DESIGN RECORD

CANADIAN-DEVELOPED MILITARY VEHICLES WORLD WAR II

VOLUME II

ARMOURED VEHICLES (OTHER THAN TANKS)

ISSUED BY
Army Engineering Design Branch
Department Of Munitions And Supply
Ottawa, Canada

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ARMY ENGINEERING DESIGN BRANCH
DEPARTMENT OF MUNITIONS & SUPPLY
OTTAWA CANADA

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MANUFACTURE AND WELDING OF BULLET-PROOF AND ARMOUR STEEL

Up until July 1940, only a few experimental plates of bullet proof steel had been produced in Canada, no armour plate had been made and welding of bullet proof and armour steel was an operation which had been tried but with very little success. By September 1940, sufficient bullet-proof steel and armour plate to commence the fabrication of Armoured Vehicles had been produced and successful electrodes had been developed to weld bullet proof and armour steel by both the automatic and manual processes.

Bullet proof plate - 3-14 mm. in thickness.

At the commencement of production operations, bullet proof plate was merely required to withstand a ballistic test without any attention being given to machining, fabrication or welding properties. It was soon realized that ballistic tests alone were not sufficient to determine the suitability of bullet proof plate for the production of light armoured vehicles. Bullet proof plate of high hardness would withstand bullets if it did not crack but a plate of high hardness presented machining problems, flame cutting difficulties and plate failures in fabricating. