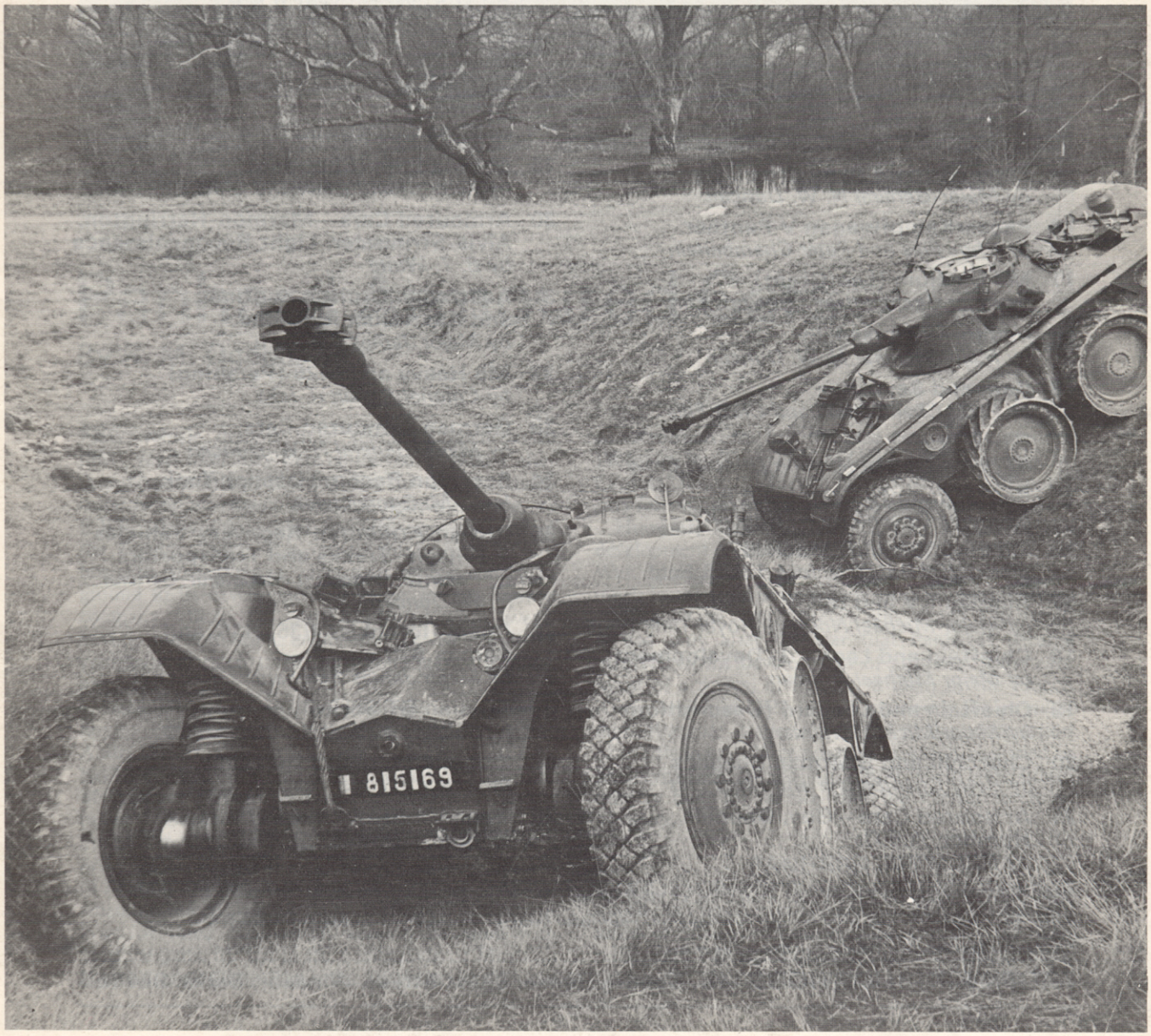
PROFILE AFV WEAPONS 39

Panhard Armoured Cars

By R. M. Ogorkiewicz



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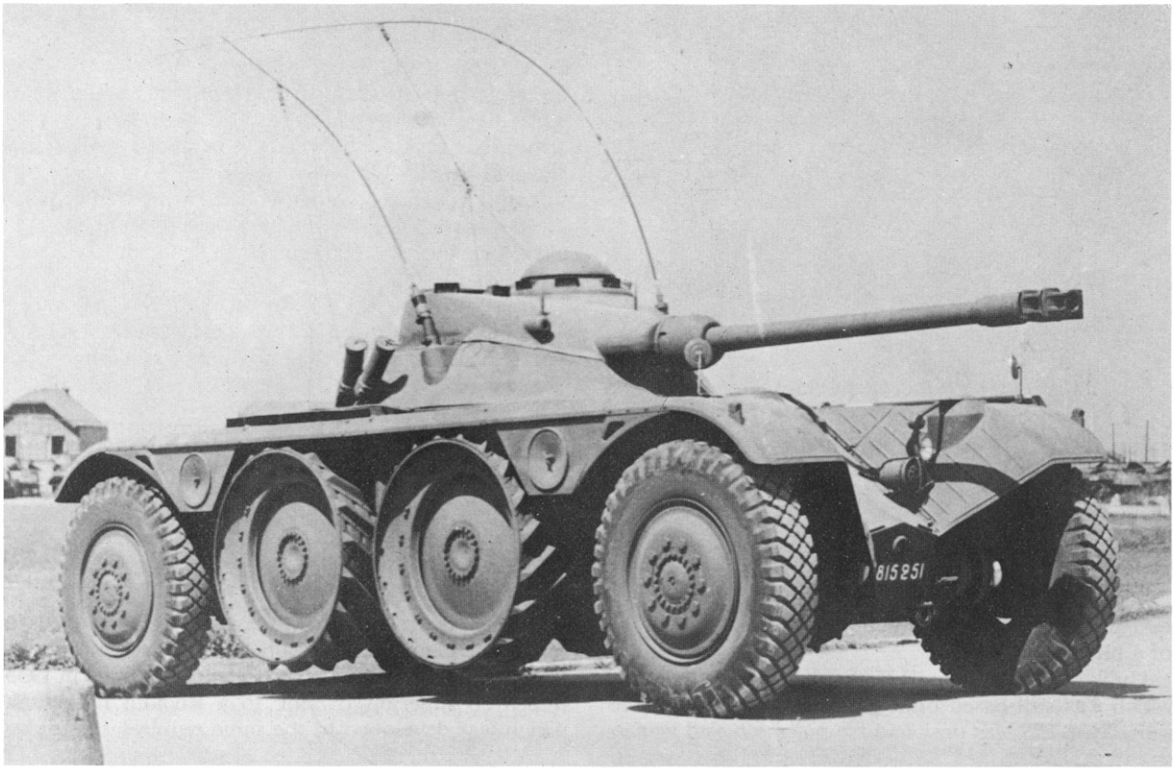


E.B.R.75, the original version of the Panhard Engin Blindé de Reconnaissance.

Panhard Armoured Cars

By R. M. Ogorkiewicz

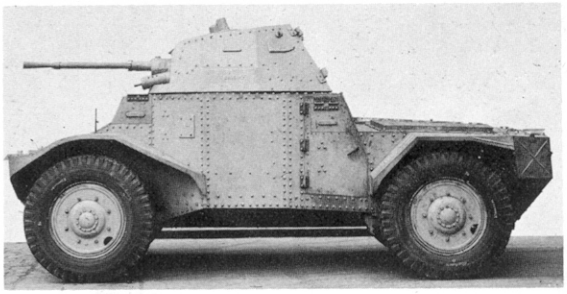
FEW vehicle designs have remained unsurpassed thirty years after they were conceived or twenty after they were put into production. But this is true in many respects of the *Engin Blindé de Reconnaissance,* or E.B.R., the eight-wheeled Panhard armoured car of the French Army. This remarkable vehicle is not, however, so surprising when seen against the background to its development. It came, in fact, from a company which had been associated with several advances in automobile engineering as well as military vehicles and which successfully continues to produce armoured cars.

Since the merger in the mid-sixties with another famous French automobile firm, the Société Anonyme André Citroën, the company responsible for the E.B.R. has been known as the Société de Constructions Mécaniques Panhard & Levassor. Previously it was called the Société Anonyme des Anciens Etablissement Panhard & Levassor and it was under this name that it first became directly associated with the development of fighting vehicles. This took place as early as 1911, when it received an order from the French Ministry of War for three cars, which were to be fitted with machine-guns, for use in the pacification of Morocco by the French Army. The order for these unarmoured *autos-mitrailleuses* followed the successful use since 1905 of a Panhard car, fitted with a machine-gun, by Captain Genty, the French pioneer of the use of motor cars for military reconnaissance purposes.

However, Panhards did not play a part in the development of armoured cars during the First World War. Instead, they became involved in 1916 in the much larger scale development of tanks by supplying engines for the second French tank, the St. Chamond. It was only after the war that Panhards became involved in the development of armoured cars, as a result of a revival of interest in them by the French Army, which in 1923 invited proposals for an *auto-mitrailleuse de cavalerie*. This led to the construction of the Panhard 175 armoured car which was tried in prototype form in 1927 and 28 of which were subsequently built for service with the French forces in Morocco.

PANHARD 178

By the time the first Panhard armoured car was produced the French cavalry redefined its requirements in terms of three armoured vehicles. One was the *auto-mitrailleuse de reconnaissance,* or A.M.R., a light vehicle for short-range tactical reconnaissance. The



Auto-mitrailleuse de decouverte *model 1935, or Panhard type 178.*

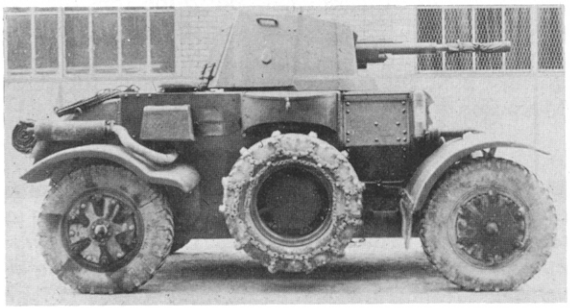
second was the *auto-mitrailleuse de decouverte,* or A.M.D., a fast vehicle for long distance reconnaissance mainly along roads. The third vehicle was the *auto-mitrailleuse de combat,* or A.M.C., which was in effect a tank but was not originally called one as tanks were at that time the prerogative of the infantry. A development programme incorporating these three types of vehicles was formulated by the French General Staff in 1931 and in response to it Panhards put forward a design for an A.M.D., which led to the construction of a prototype in 1933.

Unlike the first, Type 175, Panhard armoured car, which was still based on a passenger car chassis, the new, Type 178 was designed from scratch and was in advance of its day in many respects. In particular, all four of its wheels were driven and its engine was located at the rear. It still had rigid, beam axles and semi-elliptic leaf springs at the front and rear but it also had large, 42×9 tyres which gave it a relatively good performance off-the-road. Thus, when the prototype of Type 178 began to be tested in 1934 at the French cavalry centre at Rheims it showed itself greatly superior to its competitors. As a result it was adopted as the *A.M.D. Panhard modèle 1935* and an initial production order for 30 was placed in 1935. Further orders followed and in 1938 the number rose to 180. By May 1940 more than 360 had been produced and they became the basic equipment of the reconnaissance regiments of the three *Divisions Légères Mécaniques,* the French cavalry's armoured formations. After the defeat of the French Army in 1940 about 190 Type 178 armoured cars were taken over by the German Army in whose reconnaissance units they saw further service and some served the French Army again after the Second World War.

GENDRON-SOMUA

Although the Type 178 represented a significant advance on its predecessors, the rate of progress in armoured car design during the thirties was such that even before the outbreak of the Second World War it no longer represented the best that could be done. In particular, the development of multi-wheel drive armoured cars in Germany produced the eight-wheeled Sd.Kfz.231, which represented a very considerable advance on other wheeled armoured vehicles in cross-country performance while it retained their advantage over tracked vehicles of being more efficient on roads.

Prototype of the Gendron-Somua armoured car.



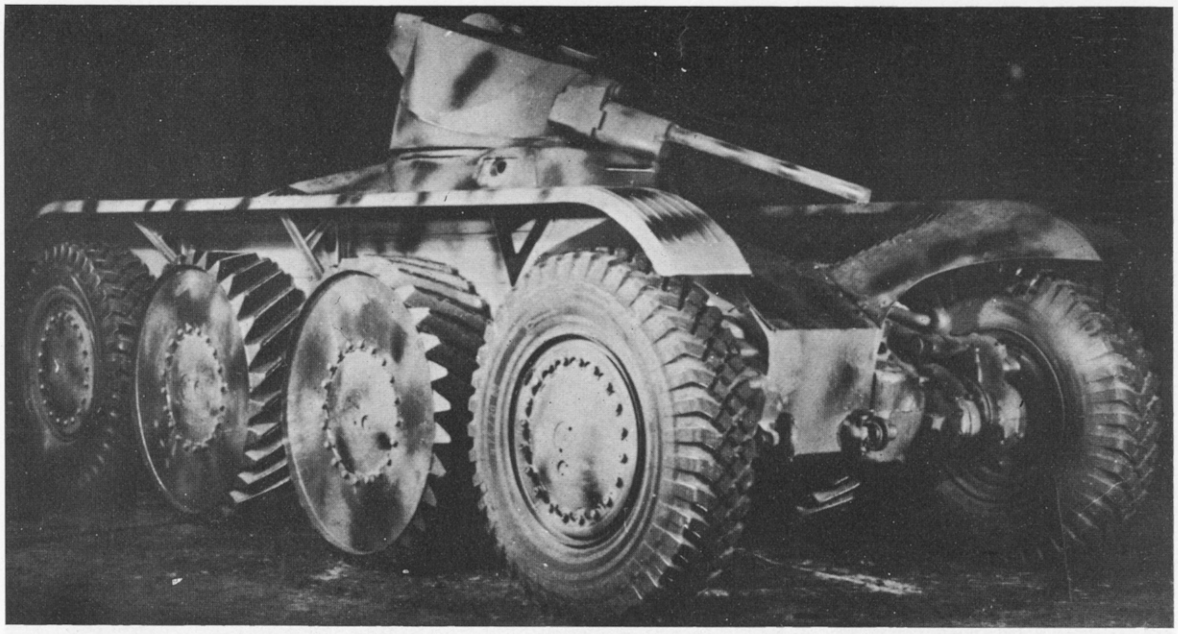
What is more, in France itself a new advanced armoured car appeared in 1935. This was the Gendron-Poniatowski, a prototype of which was built by the Société d'Outillage Mécanique et d'Usinage d'Artillerie, or S.O.M.U.A., and which consequently became known as the Gendron-Somua. It was a 6·5 ton 2-man armoured car with three equally spaced wheels on each side. The wheels were independently suspended and all could be driven, but the drive to the centre pair of wheels was intended to be disengaged and the wheels raised for road operation. Thus the centre pair of wheels was only to be lowered on to the ground and driven for off-the-road operation. As a result, the Gendron-Somua performed well off as well as on roads. In fact, when it began to be tested in 1935 it proved superior, overall, to a Renault light tank which was developed to the same requirement for an A.M.R. But the Renault A.M.R. was developed earlier and a production order had already been given for it after it was adopted as the *modèle 1935 type Z.T.* Nevertheless the French cavalry decided to adopt the Gendron-Somua as its next, *modèle 1939,* A.M.R.

Plans for the production of the Gendron-Somua were disrupted by the outbreak of the Second World War and eventually came to nothing. However, the appearance of the Gendron-Somua spurred Panhards to develop an A.M.R. with even better off-the-road performance. Work on this vehicle, which became known as Panhard Type 201, started in 1937 and by 1940 resulted in the construction of one prototype.

PANHARD TYPE 201

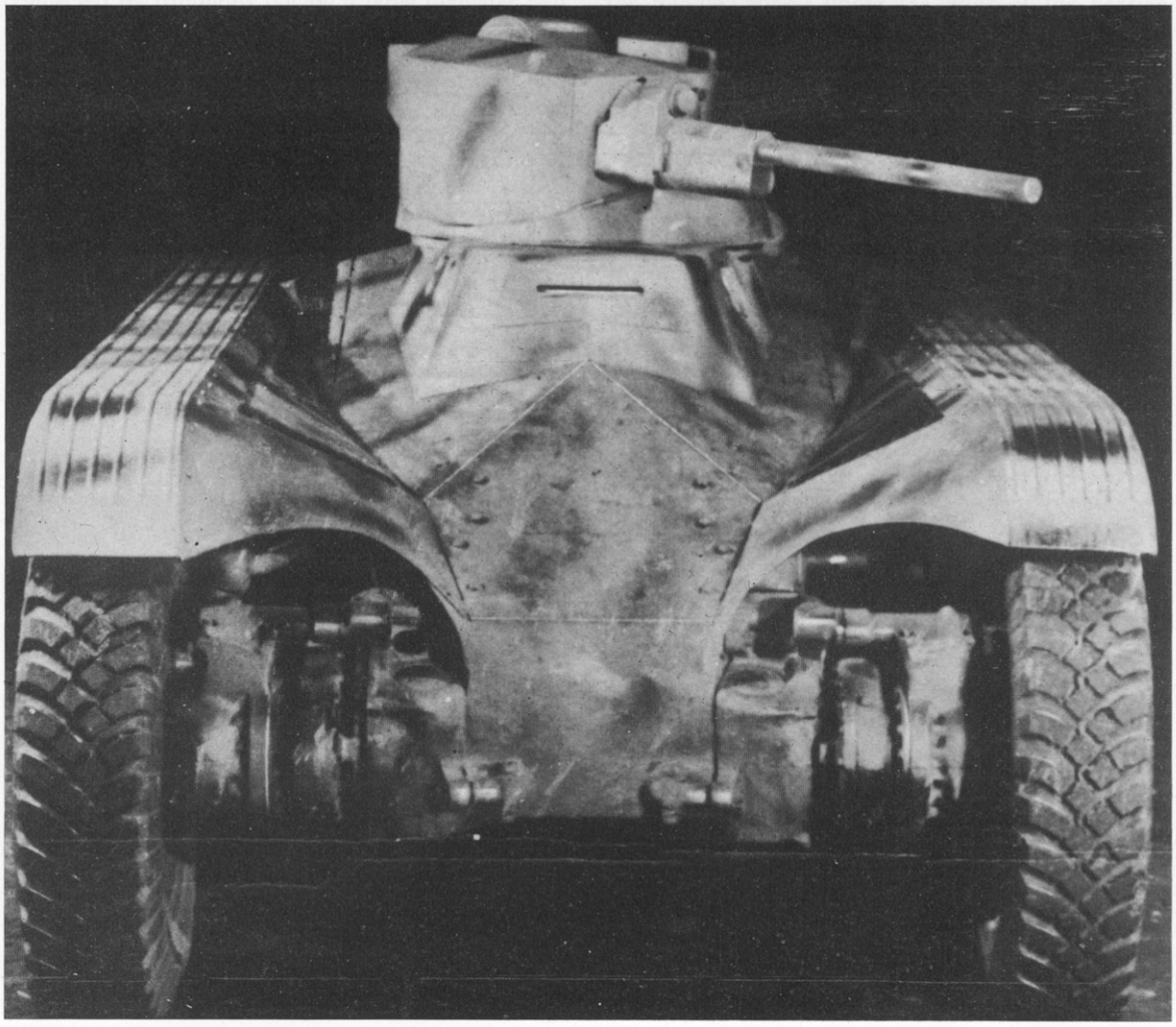
Like the heavy German armoured cars and most other, more recent wheeled armoured vehicles designed to have a good cross-country performance, the Type 201 had eight wheels, all of which were driven. The two outer pairs of wheels were fitted with large, 9·75×20 tyres but the two inner pairs of wheels were, like the centre pair of the Gendron-Somua, raised for road operation and were only to be lowered for cross-country running. They were not, therefore, fitted with pneumatic tyres. Instead, the four inner wheels were of a type used by agricultural tractors and had steel rims with heavy grousers. This together with the large size of the wheels in relation to the 9 tons which the Type 201 weighed, fully laden, resulted in it being able to operate well even over soft ground. Its cross-country mobility and in particular its speed over broken ground and trench crossing capabilities were further increased by its relatively long, 3·3m wheelbase. At the same time it was capable of a maximum speed of 80 km/hr on hard level surfaces.

Another commendable feature of the Type 201 was its low centre of gravity due largely to the location of its engine in the centre of the hull, under the turret. In

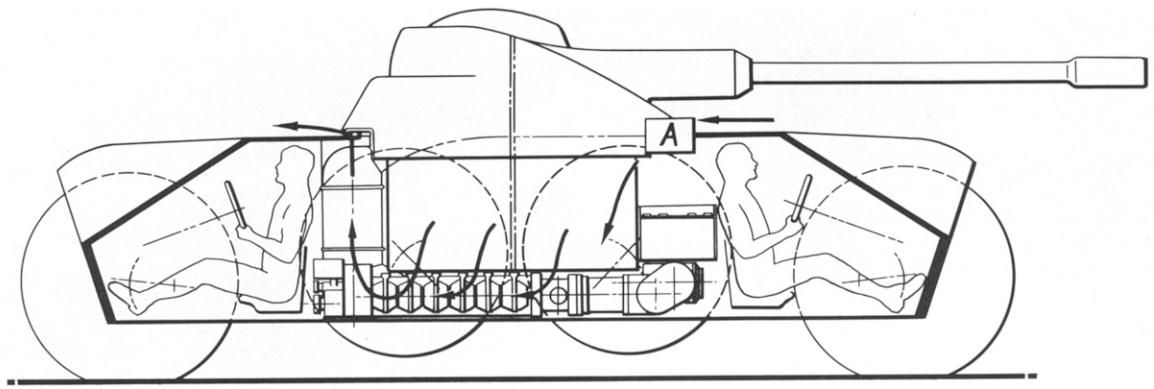


Panhard Type 201.

Front view of the Type 201 showing its unconventional two-piece turret.

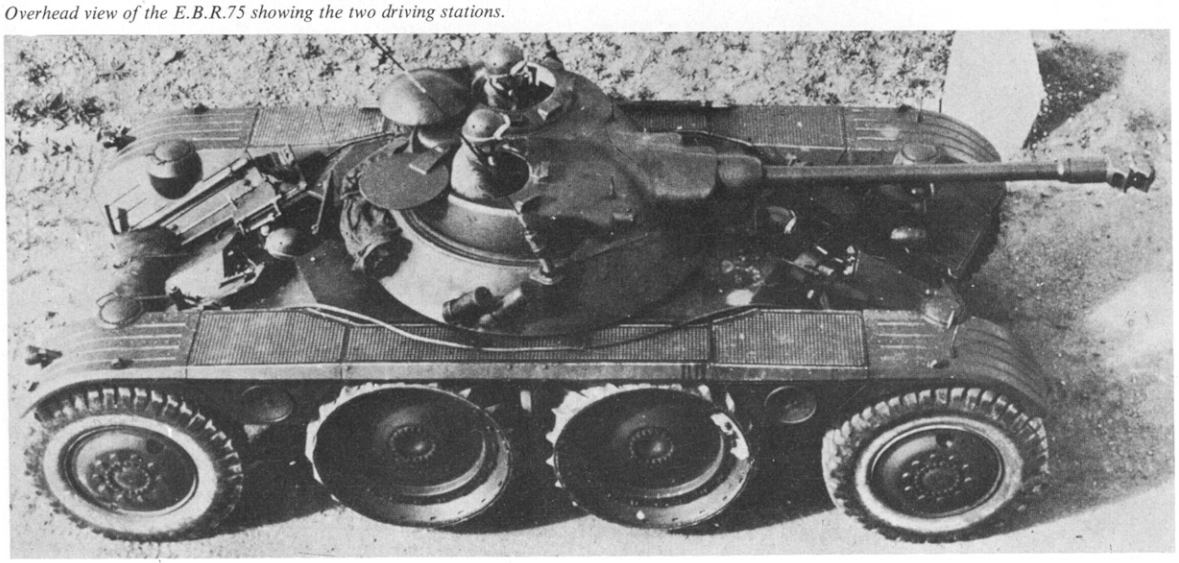


An early version of the E.B.R.75 with F.L. 11 turret.



Cross section of the E.B.R. showing the engine cooling air intake at A.

Overhead view of the E.B.R.75 showing the two driving stations.



this respect the Type 201 was similar to the Gendron-Somua but the central location of the engine was exploited in its design still further, to achieve a symmetrical hull layout with similar driving stations at the front and rear. Provision for two—front and rear—drivers had been incorporated in the design of the Type 178 and several earlier armoured cars and was very valuable for a reconnaissance vehicle which might have to dash back quickly. Type 201 differed, however, from all earlier armoured cars in having a more thoroughly thought out and more successful arrangement of the duplicated driving controls.

The armament of the Type 201 consisted of a turret-mounted 25mm gun and a 7·5mm machine-gun, which was the same as the armament of the Type 178 and the Gendron-Somua but still as good as that of any other armoured car. The 25mm gun was actually an adaptation of the standard French infantry anti-tank gun which was smaller in calibre than other contemporary anti-tank guns but had a much longer, 73 calibre barrel and a higher, 900 m/sec muzzle velocity.

The turret in which the weapons were mounted was of a unique design, patented by Panhards. Like the later oscillating or trunnion-mounted turrets it consisted of two parts: an upper part in which the weapons were mounted and a lower part which rotated on the usual turret bearing. The two parts were not, however, connected by trunnions but by a large diameter ball bearing which was at an angle to the bearing on which the whole turret assembly rested. As a result, rotation of the lower part in relation to the upper part tilted the latter and thus elevated or depressed the weapons, while rotation of the two parts together traversed the weapons at a fixed elevation. This type of turret offered the same advantages as the trunnion-mounted turrets, namely that the weapons were fixed in relation to the upper part of the turret, which facilitated such things as the ejection of shell and cartridge cases, but it was easier to seal.

ENGIN BLINDE DE RECONNAISSANCE

None of the ingenious features incorporated in the design of the Type 201 could be put to test as its development came to an abrupt end when France was defeated in 1940. The prototype was actually evacuated to what was then French North Africa, only to be lost in the Sahara, and the design drawings were destroyed to prevent them falling into enemy hands. However, the ideas embodied in the Type 201 were not forgotten. Thus, when armoured vehicle development was resumed in France after the liberation in 1944 and the French Army issued a requirement for a wheeled reconnaissance vehicle Panhards designed a new armoured car on the lines of the Type 201, which became the *Engin Blindé de Reconnaissance*.

The specification for the E.B.R. was issued in July 1945 and Panhards started work on the design which was to meet it in January 1946. The first two prototypes of the new Panhard Type 212 were ordered only three months later and were completed in July 1948—a remarkable achievement in the light of the time taken since the Second World War by most other armoured vehicles to reach a comparable stage in their development. The Type 212 was adopted as the *E.B.R.75 Modèle 1951* and its production started in August 1950, continuing until about 1960.

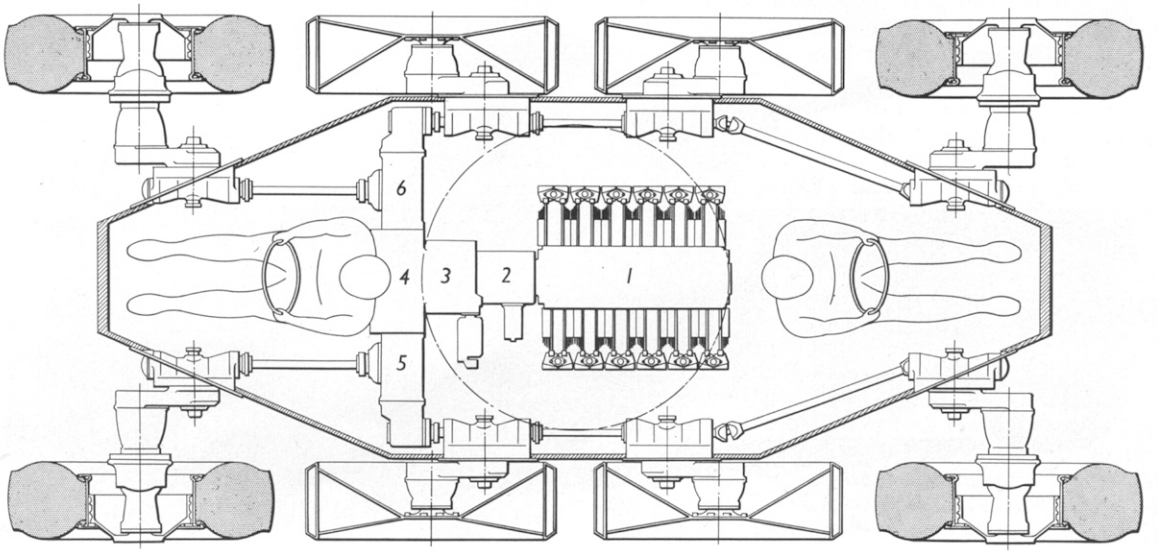
The E.B.R. is about one metre longer and 0·4m wider than the Type 201 but it has a similar, symmetrical hull with a driver at either end and the engine in the middle, buried under the floor of the fighting compartment. It also has eight driven wheels, the two inner pairs being of the tractor type and raised off the ground for road operation, as in the Type 201.

FLAT-12 ENGINE

To achieve a satisfactory installation in the centre of the vehicle the engine has had to be as flat as possible. In consequence, Panhards developed a special, 12-cylinder, horizontally-opposed, air-cooled engine which is only 0·2m high and can therefore be located under the floor of the fighting compartment without adversely affecting the height of the hull. The hull of the E.B.R. is, in fact, remarkably low being only 1·03m high.

The 12H 6000 engine has a swept volume of 6 litres

Plan view of the E.B.R. transmission: 1—engine, 2—clutch, 3—first gearbox, 4—second gearbox with differential, 5 and 6—free-wheel differentials.



Two E.B.R.s demonstrating their cross-country performance.

and two carburettors but a compression ratio of only 6·6:1 to be able to operate on low grade gasoline. It develops 200 h.p. at 3,700 revs/min, which is sufficient to give the 13-ton E.B.R. a maximum road speed of 100 km/hr. Although the engine was developed specially for the E.B.R. its design was based on an earlier 2-cylinder air-cooled Panhard car engine. Thus the two engines shared a number of features reflecting Panhard's unconventional approach which had manifested itself earlier in the double sleeve-valve engine of the Type 178. In the case of the 12H 6000 engine these features include roller type connecting-rod big-end bearing and torsion bar valve springs.

The arrangement for cooling the engine is also unusual. Thus, instead of entering the engine compartment through the usual louvres, the cooling air is drawn into the hull under the lower edge of the turret through a series of oval holes around the front half of the turret ring. It then flows down, in two streams, over each bank of six cylinders. After passing through two axial flow fans the cooling air is exhausted through another series of oval holes around the rear half of the turret ring and through ducting which takes it to each side of the vehicle.

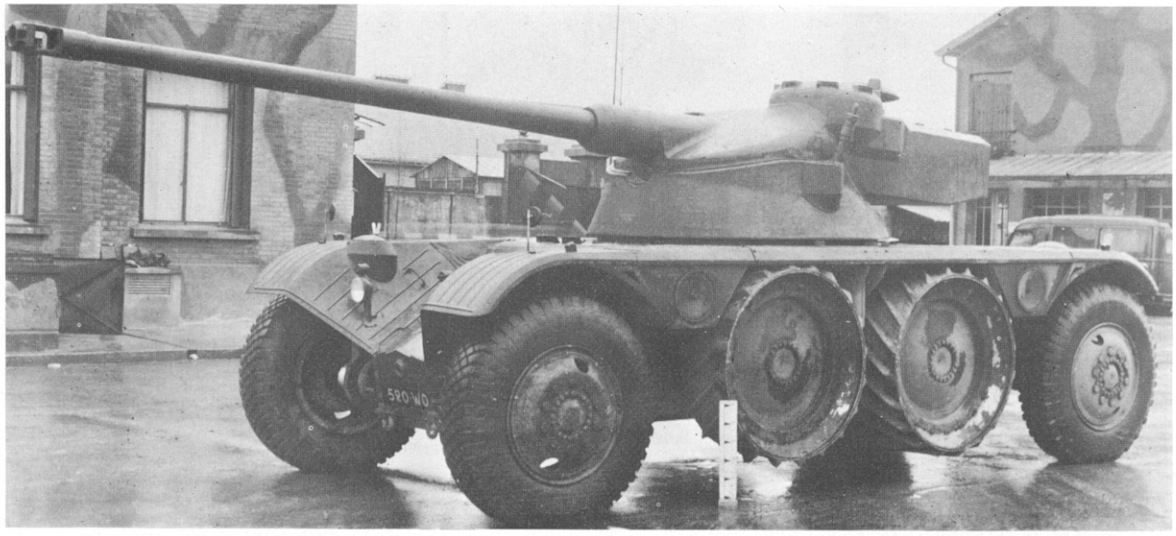
TRANSMISSION LAYOUT

The main drive from the engine is through a small-diameter four-disc clutch whose design has again been dictated by the requirement to keep the engine installation low. The clutch is connected to a four-speed gearbox from which the drive is taken through bevel gears, giving forward or reverse, to a second, transversely mounted gearbox. With this arrangement there are 16 speeds in each direction but for off-the-road operation only the first box is used with the second kept in first gear and only six ratios are normally used for road running.

