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The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE 1909 AUTOMOBILE.

The tendency toward standardization and interchangeability of parts which for the past two or three years, has been one of the most promising features in the development of the American automobile, is more distinctly noticeable in the product for 1909 than in that of any preceding year. It is one of our national characteristics that, when the American takes hold of a device which, in its inception and early development, is distinctly, or at least mainly, foreign, he invariably improves it in two very important particulars; first, he simplifies both the construction and operation, and, secondly, he reduces the price. If simplicity and low cost, however, be gained at the expense of reliability, they are a doubtful and certainly very costly advantage, and the makers of the expensive foreign cars have argued, and not without reason, that their costly output, because of its greater reliability, was, in the long run, more profitable than the cheaper, but short-lived machine. The day when such an argument had any force, however, is now happily past; for during the past year the American car has proved, both in reliability runs and in the day-by-day service of the several hundred thousand automobile owners of the country, that it is a thoroughly serviceable machine.

In a first general survey of the cars in this year's exhibition, one is impressed with the relatively large number of really fine machines that are offered at moderate prices, for it is probable that over one-half of the exhibits are listed at less than $1,500. The typical car of moderate price is driven by a 4-cylinder engine of from 20 to 30 horse-power, and will weigh from 1,500 to 2,000 pounds. The tires will be 3½ inches on the front, 4 inches on the rear wheels, and 34 inches in diameter, and the wheel base will be from 100 to 115 inches. It will have magneto ignition, with battery ignition in reserve; water-cooled cylinders; forced-feed lubrication; direct shaft drive, with three speeds ahead and one reverse; sliding gear transmission; a pressed-steel, riveted frame; some good form of leather-covered cone clutch; and a seating capacity for four people.

As compared with last year, the principal change noted in the chassis is that more manufacturers are using the drop frame, and thereby bringing the frame and gear nearer the ground, with the advantage of reducing the angle in the driving shaft at the universal joint. The semi-elliptic springs of former models are being replaced by three-quarter elliptic or full elliptic springs; and it is not unlikely that the use of the full-elliptic will become the standard practice of the future. The platform spring suspension, with its universal joint connection to two half-elliptical side springs, is used on some cars, but it seems destined to give place to the snugger and more simple full-elliptical springs above mentioned.

The general appearance of the car bodies has been improved by the removal from sight of many accessory parts, which formerly were obtrusively crowded upon the dashboard and running board. In general line, color, and decoration there is evidence of an even greater simplicity and more refined taste than marked the cars of last year. Outside of the various shades of red which still maintain their popularity, the colors are generally dark and pleasing; and there is a fortunate tendency to reduce the amount of lining and striping to a minimum. Naturally, the runabouts present the smartest and most racy appearance, and in this type is to be found, we are inclined to think, the last word in developing the automobile to the point of positive mechanical beauty.

In spite of its more even torque, reduced vibration, and acknowledged hill-climbing qualities, the 6-cylinder engine has not fulfilled the promise of growing popularity which was freely made at last year's exhibitions. The 4-cylinder engine is the prevailing type, and the public seems perfectly satisfied to forego the above-named advantages of the 6-cylinder engine, in favor of the saving in weight, space, complication, and cost, of the 4-cylinder type. Although ball bearings are still used to a considerable extent on the wheels, there is a tendency to replace them by some form of roller bearing, especially for the front wheels. The belt drive for fans is disappearing in favor of the gear-drive. Pump circulation is almost universal; although the thermo-siphon system is still retained on some high-class cars. The 2-cycle engine was exhibited; but it does not seem to be making the advance that was predicted. Undoubtedly, the most marked tendency in engines is toward the lengthening of the stroke. The theoretical advantages of this change, in reducing shock and permitting a lighter construction in the reciprocating parts, have been borne out by the experience of the past year. Mechanically considered, there is much to be said in favor of the change. Shock and vibration are reduced throughout the whole of the driving mechanism; wear is lessened; and a general reduction of weight becomes possible.

In this connection it should be pointed out that the makers are thoroughly alive to the importance of weight reduction, because of its effect not merely in reducing the first cost of the car, but in prolonging its life and keeping down the running expenses. The ponderous machine of excessively high power is rapidly becoming a thing of the past, and the lessening of weight and improvement of details of design, particularly in the engine, has been shown in the racing of the past year, when light, moderate-powered cars covered the long-distance courses, at an average speed that was only a few miles below that of the most powerful racing machines.

