

these are the Gin & Leleux, Bertolus, Nicolai, Bovy, etc. The former is used for carbide and for phosphorus; it has four pairs of carbons above a sole movable vertically, thus giving four arcs. The Bertolus type has three movable inclined carbons above a common sole; it is used at the Bellegarde works (France) on the triphase system. In the Nicolai furnace a fixed metallic crown is covered with carbons and forms one pole, while the other pole has several electrodes disposed in a circle and placed above the crown; upon the latter is placed the material. The Bovy furnace is characterized by the use of several vertical electrodes in the same chamber with a common sole in an inclined position; the electrodes are connected in parallel. Considering arc furnaces in general, it seems that the temperature varies with the current; as the tension is nearly constant for a given case, it follows that in powerful furnaces the temperature is too great in the arc itself; the use of multiple arcs only partially remedies this fault, and from the high temperature at a given point there results a volatilization of the matter, and sometimes decomposition. Besides, the arc has a blowing power and the matter is carried off in fine particles; this causes a loss and also vitiates the air.

The second class of furnaces, which may be called resistance furnaces, are disposed like the former, but work at low tension. The vertical electrode is not placed over the fused material, but plunged into it, and the latter becomes the conductor between the electrode and sole. The electric work thus depends upon the resistance and the square of the current, and the temperature for a given power depends upon the section of the electrodes; a good distribution of heat is thus obtained. The fusion takes place quietly and the gases are not violently blown off, as with the arc. Low tensions of 20 and 25 volts may be used. To this class belong the new Gin & Leleux furnaces, which are used for carbide at a number of works; in this the movable electrode is formed of an assemblage of carbons of different conductivity, measuring up to 32 inches on a side. A third class of furnaces is that in which the electrodes are united by a series of carbon blocks, which become heated to incandescence by the current and constitute a bed of fusion for the material; it has the advantage that the current uses as a conductor only the fused portion of the matter, and is not obliged to traverse it entirely, thus avoiding the losses due to the great resistance of the unfused part, as in the other furnaces. To this class belongs the new type of Cowles furnace, having two groups of electrodes, one for the arrival and the other for the return of the current, or two groups of soles which have the same effect.

Electric furnaces may also be divided according to the nature of the current and manner in which it acts. The first electric furnaces used continuous current, and were designated as *electrolytic* or *electrothermic*; in the former, the current served both as a source of heat and as an electro-chemical agent, while in the latter it served only for heating. The use of alternating current has taken a great extension in electric furnaces, and the electrothermic furnaces used for simple fusions or reactions at high temperature employ it for the most part. Both the monophasic and polyphase systems are used, but chiefly the former.

The carbon electrodes play an important part, and it is the difficulty of obtaining these of sufficient dimensions and proper form which limits the size and power of the furnaces. The consumption of the electrodes forms in some cases an important item in the cost of production, and the ingenuity of inventors has been exercised on their design and disposition. In the case of vertical, movable electrodes they are formed of an assemblage of high conducting carbons, and have usually a square or rectangular form; in some cases they are protected from the air to prevent burning, and have water or air-cooling arrangements. As to the tensions used in the electric furnace, this depends upon the conductivity of the vapors and the distance between the electrodes; this distance is generally from 1 to 1½ inches for arc furnaces, requiring 50 to 60 volts. In the resistance furnaces the tension may be less; in some cases it does not exceed 25 volts; on the contrary, in the incandescent furnaces last mentioned, it may reach 80 to 100 volts, due to the great resistance between the electrodes. As to the intensity of current used, this has reached, in the Cowles furnaces, as high as 5,000 amperes, corresponding, at 50 to 60 volts, to 350 to 400 horse power. In the Heroult furnace, the current reaches 6,000 amperes; for carbide, furnaces with one arc and two movable electrodes use 1,000 to 2,500 amperes, which, at 50 volts, corresponds to 79 to 170 horse power; this power has been even quadrupled by using four arcs in the same furnace. Furnaces with one arc and one movable electrode are better adapted for heavy currents, and at present 5,000 to 6,000 amperes are commonly reached, corresponding to 400 horse power. The Gin & Leleux furnace, of the resistance type, uses as high as 10,000 amperes at low voltage; the greatest power is obtained from the fusion-fed apparatus, in which, owing to the great quantity of material between the electrodes, as high as 1,300 horse power is utilized in a single furnace.

As to the development of the industry, the total power now used in electric furnaces reaches 230,000, of which carbide represents 185,000; aluminium, 27,000; copper, 11,000, and carborundum, 2,000. Recently the combined production of phosphorus and carbide has been commenced, and some works in Savoy are producing vanadium and ferro-chromium; among other new processes may be mentioned that of artificial corundum by the fusion of bauxite. Great progress has been recently made in the construction of industrial furnaces; thus the efficiency, for the manufacture of carbide, which in 1897 was only 5 pounds per horse power and per 24 hours, has lately been brought in the new Gin & Leleux furnace to 10.2 pounds, which corresponds to a calorific efficiency of 75 per cent.

The Electrical Lead Reduction Company has resumed manufacture in its new building at Niagara Falls, which replaces that destroyed by fire last March, says The Electrical World and Engineer. The new plant has a capacity about tenfold that of the one burned down,

occupying a building 182 feet by 140 feet. The electrical machinery equipment consists of two Westinghouse motors, of 300 horse power each, direct-connected to a Westinghouse direct-current generator of 250 horse power. The process consists in the electrolytic reduction of lead from galena (sulphide of lead) to the form of a sponge. The sponge may then be compressed into the form of storage battery plates, or converted into litharge, red lead, lead peroxide or white lead. One hundred pounds of spongy lead will yield 108 pounds of litharge, 110 pounds of red lead, 116 pounds of lead peroxide, or 125 pounds of white lead. Sulphuric acid is a by-product of the process, 800 pounds of acid being produced for every ton of lead reduced. The present capacity of the factory is 10 tons per day, but this may be extended to 40 tons, and there is sufficient ground space for an eventual capacity of 100 tons. At present the product is confined to litharge for use in rubber manufacture and storage batteries. The galena is procured from Joplin, Mo., and is concentrated, before being shipped, to 80 to 85 per cent metallic lead. About five days are required to reduce the raw material to spongy lead. The sponge is then washed and burned in the furnace to litharge, the product being 99.36 per cent pure, while the highest grade of litharge manufactured by former processes is 98.12. Plant is now being put in for rolling and stamping the sponge into storage battery plates.

#### THE PROSPECTS FOR ECONOMICAL AUTOMOBILING.

By M. C. KRARUP, New York.

THE slump from which the automobile market in France suffered during the latter half of the year 1900 was followed by a material reduction of the selling prices at the beginning of the present year, and now the public demand for automobiles is being quickly revived in that country. Great Britain and Germany are following suit in a measure modified considerably by the lower range of prices previously prevailing in both these countries. Will something similar take place in America, notwithstanding that our prices from the beginning have been far below the schedules of Europe? And, inquiring further into the future, how long will it be before any person whose economical condition would permit the ownership of horse and vehicle may just as well contemplate the purchase of an automobile?

Commonly these questions take the more definite form: How soon will it be possible to buy a practical, reliable and useful automobile for \$500? With this price limit the question refers mainly to pleasure vehicles, from the use of which no pecuniary returns are expected. With reference to business vehicles it may be put a little differently. The American business man does not like a large initial investment in a new venture. He has been accustomed to "turn his capital over" once a year in every enterprise involving risk and personal work. He wants to do the same with business motor vehicles. Spite of all computations of interest and depreciation tending to show that automobiles at their present prices and cost of operation compare favorably with the capitalized cost of horses and their keep, he will continue to consider them dearer so long as their first cost is much higher than that of the horse equipment which suffices for his work. The possible savings in operation, upkeep and time constitute his business chance. It is an uncertain factor, and reimbursement from future savings must be very sure before he will consider it a suitable compensation for a high and certain immediate disbursement. Perhaps the average business man will consider a 25 per cent higher purchase price the limit of "what is about right." If a team of draft horses and a dray cost him \$700, he may be willing to pay \$900 for a motor dray, but ordinarily not much more.

How soon will he be able to buy it at that figure? Probably his expectations may be met long before those others can be gratified who hope to buy a smaller power in a pleasure vehicle for about half as much money, for within the moderate dimensions available for vehicles it is not principally size that enhances first cost of machinery and wagon work, but the quality of reliability of the motor as a power producer and the refinement of its operation. Reliability once attained will be imperatively demanded for a small pleasure vehicle as well as for the dray, and refinement in operation is naturally more important in the former.

These principal factors of cost will continue to apply to all sizes of motor vehicles in nearly equal degrees until standard patterns shall have been reached and the manufacture reduced to routine processes, and the tendency must therefore be that of maintaining a certain level below which the prices for an acceptable quality in automobiles cannot descend at any given time, almost irrespective of size and the animal horse-power which the automobile is intended to supplant.