The second gearbox incorporates a differential from which the drive is taken to the two sides of the vehicle; it is of a conventional bevel type but can be locked for off-the-road operation. On each side of the vehicle the drive is taken to a de Lavaud type free-wheel differential and then, through bevel gears and ball or universally jointed shafts, to the four wheel stations. Each side differential is located between the front and the three rear wheels but is mainly intended to prevent transmission wind-up and tyre scrub when the vehicle is operating on roads and the two intermediate wheels on each side are raised; when the intermediate wheels are lowered for operation on soft ground differential action between the three rear wheels on each side is unnecessary or even undesirable.

At each wheel station the drive is turned through 90 degrees by a pair of spiral bevel gears and then taken through a train of double helical gears housed in the trailing or leading arms which locate the wheels. The train consists of equal size gears at the arm pivot and wheel axis connected by two pinions in parallel, so that the input to output velocity ratio remains constant whatever the motion of the arm. The arm and gear train assemblies are virtually the same for all eight wheels but the extreme front and rear wheels, which

E.B.R.75 with F.L. 11 turret: the two centre wheels are raised for road operation.



Early version of E.B.R. with the F.L. 10 turret of the AMX 13 tank.

are steered, have a lateral extension housing a Tracta constant velocity joint.

SUSPENSION AND STEERING

The extreme front and rear wheels are sprung in a conventional manner by means of two concentric coil springs and a telescopic damper attached to the wheel arm. Each of the four intermediate wheels has, instead, a hydro-pneumatic unit which consists of a cylinder with nitrogen separated from the hydraulic fluid by a floating cylinder and with a second piston connected to the wheel arm which acts as a spring, damper and ram for lowering or raising the wheel.

Fluid under pressure is supplied to the suspension units by an integrated hydraulic system which also provides hydraulic power for steering and for operating the brakes. When the vehicle is running on four wheels only the two wheels which happen to be leading are normally steered, having been unlocked by the driver who is then in control of the vehicle. However, for sharp turns the trailing pair of wheels can also be unlocked to give four wheel steering and this is done automatically whenever the intermediate wheels are lowered.

Only the four outer wheels are braked. They also differ from the intermediate wheels in having Michelin F24 14·00 × 24 tyres and Veil-Picard tubes which have small cells filled with nitrogen under pressure. Bullet-proof inner tubes of this type have been used on several French vehicles since the thirties in preference to the common type of "bullet-proof" tyre which depends on the stiffness of its side walls for the ability to function for a time after being perforated by bullets.

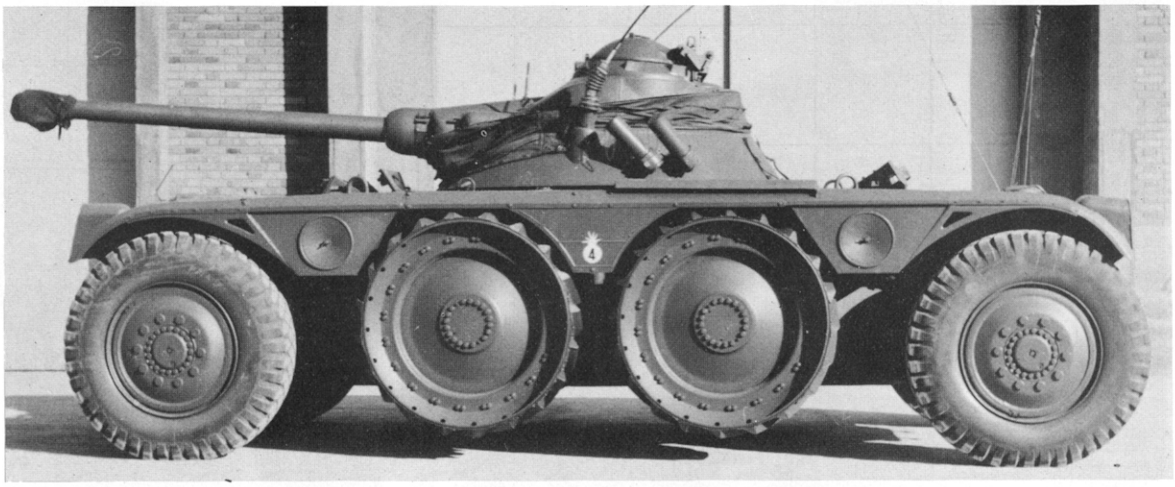
The intermediate wheels have duralumin tyres with steel grousers but they are provided with a limited degree of resilience by a row of rubber blocks inserted between the wheel disc and the rim. When all eight wheels are in contact with the ground and have penetrated it to a depth of 100mm the pressure exerted by the E.B.R. on the ground is 0·7 kg/cm², which is less than the nominal ground pressure of battle tanks and makes the E.B.R. competitive with tracked vehicles off-the-road.

Service version of E.B.R. with F.L. 10 turret.

OSCILLATING TURRETS

The hull of the E.B.R. is welded from steel armour plates ranging in thickness from 10 to 40mm. An unusual feature of its design is a mounting for a 7·5mm machine-gun in the lower front and rear plates: these machine-guns were to be operated by the drivers but have seldom been fitted. However, a much more noteworthy feature of the E.B.R. has been the oscillating, or trunnion-mounted, turrets with which it has been fitted. In these turrets the upper part is mounted on trunnions in the lower part and is elevated or depressed with the weapons mounted in it. In all cases the turrets have been manned by the vehicle commander and the gunner whose seats have been attached to the upper part of the turret.

The original *E.B.R. 75 Modèle 1951* and the *Type 1954* developed from it were fitted with the F.L. 11 turret mounting a medium velocity 75mm gun and a coaxial 7·5mm machine-gun. Some E.B.R. *Type 1954*, the *Type 54-10*, and also some of the *Type 1955* were then fitted with the same F.L.10 turret as the A.M.X. 13 light tank which mounts a more powerful, high velocity 75mm gun with an automatic loading mechanism. The increase in the muzzle velocity from 600 to 1,000 m/s increased the anti-tank capability of the E.B.R., but the F.L.10 turret also increased its



E.B.R.90, the latest 90mm gun version.

weight from 13 to 15 tonnes and its height from 2·24m to 2·58m. This and the development of a highly effective 90mm smooth bore gun led to all E.B.R. being refitted with the F.L.11 turret mounting the new gun. This fires fin-stabilised shaped-charge projectiles which have a muzzle velocity of 750 m/s and are capable of penetrating 320mm of armour. In consequence the latest *E.B.R. 90 F 2* can even engage battle tanks. In addition to its shaped charge projectiles the *E.B.R. 90 F 2* also carries fin-stabilised high explosive projectiles, the total number of rounds carried being 43, compared with 56 of the original 75mm gun version.

In addition to the 75 and 90mm gun turrets the E.B.R. was also experimentally fitted with a large turret mounting two Hispano-Suiza Type 831 30mm automatic anti-aircraft guns. This version was not however adopted. Neither was an armoured personnel carrier version, the E.B.R.-E.T.T., built in prototype form in the mid-fifties. This had a modified hull with a high superstructure surmounted by two small machine-gun cupolas and no rear driving station; in consequence, it could carry 14 men in addition to the driver.

PANHARD MODEL 245

Excellent as it has been from many points of view, the E.B.R. has not met all the needs of the French Army for armoured cars. In particular, the counter-insurgency operations of the French forces in Algeria in the mid-fifties brought out the need for a lighter,

Rear view of the E.B.R.-E.T.T., an experimental armoured personnel carrier version of the E.B.R.

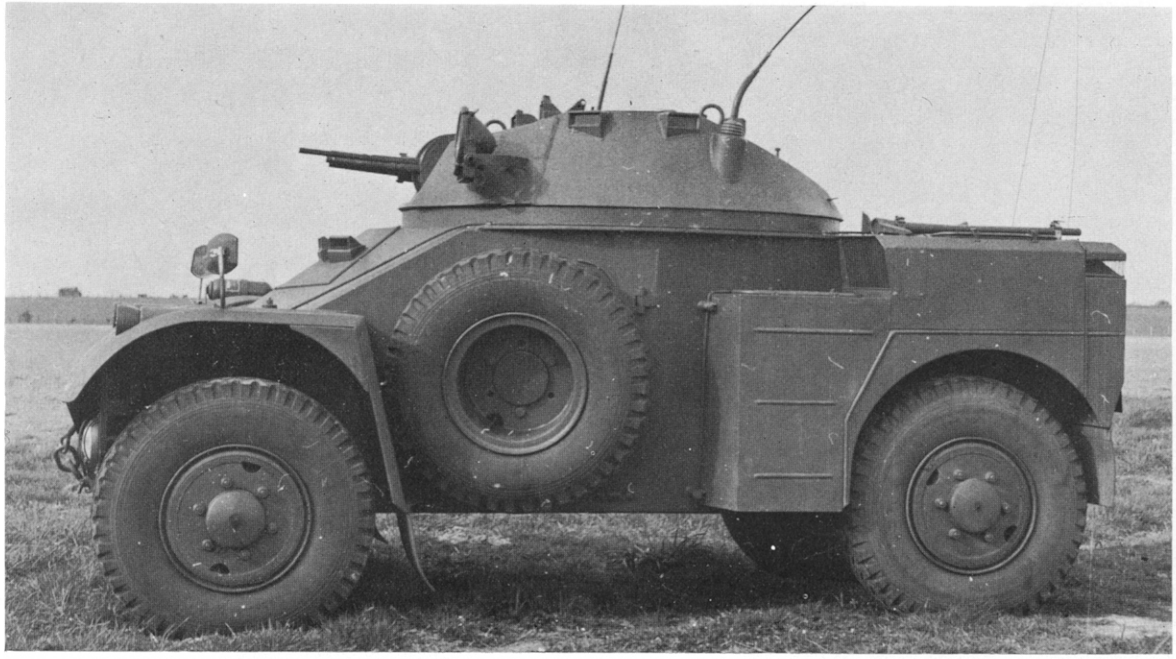
less sophisticated vehicle which would be easier to operate. The sophistication of the E.B.R. design inevitably increased the amount of maintenance it required and created such problems as the need to remove the turret before major maintenance could be carried out on the engine. As a temporary measure the French Army purchased from Britain a number of Daimler Ferret Mark 2 scout cars. These were light enough but had been armed only with a light machine-gun which was inadequate for many purposes. Thus, in the spring of 1956, the French Army issued the specification for a new *Automitrailleuse Légère,* or A.M.L.

Panhards designed the A.M.L. in competition with the Atelier de Construction d'Issy-les-Moulineaux, the French Army's fighting vehicles design establishment, and called it Model 245. Its first prototypes were built by mid-1959 and by the end of 1961 one French regiment in Algeria was already equipped with it. Since then Panhards have produced the A.M.L. in quantity not only for the French Army but also for the armed forces of more than a dozen different countries. Moreover, in addition to those produced in France, several hundred more A.M.L.s have been produced, under licence, in South Africa.

Compared with the E.B.R., the A.M.L. is a much simpler vehicle, designed to meet more modest requirements. The simplification achieved in its design is well illustrated by its hull which is welded from only 13 pieces. Its layout is conventional, with a single driving compartment at the front and an engine compartment at the rear. However, the hull belly plate is bent down its centre to form a very shallow V, which improves its resistance to the blast of mines. Another uncommon feature is the provision of a large hatch in each side of the hull which enables the crew to leave the vehicle without exposing themselves by jumping out of the top hatches, as in most other armoured vehicles.