The advantages of lighter weight have been shown nowhere more than in the tires. Tire trouble is becoming less serious, and the life of the individual tire has been greatly prolonged. No particular novelties have been exhibited by the tire manufacturers this year. The quick-detachable rims continue to show satisfactory results, and the several forms of non-skidding, metal-studded treads which were exhibited appear to have given satisfactory service.

The sliding-gear transmission, with three speeds ahead and one reverse, continues to be the prevailing type, although the friction-disk transmission is also exhibited and is attracting no little attention. Mention should be made in this connection of the hydraulic drive, which was illustrated and described in the SCIENTIFIC AMERICAN of December 12, 1908; for in this ingenious device is found the most striking and radical departure of the year from the commonly accepted standard practice. Although it is at present adapted mainly for heavy and relatively slow-moving vehicles, it possesses corresponding advantages in its application to high-speed vehicles, for which its great flexibility, absence of shock, and minimum amount of wear, give promise of ultimate popularity. The planetary gear transmission is reported to have given good service on light cars, if they were provided with ample power. Of the three types of clutch, namely, the expanding and contracting band, the floating disk or ring, and the cone clutch, the last-named still remains the most popular. Multiple-disk clutches are being improved by the use of a smaller number of disks of larger diameter, operated under reduced pressure.

Some of the finest mechanical work on the automobile is shown in the live rear axle construction, which is generally of the floating type. Great attention has been paid to the housings, which have been made more rigid. In some cases, they have been made in two pressed steel, coned halves, with the resulting advantages of complete inclosure of the parts and unusual rigidity.

The direct shaft drive is almost universal in the standard American machine, although some high-class vehicles were shown which still use the double, side-chain drive. Much attention has been given to the improvement of the brakes, the tendency being to lessen the number of brakes on a car and improve their quality. Some vehicles show two sets on the rear wheels and others one set. The diameter of the drum has been increased, and the faces have been widened, with the resulting advantage of greater power and longer life in service. Asbestos and cork are being largely introduced, although many machines still adhere to the straight metal contact.

Unquestionably, the low-price car, costing less than $1,000, has come to stay. If we include the comparatively new and increasingly-popular buggy type of machine, it is safe to say that a large proportion of the space at the Grand Central Palace show was taken up by automobiles of this class, costing from $500 to $950. The $500 machines are, of course, of plain appearance. They are driven generally by 2-cylinder engines, of the opposed horizontal type. But perhaps the "biggest show for the money," if we may be allowed the phrase, was presented by the runabouts costing from $800 to $1,000. These machines contain all the essential elements of the elaborate high-powered, high-priced machines shown in neighboring exhibits, since they embody pressed-steel frames, 4-cylinder, water-cooled engines, magneto ignition, direct shaft drive, etc. Moreover, the record of the past year shows that, because of their light weight, they are remarkably economical in fuel and particularly in repairs to tires.

One of the finest sections of the Grand Central Palace exhibition was that devoted to heavy commercial vehicles, such as trucks and drays, delivery vans and wagons, buses and sight-seeing cars. The character of the work both in the chassis, driving mechanism, and bodies was fully up to that of the high-class automobiles. The comprehensive character of this section is shown by the fact that one western firm alone had eight separate exhibits, including a 1½-ton chassis, a 1½-ton truck, a 12-passenger Pullman, a 1-ton wire-work delivery truck, a 16-passenger sight-seeing car, a 5-ton chassis, an ambulance car, and a delivery van which covered 2,000 miles in the Glidden tour without making any adjustment.

STANDARDIZING THE AUTOMOBILE.

The largest and best-equipped automobile factories to-day make a point of accurately duplicating parts, so that there is no resorting to cut-and-fit methods in the assembling department. The utmost precision is observed in casting, forging, boring, grinding, and threading to exact standards, so that a gear will operate as well in one set as in another, and valves and their stems and operating camshafts will fit in any one of a thousand different engines of the same size and design.

The "standardization" of certain parts and fittings began more than five years ago, when certain manufacturers agreed upon the spacing of tire lugs for wheels of different diameters, and wheel and rim makers bored their products in accordance with this standard. Rim and tire makers also agreed upon a certain standard form and standard dimensions for steel clincher rims and tire beads, so that during the past five years almost any leading make of tire could be fitted to any car. The advantages are plain. Lamp brackets were similarly standardized, the lamp and fork makers agreeing upon the distance between centers of the arms or prongs, the diameter and taper of the lamp sockets and arms, and the size of set-screws.

This work has been carried on since 1904 by the oldest and most reputable of the American motor-car builders. Among the important results obtained have been the adoption of standards for screws and nuts, reducing the former multiplicity of sizes and threads to a minimum, based on the United States standard, to which carriage bolts conform. Since every hardware store and machine and carriage shop carries carriage bolts in stock, the man whose car is built to conform to this standard will have no trouble in replacing a lost or broken bolt wherever he may be.