Infractions of this rule at the present stage are more apparent than real. High prices are frequently arbitrary and find little response among the buying public, while low prices, such as asked for motor cycles, represent a deliberately reduced standard of utility, a compromise between economy and vehicle qualities. Purchasers of motor cycles are supposed to "put up with" crudities in construction, design and operation that could not be tolerated in vehicles intended for something more substantial than sportive play. There is nothing derogatory to motor cycles in acknowledging their limitations. They occupy an essentially new field, most nearly comparable to that of the road and track sulky, and it remains to be seen if this field will be cultivated after means shall have been found for removing the shortcomings in automobile vehicles which in the motor cycle are now more or less frankly accepted in consideration of the low price.

The lack of a commonly accepted standard of automobile quality or fitness explains other deviations from that level—about \$1,500—at which the highest automobile quality of the day is obtainable in combination with vehicle qualities corresponding to those of a buggy or "spring wagon." Above this level should ordinarily be found the comforts and style of a fine carriage. Below it there is usually a sacrifice of vehicle convenience as well as of motor quality or traveling radius.

One feature in the automobile market seems at first to support the hope of cheap gasoline vehicles. It consists in the manufacture and offering for sale of vehicles complete with pneumatic wheels, steering gear, differential gear and driving pinion, for \$200 or less. That is to say, the motor is omitted; also the transmission mechanism. But the supposition is that any good mechanic with an ambition for constructing and owning an automobile can fit the motor of his choice, steam or gasoline, at an expense of \$200 for a gasoline motor and \$400 for a steam engine, boiler, etc.

There is the cheap automobile. But it is the part of wisdom when the makers of these running gears and wagon boxes refuse to shoulder the responsibility of fitting a motor in their product and by this omission escape all blame for the shortcomings of the automobile-to-be. In this form of business it is taken for granted that: 1, a satisfactory motor and power transmission gear can be procured; and, 2, that the problems of a running gear and a vehicle body suitable for any motor and transmission gear have been solved. Both assumptions are of course radically faulty. If they were not so, the ideal motor vehicle would already be among us. The best that may be said for a motor vehicle built according to this system is that it may not turn out much worse than more expensive automobiles bought in the open market, and that it may be adapted for the first experiments of inventors who have new motors to try.

#### ECONOMY IN FIRST COST.

From the public's viewpoint the question of economy in first cost is a different one and implies that the complete vehicle shall be known in advance to operate satisfactorily and to be possessed of a reasonable degree of durability. Apart from these requirements, economy has no sensible meaning. With any of the essential conveniences left out which constitute the reasons for using horse and carriage instead of a bicycle, for example, economy takes on a very much restricted meaning, and this applies to motor cycles, to any automobile without baggage carrying capacity, to any automobile requiring special technical education in the operator or caretaker, and to electric vehicles of very limited traveling radius. These are all new commodities, comparable to nothing that has previously existed. They do a new class of work, each of them, by new means, and the idea of economy as here considered, being relative and only intelligible in comparison with earlier methods of doing the same work, is inapplicable. Their economical worth must be judged by new standards drawn directly from the consideration of the special class of work for which they are fitted.

In order to have a clear case the economy of the automobile must be looked upon solely with reference to such automobiles as are intended and adapted to take the place of a horse and vehicle equipment in all respects. Whether other self-propelled vehicles are worth the money asked for them each individual must decide according to his needs, his fancy and his knowledge of what the vehicle will do. If he has had a saddle horse and wants a change, a bicycle is the nearest substitute. It can be obtained at from \$25 to \$75, and costs practically nothing to keep, but it is impracticable on muddy roads and under certain other conditions. A motor cycle is still more impracticable on muddy roads, but it will go much further and faster than either bicycle or saddle horse on good dry roads. It can easily be arranged to take an extra passenger. It supplies at present a somewhat troublesome and decidedly disagreeable form of locomotion. What this *ensemble* of attributes is worth is an individual question. Comparisons are idle. The cost—\$400 to \$600—may be low for a fancier and prohibitory for one who wants to cart goods to market. The convenient little electric runabout of recent production, of which the battery weighs less than 200 pounds and may be easily handled, may be excellent and well worth \$500 for taking a man to his office or a woman to the shopping district and back, but it is worthless for many other kinds of work for which a horse and vehicle could be used.

