ 464,248
Libby, M. A., Vehicle Gear.....	447,616

— 1892 —

Gardner, F., Elec. Vehicle.....	473,871
Saubrey, G. G., Steam Vehicle.....	488,224

— 1893 —

Ames, A. C., Vehicle Gear..	500,544
Harris, W. T., Vehicle Motor.....	495,733
Luhrig, C., Motor Vehicle.....	502,443
Maybach, W., Motor Vehicle.....	494,641

Richmond, J. M., Steam Vehicle.....	495,709
Thorp, T. J., Motor Vehicle	495,531

— 1894 —

Farrell, W. P., Motor Vehicle..	513,773
Rand, A. C., Pneumatic Vehicle.....	530,550
Rodgers, J. H., Elec. Vehicle..	512,327

— 1895 —

Baker-Elberg, Elec. Vehicle.....	532,016
Best, A. W. J., Motor Vehicle.....	538,763
Clark, J. B., Elec. Vehicle..	537,673
Duryea, C. E., Motor Vehicle	540,648
Morris-Salom, Elec. Vehicle.....	541,001
Sheldon, H. F., Vehicle Gear.....	532,596
Tower, C. A., Vehicle Motor	535,605
Twombly, W. I., Vehicle Motor.....	542,319

— 1896 —

Barrows, C. H., Motor Vehicle.....	567,445
Capitaine, E., Motor Vehicle.....	572,498
Cook, J. M., Motor Vehicle.	569,175
De Dion-Bouton, Driving Gear	562,289
Delahunt, C., Motor Vehicle.....	568,431
Duryea, J. F., Motor Vehicle.....	572,051
Ellis-Stewart, Motor Gear.....	570,203
Goddard, C. J., Vehicle Motor.....	574,200
Grant, W. W., Motor Vehicle.....	552,757
Haviland, F. W., Driving Gear.....	{ 570,396
	{ 570,395
Kennedy, A. H., Motor Vehicle.....	561,997
Kulage, J. J., Motor Vehicle.....	573,334
Langer, G., Motor Vehicle.....	573,010
Mishel, M., Motor Vehicle..	569,343
	{ 571,392
	{ 570,952
	{ 571,447
	{ 570,440
Pennington, E. J., Motor Vehicle....	{ 570,441
	{ 574,262
Prouty, E., Speed Gear.....	570,501

— 1897 —

Baker, H. C., Motor Vehicle....	583,018
Barrows, C. H., Elec. Vehicle.....	592,682
Bird, H. R., Motor Vehicle.....	582,251
Bollée, Motor Vehicle.....	584,666
Brown, L., Motor Vehicle	577,716
Butler, W. A., Elec. Vehicle.....	574,388
Clapp, H. W., Motor Vehicle.....	577,185
Cross, E. D., Motor Vehicle.....	577,572
De Dion-Bouton, Diff. Gear	588,856
Duryea, J. F., Exp. Motor Vehicle.....	585,159
Duryea, J. F., Speed Gear.	586,084
Duryea, C. E., Motor Vehicle.....	588,103
Dutton, E. K., Speed Gear.....	587,714
Elston, R. W., Motor Vehicle.....	576,517
Evered, J. E., Motor Cycle..	576,439
Flucks, P., Motor Vehicle	589,710

Foye, G. W., Vehicle Motor.....	575,639
Gibbons, R. J., Motor Vehicle	581,816
Grant, A. W., Roller Bearings.....	583,050
Grenlich, G. H., Motor Vehicle.....	591,398
Gruber, F., Vehicle Motor.. ..	578,329
Hertel, M. E., Motor Vehicle.....	583,749
Kenna, T. M., Trolley Truck.....	587,738
Langer, G., Motor Vehicle.....	589,001
Lefroy, F. H., Change Gear.....	584,377
Libbey, H. W., Steam Bicycle.....	583,809
Maxim, H. P., Elec. Motor Vehicle.....	594,805
Meuman, H. G., Motor Vehicle.....	589,531
Morris-Salom, Elec. Vehicle.....	{ 578,651 579,890
Mueller, H., Motor Vehicle.....	582,530
Mueller, H., Motor Cycle.....	583,500
Peck, B. L., Motor Vehicle.....	595,203
Pennington, E. J., Motor Bicycle.....	574,818
Plass, R. H., Motor Vehicle.....	583,154
Praullette-Catois, Motor Vehicle.....	584,127
Rüb, L., Motor Cycle.....	576,158
Spaulding, H. C., Motor Vehicle.....	596,281
Stewart, R. F., Speed Gear.....	554,319
Stock, G. M., Vehicle Motor.....	584,169
Trotter, J. M., Vehicle Motor.....	592,674
Woods, C. E., Elec. Vehicle.....	585,371

— 1898 —

Altham, G. J., Steering Gear.....	614,781
Bird, H. R., Motor Vehicle.. ..	605,243
Bollée, L., Motor Vehicle.	601,545
Brightmore, A. W., Steering Gear.	609,955
Capewell, G. J., Vehicle Gear.....	612,822
Clarke, L. S., Motor Vehicle	602,283
Clark-Morgan-Gordon, M. Tricycle.....	602,283
Clough, J., Speed Gear.....	615,430
Clubbe-Southey, Steering Gear.....	612,017
Crowdus, W. A., Motor Vehicle.....	598,314
Duryea, J. F., Expl. Motor.....	605,815
Eisenhuth, J. W., Motor Vehicle.....	612,026
Gaertner, R., Motor Gear	610,177
Gerard, L. L. H., Speed Gear.....	610,178
Gillingier, J. J., Traction Wheel.....	615,157
Grant, W. W., Vehicle Gear.....	602,621
Haynes-Apperson, Motor Vehicle.....	607,116
Hildebrandt, C. T., Vehicle Gear.	604,754
Hildebrandt, C. T., Motor Vehicle.....	613,272
Hill, G. H., Motor Vehicle.....	601,205
Holmes, B., Motor Vehicle.....	601,440
Johnson, C. M., Motor Vehicle	609,811
Knudson, K., Vehicle Frame.....	611,258
Knudson, K., Elec. Vehicle	613,420
Krieger, L., Elec. Vehicle.....	607,997
Larue, C., Driving Gear	607,443
Lewis, G. W., Motor Vehicle.....	604,237
Lewis, G. W., Vehicle Motor.....	{ 604,332 609,443
Lindsay, T. J., Motor Vehicle.....	612,360
Lufbery, C. E., Speed Gear.....	601,731