ENGINE AND TRANSMISSION

Like the E.B.R., the A.M.L. is powered by a horizontally opposed air-cooled engine, but this has only four cylinders, which are the same as those of a Panhard two cylinder car engine. Like the other Panhard engines it incorporates a number of unusual



Early version of the A.M.L. with an experimental, low turret.

features, including torsion bar valve springs, connecting-rod big-end roller bearings and a built-up crankshaft carried in three ball bearings which reduce engine friction. At the end of the crankshaft there is a cast aluminium, centrifugal type cooling fan which draws air over the closely cowled cylinders.

The 4 HD engine has a swept volume of 1·99 litres out of which, at a compression ratio of 7·25:1, it produces a maximum of 89 b.h.p., sufficient to give the 4·8 tonnes vehicle a maximum road speed of 90 km/hr.

From the engine the drive is taken through a centrifugal clutch with electromagnetic control which eliminates the need for a clutch pedal. Behind the clutch is a transversely located gearbox made up, in effect, of two gearboxes arranged in series. The first has three forward ratios and reverse and the second has four gears. However, whenever any of the last four gears, which are used for road running, are engaged the first box is already in third gear and the second box remains in its lowest gear whenever the second, first or reverse gears of the first box are to be engaged. There are, therefore, only six forward speeds and one reverse, all simply selected by a single gear shift lever.

Rear view of an early version of the A.M.L.

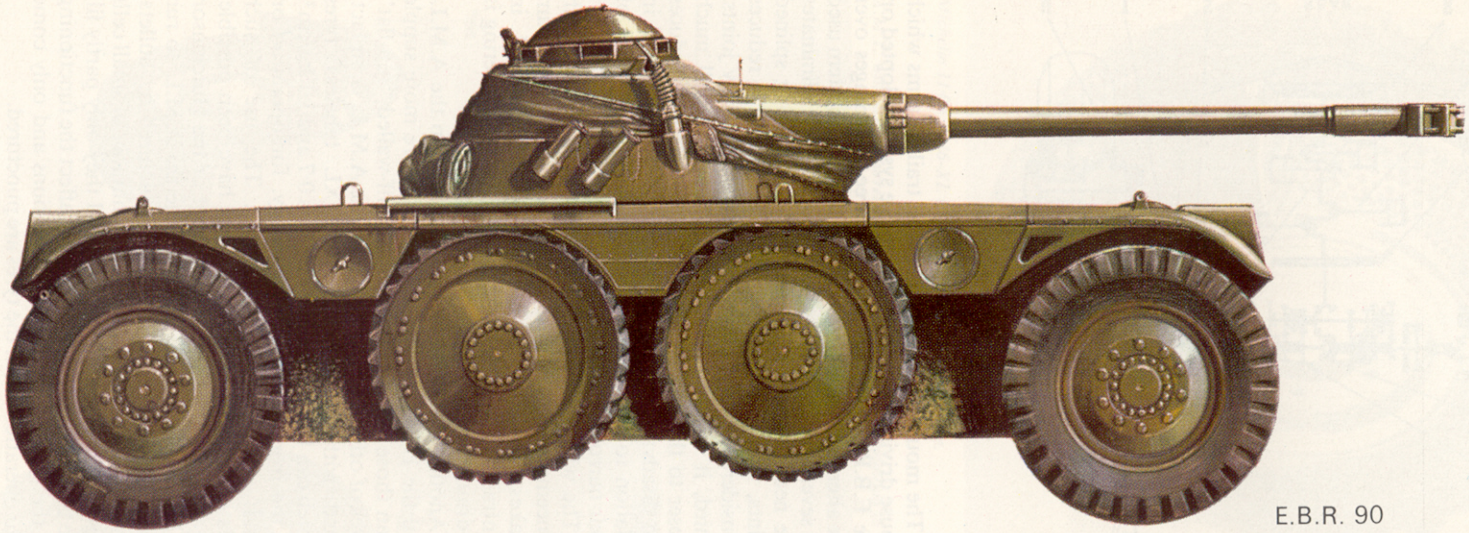
The output shaft of the second gearbox drives a Panhard cam-type differential from which two half-shafts transmit the drive to the sides of the vehicle. This arrangement provides for differential action between the wheels on each side of the vehicle but because of friction built into the Panhard differential there can be no relative motion between them unless a certain minimum torque is applied to each. As a result, if the wheels on one side of the vehicle lose adhesion they cannot spin but are made to rotate at the same speed as the others by what is, in effect, a limited-slip differential.

Each half-shaft drives another cam-type differential which distributes the drive between the front and rear wheels on each side of the vehicle. The two side differentials are basically the same as the central one and prevent either of the two wheels on each side having a speed different from that of the other unless the tractive effort which it exerts is at least a tenth of the other wheel's effort. In consequence neither wheel can spin but there can still be differential action between the front and rear wheels on each side, which eliminates transmission wind-up and reduces tyre wear during road operation. Thus, the design of the A.M.L. represents an advance on that of other military vehicles with a single central differential.

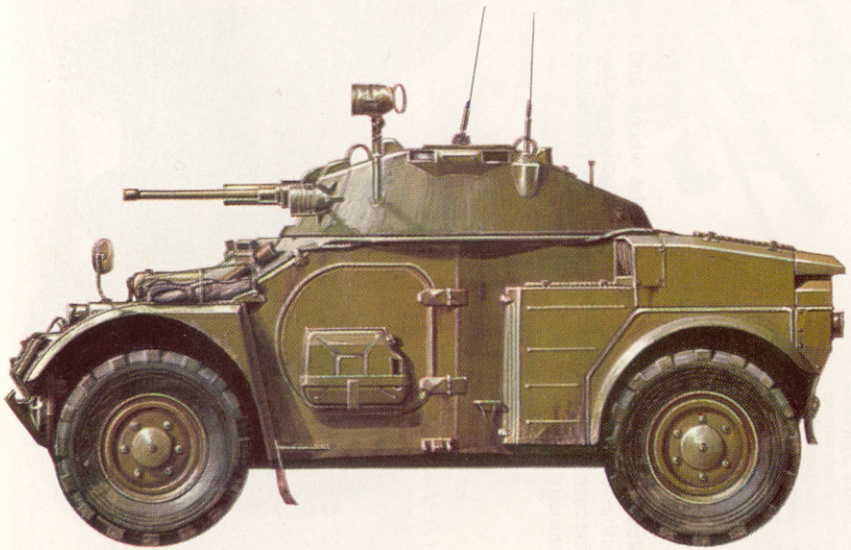
The drive lines on each side are similar and include universally jointed shafts as well as bevel gears at each wheel station. The drive is then taken through a train of three double-helical gears housed within the cast

E.B.R. 75s in column of march

A.M.L. with H.90 turret

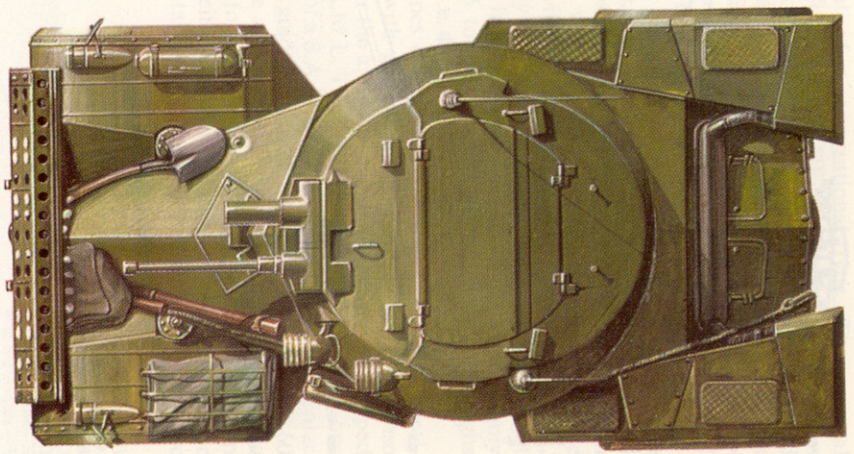


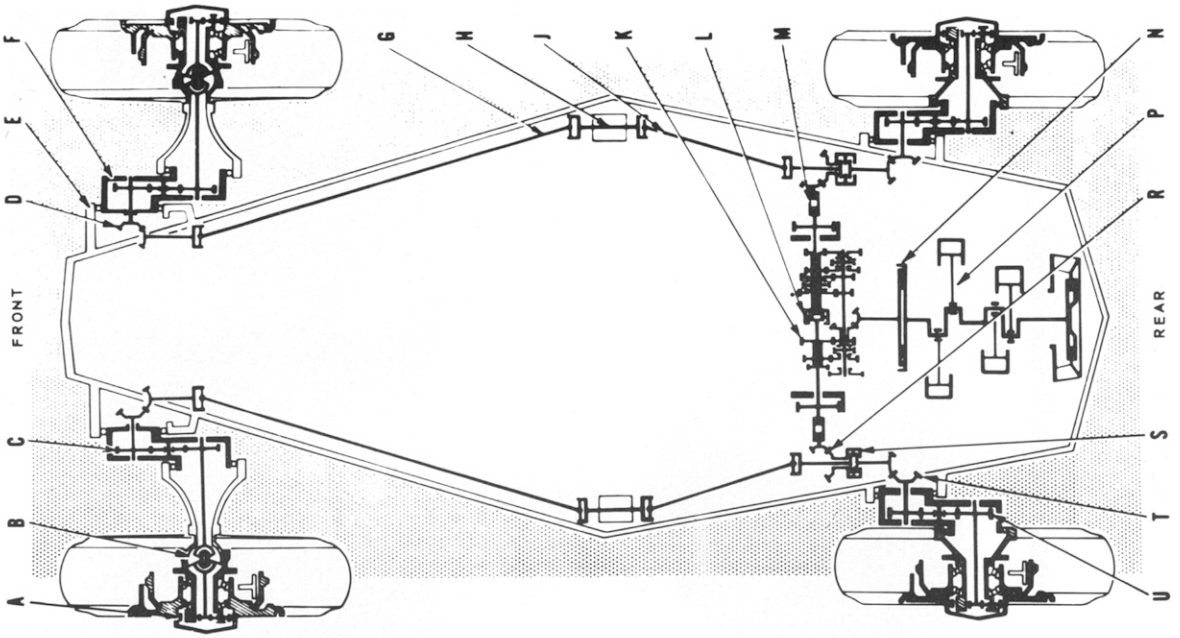
E.B.R. 90



A.M.L. with HE.60 turret

M. Trim © Profile Publications Ltd





Plan view of the A.M.L. transmission:
A—epicyclic hub reduction gears
B—constant velocity joint
C and U—suspension arm gears
D and T—bevel gears
E—suspension arm bearing
F—suspension arm
G and J—drive shafts
H—intermediate shaft
K—gearbox
L—central differential
M—toothed coupling
N—centrifugal clutch
P—engine
R—bevel gears
S—side differential

steel trailing arms which locate the wheels and then either directly to epicyclic hub reduction gears or, in the case of the front wheels, through a Tracta constant-velocity joint.

