

Automobiles in the Great War—I*

Types of Cars Used and Technical Details Considered in the Light of Experience

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ALTHOUGH a tempting subject, and one on which comparatively little reliable information has been published, it is not intended in this paper to detail all the uses to which automobiles are being put in this war. On the Allied front in France, from the North Sea to the Swiss frontier, there are no doubt 60,000 army automobiles of all kinds. It is known too that there are 24,000 American trucks in service with the Allies.

Before August, 1914, it was realized that automobiles would play a prominent role if the nations of Europe went to war. In the annual maneuvers some nations had gone so far as to abolish the use of horses in the supplying of food and ammunition to an entire army corps, and had found the experiment to be successful. But no single expert, either military or automobile, appears to have foreseen the extensive use of automobiles to be developed within a month of the outbreak of war. In all their preparations, it is certain that the war authorities had never contemplated having to go outside Europe for their supply of automobiles.

Yet the war had not been in progress more than a month before France, the nation that had most carefully studied the use of automobiles in war, had sent an official to the United States with instructions to buy several thousand trucks; England, with a greater number of commercial vehicles than any other nation, was also anxious to supplement her military fleet with trucks from across the Atlantic. The trucks available were ordinary commercial vehicles, built for commercial conditions in the United States, without their designers or manufacturers ever having conceived that they might some day be employed in war service. These purely commercial trucks were put to work side by side with the more specialized European machines, and although they were all open to improvement in some or many respects, they all gave—and are still giving—good service in the war zone.

From this it must not be assumed that any ordinary truck is fit for war work, that there are no special military requirements, and that no lessons have been learned during nearly two years of war. The point to be enforced is the uselessness of trying to develop a special type of automobile truck to meet purely military requirements, without any consideration of commercial service. Of necessity a certain number of purely military automobiles will differ from the commercial truck as much as a battleship differs from a cargo boat; but the great bulk of the automobile trucks for any future war will be the commercial trucks of the nations involved.

PART PLAYED BY SUBSIDY VEHICLES.

Before the war the British authorities had designed a subsidy type of truck. Admittedly a good vehicle for military purposes, it had been designed with such disdain of commercial service that few business houses would purchase it. When England went to war less than fifty of these army subsidy trucks were to be found in the whole of Great Britain. Then the requisition officers gathered in practically everything on wheels. It was a jump from one extreme to the other, for many of these hastily requisitioned trucks never got within sound of the guns.

The French system was much less drastic. The military authorities, instead of saying dogmatically what were and what were not good features of army truck design, left these matters largely to the engineer and were content principally with imposing working conditions. If a truck could fulfill those conditions, it would be accepted as an army subsidy vehicle, no matter whether it had worm or chain drive, whether its motive power was obtained from steam, gasoline, electricity, or from a combination of these. In the end this tended towards uniformity, for it automatically eliminated unsuitable types. But it did not bar a manufacturer who failed to see eye to eye with the military expert on the question of final drive, or who refused to give up his preference for a particular type of wheel bearing or gearbox.

The problem was, and ever will be, one of directing design into such channels that the whole of the nation's commercial trucks could be applied to purposes of war. This application must be possible, however, without interfering with the primary usefulness of the trucks as commercial vehicles. It is a matter of compromise. If the truck is highly specialized for some class of commercial work, it will probably not be of great value on

war duty; if it is designed only to meet military requirements, the ordinary customer will refuse to buy it, either with or without the offer of a subsidy.

For instance, in France it was considered that the most suitable military type was a 2-ton truck. But the commercial user was not satisfied with a 2-tonner and would have preferred a vehicle with a 5-ton load capacity. Thus a compromise was struck with 3½ tons, and it is this capacity of truck that has proved most suitable under actual war conditions. It is not so light as to be constantly threatened with overloading; it is capable of hauling one or more trailers; and its dead weight is sufficiently low to enable it to operate over poor road surfaces. For the general conditions of war service the 5-ton truck has too great a dead weight.

For certain special classes of work it has been found that a 4-ton truck gives the most efficient service. This model has not been produced in great quantities in Europe, and, curiously, is not found in America. Manufacturers in the United States have specialized on 3-ton models, but have not produced any intermediary model between this and the 5-ton truck. The demand for a 4-tonner is comparatively recent; it does not alter the general statement that the bulk of the work is best done by the 3½-ton vehicles.

