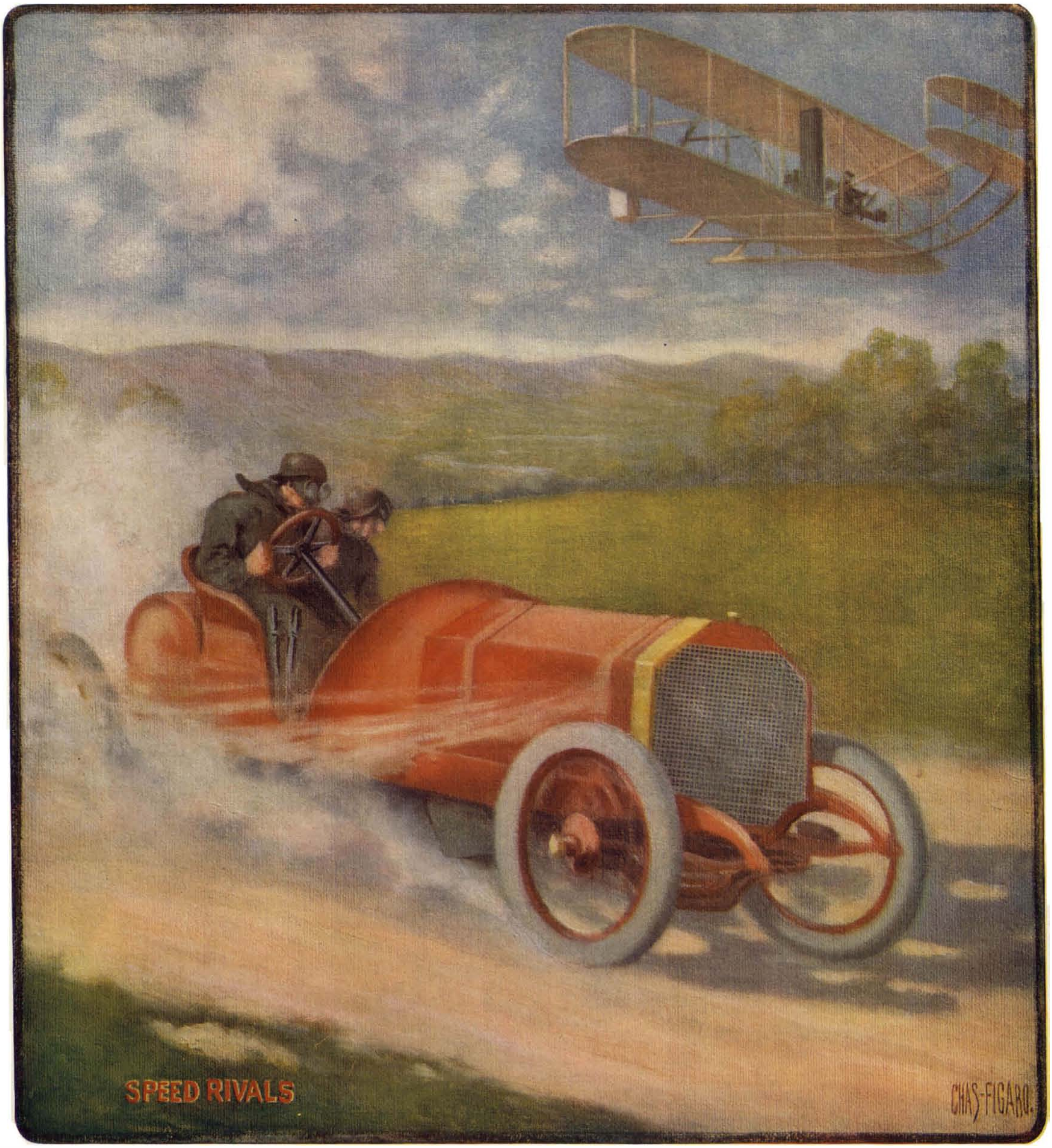
SCIENTIFIC AMERICAN

AUTOMOBILE NUMBER



SCIENTIFIC AMERICAN

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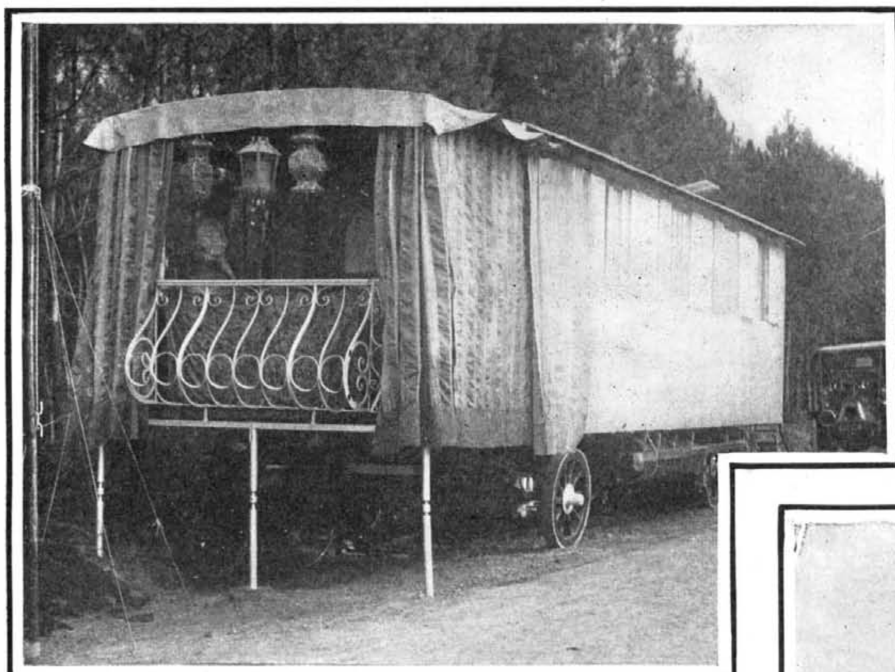
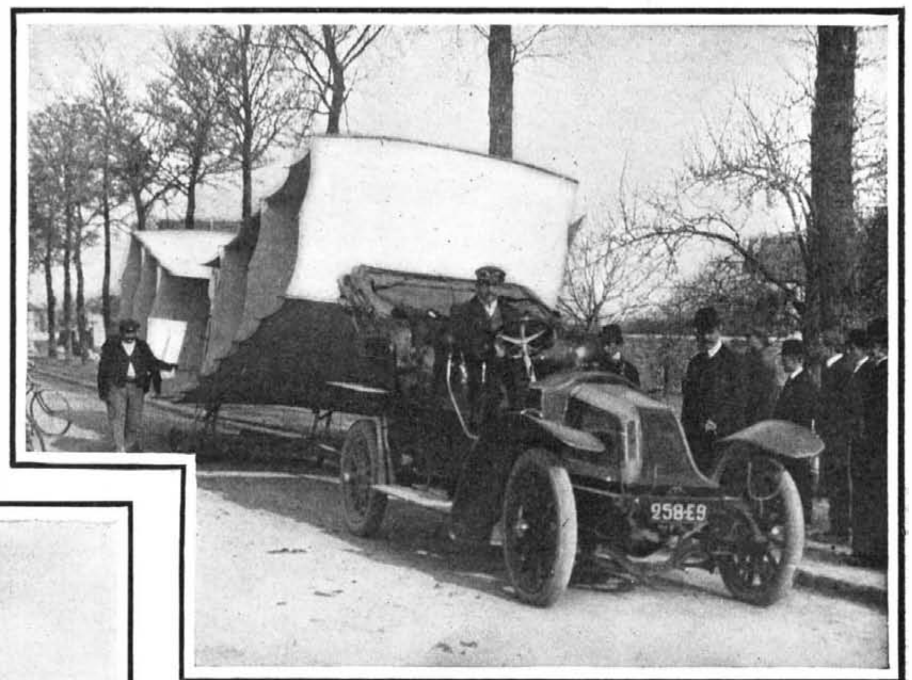
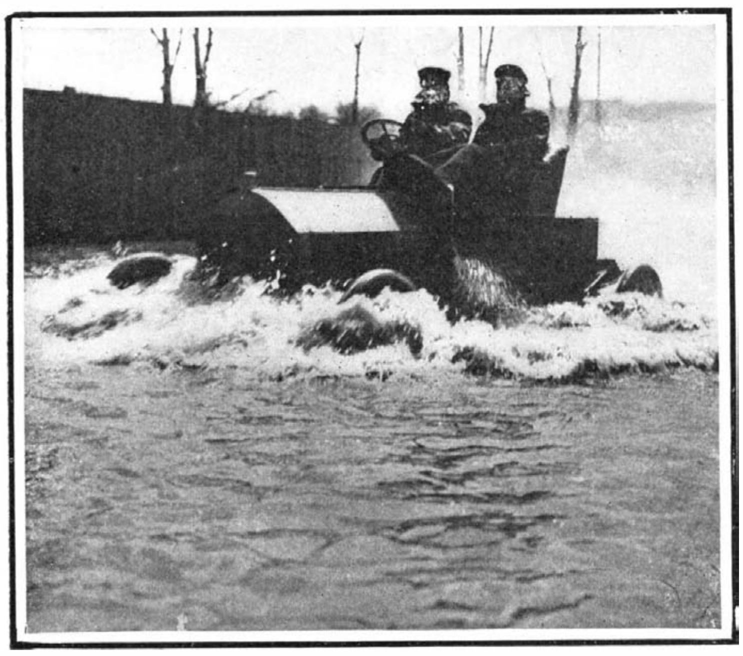


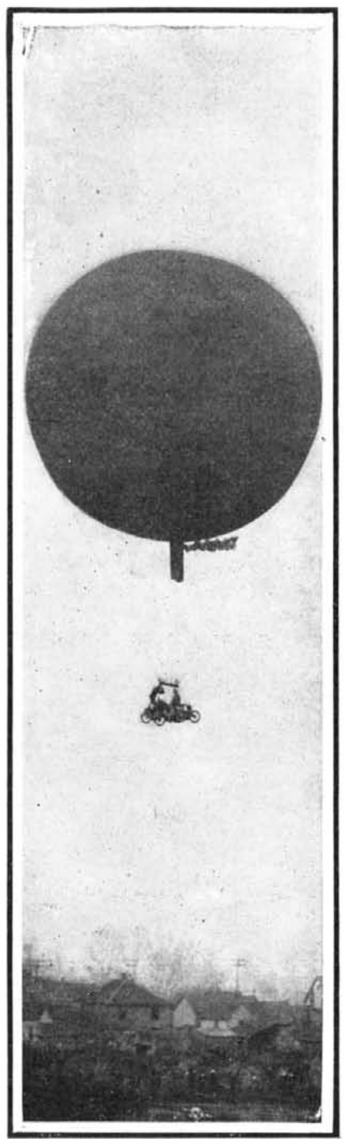
Baron de Sennevoye's automobile cottage, a luxuriously furnished dwelling, which may be considered a houseboat on land.



The horse once used to help the automobile. In France the automobile is frequently employed to transport to the testing ground its probable successor, the aeroplane.



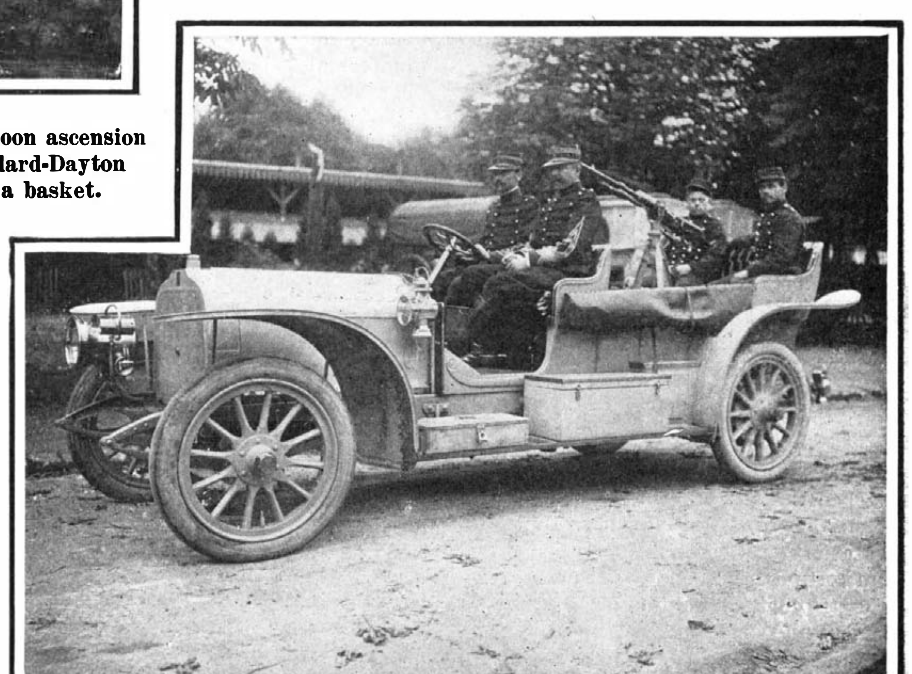
A waterproof Premier car running through water, even though the low-tension magneto is submerged.



An automobile balloon ascension in which a Stoddard-Dayton car serves as a basket.

An attachment by means of which any automobile can be converted into a sled.

An automobile ice cream and refreshment wagon at Ostend.



The touring car as it is used by the French army for carrying machine guns.

AUTOMOBILE CURIOSITIES.

SCIENTIFIC AMERICAN

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NEW YORK, SATURDAY, JANUARY 16, 1909.

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 wirework 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.

The Commercial Truck vs. the Horse.

By Benjamin Rogers.

The use of automobiles for delivery purposes in place of horse-drawn vehicles appeals to the business man as offering advantages in speed, radius of action, independence of weather conditions, and the greater traffic that can be accommodated in a given space, while to the other users of the streets their cleanliness, silence, and the safety that comes from more complete control make desirable their general adoption.

The number of automobiles engaged in commercial service cannot fail to impress the man who has goods to deliver; but in considering their adoption, his first inclination is to compare the cost of operation with that of the horse-drawn system that he employs. As a general thing, he does not consider the increase in the volume of his business that will come with the extension of the district through which he can make deliveries, and also the quicker service that the automobile makes possible. It is these factors, nevertheless, that make the adoption of automobiles an economic necessity. As an example may be cited the case of a cracker manufacturer in one of the larger cities, whose automobile truck has enabled him to increase his sales by three tons of crackers weekly. With horse-drawn trucks he could make deliveries only to the city limits, while with the automobile he can deliver his goods to distant suburban points, and is in close touch with customers that were formerly beyond his reach. Another case is that of a concern dealing in roofing materials, in the delivery of which promptness is essential. The 5-ton gasoline truck that is in use averages 36 miles daily, and deliveries are made to points that would be inaccessible with horse trucks unless a relay system was employed. Again, a New York department store, under a horse-drawn system, delivered goods for Westchester County to a distributing station on 125th Street, from which they were relayed. The use of automobiles has moved the distributing station to 155th Street, and the limit of delivery has been increased by eight miles. This concern gives credit for a considerable increase in its business to the improved and extended delivery service.

The prospective purchaser cannot estimate from the experiences of others the advantages of this kind that he will obtain from the use of automobiles, but he may be guided to some extent by comparing the expense of an automobile delivery service with the cost of his present system. The manufacturers of automobile trucks are in a position to know the costs of operating them, for they are in constant touch with the concerns using their trucks, and usually have access to their records. A study of the accounts, however, will give only an approximate idea of the expense involved, for the load and route conditions will result in a wide variance in certain items, and no estimate can be made of the inevitable overcharges due to inexperience during the first months of operation. A considerable number of manufacturers have submitted estimates of the costs of operating their vehicles, and the following figures have been selected for presentation, because an inquiry among the users of automobile trucks has shown them to be extremely conservative. Proper management should make it possible to operate any well-designed and carefully-selected truck at a materially reduced expense.

Annual expense of operating a 2-ton and a 5-ton gasoline truck:

	2-ton.	5-ton.
Fixed charges	$965.00	$1,315.00
Operating expense	1,215.00	1,440.00
Repairs, supplies	700.00	1,050.00
	$2,880.00	$3,805.00

The expense of operating horse-drawn trucks of similar capacities in New York city is as follows:

	2-ton.	5-ton.
Fixed charges	$223.00	$254.00
Operating expense	2,263.00	2,471.55
Repairs, supplies	125.00	126.00
	$2,611.00	$2,851.55

Annual expense per truck of operating 2-ton and 5-ton electric trucks in lots of 10:

	2-ton.	5-ton.
Fixed charges	$656.00	$820.00
Operating expense	1,278.40	1,324.00
Repairs, supplies	825.30	1,437.20
	$2,759.70	$3,581.20

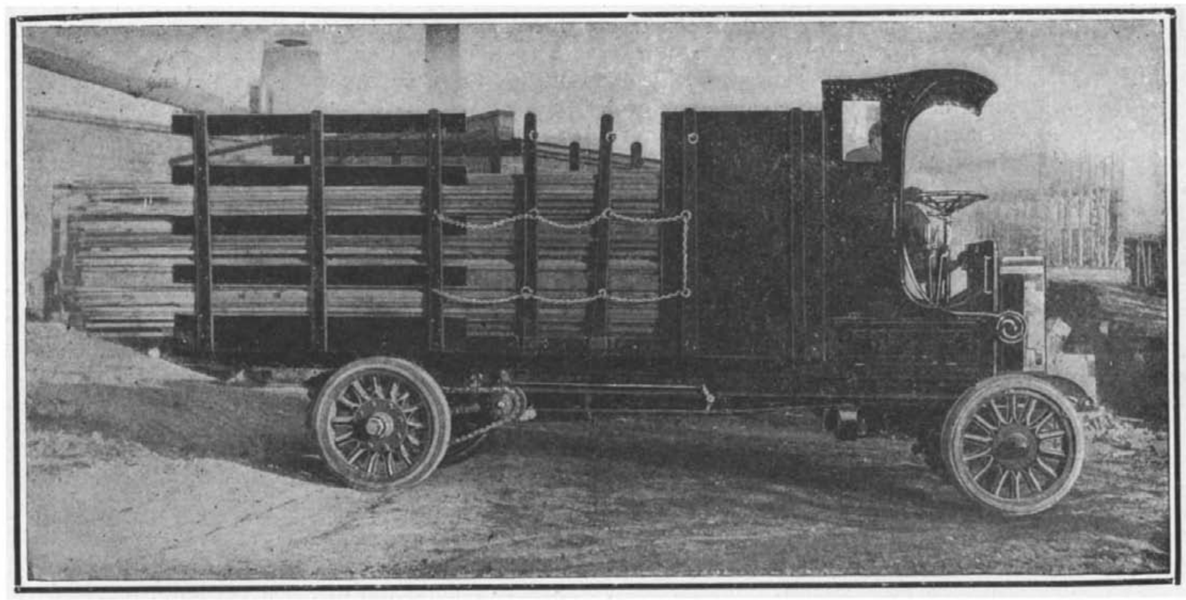
The limit of profitable horse haulage per day with a 2-ton truck is 11 miles, and with a 5-ton truck 9 miles. A 2-ton gasoline truck should have no difficulty in maintaining a daily average of 50 miles, while a 5-ton should cover 40 miles. The 2-ton electric truck should average 30 miles a day, and the 5-ton 25 miles. While the daily cost of the horse-drawn trucks is less than that of the automobiles, the cost per ton-mile, which is the measure of the work done, is much higher.

As an example of what may be expected from automobiles under proper conditions and with intelligent management, the following figures merit careful examination. They are extracted from a report made by the manager of the traffic department to the board of an express company, and embody a comparison between the number, cost, and operating expense of the horse-drawn vehicles required to perform a certain work and the number, cost, and operating expense of automobiles accomplishing the same work. The figures are compiled from actual stable and garage accounts, and are authoritative.

Cost of fifty-three double wagons.

39 3-ton wagons at $373..................	$14,547.00
5 2-ton wagons at $329.43...............	1,647.15
9 1-ton wagons at $379.10...............	3,411.90
212 horses at $220	46,640.00
53 sets double harness at $45	2,385.00
	$68,631.05

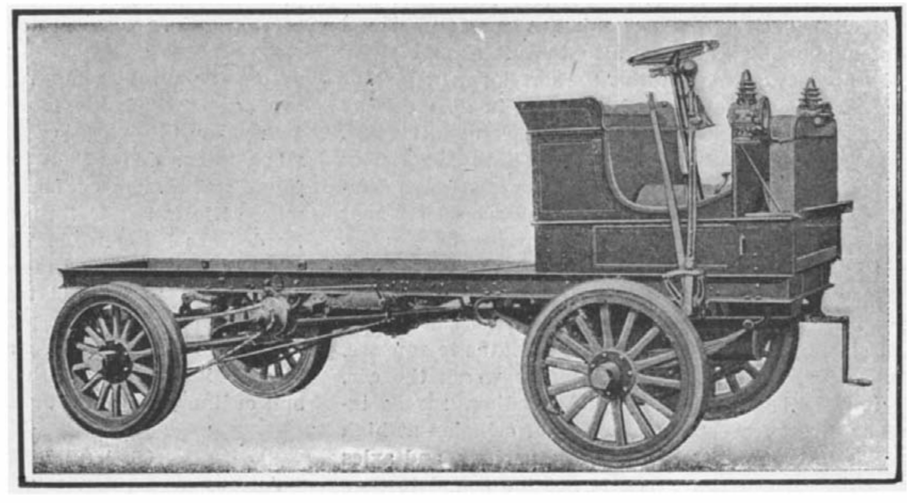
SAURER TRUCK RUNNING BETWEEN NEW YORK AND WHITE PLAINS.



A 5-TON "RAPID" TRUCK AND LOAD OF 6¾ TONS OF HARDWOOD LUMBER AND DRIVER ON SEAT.

A WHITE STEAM AMBULANCE IN SERVICE.

The steam engine is so smooth running that it is particularly well adapted for hospital service.



GRAMM-LOGAN ALL-STEEL 3-TON TRUCK.

A clutch is used that can be thrown in at high speed.

Annual operating expenses.

Interest on $68,631.65 at 5 per cent......	$3,431.55
Depreciation:	
Wagons, $19,606.05, at 10 per cent........	1,960.60
Horses, $46,640.00 at 13 per cent........	6,063.20
Harness, $2,385.00, at 14 per cent........	333.90
Feed and labor:	
212 horses at $26.70 per month..........	67,924.80
53 drivers, at $65.00 per month.........	41,340.00
53 helpers, at $45.00 per month........	28,620.00
	$149,674.05

Cost of forty electric trucks.

10 3-ton trucks at $3,600..................	$36,000.00
Extra battery	442.20
30 2-ton trucks, at $3,400	102,000.00
3 extra batteries, at $376.20..............	1,128.60
Fittings for 10 trucks, at $100............	1,000.00
	$140,570.80

Annual operating expenses.

Interest on $140,570.80 at 5 per cent......	$7,028.54
Depreciation:	
Trucks, less tires and batteries:	
$110,742 at 10 per cent................	11,074.20
Battery trays, jars, and fittings:	
$2,978.80 at 10 per cent................	297.88
Battery plates, $14,300 at 75 per cent....	10,725.00
Tires, $11,550 at 125 per cent............	14,437.50
Current and labor:	
Complete charge, 313 days:	
3-ton trucks, 26 kilowatts, at 5 cents...	4,069.00
2-ton trucks, 20 kilowatts, at 5 cents...	9,390.00
Garage help, 5 men......................	4,080.00
40 drivers at $65 per month.............	31,200.00
40 helpers at $45 per month.............	21,600.00
	$113,902.12
Saving in favor of electric trucks....	$35,771.93

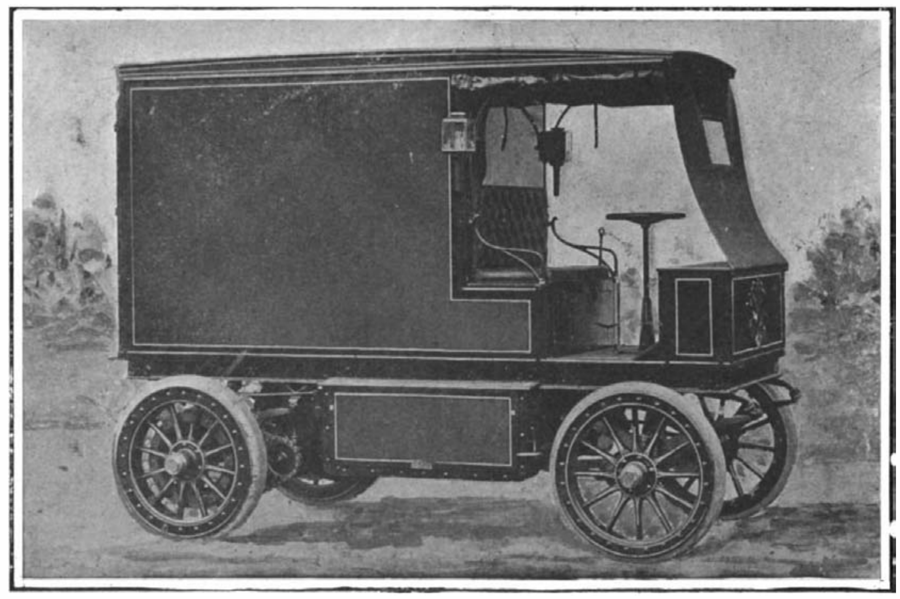
This saving is 23 per cent.

In deciding on the type of vehicle *best* adapted to the work to be done, the purchaser must take into consideration the character of the load, the length of the haul, and the nature of the road surfaces. For hauls of less than a mile there is no economy in adopting automobiles over horses, nor is it advisable when there are long waits for loading and unloading. The electric gives its best service over smooth and level roads, and for round trips of not more than 35 miles. It is silent, the operation is simple, it is easily handled in traffic, and insurance rates are low. Its smoothness of operation reduces the wear on the tires, and the absence of reciprocating parts eliminates one cause of deterioration. On the other hand, gasoline cars can travel for unlimited distances, are unaffected by gradients and adverse road conditions, and are the only ones that can be used for long hauls.

In the European countries steam is being applied

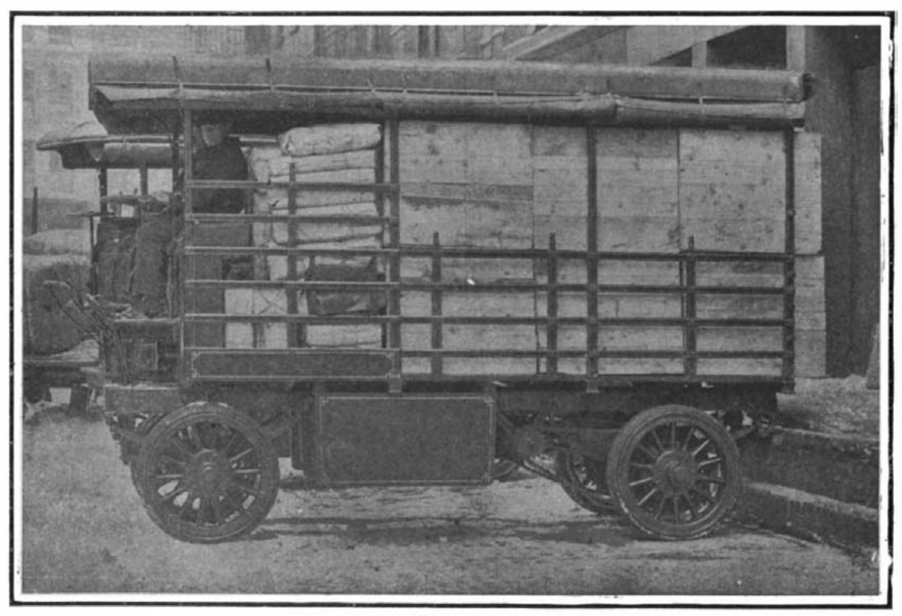
(*Continued on page 63.*)

A HEAVY-SERVICE RELIANCE TRUCK. TWO-CYCLE ENGINES ARE USED.

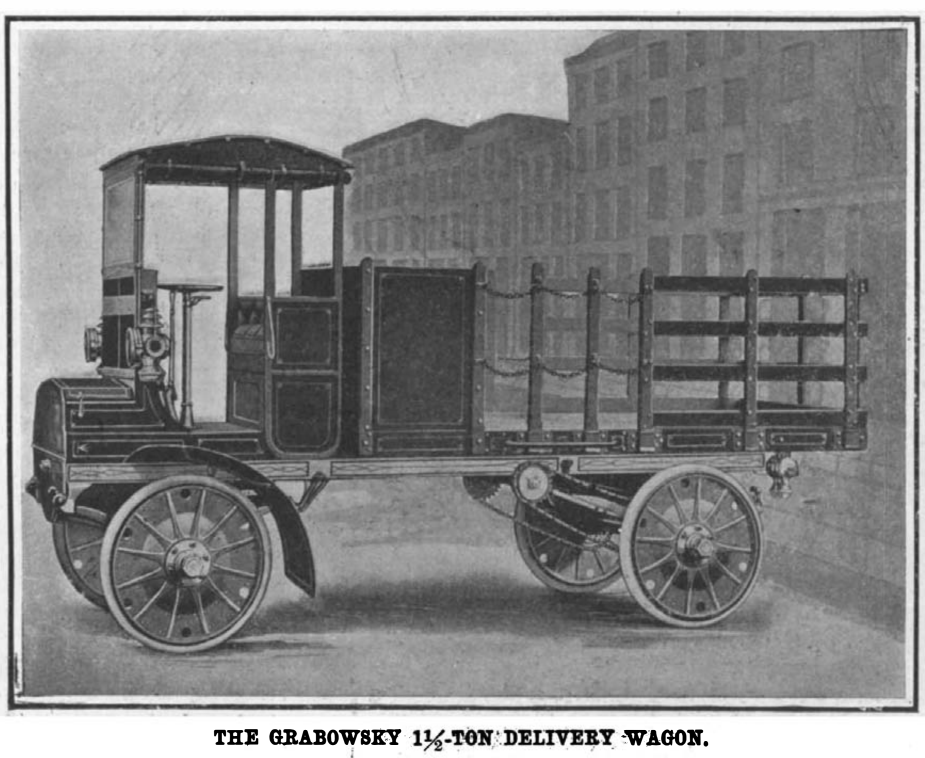


ONE OF 53 WAVERLEY ELECTRIC WAGONS USED BY A ST. LOUIS BREWING COMPANY.

A LAMBERT 3-TON TRUCK USED FOR DELIVERING LARGE QUANTITIES OF PAPERS BY A CHICAGO NEWSPAPER.

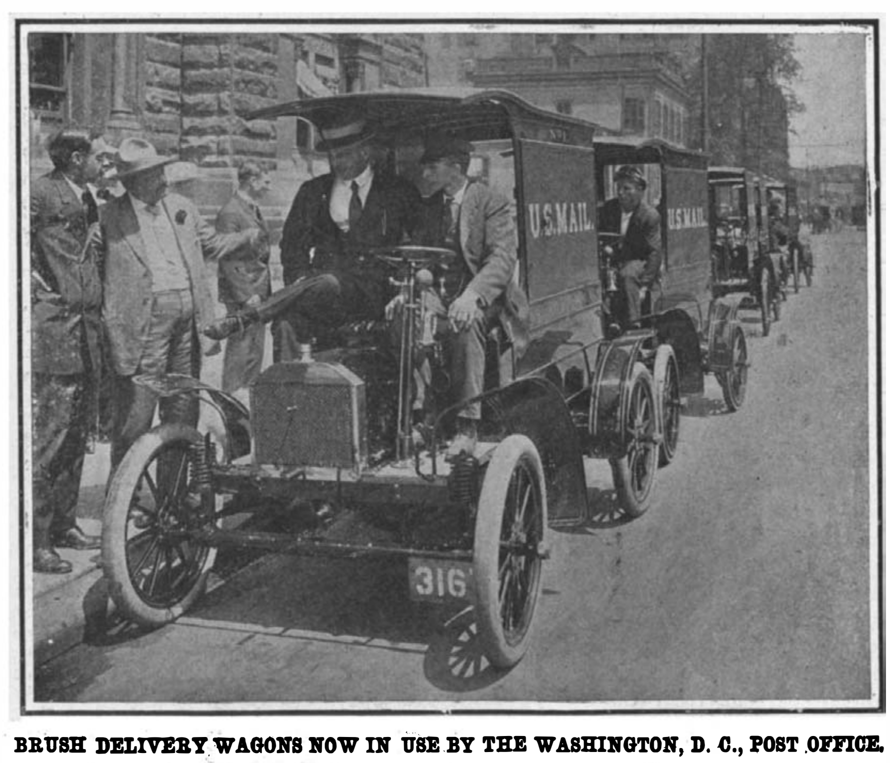


GENERAL VEHICLE COMPANY'S 3½-TON TRUCK IN USE BY A NEW YORK DRY GOODS FIRM.



THE GRABOWSKY 1½-TON DELIVERY WAGON.

The wagon has a quick-detachable power plant which can be taken out entirely and replaced in fifteen minutes.



BRUSH DELIVERY WAGONS NOW IN USE BY THE WASHINGTON, D. C., POST OFFICE.

A good example of the possibilities of the automobile in light service.

High Tension Ignition by Magneto.

By Roger B. Whitman.

The builders of internal-combustion engines realized from the first that the problem of ignition was of paramount importance, and its solution has required careful study and exhaustive experimental work. The task to be achieved is the positive ignition of the charge at such a point in the compression stroke that complete combustion will result when the piston reaches its inmost point in the cylinder. On the variable-speed automobile engine it must in addition be possible to alter the point of ignition according to the volume of the charge and its quality.

The early "hot-tube" ignition system was soon displaced by the Ruhmkorff coil, which was so modified that the high-voltage current from the secondary winding passed across a gap located in the combustion chamber, where it formed a spark of sufficient intensity to ignite the charge. While this system was and still is in very general use, it is not entirely satisfactory because of the possibility of interruptions arising from the multiplicity of wires and connections, the corrosion of the vibrator contacts, and the instability of the batteries.

To avoid the use of batteries, experiments have been made with various types of mechanical generators.

The development of the magneto has been the result. This type of apparatus originated with Faraday, who revolved a coil of wire in a magnetic field, and discovered that changes in the degree of magnetization of the iron core on which the wire was wound resulted in the development of electric currents in the wire, an effect which is in accordance with the laws of induction.

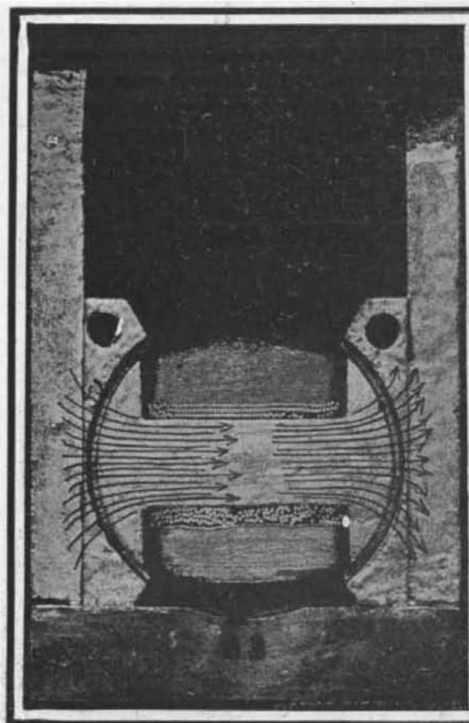


Fig. 1.—Magnetic flow through the cross bar.

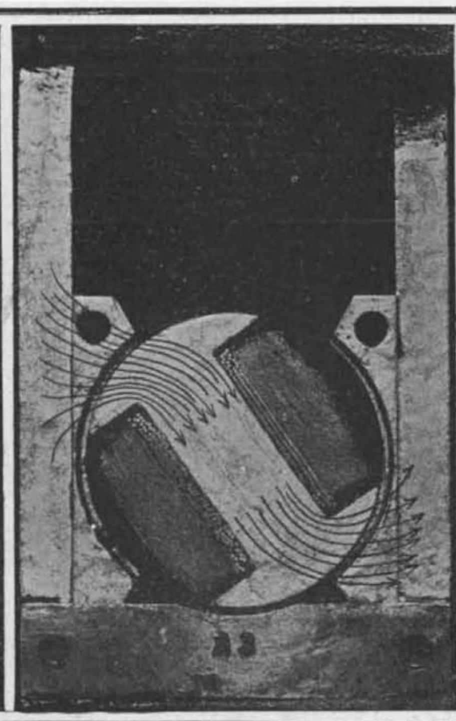


Fig. 2.—Cross bar partially turned with magnetic flow through it.

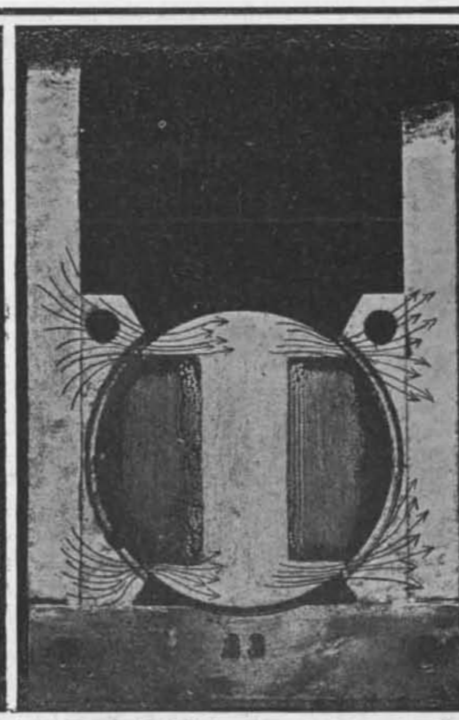


Fig. 3.—The field thrown out by the cross bar disappears in this position.

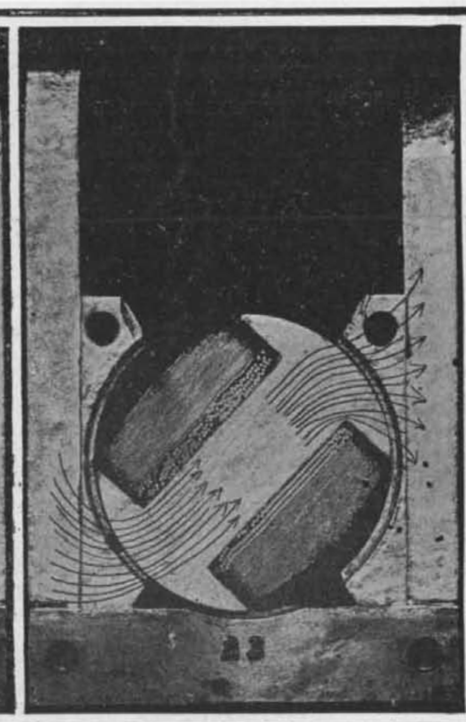


Fig. 4.—The cross bar again becomes magnetized as the magnetism resumes its flow.

CHANGES IN THE STRENGTH OF THE MAGNETIC FIELD THROWN OUT BY THE CROSS BAR AFFECT THE ARMATURE WINDING AND ELECTRIC CURRENTS ARE INDUCED IN IT CORRESPONDING IN INTENSITY WITH THE EXTENT OF THE CHANGES AND THE RAPIDITY WITH WHICH THEY OCCUR.

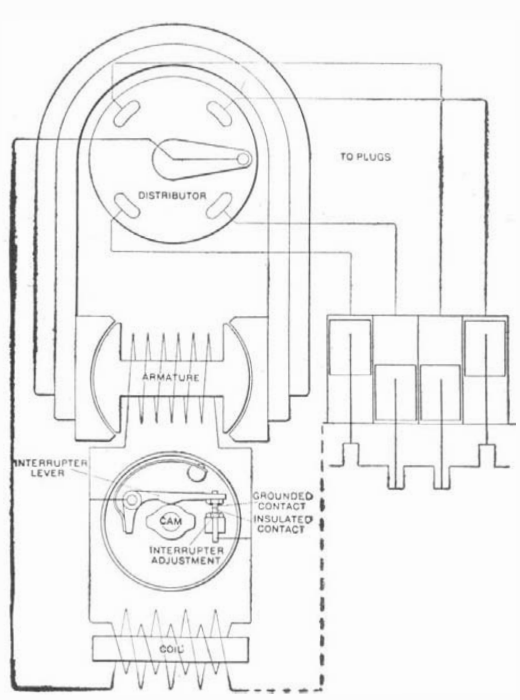


Fig. 6.—The Eisemann system.

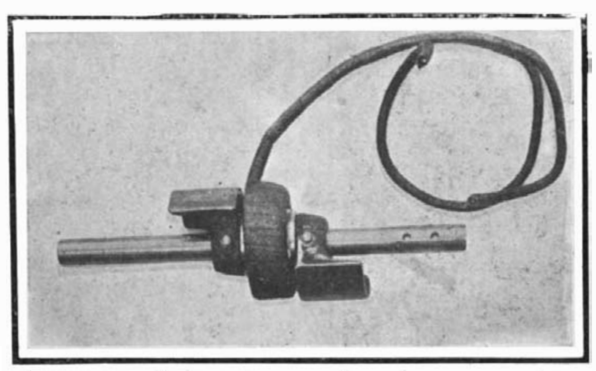


Fig 7.—The Remy armature with stationary winding and revolving core.

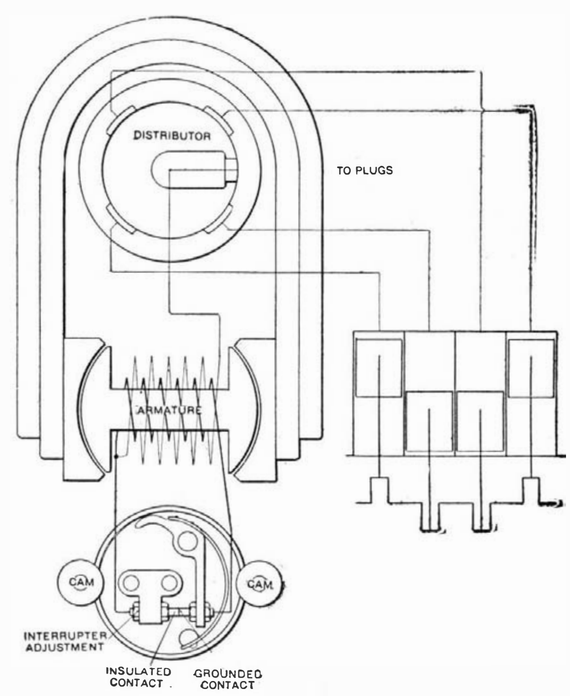


Fig. 9.—The Bosch system.

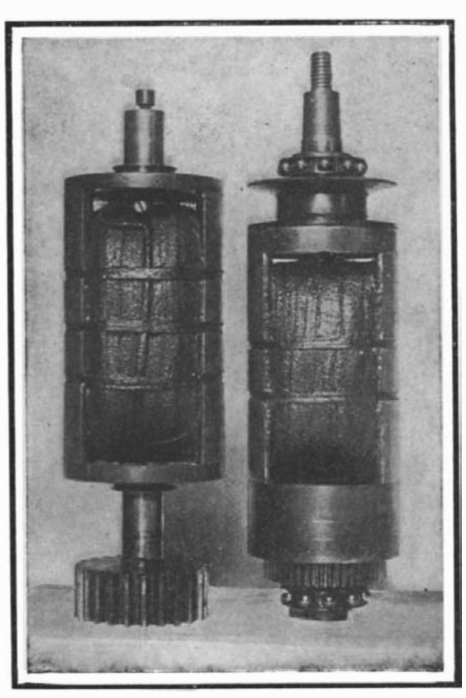


Fig. 5.—Typical magneto armatures.

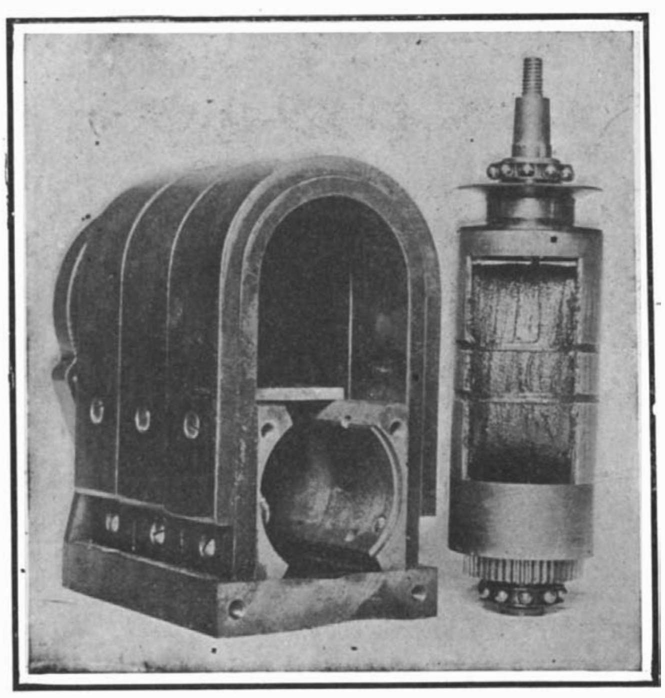
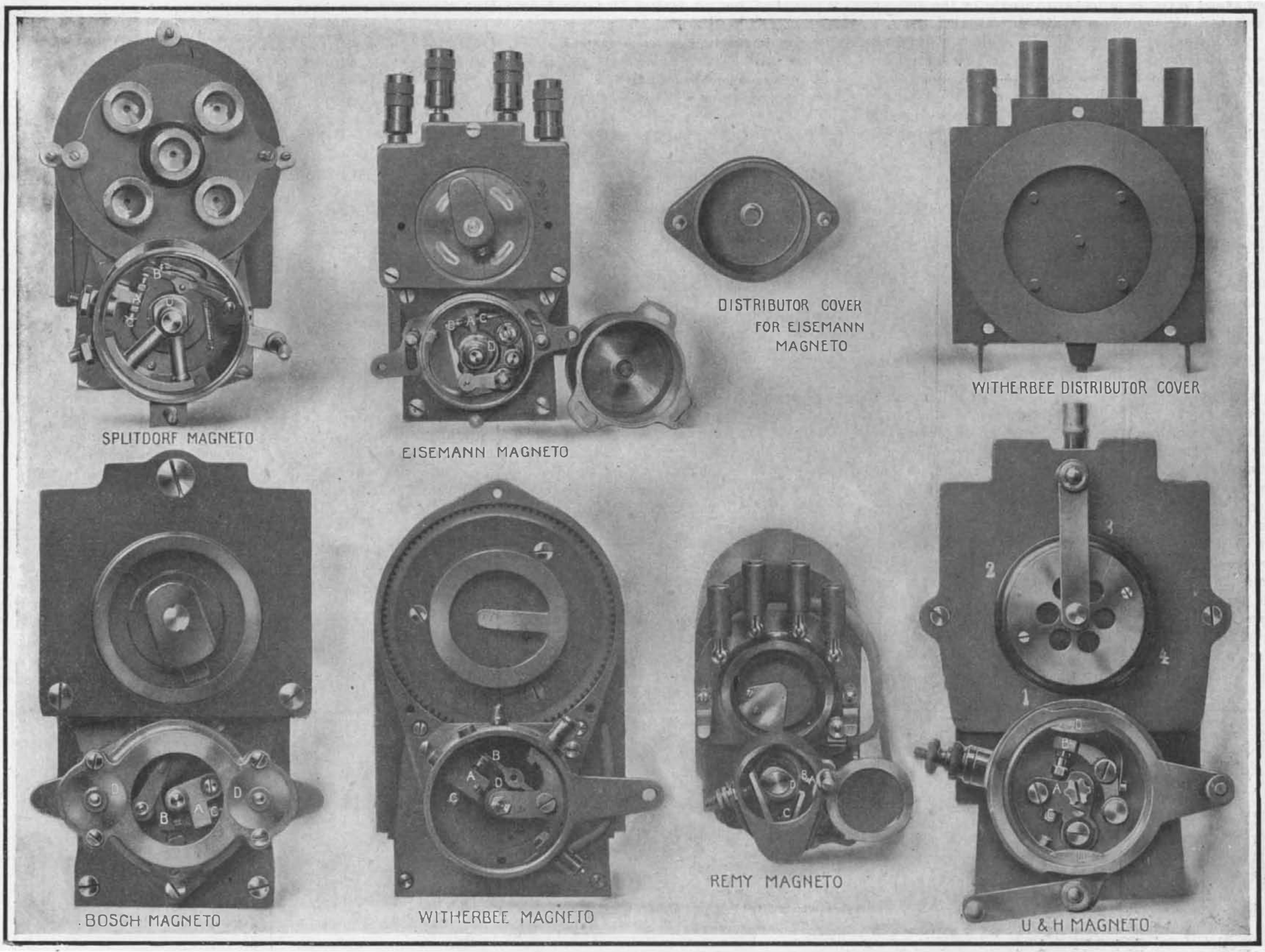


Fig. 8.—Field and armature of Bosch high-tension magneto.

In the modern magneto, the magnetic field is formed between the poles of powerful U-shaped magnets, the coil that revolves in it being wound on an iron core of which the cross section is shown in Figs. 1 to 4. These parts are known as the armature (Fig. 5). Whatever the position of the armature in the field may be, the core serves as a conductor by which the magnetism may flow from one pole to the other. In the positions of Figs. 1 and 2, the magnetic flow is through the cross bar, a condition under which the cross bar becomes magnetized and throws out its own magnetic field. When the armature assumes the position of Fig. 3, the magnetic flow abandons this path in favor of the two shorter paths offered by the side pieces, and the field thrown out by the cross bar disappears. On the further rotation of the armature, the cross bar again becomes magnetized as the magnetism resumes its flow through it. These changes in the strength of the magnetic field thrown out by the cross bar affect the armature winding, and electric currents are induced in it corresponding in intensity with the extent of the changes and the rapidity with which they occur. The greatest changes in the strength of this field will occur as the armature passes from the position of Fig. 2 to that of Fig. 4, for in that interval the magnetic field thrown out by the cross bar will be destroyed and then reproduced.

During the greater part of the revolution of the armature, the changes in strength will be slight and the induced currents correspondingly small; but at the instant when the cross bar becomes remagnetized as the armature leaves the position of Fig. 3, the current will be of sufficient intensity to produce satisfactory ignition. This condition will exist twice during each revolution of the armature, and it is necessary for the armature to be driven in such relation to the crank shaft that each production of maximum current coincides with the ignition point of the cylinder to be fired.

Magnetos were first applied to the ignition of automobile engines on Mercedes cars, the system employed becoming known as low tension, or make-and-break. The maximum pressure developed by these magnetos being in the neighborhood of 100 volts, it can not overcome the resistance of the gap existing in the spark plug, and use is made of a device known as an igniter. This projects into the combustion space, and is connected with the magneto in such a manner that the circuit is made and broken as its two points touch and then separate. By breaking the circuit at the instant when ignition is desired, and having this action coincide with the production of maximum current by the magneto, a spark or flame of high igniting power is obtained. The advantages of this system were recognized immediately on its introduction, but the frequent adjustment made necessary by the wearing of the igniter parts, and the mechanical difficulties to be overcome in making an igniter that is reliable and proof against leakage of compression, prevented its general adoption.



A. Insulated interrupter contact. B. Grounded contact on lever. C. Contact adjusting device. D. Cam.

TYPICAL MAGNETOS USED ON AMERICAN CARS.

While the make-and-break system as a whole did not solve the ignition question, it showed the magneto to be greatly superior to a battery as a source of current. This advantage does not lie alone in the mechanical production of current, but also in the simplification of engine operation; for with a magneto it is unnecessary to alter the point of ignition with each change in engine speed, as is required with a system employing a battery. The intensity of the current being in accordance with the armature speed, and this being in direct relation to the speed of the crank shaft, an increase in the speed of the engine due to opening the throttle will result in the production of a current of greater igniting value. Except for extreme changes in speed, or under special conditions, the effect of advancing or retarding the spark is obtained without the use of the spark-control lever.

The advantages of the magneto have led to its application to high-tension or jump-spark ignition, and to a development that has made the ignition system one of the most trustworthy parts of the car. This evolution has developed two distinct types of magnetos, both of which are driven synchronously with the engine by gearing. One type generates the high-tension current direct from the magneto armature and the other uses an induction coil for raising the voltage to the potential necessary for jump spark ignition. All commercially successful systems are along one or the other of these lines.

The Eisemann and Remy and similar systems are a development of the logical attempt to make use of a magneto as the source of current for a high-tension or secondary coil. Their direct connection with the primary winding of the coil would not give satisfactory results, for the gradual rise in the intensity of the current would give correspondingly gradual changes in the magnetization of the core of the coil. Good results will be obtained only when the magnetic field thrown out by the core of the coil changes its strength abruptly, and to attain this end use is made of a device known as an interrupter or circuit breaker. Fig. 6 illustrates the general principles of the Eisemann system.

The magneto itself is of the low-voltage type, giving a current at from 20 to 40 volts only. One end of the armature winding is grounded, the live end passing to the insulated contact of the interrupter, which is located at the end of the armature shaft. From this point the circuit continues to one terminal of the primary winding of the coil, the other terminal of which is grounded. The grounded part of the interrupter, a pivoted lever, is operated by a cam carried on the armature shaft, and makes and breaks contact with the insulated part. The cam is set in such relation to the armature that the breaking of the circuit by the interrupter coincides with the production of maximum current in the armature winding. When the interrupter is making contact, the magneto current is offered two circuits by which it may flow to ground, one being through the interrupter and the other through the primary winding of the coil. The resistance of the former being low, the current takes that path in preference to the other, which is of higher resistance. When the current reaches its maximum the cam breaks the interrupter circuit, and the only path by which the current can then flow to ground is that offered by the primary winding of the coil. This sudden and intense flow causes the core of the coil to throw out a powerful magnetic field, which induces a current in the secondary winding of from 20,000 to 40,000 volts. This current is passed to the proper spark plug through the medium of a distributer located on the magneto and driven by the armature shaft. A condenser is connected across the interrupter contacts to reduce the sparking as the circuit is broken, and to effect a more abrupt change in the magnetic field of the coil.

In the Remy magneto the winding, which is stationary, is connected through the magneto circuit breaker with the primary of the spark coil. The circuit is mechanically broken during the current wave or impulse generated by the magneto. The current wave generated, due to design of the magneto, retains practically its maximum strength for over 45 deg. of the inductor's revolution. It is claimed for this construction that it permits of a very large timing range for advancing and retarding the ignition point without weakening the spark. The timing of the spark is accomplished by shifting the circuit breaker around the armature shaft, to which is attached the circuit-breaker cam.

This arrangement is frequently confounded with the true high-tension magneto system, and spoken of

(*Continued on page 63.*)

Our Legion Tires and Their Troubles.

By Orrel A. Parker.

Tires have long been made the scapegoat for a great many automobile ills. Not only is the tire blamed for any breaks or derangements of machinery, but during contests of both speed and endurance, the words "tire trouble" are supposed to be sufficient excuse for almost any delay. From their very nature and from the work they are called upon to perform, tires are subject to severe wear and are apt to be sources of trouble, but it is safe to say that ninety per cent of tire trouble arises from causes that can be removed.

A discussion of automobile tires is very much like a discussion of footwear, for the needs of self-propelled vehicles in the way of tires are as varied and diversified as the varieties of footwear needed by the different races and nations of mankind. In selecting tires for a car, the same judgment and discretion is necessary as in selecting shoes. Dancing pumps that wear satisfactorily in the ballroom would not last very long while tramping through the woods or mountain climbing. A track athlete would make a very poor showing if he were shod with a miner's hobnailed boots, and ordinary walking shoes would give a miner very poor service.

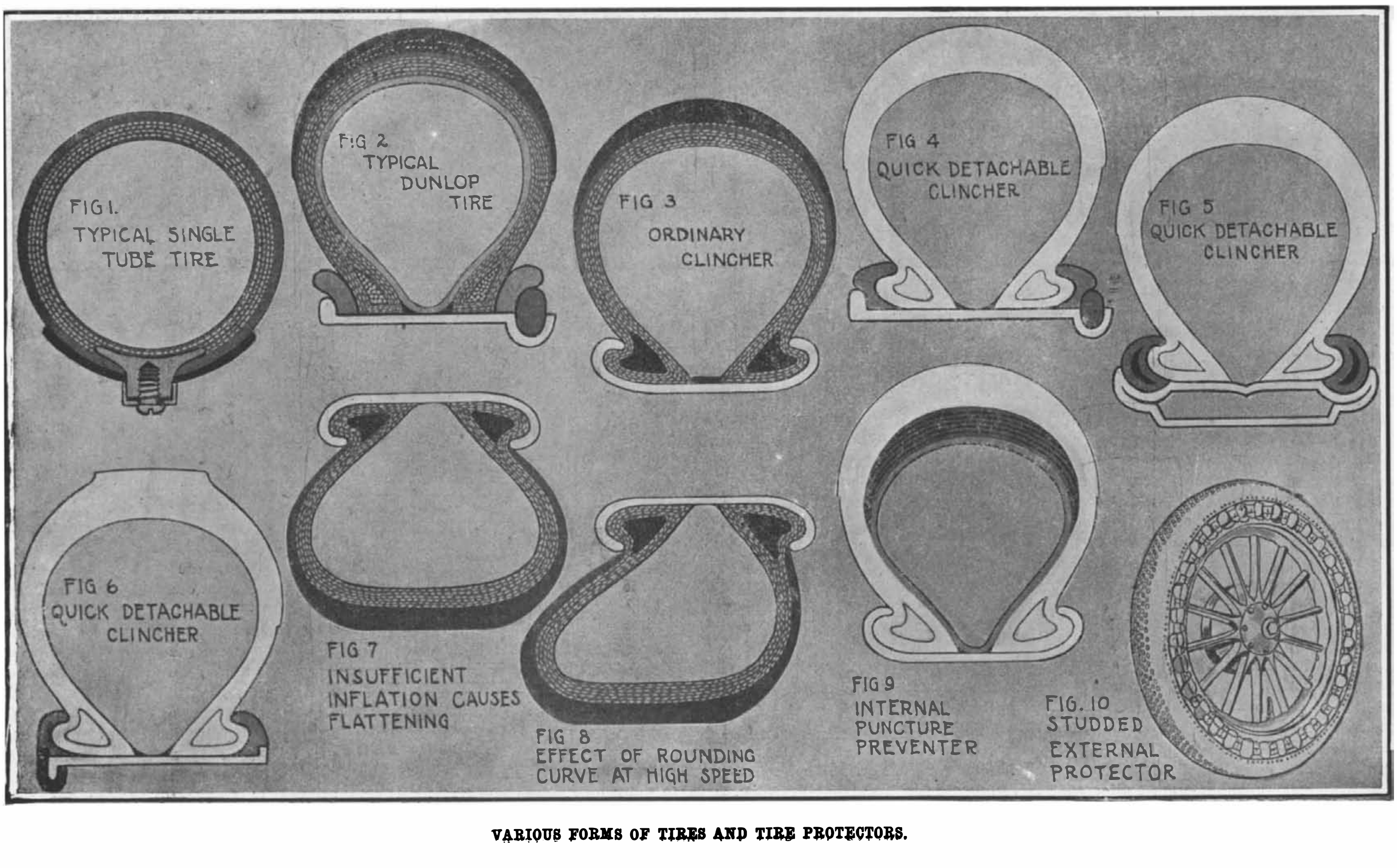
Tires may be roughly classified as pneumatic, solid, and special. The pneumatic tire is again subdivided into the "single-tube" or "hose-pipe" tire, which is now very little used, and the almost universal "double-tube" tire. A double-tube pneumatic tire consists of an outer shoe or casing, which is designed to be more or less readily removed, within which there is an inner tube or air chamber. The inflation of the inner tube usually serves the double purpose of holding the tire securely to the rim and at the same time inflating the tire sufficiently to sustain the weight of the vehicle.

A single-tube tire, as shown in Fig. 1, is usually secured to the rim of the wheel by means of bolts or lugs. Tires of this type are generally credited with giving very good service, except that in the case of a puncture it is exceedingly difficult, if not impossible, to repair the tire properly. Tires of small size can sometimes be repaired by cementing an inserted plug, but larger size single-tube tires can be repaired only by cutting down through the various layers of fabric to the inside layer of rubber, which is designed to hold the air. After this has been vulcanized, the fabric is again built up layer by layer, and the outer covering and tread is put on last of all.

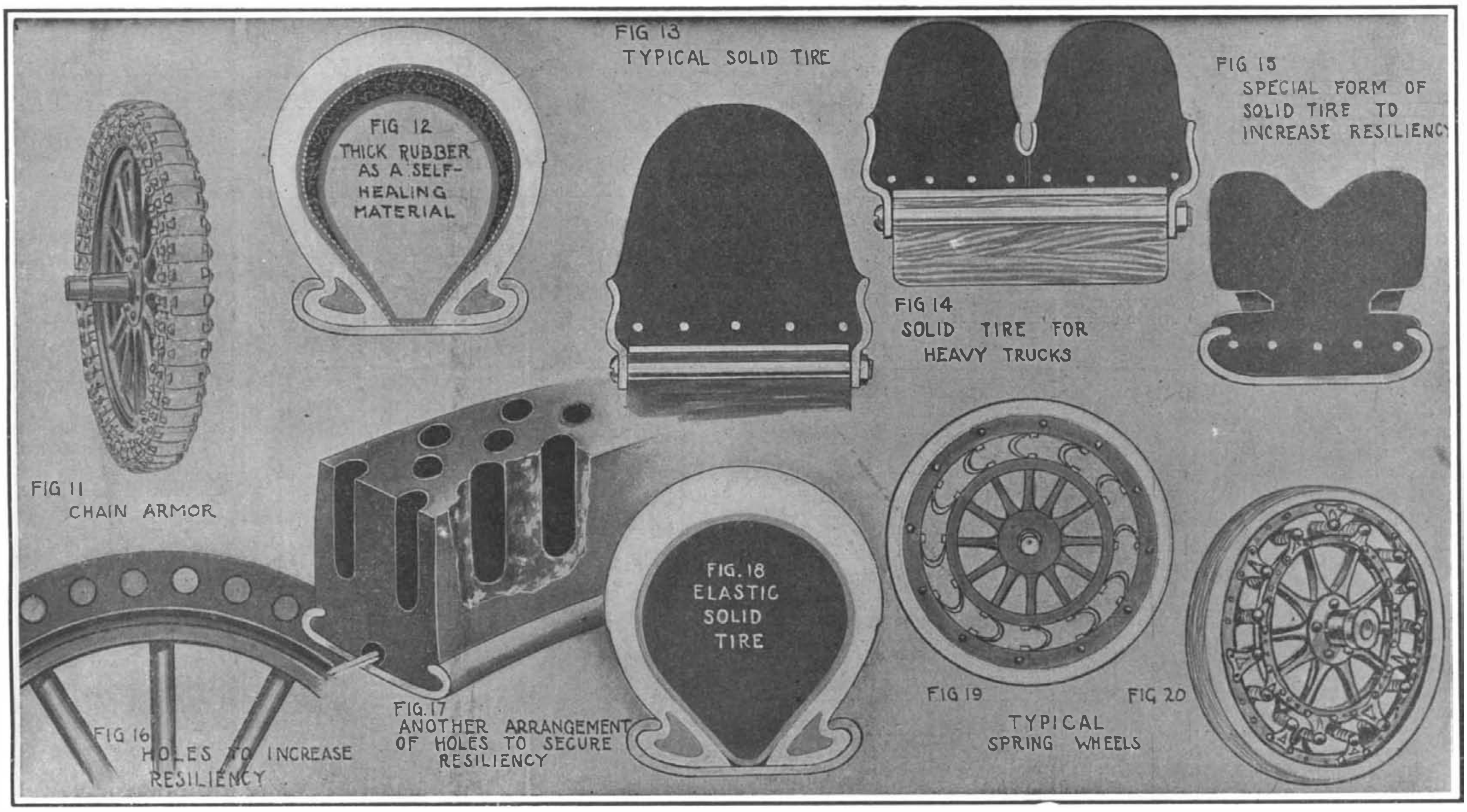
With the exception of one special type of pneumatic tire, which is bolted to the rim and not held on by the inflation of the inner tube, practically all double-tube tires can be classified as "clincher" or "Dunlop." Tires of the Dunlop type (Fig. 2) have wires in each side of the tire, as indicated by the letters *A* and *A'*, which keep the tire from enlarging as it is inflated against the rim. The clincher type of tire is very widely used, and is again divided into two classes: the ordinary clincher (shown by Fig. 3) and the quick detachable (shown in Figs. 4, 5, and 6). The regular clincher tire is made usually with a bead which is more or less flexible, so that it can be stretched over the one-piece clincher rim on which it is used. On the other hand, the quick-detachable type of clincher tire is manufactured usually with a hard bead, which is designed not to stretch, for the reason that the lugs or stay bolts which are generally employed with the regular form of clincher tire are nearly always omitted in the quick-detachable type of clincher tires. Quick-detachable is a term now applied to clincher rims of any form which permits the removal of the outer flange, so that the casing containing the inner tube can be slipped on. After the outer flange or ring is put in place, the tire is inflated, as in the case of the regular clincher form of tire. A great many people confuse quick-detachable tires and demountable rims. All of the demountable rims manufactured in this country (with the exception of one of the bolted-on type) use the regular one-piece clincher rim, and the regular form of clincher tire. This one-piece clincher rim is fastened to the wheel in some manner which permits it to be more or less readily removed. We have no time or space in this article to go into a discussion of the various mechanical means by which this is accomplished. It is sufficient to say that on some forms of demountable rims, the ordinary long valve stem can be used, while on others it is necessary to use a short valve stem, which does not extend more than a small fraction of an inch within the interior circumference of the rim. The difficulty with this form of rim is that air can be pumped into the tire only when the rim is removed from the wheel. To overcome this difficulty, some demountable-rim manufacturers who cannot conveniently use a long stem, employ an L-shaped stem, which protrudes slightly from the side of the tire close to the rim. At least one form of demountable rim permits the use of regular long-stem lugs. Nearly all others require the use of what are called short lugs, which are held in place by a bolt or screw extending but a small fraction of an inch within the inner circumference of the rim. Most demountable rims require attention, on account of the loosening of the mechanical fastenings. The short lugs seem to work satisfactorily, but demountable rims which have inaccessible air valves are apt to give trouble. It may be said that, with this exception, most forms of clincher tires give satisfactory service upon demountable rims, and that the terrors of a deflated tire are very much lessened by having an extra tire already inflated upon a rim ready to take the place of the one which has gone out of commission.

Each type of pneumatic tire is manufactured with treads of various kinds. Perhaps the plain smooth rubber tread is most generally used, but many manufacturers have a special form of raised, grooved, or corrugated rubber tread, each supposed to have special merit in preventing skidding and in wearing well. Various forms of steel studs and leather strips are also used to prevent skidding and slipping, not to mention combinations of wire and rubber for the same purpose. The recent offerings of tires made wholly or in part from leather are the result of the high state of perfection to which the mineral tanning processes have been brought, rendering the leather used so exceedingly tough yet soft and pliable as to be practically puncture proof. One recent make of tire, which combines in its composition leather, canvas, and rubber, with cold-drawn steel rivets for anti-skidding purposes, is distinguished from others of its kind by the fact that the leather tread is so designed in alternate layers that each section is renewable, and the life guaranteed by the maker is from 5,000 miles for the larger sizes to 10,000 miles for the 3-inch and 3½-inch sizes. Each of these forms of tread is perhaps well suited to certain conditions. Tires which give very good service when used in the city upon asphalt do not always prove satisfactory when used upon country roads. It seems that combinations of metal and rubber, or metal, leather, and rubber, do not last as well as treads that are made of rubber alone. Whatever form of non-skid tread is used, it is found of little value when an automobile encounters really deep mud or snow. Under these more severe conditions, all drivers of experience use some form of chain. Apparently smooth all-rubber tires are most economical and satisfactory for ordinary use, and chains used in connection with these tires form the best combinations for severe conditions of travel.

Every automobile owner is interested in what causes tire trouble, and is anxious to know by what means it can be avoided. In the first place, too much must



VARIOUS FORMS OF TIRES AND TIRE PROTECTORS.



PUNCTURE PREVENTERS, SOLID TIRES, AND SPRING WHEELS.

not be expected of a pneumatic tire. A new tire properly designed for the work it has to do should run about 2,000 miles without trouble, except in case of direct injury through a cut or a puncture. After the first two or three thousand miles, trouble is to be expected. I know of one very prominent automobilist of considerable experience who renews his tires after about 2,000 miles, and says that what he loses is more than made up by what he saves in the way of trouble when he tries to wear out the tires completely. *Overloading and under-inflating* are the two things which perhaps shorten the life of a tire more than anything else.

Too many manufacturers have been inclined in the past to equip their cars with pneumatic tires of too light weight. To lessen the cost of his product, the tire is the first thing upon which the manufacturer economizes. Sometimes tires of inferior quality are used, but generally the "economy" is attained by equipping the car with tires a size or two too small for the weight to be carried. Many times the manufacturer is not to blame for overloading the tires, for the reason that the owner of the car puts a tonneau on a runabout, or replaces a touring car body with a heavy limousine. This overloading of tires is sure to cause trouble; and very greatly shortens the life of a tire. Each size and weight of pneumatic tire is designed to carry a certain load, and to stand certain strains. If the load or the speed is very greatly increased, the strains upon the tire increase in even a greater proportion. There is no better investment than the slightly increased cost of larger tires. A tire with a comparatively light load upon it will run many times as far as the same tire with a slight overload.

Under-inflation is the cause of about as much trouble as overloading. A pneumatic tire is depressed or flattened slightly at the point where it rests upon the ground, and this point of flattening travels round and round the tire as the tire rolls along the road under the wheel. This flexing or bending of the tire gives the pneumatic tire its easy-riding qualities. If a tire is pumped up too hard, the weight of a car is not sufficient to flatten it, and the tire rides hard. On the other hand, if the tire is not sufficiently inflated, the tire flattens too much (Fig. 7). This flattening causes an excessive bending of the walls of the tire. A piece of wire may be broken by being bent back and forth a sufficient number of times. In the same way a tire will give way or blow out when its sides are flexed or bent too often. Pneumatic tires are designed and constructed to stand a certain amount of this bending, but under-inflation causes such severe bending that the life of a tire is very greatly shortened. A tire which will run 3,500 or 4,000 miles properly inflated, will have its life shortened to 1,500 or 2,000 miles or even less when run with poor inflation. The excessive flexing or bending of the sides of a tire also causes the tire to heat up. Rubber is vulcanized at a comparatively low temperature, and excessive heat is very injurious to the casing and inner tube. A tire which is properly designed will stand a pressure many times greater than that which is ever put on a tire in use. Few tires are ever injured through over-inflation. Every tire manufacturer continually urges his customers to keep tires properly inflated.

If a tire is constructed with many layers of fabric, so that the walls of the tire are very thick, two difficulties are at once experienced. The bending of the sides of the tire as the car runs causes excessive heating. This bending also causes the different layers of fabric to separate. Besides, a tire frequently "rim-cuts," and is injured by having the steel rim pressed down against it. Tires that have heavy thick walls frequently give good service if they are kept well inflated, while, on the other hand, under-inflation causes them to "rim-cut" and blow out very quickly. Some tires, especially those of foreign manufacture, are very thin and flexible. They are made of strong fabric and high-grade rubber, and are less liable to injury through under-inflation. The bending of the sides of the tires also generates less heat, because the sides of the tire are thinner. Such tires are serviceable on good roads and at high speeds, but frequently they do not stand the cuts of a rough country or mountain road as well as a heavier form of tire.

A defective rim will also frequently shorten the life of a tire. A dent in the rim may cause undue strain upon the fabric at that point. Sometimes a rim which has been run without a tire is slightly flattened down and sharpened, so that a tire will not fit exactly, and is cut and injured by the rim. Persistent trouble with one wheel usually results from this cause or from the wheels being out of line. Any mechanical derangement of the car or its running gear which causes a wheel to be out of line, or the bending of a wheel which causes it to "wobble" as it goes round, will soon cause trouble with the tire. In the same way unequal action of brakes on the rear wheels, by which all the braking strain comes upon one wheel, or an improper design of the differential, which causes more driving strain upon one wheel than the other, will cause that particular tire to show excessive wear.

Other things being equal, the wear on tires is proportional to the skill and care used in driving. A driver who starts his car suddenly, jumps into high gear within a few feet, comes up at full speed to within a few feet of the place where he wishes to stop, and then puts on the brakes hard, subjects his tires to unnecessary wear and to excessive strains which greatly shorten their lives. In the same way a driver who applies excessive power, and unnecessarily spins his wheels upon a wet pavement or muddy or sandy road, grinds down his tires. The sides of tires are very frequently injured by being needlessly run in narrow ruts, or by being rubbed up against the curb when stopping or by turning a corner too sharply. Perhaps the greatest strain is placed upon tires in taking curves and turns at too high a speed. Everyone knows that it takes a great deal of power and force to change the direction of a moving body. Friction between the roadway and the tires causes this change of direction, thus producing very great side strains upon the tires (Fig. 8). The frequency with which tires explode at turns should be a sufficient warning even to the most reckless driver. The slower the speed with which corners and curves are taken, the longer tires will last. The life of the tire can also be increased by throwing out the clutch in going around corners and over severe bumps. The differential or equalizing gear works when a car turns a corner. It does not turn as readily when transmitting power as when running idly. One racing driver of worldwide reputation goes so far as to assert that a differential gear does not work at all when a car is rounding a curve under power. If the differential does not work, the rear tires must slip and undergo the strains and wear that go with slipping. Many automobiles are so designed that when the body of the vehicle is jounced up and down, as when crossing raised car tracks or similar obstructions, motion is transmitted by the body of the vehicle to the tires through the driving chains or driving shaft. This slight jerking back and forth of the tire, which an owner could hardly discover, is given by engineers as the reason why some cars are especially hard on tires.

The lightness and resiliency of air are responsible for the worldwide adoption of pneumatic tires in spite of their many shortcomings. That the expense and uncertainty of pneumatic tires have caused thousands of inventors to try to solve the problem of providing a trustworthy resilient tire, is shown by the three thousand patents on improvements in tires which have been issued by the United States Patent Office. Of course, a vast majority of these patents are worthless, because they were taken out by men with no experience in the manufacture or use of tires.

Various forms of internal puncture protectors have been devised. Some consist of layers of felt, and others of disks of metal between layers of fabric. These are usually crescent shape in design, and are placed between the inner tube and the casing (Fig. 9). Under favorable conditions some of these protectors have been known to stay in a tire for a considerable period of time without causing trouble. No doubt they prevented many possible punctures. As a general rule, however, the introduction of any material between the casing and the inner tube soon causes trouble. The continuous flexing or bending of the tire, especially when run with under-inflation, soon causes a breaking or derangement of the internal protector. The added thickness also causes excessive heating. For these reasons the use of internal protectors of these types has not become very general.

In seeking to protect a tire from puncture, a great many forms of external protectors have been devised. They are usually made from leather or from fabric and rubber, and are frequently covered with rivet heads or metal studs (Fig. 10). Sometimes these protectors are placed over the casing when the tire is deflated, and are held on by inflation. In other cases there are metal hooks, which catch under the edge of the clincher rim. Other types of protectors are held on by rings and by buckles. Such protectors are usually rather expensive, and cost perhaps about half

(Continued on page 65.)

Automobile Lubrication.—Some Elementary Principles.

By Thomas D. Hanauer, M.E.

Member A.S.A.Eng., Chief Instructor of N. Y. School of Automobile Engineers.

The successful operation of any kind of automobile, be it a touring car, commercial vehicle, motor cycle, or motor boat, depends to a great extent on the proper lubrication of all the many working parts, a fact which is very often overlooked by both owner and chauffeur, and which results in shortening the life of the vehicle and in large repair bills. If a car has been neglected for any length of time, as far as conscientious lubrication is concerned, nearly every moving part becomes badly worn. Fifty per cent of all repair bills could easily be saved if the chauffeur would lubricate the entire car systematically.

Of all the troubles which may occur, those resulting from faulty lubrication are the most serious because they can be remedied usually only after long delay on the road. In many cases, however, the car must be towed home, so that the defective part may be renewed. Other troubles, such as those caused by faulty ignition, carburetion, or even tire troubles, can be remedied quickly. Moreover, the chauffeur is usually warned in these cases. Lubrication troubles, however, appear suddenly.

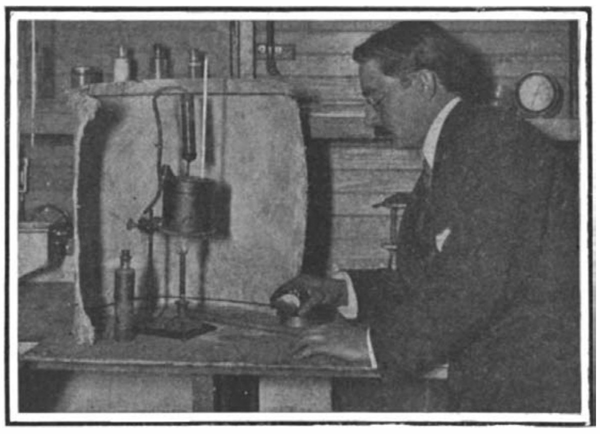


Fig. 1.—VISCOSITY TEST.

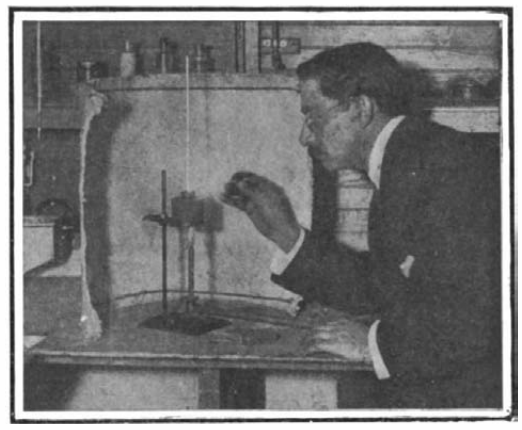


Fig. 2.—FLASH TEST.

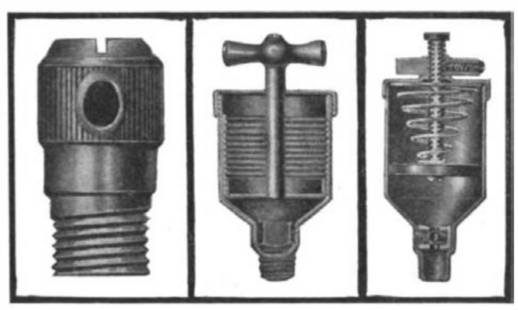
To be able to lubricate our car properly, it is absolutely necessary to have a system of lubricating. In other words, we must lubricate certain parts daily, some weekly, and others monthly. In addition, we must understand the nature of the lubricants used, and the devices employed to take care of the individual lubrication of bearings. We must familiarize ourselves, therefore, with the following:

1. Lubricants, their nature in general.
2. Lubricants used on a car, which may be subdivided into the following groups: (a) Liquid lubricants (cylinder oils). (b) Semi-liquid lubricants (non-fluid oil, vaseline, greases). (c) Solid lubricants (graphite).
3. Lubricating oil tests: (a) Specific gravity. (b) Viscosity. (c) Evaporation or volatility. (d) Flash and fire test. (e) Cold test. (f) Acid test.
4. Lubricating systems: (a) Grease cups. (b) Gravity feed. (c) Pressure feed. (d) Mechanical force feed. (e) Splash system.
5. How to lubricate the car systematically: daily, weekly, semi-monthly, monthly.
6. General remarks.

Lubricants: Their Nature in General.—The majority of oils and lubricants marketed as automobile oils to-day by a very large number of concerns are made by the Standard Oil Company. Numbers of small jobbers have helped considerably to confuse matters by selling one of the Standard Oil Co.'s ordinary machinery oils as a special automobile oil.

Hydrocarbon oils are strictly mineral oils, free from acid, and having petroleum as a basis. They are subdivided into residual oils and distillate oils. Residual oils are the products left over after the more volatile oils (gasoline, kerosene) have been volatilized during the process of distillation. They consist of hydrogen and carbon only. Distilled oils are produced by distilling, deodorizing, and coloring by chemical treatment the petroleum tar which is left after all residual oils have been obtained. The lubricating qualities of a mineral oil are greatly increased by compounding or mixing it with some fatty oil (animal or vegetable), such as sperm, lard, tallow, fish oil, or vaseline. At high temperatures most of these oils, however, lose their lubricating qualities. Vegetable and animal oils are liable to decompose at high temperatures and then liberate acids (injurious to metal) or tar. To the group of animal oils belong: (a) The blubber of the whale (sperm-oil); (b) neatsfoot oil, from boiled cattle feet; (c) lard oils; (d) tallow; (e) fish-oils.

To the group of vegetable oils belong: (a) linseed oil, obtained by compressing flax seed; (b) cotton-seed oil, produced by grinding, steaming, and pressing the seed of the cotton plant; (c) olive oil, from olives;



Oil cover. Grease cup. Grease cup.

Fig. 3.—TYPICAL LUBRICATING DEVICES.

(d) palm oil, from African palm nuts; (e) resin oil, produced by distilling the resin of pine trees; (f) castor-oil.

As far as the origin of petroleum or crude mineral oil is concerned, it must be said that the opinions of scientists, chemists, and geologists still differ considerably. Some say that crude oil comes from inorganic substances, while others claim that it is of organic origin. At any rate, one fact remains: All mineral cylinder lubricating oils contain carbon, although some manufacturers try to impress on the public that their products "will not char," "contain no carbon whatever," or "will deposit no carbon." These broad claims show how very, very little some oil dealers seem to know about their own products. While all oils deposit some carbon, different brands will deposit different percentages of carbon, depending also on conditions in cylinders.

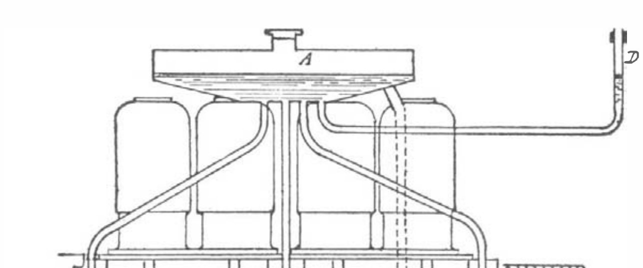


Fig. 4.—GRAVITY FEED OILING SYSTEM.

The oil flows from the crankshaft into the oil well *B*, and is pumped from there into the tank *A* at the cylinder heads. It flows by gravity to the main bearings and oilways drilled in the crankshaft to the connecting-rod bearings. The oil pump, not shown, is at *C*. *D* is a glass showing height of oil in the reservoir.

Obviously, the oil that deposits the least carbon will be the best to use. By filtering an oil, one can reduce its carbon-producing qualities. The more an oil is filtered, the lighter and clearer in color it becomes. In its natural state, oil is greenish black to dirty dark brown in color. A completely filtered oil would be water white or colorless. Partially filtered oils are of a reddish, yellowish, or straw color.

Liquid Lubricants (Cylinder Oils).—Marine steam engines are strictly high-speed engines, the steam itself being of very high pressure and high working temperature. Therefore oils which may give perfect satisfaction on slow-running, low-pressure stationary steam engines cannot be used. A good automobile steam-engine oil should have the following qualities: High flash test (600 deg.), and sufficient viscosity to adhere to the very hot cylinder walls. The table will enable the reader to compare some of the best-known oils on the market to-day. For obvious reasons manufacturers' names have been omitted. The writer advises that every owner comply with the lubricating directions furnished by the manufacturer of the car. This is the cheapest and best course to follow, for the maker of the car has in most cases tried out a large number of leading lubricants, and if he recommends a certain brand, he does it only because he has found it particularly satisfactory.

Gas-Engine Cylinder Oils.—In cylinder and piston lubrication, where very high temperatures prevail, not only the viscosity and purity but also the flash point will have to be considered. The flash point should not be below 410 deg. F. Cylinder oils should not decompose at high temperatures. The price varies from 50 cents to 75 cents a gallon wholesale. Inferior oils cause knocking and gumming of rings.

Semi-Liquid Lubricants (Non-fluid Oils, Vaseline, Greases).—To this group belong the partially liquefied oils, which should be free from acid and manufactured from mineral oils only. Generally they exist in a plastic condition, flowing slowly to the bearing,

TESTS OF SOME LEADING LUBRICATING OILS.

Brand.	Specific Gravity.	Viscosity at 212 Deg. F.	Flash Point, Deg. F.	Fire Point, Deg. F.
1	0.882	59	450	500
2	0.919	57	415	480
3	0.910	57	365	410
4	0.880	73	435	510
5	0.875	51	450	500
6	0.900	120	500	560
7	0.892	57	410	500
8	0.869	47	420	480
9	0.868	50	435	480
10	0.892	55	500	560
11	0.905	27	400	450
12	0.895	47	420	470

and beginning to lubricate as soon as applied. Non-fluid oils (vaseline) have special oil cups in which the lubricant is forced to the bearing by spring pressure (Fig. 3). When using greases, however, screw pressure cups turned by hand are employed. Greases in general are nothing but mineral oils, thickened with tallow, soaps, graphite, chalk, starch, etc. Some of these ingredients, added to thicken the oils, actually increase their lubricating quality. This is true of graphite. More often, however, they increase the manufacturer's profit. They are employed to lubricate steering connections, wheels, water pumps, universal joints, ball bearings, and transmissions and main-bearings of 2-cycle engines.

Non-fluid oils are mineral oils so treated as to be-

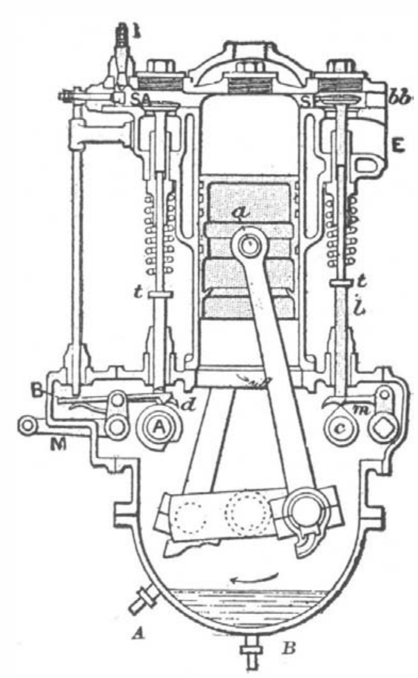


Fig. 5.—SPLASH SYSTEM OF LUBRICATION.

A is a cock to test level of oil. *B* is a drain cock.

come partially solidified. Their consistency varies but little with changes of temperature. They have the advantage over regular oil that they do not drip.

Solid Lubricants (Graphite).—Graphite is one of the best lubricators known and can be used in most parts of the car, added to the oil, which then carries it to the bearing proper. Mixed with grease, forming a heavy paste, it has been used successfully in slow-running journals, transmissions, or wherever very heavy surface pressures exist, or wherever oil does not permanently identify itself either with the journal or bearing but forms an intermediate film only, depending on the pressure transmitted and the viscosity.

Graphite forms hardly any film between rubbing surfaces, but associates itself with either one or the other or both working parts. It acts like a filler or veneer and is of great value when used on poorly surfaced machine-parts. It is marketed in two forms—amorphous (or powdered) and "flake"—and in connection with cup grease, universal-joint and gear-case compounds, good for chains and fiber cam-shaft gears. Mixed with quickly-drying shellac, it forms a rust-proof coating for rims. Threaded connections treated with a mixture of graphite and oil will form tight joints, but can nevertheless be easily removed.

Oil Tests.—As the conditions (temperature and pressure) under which lubrication must take place are so changeable throughout the various moving parts of an automobile, the greatest care should be exercised in selecting lubricants. To be able to judge oils it is necessary to be acquainted with the various tests which are made to determine their qualities. In the following these tests are as briefly described as possible.

1. *Specific Gravity*.—The relative weight of an oil as compared with that of water at a given temperature is called specific gravity of the oil, and is measured in degrees Baumé. Only manufacturers conduct specific gravity tests.

2. *Evaporation, or Volatility*.—The amount of oil lost by evaporation is determined by the saucer test, which consists in exposing an oil in a flat receptacle to a temperature of from 200 to 250 deg. F. for twelve to twenty-four hours. The test is made chiefly by manufacturers, but can be made by the automobile owner.

3. *Viscosity*.—Of all oil tests, this is probably the most important. By it we determine the fluidity or body of an oil at certain temperatures. For instance, the body or thickness of a cylinder lubricating oil at normal temperature is absolutely no guide to its lubricating quality. It will be much thinner at higher temperatures, such as we find in the cylinders of a gas engine, where the normal temperature is not lower than 200 deg. F. and rises to 350 deg. F. Viscosity, properly speaking, is the cohesion of the oil molecules, and defines their adhering qualities to the metal surfaces which they are to separate and lubricate at given temperatures and pressures. The viscosity test consists in determining the length of time in seconds it takes a certain amount of oil to flow through an aperture such as a small tube of a given size and length. The temperature of the oil is kept either at 100 deg. F. or 212 deg. F. It is essential that this temperature be carefully maintained throughout the test. The body of most oils raised to 300 deg. F. is only about 2 per cent to 6½ per cent of the body at 70 deg. F. (See Fig. 1.)

4. *Flash and Fire Tests*.—The flash point of a lubricating oil is the temperature which, a burning taper being held over the surface of the oil, will produce a flame. Only the vapors which have risen from the surface of the heated oil are ignited, however, and not the oil itself. Hence the flame is almost immediately extinguished. By the fire test, we determine the temperature at which an oil takes fire and continues to burn when brought in contact with a burning taper. (See Fig. 2.)

5. *Cold Test*.—Lubricants, in general, when exposed to low temperatures, congeal and set more or less, thereby clogging lubricators, oil feeds, etc., and ceasing to lubricate on the one hand or increase friction on the other. A motor is started with greater difficulty in cold than in warm weather. A large number of manufacturers put three grades of gas engine cylinder oil on the market. These are the light, medium, and heavy qualities, often called summer and winter oils. The cold test of a fairly light oil is the temperature at which the oil starts to congeal and stops flowing. When testing heavier lubricants, the oil to be tested is first frozen, and the temperature is taken at a point at which it starts to flow again. In a cold test for steam cylinder oil the congealing point is about 45 deg. F. Machine and engine

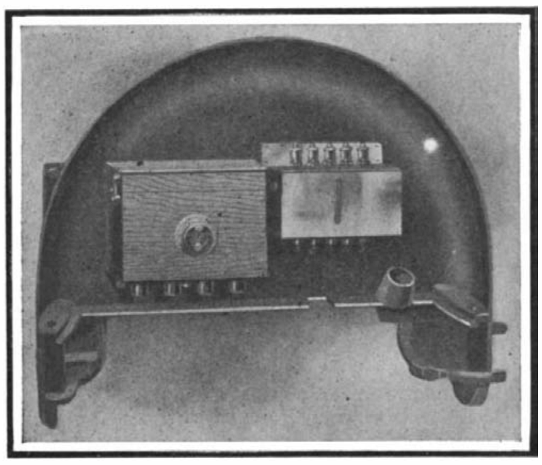


Fig. 9.—LUBRICATING DEVICES ON DASHBOARD.

oils congeal at about 32 deg. F. There are some light oils which are specially manufactured for winter use, having a cold test as low as 0 deg. F.

6. *Acid Test*.—When using greases or non-fluid oils for ball bearing lubrication, it is essential that they be free from both mineral acids and fatty acids (due to bad refining or presence of some fatty oil). A simple and practical method of testing for acid is to take a polished steel plate or rail and partly cover it with a strip of flannel or lamp wick which has been saturated with the lubricant to be tested. This done, it should be exposed to the sunlight for a day or two. The flannel should then be removed and the plate or rail wiped dry. If the lubricant is free from acid, the steel will have retained its old gloss. If, however,

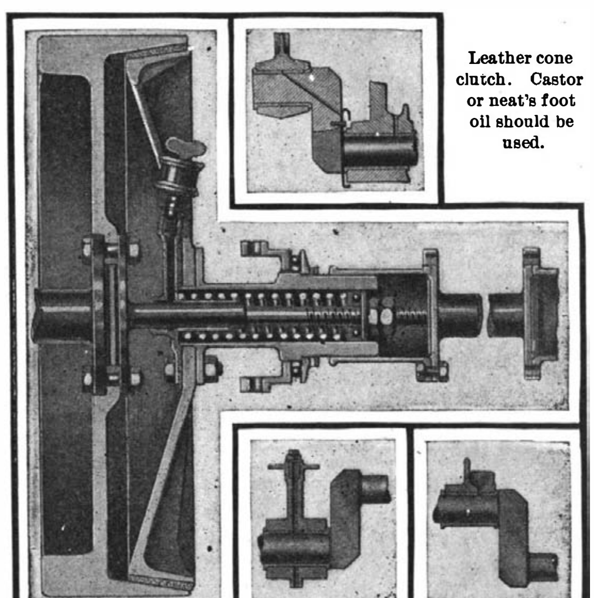


Fig. 10.—VARIOUS TYPES OF OILING SYSTEMS.

dull spots have developed on the surface covered by the flannel, it is a sure sign of the presence of acid.

Lubricating Systems.—*Grease Cups* (Fig. 3).—There are several types of grease cups in use to-day. These are: (1) Magazine grease cups, used to lubricate more than one bearing. In these a comparatively thin grease should be used. (2) Small grease cups located on the bearings proper. The grease is forced to the bearing either by spring pressure (thin grease or non-fluid oil) or by hand pressure (thick grease). In many instances the main shaft bearings of transmission cases are lubricated separately by grease cups, which are generally located under one of the side members of the frame. Care should be taken that the grease actually gets to the bearings, as the pipes leading from the cups to the bearings must be filled completely before any grease will lubricate the bearings. The ordinary commercial grease cup should not be used on automobile work, as the cap is very easily unscrewed by the vibration of the car and then falls off. Only self-locking cups are to be recommended.

The Gravity Feed System (Fig. 4).—Probably the simplest system used to convey lubricating oils to their respective bearings is the gravity system. The oil flows by gravity from a cup or a tank to the bearing through small copper pipes. The amount is regulated by a needle valve for a certain number of drops per minute, which can be counted as they leave the oiler and pass through a sight (glass) tube before entering the feed pipe. In cold weather care should be taken that the oil actually reaches its destination. If the oil proves too thick and a thinner grade cannot be procured at once, it may be thinned with a little kerosene. Perfectly clean oil should be used, for the least foreign matter is liable to stop up a small opening in the needle-valve through which the oil drops. When the system is used to lubricate engine cylinders, a pressure-tube must be provided inside of the gravity-feed cup, so as to allow for all back pressure from the cylinder.

The Splash System (Fig. 5).—This system is extensively used to lubricate the motor and transmission. The crank case is filled up to a certain level with cylinder lubricating oil, in which the revolving crankshaft and connecting rods dip, splashing the oil over the crank-case interior. In some cars the entire motor is lubricated by the splash system (cylinders, camshafts, and connecting rods). To replenish the lubricating oil in the crank case, the drain plugs on the bottom are first unscrewed to let the old oil run off. The crank case is then washed out with kerosene. This done, the drain plugs are screwed up tightly, and the pet-cock on the side of the base is opened. Oil is then filled in until it starts to run out of the pet-cock, which indicates that the proper level inside has been reached. This should be done every two weeks, besides daily pumping in a small amount with the dashboard hand pump, especially when touring. Usually, however, the cylinders and main bearings of the motor are lubricated by a dashboard oiler (force feed lubricator or pressure feed tank), and only the connecting rods are lubricated, Fig. 7, the oil being taken up through small copper tubes fastened to the connecting rod caps, from small troughs cast into the base chamber. Gears in transmission cases are also lubricated by this system. The oil level should be kept at least ½ inch below the lowest part of the gear-shaft bearing; otherwise the oil is liable to flow out of the case through one of these bearings. Light oil should be used when the main shaft bearings are of the plain type, some of the oil splashed by the gears being depended on to lubricate them. When ball bearings are used, a fairly light grease free from acid will do good service (vaseline).