A.M.L. with HE.60 turret

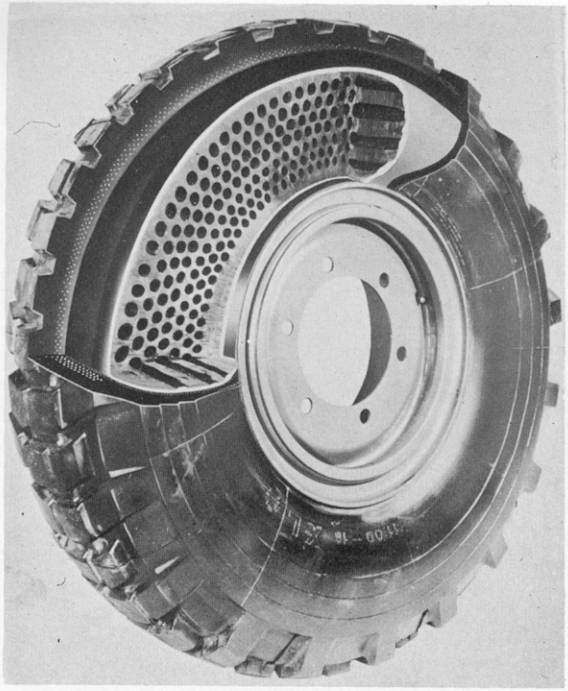
The mounting of the wheels on trailing arms which house driving gears is similar to the system adopted on the E.B.R. and offers at least three advantages over the alternative double transverse wishbone system used in several other military vehicles. First, it eliminates the need for wheel drive shafts with sliding splined joints, which can be troublesome. Second, it reduces considerably the number of constant velocity joints. Third, it makes it possible to bring the hull much closer to the non-steered wheels and thereby reduces the disadvantage at which wheeled vehicles stand in relation to their tracked counterparts on account of their narrower hulls.

The wheels are sprung by single coil springs with concentric telescopic dampers. All four have drum brakes but only the front two are steered and, in contrast to the E.B.R., neither braking nor steering is hydraulically assisted.

Another interesting difference between the A.M.L. and the E.B.R. are the tyres, which are more supple than those of the E.B.R. or the stiff-walled "run-flat" tyres of other military vehicles. The A.M.L. is, in fact, fitted with Michelin 11·00×16-XL tubeless tyres which can be deflated to as little as 0·7 and 1·1 kg/cm², at the front and rear respectively, for operation on sand, with obvious advantages. The use of such relatively flexible tyres would not have been possible, however, but for the development of the Hutchinson V.P.-P.V. inner tubes which enable the A.M.L. to run even when its tyres have been punctured by bullets. These inner tubes contain a large number of small cells permanently inflated with gas and they only partly fill the tyres. They do not, therefore, affect the functioning of the tyres under normal conditions and only come into operation when the tyres are punctured.

ALTERNATIVE TURRETS

Like the E.B.R., the A.M.L. is fitted with a two-man

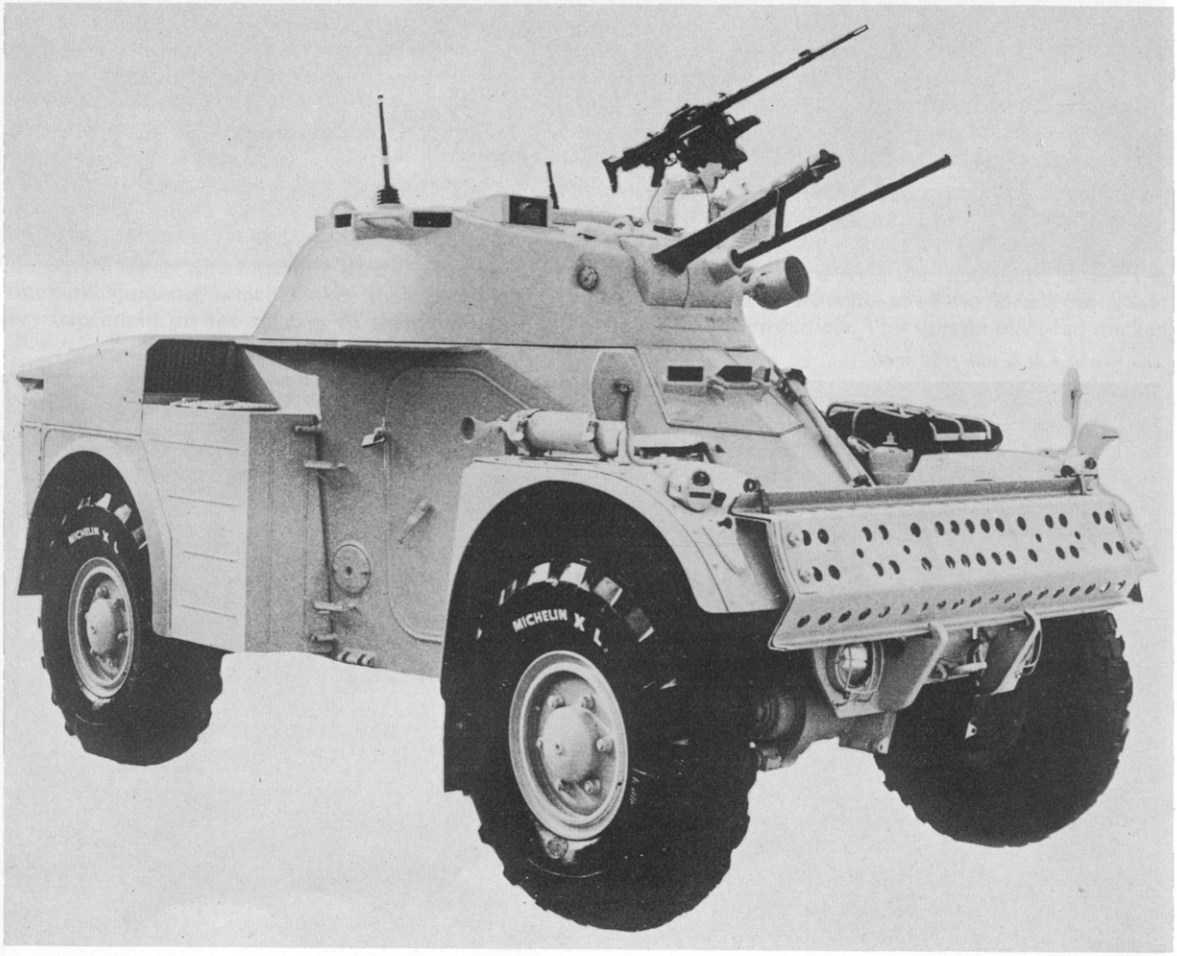


Michelin 11·00 × 16-XL tyre with Hutchinson inner tube.

turret—but of a conventional type. The original version is fitted with the HE.60 turret which mounts an unusual combination of a 60mm breech-loaded mortar and two 7·5mm, or one 12·7mm, machine-guns —a combination inspired by experience of counter-insurgency operations. The second version is fitted with the H.90 turret which mounts a 90mm smooth-bore gun and a coaxial 7·5mm machine-gun. The 90mm gun, which fires fin-stabilised shaped-charge and high explosive projectiles, is similar to that mounted in the latest version of the E.B.R. and provides the A.M.L. with a very effective form of armament, particularly in relation to its small size and light weight. In fact, the second version of the A.M.L. only weighs 5·5 tonnes while the original version weighs even less, i.e. 4·8 tonnes.

Both types of turret have also been fitted experimentally with guided missiles which would increase still further the anti-tank capabilities of units equipped with the A.M.L. The first of these missile installations consisted of a S.A.M.O. 1160 launcher with four Entac anti-tank guided missiles mounted on the HE.60 turret. The missiles were normally stowed behind the turret but for firing the launcher brought them out, in pairs, on either side of the turret. A somewhat later experimental installation consisted of four of the more

A.M.L. with HE.60 turret mounting a 20mm MG 151 in addition to its usual 60mm mortar.



A.M.L. with H.90 turret mounting a 90mm anti-tank gun.

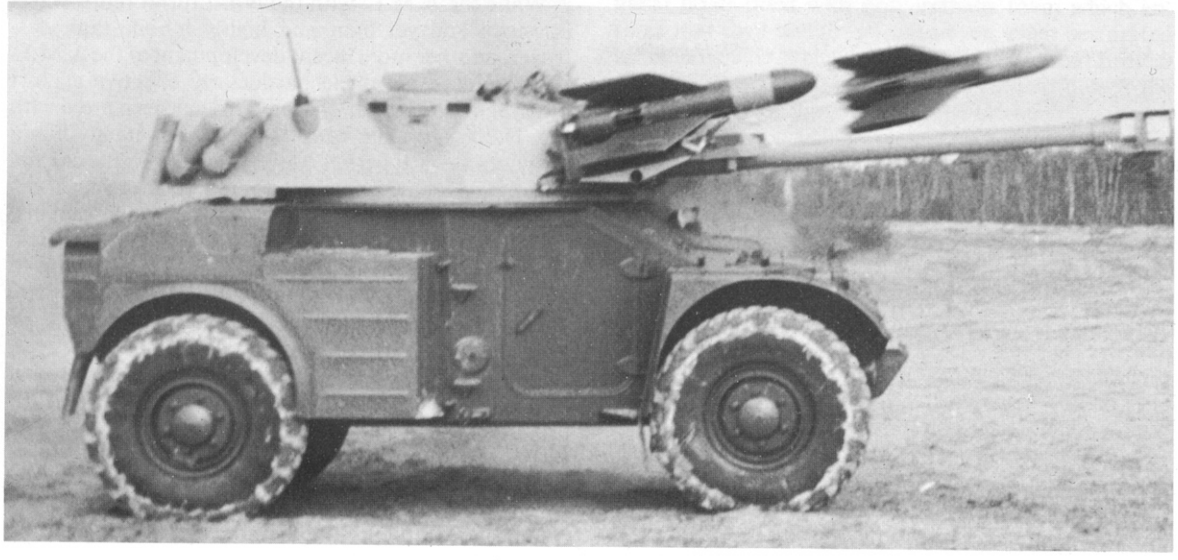
Side view of A.M.L. with H.90 turret.

A.M.L. with HE.60 turret and S.A.M.O. 1160 launcher with Entac anti-tank guided missiles.

powerful and longer-ranged SS-11 missiles mounted on the H.90 turret.

The Entac and the SS-11 are both first generation anti-tank missiles with a trailing wire link and manual command guidance which makes their performance very dependent on the reflexes of their human controllers. To overcome this limitation automatic guidance, or *Télécommande Automatique* (T.C.A.), has been developed for the SS-11 missiles by their manufacturers, the Nord-Aviation company, now the *Division des Engins Tactiques* of the *Société Nationale Industrielle Aerospatiale*. This uses an infra-red tracker

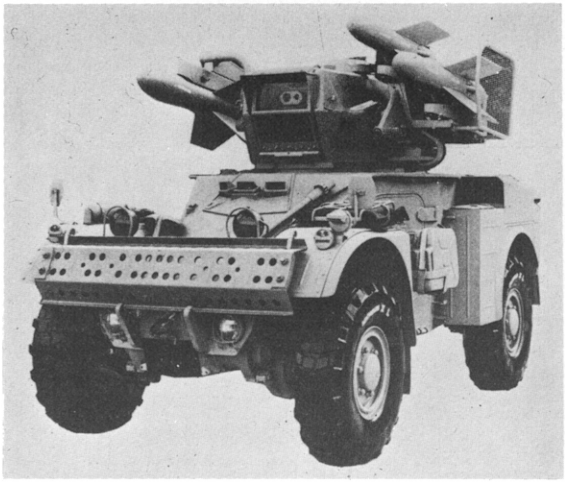
A.M.L. with H.90 turret and SS-11 missiles one of which has just been launched.