Light weight, consistent with strength, has been shown to be essential. The French truck, as it had been developed up to the eve of war, had to weigh not more than 3½ tons (7,716 pounds) this including the entire truck with its body, water, gasoline, oil and hoops capable of receiving a suspended load of 2,645 pounds. In reality the weight was nearly always below the maximum, some of the trucks scaling as low as 5,730 pounds and the average being just under 6,200 pounds. The tendency since the war has been toward a further reduction in weight. Such bodies are of the platform type with movable sides and detachable canvas top on reinforced hoops, the hoops being used to carry a portion of the load—generally wounded men.

FOUR-CYLINDER ENGINES SATISFACTORY.

Four-cylinder engines are insisted on, and these have been found quite sufficient for all ordinary purposes. Some of the heavy tractor engines have 6 cylinders, but their number is small. The French military authorities have never made any attempt to impose cylinder dimensions. It was in the interests of the manufacturers to get the smallest engines capable of doing the work, for fuel consumption was taken into consideration. The small engines of two or three years ago have, however, been found unsatisfactory. Moreover, the requirement that each truck should be capable of hauling a fully loaded companion up a macadamized 8 per cent gradient, has tended toward a slight increase in piston displacements, and also toward certain modifications in gear ratios. Statistics of 18 different makes of French army type trucks that went into service August, 1914, show that the average bore was 3.9 inches and the average stroke 5.7 inches. The biggest engine measured 3.9 by 6.69 inches and the smallest 3.5 by 5.5 inches, bore and stroke, respectively.

All engines are carried under a hood. There has been a tendency toward this for several years; but the war has shown its advantage over the under-the-seat position so clearly that the latter will no longer be accepted. There are a few exceptions, which only tend to prove the rule, notable among them being the Paris omnibus type of chassis. These vehicles, however, are used exclusively for carrying troops. On such work the greatest possible body area is required.

In passing, it may be mentioned that the internal-combustion engine has proved itself without a rival for military transportation. No gasoline-electric systems have made good. The tendency is toward a reduction in the number of steamers. Even the British, who have always shown a partiality toward steam, are making comparatively little use of it in France, although steam tractors are much in evidence around the camps of England.

MANY TYPES OF FINAL DRIVE.

Under the French military regulations every type of final drive was admitted; the English military subsidy specification called for worm drive. Those partisans who looked to the war to settle the question of final drive are likely to be disappointed. At present automobile trucks are in service on the front with straight bevel drive, double reduction bevel, worm, internal gears, and side chains with and without housings. No one

type has shown itself incontestably superior to all the others, and so far as it is possible to estimate their opinion, the higher authorities have no intention of imposing the adoption of any particular type of final drive. The automobile department of the French army has carefully compiled statistics dealing with parts supplied to trucks in service, but it is likely they will be used only to determine the makes that have been most economical and satisfactory, and not which type of design is superior. These data are closely guarded, and even if given out would be useless without explanations. One poorly built make of truck would be quite sufficient, for instance, to discredit a particular type of final drive if statistics were examined without a complete understanding of them.

While the question of final drive will remain unsolved by the war, it being left to commercial users to work out this problem, the writer is of the opinion that chain drive will gradually disappear before worm, internal gear, and double reduction bevel axles. This is not intended to infer that the chain has given more trouble than its rivals. It is represented in the French army by White, Packard, Berliet, Clement-Bayard, Rochet-Schneider, Sauer, Fiat and Delahayne trucks. These makes have given as good service as any others, but the impressions remains, and is probably correct, that the chain is less mechanically efficient, when new, than some other types of drive; its efficiency is certainly less under some conditions of operation. The ease with which the chain can be repaired or replaced is an asset in its favor; but the claim of high clearance is open to question. Under certain conditions of operation unprotected side chains constantly plow through a bed of mud, and although they can get through it is at the cost of their chains.

DEFECTS REVEALED BY WAR SERVICE.

It is not an easy matter to generalize on defects revealed by war service. There is not a make of truck that has not developed some weak point of minor or major importance. To cite all these would tend to give the impression that automobile trucks are a hotbed of trouble, whereas few of the defects are applicable to more than one or two makes. For instance, one American worm-driven truck cracked its axle housings; this was a case of faulty design, and was a particular and not a general defect. A light American truck literally ate up differential drive shafts; this was traced to poor material. A French chain-drive truck warped its differential casing under heavy braking stresses. Another had cast timing gears mounted on bearings of insufficient size. Vibration ensued and the gears were reduced to what the mechanics termed "marmalade." A more general complaint was the breakage of canvas and leather universal joints, it being not uncommon to see drive shafts flung across the road during heavy pulling in sand and mud.

Spring troubles were fairly general, but in only a few makes did the breakage of a front spring entail the smashing of the crank chamber. In these makes when the frame dropped the basechamber came in contact with the axle. Also, spring failures were almost invariably confined to the front, it being rare for a rear spring to break, even on trucks and cars known to be of poor quality. On trucks this may be attributed to the narrowness of the front wheels; these would drop into small holes over which the rear tires would ride safely, thus putting additional stresses on the front. Few if any trucks on war service had sufficiently heavy front springs. The generally adopted method of attaching the springs to the axle cannot be considered safe. Not one driver in a hundred thinks it necessary to give any attention to his spring clips, yet these have a habit of working loose, and in many cases when an axle has shifted it is practically impossible to steer the vehicle. Frequently the complete breakage of a front spring is to be preferred to the loss of nuts or the breakage of clips.

Radiators were a general source of trouble, many a good engine being burned out by reason of small diameter tubes or by brackish water. The honeycomb radiator is not suitable for army truck service. The large diameter vertical-tube type is most successful, and is adopted whenever replacements become necessary. It has been found to give good service even when used on trucks that originally had a honeycomb cooler. Incidentally, it is not safe in the war zone to judge the make of a truck by its radiator. Another good type is the circular tube radiator with a centrifugal fan, as used on the Paris omnibus type of chassis.

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REQUIREMENTS IN ENGINE DESIGN.

Considering a 3½-ton truck as the most suitable type (and of this all who have had experience in the war zone are in agreement) the engine should be a 4-cylinder L-head of about 450 cubic inch piston displacement. It has already been stated that the under-the-seat position is not suitable except for special service where a maximum body space is required. The underpan is an abomination on an army truck. The basechamber should be easily removable, although unfortunately this does not necessarily follow when there is no mudpan. The connecting-rod bearings should be detachable, so that it is possible to change them, in case of necessity, without taking the engine out of the frame. A governor is a desirable equipment.

War service has tended to prove the superiority of pump circulation over thermo-syphon. As a general rule trucks tend to overheat when operating in convoy formation on crowded roads. This condition, only occasionally met with on civilian service, is common on certain portions of the front, and should be provided for. There are few trucks on which sufficient attention is paid to draining off all the water from radiator, pump and jackets. This is a detail when trucks are housed in a heated garage; it is an important feature when automobiles remain constantly in the open air, with the possibility that the engines may have to be cranked, to meet an urgent call at 2 or 3 o'clock in the morning.

No man who has had to start an engine at daybreak on a frosty morning, with the knowledge that delay meant disaster, is inclined to treat this matter lightly. It is common practice for drivers to make straw mats to fit the hood and the radiator, and to use these as heat retainers whenever the truck has to stand idle for a few hours. An additional precaution is to disconnect the gasoline line, empty the float chamber of the carbureter, and leave one of the kerosene side lamps burning under the hood. The manufacturer might help in this direction by making a tightly fitting hood with louvers that could be opened or closed at will, by supplying a heat retaining radiator cover and also providing a safety lamp capable of maintaining a certain amount of heat under the hood when the truck is left standing in the open all night. An adjustable air-shutter on the carbureter is a valuable fitment. It is important, too, that the engine should develop something like its full power within a few minutes of starting. In the early days of the war, before men had learned to take precautions, the writer has known convoys to be held up for 3 or 4 hours owing to starting difficulties. A delay of this nature is sometimes fatal.

Mechanical starters are not necessary on army trucks. In the few cases where these have been fitted the batteries have generally been requisitioned to light some dug-out or office. As there are always two drivers on army trucks, it is hardly necessary to relieve the spare man of the only real work he has to perform.

RADIATOR GUARDS FOR ALL TRUCKS.

All army trucks should have radiator guards attached, not to the radiator itself, but to the frame members. The design should be such as not to interfere with free operation of the starting crank. Some guards have been supplied that certainly protected the radiator but caused a bit of finger to be left behind every time the crank had to be swung. The guard should be so designed, too, that it will not allow the overhanging rear of the body to pass above it. In some cases it has been found advisable to fit a transverse bumper with coil springs at the rear of the trucks, this bumper coming in contact with the center of the radiator guard in case of a collision. It must be remembered that many of the drivers have had little road experience. The traffic is much more dense than is generally imagined. During the height of the Verdun battle there was a 90-mile circuit over which trucks passed day and night, for a period of several weeks, at average intervals of 20 seconds between each vehicle. This means that at times traffic was as dense as it is on lower Broadway during the rush hours.