Millot, J., Motor Gear.....	615,360
Millot, J., Speed Gear	615,360
Morris, H. G., Elec. Vehicle.....	603,198
Pender, J., Motor Vehicle.....	601,274
Pickering, W. H., Motor Vehicle.....	603,047
Pretot, V. E., Exp. Motor Vehicle.....	610,460
Reichel, E. B. W., Vehicle Gear.....	613,018
Reuter, J. C., Motor Vehicle.....	612,506
Kiker, A. L., Elec. Motor.....	604,842
Smith, H., Motor Vehicle.....	616,267
Smith, M. H., Steering Handle.....	610,871
Southey, A. W., Steering Gear.....	613,399
Sperry, E. A., Motor Vehicle.....	616,153
Sydenham, W., Vehicle Gear.....	606,311
Twitchell, W. E., Motor Vehicle.....	610,503
Wattles, L. B., Motor Cycle.....	597,042
Whitney, G. E., Expl. Motor.....	601,218
Winton, A., Expl. Motor.....	{ 600,819 598,832
Winton, A., Motor Vehicle.....	610,465
Winton, A., Motor Vehicle.....	610,466
Worth, W. O., Motor Vehicle.....	607,318

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Almond, T. R., Burner.....	639,490
Anderson, B. C. J., Carbureter.....	637,062
Anderson, J. C., Vehicle Wheel.....	637,691
Ayers, S. A., Carbureter.....	632,509
Barr, W. C., Motor Vehicle.....	618,244
Benier, L., Motor Vehicle.....	618,637
Birrell, G. B., Vehicle Gear.....	{ 627,383 627,382
Brewer, W. J., Motor Vehicle.....	621,483
Brown, L., Steering Gear	626,483
Burger, F., Brake.....	624,451
Burger, F., Exp. Motor.....	632,913
Camp, T. L., Fifth Wheel.....	623,651
Canda, F. E., Carbureter.....	635,298
Canellopoulos, J., Steering Gear.....	635,654
Carmont, W. E., Resilient Hub.....	635,231
Casgrain, H. E., Carbureter	633,800
Chauveau, G. V. L., Motor Vehicle.....	627,842
Conti, J. F. T., Motor Fore Carriage....	629,064
Cook, W., Trans. Gear.....	626,967
Craig, J., Jr., Speed Gear	633,687
Daly, R. F., Diff. Gear.....	624,186
Des Granges, J. C., Speed Gear.....	637,202
Dion-Bouton, Vehicle Motor.....	617,984
Dissosway, C. M. Motor Vehicle.....	633,283
Draullette-Catois, Speed Gear.....	633,234
Dyer, F. L., Motor Vehicle.....	639,541
Eastman, H. F., Vehicle Frame.....	639,976
Eisenhuth, J. W., Expl. Motor.....	{ 620,431 620,554
Eisenhuth, J. W., Running Gear.....	631,627
Eisenhuth, J. W., Speed Gear.....	617,647
Entz, T. B., Elec. Vehicle.....	{ 636,965 636,964
Fessard, E., Expl. Motor.....	639,160

Field, T. C., Speed Gear.....	639,548	Pocock, F. A., Motor Vehicle.....	623,383
Forbes, J. N., Motor Vehicle.....	624,319	Pond, S. N., Expl. Motor.....	633,484
Gibbs, W. E., Clutch.....	634,292	Raders, J. F., Motor Bicycle.....	626,440
Glazier, J. L., Motor Vehicle.....	617,332	Reed, G. F., Motor Vehicle.....	637,665
Grant, W. W., Motor Vehicle.....	638,331	Reichel, E. B. W., Elec. Controller.....	624,250
Gunderson, G. J., Fric. Clutch.....	635,477	Revel, L. L., Vehicle Motor.....	625,416
Hampson, F. G., Speed Gear.....	624,017	Riker, A. L., Elec. Vehicle.....	620,968
Hart, H. C., Motor Vehicle.....	623,149	Riker, A. L., Elec. Motor Vehicle.....	623,037
Hertel, M. E., Motor Valve.....	639,385	Riotte, C. C., Vaporizer.....	633,274
Herschman, A., Fric. Clutch.....	635,684	Roby, G. L., Motor Vehicle.....	619,505
Heyman, F. W., Vehicle Frame.....	639,054	Roe-Knight, Speed Gear.....	625,808
Hirsch, F. C., Motor Vehicle.....	639,237	Sangster, C. T. B., Motor Tricycle.....	632,474
Humphrey, J. D., Motor Vehicle.....	627,503	Schellenbach, W. L., Speed Gear....	638,359
Hunter, R. M., Elec. Vehicle.....	{ 625,953 629,079	Schneider, F. W., Elec. Vehicle.....	617,192
Inman, E. R., Carbureter.....	{ 633,319 633,320	Schnepf, J., Bicycle Motor.....	627,066
Jamieson, R. W., Running Gear....	636,999	Schultze, W. C., Motor Vehicle.....	635,603
Joel, H. F., Vehicle Frame.....	625,772	Schuyler, W. S., Motor Vehicle....	624,689
Kempshall, E., Tire.....	639,399	Secor, J. A., Regulator Expl. Eng....	623,567
Knuksen, K., Elec. Vehicle (reissue)...	11,724	Sedgwick, I., Traction Engine.....	621,158
Korsmeyer, E. H., Expl. Motor.....	636,049	Serpollet, L., Expl. Motor.....	{ 629,398 629,399
Korsmeyer, E. H., Motor Vehicle.....	636,948	Sieg, G. E., Driving Gear.....	638,816
Krieger, L., Elec. Wiring (reissue)....	11,780	Simms, F. R., Expl. Motor.....	617,660
Krieger, L., Motor Vehicle.....	633,763	Smith, H., Exp. Motor.....	{ 632,763 632,762
Krotz, A. S., Motor Vehicle.....	621,684	Smyser, I. B., Speed Gear.....	617,819
Lawson, H. J., Motor Vehicle.....	633,014	Sperry, E. A., Elec. Controller.....	{ 635,816 635,815
Leitner, H., Elec. Controller.....	632,874	Steele, H. B., Motor Bicycle.....	627,359
Lewis, G. W., Expl. Motor.....	{ 620,941 621,110	Sterling, C., Motor Vehicle.....	618,915
Lewis, T. C., Carbureter.....	633,287	Stewart, A. C., Motor Vehicle.....	633,665
Lucas, R., Speed Gear.....	639,256	Stoddard, E. J., Vehicle Motor.....	{ 623,224 623,190
McAneely, M. F., Motor Vehicle.....	620,166	Stommel, H., Motor Vehicle.....	626,735
McDougall, W. M., Elec. Vehicle.....	627,123	Strong, G. S., Clutch.....	631,831
McInerney, B., Elec. Igniter.....	638,933	Strong, G. S., Hub Pivot Wheel.....	636,012
Mathieu, L., Speed Gear.....	635,171	Strong, G. S., Sparking Device.....	637,302
Maxim, H. P., Exp. Motor.....	620,602	Strong, G. S., Expl. Motor.....	637,298
Maxim-Pope-Alden, Gear.....	621,532	Strong, G. S., Trans. Gear.....	637,297
Metz, C. H., Diff. Gear.....	624,519	Strong, G. S., Running Gear.....	637,296
Newman, C. E., Motor Vehicle.....	630,032	Strong, G. S., Crank Shaft.....	637,300
Newman, W. H., Speed Gear.....	637,477	Strong, G. S., Vaporizer.....	637,299
Norris, A. E., Driving Gear.....	638,184	Struss, H. W., Speed Gear.....	621,436
O'Donnell, M. J., Motor Vehicle.....	637,015	Stutzman, F., Traction Eng.....	622,729
Ogden, J. W., Motor Vehicle.....	637,750	Stutzman, F., Reversing Gear.....	{ 630,470 630,471
Olds, R. E., Elec. Igniter.....	635,506	Torbensen, V. V., Clutch Gear.....	632,866
Paget, A., Motor Vehicle.....	627,201	Twitchell, W. E., Driving Gear....	627,282
Parks, A. F., Exp. Motor.....	639,686	Underwood, H. G., Steering Gear....	634,514
Patin, O., Elec. Vehicle.....	623,820	Van Hoevenbergh, H., Elec. Vehicle..	628,967
Pender, J., Motor Vehicle.....	637,658	Walters, J. W., Motor Wheel.....	{ 624,414 635,620
Pennington, E. J., Motor Bicycle....	{ 626,295 626,294	Warren, J. H., Steering Gear.....	634,597
Pennington, E. J., Steering Gear....	626,296	Whitcomb, G. A., Expl. Motor.....	634,654
Pennington, E. J., Motor Vehicle.....	627,523	Winton A., Expl. Motor.....	617,978
Pettee-McCutchan, Comp. Air Motor..	638,660	Winton, A., Expl. Mot. and Regul'or..	{ 626,120 626,121 626,122
Phelps, L. J., Motor Vehicle.....	629,521		
	{ 631,438 631,437 634,067 632,278		