A.M.L. with H.30 turret mounting a 30mm gun.

in conjunction with a command computer to guide the missile within less than one metre of the tracker axis, that is within an imaginary two metre diameter "tube" which is parallel to the optical line of sight aimed at the target. As a result the missile no longer has to be "piloted" to its target. In fact, the missile controller of the improved SS-11 B1 with T.C.A. only has to aim at the target using an optical sight. One important result of this is that the amount of time required to train missile operators has been greatly reduced. In addition, the T.C.A. with its much reduced reaction time has made it possible to decrease the minimum practical range to 400 metres.

A.M.L. with NA-2 turret mounting two SS-11 and one SS-12 missiles.



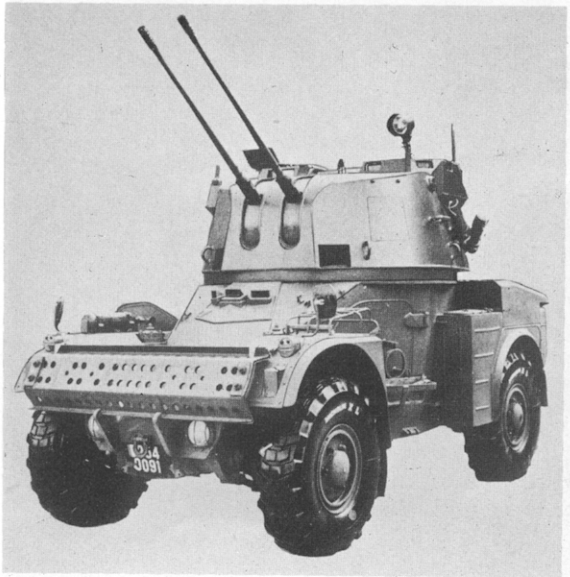
To provide a suitable installation for the SS-11 B1 with T.C.A. Nord-Aviation developed a special one-man NA-2 turret which has been mounted on the A.M.L. as well as other light armoured vehicles. The NA-2 turret contains all the missile firing and control equipment associated with the SS-11 missile system and mounts externally four missiles as well as two 7·62mm machine-guns. As an alternative, the pair of SS-11 anti-tank guided missiles on either side of the turret can be replaced by a single launcher for the much more powerful SS-12 "artillery" missile.

While the A.M.L. with the NA-2 turret represents a powerful and yet light and highly mobile tank destroyer, another more recent development of the A.M.L. has produced a vehicle particularly effective against other light armoured vehicles. This has been fitted with the H.30 two-man turret which mounts a 30mm Hispano-Suiza type 831 automatic gun and a coaxial 7·62mm machine-gun. In addition to firing armour-piercing as well as high explosive projectiles against ground targets the 30mm gun can also be used against aircraft or helicopters because it can be elevated up to 45 degrees. The A.M.L. with the H.30 turret can, therefore, help to discourage attacks from the air against itself and other armoured vehicles. However, to provide a more effective form of protection from low-flying aircraft and attack helicopters the A.M.L. has been fitted with an even larger, two-man S-530 turret which mounts two 20mm type 621 automatic guns. The S-530 turret is power-operated and the guns, which have a combined cyclic rate of fire of up to 1,480 rounds per minute, can be elevated up to 75 degrees.

Amphibious version of the A.M.L. with H.90 turret.

A single 20mm type 621 gun has also been mounted in the original HE.60 turret in place of the machine-guns. As it fires armour-piercing projectiles with a muzzle velocity of 1,000m/s it makes the original version of the A.M.L. capable of destroying light armoured vehicles and, because of the elevation of its mounting, also of firing at aircraft. At the same time this version of the A.M.L. can still fire 60mm high explosive projectiles from its mortar and, what is more, retains the great advantage of the original design which was its low turret and consequently low silhouette. In fact, the overall height of the A.M.L. with the HE.60 turret is only 1·89m to the top of the turret roof periscopes, whereas the height of all the other versions is greater, rising to 2·24m in the case of the S-530 turret model.

Anti-aircraft version of the A.M.L. with two 20mm automatic guns in a S-530 turret.



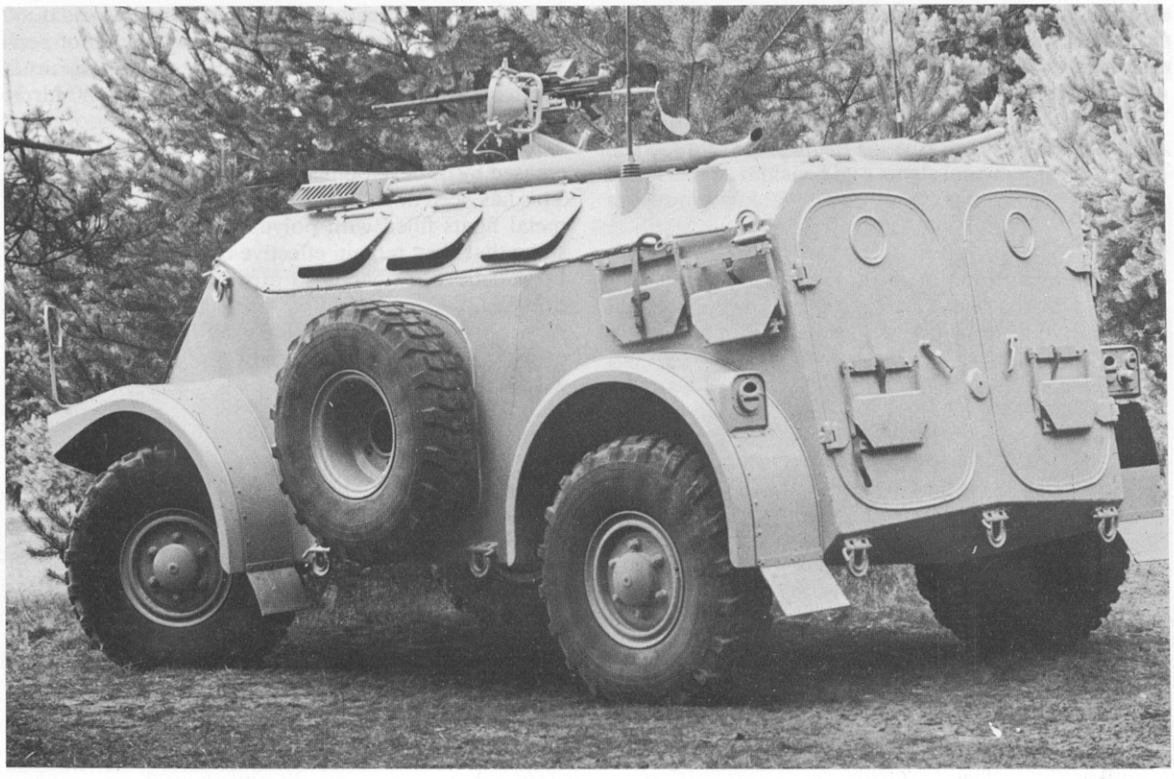
The effectiveness of the A.M.L. has also been increased by its development into an amphibious vehicle. This has been done by the addition of detachable sheet metal floats filled with polyurethane foam which ensures that they remain effective even when perforated by bullets. The floats also provide additional protection against shaped charge projectiles. Although the A.M.L. could have propelled itself in water by means of its wheels it has also been fitted with a propeller which has increased its water speed to between 6 and 7km/h.

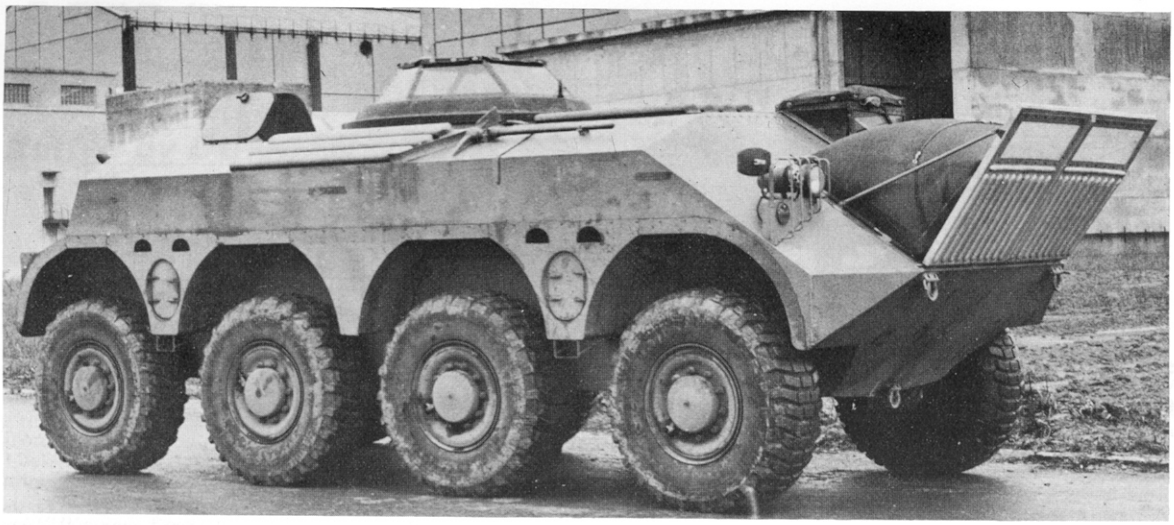
AML—VTT

To provide a complete family of light wheeled armoured vehicles, an armoured personnel carrier, or *Véhicule Transport de Troupes,* has also been added to the various turreted versions of the A.M.L. The A.M.L.-V.T.T. was actually developed in prototype form by 1969 and into the production version by 1971, when it became known as the M3. In contrast to all the other developments of the A.M.L., which retained the original hull, the M3 has had to have a different hull with the engine relocated forward, behind the driver, in

Prototype of the A.M.L.-V.T.T. with one of its side doors open.

M3 armoured personnel carrier, the production version of the A.M.L.-V.T.T.





M2 experimental amphibious armoured personnel carrier.

order to provide a large compartment at its rear. The wheelbase has also been increased from 2·5 to 2·7m and the track from 1·62 to 2·05m. In spite of this, 95 per cent of the automotive components of the M3 are the same as those of the original A.M.L., which greatly simplifies maintenance when the M3 is used alongside the turreted A.M.L.s.

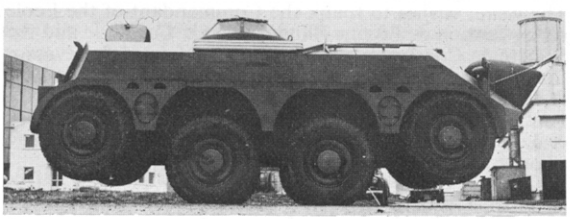
The increase in the size of the hull of the M3 over that of the other A.M.L.s has been accompanied by only a modest increase in weight to 5·9 tonnes and this together with the location of the engine cooling air inlets and outlets and of the exhaust on the hull roof has made the M3 amphibious. It is therefore superior in this respect to the turreted A.M.L., unless the latter is equipped with floats. Otherwise its performance is very similar to that of the other models and it is roomy enough to carry up to 12 men, including the driver, or 1 tonne of cargo. As an alternative to acting as an armoured personnel or cargo carrier the M3 can also be fitted to play the rôles of an armoured ambulance, a workshop vehicle or an armoured command vehicle.