The spark plug has also just recently been standardized and the engines of some thirty or more prominent makes of motor cars will hereafter be bored and threaded to receive plugs of ⅞ inch diameter, with straight thread of eighteen pitch. Steels and other metals purchased as raw materials must now conform to certain chemical and physical standards; and as these standards are very high, the user of a machine built from such metals is assured of a high factor of safety, provided the design is good throughout.

In the long run, standardization and interchangeability of parts will have the effect of giving us a higher grade of motor car at a lower price, but this is dependent in considerable degree upon the production of one model in great numbers and the elimination of extensive annual changes in design that necessitate the making of costly jigs, gages, and special machinery.

GROWTH OF THE AUTOMOBILE INDUSTRY.

Evidence of the stability of the automobile industry and the permanent popularity of this new means of locomotion, is afforded by the fact that, in spite of the recent financial depression, there was but little, if any, falling off in the volume of trade. Statistics published in connection with the present automobile exhibitions draw attention to the fact that whereas the automobile business done in 1903 amounted to less than $8,000,000, the total for 1907 reached $105,000,000, and in 1908 will show but little, if any, falling off. The total amount of capital invested is about $200,000,000 and the various establishments connected with the manufacture, sale, and housing of automobiles employ nearly 110,000 people. There are in the United States over 250 firms engaged in the construction of automobiles, and it is estimated that over 52,000 cars have been sold during the year. Returns from the twenty-nine States which have compulsory registration show that over 250,000 cars have been registered; and an estimate of the approximate total for all the States gives reason to believe that

there are at present over 320,000 motor cars in this country. According to the table of registrations, New York State leads with 64,500 cars; Pennsylvania is second with 25,129 cars; California third with 19,375 cars, followed by New Jersey with 19,021 cars; Massachusetts with 17,439 cars, and Illinois with 17,296. The importation of motor cars is rapidly decreasing, although it is estimated that about $28,000,000 of foreign cars have been imported and sold in the United States. It is satisfactory to know that the tide has turned, and that American builders are sending their cars abroad in increasing numbers.

ALLOY STEELS AND AUTOMOBILE DURABILITY.

In the fall of 1901, the writer of these lines was a passenger in one of the competing cars in the automobile endurance run from New York to Buffalo—the first American event of its kind and magnitude. The car was a two-passenger phaeton, tiller-steered and driven by a two-cylinder motor of 8 horse-power. It weighed approximately 1,700 pounds, and was capable of a speed of about 25 miles per hour. For its day, it was one of the best examples of American construction, and it completed the run creditably, requiring few repairs. Some of the lighter cars were practically rebuilt *en route*, and one of those finishing was even said to have been assembled from the unbroken remains of two similar cars that had left New York. Yet, despite the general excellence of that car, something had to happen to it. While traveling at the rate of 15 miles an hour (break-neck speed in those days) the right front wheel parted company with the car, and went spinning merrily down the road, while the stub end of the axle, dropping unsupported, began to plow up the macadam as the rudderless car veered toward the curb. The car was short and rather high. By good luck it did not upset, and the driver quickly brought it to a stop. The steering knuckle spindle had broken; the steering knuckle being the short pivoted member at each end of the front axle, which carries the wheel and by its deflection controls the course of the car; and the spindle being the round part of the knuckle on which the wheel turns. That knuckle was a steel casting. Anyone even slightly familiar with the properties of iron and steel, knows that a steel casting which, when new, appears to be as strong as a forging, and which makes as good a showing under ordinary tests, nevertheless weakens and becomes brittle when subjected to repeated vibration and shocks. So well has the phenomenon of "fatigue" become recognized that steel castings are never used nowadays in any but the cheaper and lowest-powered automobiles, and even in them rarely save for parts not subjected to shock.