Wintzel-Whitney, Running Gear.....636,701
Woods, C. E., Elec. Motor Vehicle.....619,527
Woods, C. E., Elec. Controller.....620,628
Wynne, W. R., Elec. Controller631,917
Wynne, W. R., Signal Apparatus.....631,917

Hunt, C. W., Vehicle Gear.....	641,514
Ingalls, A. T., Fuel Burner.....	641,776
Jones, L., Igniter.....	645,398
Kope, W. A., Expl. Motor.....	642,043
Leitner, H., Accumulator.....	645,478
Lewis, G. W., Expl. Motor.....	640,393
Macey, F. J., Expl. Motor.....	643,513
Malcomson, T., Expl. Motor.....	642,143
Martin, A. J., Motor Vehicle.....	641,313
Maxim, H. P., Elec. Indicator.....	640,787
Mongredien, C. A. A., Vehicle.....	641,878
New, A. G., Heavy Oil Motor.....	642,871
Osburn, H. E., Storage Battery.....	644,144
Otto, A. T., Expl. Motor.....	645,044
Pearson, W. E., Vehicle Gear.....	641,004
Perkins, W. J., Elec. Igniter.....	643,002
Probert, H. F., Vaporizer.....	642,562
Schen, W., Vehicle.....	645,272
Schnoar, P. J. A., Gear.....	641,043
Simms, F. R., Spark Plug.....	642,167
Sintz, C., Expl. Motor.....	646,322
Sperry, E. A., Elec. Vehicle.....	640,968
Sperry, E. A., Motor Vehicle.....	{ 643,257 643,258
Sperry, E. A., Motor Gear.....	645,902
Sperry, E. A., V Brake.....	645,903
Sperry, E. A., Wagon Gear.....	645,081
Stommel, H., Motor Vehicle.....	645,497
Thornton & Lea, Expl. Motor.....	644,951
Thornton & Lea, Vehicle.....	644,950
Underwood, W. H., Vehicle.....	644,113
Whitney, G. E., Motor Vehicle.....	642,771
Whitney-Howard, Steam Vehicle.....	642,943
Whittlesey, J. T., Elec. Motor.....	643,854
Worth, W. O., Vehicle Frame (design). 3,199	
Worth, W. O., Motor Vehicle.....	645,378

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Anderson, J. C., Wheel.....	642,777
Baines, W., Vaporizer.....	644,027
Baines, W., Vehicle Gear.....	640,522
Bink, A., Motor Vehicle.....	644,843
Blackden, P. D., Brake.....	645,926
Bleveney, J. C., Pr. Trans..	643,627
Brunler, O., Fuel Burners.....	641,369
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Bullard, J. H., Motor Gear.....	641,834
Burrows, C. G., Controller.....	643,865
Charon, L., Oil Motor.....	645,458
Cruntz, H. F., Elec. Indicator.....	640,753
De Dion & Bouton, Fr. Clutch.....	645,312
Drawbaugh, D., Spark Gener.....	643,087
Duryea, J. F., Expl. Motor.....	646 399
Dyer, L. H., Gearing.....	643,505
Elsner, H. J., Motor Vehicle.....	644,225
Fahl, E., Motor Vehicle.....	644,853
Finlay, R. H. & A. H., Gear.....	642,594
Franz, H. A., Motor Vehicle.....	644,590
Frith, A. J., Exp. Motor.....	644,798
Godding, M. O., Burner.....	646,386
Gray, E. F. Gearing.....	641,204
Harris, C. R., Vehicle Body Design.....	32,198
Headech, E. T., Exp. Motor.....	646,282
Heermaus, T. W., Pr. Trans.....	643,130
Heggem, C. O., Motor Vehicle.....	644,598
Hildebrandt, C. T., Gear.....	641,511

Chapter XIX.