It is the full-fledged automobile which is of prime interest. Automobility will stand or fall with it, economically and otherwise. When perfected its perfection will be the standard from which no downward deviation will be tolerated in any other class of mechanical vehicle. Its speed, now its chief recommendation, will be a mere incident, to be arranged to suit purchasers—a mere matter of power, gearing and strength of material, involving no special engineering difficulties.

In gathering data for forecasting the future price of the full-fledged automobile, one is first astonished at discovering that there are no full-fledged automobiles at present except delivery wagons, electric cabs and carriages, a few drays and here and there a gasoline vehicle with the motor mechanism suspended between the axles under the wagon box. In all others the ordinary vehicle conveniences for carrying goods in addition to passengers have been sacrificed to the necessity of carrying the power source and to the desire for imitating the horse vehicle's outward appearance. They are mere locomotion machines, but not vehicles in the sense of supplying adequate means for carrying, say, 1,000 pounds of baggage if required, as does the ordinary spring wagon.

To remedy this defect is likely to mean additional cost of construction. In the case of some of the electric pleasure carriages the conveniences are equal or superior to those of ordinary carriages of corresponding types—victorias, broughams, hansoms—but with such an addition of weight, causing tire troubles and high operating cost, that the remedy is less acceptable than the defect. The solution adopted in a few makes of gasoline vehicles of hanging the motor mechanism under the wagon box has few advocates, being unsightly and bunglesome for caretaking, cleaning and repairing. But progress seems open in this direction, though on new lines. For light steam pleasure vehicles no remedy worth the name has been discovered. The shortcoming may be considered trifling so long as there are other shortcomings apparently calling for more engineering skill, which must also be removed, but in the competition with horse traction from an economical viewpoint it is not trifling but fatal, and no remedy is in sight short of a radical redesigning of every automo-

bile intended to be more than a toy. Specialties such as physicians' automobiles, solely and exclusively meant for transporting one or two persons, may perhaps be excepted. These represent the cheapest possible construction of an automobile, and this construction being the one now generally adopted, an increase in cost may be looked for when the defect here referred to shall have been removed.

#### THE EXPERIENCE WITH BICYCLES DELUSIVE.

The popular hope for cheap automobiles rests mostly on the experience with bicycles. On the other hand, sewing machines and typewriters may be cited as commodities in which cheapness is following only very slowly upon extensive manufacture and large competition. If, however, automobiles are to be cheapened it must be through the standardization of certain types of automobiles and the security for large investments in manufacturing plants which such standardization of types will engender. Until the lines of design and construction shall have become fixed and accepted it is reasonably sure that large capital will shrink from the manufacture, especially with the examples before it which the industry affords now of large but apparently premature and unprofitable investments made with the purpose of rushing the manufacture of heavy electric vehicles and light steam vehicles. Yet until capital is freely supplied to organize automobile manufacture economically no great reduction of selling price is to be expected if a margin over the cost of production is to be reckoned with.

While there can be no reasonable doubt that the production of any highly successful type of automobile—and the success well tested out by the public—will be followed by manufacture on a gigantic scale, it is not by any means certain that this will mean a price reduction to the buyer in less than twenty years after the inception of such manufacture. It will beyond all doubt mean a lessening of the cost of production, but it will depend largely on the breadth and validity of patents whether the public will receive the benefit.

In this respect the competition with horse traction is perhaps the only feature which may be relied upon to brighten the horizon and prevent a repetition with automobiles of the scandalous extortions which have been practised in this country with relation to telephone and telegraph service.

#### AN INCREASE IN AUTOMOBILE PRICES.

Most other data point rather to an increase of automobile prices than the reverse. Among such data are the following:

The price of steam pleasure vehicles is now considerably higher than when the light steam vehicle was first put on the market, it having been found necessary to make the construction more substantial. Owing to the absence of basic patents in steam engine construction and the comparative economy in operation of the larger sizes of engines, there seems, however, to be the best chance that steam automobiles for heavy hauling—sufficiently heavy to warrant the employment of an engineer—will reach an economical basis at an early date. Steam pleasure vehicles will probably hover over the average figure of \$1,500, where they practically are today, for some length of time, until gasoline vehicles become so perfected that the much lower cost of operating them—not much more than one to five as compared with steam—begins to depress the price of steam pleasure vehicles, and perhaps forces them out of the market.

The electric storage battery vehicle is intrinsically the cheapest of all to manufacture. The cost of raw material plus the cost of labor figures up lower than for any other automobile. When the patents on storage batteries expire, in a few years, it will be quite possible to make and sell an electric vehicle of the kind now in use and selling for \$1,000 for, say, \$600 or less, but improved batteries have already been patented which promise less weight and greater traveling capacity, interchangeably. Other more radical improvements are, while not probable, by no means inconceivable. Nothing relating to new means for generating or storing electric energy may be pronounced impossible. But whatever progress will be made is likely to be patented and will, if radical enough to compete with the gasoline motor for general vehicle purposes, render the present form of electric vehicle hopelessly antiquated.

#### THE HYDROCARBON MOTOR.

The mainstay of all hopes for cheap automobiles is the hydrocarbon motor, with kerosene, gasoline, alcohol

About fifty American manufacturers produce somewhat similar motors for use in boats and thousands of gasoline motors are more or less successfully employed to drive machine tools in factories and dynamos in electric light plants. These motors are sold at good profits and yet at prices that do not seem high, but any argument drawn from this condition in favor of cheap gasoline vehicles—of satisfactory construction—would be sadly at fault.

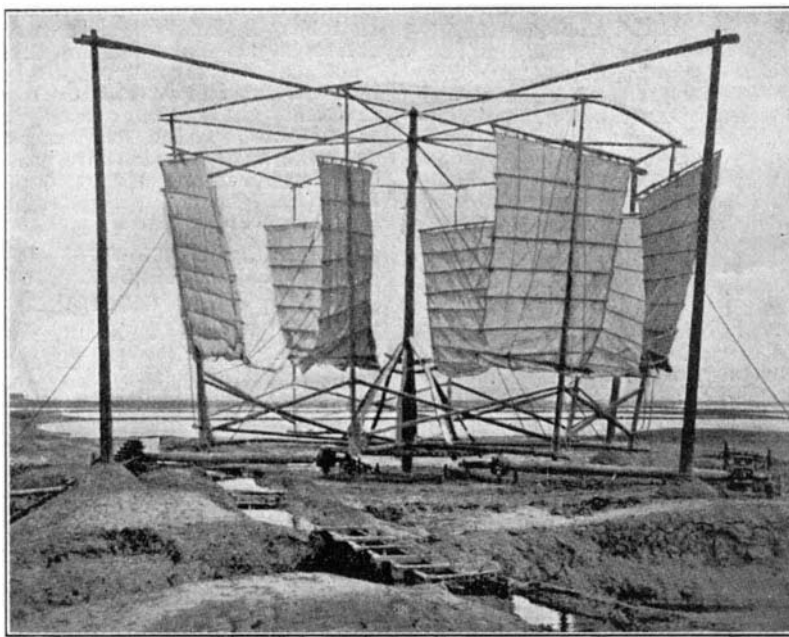
#### DIFFICULTIES INVOLVED.

The hydrocarbon or internal combustion motor is generally known to be the most economical power available and the simplest in construction. Unfortunately, however, this power is by its explosive nature as poorly adapted for the work of driving a vehicle as imaginable,

to handle. And yet they are the standard bearers of automobilism. Furthermore, they are growing more complicated rather than less so. Refinement spells complication in the gasoline engine as it did in the formative period of the steam engine. Promising improvements are snapped up by large concerns. The possibilities of unpatentable features have been nearly, if not quite, exhausted. The vista of needed improvements presents a deep and interesting but hazy perspective. Automobilism is yet in its infancy.

Cheapness combined with efficiency is not an immediate prospect, but there is compensation in the thought that when cheapness arrives "to stay," it will come in company with all other good and desirable qualities.

In this thesis several apparent contradictions in a



THE CHINESE METHOD OF OBTAINING SALT BY THE EVAPORATION OF SEA WATER.

especially where crude roads prevail. To make it available even for unvarying work it is necessary to store it first in the rotary energy of a heavy flywheel and then to take the power wanted from the shaft of the latter. This works very well when the power is uniform or of necessity proportionate to the power developed, as that of turning a propeller wheel in water. Still, when the flywheel is heavy enough to absorb the spasmodic power impulses it does not respond promptly to variations in either the work or the power. It takes some time before an adjustment to slow down the motor can take effect. This would be bad for boats and fatal for automobiles. For this reason alone heavy flywheels cannot be used in boats and automobiles, but their size and weight would also prohibit their use. If, on the other hand, the flywheel is small, its stored energy easily becomes insufficient for the work in hand and the force of each explosion takes effect directly in the work, rendering it highly disagreeable for anybody exposed to the jarring.

If the public would accept a form of transportation in which constant shaking of the vehicle is the unavoidable accompaniment of crude construction, there would be no reason why gasoline automobiles should not be sold very cheaply. But the public, in sober reflection, will do no such thing, as long as there are horses, steam and electricity. The majority still believe in the testimony of their senses and cannot remain persuaded that jarring is pleasant and the odor of partly burned gases a delight.

The cost of gasoline vehicles of the highest quality which the present stage of the art affords is mainly that incurred in making a hundred and one more or less efficacious provisions for minimizing, subduing, smothering and absorbing the evil effects of an explosive power by heavy material, fine workmanship, multicylinder high speed motors, ingenious transmission gears, balancing of rotary parts, etc., and the problems in-

brief and brash analysis of a vast subject may be found harmoniously resolved.—The Iron Age.

#### SALT MINING IN CHINA.

According to Ueber Land und Meer, China obtains most of her salt from the sea. When the allied armies landed at Taku they saw many curious structures, the purpose of which was not apparent.

The structures in question are peculiar windmills which pump water into elevated basins, where it is evaporated by the wind and sun, leaving behind the sea salt. It is true that the salt thus obtained is not agreeable to the European palate. But the Chinese seem satisfied with it, and ship it to Tientsin in loaf-like blocks.

#### AUTOMOBILE COMPETITION IN 1900.

At the Vincennes annex, during the Exposition, the Automobile Club of France organized various competitions that furnished data which were very interesting, since they concerned all kinds of horseless vehicles. The award of prizes was based upon consumption, regularity of operation, ease of steering and comfort.

The principal prizes decreed were the following:  
Touring Competition.—Carriages weighing more than 800 pounds; 4 classes; 2, 4, 6 or more seats. Five days' tests at 90 miles a day.

Gold plaquettes.—Peugeot, Delahaye, Dietrich, and Panhard-Levassor (gasoline) carriages.

Motocycle Competition.—Duration 5 days; total trip 480 miles.

Gold medals.—Werner motocycle, mean speed 24 miles, consumption about two ounces of gasoline to the mile. Rochet-Petit tricycles and quadricycles, mean



FIG. 1.—DE DION-BOUTON DELIVERY WAGON.

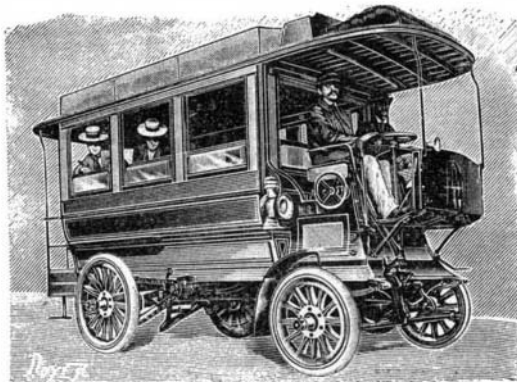


FIG. 2.—PANHARD-LEVASSOR OMNIBUS.



FIG. 3.—PEUGEOT TRUCK.

or acetylene as fuel. Almost any of the existing models of gasoline motors might be produced in quantities at a cost of less than \$100 for a single cylinder five horsepower engine, the material in the rough being worth about \$40. Not one of the double, triple or quadruple cylinder motors used in automobiles would necessarily cost more than \$200 if produced by economical repetition methods. But not one of them is so near perfection that it may even be thought of as approaching finality. The "overhead" expenses in their production are enormous, unless an artificial halt has been made in progressive construction for purely commercial reasons.

involved are so many sided and difficult that the progress made so far looks like a drop in the bucket from the standpoint of a perfectly unbiased spectator.

If the progress were really satisfactory and conclusive evidence of ultimate complete success, steam vehicles could no more be thought of as in the race, and electric vehicles would be at once abandoned to await some revolutionary invention in applied electricity.

The crude gasoline vehicle is cheap, or ought to be cheap—\$500—now. The acceptable gasoline vehicle is not yet made, and the creations which come nearest to the ideal conception of the striving engineer are expensive to make, expensive to sell and none too easy

speed 22 miles an hour, consumption about three ounces of gasoline an hour.

Competition of Hacks and Delivery Wagons.—The latter carried an effective load of from 1,100 to 2,600 pounds.

Gold Medals for Public Carriages.—Peugeot gasoline victoria; Kruger electric victorias. For gasoline delivery wagons, the Brouhot carriage.

Voiturette Competition.—Distance 480 miles. Two categories: Carriages weighing less than 550 pounds empty, and those weighing from 550 to 880 pounds empty.

Gold and Gilt Silver Medals.—For the first category: Gladiator (Astor motor); mean speed 15 miles, con-