It has been noticed by officers in charge of army repair depots that engines with the old-fashioned splash system of lubrication are generally better preserved than those with pressure feed of oil to all bearings. On war service the lubricating oil is apt to remain in service longer than is desirable, and the impurities deposited in the oil are picked up by the pump and forced into the bearings. The remedy seems to be, not a return to splash, but a pressure or circulating system so designed that the dirt will deposit away from the pump. It is really not necessary that the pump should be in the lowest portion of the basechamber. The basechamber can be designed so that the lowest portion is merely a trap for impurities, and this can be done without any danger of the pump being accidentally deprived of oil. Whatever the system it ought to be an easy matter to dismount the pump and to drain the basechamber of every drop of lubricant. This presupposes the absence

of a mudpan. Several American trucks have suffered materially and in reputation by the absence of a suitable oil. Pressure feed being common in Europe, a heavy oil is generally employed, and this has been used with disastrous results in engines requiring a light bodied oil. The only remedy appears to be for manufacturers to clearly indicate the type of oil to be used on their engines.

GASOLINE ONLY ARMY FUEL.

So far as the Allied armies are concerned, there has been no necessity to use alternative fuels such as benzol, alcohol and kerosene, although it was a pre-war specification in France that all automobile trucks should operate on benzol and on a 50-per-cent mixture of benzol and alcohol. Benzol and alcohol have been monopolized for making explosives, and gasoline has been the only army fuel in use. It is certain, however, that the benzol requirement will be insisted on after the war, and in all probability alcohol will be a widely used fuel.

The best place for the fuel tank is on the dash. Pressure tanks at the rear are inconvenient and dangerous. The filler should be of sufficient size to allow a man to pass his hand inside the tank, and there should be easy provision for draining the tank. Drivers in the war zone invariably carry a reserve supply of gasoline, this being done because of the feeling of security it imparts rather than because of any urgent necessity for its presence. Suitable provision has not been made, particularly on French and American trucks, for the carrying of this reserve supply. Thus drivers have had to fix up as best they can a storage place for a 12-gallon can of gasoline.

Ignition by high-tension magneto has proved all that could be desired for war service, no need having been shown for a second system, either as a reserve or for ease in starting. The only general trouble has been the swelling of the fiber and condensation on the spark-plug points, this being due to the excess of moisture in the atmosphere of northern France. The French military authorities have insisted on the standardization of magneto bases and couplings, and also on all magnetos turning right-handed. The intention, of course, was to make all magnetos interchangeable throughout the army, and although this result has not been obtained, owing to the influx of foreign machines, the system has been good so far as it has been possible to apply it.

There is an amazing lack of uniformity in the steering lock and the turning radius of army trucks. This is most disadvantageous when convoys are composed of different makes of trucks, for while one vehicle can make a turn easily the one following may be unable to do so. The disadvantage is also felt where makes are grouped, for one convoy may negotiate a difficult road with ease while the next will be stopped. In some makes of trucks the short turning radius is only an illusion, for owing to the radiator extension in front of the axle it is only possible to turn within the given radius if the road is entirely free. In other cases the radiator is so high that it is impossible for the driver to see directly ahead and take full advantage of his lock. This matter is important, for when a road is under fire the greater the time spent in making a turn the greater the chance of being hit by a shell.

Only the southeastern end of the present battle line is in a mountainous district. Thus brakes have not been put to a severe test. Generally there is much room for improvement in the matter of brake adjustment. Several cases have been noted of brake rods so close to the road or to the road wheels that they have been bent by a board lying in the road and thrown up at an acute angle as the wheels passed over it. Brake rods should be regarded as organs needing protection and placed in such a position that they are not likely to be damaged by obstacles on the road. Not many American trucks are fitted with a sprag, although this is a valuable accessory on military trucks working in convoy formation in hilly country. Picture a closely packed convoy on a greasy hill, trucks without sprags, and a green driver in the center of the column who misses his gears and fails to use his brakes in time.