LIST OF MANUFACTURERS OF AUTOMOBILES
IN THE UNITED STATES, WITH
THEIR ADDRESSES.

CHAPTER XIX.

LIST OF AUTOMOBILE MANUFACTURERS IN THE UNITED STATES, WITH THEIR ADDRESSES.

California.

J. C. Baker.....Oakland
Oakland Iron Works.....Oakland
Steffy Mfg. Co., 1313 Fourth St.San Diego
A. D. Stealey, 450 Main St.....San Francisco
The Best Mfg. Co.San Leandro

Connecticut.

H. A. House.....Bridgeport
National Bicycle and Motor Co., Bridgeport
Columbia Motor and Mfg. Co.Hartford
Columbia and Elec. Vehicle
Co., 1 Laurel St.Hartford
Director Wagon Co.Hartford
Seery Steam Carriage Co.....Hartford
Palmer Gasoline Engine Co., Mianus
Keating Wheel and Autom-
obile Co.....Middletown
L. J. Aubrey Carriage Co.,New Haven
Denison Elec. Engineering Co.,
106 Park St.....New Haven
Denison Motor Wagon Co.,New Haven
Henry W. Clapp.....New Haven
Hay and Hotchkiss Co.,New Haven
Geometric Drill Co.,Westville
Eddy Elec. Mfg. Co.,Windsor

Delaware.

American Elec. Mfg. & Power
Co.....Dover
Beacon Motor Traction Co.,Dover
United States Vehicle Co.,Dover

Illinois.

American Elec. Vehicle Co.,
1545 Michigan Ave.,Chicago
A. W. King.....Chicago
Arnold Schwimm & Co.Chicago
Bond C. Hico, Howard Ave.,
Englewood.....Chicago
Carlisle Mfg. Co., 69 Jackson St., Chicago

Chicago Elec. Vehicle Co., 204
Dearborn St.....Chicago
Chicago Motor Vehicle Co., 345
Wabash Ave.....Chicago
Elgin Automobile Co., 325 Wa-
bash Ave.....Chicago
Hartford Power and Supply Co., Chicago
Hartley Power and Supply Co., Chicago
Illinois Elec. Vehicle and Trans.
Co., 1215 Monadnock Bldg., Chicago
G. W. Lewis.....Chicago
McMullen Mfg. Co., 70 W. Jack-
son Boule.Chicago
Roe Motor Cycle Co.,Chicago
Siemens and Halske Elec. Co., Chicago
The Fisher Equipment Co., 20th
St. and Mich. Ave.,Chicago
Woods Motor Vehicle Co., 340
Dearborn St.,Chicago
H. Mueller Mfg. Co.,Decatur
H. H. Brown Automobile Co., Elgin
Duryea Motor Mfg. Co.,Peoria
Peoria Rubber Mfg. Co.,Peoria
Chester Gas Engine Co.,Sterling

Indiana.

Roach & Albanus Co., 11 Clay St., Fort Wayne
C. B. Black Mfg. Co.,Indianapolis
Hearsey Horseless Vehicle Co., Indianapolis
Indianaapolis Transfer Co., 215 N.
Delaware St.,Indianapolis
Indiana Bicycle Co.,Indianapolis
Parry Mfg. Co.,Indianapolis
Haynes-Apperson Co.,Kokomo
Munson Electric Motor Co., La Porte
Studebaker Bros.,South Bend
Terre Haute Carriage and Buggy
Co.,Terre Haute

Iowa.

Burg Wagon Co.,Burlington

Kentucky.

Louisville Carriage Co. Louisville
 Louisville Motor Vehicle Co. Louisville

Maine.

U. S. Motor Carriage Co. Andover
 Rand & Harvey Lewiston
 American Automobile Co. Portland
 Belknap Motor Co. Portland

Maryland.

Baltimore Auto. Mfg. Co. Baltimore

Massachusetts.

Amesbury Auto. Co., 71 Elm St. Amesbury
 Carriage Mach. Co., 87 Elm St. Amesbury
 Altham International Motor Co. Boston
 American Rotary Engine Co., 113
 Devonshire St. Boston
 Anderson Mfg. Co., 289 A St.,
 South. Boston
 Cummings Auto. Co., 257 Washing-
 ton St. Boston
 Back Bay Cycle and Motor Co., 121
 Mass. Ave. Boston
 Bay State Auto. and Engine Co.,
 7 Exchange Place. Boston
 Beacon Motor Traction Co., 206
 Exchange Bldg. Boston
 Colonial Auto. Co., 32 Hawley St. Boston
 A. M. Cummings, 257 Washington !
 St. Boston
 Cunningham Engineering Co., 73
 Tremont St. Boston
 Edw. S. Clark, 272 Freeport St. Boston
 Equitable Auto. & Truck Co. Boston
 Graham Equipment Co., 170
 Summer St. Boston
 International Auto. and Vehicle
 Co. Boston
 Liquid Air Power and Auto. Co.,
 186 Devonshire St. Boston
 W. T. McCullough Auto. Co., 121
 Mass. Ave. Boston
 Motor and Carriage Co. Boston
 New England Elec. Vehicle and
 Trans. Co., 53 State St. Boston
 New England Motor Cycle Co. Boston
 New Era Motor Co. Boston
 Stanley Mfg. Co. Boston
 Strathmore Auto. Co., Albion
 Bldg. Boston
 The Turbine Motor and Car-
 riage Co., 7 Exchange Pl. Boston
 Standard Motor Carriage Co. Braintree
 Motor Carriage Co., 107 Main St. Brockton
 Marsh Motor Carriage Co. Brockton
 Haltzer-Cabot Elec. Co. Brookline
 Pilgrim Motor Vehicle Co. Cambridge

Overman Wheel Co. Chicopee Falls
 Crest Mfg. Co. Dorchester
 Whitney Motor Wagon Co. East Boston
 Leach Motor Vehicle Co., 210
 Broadway. Everett
 Oakman Motor Co. Greenfield
 Chas. R. Grenter, Columbia
 Stoker Works. Holyoke
 Mass. Motor Vehicle Co. Holyoke
 Holyoke Motor Works Co. Holyoke
 Branwell-Robinson Co. Hyde Park
 Stanley Mfg. Co. Lawrence
 General Elec. Co. Lynn
 Heyman Motor Vehicle Co. Melrose
 American Motor Carriage Co.,
 Glen Ave. Newton Center
 F. E. Stanley. Newton
 Wm. G. Clark, 23 Chester St. No. Cambridge
 G. A. Whitcomb. Natick
 Grout Bros. Machine Co. Orange
 Chapman & Sons Mfg. Co. Staughton
 Pilgrim Motor and Vehicle Co. Somerville
 Duryea Mfg. Co. Springfield
 Hilsdale Smith. Springfield
 Fred. C. Wright & Co. Springfield
 New England Motor Carriage
 Co. Waltham
 Waltham Mfg. Co. Waltham
 Piper & Tinker. Waltham
 American Wheelock En. Co. Worcester
 J. C. Wood, 3 School St. Worcester

Michigan.