In 1901 automobile constructors thought that they had done their whole duty if they used steel forgings instead of castings. To-day we know better. There are more kinds of steel than there are kinds of cigars. Any kind of steel is good for something—if it be only for ballast—but not many kinds are good enough for the severe conditions of automobile usage. The proportionate difference that exists between castings and forgings is found also between forgings of ordinary steel and forgings of some high-grade alloy steels. A shaft of common machinery steel, which if pulled asunder in a testing machine would stretch a fifth or a quarter of its length before letting go, if used in an automobile transmission or axle will in time crystallize and break, with a brittle pipe-stem fracture, under stresses which, when it was new, would not even have "sprung" it. So it has come to pass that nickel steel, chrome-nickel steel, and chrome-vanadium steel have ousted the ordinary variety for all the more important parts of the best automobiles. All of these steels are much stronger than the ordinary simple steels, and possess in varying degrees the property of resistance to the abnormal shocks of accident. Later investigation, however, has proved that these stronger and shock-resisting compound steels must be rigidly classified, as not only is it very important that the steel for such purposes should be strong and should resist a simple shock, but also that it should resist in the highest degree possible the development of that potential brittleness which is induced in *all* steels by prolonged subjection to repeated shock and impacts. In this respect vanadium steels have shown superiority to all others, at least as far as laboratory tests can demonstrate. The ordinary nickel steel, unless properly heat treated, unfortunately possesses the power of developing this potential brittleness almost as fast as the ordinary carbon steels that have been used in the past; hence its demonstrated superiority does not show up as great as simple physical tests would lead us to suppose. Abnormal shock due to accident may wreck the car, but it will be by twisting and bending, rarely indeed by direct fracture. The effect of collision at high speed is to crumple the framework, springs, and axles like paper; but if the wreck is not too complete they can be heated and straightened as if nothing had happened. The force required to bend such steel is almost unbelievable to one who has known only the common grades. Even transmission gears, hard and relatively brittle though they are, can hardly be broken with a sledge hammer.

With material such as this in its make-up, the little 8-horse-power car previously referred to might have gone around the world without the steering knuckles giving a moment's anxiety. The same betterment has affected every vital part of the modern automobile. Gears that used to be made of bronze or soft steel are now made of alloy steel, and are clashed into mesh by bungling drivers with comparative impunity. Instead of axles which rarely outlasted the shortest-lived car, we now find I-beam forgings which survive ditchings and upsets, the blows of cross gullies seen too late and taken at high speed—anything indeed, which the passengers themselves may reasonably hope to survive without injury. With the occasional exception of the crankshaft, which still resists the efforts of builders to make it entirely unbreakable, because it is subject to a great many other considerations than its component metal, there is hardly a part of the modern automobile which, given proper design and workmanship, can be excused for failing in service or legitimately wearing out.

To the man who buys a high-grade car of current model, these facts convey merely the comforting reflection that he is getting good value for his money, and that there is a substantial reason for the seemingly high price of a good machine. But to him who purchases a second-hand car which has seen two or three seasons' use, they mean something more important. So recent has been the general adoption and intelligent treatment of alloy steels, that if the car was built in this country it is very likely to develop breakages quite unknown to its younger days. We have in mind a car which was built in 1903, according to the best standards of its time, and which had covered many thousands of miles in honorable service. Naturally, it contained no alloy steel, and naturally it had reached the point where one or another part needed attention somewhat frequently. The owner knew it, inside and out, pretty well, and realized that it was only a question of time when certain parts were sure to "let go." But he could scarcely undertake to rebuild the car, and therefore contented himself with going carefully over the weaker parts and putting them into the best condition possible. One day on entering a little New Jersey coast village an ominous grating reached his ears. He maneuvered the car cautiously. It ran two blocks and stopped with a jar—immovable as a monument. A half hour's work with a wrench showed that a certain ball bearing, close to one of the bevel gears in the rear axle, had broken and had jammed inside the axle. It was not so much the fault of the material as of careless fitting, but it was eminently the kind of thing that crops up after the guarantee has expired.

Although we have mentioned this incident to illustrate what may in time be expected of any car built less carefully and of less perfect materials than the best, it must not be inferred that an old car at any price is to be avoided. One must indeed be prepared to spend money on replacements; but it is quite possible that the parts liable to premature failure can be replaced with others, specially made of better material or design, which will outlast the car.

Every motorist has known cars which, while of good design generally, had certain parts which persisted in giving trouble. In such a case it is a mistake to get rid of the car as useless, since almost invariably the offending parts can be corrected at much less expense than would be involved in the sacrifice of the car. If a part works loose, it is because of poor design or fitting. If it breaks, the remedy may be found in substituting a new part of stronger material, if it is inconvenient to increase the dimensions. When a rubbing part wears out quickly the chances are that it is insufficiently lubricated or imperfectly protected from dirt. To devise efficient lubrication or dust protection for any wearing member of a car is an easy task, and proper attention to it will add many miles to the car's service and save many dollars to the owner.