Pressure System.—This system we can divide into three groups:

(a) The lubricating oil is carried in a tank which is placed in some convenient spot (generally under the footboards, seat, or frame), and is forced by pressure (exhaust or water) to the row of sight feeds on the dashboard, from which it flows by gravity to the respective bearings. (b) The oil is kept circulating by a plunger or gear pump through a main pipe under a given pressure and is branched off to each bearing individually through an adjustable sight feed and short pipe. This is a very reliable system to be recommended for motor racing boats. (c) Lubricating oil is forced by a gear or plunger pump, located in the base of the crank case, through internal leads in the motor to all the bearings in the motor. The pressure is kept at all times from 1 to 4 pounds. The cylinders are then often lubricated from a spray of oil that flies off from the connecting rods, which are fed by long internal leads in the crankshaft.

Mechanical Force Feed System (Fig. 6).—This system employs pumps which are mechanically driven by belts, chains, etc., from the camshaft. Generally we find two pumps for each feed. All are, however, housed in one casing, which acts as an oil reservoir and is generally fastened to the dashboard. One pump

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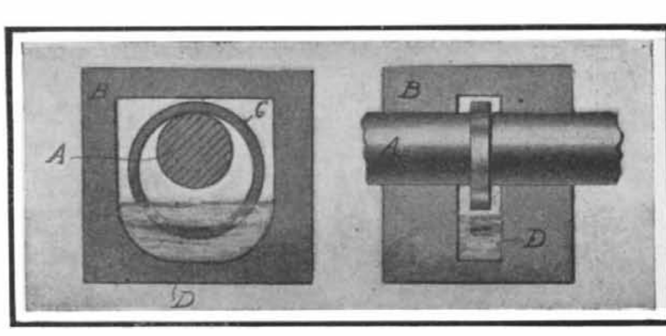


Fig. 8.—THE OIL RING SYSTEM.
A is the shaft; *B*, the bearing; *C*, oil ring; *D*, oil.

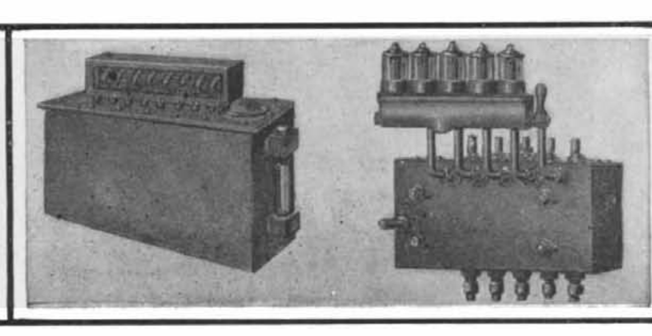


Fig. 6.—TYPES OF FORCE FEED LUBRICATORS.

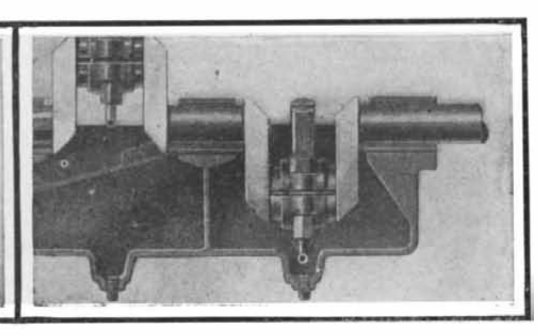


Fig. 7.—CRANKSHAFT LUBRICATION BY THE SCOOP SYSTEM.

The Two-Cycle Automobile Motor.

By E. W. Roberts.

There are in practical use in automobiles two distinct types of hydrocarbon motors, distinct in their method of supplying the cylinder of the motor with the explosive mixture of combustible vapor and air and in their method of discharging the products of combustion (the burned mixture) to the atmosphere. These types are known as the four-cycle and the two-cycle motor.

In order that the reader may understand the terms used I will explain briefly the meaning of the term "cycle." The word cycle is employed for the complete series of operations beginning with the drawing of the explosive mixture from the carbureter or mixing device (suction) and ending with the discharge of the spent gas (exhaust). A stroke of the piston is its travel in one direction, and two strokes take place for each revolution of the shaft from which the power of the motor is taken to the driving mechanism of the car.

Strictly speaking, the term "four-cycle" should be "four-stroke cycle," since it requires four strokes of the motor to complete the cycle. This cycle consists first in drawing the fresh mixture from the carbureter through a valve known as the inlet valve, much in the same manner as water is drawn into a pump. In a few of the four-cycle motors this valve is drawn open by the suction of the piston, but more generally it is opened by the mechanism of the motor. The piston, having completed its stroke, returns and, the inlet valve being closed, compresses the mixture, which is ignited by an electric spark just before the stroke is completed. The ensuing explosion of the mixed vapor and air raises the pressure within the cylinder, driving the piston before it, on the next stroke, in the opposite direction. The stroke following drives the gases from the cylinder through the exhaust valve, which is opened by the mechanism of the motor, thereby completing the cycle. Thus the four parts of the cycle are the suction stroke, the compression stroke, the expansion or explosion stroke, and the exhaust stroke.

In the two-stroke cycle of the two-cycle motor, precisely the same series of operations occurs, but in such a way that the cycle is completed in two strokes of the piston. Suppose that the mixture instead of being drawn in by the suction of the motor piston, were to be drawn first into an air pump and then slightly compressed. Assume that the cycle has progressed as far as the completion of the expansion stroke, and that the piston at the end of this stroke has uncovered a large opening in the wall of the cylinder, thereby permitting the exhaust gases to escape. If at this stage of the cycle communication be made with the pump containing the mixture under pressure and with the motor, the cylinder would be filled with fresh mixture, and at the same time the fresh mixture coming in would assist in clearing the cylinder of the burned gas. The exhaust stroke would then be transformed into a compression stroke, and the suction stroke would be eliminated. Note particularly that the cylinder is filled by the pump during a very short portion of the stroke and very quickly, leaving the greater portion of the stroke for compression of the mixture.

Suppose, that, instead of the separate air pump, the lower end of the piston were to be made to perform this function, by making the base of the motor airtight and supplying proper valves and passages to draw the mixture into the base from the carbureter and to force it into the cylinder above the piston. We should then have the two-cycle motor in its usual form, which I will now describe by means of diagrams.

In Fig. 1 is shown a vertical two-cycle motor in section with the piston *P*, on its upward stroke, drawing the mixture from the carbureter into the base through the check valve *C*. A charge is also being compressed on the upper side of the piston, suction and compression taking place at the same time. Just before the up-stroke is completed, the mixture is ignited by the spark at the spark plug and, when exploded, gives the pressure to drive the piston downward and furnish power.

In Fig. 2, the piston has nearly completed its downward stroke and the burned gases are escaping through an opening in the wall of the cylinder, the exhaust port *E*. During the down-stroke the valve *C* is closed and the piston compresses the mixture to a pressure of from four to eight pounds. The inlet port *I* opens a little later than the exhaust port and after the pressure in the cylinder has fallen nearly or quite to that of the atmosphere. As soon as the inlet port opens, the pressure of the gas in the base or crankcase drives it through the passage *B*, called the by-pass or transfer port, through the port *I* into the upper portion of the cylinder. These ports are so designed that little or none of the fresh mixture escapes through the exhaust port; and the piston, covering the ports on its upward stroke, compresses the mixture above the piston and draws a new charge into the base, thus beginning another cycle. For the reason that there are but two openings or ports in the wall of the cylinder opened and closed by the piston, this particular form of two-cycle engine, in which the mixture is drawn into the base through a check valve, is known as a two-port motor.

Another form of two-cycle engine is shown in Fig. 3 in which the check valve is not used, but, in its stead, a third port in the cylinder wall, which port is uncovered by the piston when nearly at the top of its stroke. On the up-stroke of the piston the base is closed and a vacuum is produced. Hence the pressure in the base, when the piston is near the top of its stroke, is from two to four pounds below the pressure of atmosphere, so that, when the port *C* is uncovered, the fresh mixture rushes into the base from the carbureter and fills it. The other functions of the cycle are performed in exactly the same manner as in the two-port motor. Because of the fact that there are three ports in the cylinder wall, instead of two, this form is called a three-port motor.

The honor of placing upon the market the first automobile powered with a two-cycle motor, belongs to the Elmore Manufacturing Company. This company started with a wheel-friction-drive car in 1900, but the first car which could be called a commercial success was their 1902 model. For several years the Elmore Company had the only two-cycle automobile in the field.

Fig. 4 shows the Elmore automobile motor in section. It is of the three-port type, with the base divided in the horizontal plane passing through the axis of the crankshaft. The base is an aluminium alloy casting, and the cylinders, of gray iron, are bolted on. The special feature of this motor is the use of a wire screen of fine mesh in the by-pass to prevent the flame from the burning charge from traveling through the by-pass and setting fire to the mixture below the piston, and causing a base explosion. In order to prevent rupture, the fine wire screen is held between two plates of perforated metal with comparatively large openings, as shown in the smaller figure at *X*, *C* being the fine wire screen and *D D* the perforated plates supporting it.

A modified form of the two-port motor is that used in the Atlas car made by the Atlas Motor Car Company and shown in Fig. 5. It has several features which are departures from customary two-cycle practice. One of these is the disk valve, between the carbureter and the base, used first on a motor called the "Yale," formerly built somewhere in New England. The name of the inventor and the locality I am unable, at this writing, to recall. Another feature is the arrangement of the by-pass and the cylinder ports, which entirely surround the cylinder. Referring to the figure, the disk valve to the crankcase is shown in the lower right-hand corner and in section to the left. The disk *D* is held to the side of the case by the springs *S*, making a gas-tight joint. As the disk revolves with the crank, the opening *O* in the disk uncovers the opening *Y*, shown by dotted lines, and makes communication with the carbureter through the crankcase inlet *C*. It will be seen by the location of the opening *O* with relation to the crank pin *K*, that the valve does not begin to open until the piston has made a small portion of its upward stroke and that it closes shortly after the piston has started on its downward stroke. The by-pass *G* entirely surrounds the cylinder, and through it the mixture passes from the base to the inlet ports *I* and thence to the cylinder. After the mixture enters the cylinder it passes under the deflecting hoods *F*, which throw it to the top of the cylinder and prevent it from mixing with the exhaust as it passes out through the exhaust ports *X* and thence to the atmosphere through the passage *X*. The exhaust ports open considerably in advance of the inlet ports, their relative positions being shown at the middle right of the cut.

The general external appearance of the two-cycle automobile motor is shown in Fig. 6, which illustrates an automobile two-cycle motor of the three-port type designed by the writer for large cars. This figure serves to illustrate the freedom from exterior mechanism which is characteristic of the two-cycle. It further shows the general arrangement of the inlet and the exhaust pipes or manifolds and their general design. Special attention is called to the broad sweep of the exhaust piping, which is very necessary in a four-cylinder of this type in order to prevent the exhaust from one cylinder from interfering with that from another. Observe also the diameter of these pipes as compared with a four-cycle of the same size. The inlet and the exhaust pipes on this motor are two inches inside diameter, and the dimensions of the motor are 4½-inch bore by 5-inch stroke. These large pipes are made necessary because the time for the gas to get into and out of the engine is very small as compared to the four-cycle. In fact, it is less than half.

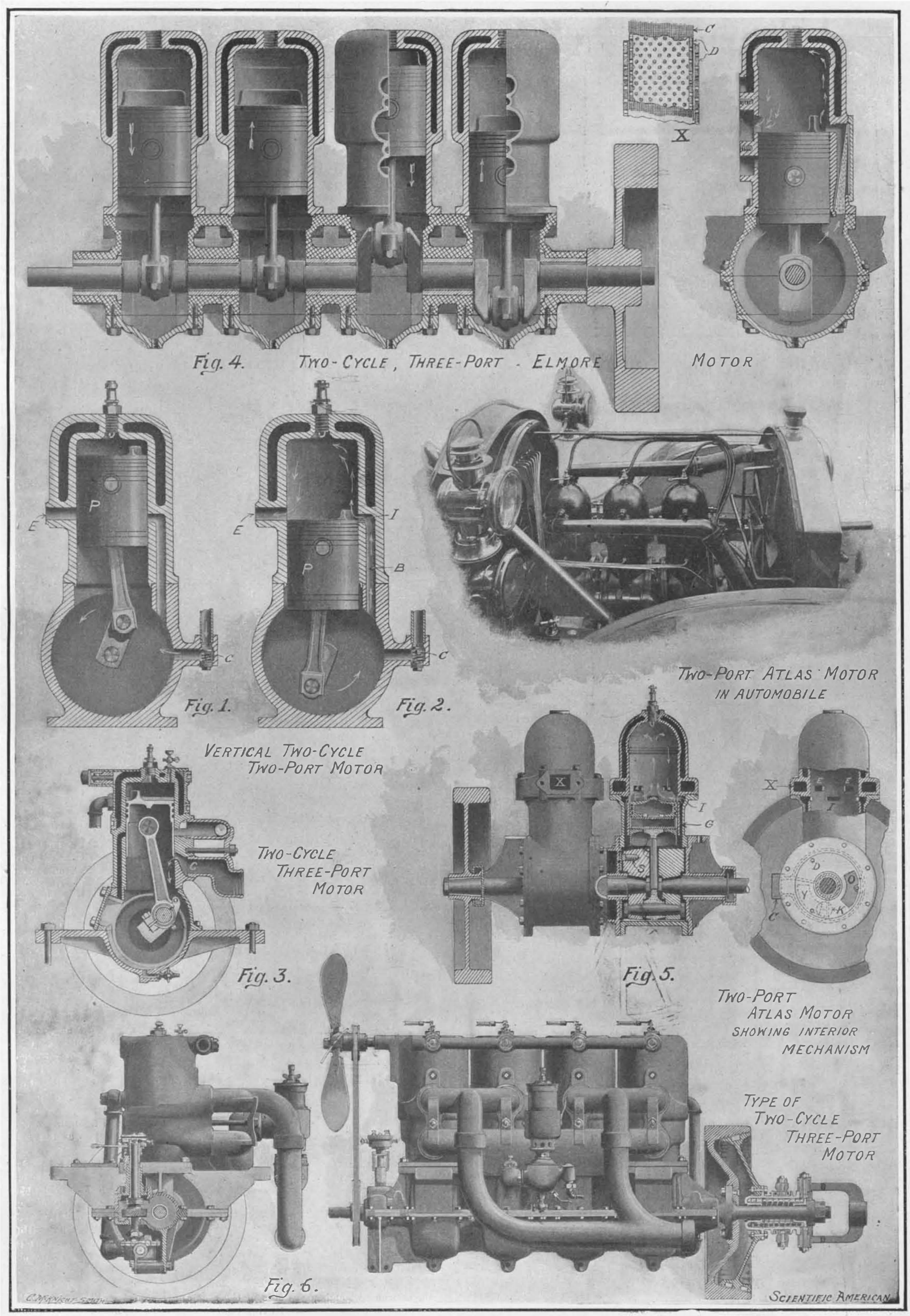
It is probable that the slow introduction of the two-cycle motor as an automobile power is due more than anything else to two factors. One of these is the prejudice caused by the cheap two-cycle marine motor, which, while it will work well when set for one speed, is not flexible and often difficult to control at low speeds. This is not true of every well-designed two-cycle engine. The other factor is the poor understanding of these motors by the majority of designers, and the difficulty they have in breaking away from four-cycle practice. The problem is a difficult one in a way, and, like every other in engineering, requires experience.

One of the annoying features of the average two-cycle is the tendency to base explosions, or the firing of the mixture in the base before it reaches the cylinder. This generally occurs at low speed, and invariably checks the speed. It can be avoided by careful design of the ports and other elements and by some means of extinguishing the flame from the cylinder when it attempts to pass downward through the transfer port. This can be accomplished by some cooling surface such as the screen in the by-pass of the Elmore motor. Properly designed, the two-cycle is practically free from this trouble and will explode through the carbureter less than a good four-cycle. Another method of avoiding base explosions is to operate the motor on a mixture rich in gasoline, and this plan is quite generally employed on marine motors. A good two-cycle automobile motor should not "back-fire" on any mixture, and if it is so designed it will operate as economically in regard to fuel consumption as the four-cycle.

The difference in action between the two types is especially marked when there is heavy work to do. Generally speaking the two-cycle will hang on to its load better at low speeds and therefore climb steeper grades or go through heavier roads on the high gear. It is at no disadvantage on high speed and it will drive a car just as fast as the four-cycle. I am aware that there is considerable evidence to the contrary, but it will be found that motors giving such testimony have small pipes for the intake to the base. Generally, a two-cycle will begin to drag after it passes a certain number of revolutions per minute, and often a motor that will give 6 horse-power at 600 will give scarcely 8 at 1,000. Give the same motor larger inlet and exhaust passages and it can be made to give 10 horse-power at 1,000 and 12 horse-power at 1,200. The usual gain in power by using the two-cycle principle is about 50 per cent. That is, taking two motors of the same bore and stroke, the two-cycle will give 50 per cent more power than the four-cycle.

There are further advantages in the two-cycle type, among which may be mentioned the fact that the greater frequency of the explosions gives a smoother running motor and one with less vibration. Moreover, there are fewer parts and hence less liability to disorder, and fewer breakdowns. The liability to derangement in the hands of a careless or ignorant operator is small, and the life of the motor is fully equal to, if not greater than, that of the older type.

The use of cork as a frictional surface in clutches and brakes of automobiles has assumed surprising proportions, clutches of this type being used by forty-eight manufacturers in 1908, with every indication of a material increase in number of manufacturers and of cars produced using these clutches in 1909. This surface, which is a combination of cork and metal, and obtained by compressing corks into sockets or holes in one or the other of the engaging surfaces, is fast becoming one of the necessary features of car clutches.



TYPES OF TWO-CYCLE ENGINES.

Handy Man's Workshop

How to Convert a Horse-drawn Buggy Into a Motor Buggy for Less Than $300.

By George Heron.

By following the directions here given, a horse-drawn buggy can be rebuilt at moderate cost into a self-propelled vehicle, which, though roughly made, will give good results and prove satisfactory.

The frame is of angle iron, 1½ x 1½ x ¼ inches, cut 6 inches longer than the distance from the front to the rear spring of the buggy, and bent cold 3 inches from the ends, as in Fig. 1. Triangular pieces should be sawed out where the corners are to come, and the bending done little by little. The body hangers or spring bars for the front and rear can be made of wood, as indicated. Drill a ⅜-inch hole at each end, and fit large-head carriage bolts, with the heads inserted in the wood. About 1½ inches from the edge of the dash (inside) and the same distance from the rear panel of body, drill ⅜-inch holes for body bolts, and 3 inches from the front and rear of the engine hangers cut slots for ½-inch bolts.

The engine and transmission should be placed under the center of the seat, to avoid cutting the floor boards. The supports should be secured to the angle-iron side members of the frame with three ½-inch carriage bolts, one on each end and one as near the center as the transmission shaft and starting crankshaft will allow without striking. The holes in the side members should be slotted to provide for chain adjustment, and made large enough to insert the square of the bolts, to prevent them from turning when loosened. Power-plant hangers can be bought, or may be made as shown in Fig. 2. Holes of ⅜-inch diameter should be drilled in the frame for the steering-post supports where the steering wheel will be most convenient, which can be determined by trying the wheel in different positions. The distance can then be marked off from the inside of the dash.

The engine should be fastened securely to the engine hangers, and the transmission bolted to the flywheel or coupling before babbitting the transmission bearing. Cut two washers out of wood to fit easily over the shaft, making the inner washer in two parts, so that it can be fitted around the shaft after the hanger is in place. Putty all cracks where there is danger of the babbitt metal running through. Drill one 5/16-inch hole near each end of the bearing on top, and one ½-inch hole in the center for pouring. Build three cones around the holes, the largest one around the center hole and about ¾ inch high. Heat the bearing until it gets hot, but not red, before pouring. When melting the babbitt, put about a teaspoonful of resin in the ladle to make it flow better. To tell when the babbitt is hot enough, insert a perfectly dry stick for a second or two, and if it begins to char or to blaze, the metal is ready. Continue to pour steadily until the bearing and the pouring hole are full, and if the babbitt settles below the holes, pour in more while hot.

As this buggy is driven by one rear wheel only, no differential countershaft is needed, and only one brake drum, drive chain, and set of sprockets is required. Driving sprockets for the transmission shaft and rear wheel can be bought from the manufacturers or dealers. To insure that the wheel sprocket will be concentric with the hub and run true, it is advisable, when marking out holes for the brake drum, to mark one first, then secure the drum to the wheel with one clip, place the wheel on the axle, and hold a stick on the axle. Now revolve the wheel and shift the drum repeatedly until the stick touches all around. Then mark off more holes, two at every fourth spoke (if it is a 16-spoke wheel) and clamp spring clips to the wheel and revolve as before until it runs true. Finally, mark off two holes for clamps to straddle every second spoke.

Brake bands, cams, and hanger set can be bought or can be made, as shown in Fig. 3.

Steering rods are secured to the front axle as in the plan view and are fitted with turnbuckles. The length of chain passes around the rear arc of a sprocket on the lower end of the steering post, which should be in the same horizontal plane as the axle. The steering wheel and column complete can be bought.

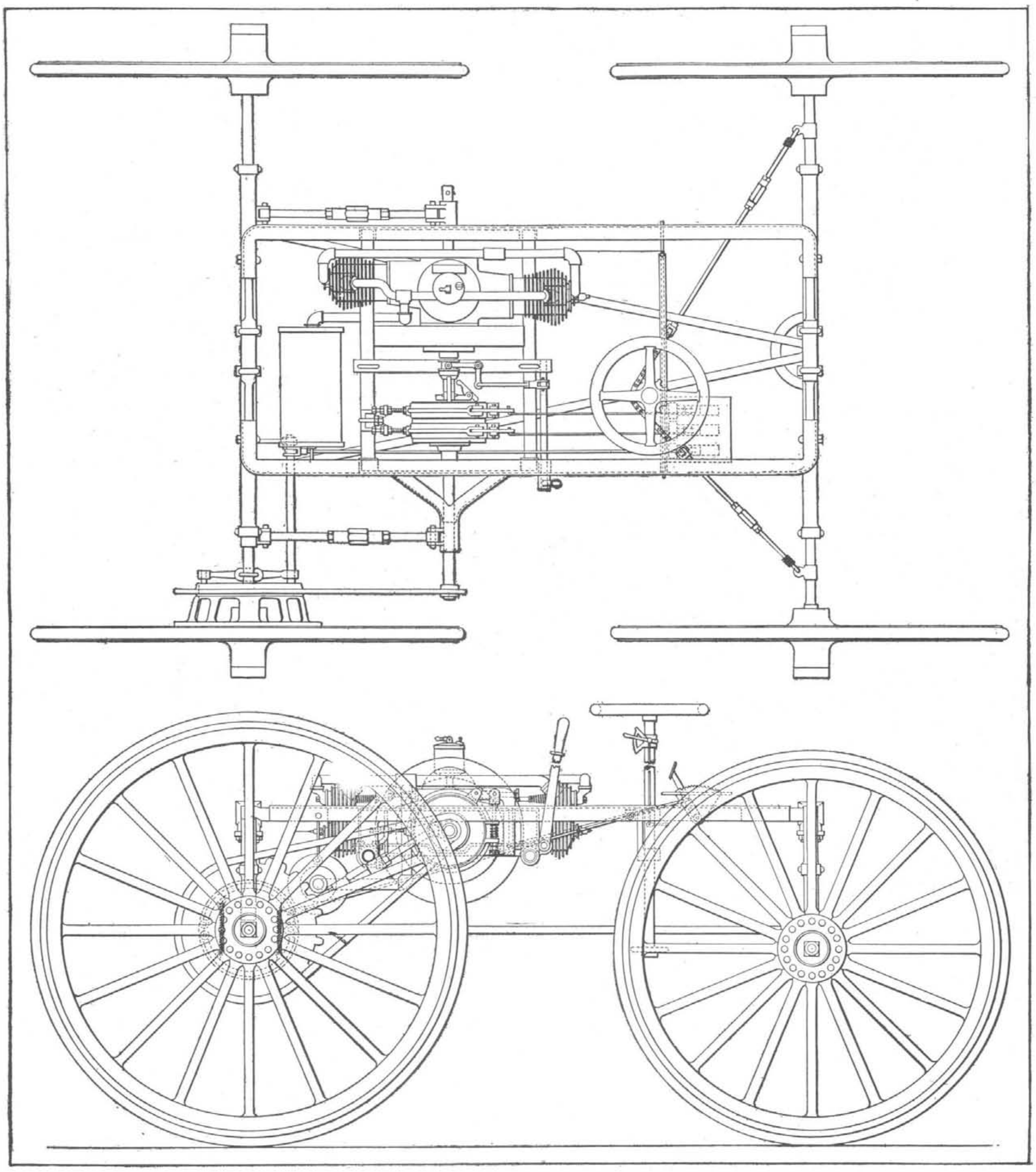
When setting the spark and throttle controls, it is advisable to have them drawn as far to the rear as possible, the spark lever on the right and the throttle lever on the left. Set the commutator or timer arm backward also (provided, of course, the timing shaft turns in the opposite direction from the crankshaft) and make the rods of the right lengths to enable you to get the timer lever all the way back.

As the engine shown in the drawing is of the automatic intake type, the intake valves will take care of themselves. Turn the engine over toward the front until the exhaust valve begins to open, as shown by the compression of the valve spring. Continue turning until the valve is full open, when a wire inserted through the spark-plug hole will show that the piston is at the top of the cylinder or at the upper dead center. At this point the flywheel will revolve some distance without the piston's moving. Mark the wire, and then turn the wheel one more complete revolution and until the piston descends about 3/16 inch past the dead center. Now set the roller, ball, or other type of contact of the timer where it will strike the contact post that is to represent the cylinder you have timed to fire at this point, making sure that the roller or ball is striking the contact so that it will continue to spark after passing 3/16 inch beyond dead center, as this is a vital point. Fasten a double-cylinder spark coil to the inner side of the body nearest to the engine, so as to use short wires.

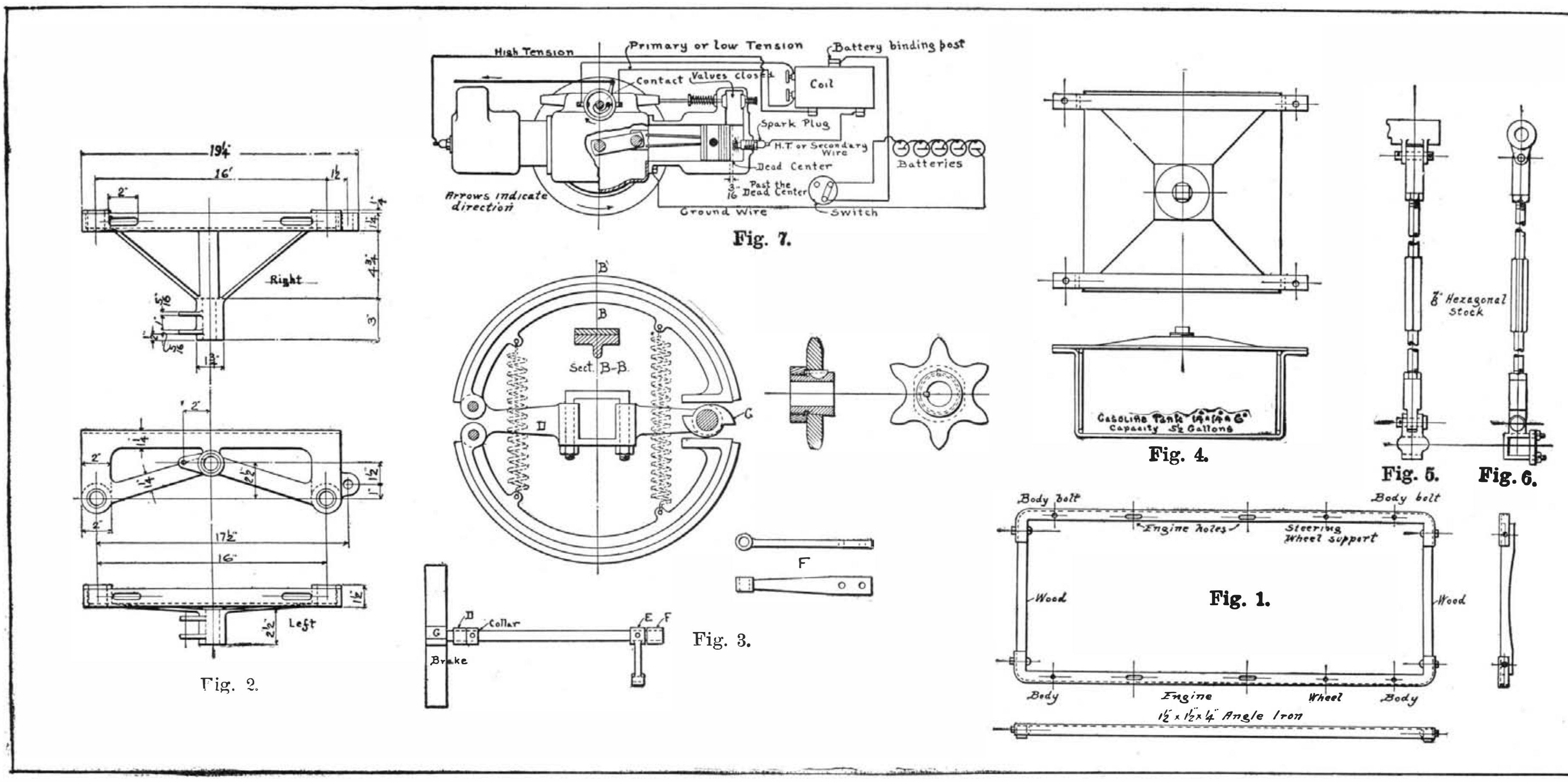
Throttle lever, rods, etc., should be set backward as the timer was. A simple, inexpensive carbureter is advisable, such as a Schebler model E, which has only two adjustments to make, one for the air and another for the gas. Screw the air adjustment screw about half way down, and lock it there. Then adjust the gas to give the best results. When the gas throttle is closed, the lever on the steering post should be in rearward position, that is, toward the driver.

The gasoline tank should be made to fit between the sills of the seat and fastened on the right-hand side, leaving the space over the engine open. The tank can be made in any tinshop, of galvanized iron with strap iron supports, as in Fig. 4.

A force-feed oiler will give the best results, and can



PLAN AND SIDE ELEVATION OF THE ASSEMBLED BUGGY.



DETAILS OF MOTOR BUGGY PARTS.

Fig. 1.—Angle iron frame with wood spring bars. Fig. 2.—Plan and elevation of engine hangers. Fig. 3.—Expanding brake sleeves and operating rod. Fig. 4.—Plan and end view of fuel tank. Figs. 5 and 6.—Plan and side view of radius rods. Fig. 7.—Wiring diagram for engine.

be driven by leather or spring-wire belt from a pulley on the crankshaft.

Radius rods are made from 7/8-inch hexagon stock, turned down as in Figs. 5 and 6, and with right and left threads cut on the ends, so that they can be lengthened or shortened by turning.