English Automobile Co. Benton Harbor
 Dealers Vehicle Co. Detroit
 Detroit Automobile Co. Detroit
 Detroit Horseless Carriage Co. Detroit
 Fisher Elec. Mfg. Co. Detroit
 Hart & Co., Ltd. Detroit
 Still Motor Co., 707 Chamber
 of Commerce. Detroit
 Sintz Gas Engine Co. Grand Rapids
 Wolverine Motor Works Grand Rapids
 Olds Motor Works Lansing
 Standard Novelty Co. Port Huron
 A. H. Herring. St. Joseph

Missouri.

Miss. Valley Auto. Trans. Co. East St. Louis
 W. J. Staples, 105 W. Main St. Marysville
 Erie Cycle and Motor Carriage
 Co. St. Louis
 National Auto. Co., 714 Chest-
 nut St. St. Louis
 National Motor Co., 1909 Lo-
 cust St. St. Louis
 St. Louis Gasoline Motor Co.,
 822 Clark Ave. St. Louis
 Wagner Elec. Mfg. Co. St. Louis

Nebraska.

Omaha Gas Engine Works..Omaha
Omaha Gas Engine and Motor Co.....Omaha

New Jersey.

Atlantic Elec. Vehicle Co...Camden
Evans Pneumatic Motor Co.,
126 Market St..... Camden
Gen'l Carriage Co., Care
Guarantee and Trust Co..Camden
Tractor Truck and Auto. Co.Camden
The Canda Mfg. Co.....Cartaret
Riker Elec. Vehicle Co.....Elizabethport
Ascot Vehicle Co., 1 Montgomery St..... Jersey City
Messerer Auto. Co., 15
Springfield Ave.....Newark
Smith Motor Co., 54 Morris
and Essex Railroad Ave.Newark
U. S. Standard Motor Vehicle Co., 22 Clinton St.....Newark
The Voght Auto. Co., 105
Plain St. Newark
John C. Blednay, 132 Orange
St. Newark
The Quick Mfg. Co.....Paterson
Union Transit Co., 30 Hamilton St Paterson
Percy C. Ohl..... Plainfield

New York.

Binghamton Gas Engine Co Binghamton
Groef Motor Co. Brooklyn
Maltbey Auto. Co., 12 Clinton St. Brooklyn
Krajerowski Peasant & Co.,
Erie Basin Iron Works..Brooklyn
The Perrett Storage Bat. Co.,
Anhauser-Busch Bldg...Brooklyn
W. G. Stolz, 736 Grand St...Brooklyn
Buffalo Spring and Gear Co.,
1520 Niagara St. Buffalo
Kensington Bicycle Mfg. Co.Buffalo
Natl. Motor Transit Co.....Buffalo
Hunter Gun and Cycle Wks.Fulton
Geneva Wagon Co. Geneva
Horseless Wagon Co. Jamaica
Daimler Motor Co..... Long Island City
Harry Gosper.. Mumford
American Motor Co., 32
Broadway New York
Anglo-American Rapid Vehicle Co., 20 Broad St... New York
American Liquid Air Co., 1
Broadway New York
Auto. Air Carriage Co.....New York
American Electric Vehicle
Co., 134 W. 38th St.....New York

Auto. Co. of America, 32 Broadway..... New York
Auto. Acetylene Co., 15 Park
Row.. New York
Burr & Co..... New York
Balzer Motor Carriage Co., 370
Girard Avenue..... New York
Columbia and Elec. Vehicle
Co., 100 Broadway..... New York
De La Vergne Refrigerating
Co. New York
Deuison Motor Wagon Co..... New York
Elec. Vehicle Co., 1634 Broadway..... New York
J. W. Eisenhuth, 40 Wall St....New York
G. Edgar Allen, 302 W. 53d St..New York
Hasbrouck Motor Co., 20 Nassau St. New York
Industrial Invest. and Develop.
Co., 1123 Broadway..... New York
International Power Co., 253
Broadway New York
International Motor Vehicle
Co., 2158 Broadway New York
Judd Comisky Motor Vehicle
Co., 1724 Broadway.....New York
Lancamobile Co. of America, 11
Broadway New York
N. Y. Elec. Vehicle Trans. Co.,
1634 Broadway..... New York
N. Y. Auto Truck Co., 253
Broadway & 541 Fifth Ave..New York
The General Power Co., 100
William St..... New York
Pneumatic Carriage Co., 253
Broadway..... New York
Strong Motor Co., 32 Broadway..... New York
The Fore Carriage Co., 25 W.
33d St New York
The Elec. Undertakings Co.,
Ltd., 52 Broadway... .. New York
The Canda Mfg. Co., 11 Pine
St. New York
U. S. Vehicle Co., 1123 Broadway..... New York
International Motor Wheel Co.,
302 W. 53d St. New York
Fredk. E. Wood & Son, 219 W.
19th St New York
The Trenton Auto. Co., Eighth
Ave. and 49th St New York
The Safety Three Wheel and
Vehicle Co., 228 E. 63d St. New York
Geo. T. Hanchett, 123 Liberty
St New York
L. J. Wing, 97 Liberty St..... New York
J. H. Lancaster Co., 97 Liberty
St. New York

American Auto. Co., 35 and
37 Nassau St.....New York
Traffic Cycle Co., 944 Eighth
Ave.....New York
English Auto. and Motor
Co., 35 Broadway.....New York
American Motor and Vehi-
cle Co., 145 Broadway....New York
Niagara Auto. Co.....Niagara
English Motor and Auto.
Works,Oakfield
Rochester Elec. Motor Co., Rochester
John B. West, 105 Meigs St., Rochester
Saul & Van Wagoner,Syracuse
John M. Walshe, Mgr., 117
N. Warren St.....Syracuse
Syracuse Auto. Co.....Syracuse
C. E. Tower,Syracuse
E. C. Stearns & Co.,Syracuse
Mobile Co. of America (180
Times Bldg., N. Y.).Syracuse

Ohio.