Four-speed gearboxes are now insisted on by the French military authorities and are found to be indispensable for active service. First speed should be equivalent to 2 m. p. h. with the engine running at its normal speed (1,000 to 1,200 r. p. m.). One type of gearbox that has proved satisfactory under war service is the Damaizin patent constant mesh gears. This gearset was fitted to the Paris bus chassis and its use has been extended to other makes. It is impossible for a driver to muddle his gears, no matter how ignorant he may be of the elementary methods of changing. No experiments have been made with trucks without a differential, but a differential lock, capable of being operated from the driver's seat, if possible, is an absolute necessity under many conditions of active service. The only reproach brought against one of the best American trucks on the French front is the absence of this lock.

OPERATION OFF MADE ROADS.

This naturally leads to the question of operation away from made roads. The greatest objection brought against the automobile truck is the rapid fall of its efficiency as road surfaces deteriorate. The touring car, the ordinary commercial truck applied to war service and the various types of 4-wheel drive and purely military vehicles are all, in varying degrees, open to improvement in this respect. The general rule is that convoys should keep to made roads and not attempt to operate across country. Officers using touring cars are specifically forbidden to order their drivers to go across country. While this general rule is observed, there are frequent circumstances where the made road practically ceases to be a road, or where the only means to safety lies in a dash across country. The final distribution of food and ammunition under really difficult circumstances is still effected by horse teams or by men. A 2-wheel cart with a ½-ton load will get over a road where a 3-ton vehicle, whether drawn by horses or propelled by a gasoline engine, would be in difficulties. If the light cart is hit by a shell the wreckage is easily cleared away and the procession continues; but a heavy truck disabled on a narrow dirt road stops all further traffic.

The most common expedient to render a truck fit to travel away from hard road surfaces is to fit chains to the wheels. These, however, have been far from giving general satisfaction. The circumferential chain, lodged in the space between the dual tires, has not been a great success, for the available space is too narrow to allow of a heavy chain being fitted, and breakages are frequent. The same objection applies to the type consisting of a circumferential chain placed between the dual bands, with transverse ribs at regular intervals having one surface in contact with the tread of the tire and the opposite face in contact with the road surface. The chain uniting these ribs has always proved too weak.

Short lengths of chain, hooking from the outer to the inner face of the rim, across the tire, fitted among others to the Pierce-Arrow trucks, are fairly satisfactory. The lengths being independent, the breakage of any one does not affect the efficiency of the device. Experiments were made with the same trucks with a caterpillar attachment secured to a flange bolted to the wheel felloe. This device was quite unsatisfactory. After a truck became bogged it was impossible to apply the attachment, and if used over a made road it broke the chains or bent the steel shoes in such a way that they could not be used a second time. In the case of some of these trucks, carrying a heavy load of armor and an anti-aircraft gun, it was found that if the ordinary chains would not take them through, nothing else would. Thus these chains were always kept on when operating away from the roads.

It is surprising, however, how soon a set of chains will be eaten up if used over a hard macadam road or a granite surface. A few seconds are sufficient to reduce a set of chains to individual links and portions of links under certain road conditions. Thus the necessity arises for a quickly detachable device, so that it can be taken off immediately a hard road surface is encountered. It should also be pointed out that the ordinary chain devices are not applicable to chain-driven trucks, the clearance generally being insufficient between the road wheel and the pinion to allow a chain to be attached. It is not necessary to describe what happens when an antiskid chain breaks away and mixes itself with one of the driving chains.

A device adopted as the result of practical experience in the field consists of an endless chain passing round the road wheel (fitted with dual tires) and around a loose pulley some distance back of the road wheel. A spring-controlled bell-crank arrangement operates on the pulley and maintains a sufficient tension on the chain. On greasy roads and mud-coated granite surfaces this was a most effective non-skid device and one that gave little trouble through breakage. It was found to be useless, however, on soft earth. Under these conditions the chain refused to revolve with the driving wheel and the whole thing became embedded.

The problem of securing traction has not been confined to rear-wheel drive trucks. Four-wheel drivers have had to face the same difficulties, although, of course, in a different degree. The most difficult feature has been to find a device that would prove satisfactory under all circumstances.

(To be continued.)

Elevation of the Aurora Borealis

A RECENT expedition to northern Norway was able, by means of simultaneous photography, taken from two stations, to make 2,500 observations on the height of the aurora borealis. It was found that by far the greater number of displays took place at an elevation of about sixty to sixty-five miles. A few were observed as low as fifty-three miles, and as high as eighty-five miles.