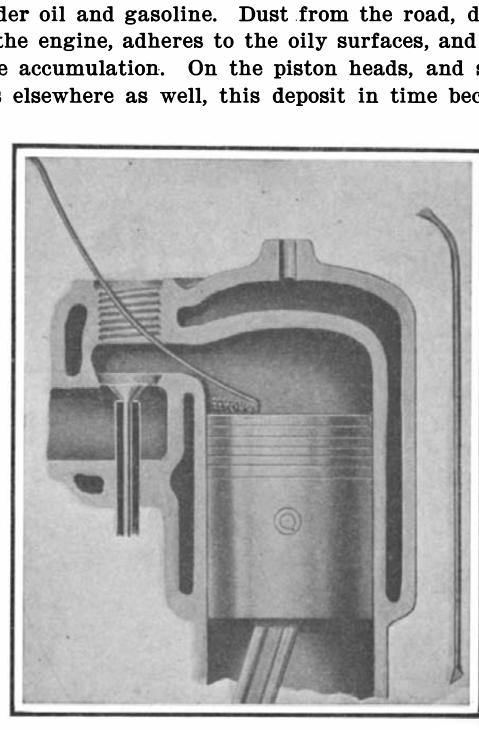
A two-speed planetary transmission is used, which also has a reverse gear. The band nearest the fly-wheel gives reverse motion, and the other is for first or slow speed ahead. High speed is controlled by a lever on the side, which, when pushed forward, locks all the gears, the transmission turning as a unit, so that the drive is direct at the same speed as the engine. First speed and reverse are controlled by pedals, which, when pushed forward, tighten the friction bands around the drums on the transmission. The bands should be free of the drums when the car is not running. Otherwise the machine will have a tendency to creep forward or backward when the engine is running and the gears are not engaged, according to which band is dragging, and the bands will wear out rapidly. The pedals are held in plates screwed to the floor of the car in front of the seat, and have ratchets to hold them in position when set. The brake pedal is held in the same way. The footboard must be sawed away to receive the plate at just the proper distance from the seat to be comfortable in operation, and care must be taken to have the pedals come in exact line with the transmission bands, otherwise there will be a tendency for the rods to pull the bands sidewise, so that they will not hold securely and will wear unduly.

All the necessary parts and materials for transforming a buggy as described, and equipping complete, can be bought ready made at a total of $283.57, as itemized herewith:

1—2-cylinder spark coil	$14 00
1—switch	70
2—standard spark plugs	2 68
1—6½ x 12-inch muffler	7 50
5—dry cell batteries	2 00
6—battery connections	20
6—secondary copper terminals	15
6—primary copper terminals	20
20 feet primary wire	2 80
10 feet secondary wire	3 00
1—pair side lamps	5 00
1—tail lamp	5 00
1—set of lamp brackets	3 00
1—4½-inch horn	4 00
1—gallon can lubricating oil	1 40
1—pound can of cup grease	30
1—⅛-inch brass grease cup	26
1—oil gun	60
1—small oil can	30
1—box assorted cotter pins	25
1—box assorted lock washers	60
1—tool kit	8 00
1—rear wheel brake drum	4 25
1—¾-inch pitch ½-inch wide 60-tooth roller chain sprocket	10 20
1—countershaft sprocket hub	2 00
1—¾-inch pitch, ½-inch 9-tooth roller chain sprocket	50
6 feet ¾-inch pitch, ½-inch roller chain, $1.17 per foot	7 02
2 feet 1-inch pitch, 5/16-inch block chain	86
1—1-inch pitch 5/16-inch 6-teeth ⅝-hole sprocket	36
1—6-horse-power double-opposed air-cooled motor	85 00
1—6-horse-power transmission	32 00
1—4-feed force-feed oiler, pulley and belt	15 00
½ pound oil tubing	60
3 feet 1-inch standard pipe for muffler (8 cents per foot). (Add 10 cents for each piece cut and threaded)	24
2—1-inch malleable elbows	20
2—1-inch Street ells	20
1—1-inch tee	15
1—1 by 2-inch nipple	10
1—steering wheel complete (with fittings, turn-buckles, tie rods, etc.)	15 00
1—set power-plant supports (hangers, pipe, high-speed lever, support, bolts, etc.)	18 00
1—high-speed lever, finished	75
1—set radius rods, complete, with axle clips	6 00
1—set brake shoes, hangers, rod, yokes, etc., complete	6 00
1—pedal plate, transmission rod and yokes	5 00
1—frame to fit any body, finished complete	7 00
1—starting crank, finished	75
1—set spark and throttle control rods, levers, etc.	1 25
1—pound copper tubing, for gasoline	1 20
1—gasoline tank, holding about 3 gallons	2 00
Bolts and screws at any hardware store.	
	$283 57

SCRAPING CARBON FROM THE PISTON HEADS.

Carbon is deposited in the combustion chambers of all automobile engines by imperfect combustion of the cylinder oil and gasoline. Dust from the road, drawn into the engine, adheres to the oily surfaces, and adds to the accumulation. On the piston heads, and sometimes elsewhere as well, this deposit in time becomes so thick as to be raised to incandescence, so that it causes premature ignition of the charge. It may usually be removed from the piston head by the use of long scrapers, as illustrated. These scrapers are made of ¼-inch or 5-16-inch soft steel, with the ends flattened in the forge and bent hoe-shaped. By suitably bending the shanks and by turning the crank to bring the piston into an accessible position, it is usually possible to detach all the carbon on the latter. Kerosene is used to soften the carbon, and a small battery lamp connected to a length of cord, aided by a flat dentist's mirror, enables the whole interior of the combustion chamber to be explored with ease. The material detached is scooped out clean with the piston at its highest point.



HOW THE CARBON IS SCRAPED FROM THE PISTON HEAD.

RELINING THE BRAKE SHOES.

There is more to the care of the brake shoes than simply keeping them in proper adjustment. By degrees the materials of the friction surfaces wear away, and the toggle or other mechanism by which the brakes are expanded or contracted reaches the limit of its efficient movement. It then becomes necessary to reline the brakes, or to provide new brake shoes, according to the nature of the friction material. Usually the brake drum is a steel casting, but the shoes may be fiber, cast iron, bronze, or mixtures of asbestos, camel's hair, copper, and the like. It is easy to tell what to do when replacements become necessary. The important point is to bear in mind that adjustment cannot be indefinitely repeated before the brakes become ineffective.

WHEN A LOST NUT CANNOT BE REPLACED.

There are various roadside expedients possible when a nut has been lost and no duplicate is at hand. Usually as good a plan as any is to wind the threads of the bolt tightly with soft iron wire, such as stovepipe wire, of which a coil should always be carried in the tool locker. The winding should start at the end of the bolt, and follow the threads up to the part it is desired to retain. The wire is then wound back in a second layer over the first, and the ends twisted together. If there is a hole in the bolt for a cotter pin, one should be inserted, and the ends of the wire twisted around it, so that the improvised "nut" cannot screw itself off from the bolt.

GETTING HOME WITH A WEAK BATTERY.

When a storage battery is exhausted, no more current can be obtained from it until it has been recharged, which should be done at once. A dry battery, on the other hand, weakens gradually. If one gets out on the road and the engine starts to miss after running a few miles, he may get to the next town sometimes by slightly adjusting the trembler contacts, sometimes by adjusting the tremblers themselves to bring them a little closer to the magnetic core beneath them, and sometimes by bending the spark-plug points a little closer together, so that the spark has a smaller gap to jump. If these expedients fail, the pitch may be dug out from the tops of the cells, and water poured in until the cells are saturated. If salt is at hand, salt water is better.

A HANDY TESTING CHART.*

WHAT TO DO WHEN THE ENGINE STOPS.

Arranged for the Scientific American by

ROGER B. WHITMAN,

Technical Director of the New York School of Automobile Engineers.

EFFECTS OF TROUBLE.

Engine will not start.
- Test ignition and carbureter.
- Slow cranking or cold weather will interfere with the proper formation of the mixture.
  - Prime cylinders with gasoline in cold weather to obtain mixture for starting.
    - To increase suction in carbureter, prevent operation of air-valve.

Engine starts, but will not continue running.
- Fuel does not flow freely to carbureter.
- Weak battery.

Engine runs well slowly, but misses when speeded up.
- Worn timer.
- Weak battery.
- Faulty vibrator adjustment.
- Faulty carbureter adjustment.
- Fuel does not flow freely to carbureter.

Irregular miss.
- Slipping timer.
- Loose half-time shaft.
- Sticking air-valve.
- Intermittent obstruction in spray nozzle.
- Sticking valve.
- Broken or weak valve-spring.
- Loose connection.
- Short circuit.

Engine will not run slowly.
- Weak magneto.
- Faulty carbureter adjustment.

Explosions cease abruptly.
- Break in ground wire, battery connections, switch lead.

Engine will not stop.
- Preignition.
  - Glowing carbon or metal point in cylinder.
- Engine too hot (see Cooling trouble).

Engine noises.
- Knocking.
  - Too much retard of spark.
  - Preignition.
  - Worn bearings.
  - Loose or cracked flywheel.
- Hissing.
  - Broken piston rings.
  - Leaking air inlet pipe or gasket.
- "Popping" in carbureter.
  - Leaking inlet valve.
  - Weak mixture.
  - Excessive retard of spark.

Steady miss in one or more cylinders, (other cylinders firing normally).
- Vibrator, timer, secondary circuit.

Engine does not deliver full power.
- Faulty setting of valves.
- Tight bearings or broken balls.
  - Indicated by excessive heating
- Back pressure.
  - Fouled muffler.
- Dragging brakes.
- Friction in transmission.
- Faulty carburetion.
- Weak ignition.
- Weak compression.
- Overheating.

Explosions weaken and cease.
- Carbureter or fuel trouble.

IGNITION. Jump spark, with single coil, battery secondary distributor.
- Test primary circuit as described for system using coils and timer.
- Secondary may short circuit from
  - Fouled or worn distributor.
  - Defective insulation

IGNITION. Jump spark, with battery, timer and coils.
- To test, revolve crank-shaft twice, listening for vibrators.
  - All vibrators sound normal, primary circuits O. K. unless timer has slipped on shaft.
    - Vibrator should begin to operate as a piston gets to top center of compression, with spark lever retarded.
  - One or more vibrators sound normal, showing that battery connections, lead and ground wires, and battery are O. K.
    - To test coils, short circuit the timer by making contact between primary terminal of coil and ground.
      - Vibrator normal, coil is O. K., look for
        - Interruption in timer circuit.
      - Blade moves, but will not vibrate.
        - Punctured condenser (a).
        - Short circuit at vibrator.
      - Vibrator does not operate.
        - Faulty adjustment.
          - Too stiff.
            - Will operate only with strong battery.
            - Excessive sparking at vibrator, and battery exhausts rapidly.
          - Too weak.
            - Feeble secondary spark; misfiring with slightly corroded contacts.
        - Contacts corroded.
        - Contacts stuck.
  - Vibrators do not operate.
    - Open switch; vibrator trouble.
    - Trouble in battery or in primary circuit.
      - To test, make momentary contact from switch terminal to ground.
        - Bright spark, battery lead and ground wire O. K.
        - Weak or no spark.
          - Break in battery connections, lead or ground wire.
          - Battery exhausted or dry cells polarized.
- **TEST 1. Alternate test, prime cylinders with a few drops of gasoline, close relief cocks, and crank. Explosions show ignition to be O. K.**
- To test secondary, disconnect spark plug leads, support them ⅜ inch from engine ground and crank.
  - Good spark, O. K.
  - Weak spark. No spark.
    - Vibrator trouble.
    - Plug short circuited, fouled, oily.
    - Points too far apart—should be 1/32 inch.
    - Short circuit in secondary.
    - Broken condenser connection (a).
      - Shown by brilliant sparking at vibrator.

IGNITION. Make and break, with low tension magneto. Use Test 1, cranking briskly.
- Explosions.
  - Ignition O. K. unless
    - Magneto is out of time and igniters incorrectly adjusted.
      - Should break circuit at top center of compression when spark is retarded.
- No explosions.
  - Short circuit.
    - Insulated bridge on magneto.
    - Switch or switch lead.
    - Bus-bar or bus-bar lead.
    - Igniter insulator broken.
    - Igniter stuck closed.
  - Open circuit.
    - Broken spring.
    - Tappet stuck in guide.
      - To test operate by hand.
  - Magneto broken down.
    - To test magneto, disconnect magneto lead from bus-bar and hold free end in bare fingers, or
    - **TEST 2. Hold free end against teeth of metal gear and crank briskly.**
      - Shock or spark.
        - Magneto O. K.
      - No shock or spark.
        - Fouled collecting brush.
        - Armature burned out (a).
        - Fields demagnetized (a).
          - To test, unmesh gear, revolve armature by hand. If fields are O. K., armature should turn perceptibly hard twice in each revolution.

CARBURETER. To test, hold lighted match over open relief cocks while engine is cranked briskly.
- Mixture ignites
  - Proving that carbureter is doing its duty.
- Mixture does not ignite. Operate primer to flood float chamber.
  - Gasoline drips from spray nozzle.
    - Mixture too rich.
      - Insufficient air.
        - Faulty adjustment of air valve.
        - Clogged inlet pipe.
        - Dust on inlet pipe screen.
      - Leaking float valve.
      - Float too heavy.
        - Soggy (if of cork) (b).
        - Punctured (if of metal) (c).
      - Faulty adjustment of float.
    - Mixture too poor.
      - Too much air.
        - Faulty adjustment of valve.
        - Leaks in inlet pipe.
        - Faulty adjustment of float
      - Water in gasoline.
  - No drip from spray nozzle.
    - Clogged spray nozzle.
    - Clogged float valve.
    - Clogged fuel feed.
    - No gasoline.
    - Empty tank.
    - Closed supply cock.

IGNITION. Jump spark with low tension magneto and coil (Eisemann, Remy, Splitdorf, etc.)
- Proceed as in Test 1, cranking briskly.
  - Explosions.
    - Ignition O. K. unless magneto is out of time. Should be reset.
  - Sparks in safety spark gap.
    - Interruption in secondary circuit.
    - Too wide a gap at plugs (should be from 1/64 to 1/32 inch).
  - No explosions.
    - Primary circuit open.
    - Primary short circuit.
    - Magneto broken down.
      - To test magneto, disconnect primary lead to coil and proceed as in test 2.
        - Shock (or spark), magneto O. K.
        - No shock (or spark).
          - Interrupter short circuited, wet or oily.
          - Field demagnetized (a).
          - Condenser broken down (shown by brilliant spark at interrupter) (a).
    - Coil broken down.
      - To test primary winding of coil disconnect ground wire and proceed as in second part of test 2.
        - Spark, winding O.K.
        - No spark.
          - Winding broken (a) down or short or open circuited.
      - To test secondary winding of coil, disconnect spark plug leads from magneto and crank briskly, watching for sparks at safety spark gap.
        - Sparks, look for
          - Plugs short circuited.
            - Fouled.
            - Insulation broken down.
            - Fused metal bead at points.
          - Secondary short circuit (a)
            - Leads short circuited.
          - Ground circuit open.
        - No sparks, winding broken down.

IGNITION. High tension magneto (Bosch, U. & H. Lacoste, Witherbee, etc.)
- Proceed as in Test 1, cranking briskly.
  - Explosions.
    - Ignition O. K. unless magneto is out of time. Should be reset.
  - Sparks in safety spark gap.
    - Break in secondary circuit.
    - Too wide a gap at plugs (should be 1/64 to 1/32 inch)
  - No explosions.
    - To test magneto, disconnect spark plug leads from distributor and crank briskly, watching for sparks at safety spark gap.
      - Sparks.
        - Magneto O. K.
        - Look for short circuits in
          - Spark plugs.
            - Fouled.
            - Insulation broken down.
            - Bead of fused metal between points.
          - Switch lead.
          - Switch.
      - No sparks.
        - Corroded interrupter contacts.
        - Interrupter stuck.
        - Armature burned out (a).
        - Condenser broken down (a).
        - Field demagnetized (a).

FUEL FEED SYSTEM. To test, open drain cock at carbureter.
- Gasoline flows.
  - System is O. K.
- Gasoline does not flow.
  - Gravity feed.
    - Clogged vent hole in filling cap.
    - Clogged piping (d).
  - Pressure feed.
    - Sufficient pressure in tank.
      - Clogged piping (d).
    - Insufficient pressure in tank.
      - Leaking tank or piping.
      - Leaking filling cap.
      - Stuck relief valve.

COMPRESSION.
- To test, crank engine slowly, noting resistance, which should be the same in all cylinders. (Do not confuse constant mechanical resistance with intermittent resistance of compression).
- Inject oil into faulty cylinder.
  - Improved compression indicates
    - Stuck piston rings.
      - Dose cylinder with kerosene and alcohol ½ and ½ to cut carbon.
    - Worn or scored piston rings.
    - Scored cylinder walls.
  - No improvement in compression indicates
    - Worn or pitted valves.
    - Leaking spark plug, igniter plate, relief cock, etc.
      - Test by running oil around these and cranking.
        - Leak indicated by bubbles.
    - Piston ring splits in line.
    - Broken piston rings.
      - Crank case will be abnormally warm.
    - Cracked walls or head.
      - Indicated by water in cylinder.
    - Sticking valves.
    - Insufficient space between valve stem and push rod.

COOLING. (Water.)
- Radiator should heat evenly shortly after engine is started.
  - Radiator does not heat.
    - Clogged circulation system.
      - Empty tank.
      - Clogged piping.
      - Defective pump.
    - Test by opening pet cocks.
  - Radiator steams.
    - Failure of lubrication.
      - Indicated by groans from cylinders affected.
        - Supply should be just sufficient to produce faint whiff of blue smoke at exhaust.
    - Defect in circulation.
    - Too much running on retarded spark or on low speed.
    - Slipping fan drive.

* It is taken for granted that the engine is capable of running properly, that the tanks are filled, and that the switch is correctly thrown.

(a) Return to makers for repair. (b) Dry in oven, and coat with shellac. (c) Plunge in hot water to expel gasoline and to locate leak. Repair with solder. (d) May be cleared with blast from foot pump.

A TALK WITH FLANDERS

AN INTERVIEW WITH A FAMOUS AUTOMOBILE MANUFACTURER

WALTER E. FLANDERS, of the Everitt-Metzger-Flanders Company, of Detroit, Mich., who, more than any other man, has been instrumental in making an "industry" out of what, until recently, was called the Automobile "Game," gives an insight into the methods which have placed within the reach of thousands, at a price they can afford, a car such as $2500 could not have purchased one year ago.

"A BETTER automobile can be built and sold for $1250 than is possible at twice that price."

This is an astounding statement—at least so it seemed to the "automobile editor," when he first heard it.

The speaker was Walter E. Flanders, General Manager of the Everitt-Metzger-Flanders Co., of Detroit, a man who is reputed to be the greatest factory organizer and producer of automobiles that industry has ever known.

Now the writer-man knew Flanders to be a very genial gentleman outside the office, but he is seldom known to joke during business hours or about business matters.

Certainly there was nothing in the expression of his face to indicate that he was trying to catch the writer by a juggling of words. Rather was his mien most serious and his tone most earnest.

Still I could not accept the statement at par. Surely, thought I, there must be a double meaning somewhere; and so I turned the words over and over; transposed them this way and that; tried to read the sentence backward as well as forward, so as to make it sound like sense and yet mean anything but the astounding fact it stated.

Flanders is a man of few words. He is a doer of deeds, and what information an interviewer gets from him must be elicited by following up question after question along the lines he desires enlightenment.

I had been reading "The First Word," a preliminary announcement of the E.-M.-F. "30" Car which is being manufactured under Mr. Flanders's direction, and the claims made therein piqued my interest.

Having charge of the "automobile column" the writer necessarily has imbibed a good deal of technical information on that interesting subject, the motor car, and a careful perusal of the specifications of the E.-M.-F. "30" seemed to bear out the startling claims of the prospectus. So I had determined to find out for myself and had come to the fountain-head for information. The opening sentence of this article was the reply to my first question.

"I give it up," I said. "What's the answer?"

Mr. Flanders smiled: "There is no answer. I meant just what I said. *A better automobile can be manufactured and sold for $1250 than at twice that price—$2500.*"

"Do you mean by that that it is possible to build a better automobile now for the lower price than it has been heretofore for twice the figure?"

"Not at all. I mean that a better car can be built at the lower figure than it is possible to build at the higher figure. Now!——"

"Reasons 'why' are in order," I said—"for if there is no answer there must be a reason why."

"There is," said Mr. Flanders. "It's a simple problem. In fact I think its obscurity lies in its very simplicity—for most people go a long way round in search of a simple fact, while the great successes are achieved by the most direct routes.

"The demand for a car at $2500 is limited. I would say that no man with an income of less than $5000 a year has any business to own a car at that price—the first cost of an excessively large, high powered car is not so much a consideration as cost of operation and upkeep. On the other hand a car of $1250 may not be considered a luxury for a man with an income of $1800—be it in the form of a salary or income from office, shop, store or other business. Such a car will necessarily be of moderate power and light weight and the tire, fuel and other items of maintenance cost will be correspondingly small.

"Having reached that point it is a simple matter of statistics to find that there are at least 500 men who earn $1800 a year for each one whose income is $5000. In other words the possible consumption of a $1250 car is fully 500 times the possible demand for one selling at $2500.

"Now in manufacturing, the first point we want to make sure of is—demand.

"For high priced cars the demand will always be limited. The manufacturer who would make sure of the future must produce a car to meet the requirements and at a price within reach of the multitude of judicious buyers—the men to whom price is an object and yet who demand high grade quality. That this is the safest policy is proven by the fact that even last year (1908) when there was so much talk of hard times, makers of moderate priced cars were all over-sold, and the high priced were the only ones that experienced a falling off in the market.

"There are at least half a million people in the United States to-day who can afford a $1250 car. It's only a question of deciding they want one. For our own purpose, a very small percentage of this number will suffice—12,000, for that is all the cars we can hope to build before October 1st, 1909, even with our splendid organization and factory facilities.

"A certain demand enables us to plan for production on an immense scale and to adopt methods that are impractical in the building of a $2500 car which must necessarily be confined to small quantities—1000 at most. Of course there is a market for several thousand high priced cars but no single maker can hope to corral it all."

"But do you mean to say," I asked, "that you can build a car of the same size and power and quality, material and workmanship both considered, for $1250 as that which can be built for $2500?"

"I said a better one," said Flanders.

"Take the E.-M.-F. '30' for example. It is a full size, 5-passenger car with wheel base of 106 inches—longer than most $2500 cars of a year ago. There is ample room for five large adults.

"The engine develops over 30 horse power—sufficient to take 5 passengers anywhere and giving more speed than should ever be used on public roads. I can show you 55 miles an hour with five up.

"In this car is incorporated every feature that is a necessary or desirable part of an up-to-date automobile—made of the best material procurable and machined better than any $2500 car you can name. I say better advisedly; for, in planning for a production of 12,000 cars we are, as I have said before, able to utilize methods which are absolutely impractical in the making of a car at $2500 when made in the limited quantities which the comparatively limited demand justifies.

"For example: Our rear axle housing is drawn from two sheets of steel—lighter and vastly stronger than the ordinary seamless-tube-and-cast-steel combination you'll find in other cars no matter of what price.

"Some twenty operations are necessary to form this housing. The cost of dies and tools for the job is $9000. Now suppose we were making only 100 E.-M.-F. '30' cars: the tool cost alone on this part would amount to $90 per car. On 1000 cars it would still amount to $9 a car. That would be prohibitive in a $5000 car."

"Do you mean to say I—— " I interrupted—

"*I mean to say that if the same practice was carried throughout the entire car and it was made in quantities of only 1000 it could not possibly be sold for $2500 nor four times that price.*"

"But 12,000 cars——" I began.

"Yes I know," Flanders interrupted: "Some makers claim that 2500 cars constitute 'quantity production.' As a matter of fact it's only a beginning. If, instead of distributing our initial tool cost, of several thousand dollars, over but 2500 cars instead of five times that number—for you know we must make 500 extra sets of parts for replacements and repairs, a complete set of which every E.-M.-F. dealer must carry in stock—if this cost instead of being divided among 12,500 and had to be borne by 2500 we would have to charge $1500 to $1600 for the car, as others do and there are many reasons why we couldn't make it as good at that price in the smaller quantities as we do at $1250. The systematizing of a factory and training of a force of several hundred men till each is an expert on his own particular specialty, are problems you would hardly understand but their solution is simplified when the quantities are such that each man performs one task until he becomes expert at that one operation. But to return to the matter of tool cost which I can more easily explain to one unfamiliar with the multitudinous problems of factory organization and operation.

"Take this axle item. In 2500 lots the tool cost on this piece—and it's only one of over a thousand parts in an automobile—would be $3.60 per car. That still would be prohibitive. You never saw a $2500 car with a pressed or drawn steel axle. They are all built up of a combination of steel tubing with malleable iron casting for the differential housing—aluminum sometimes, lighter and more expensive than malleable (or 'cast steel') but also less than half as strong.

"In 12,000 cars, however, this tool item amounts to only 75 cents per car.

"Up to a certain point in manufacturing, hand methods—and the hand cannot approximate the machine in accuracy for re-duplicating parts—are less expensive than automatic machine work—taking into account of course the enormous first cost of automatic machines, jigs, tools and fittings. But just as soon as you pass that point you can inaugurate manufacuring methods which reduce the cost of every operation to a degree that is almost incredible to one not versed in manufacturing problems.

"For example: No $2500 car ever made has a cam shaft forged in one piece with eight cams integral and *the cam contours as well as the bearings* ground to absolute accuracy in size and form—yet this is a detail of the $1250 E.-M.-F. '30' car.

"This operation could not possibly be performed by hand. Automatic machinery is necessary; and as there was no such machine on the market we had to design it. When you consider that we have about 100,000 cams to grind, you will see that the cost of a $6,000 automatic machine will spread out pretty thinly over that number—less than fifty cents for each set of eight cams. That is cheaper than to mill them by the ordinary method to say nothing of its being infinitely more accurate. Now accuracy in a cam guarantees uniform power with absence of noise—because it guarantees a definite clearance between plunger and valve.

"That is just one of many details wherein the $1250 car may be superior to a $2500 one in which such methods would be commercially impractical.

"I might mention a hundred other operations where the cost is reduced at the same time that better quality is secured. Here are a few:

"24,000 twin-cylinder castings make possible the adoption of moulding machines instead of hand work. This makes for higher quality because the cylinder invariably is smoother in outward appearance and of uniform thickness throughout. Uniform thickness is another guarantee of power because the expansion under heat is uniform; it also eliminates one of the most fruitful sources of scored-cylinder troubles.

"The yokes which hold the exhaust and intake pipes are steel stampings—half the weight, twice the strength, of forgings or castings—and of course they cost less to make.

"In planning to turn and grind 48,000 pistons, an item of $10,000 for automatic machinery is a mere bagatelle—each machine will finish a piston in ten minutes, more accurately than it is possible to do on an ordinary lathe in an hour, and one man will operate four machines.

"The same pressed steel frame—same material, and same workmanship, same quality throughout that would cost $40.00 to make in lots of 2500, costs us less than half that price in quantities such as we make—another example of distributing a heavy initial tool-and-die expense over a large number of cars.

"I could take you through the entire car and show you where the labor cost is reduced 50 to 90 per cent. by quantity production as compared with making the parts in limited numbers, *and every step would show a corresponding increase of quality with decrease of cost.*

"By the use of steel stampings and pressed steel—which operations are commercially practical only in large quantities—we are enabled to practically eliminate such metals as manganese-bronze, cast-iron, malleable iron and aluminum.

"We retain aluminum for the transmission housing and engine crank-case but nowhere else."

"You discard aluminum because it costs you more?" I ventured.

"Costs us more? Not at all! It is all the same to us. It is the buyer of the car who pays the bill.

"Supposing our net profit on a machine is 10 per cent; and that the selling price is necessarily based on the manufacturing cost; you will see that if we pay 50 cents a pound for aluminum, the buyer of a car pays 55 cents a pound. Now if we are able to replace that aluminum with a steel stamping, of handsomer appearance, vastly greater strength and at a cost of say 5 cents a pound, the buyer of the car pays only 5½ cents. You cannot get something for nothing.

"No automobile manufacturer would use so weak and so uncertain a metal as aluminum if it were possible to cast a stronger metal in the same form and sufficiently thin to get the weight within reasonable limits. Unfortunately, while iron is twice as strong as aluminum, it is not practical to cast it any thinner; and a 3/16-inch wall of iron weighs just three times as much as the same thickness of aluminum. In some places—such as engine crank-case—we get sufficient strength in an aluminum casting and with the lesser weight, whereas the form precludes the possibility of stamping it satisfactorily from steel.

"For motor supporting arms, however, we use pressed steel—this is one place where aluminum has proven most unsatisfactory through its liability to frequent breakages and its inability to withstand severe vibratory stresses.

"Now in a $2500 car the cost of making dies for pressing these members would amount to more per car than the 50-cents-a-pound-aluminum—so the average maker is compelled to charge the buyer for the most expensive metal without being able to give him the desired safety factor. The cost of making the dies for the pressed steel members, though several hundred dollars, distributed over 24,000 pieces—two for each motor—is a negligible item in the case of the E.-M.-F. '30'.

"Here's another fact which may not have occurred to you: In reading over our specification sheet you doubtless noticed that we grind many shafts and other parts which you do not ordinarily find so accurately made in cars of the highest price.

"Now grinding is the most expensive operation in machining metal—but it is also the most accurate. Accuracy is economy—though not all makers seem to appreciate that fact.

"We can better afford to grind a part than to take the risk of its not fitting the other part with which it must engage. *We could better afford to grind one hundred parts than to disassemble one car to replace a noisy gear or a bearing that has seized because too tight or which is noisy because too loose.*

"Grinding is cheaper, provided the quantities justify investment in highly specialized machines for the work, than it is to buy files and pay a force of men to fit crudely machined parts. We grind to ensure facility in assembling—and the buyer gets better quality throughout. It is a selfish consideration with us, for it reduces the cost; but the customer gets the benefit of this saving as well as the greater accuracy.

"Another saving is effected in the testing of cars after assembling.

"As a matter of fact the term 'testing' no longer has an application to automobile manufacturing among men who know their business and possess the facilities to do things the modern way.

"To say that a car needs testing is to admit the possibility at least, of inaccuracy—generally, it implies a probability.

"In these days when science can tell us to an ounce the strength of a metal, the only chance for error is in the machining of a part. Eliminate that chance by machining it—reaming, grinding or otherwise—to the necessary degree of accuracy, a quarter to a half thousandth of an inch—what is there left to test?

"Watches made by the millions are never tested. They are regulated—adjusted—that is all.

"So with a properly manufactured automobile. Engine parts, axle, driving gears, bearings, may need adjustment after assembling; but testing—that implies careless work; and that is the one luxury we cannot afford in a $1250 car! It is permissible only in a car for which the customer is induced to pay a high price under the delusion that 'hand work' is superior, whereas, as a matter of fact, it is simply a process of making one error to fit another. And he pays treble every time he must replace a part by the cut-and-try process.

"You'll find a parallel for these conditions in many other commodities of everyday use.

"Detroit is the center of the stove industry, as it is the automobile center of the world. Any stove manufacturer will tell you it costs $40,000 to $50,000 to produce the first plain cook stove of any new model. Taking into account, of course, the designs, patterns, dies, jigs, tools, experimental work, and the changes that are necessary before a satisfactory product is secured—every item of which preliminary expense must be distributed pro rata over all the stoves of that model made thereafter.

"Once perfected, they turn out that stove in lots of 20,000 to 150,000 a year—and sell it for seven or eight dollars—the 'overhead' spreading thinner as the quantities increase.

"The first typewriter that would write cost over $300,000—and the man who would have paid $100 for that particular machine would better have thrown his money away. Not one part could be replaced at any reasonable figure. To-day, a highly perfected machine of that same make, a marvel of ingenuity, is manufactured for a few dollars—steel stampings and automatic machine work. The low price has made it a necessity in every office—hundreds of thousands are sold annually to persons who a few years ago did not dream they ever would need one.

"The E.-M.-F. '30' at its price has already created a demand greater than even we had expected. And this is only the beginning.

"When your father was a boy, a good rifle was a luxury few could afford. To-day you can buy a better rifle than your father ever saw for one-tenth what he would have had to pay for one made by hand. They are made by the millions now because millions can afford the price—and the demand for millions makes the adoption of manufacturing methods—and hence the low price—possible."

"But these are problems peculiar to all manufacturing, are they not?" I asked. "Why have not these methods been applied to automobile making before? Why have we had to pay twice as much for a car as it has been worth?"

"There are several reasons—three primary ones: First, until recently automobile design had not crystallized into any accepted standard. While we were still in the experimental stage, uncertain as to what features were best—sliding-gear or platenary transmissions—two, versus four cycle motors—air cooling versus water cooling; and a hundred other details, matters of dispute among designers, no maker dared turn out a large number of cars of any model—none dared anticipate the future by more than a few months.

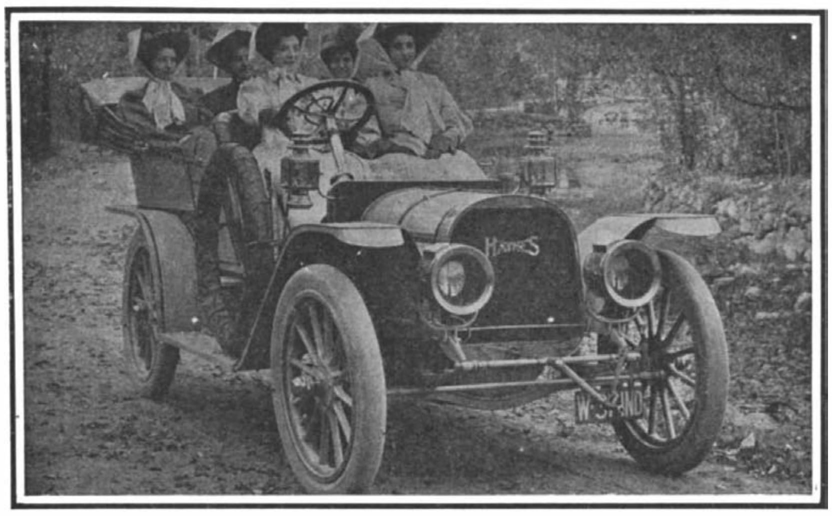
"The public—the motoring public—seems to have been alive to the conditions. The maker who would have turned out 10,000 30-horse-power, four-cylinder cars four years ago would have found no market even had he offered them at $1250.

"Anyone at all interested in the subject, knows that at that time the motor car was still in the transitory state—no part had been standardized—none accepted as final. Only a few enthusiasts bought, the great conservative public waited and watched—interested, hopeful, but unsatisfied.

"It's an interesting fact that, from year to year the demand has just kept pace with—always a little in advance of—the mechanical development of the automobile.

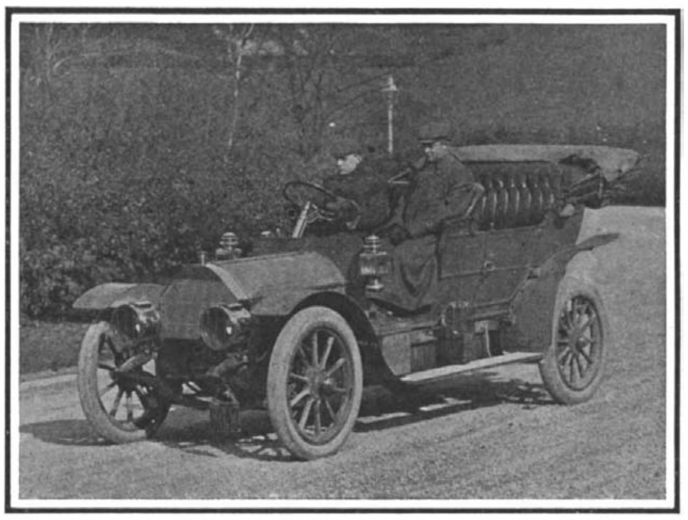
"We now have come to the place where we know what a car should be, and we find our public ready to buy—able to buy since we can produce at a price within the reach of the great moderately-rich class.

"The second and the chief reason why manufacturing methods have not heretofore been applied to automobile building is that a broad experience is necessary to equip and organize a factory for economical production on a large scale. The automobile business can boast of few men with the proper training. Most of the engineers have grown up with—been developed by, the growth of this industry. And they are unable to rise above their experience."



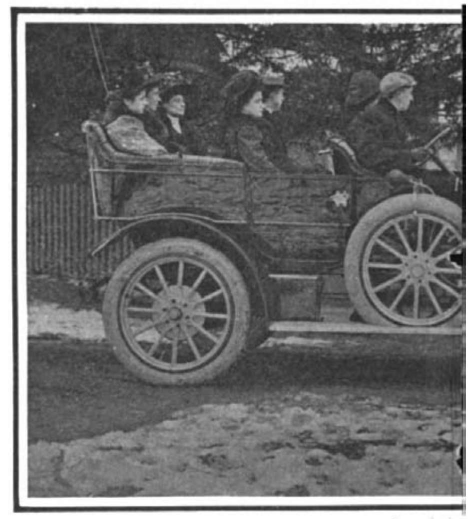
Wheel base, 112 inches ; 36 horse-power ; 4 cylinders, 4¾ x 5 inches ; cellular radiator ; dry battery and high-tension ignition ; contracting band clutch ; selective sliding gear transmission with three speeds forward and one reverse ; shaft drive.

Haynes touring car.



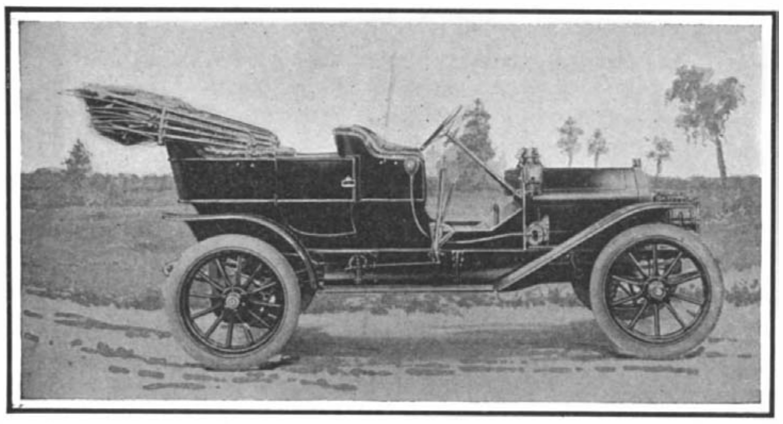
36 horse-power ; wheel base, 119 inches ; 6 cylinders 3$\frac{5}{8}$ x 4¾ inches ; cellular radiator ; storage battery and high-tension ignition ; cone clutch ; selective sliding gear transmission with four speeds forward and one reverse ; shaft drive

The Pierce "Arrow."



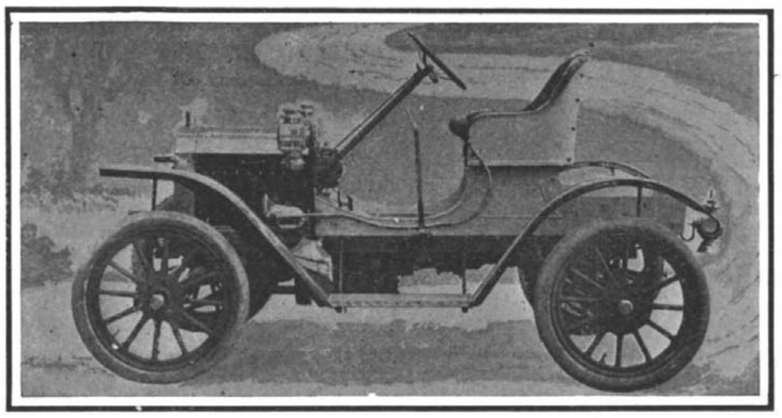
34 horse-power ; 4 cylinders. A feature of the 4-cyli except for the hub center, and carrying a tire infla hub center by six bolts. The spare wheel can be

Rambler tourin



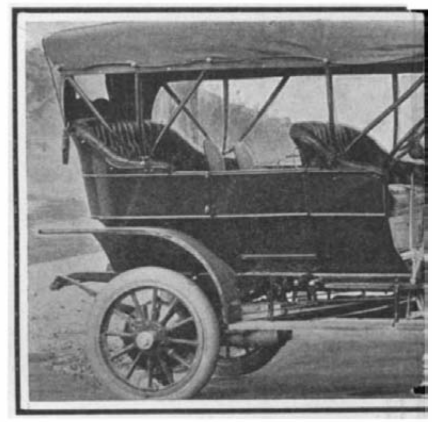
Wheel base, 106 inches ; 4 cylinders, 4 x 4¼ inches ; vertical tube radiator ; dry battery and high-tension magneto ignition ; expanding ring clutch ; selective sliding gear transmission ; three speeds forward and one reverse ; shaft drive.

Everitt-Metzger-Flanders 30-horse-power touring car.



7 horse-power motor ; 4 x 4 inch single cylinder ; planetary transmission with multiple disk clutches. Drive : Bevel gear to jack shaft and double side chains to rear axle. Coil spring with friction joint radius rods. Maximum speed, 30 miles an hour.

Brush runabout.

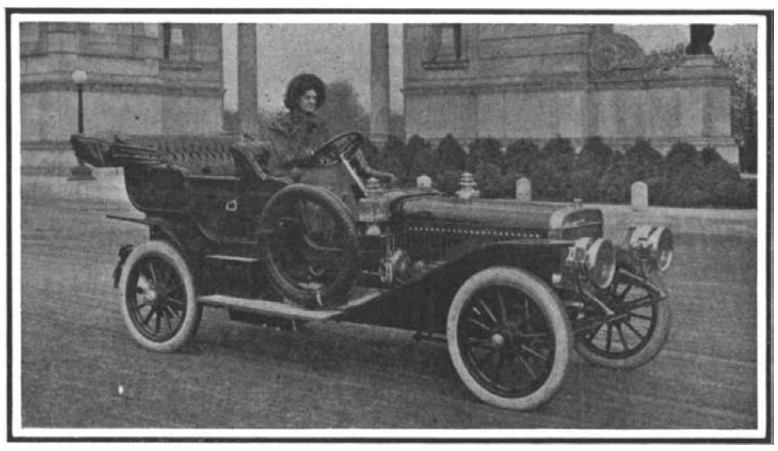


4 cylinders ; 45 horse-power ; speed, 3 to 50 mile unit coil ; storage battery : high-tension magneto Selective sliding gear transmission. Three

Glide tourin

High-pressure cylinder, 2½ x 3 inches ; low-pressure cylinder, 4¼ x 3 inches. Joy valve motion actuated from connecting rods ; pumps driven by levers of the valve mechanism.

White steam car. 20-horse-power touring car.

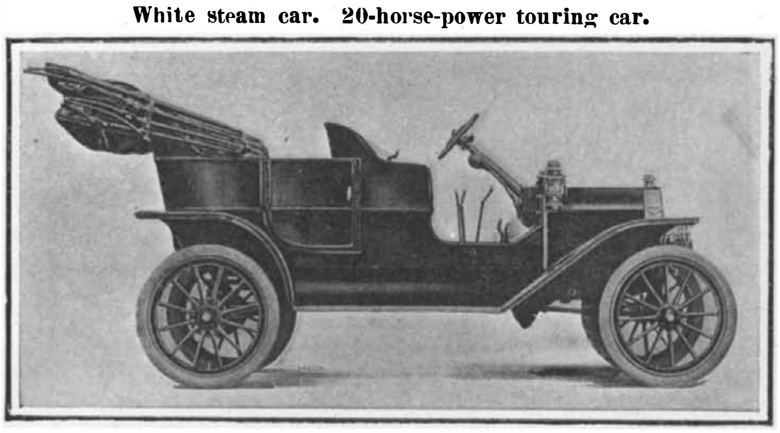


48 horse-power ; 6 cylinders, vertical tube radiator ; dry battery and high-tension magneto ignition ; multiple-disk clutch ; selective sliding gear transmission ; shaft drive.

Winton five-passenger car.

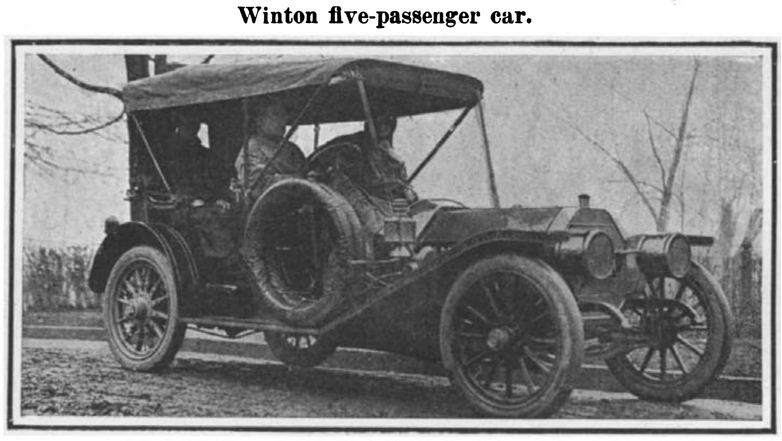
4 cylinders ; water cooled ; make-and-break type change gear ; three speeds forw

Premier 30-35 horse-



Wheel base, 100 inches ; 4 cylinders ; spur planetary transmission ; low tension magneto ignition ; vanadium steel springs, axles, shaft, gear, etc. ; weight, 1,200 pounds.

Ford 20 horse-power touring car.

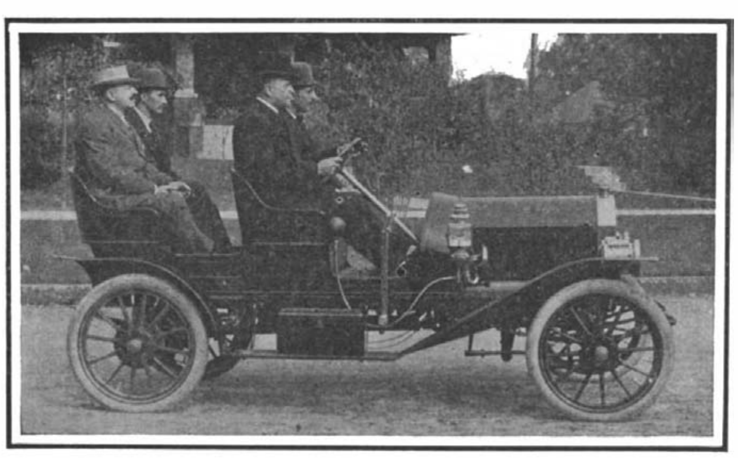


4-cylinder ; cellular radiator ; low-tension magneto ignition ; selective sliding gear transmission ; shaft drive.

Locomobile 30 horse-power touring car.

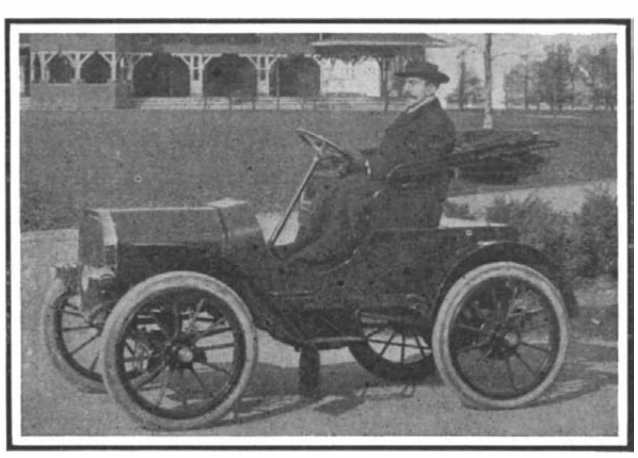
6-cylinder ; jump spark ignition ; three-disk cl with four speeds forward and one re

Thomas 70-horse-p



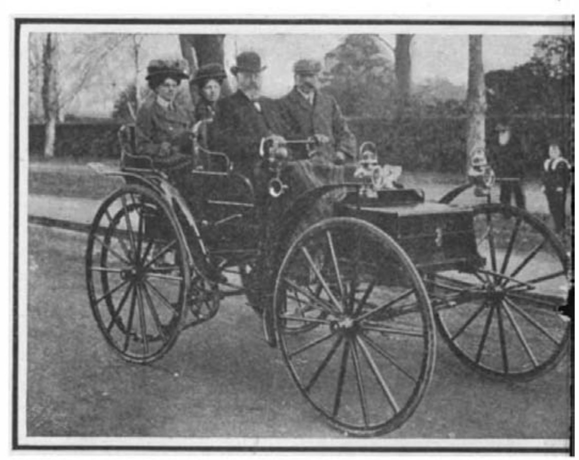
The transmission is of the double-disk type, the flywheel being used as one disk. The flywheel is horizontally placed to exert a gyroscopic effect in resisting shocks.

Blomstrom gyroscope car.



Six speeds forward, three reverse ; motor, series wound, rated at 2 horse-power with 300 per cent overload capacity.

Baker electric runabout.



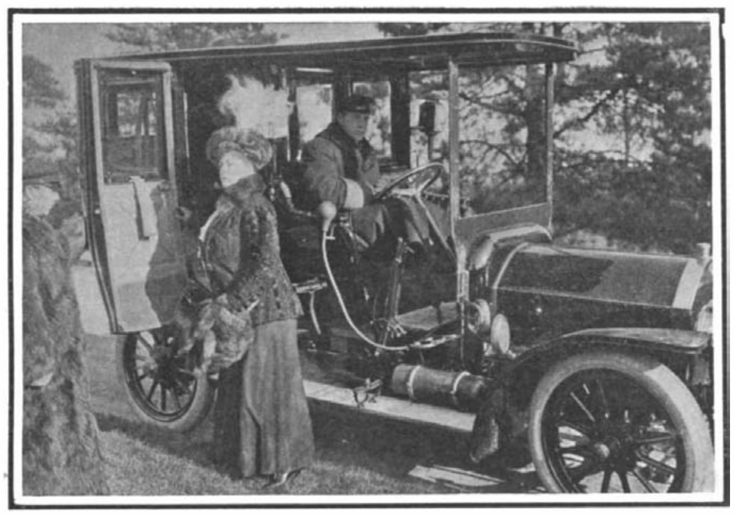
Direct power transmission by steel friction chain ; ball and roller for motor ; 4 cylinders.

Holsman high-wheeled surrey.

THE CARS OF 1909

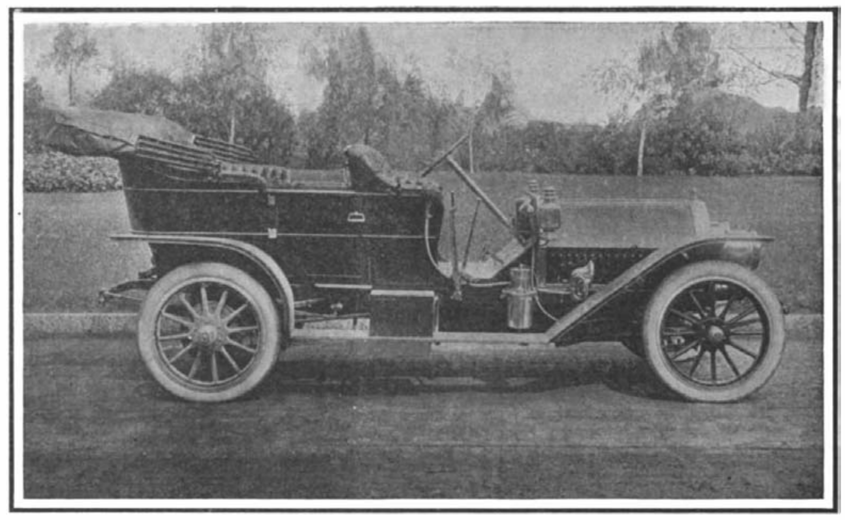
nder Rambler is a spare wheel, complete
:d. The regular wheel is screwed to the
placed on the hub in three minutes.

g car.



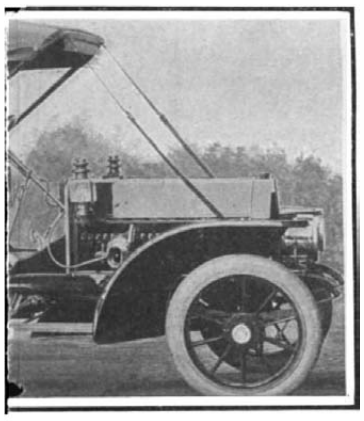
Wheel base, 117 inches; 40 horse-power; 4 cylinders, 4¾ x 5¼ inches; cellular radiator; low-tension magneto; cone clutch; selective sliding gear transmission with four speeds forward and one reverse; shaft drive.

Studebaker limousine.



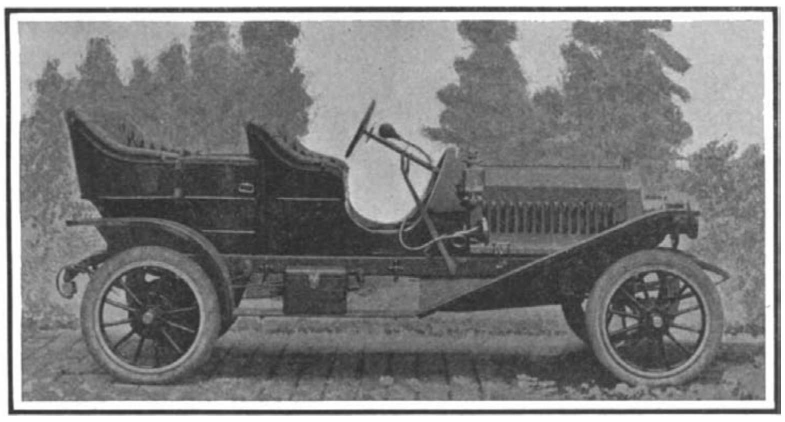
Wheel base, 120 inches: 40 to 45 horse-power; 4 cylinders 4¾ x 5 inches; double ignition system with Bosch magneto; cellular radiator; cone clutch; selective sliding gear with three speeds forward and one reverse; roller bearings throughout; shaft and bevel gear drive.

Speedwell touring car.



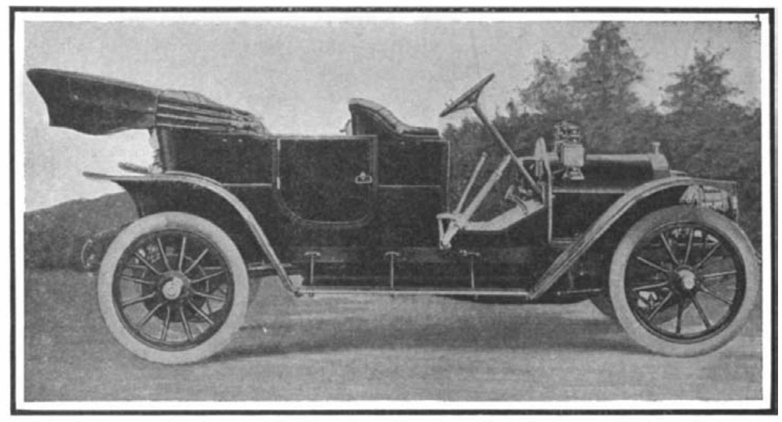
ı an hour. Ignition: Jump spark; four
ı. Irreversible bevel gear steering gear.
ı speeds forward and one reverse.

g car.



Wheel base, 110¼ inches; 28 horse-power; 4 cylinders, 4 x 4 inches; water cooled; jump spark ignition (storage battery); splash lubrication; single silent chain drive inclosed in dust-tight metal case; friction change gear.

Lambert roadster.

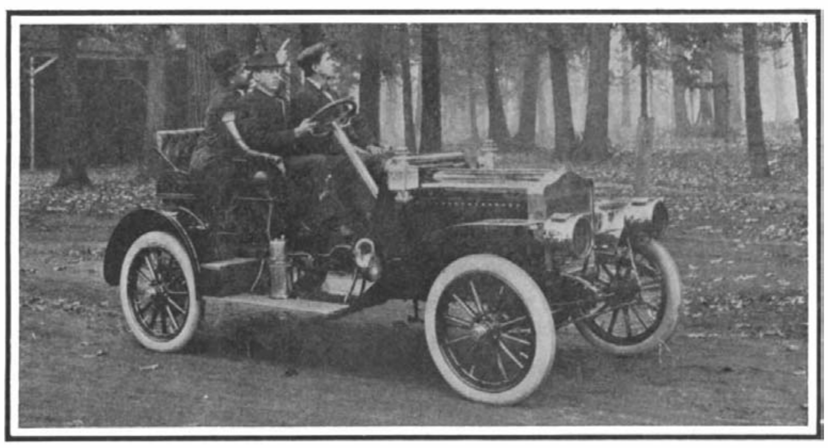


4 cylinders cast integrally; short bonnet; long wheel base; body swung between axles to giv ease in riding; ignition by storage battery and coil; special equipment for double ignition (magneto with separate set of spark plugs).

Chalmers-Detroit 30-horse-power touring car.

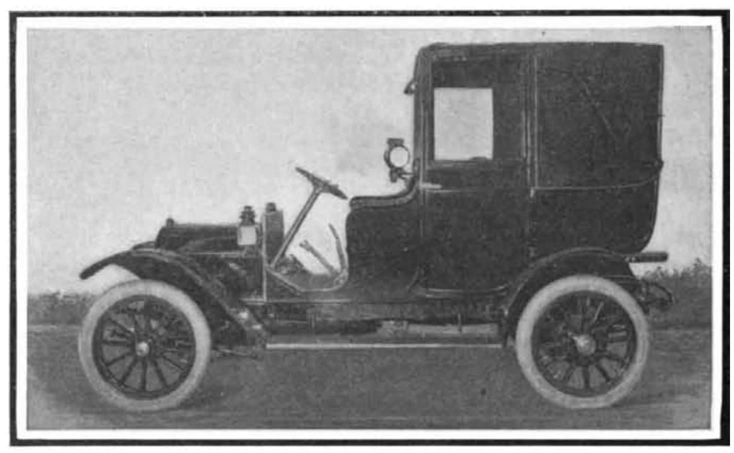
gnition; multiple-disk clutch; selective
rd and one reverse; shaft drive.

ower touring car.



4 cylinders; 24 horse-power; magneto and battery ignition; positive shaft-driven oiler; honeycomb cooler; sliding gear transmission, three speeds forward and one reverse; bevel gear drive.

Maxwell-Briscoe 30-horse-power.



Wheel base, 106 inches; wheel tread, 54 inches; wheels, 32 x 4 inches (all four); 4 cylinders 20 horse-power; seating capacity, 4; steering on left-hand side; turns in 25 feet.

Cleveland auto cab.

ıtch; selective sliding gear transmission
rerse; double side chain drive.

ɔwer flyabout.

Vertical 2-cycle motor, 3 cylinders; jump spark ignition (dry and storage battery); multiple-disk clutch; shaft drive; speed, 40 miles an hour.

Atlas 34-horse-power touring car.

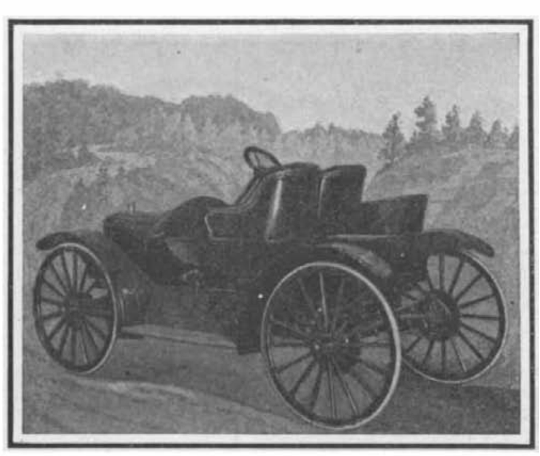
Wheel base, 95 inches; 18-20 horse-power motor; thermo-syphon cooling; mechanical oiler; jump spark ignition; friction transmission; pressed steel frame.

Carter car gentlemen's roadster.

ɔearings

20 horse-power; 2-cylinder water-cooled motor; friction drive; force feed oiler; long Concord side springs.

Shacht automobile buggy.



Wheel base, 95 inches; double opposed motor half offset; 16 horse-power; jump spark ignition (coil and battery).

McIntyre solid-tire high-wheel runabout.

2-cylinder, 14-horse-power engine; planetary transmission; two speed forward and one reverse; maximum speed, 30 miles.

Black automobile buggy.

--BIG AND LITTLE.

Some Automobile Novelties.

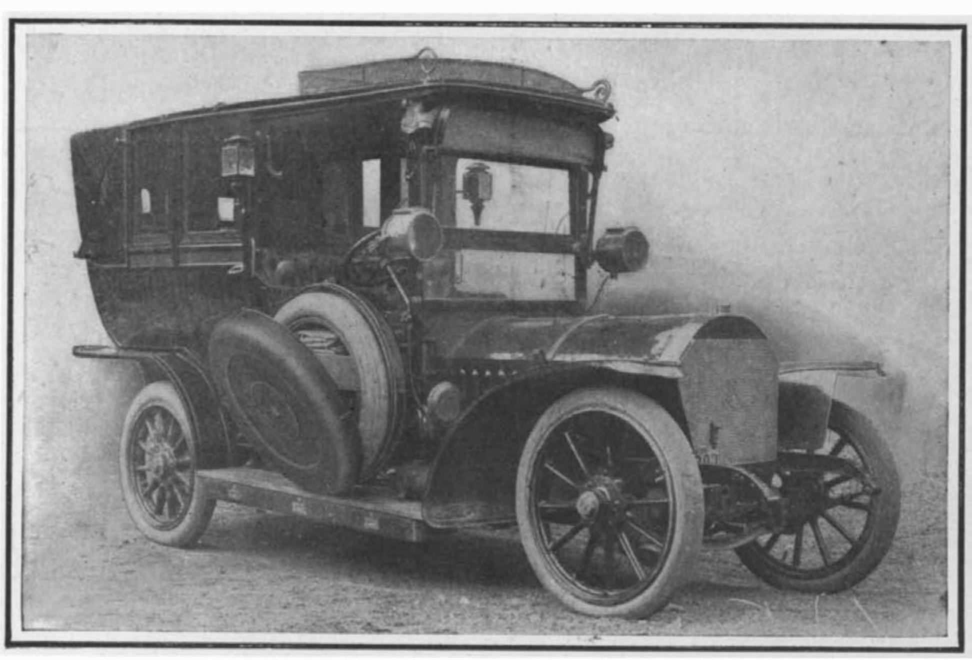
STORM PROTECTION FOR THE AUTO DRIVER.

The latest addition to the equipment of a well-appointed car is the "cling tight storm apron," manufactured by the Beebe-Elliott Company of Racine, Wis., and shown in the accompanying illustration. The storm apron, designed to protect the driver of the car in cold or wet weather, is made of waterproof material, with a spring steel band to encircle the waist and another band to spring about the ankles. The apron cannot slip down from the waist, and if placed over the ordinary lap-robe, holds it snugly about the person of the driver in a manner never possible before. There is perfect freedom for the feet to operate the pedals on the floor of the car. The wind and water are kept out, and the comfort of a warm robe about the body is kept in. There are no straps or buttons or buckles to cause annoyance, and the apron may be put off or on in an instant.

A STORM APRON FOR CHAUFFEURS.

A NOVEL CARRYING CASE FOR AUTOMOBILE TIRES.

One of our illustrations shows a new metal carrying case for automobile tires, which offers several advantages over the ordinary rubber covering that is placed over a shoe. This case is made of pressed steel, and weighs only about 25 pounds. It is hinged so that the outer half can be opened instantly, as soon as the lock has been unfastened. The spare shoe can then be quickly removed if it is needed. In the center of the case there are two spaces, the upper one being for spare tubes, and the lower one for tools. These cases are made sufficiently large to accommodate two 4½x36-inch shoes, and the fact that they provide waterproof and burglar-proof holders for the tires and tools is sufficient to warrant almost any automobile user purchasing them. Added to these advantages is that of ready and quick accessibility when the tire is needed. At the recent Automobile Show in the Grand Central Palace, one of these cases made of spun copper was exhibited. Although it had been in use on a car for nearly 3,000 miles, there was practically no indication of this from its appearance. When made of pressed steel, these cases will be even more durable.

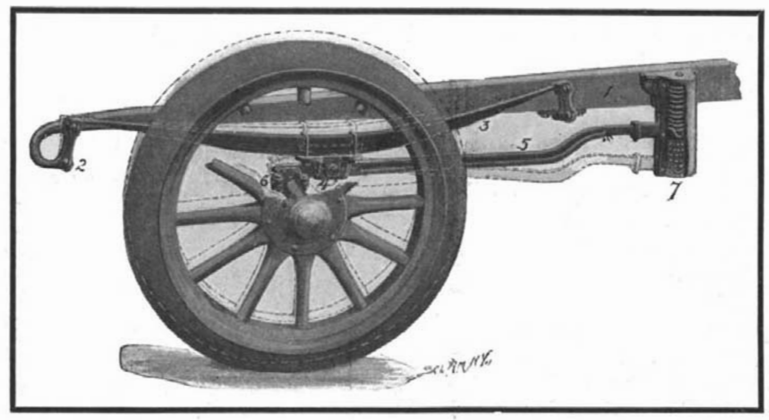


A NOVEL TIRE-CARRYING CASE.