The Diamond Rubber Tire
Co.,Akron
Bullock Elec. Co.,Cincinnati
Chas. Eckert,Cincinnati
Smith-Eggers Co., 6th and
Sycamore Sts.Cincinnati
Auto. Carriage Supply Co.,
411 Euclid Ave.,Cleveland
Cleveland Electric Co.,Cleveland
Cleveland Auto. Co.,Cleveland
Cleveland Machine Screw
Co.,Cleveland
Wm. G. Hoffman, 79 Bolivar
St.,Cleveland
Phoenix Motor Vehicle Co.,
172 E. Prospect St.,Cleveland
Elmer A. Sperry,Cleveland
Twentieth Century Auto. Co., Cleveland
Poste Bros. Buggy Co.,Columbus
Reive-Thompson Motor Co., Columbus
Meeker Mfg. Co.,Dayton
The Advance Mfg. Co., Vine
and 4th Sts.,Hamilton
Lorain Motor Carriage Co., Lorain
Richland Buggy Co.,Mansfield
M. Russell & Co.,Massillon
John F. Byers Mch. Co.,Ravenna
O. S. Kelly,Springfield
Lozier & Co.,Toledo

Geo. R. Burwell,Toledo
Toledo Steam and Air Motor
Co.,Toledo

Pennsylvania.

Elec. Storage Battery Co., 19th
and Allegheny Ave.,Philadelphia
General Elec. Auto. Co., Bourse
Bldg.,Philadelphia
Lewis Motor Vehicle Co., Room
439, Drexel Bldg,Philadelphia
Morris & Salem,Philadelphia
Amer. Elec. Mfg. and Power
Co., 20th and Wash. Ave.,Philadelphia
Oakman Motor Vehicle Co.,
Broad and Chestnut Sts.,Philadelphia
Penn. Elec. Vehicle and Trans.
Co.,Philadelphia
Philadelphia Motor Wagon Co., Philadelphia
Schwarz Auto. and Carriage Co.,
317 N. Broad St,Philadelphia
Standard Auto. Co., 1218 Betz
Bldg.,Philadelphia
Auto. Car Co.,Pittsburg
Pittsburg Motor Vehicle Co.,Pittsburg
Lancaster Motor Co.,Pittsburg
Twyford Vehicle Co.,Pittsburg
U. S. Motor Co.,Pittsburg
Seely Mfg. Co., 8 Beatty St.,Pittsburg
The Collins Elec. Vehicle Co.,Scranton

Rhode Island.

Baldwin Auto. Co.,Providence
R. I. Auto. Transit Co.,Providence
R. I. Auto. Truck Co.,Providence

Tennessee.

Harding Mfg. Co.,Nashville

Virginia.

Columbia Motor Mfg. Co.,Alexandria
Washington Auto. Co.,Alexandria

West Virginia.

Pioneer Iron Works, A. C. Os-
born, Prop.,Clarksburg

Wisconsin.

C. H. Seig Mfg. Co.,Kenosha
Milwaukee Auto. Mfg. Co.,Milwaukee
Wisconsin Auto. and Mach. Co., Milwaukee

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"Clement".....	224
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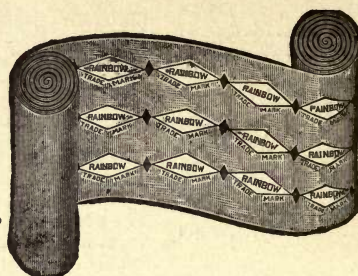
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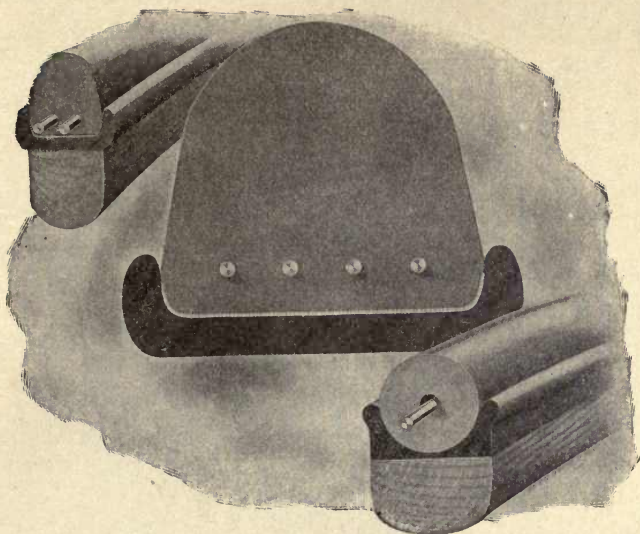
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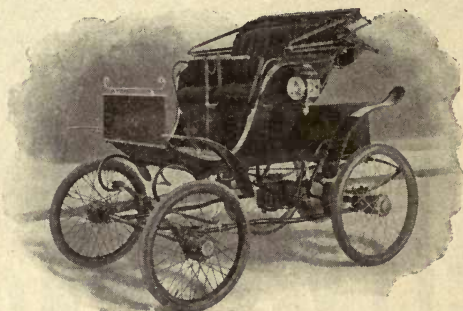
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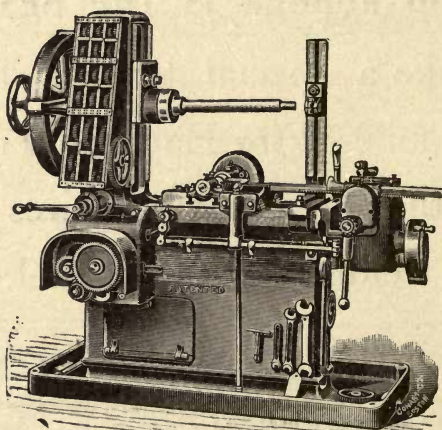
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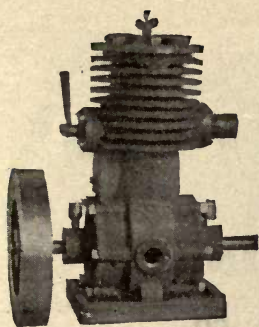
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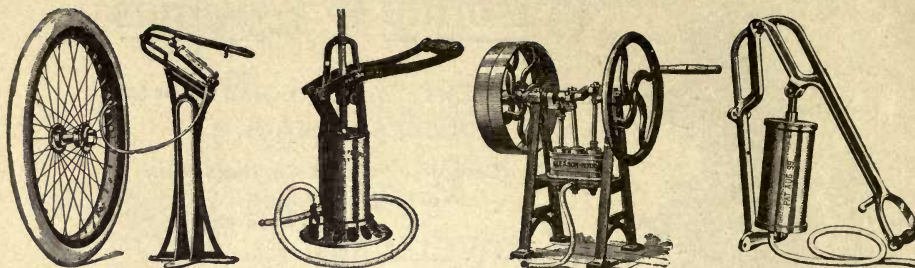
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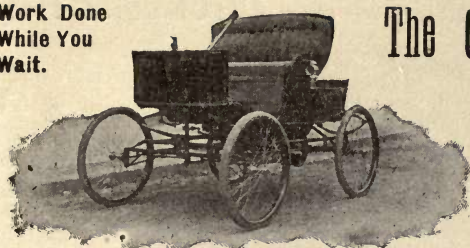
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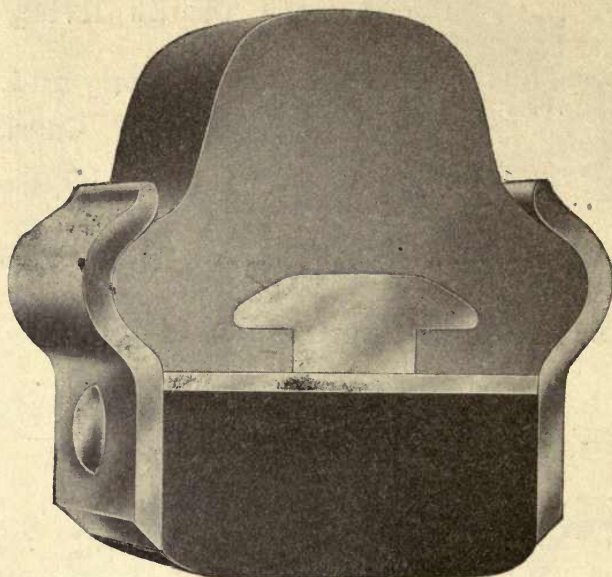


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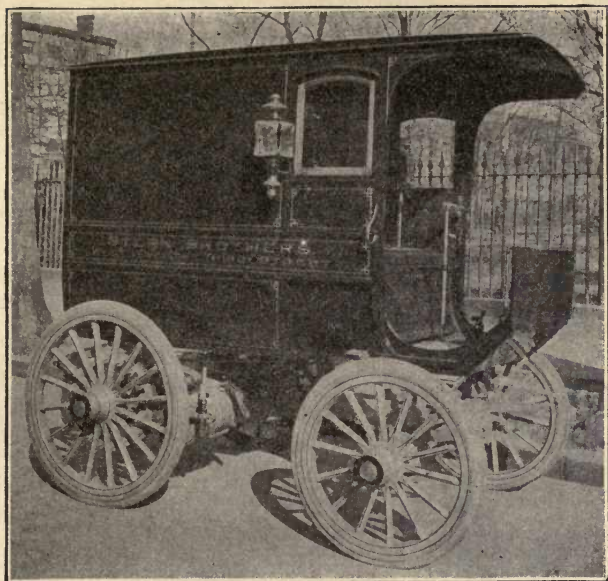
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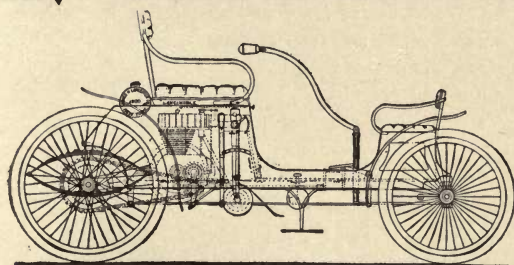