At present automobiles wear out at a great many points—slowly at some, rapidly at a few. But means are constantly being found to reduce the wear, and to render the parts easy of repair or replacement when worn. More than that, the multitudinous small joints and bearings, whose replacement is difficult and whose life is apt to fix the useful life of the car, are by degrees being made virtually non-wearing. What wear occurs is limited more and more to the essential elements of motor and transmission, and renewal of these keeps the car in practically new condition. A few years from now we shall have cars which run almost indefinitely with only periodic overhauling and ordinary daily filling and cleaning,

COST OF RUNNING A CAR.

An owner of a motor car has rendered a signal service by giving the operating cost of his seven-passenger automobile, which covered 30,000 miles in a little over two and one-half years. The figures are not estimates but are a compilation based on actual check payments. The statistics show the items of direct cost, which vary directly with the mileage. Cost per mile: tires, 5 cents; gasoline, 2.7; lubricating oil, 0.2; incidentals, 0.9; total, 8.8. The car averaged about 1,000 miles a month, and a yearly average of 7½ miles on a gallon of lubricating oil. Leaving out the interest and depreciation, which is largely a matter of judgment, and assuming the car to be owned in a New York city suburb and that it made an average of 1,000 miles a month, the following sums up the cost for a year: Tires, $500; gasoline, oil, acetylene, and repairs, $500; chauffeur and rental of private garage, $1,300. Total, $2,300.

SELECTING A CAR.

A large family desiring a car for touring purposes requires something more than a five-passenger car with small wheels and low clearance. On the other hand, the automobilist who desires a car for city use and for business purposes is not in need of a big, powerful, seven-passenger touring car. Where the user of an automobile takes excursions in highways, byways, woods, and country lanes, a car with large wheels, ample clearance, and good underbody protection is the kind for his purpose. For an opera car and a car for the park and city streets, a low one easy of entrance and of small power is desirable, because it is more economical in the consumption of gasoline, in wear on tires, and in general operating expense. No car with small wheels and wide turning radius should be considered. A multiple-disk clutch is the best for smooth operation, and a selective type transmission is preferable. The application of ball bearings to the transmission and wheels of the car has become almost universal. Such bearings have also been used on the motor crankshaft by some of the leading French and American manufacturers, but on the whole they have not been found to be as satisfactory in the long run as a well-lubricated plain bearing. The manufacturer should be asked to give a guarantee as to the tensile strength and elastic limit of the steels used, as well as to their other properties. An axle or gear not made of proper alloy steel may break.

The tyro who purchases a car is generally more or less ignorant of the use of the different parts. Spark plugs and coils are somewhat easier to understand than carbureters, and for this reason if a chauffeur has any trouble with his car, no matter what it may be, he blames the carbureter. The owner should understand that trouble may be located elsewhere than in the carbureter, which cannot change without outside assistance, provided, of course, that it is rightly made and that the float is of the right material. Half of the so-called carbureter troubles are due to ignition disturbances and other engine troubles, or to a generally run-down condition of the motor from over-use or abuse without the proper care being taken of it or the necessary repairs being made.

THE BUGGY TYPE AUTOMOBILE.

The difficulties in the way of automobiling in the West are far more serious than in the East. Outside of the immediate vicinity of the larger cities, there are very few rock roads. Every rain means heavy mud, and the country, particularly through the middle West, being flat and level, this mud remains for several days after each rain. Beyond the middle West the roads are rough, rugged, full of ruts and stumps. Many of the streams have no bridges, and must be forded. The first attempt to supply a machine capable of traveling over these roads was the production of the high wheel or buggy type automobile, with machinery very similar to the regular automobile. This type has been brought to a remarkable point of development in the last few years. Among its features are the use of large wheels which are generally from 36 to 50 inches in diameter, with 1½-inch solid-rubber tires. All the machinery is carried above the axles, so as to give the greatest road clearance. The tires are wedge shaped, so that in thick mud they cut their way down to solid ground, and then forward through the mud. A double chain drive with large sprockets on the two rear wheels and small sprockets on the jackshaft gives considerable leverage for heavy pulling. A very elastic transmission is used to ease the machinery, so that the chance for breakage in rough places is materially lessened. In fact, the peculiar advantage claimed for this form of transmission on these Western roads, is that in hard pulls and heavy mud it can be set so that it will slip just before the strain approaches the breaking point.

Cases are known of cranking a car while the clutch was left in and the gears were in mesh, with the result that the car reversed or started ahead. Several accidents in which automobiles have run off ferry-boats have occurred in this way, viz., by the releasing of the emergency brake lever (which generally holds out the clutch) just as the engine started. A valuable improvement, therefore, would be a device that would automatically set the gears in the neutral position whenever the car stops.