A NEW SUSPENSION FOR AUTOMOBILES.

The ordinary elliptical spring, if it could be made flexible enough, would serve as an excellent device for relieving an automobile body of the tossing to which it is subjected in passing over inequalities of the road and would save much tire and machinery trouble. Unfortunately, if the spring is sensitive, it is too weak, so that the body is bound to strike. It has, therefore, been the practice to make the spring so stiff that less comfort is obtainable. Moreover, even the stiff spring is not always able to cope with the violent tossing, for which reason shock absorbers have come into more or less general use. It is the purpose of the shock absorber to relieve the elliptical spring of unusual strains, which purpose it accomplishes either by friction devices, or recoil cylinders.

Mr. Oscar Stolp, of 20 Fletcher Street, New York, N. Y., has adopted an entirely new means of overcoming the suspension problem. In his device he abandons friction devices and recoil cylinders and employs instead a very simple equalizing lever which dissipates the tossing effect, not by causing it to overcome friction or compress air or a liquid, but by changing its direction and causing it to expend itself in holding the car down on the road. The accompanying illustration shows the device. To the chassis 1, an elliptical spring 3 is secured by hangers 2. The axle 6 is mounted not at the center of the elliptical spring, but at the end of an equalizing lever 5, which is fulcrumed at 4 (the center of the elliptical spring). The other end of the equalizing lever is connected with a coil spring inclosed in a case 7. When the car strikes a depression the short arm of the equalizing lever is thrown up and the long arm down, thereby distending the coil spring and pulling the chassis down. The result is that the elliptical springs are entirely relieved of strain, so that they can be made sensitive and responsive. This new lever suspension has the merit of adapting itself to the character of the road, for it is obvious that the arm 5 will be rocked to a degree corresponding with the tossing effect. The inventor of this device has traveled over 20,000 miles on a car fitted with solid rubber tires and claims that he rides as comfortably in his vehicle, if not more so, than would be possible with an ordinary shock absorber on a pneumatic tired car. The device would seem to be particularly applicable to the high-speed roadsters which are now so popular—cars which are apt to leave the road when they strike a very slight obstacle and which obviously need some mechanical device for holding them down.



THE STOLP EQUALIZING SUSPENSION LEVER.

The dotted lines show the position of the parts when displaced by an inequality in the road.

A NOVEL SPEED-CHANGING GEAR.

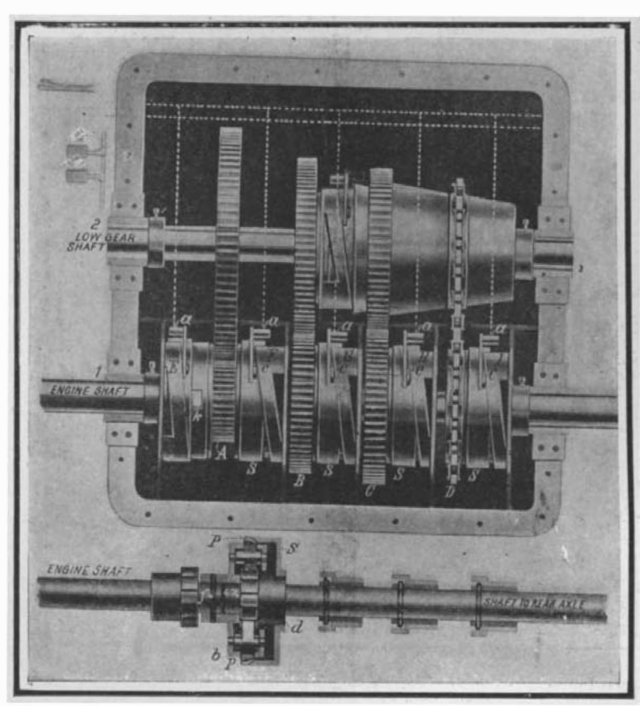
A novel speed-changing gear has been patented by Joseph A. Wilkin, of Matamoras, Pa., which is adapted for use on machine tools, automobiles, and motor boats. The device has been examined by Prof. Arthur L. Williston, who reports that in his opinion it is "thoroughly mechanical in principle and altogether practical; it is positive in its action; it is simple and effective in its operation; and it has many advantages not possessed by any other change speed mechanism."

In the accompanying illustration the device is shown applied to the transmission of an automobile. The engine shaft and the shaft to the rear axle or main driven shaft are in alinement but separated. The engine shaft carries a gear *A*; the rear axle shaft carries the gears *B* and *C* and the sprocket *D*. These three gears and the sprocket are loosely mounted on their respective shafts, but any of them can be made fast by moving the lever *a* of the appropriate clutch. The corresponding or mating three gears and sprocket wheel mounted on the countershaft and low gear shaft above the engine shaft, are all fixed, except for the provision of a slip clutch.

The engine shaft may drive the rear axle shaft through either pair of gears *A* and *B* or *A* and *C*, or may drive it in the reverse direction through the gear *A* and the sprocket *D*, simply by throwing the levers of the appropriate clutches and making the proper gears or sprockets fast to the engine and the driven shaft. The reverse motion of the driven shaft may also be obtained by means of two sprocket wheels and a chain, or by means of two gears in place of these sprockets with an idler running between them on an independent shaft.

The clutch which connects the gears with the driving or driven shaft is shown separately. Securely keyed to the shaft is a bushing to which a ratchet wheel *d* is attached. On the face of the gear a disk *b* is fixed, which is provided with four pawls *p*, so located that they may engage in the ratchet wheel simultaneously at four points equidistant on its circumference. By throwing these pawls in or out, therefore, the gears or sprocket may be made fast to or released from the shaft. The pawls may be held in action either by springs or by a pressure created on them through lugs located on their hubs by the driven or the driving gear. The operation of the pawls is controlled by a sleeve *S*, conical on the inside, which moves to the right or to the left longitudinally with the shaft and which permits them to engage in the ratchet wheel or holds them out of mesh with it. These conical sleeves are shown at *S* in the upper view. On their outer surface there

(Continued on page 67.)



A NOVEL SPEED-CHANGING GEAR.

The gears are always in mesh and it is possible to change directly from a low to a high speed.

Automobile Notes and Suggestions.

An automobile accessory in the form of a combination six-volt cigar lighter, acetylene lamp lighter, and incandescent repair lamp, made by the Metal Specialties Mfg. Co., of Chicago, Ill., has now been on the market for two years, and has proven itself to be a most useful article for automobile and electric vehicles. The lamp is six inches in length, and always at your elbow. A cigar, cigarette, or acetylene lamp is easily lighted going 60 miles an hour. The repair lamp is very handy for purposes of inspection. The ten feet of cord attached is sufficient for exploring any part of the machine. Its use leaves the hands free.

A 45 actual H.P. motor, 4¾" x 5", and a seven-passenger touring car with 120-inch wheel base, weighing 3,000 pounds, gives 1½ H.P. for each 100 pounds of car weight; 34 x 4½-inch tires all around is the equipment, and costs more money than the 36 x 4½-inch in the rear and 36 x 4-inch in the front. They are more convenient, and any tire manufacturer will tell you that they are more than ample to carry the load. These remarkable characteristics of the Glide car must arouse some interest. A car that is about the same in weight as the actual weight of the widely advertised, especially light cars (2,100 pounds), with a more powerful water-cooled motor, and is from 1,000 pounds to 2,000 pounds lighter than other high grade touring cars of about the same wheel base (120 inches). The motors of Glide cars have the five-bearing principle. The cylinders of the car are cast separately, so that the expansion and contraction of each cylinder is entirely separate from the others. The motor is water cooled and is provided with a simple apparatus, by means of which the carbon can be removed from the cylinders, without tearing the motor down. The universal joint is located between the motor and the transmission, and is called upon to transmit only the initial H.P. of the engine. It is housed oil-tight and dust-proof. The transmission is of the sliding gear selective type and has three speeds forward and a reverse drives direct on the low speed with all gears cut out and running idle. The Glide rear axle overcomes the flimsy, faulty construction common with bevel-gear-drive cars. The gears are large enough in proportion, and are made of the best material. The bearings are strong enough and made adjustable, and the shafts are large enough to do their work without overtaxing the rear system.

The power plant of the Rapid five-ton truck, appearing on another page, comprises an engine of the 4-cylinder, 4-cycle, vertical type, with a bore of 5½ inches and stroke of 6½ inches. It develops 60 horsepower. The cylinders are cast in pairs. The cylinder heads are cast integrally with the cylinders, as are also the valve chambers. The water-jacket head is separate. This permits of the cylinder cores and water-jacket cores being uniform, and allows the thorough removal of the core sand. The valves are of large diameter, the inlet and exhaust valves being interchangeable and located on the left-hand side of the motor, thereby necessitating only one camshaft. The valve heads are nickel steel, electrically welded to a carbon-steel stem of large diameter. Lubrication is by force-feed oiler to each bearing and cylinder. The oiler is attached directly to the upper half of crankshaft, and is positively driven by gears. The circulating water pump is of the centrifugal type, gear driven, and of such construction that it will not impede the natural circulation of the water in case of accident to the pump. The clutch is of the multiple-disk type, and is inclosed in the flywheel. Connecting the clutch with the transmission is a short propeller shaft provided with a specially designed universal joint at each end. The transmission is of the selective sliding-gear type, giving three speeds forward and one reverse. The driving spindle is forged integral with the driving gear, and is mounted on two large Timken roller bearings. The direct-drive shaft has three keyways milled from the solid shaft, thereby doing away with the square broached hole in the gears, as in the usual construction. The countershaft has flanges forged integral with the shaft for bolting the various gears thereto. The reverse gear runs in a pocket, and is mounted on a hardened and ground shaft, where it can be thoroughly lubricated. The bevel gear is bolted direct to a Hedgeland equalizer, which acts as a differential and gives a positive drive, no matter what the condition of the roads, and one which does not have the inherent faults of the ordinary differential in this respect.

The Holsman Automobile Company, of Chicago, Ill., have introduced a decided novelty in the way of a four-cylinder high-wheel automobile that deserves more space than we are unfortunately able to give it. The company has succeeded in building a motor in which there is not a single plain bearing, and in which every bearing is either a ball or roller bearing. It has dispensed with connecting rods and all unnecessary bearings. The motor is an air-cooled, four-cylinder, four-cycle type, 26 horse-power by standard rating, with twin mufflers, oiling device, carbureter, sparking apparatus, and transmission for both low and high gear all in one piece. It has three 5-inch radial ball bearings of best silent type, two 5-inch roller bearings of best frictionless type, and two Hyatt flexible roller bearings at the ends of the shaft near the sheaves. It has no plain bearings or journals whatsoever—not even a piston wrist-pin bearing. The ball and roller bearings, besides being the best that can be had, are fully twice as large as have ever been used on any motor of the same capacity, and are intended to be practically non-wearable. There are several other features that are new. For instance, power is transmitted directly from the motor shaft to the wheels without any intermediate gearing whatever by the use of a friction chain, thus making a real direct drive.

Some day the farmer will use the automobile more generally than now. The nearest approach to that day is represented by runabouts of the buggy type, which have large wheels, solid tires, and simple transmission. In this field a great success in automobile manufacture is being achieved. The force of this suggestion cannot be appreciated by anyone not intimately acquainted with the roads of our undeveloped districts, which make up the great area of this country. One of the first to follow the principle that an automobile can be made to go wherever a horse and buggy can, was W. H. McIntyre, of the W. H. McIntyre Company, Auburn, Ind. To-day the McIntyre Company has four immense factories with half a million feet of floor space and a combined capacity of twenty-five cars per day. It is building one, two, and three-seated pleasure cars, telephone and express wagons, rural mail wagons, laundry wagons, open and covered delivery, and in fact a complete line of commercial and pleasure cars. The McIntyre Company is the actual manufacturer of the car complete, building engines, transmission, chassis, body, etc. Several patented features make the McIntyre car distinct from any other on the market. Both two-cylinder and four-cylinder engines are used. The double-cylinder motors are of the half offset type. The planetary transmission used gives two speeds forward and one reverse. Both chain and shaft drive cars are built. All motors are air-cooled, and the McIntyre patented flywheel is claimed to have a blowing power of over 33 1-3 per cent above that of an ordinary fan of the same diameter. The spokes of the flywheel are cast in the form of fan blades, doing away with the use of fans, belts, etc.

The Lambert drive system, embodied in the Buckeye Manufacturing Company's automobiles and trucks illustrated elsewhere, embraces but two elements—a friction disk and a friction wheel, the former mounted on the rear end of a continuation of the crankshaft, and the latter on a transverse shaft lying to the rear of the disk face and from which a chain drives the rear axle. The friction wheel can be slid by a lever along the jack shaft, so that it contacts with the face of the friction disk at its center, or at any point from the center to the periphery of the right side for forward speeds, and on the opposite side of the disk for reverse speeds. Once the friction wheel is positioned for the desired speed, the friction disk has to be carried rearward, in order to press firmly against the paper ring on the rim of the friction wheel. This is accomplished by sliding rearward the longitudinal shaft with the disk—a movement made possible by the keying of a three-arm spider on the forward end of the longitudinal shaft, and the inserting of three studs in the rear face of the flywheel, so that all ball and socket joints in the spider arm may slip back and forward on these studs. The construction of the babbitt ball, which is used in the three-point spider connecting the extension shaft with the flywheel on the motor, is novel. This babbitt ball is cast around a copper gauze cover with small pyramids of graphite, so that when the ball slides back and forth on the driving pin, the graphite points make it self-lubricating. The ball and socket connection of the spider is such that by loosening the cap screw one can turn the adjusting nut, and take up the wear on the ball.

One of the most notable lines along which automobile construction is developing is the tendency toward a reversal to the earlier structural forms, made possible by refinement in detail and the greater skill and experience of designers and manufacturers. For instance, the earlier automobiles were built with but one cylinder. In order primarily to obtain more power, and secondarily to reduce vibration, multiple-cylinder engines were resorted to. Two or three years ago it seemed as if the single-cylinder automobile motor, if not the two-cylinder as well, was to be entirely superseded by fours and sixes. However, a variety of considerations, such as cost, weight, and expense of operation, have brought the single-cylinder back into favor, and luckily the greater skill of designers and producers has made this form of car perfectly practical and satisfactory. Those accustomed to the large motors can hardly believe the results of the small car races in France for the past two years, in which single-cylinder engines with a bore of barely four inches traveled for hundreds of miles, carrying two people, at an average rate of around fifty miles an hour. One of the first cars, if not the first, to cross the American continent was a single-cylinder; and so fraught with extraordinary difficulties, hardships, and dangers is the route from Denver to the Coast, that but a small number of even the most powerful cars have succeeded in making this trip. The latest transcontinental run has just been completed by the Brush Runabout, which is a single-cylinder car with a four-inch bore and four-inch stroke, and which from Denver to San Francisco carried Mr. F. A. Trinkle and his wife. This trip illustrates the unexpected results that may be obtained from apparently small means when the design is harmonious and correct, coupled with the proper materials, properly worked. The car itself, covered with mud and carrying the spade and tackle block used by Trinkle in the trackless wilds of the West, was one of the features of the New York Automobile Show.

A glance at the Premier cars readily indicates the rapid progress made toward the standardization of the modern motor car. The motors of the four and six-cylinder types have cylinders cast in pairs, with intake and exhaust valves on opposite sides. Lubrication is by force feed direct to the cylinders, and also by splash. The engines are fitted with low-tension ignition regularly, this being the make-and-break with Bosch magneto, and in addition they have a high-tension system, with battery, coil, and plugs, as an auxiliary. A Weston type multiple-disk clutch is inclosed in an oil-tight housing attached to the flywheel, and the drive from this to the transmission is through a floating member, whose forward end is squared well up within the clutch, and whose rear end consists of a three-jaw coupling with jaws slightly spherical, making it practically a universal joint. The transmission affords three speeds forward and a reverse. The drive is by propeller shaft. The rear axle is unique in several respects. The housing consists of two bell-shaped steel castings thoroughly ribbed on the inside to preserve alignment, and without truss rods. The driving pinion is located centrally, both it and its spindle being cut from one piece of metal, and is carried on two annular ball bearings suspended in saucer-like castings, dished diversely, the circular flanges registering together. The squared inner end of the live axle is carried in the hub extension of the differential, and on the outer end is a three-jaw clutch, which engages with a corresponding clutch in rear wheel hub.

The electric vehicle does not compete with the gasoline car for touring, but has a large field of its own in city and suburban needs. The limitations in the radius of action on one charge are not apparent in this use, since the radius is much greater than the requirements. The advantages of the electric are economy of operation, safety, freedom from noise, smoke, and dirt. The electric motor used to-day is fifty per cent better than it was. The storage battery has been improved in many ways. The materials and construction have improved in the electric class just as much as in the gasoline cars. Five years ago the average ability of an electric was 25 miles on a battery charge. Now it does 50 to 80 miles at less expense. The general idea is that electrics are expensive to maintain, but the cost of keeping them is about the same as that of horse buggies, while they do at least three times the work. The electric is not intended for high speeds, but is capable of traveling much above the speed laws, and when charged for a distance of say 50 miles per day, it costs often less than mentioned above. It is simple and easily kept in perfect condition. No other vehicle is so easily controlled and guided, or so safe and dependable.

Studebaker A TALK ON ELECTRICS

DO YOU DIFFERENTIATE?

ARE YOU ONE OF THOSE WHO SAY "I'd rather have a gasoline car than an Electric"? If you are, avoid this error in the future, we pray you. Don't be guilty of that break again—it exposes an ignorance of the functions of the two types of vehicles that is deplorable in a person otherwise well informed and one which we are sure you would rather not be guilty of.

LET US PUT YOU RIGHT: Out of the fullness of an experience dating from the very infancy of the automobile; and with the assurance of the impartiality of our position—since we are the largest producers and distributors of gasoline cars of all types as well as of Electrics, in the world; we believe we can give you a more accurate understanding of the essential qualities of each type and of the uses for which each is most suitable. We cannot afford to praise the one at the expense of the other.

THERE IS NO COMPETITION between electrics and gasoline cars. Do you get that? They are not rivals. They are not designed nor intended the one to perform the part of the other. They are allies—not enemies. Where the one is, there also should the other be—in every garage where there is a high priced gasoline touring car, there ought also to be an electric for city service—Studebaker preferred, of course, since we are considering a high class equipment.

NO!—NOT ALONE FOR MILADY'S USE, tho of course the electric is the only car a lady ever should drive herself—the only one in which she can maintain her dignity and her beauty—protect her gown and safeguard her temper. But you, too, the head of the house, need an electric for your business-hour's calls. It is so much quicker—more mobile—more nimble—in congested city sections than the big touring car or roadster, and it saves more than its cost in a year by doing this work for which the gasoline car is so thoroughly unsuited.

REMEMBER WE SELL EVERY TYPE of gasoline car—from the luxurious Studebaker 40 limousine through the entire line of seven and five passenger touring cars, including the E-M-F "30," which has created such a sensation of late. If these would serve all purposes, would we also make electrics by the thousands—and in every type for every service—Victorias, Landaulettes, Stanhopes, Coupes, Runabouts and the rest? Certainly not.

SO YOU MAKE YOURSELF RIDICULOUS, you see, when you compare the gasoline with the electric as if they were rivals—just as ridiculous as if you were to say you preferred a Tuxedo to a traveling suit, without specifying for what occasion.

THE LAYMAN IS EXCUSABLE for making this bull, because he has been led into the error by those he thought should know—manufacturers of Electrics—especially those who are very "new" to the business. The first impulse of the uninformed amateur designer is to produce a car which will do some spectacular, tho useless stunt. Because gasoline cars seek reputations for speeding and long distance touring—for which work they are intended—he needs must perform the same feats with the electric—hitch the family bay to the sulky and try conclusions with the thoroughbreds on the speedway.

IT IS FROM SUCH PEOPLE WE HEAR of 200-mile cross-country runs; 35 miles an hour and other performances perfectly easy to attain but entirely apart from the purpose of the electric pleasure vehicle—just as much as would be the use of a tallyho for social or business calls.

BY SIMPLY SACRIFICING more desirable qualities, an electric car can be made to cover a mile faster than any other thing on wheels—just shoot the entire charge, in one bolt of lightning, through the motor and the speed will be limited only by the nerve of the driver.

IF YOU WANT MILEAGE in excess of any rational requirements—for the uses intended—all you have to do is to possess a complete ignorance of the laws of electrical engineering—or, if so unfortunate as to possess, ignore them entirely. Make your batteries with an eye single to "miles-on-one-charge"—without regard to permanence of the battery plates, maintenance cost or any other consideration. You see it is simple—just as simple as to be a demagogue in any other line.

NOW STUDEBAKERS POSSESS ALL the facilities to do these things—except the necessary ignorance and the inclination to Gold Brick patrons. For any person who makes or sells an Electric recommending it for such work is selling something that his customer doesn't want—he needs a gasoline car.

STUDEBAKER ELECTRICS are standard of the world—just as are our gasoline cars. And the reason is, they are designed for the service intended and not with a view to creating a sensation—not to gratify some engineer's whim—nor to furnish the advertising man a catchy catch phrase.

SUITABILITY FOR YOUR PURPOSE is what you pay for. You buy an Electric pleasure vehicle because nothing else will answer that particular purpose so well. When you buy a Studebaker Electric you get a car designed expressly for that purpose—nothing omitted that will attain the end, nothing incorporated that belongs to another type of car.

If you are interested—we will gladly send you a little pamphlet "The Studebaker Plan," showing how to maintain an Electric at home and why it is the cheapest type of car to own and drive, year in and year out.

STUDEBAKER AUTOMOBILE COMPANY

General Office; Cleveland, Ohio

BRANCHES: New York, Boston, Philadelphia, Chicago, Kansas City, Denver, Portland, Ore., San Francisco, Salt Lake, Seattle, Wash., Los Angeles. Agents—everywhere—5000 of them.

AUTOMOBILE LUBRICATION—SOME ELEMENTARY PRINCIPLES.

(*Continued from page 49.*)

delivers oil from the reservoir to the sight feed above, where the proper amount is regulated. After dropping through the sight feed, a second pump forces the oil to the proper bearing. These lubricators should be closely watched, for the small ball-checks in the pumps often gum up and prevent the pump from working. It is advisable to obtain full instructions from the manufacturer of the lubricator, as there are a great number of these force-feed lubricators on the market which greatly vary in their construction and adjustment.

Hand Oil Pumps.—Hand oil pumps are sometimes found on the dashboard of cars which lead to the motor base. They should be given several full strokes daily.

LUBRICATION—HOW MUCH AND HOW OFTEN.

Part.	Lubricant.	Quantity.
Engine cylinder	Cylinder oil	6–12 drops per minute.
Engine crank case	Cylinder oil	Every 300 miles, or twice a month.
Engine bearings	Cylinder oil	8 drops per minute.
Valve lifters	Machine oil	With oil-can, daily.
Fan bearings	Machine oil	1 drop every 2 minutes
Timer-shaft.	Machine oil	With oil-can, daily.
Pump shaft-drive	Machine oil	With oil-can, daily.
Magneto-drive	Machine oil	With oil-can, daily.
Lubricator shaft	Machine oil	With oil-can, daily.
Clutch release	Machine oil	With oil-can, daily.
Break-lever-bearing	Machine oil	With oil-can, daily.
Steering knuckle	Grease	One turn daily.
Water pump	Grease	One turn daily.
Clutch-shifting collar	Grease	One turn daily.
Transmission bearings	Grease	Two turns daily.
Outer bearing live rear axle	Grease or oil	Two turns daily.
Magneto, plain bearing	Dynamo oil	Keep pockets two-thirds full. Wash out with kerosene once a season.
Magneto, ball bearing	Dynamo oil	Small amount once a month.
Starting-crank bracket	Machine oil	Few drops weekly.
Spring shackles	Machine oil	Few drops weekly.
Make and break tappets	Machine oil	Few drops weekly.
Pedal-shaft brackets.	Machine oil	Few drops weekly.
Speed-change-lever	Machine oil	Few drops weekly.
Emergency lever	Machine oil	Few drops weekly.
Brake supports.	Machine oil	Few drops weekly.
Brake equalizers	Machine oil	Few drops weekly.
Control levers and joints.	Machine oil	Few drops weekly.
Spring hangers.	Machine oil	Few drops weekly.
Steering gear-case	Grease	Every 2 weeks 3 turns or gunful.
Front and rear wheel-hubs, ball or roller bearing	Grease	Monthly.
Front and rear wheel hubs, plain bearing	Graphite and oil	500 miles.
Leather boots of steer-rod joints and steer drag-rod joints.	Grease	Monthly or 500 miles.

LUBRICATION—HOW MUCH AND HOW OFTEN.

Part.	Lubricant.	Quantity.
Transmission-case sliding gear system	Gear case compound or heavy oils, or either mixed with about ten per cent of graphite.	Semi-monthly or 300 miles. Let gears dip.
Transmission case, individual clutch type	Light motor oil and little graphite	Every 300 miles.
Planetary transmissions.	Non-fluid oil, or oil and graphite.	Every 300 miles. Fill up no higher than shaft bearing.
Live rear axle housing	Non-fluid oil or heavy steam engine cylinder oil, grease and oil	One quart every two weeks.
Universal joints	Grease	Remove covering 500 miles, inspect and repack.
Torsion and distance rods	Oil	Monthly.
Timing gears.	Non-fluid oil, graphite if exposed	Monthly.
Chains	Chain graphite	Twice a year boil in graphite and grease after washing well in kerosene.
Clutch leather	[Vegetable] castor oil, neats foot oil	If clutch slips or leather gets hard, keep off machine oil.
Clutch multiple disk, steel on steel	Spindle oil and kerosene, kerosene and little graphite.	Weekly.
Clutch multiple disk, leather on steel	No oil, little graphite	Weekly.
Internal expanding clutch	Thin oil.	Weekly.
Friction disk transmission	Keep oil off friction surfaces, wash off with gasoline, dress with belt dressing or French chalk	Renew friction compost every 1,000 miles.

As it is inconvenient, however, to carry too many kinds of lubricating oils with you, cylinder oil will take the place of machine oil called for in the table.

How to Save Money in Maintaining a Car.—Follow out the oiling instructions of the manufacturer conscientiously and do not use your own judgment in the matter.

Do not let anything on your car, no matter how small it may be, rattle or loosen. Inspect your bolts weekly.

Keep your car clean, not only on the outside, but inside (under the hood and under the body).

Keep the tires well inflated, and the lugs well tightened.

When a new car is received, the first thing the purchaser does is to try out the machine. That should be the last instead of the first step. Instead of taking a spin, he should examine the mechanism in general, and the lubricating system employed in detail. He should convince himself that every part which requires oil has oil. Not until then is the machine to be taken out and tried.

The driver's eye should be glued on the oil sights. If any sight should fill up with oil, the car should be stopped and the trouble remedied. The efficiency and life of a car depend largely on proper lubrication. A new car should be lubricated rather too much than too little for the first two months at least. Oil should be kept from the tires.

The car should not be run when an unusual noise or squeak is heard. The cause should be ascertained (hot bearings, brakes, etc.). Oil should not touch the brake bands of the planetary transmissions or the brakes. During an all-day run, the grease cups should be looked at and screwed down occasionally. If the engine cranks hard in a warm place, either the cylinders or main bearings need oil; if in a cold place, however, the lubricating oil in cylinders may be a little too heavy.

Before going on an extensive tour, see that the engine base and gear case are filled properly.

Examine the grease cups, and fill the lubricator. If the car is shaft-driven, remove the cover of the rear axle housing and see that the large bevel gear dips into the lubricant.

Go over the entire car with oil can and wrenches. Pay particular attention to the clutch.

Every two weeks inject a liberal quantity of kerosene into the cylinders, turning the engine over several times by hand when engine is still warm. This will remove whatever carbon may have been deposited in the cylinders and between the cylinder walls and the piston rings and thereby assure a good compression, which is one of the most essential points in getting power.

Keep the belt on the mechanical oiler sufficiently tight to drive it, and never run the car unless the pump is working perfectly.

Squeaking bearings denote lack of oil.

Sudden falling off of power when running may be caused by insufficient lubrication (cylinder and main bearings)

In extremely cold weather and where the lubricator is exposed, an egg-cup full of gasoline or kerosene will keep the oil from becoming too thick and from causing trouble by clogging the small ball checks in the oil pumps.

Before putting on a new clutch lever it is advisable to soak it for 24 hours in water. When fastened to the clutch it should be given a liberal coating of castor oil, or better still, neatsfoot oil. It will take quite a time for the oil to soak into the leather properly, as the water must first evaporate, which takes quite some time.

To prevent the multiple disk clutches (metal to metal) from dragging after disengaging the clutch by the foot pedal, use only a very thin oil (spindle oil) mixed with kerosene. Good results have been obtained by taking ¼ cylinder oil (light) and ¾ kerosene.

Lubricating oils should always be strained before using, as grit and ground-up materials will obstruct oil-holes, pipes, etc.

Blue smoke issuing from the muffler denotes excessive cylinder lubrication or worn cylinders and has nothing to do with the mixture of gas.

THE COMMERCIAL TRUCK VS. THE HORSE.

(*Concluded from page 43.*)

to heavy vehicles, and it must be admitted that it possesses advantages in the smoothness with which the power may be applied and in the reserve power that may be called upon in emergencies. In the United States, however, this field is practically untouched.

The initial expense of an automobile equipment seems high to the man who is familiar with horses, and to reduce it many concerns are purchasing second-hand pleasure cars and fitting them with delivery bodies. There is no risk in making the purchase if the purchaser will have the chassis examined and properly overhauled, but he must realize that the car is suitable only for the delivery of light packages, and that it must have careful attention and handling. With the addition of suitable braces and trusses a fair load may be carried, but there can be no comparison, of course, with the cars that are designed and built for trucking purposes.

To get the fullest benefits from an automobile delivery service, it must be realized at the outset that everything about it is new, and that a stable foreman is rarely competent to give it the intelligent management that it requires. There must be regular and systematic inspection of the mechanism, correct adjustments maintained, and supervision exercised over every detail of handling, repair, and care. The ultimate cost of neglect and mishandling is out of all proportion, and it should therefore be possible to place full responsibility for a failure to lubricate or to attend to any other essential of the upkeep. Two weeks at the factory is not sufficient to change a stable hand into a competent driver, and a lack of smoothness in the handling of the car will be paid for in tires, bearings, and strains in the entire mechanism.

It is usual to see automobile trucks carrying loads far in excess of their rated capacity, and this is the most prolific cause of high repair bills. It is the custom of some manufacturers to protect their vehicles by underrating their capacity, and this also operates to protect the purchaser. Knowing that the car is likely to be overloaded, a truck that is capable of carrying a load of five tons will be rated at three tons; another method of protection that is practised is to limit the size of the body.

A business man will not purchase an electric lighting plant without engaging an engineer to tell him what he wants, to select the apparatus, and to supervise its installation. Yet he believes himself competent to purchase an expensive truck, and to evolve a system for its operation and maintenance. The exigencies of the situation are producing experts who are competent to examine into

the conditions under which deliveries are made, who can report on the make and type of car best adapted to perform the work, and who can establish rules for its care. It is to a man of this class that a prospective purchaser should turn for assistance. There are many houses operating automobiles successfully, but the price that they have paid for experience is far in excess of the fee that would have been charged had an expert been employed at the outset.

The construction of pleasure vehicles is approaching a condition of standardization, and the designs undergo only slight changes from one year to another. That the automobile truck is likewise emerging from a formative condition is shown by the reduced importance of the alterations required for the elimination of the weak points that develop in service. The 1909 types are far superior to the earlier models in every respect; and if their purchasers exercise common sense and business judgment in their management, there should be no difficulty in obtaining from them the swift, efficient, and economical service that is so greatly to be desired.

HIGH-TENSION IGNITION BY MAGNETO.

(*Concluded from page 45.*)

as such, but this is an error; for while it produces a high-tension current, the magneto itself delivers a current of even lower voltage than the magneto used for the make-and-break system.