Ease of entry and exit is ensured by two large doors at the rear of the hull and one on either side. There are also three large ports on either side of the hull which facilitate observation from within the vehicle and enable its occupants to fire their weapons. In addition, the M3 can be fitted with roof-mounted weapons ranging from a single 7·62mm machine-gun to a 20mm type 621 automatic gun.

M2 EXPERIMENTAL CARRIER

The successful development of the M3 and the rest of the A.M.L. family of light armoured vehicles has still left Panhards able to work on a more advanced wheeled armoured vehicle. The outcome of this has been an experimental eight-wheeled armoured personnel carrier, the M2, which carries on the tradition of sophisticated multi-wheeled vehicle designs established by Panhards with the E.B.R.

M2 carrier with its front and rear pairs of wheels raised off the ground for a pivot turn.

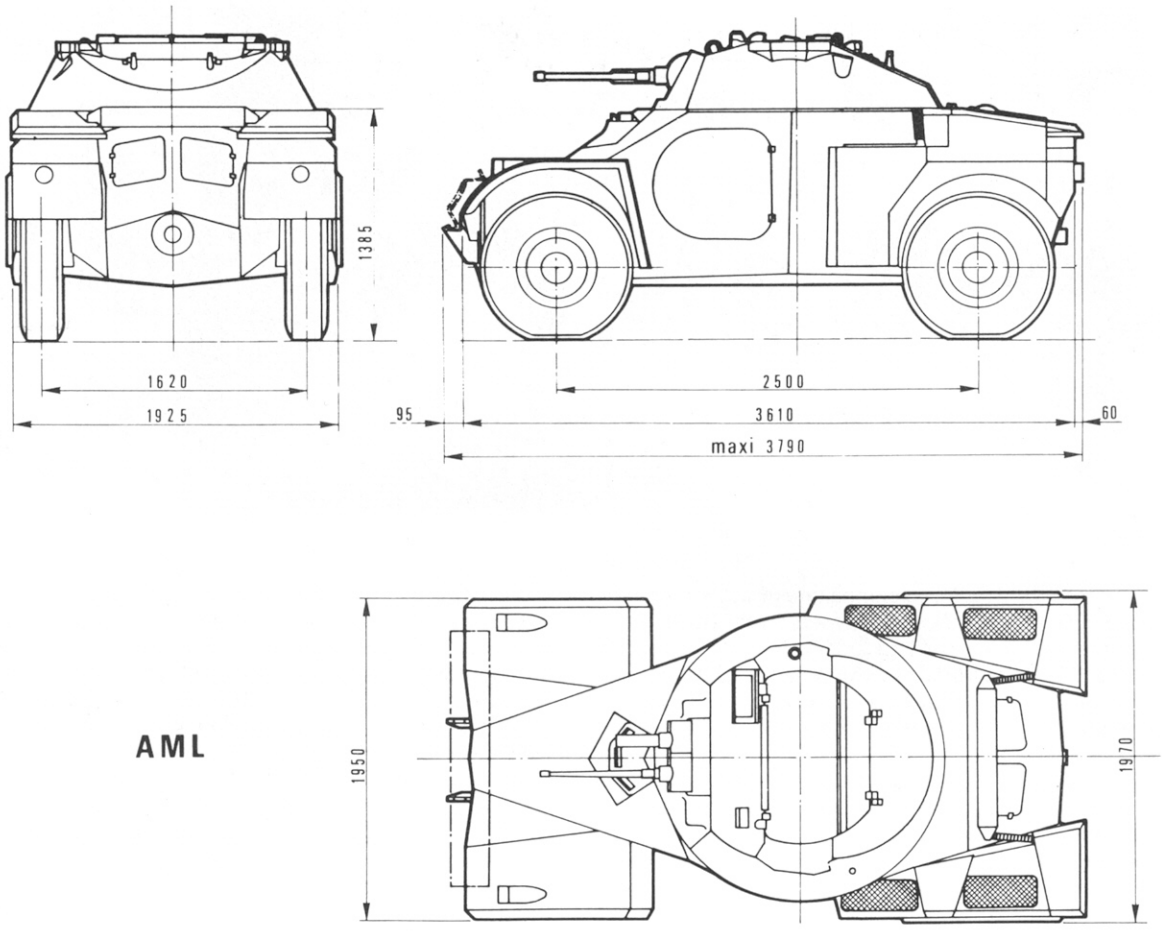


As in the case of the E.B.R., all eight wheels of the M2 are driven at all times, through a transmission which includes a differential between the drive line on one side of the vehicle and the other and a differential on each side between the front and the remaining three wheels. However, the M2 differs from the E.B.R. and all other eight-wheeled armoured vehicles in having an adjustable hydro-pneumatic suspension system which gives it several unique advantages.

One important advantage which the M2 possesses over other eight-wheeled vehicles is that its second pair of wheels can be lifted off the ground and the fourth pair of wheels simultaneously virtually unloaded for running on roads. In consequence the M2 operates on roads very much like a four-wheeled vehicle which makes it more efficient and more stable at high speeds than other eight-wheeled vehicles. It also needs only one pair of steered wheels for operation on roads: off the road, when all eight wheels are in contact with the ground, the steering effect of the front pair of wheels is assisted by braking the other three wheels on one side or the other by an automatic connection between the steering wheel mechanism and the transmission system.

Another very important feature of the adjustable hydro-pneumatic suspension and of the transmission system of the M2 is the ability to raise the front and rear pairs of wheels off the ground and to drive the remaining two wheels on each side in opposite directions so that the vehicle spins round about its centre. This is equivalent to the pivot turn which the more sophisticated tracked vehicles are able to execute and demolishes the long-standing criticism of wheeled vehicles that they can not turn round as quickly as tracked ones.

The hydro-pneumatic suspension can also be used to vary the ground clearance from as little as 0·2m, which



Three-view scale drawing of the A.M.L. with HE.60 turret.

enables the M2 to squat behind cover, to as much as 0·53m, which helps it to move over obstacle-strewn or muddy terrain. The cross-country mobility of the M2 is further enhanced by the ability of the driver to vary the inflation pressure of the tyres which are connected to an air compressor. The tyres themselves are Michelin 13·00 × 20-XL and are large in relation to the weight of the M2 which in itself makes a major contribution to its off-the-road mobility.

An additional important contribution to the overall operational mobility of the M2 comes from its ability to float without any preparation and to propel itself in water by means of two propellers, each coupled to the drive line on one side of the vehicle so that their speeds can be varied, thus greatly improving manoeuvrability afloat. On roads, on the other hand, it can move at up to 92 km/h and cover up to 1,000 km without refuelling. These figures apply to the original version of the M2 which weighs 10·5 tonnes empty and 12·5 tonnes laden and is powered by a 260 h.p. HS 115 V-8 diesel. In its original form the M2 is primarily an armoured personnel carrier which can carry up to 12 men, including the driver, and can be fitted with a 20mm gun cupola. The M2 could, however, also be used as the basis of several other high-performance wheeled armoured vehicles.

SUMMARY OF THE LEADING CHARACTERISTICS

	E.B.R. 75—Modèle 1951—Type 1954	A.M.L. Modèle 61
Turret, type	F.L. 11	HE. 60-7
Gun, or mortar, calibre	75mm	60mm
ammunition, rounds	56	53
Machine-guns, coaxial	1 × 7·5mm	2 × 7·5mm
hull-mounted	2 × 7·5mm	None
Weight, combat loaded	13,000kg	4,800kg
Length, overall, gun forward	6·15m	3·79m
without gun	5·56m	3·79m
Width, overall	2·42m	1·95m
Height, to turret periscopes	2·24m	1·89m
Ground clearance, on 4 wheels	0·34m	0·33m
on 8 wheels	0·42m	—
Drive	8 × 8	4 × 4
Tyres	14·00 × 24	11·00 × 16
Wheelbase	4·34m	2·50m
Track	2·07m	1·62m
Engine, model	12H6000	4HD
gross horse power	200	89
Maximum road speed	100km/h	90km/h
Range on roads	630km	600km
Crew	4	3

Acknowledgements
The writer wishes to thank the Commandant of the Ecole d'Application de l'Arme Blindée et de la Cavalerie and the Société de Constructions Mécaniques Panhard & Levassor for making it possible for him to study the E.B.R. and the A.M.L. at first hand, and the Military Attachés at the Ambassade de France in London and the S.C.M. Panhard & Levassor for their generous help with information and photographs of the various Panhard armoured cars.

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FORTHCOMING TITLES:

40 U.S. Armoured Cars

Although armoured cars, a familiar sight in many countries, have never been popular in the United States, more varieties have existed there than is generally realised. This *Profile* recounts the whole story of U.S. armoured cars from the Davidson car of 1898 to the XM808 on the Lockheed Twister chassis of today: BY COLONEL ROBERT J. ICKS, the famous American armoured expert, author of *AFV/Weapons Profiles 16, 24, 26 and 32,* and *Profile Book AFV/Weapons Series No. 1 Modern U.S. Armored Support Vehicles.*

41 M103 Heavy + M41 Light (Walker Bulldog

The Berlin airlift and the beginning of the so-called Cold War placed new emphasis on the U.S. post-World War II tank programme. The result was the emergence of three basic designs, the T41 Light Tank, the T42 Medium Tank, and the T43 Heavy Tank. This *Profile* deals with the first and third of these – the T41 which was standardized as the M41 and named the Walker Bulldog, and the T43 which became the M103 Heavy Tank: BY COLONEL ROBERT J. ICKS, author of *AFV/Weapons Profiles 16, 24, 26, 32 and 40,* and *Profile Book AFV/Weapons Series No. 1 Modern U.S. Armored Support Vehicles.*

42 Modern Swedish Light Armoured Vehicles

Included in this *Profile* are the Pbv 302 armoured personnel carrier and its derivatives – the Bgbv 82 recovery vehicle, the ingenious Brobv 941 bridgelayer and the IKV 91 infantry gun intended for operation in the north of Sweden, the Noorland: BY R. M. OGORKIEWICZ, author of *Design and Development of Fighting Vehicles* and *Armoured Forces,* and of *AFV/Weapons Profiles 28, 34 and 39.*

43 PanzerKampfwagen IV

While the Panther and Tiger have tended to capture the limelight, it was in fact the Panzer Kampfwagen III and IV which established the reputation of the German armoured forces. The Panzer IV, whose first prototype was built in 1934, eventually became the only German tank which remained in production and troop service throughout World War II, a fact which demonstrates its sound basic design and the brilliant foresight shown in its specification. It was still in service in the Syrian Army as late as 1967.

44 Ferret and Fox Scout and Reconnaissance Cars

Ferrets, developed from the Second World War experience with the Daimler scout cars, have become some of the world's most widely used armoured vehicles. Thus, they are in service not only with the British Army, but also with the armed forces of more than twenty different countries. The successful experience with them has, in turn, led to the even more effective Fox armoured car (or Combat Vehicle, Reconnaissance, Wheeled). This has aluminium armour and much more powerful armament but otherwise retains many of the characteristics of the Ferrets: BY R. M. OGORKIEWICZ.

45 Vickers 37-ton Main Battle Tank (Vijayanta)

46 Light Tanks M22 (Locust) and M24 (Chaffee)

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Printed in England by Edwin Snell printers Yeovil. January 1972