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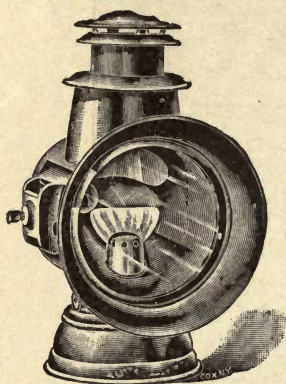
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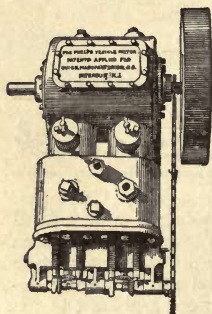
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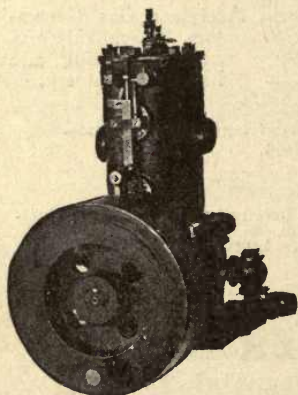
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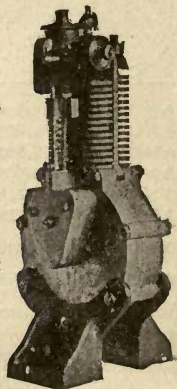
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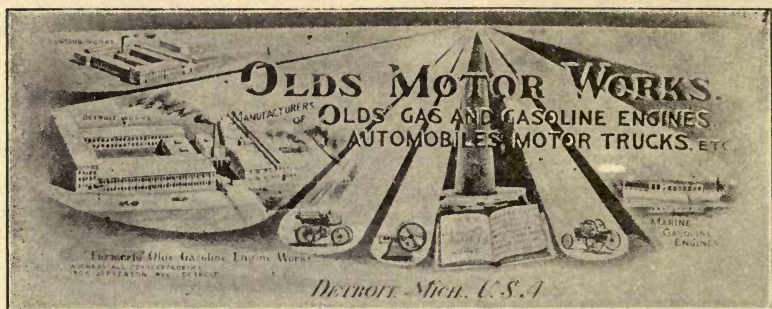
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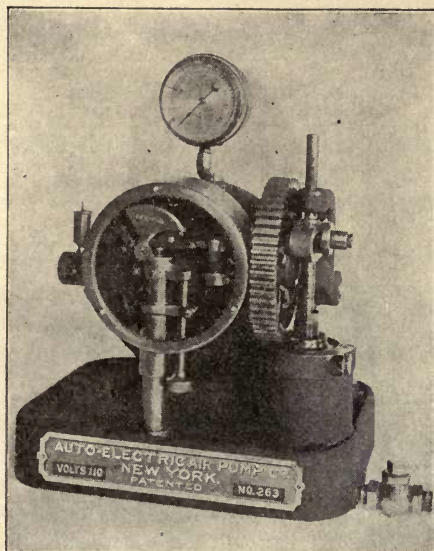
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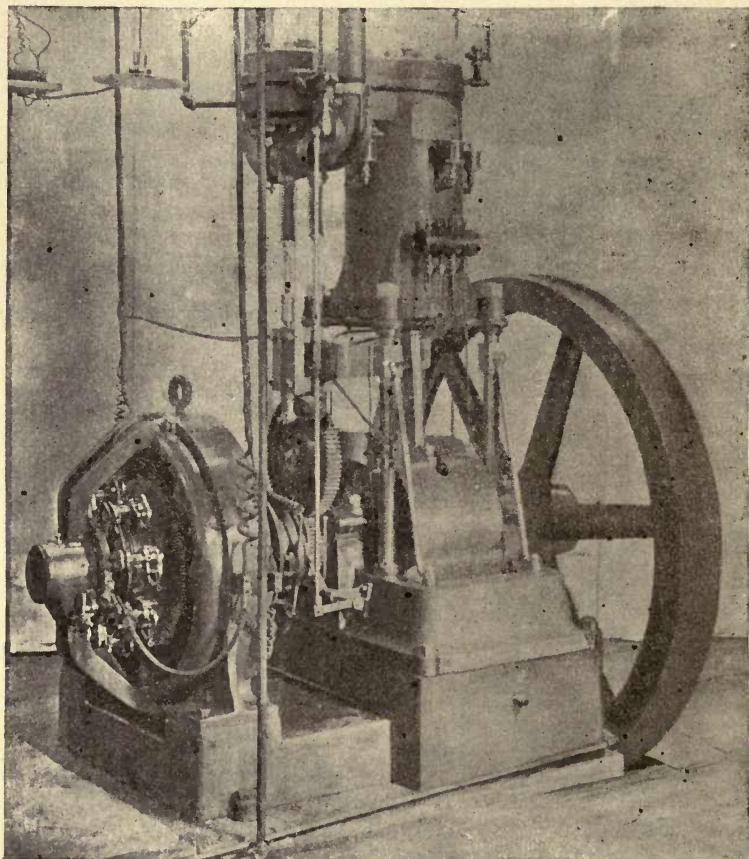
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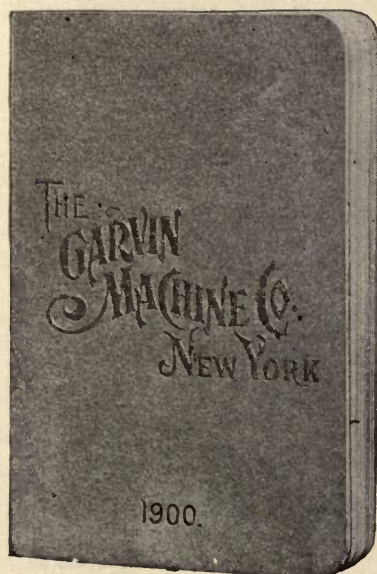
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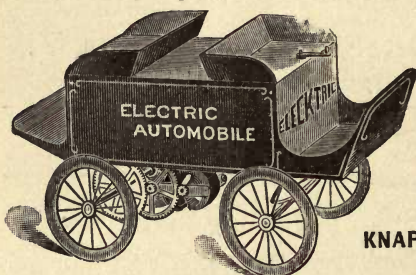
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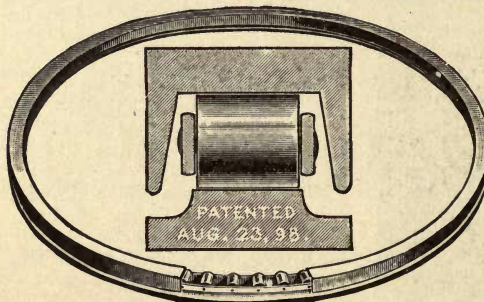
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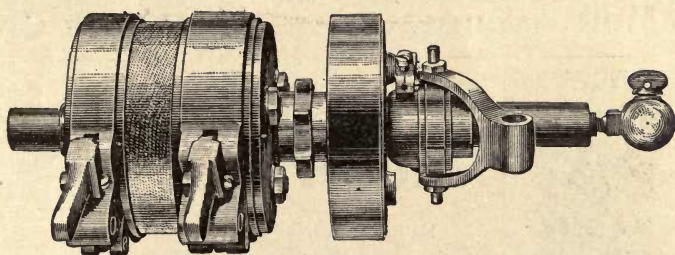
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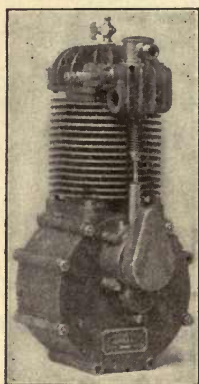
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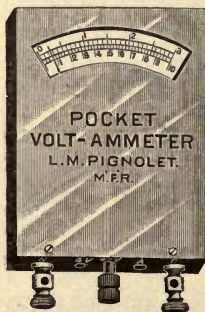
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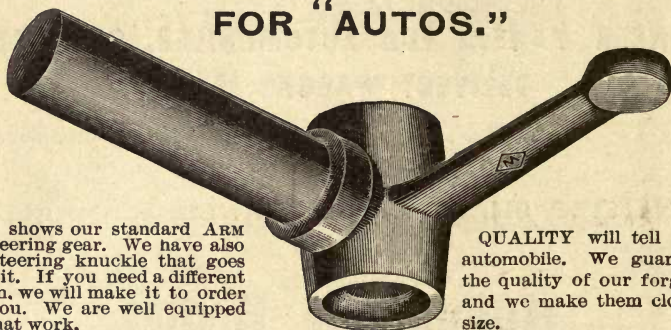
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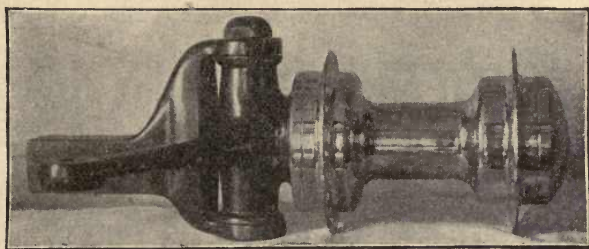
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