While the Remy and Eisemann systems are similar in that they use separate coils, the magneto construction is different. In the Remy the winding is separate from the armature core and is stationary, the core revolving within it. The core and winding are shown in Fig. 7. When the core is revolved within the pole pieces of the field magnets, the cylindrical portion within the winding becomes magnetized and demagnetized, currents being developed in the winding to correspond with the degree and rapidity of the changes.

The Bosch high-tension magneto differs from the Remy or Eisemann in producing a current of high voltage in the armature winding, and without the use of a separate coil, this construction being also common to the U. & H., the new Eisemann, the Witherbee, and Komet. Instead of but one winding, the armature carries two, the inner or primary consisting of a few layers of coarse wire, and the outer or secondary of a great number of layers of fine wire. The disposition of these windings may be seen in Fig. 1, and the complete armature with the field magnets in Fig. 8. One end of the primary winding is grounded on the armature core, and the other passes to the insulated part of the interrupter, Fig. 9. While in the Remy and Eisemann magnetos the interrupter is stationary and operated by a revolving cam, in the Bosch the two fiber wheels, serving as cams, are stationary, and the interrupter revolves with the armature. This arrangement makes it possible to conduct the current from the primary winding direct to the interrupter without the use of a commutator or of sliding brushes, the action of which might be interfered with by dirt or oil.

In the Remy magneto and in another type of Bosch the primary current is conducted direct to the interrupter without the use of a commutator or sliding brushes, on account of the use of the stationary winding, which is used in its construction.

During the revolution the grounded lever makes and breaks contact with the insulated part, offering the primary current a short circuit while the contact is closed. As may be seen from the diagram, the secondary winding is grounded on the live end of the primary, its live end being connected with the revolving part of a secondary distributer.

In order that a current may flow it must have a closed circuit, and this will be the condition of the primary winding while the interrupter lever is in contact with the insulated part. For all points in the revolution of the armature except from the position of Fig. 3 to that of Fig. 4, and, of course, the corresponding position a half revolution later, the primary circuit is closed, permitting the feeble currents to flow. When the current reaches its maximum, a cam operates the interrupter and the short circuit is broken. In the meantime the secondary circuit has been open while the distributer has been moving from one contact to another, and therefore there has been no flow of current in the secondary winding. The electrical pressure will rise in it as the armature approaches the position of Fig. 3, but there will be no flow even when the distributer is making contact, because the pressure will not be sufficient to overcome the resistance of the spark plug gap. When the interrupter operates, the maximum primary current will be diverted from its short circuit, and can then flow to ground only through the secondary winding and spark plug circuit. The high pressure already existing in the secondary winding will be greatly increased by the sudden flow of the primary current, and the spark plug gap will be bridged by a current of such intensity that an arc rather than a spark is produced at it.

In another Bosch type, the armature, while identical in winding with that already described, does not revolve, but is fixed in the position of Fig. 3. In a space between the armature and pole pieces revolves a shield formed of two pieces of soft iron similar in size and curvature to the side pieces of the armature. The magnetic flow is from one pole of the field to one of the segments of the shield, to the armature core, and to the other pole by the second segment. With this construction complete magnetic changes in the armature cross bar occur not twice, but four times to each revolution of the shield, resulting in the production of four maxima of current. The advantages are that the winding is stationary and therefore operating under better conditions than when it is revolving, that the magneto runs at half the speed that is required for the other type, and that for a 4-cylinder engine the distributer may be placed on the magneto shaft instead of on an auxiliary shaft driven at half the speed of the armature.

The high voltage of the current makes it essential to provide a circuit for it, for if by chance a spark plug lead wire were to become disconnected, the pressure would be quite sufficient to break down the insulation of the armature winding in seeking another path to ground. To guard against this a high-tension magneto should be fitted with a safety spark gap consisting of two points, one connected to the secondary circuit and the other to ground. These are set apart at such a distance that the current will pass across them before the pressure will rie sufficiently to rupture the armature insulation. A pressure of 12,000 volts will usually permit the current to pass across a spark plug gap, and on the Bosch magnetos the safety spark gap is set to operate at 16,000 volts. In the Eisemann system the gap is located on the coil box, and will be bridged by a pressure of from 20,000 to 25,000 volts.

In the Bosch magneto, the condenser that is connected across the interrupter contacts is located in the armature and revolves with it. In the Eisemann, U. & H., and Witherbee the condenser is in the interrupter housing or under the arch of the magnets, which permits its easy replacement in case of rupture. The construction of condensers has been perfected to such a point that there should be little trouble from this source, however, and it would seem advantageous to locate it in the armature, for then there is no need of sliding contacts. The limited size of magnetos and the unfavorable conditions under which they must operate, require perfection of design and construction in order that they may not give trouble, and the elimination of sliding contacts is of importance because of the difficulty of keeping them clean and in adjustment. This feature has been perfected to a high degree in some makes, while in others it seems to have been entirely overlooked.

In comparing the high-tension magneto with the high-tension system employing a low-tension magneto and secondary coil, much may be said on both sides. The chief claim for the latter system is that the small size of the armature makes it difficult to insulate the secondary winding properly, and that it is therefore liable to rupture. The coil being separate is not limited in size, and ample insulation may be provided. The argument against this is that with proper design, workmanship, and materials, no difficulty need be experienced from this source, and that a double-wound armature greatly simplifies the wiring and reduces the number of parts.

In order to give proper ignition, a magneto must be set in such relation to the crankshaft that it is delivering its maximum current at the instant that a piston is at the firing point with the engine running at normal speed. In automobile engines this point varies from $\frac{3}{8}$ inch to $\frac{3}{4}$ inch below the top of the stroke, the average being $\frac{5}{8}$ inch. When the firing point is known, the crankshaft should be revolved to bring a piston to that position, and then, the spark control being advanced, the armature should be turned until the interrupter is just breaking, when the driving gear should be meshed. It is possible to make the setting by bringing a piston to the top of the stroke, and meshing the gear when the interrupter is breaking with the spark control retarded, but this gives no assurance that on advancing the spark the production of maximum current will coincide with the firing point. If this method is used, it will be necessary to make trials and to shift the gear one tooth at a time until the best operation is secured.

The automobile user who is familiar with the operation of the battery and coil system will find several points of difference in the use of a magneto system of either of these types. In starting the engine on the magneto, it is necessary to revolve the crankshaft at a much higher speed than is required for a battery, in order that the current may rise to an intensity that is sufficient for ignition, and to utilize it at its maximum the spark control must be advanced to a point that would be dangerous with a battery. At the slow speed attained by cranking, the current will be sufficient for ignition only as the armature moves out of the position of Fig. 3, and the interrupter must break at that point. At high speeds the current at its maximum will be more intense than is actually necessary, and will not drop below the point at which it can give ignition until the armature reaches the position of Fig. 4. The interrupter may therefore operate at any point within this range, its time of breaking being controlled by moving the housing to alter the instant at which the cam touches the lever.

A feature of the U. & H. magneto is that it will give an ignition current with slow rotation of the crankshaft. The magneto driving gear is not applied to the armature shaft, but to a stub shaft in line with it, the two being connected through a ball clutch and helical spring. On cranking the engine the ball clutch prevents the rotation of the armature, and tension is put on the spring. The spring is wound up as a piston nears the top of its stroke, and at the instant of ignition the clutch releases and the unwinding of the spring drives the armature at high speed across the point of maximum magnetic change. When the engine takes up its operation, centrifugal force holds the ball clutch out of engagement, and the magneto drives in the usual manner.

The plugs made for battery and coil systems are unsatisfactory for magneto ignition, for the high amperage rapidly burns their slender points. Plugs with heavy electrodes should be used; and while the gap may be as wide as 1/32 inch, better results will be attained if it does not exceed 1/64 inch. The widening of the gap from burning will introduce resistance that is too high to be overcome, and an interruption of the circuit from this cause will be indicated by sparking at the safety spark gap.

The most important point in the care of a magneto is its lubrication. It is usual to provide the oil cups with overflows to prevent an accumulation of oil that might work its way into the armature, and the lubricant is conducted to the bearings by wick feeds. These oil cups should never be permitted to run dry, for the clearance is so small that a worn bearing will permit the armature to strike the pole pieces.

The interrupter and distributer covers should be tight to prevent the entrance of dust, but should these parts become fouled they must be wiped off with a rag and a little gasoline. Where carbon brushes are used, as in the distributer, the carbon dust that will collect must be removed, or it will tend to cause a short circuit.

The most reliable and satisfactory ignition for automobile engines is obtained through the use of magnetos, but their full benefits are realized only when they are kept clean and properly lubricated. Attempts to improve them by altering adjustments or making changes will only result in dissatisfaction, and the maker may be relied upon to have worked out the details and made the settings with a knowledge based on deeper study and wider experience than is possessed by the average automobilist.

OUR LEGION TIRES AND THEIR TROUBLES.

(*Concluded from page 47.*)

as much as a new tire would cost. Such protectors add to the thickness and consequently to the heating of a tire. There is also bound to be more or less friction between the outer covering and the tire. If the outer covering is of the right size and is properly adjusted, this friction is not excessive. Such a protector, however, frequently stretches if it is not put on sufficiently tight, and very great wear takes place between it and the tire. Another form of tire cover consists of what is really a chain armor (Fig. 11). These covers are held on in a variety of ways, very much the same as leather and fabric and rubber tire protectors. They are very heavy, and to be durable they must be made of hardened steel. They rust badly, and most forms of them wear between the links, so that they soon become loose, for which reason it is necessary to take out a row of links in order to tighten them up.

Another method of seeking to avoid trouble is to provide self-heating materials designed to close a puncture. Gummy, sticky substances of various kinds placed in a leaky tire frequently cause it to hold air temporarily, but the usual experience is that the tire holds air only when it is comparatively cool, and that as soon as the tire heats up in running, the material becomes more soft, and air escapes. In addition, these compounds usually have a bad effect on rubber and fabric, and a tire which has been thus "doped" is soon completely worthless, for the reason that the materials usually make it impossible to vulcanize and repair the tire. Various forms of self-healing inner tubes have been devised. Sometimes the thickness and softness of the rubber is employed (Fig. 12), sometimes a plastic material and fibers, and sometimes by the introduction of fabric in the construction of the inner tube. Other inventors have constructed two, three, and sometimes four inner tubes inside of one another with valves, so that when one tube is punctured another can be immediately inflated without removing the tire or inner tube.

None of these devices solves the problem satisfactorily, and many are failures. Automobilists of the widest experience usually agree that the best and cheapest form of pneumatic tire is the ordinary plain round-tread clincher tire and inner tube on the regular one-piece clincher rim.

Solid tires are used almost exclusively on comparatively slow-moving business vehicles. Many people think solid tires never cause any trouble; but in this they are mistaken, for solid tires also are subject to many ills. They are, on the whole, much more dependable than a pneumatic tire, but a cut in a solid tire is apt very soon to pound itself into a great flat place that destroys the tire. Perhaps the greatest difficulty with solid tires is found in attaching them to the wheel. Fabric bases with cross wires, diagonal wires, and wires running lengthwise are employed. Solid tires are sometimes put on by hydraulic pressure, and other forms are held on by flanges bolted up on either side. Solid tires may be classified as plain, cushion, sectional, and special. Plain solid tires (Fig. 13) do not afford very much in the way of resiliency. They serve chiefly the purposes of being a silencing band, and of giving traction upon the roadway. Their width and thickness vary according to the loads they are designed to carry, and when used on heavy trucks or omnibuses, it is found more satisfactory to use two and sometimes three narrow tires side by side than one very wide single tire (Fig. 14). The plain solid tire is rolled continually between the wheel and the pavement, which rolling has a tendency to make the tire stretch and become longer, just as a piece of metal expands in a rolling mill. This lengthening or stretching of the tire causes particular difficulty in securing the tire firmly to the rim of the wheel.

Cushion tires are not manufactured for as heavy work as the plain solid tire, and are designed to give a greater degree of resiliency, an end which is attained by making the tire of a softer composition of rubber, and also by making the tire thicker in proportion to its width. Many special forms have been designed to increase the resiliency (Fig. 15). Sometimes there are holes through the tire parallel to the axle of the wheel (Fig. 16). Sometimes the tires are manufactured with holes in them in the direction of the spokes of the wheel (Fig. 17). All of these cushion tires depend for their resiliency upon the bending of the rubber. The resiliency is therefore limited considerably. If the tire is overloaded or is improperly designed, so that it bends too much, the tire not only consumes a great deal of power and is "slow," but there will soon be a destructive breaking down of the rubber, which will destroy the tire. At speeds of from twelve to eighteen miles per hour, cushion tires give satisfactory service if they are properly designed for the work they have to do, provided the vehicle is designed to stand a sufficient amount of vibration.

Sectional solid tires have been used with considerable success, particularly abroad, on the heaviest forms of trucks. Each tire is made up of small sectional segments shaped very much like bricks, one of the main advantages of this form of tire being that an injured segment can be readily renewed.

In the class of special solid tires may be included many forms of tire which are at the present time largely experimental. We may mention tires made up of wooden blocks, fiber blocks, and tires made up of sectional steel plates with a cushion of rubber beneath, as well as many other combinations. None of these have come into very general use.

In classifying tires as pneumatic, solid, and special, we place in the last classification filled tires, spring wheels, and wheels which have pneumatic hubs or pneumatic cushions within the circumference of the wheel. A tire filler is an elastic solid substance which takes the place of air in any form of penumatic tire (Fig. 19). The filling must be introduced into the tire under pressure in just the same manner as the tire is filled with air. After the tire is filled to the proper degree of hardness, the material is allowed to set, in which process it must undergo a chemical change, so that it cannot again be melted by heat. At the present time the greatest difficulty with a tire filling is that the wheels, tires, and tubes must be sent to the factory for filling. A properly filled tire rides about as easily as an air-filled tire at the same pressure, while the advantages in favor of the filled tire are many. Punctures obviously cannot have any effect upon it.

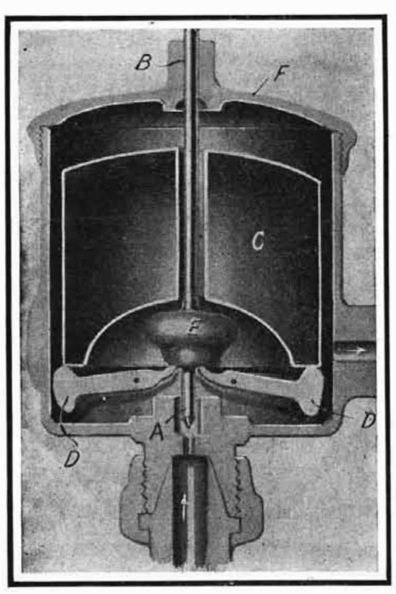
Spring wheels nearly always have an ordinary felloe and rim equipped with a solid rubber tire. Within the wheel arrangements of springs are designed to take up the shock and vibration (Figs. 20 and 21). The most common defect of spring wheels is that while they may be resilient, they do not hold the rim and tire strictly at right angles to the axle. Then again, any mechanism depending upon springs for its action is only as reliable as the spring.

Attempts have been made to introduce special wheels (usually shod with a solid tire) which depend for their resiliency upon a pneumatic tube or tire about the hub or within the felloe of the wheel. Combinations of this kind are expensive, and none of them have become very well known commercially.

The tire problem is the most serious one which the manufacturer and the automobilist have to face to-day. There is no question but hundreds of people would become users of the automobile if they were not afraid of the great expense and uncertainty of pneumatic tires.

CORRECTING A LEAKY CARBURETER FLOAT VALVE.

A carbureter float valve may leak for various reasons. There may be dirt in it, in which case a good flushing out with gasoline will stop the trouble. The connection between the float and the valve may be of such a character that the vertical movement of the float causes the valve to rock slightly on its seat. Such a valve is practically impossible to keep tight. The connection between the float and the valve may be bent or badly adjusted, so that the float is unable to close the valve. As shown, the float A has a



CORRECTING A LEAKY CARBURETER FLOAT VALVE.

long weighted stem B, and shuts off by its own weight the gasoline entering from below. This valve is held open by the float C, which rests on two small levers $D\,D$, the inner ends of which lift upward against the weight E of the float valve. The float is supposed to rise sufficiently to let the valve close when the gasoline level is just below the top of the spray nozzle (not shown in the figure). Something may happen, however, to disturb this relation. For example, the weight E, which is usually threaded on the stem B, may become loose, so that while the weight is held up by the levers, the stem gradually screws itself down through E and closes the valve. On the other hand, the top of the float may, in some manner, strike the cover F of the float chamber, or the small ends of the levers $D\,D$ may strike the bottom of the float chamber before the valve is closed.

Sometimes the valve simply leaks, and has to be ground in with pumice stone. This is a somewhat delicate process, and requires keeping the stem B as near the center as possible while the grinding is being done. By unscrewing the cover F, one can generally tell where the trouble lies. For example, if pressing down the stem B stops the dripping, it is evident that the trouble is in the float or its connections.

A metal carbureter float such as shown in the cut may have a minute leak, through which gasoline gradually enters and weights the float, so that it does not rise sufficiently to close the needle valve A at the proper gasoline level. Shaking the float will disclose the trouble. The remedy is to warm the float in a moderate oven until all the gasoline has evaporated out. While the drying out is in process, dip the float in warm water; the escape of bubbles will show where the leak is. After the float is dried out, allow it to cool and carefully solder the leak.

GETTING HOME WITH A BROKEN UNIVERSAL JOINT.

All cars in which the rear axle is driven through bevel gears have a propeller shaft transmitting power from the engine or transmission gears to the bevel pinions and gear. This propeller shaft has a universal joint at one or both ends, and sometimes the pin or bolt through this joint breaks. The obvious expedient is to hunt up a temporary bolt of any sort which will go through, and usually this is the best that can be done. Sometimes, however, not even an ordinary iron bolt is to be found, and in that case one may get along by making up a bundle of fairly thick iron wire, such as telegraph wire. This bundle, as large as will collectively enter the hole, is bound securely at its ends, and the ends of the wires are then splayed out and turned over. Evidently cautious driving is required with such a makeshift, but it has been done successfully.

SUPPRESSING RATTLE IN BRAKES, MUD GUARDS, ETC.

Most noises due to loose brake shoes and miscellaneous control members about the car are easily traced, and their correction demands only a little time and common sense. Sometimes leather may be used to quiet a part that rattles. Sometimes a tension spring will do the work. Sometimes bearing pins wear loose in their holes, and the latter must be reamed and larger pins inserted. Sometimes the mud guards work loose. A somewhat troublesome problem is presented by an aluminium mud guard which has cracked from vibration. It must be braced and held by small bolts with large heads, rather than by too large bolts with small heads, as it is dangerous to put much strain on material so soft and brittle as aluminium. It is an excellent plan to use leather washers next to aluminium mud guards, dash boards, etc., wherever bolts go through.

A NOVEL GASOLINE STRAINER.

Most carbureter troubles are caused by dirt or water, which has found its way into the carbureter. When trouble of this kind occurs, the motor usually stops. The crank is turned a few times, and then the carbureter is taken apart, with the result that in reassembling, the parts fail to readjust themselves properly.

In order to overcome this difficulty the Austro-American Separator Company of Cleveland, Ohio, have introduced a funnel which separates all water and dirt from gasoline. The separating is accomplished by the use of two pockets, in which water and dirt accumulate on account of their greater specific gravity, and by the use of two very fine, specially woven water-separating gauzes. Gasoline runs through this funnel much faster than it will percolate through chamois skin. Furthermore, chamois skin does not efficiently separate water from gasoline, automobile superstition to the contrary notwithstanding. Water settles, being heavier than gasoline. Hence the pressure of the inpouring gasoline forces the water through the skin, with the possible exception of a few drops left on the surface. Again, only one out of a hundred new chamois skins is thick enough and uniform enough to remove some water from gasoline; on the other hand, gasoline runs through this kind of a skin very slowly.

The new automatic separator mentioned prevents water from entering the carbureter, even if the gasoline tank is full of water and dirt. When a certain amount of water has accumulated in the separator the gasoline line is automatically shut off, until the water is drained by opening a pet-cock at the bottom of the separator. Water being heavier than gasoline, will naturally settle to the bottom. Therefore, when the pet-cock, which is the lowest point in the gasoline tank, is opened, all the water will run out of the tank through the separator, taking the dirt with it. As soon as the water has escaped, the gasoline line is automatically opened. The motor will start on the first turn of the crank. The gasoline flows downward into the separating chamber and thence upward through an extremely fine mesh wire gauze to the outlet. Clogging of this gauze is impossible because the gasoline flows against gravity.

A NOVEL SPEED-CHANGING GEAR.

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are two lugs which move in the spiral annular grooves in the member *c*. A twist of the conical sleeve *S* by means of the levers *a* will cause them to travel parallel with the shaft and will permit the pawls to engage in the ratchet wheels or will prevent the pawls from thus engaging. The shaft transmits the power through a rigid pin to the ratchet wheel, by which it is in turn transmitted to the four pawls. From the pawls the power is transmitted through the lugs located on the hub of each pawl, or through the disk to which the pawls are attached, to the gear. When the gear is the driver and the shaft is the follower, the power is transmitted in the reverse order.

The clutch *E* is operated when it is desired to drive the countershaft through the gear *A*, but when it is desired to drive the rear axle shaft directly from the engine shaft without going through the countershaft, the clutch *F* can be operated. The lower view illustrates this. The line *x*, the dividing line of the shafts, lies inside of the disk *b*, so that the shaft can never get out of line. The hub of the disk *b* is keyed to the driving shaft by the pin *f*, so that *b* always turns with the driving shaft. The ratchet wheel *d* is keyed to the driven shaft at *e*. The disk *b* forms a part of a casing which holds the pawls *p*. When these pawls are in mesh with the ratchet wheel *d*, the rear axle shaft will be directly and rigidly connected with the engine shaft.

When the engine shaft and rear axle shaft are direct connected, the countershaft and none of the gears are running; all the clutches except *F* are out; and the wheels *A*, *B*, *C*, and *D* are loose upon their shafts. Any number of gears can be used and therefore any number of speeds obtained.

The device furnishes a positive drive with no chance of slippage, without lost motion and with inappreciable wear because the gears run in oil. There is no possibility of stripping because the gears are always in mesh. The pawls in the opinion of Prof. Williston are "superior in strength and reliability to gear teeth as a means of transmitting power," and transmit the load "more nearly in direct compression than is the case with gear teeth." The conical sleeve is about as simple a disengaging and engaging mechanism as can be imagined. The clutch, moreover, can be operated in all positions, which is not the case with sliding gear devices. Any clutch can be operated regardless of the position of the other clutches, so that it is unnecessary to pass progressively from low speed through the intermediate to high speed.

One hand lever only is required to operate all gears. The dotted lines in Fig. 1 indicate shafts leading to hand and foot levers. The hand lever operates clutches *E* and *F* in Fig. 1, which it will be noticed face each other, thereby causing pawl *K* of clutch *E* to be thrown in at the same time pawl on clutch *F* is cut out. In this position the spiral grooves run in the same direction. It is possible to connect the small cranks of clutches *E* and *F* to the same hand lever, and operate both clutches with one movement of hand lever, thus throwing the power from the direct drive to the countershaft or from the countershaft to the direct drive as desired. The low and intermediate gears are operated by foot levers. The low gear has an automatic reversible clutch. If power is stronger to go forward, the forward pawl will engage, and if the power is stronger backward, the backward pawl will engage. For example: If a car is coasting down hill and the engine is working on the low gear forward, the speed of the car is greater against the low gear and acts as a brake.

RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

HEAD-COVERING.—W. BERNSTEIN, New York, N. Y. The object of this invention is to provide a head covering for infants and children, arranged to properly fit the head and to allow convenient washing and cleaning of the covering with a view to insure long service and to maintain the covering in a neat and tidy condition.

Electrical Devices.

COMBINED FUSE-PLUG AND CIRCUIT-CLOSER.—F. F. VINDEMORE, Fairview, N. J. Means provide in this case for closing one electric circuit of high potential, by the operation of an electromagnet energized upon the closing of a second circuit preferably of low potential, and more particularly to certain improvements, whereby the circuit closer is combined with the fuse plug, and the two supported upon a single base.

Of Interest to Farmers.

BEET-TOPPING MACHINE.—J. N. HANNA and D. K. WAUGH, Ordway, Colo. Swiveled colters are placed at opposite ends of the apparatus and in advance of the guard wheels on the tapping mechanism to cut off tops and trash and assist in guiding the wheeled truck; shovels are arranged having landsides to throw the tops, etc., cut by the colters to the outside of the topping mechanism. Means provide for taking the weight from the wheels as the guard passes over a high beet top and thus prevent the wheels from striking the beet, which avoids breaking the high tops. A mold-board cutter forward of the colters removes to one side all rank tops standing upright.

DEVICE FOR SUPPORTING AND ADJUSTING THE CONCAVE OF A GRAIN-THRESHER.—P. HASTER, El Paso, Wis. The thresher affords inexpensive and convenient means for reliably supporting the toothed concave of the machine in a substantial upright position, in front of the toothed cylinder thereof, and enables the speedy outward rocking adjustment of the concave while the machine is running at full speed, thereby facilitating the tightening of loose teeth thereon or replacing a broken one, as occasion may require.

Of General Interest.

EXTENSIBLE PICTURE-FRAME.—C. VAN DER BOOM, Platte, S. D. The object here is to produce a frame which can be adjusted so as to hold pictures of various dimensions within certain limits. Further, to enable the frame to be hung with its longitudinal axis in a vertical or a horizontal position, and to provide means for removably attaching a supporting leg to the back of the frame in such a way that the frame may rest upon a support with its longitudinal axis in a vertical or horizontal position.

BOTTLE.—F. SONNENFELD and R. FISHER, New York, N. Y. The bottle has a valve-controlled discharge nozzle carried by the neck and communicating within the neck with a tube extending substantially to the bottom of the bottle. In combination with this form a stopper having a valve-controlled passage therethrough is employed, the means for operating the valve being below the top of the stopper, so that it cannot be operated acci-

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dentally. This passage permits withdrawal after the bottle is inverted of that part of the contents of the bottle which is not forced out through the first-named passage by pressure of the gas.

Heating and Lighting.

FURNACE ATTACHMENT.—F. L. WATSON, Leeds, England. The object of this invention is to provide an apparatus, arranged for cooling the clinkers, cinders, or like hot material discharged from the furnace, for recovering the heat contained in the hot material by heating air, and for forcing the heated air into the fire box of the furnace, to insure complete combustion of the fuel burning in the box.

FUEL-REGULATOR.—C. B. WIESER and F. E. WIESER, Paso Robles, Cal. The cylinder in this invention has a working piston in communication with the boiler pressure, with means in connection with the piston for moving the fuel regulating valve in a direction to cut down fuel supply when the piston is removed by the steam pressure in one direction, and means tending to move the piston in the opposite direction against the steam pressure, the last means being variable, whereby it is possible to maintain desired boiler pressure within certain limits.

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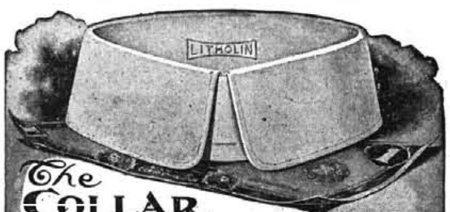

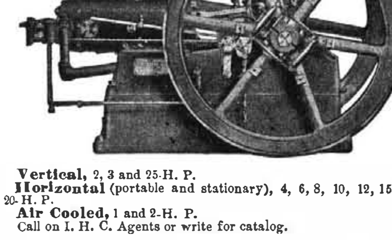

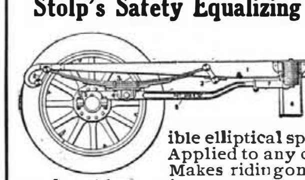

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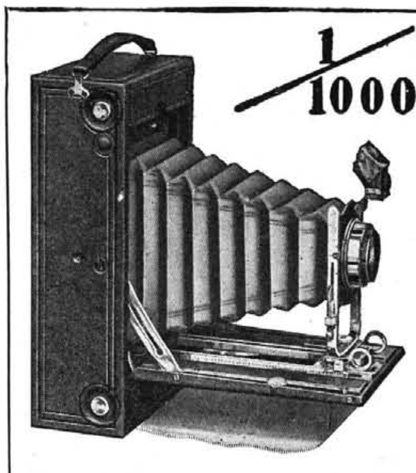

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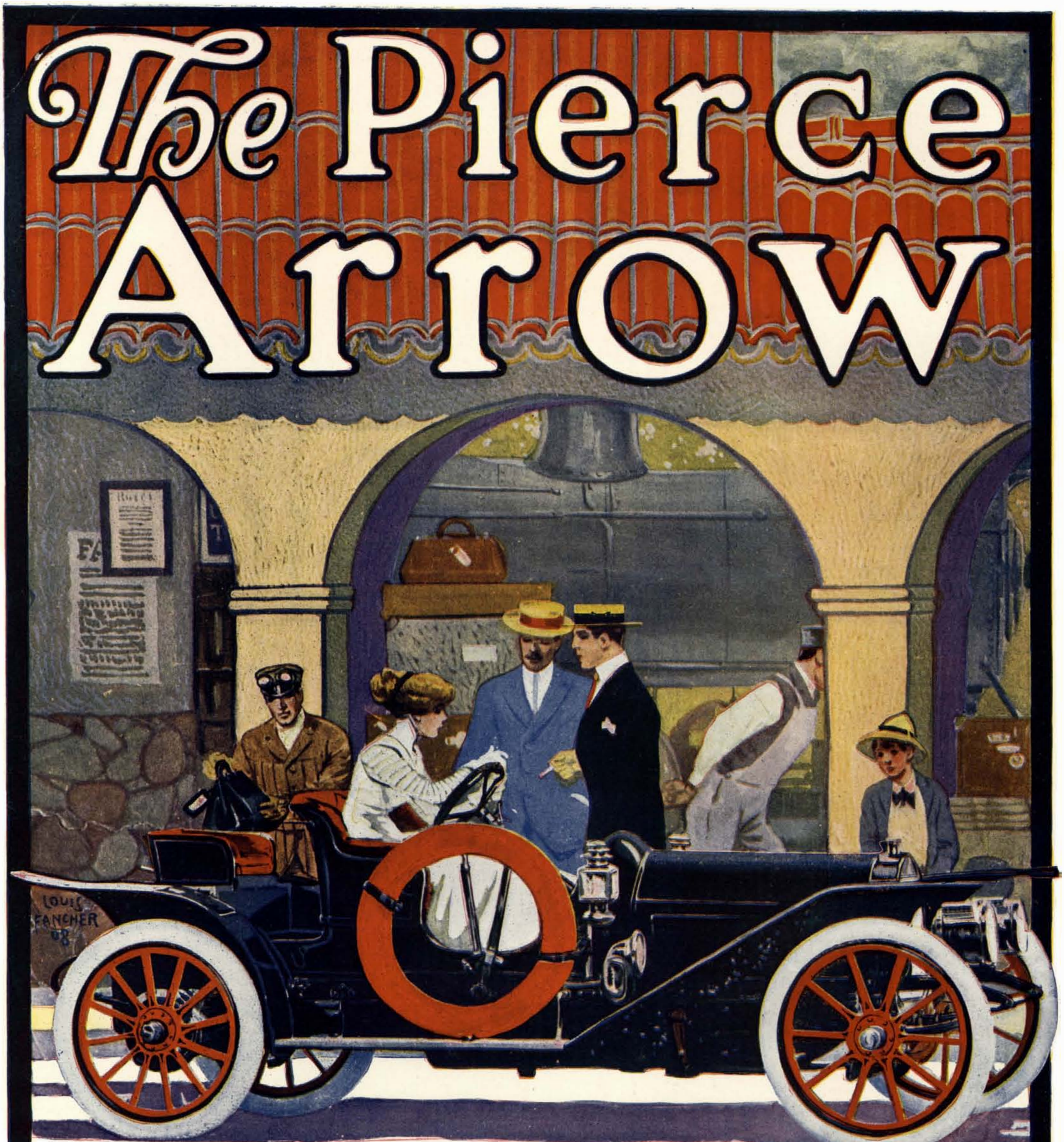

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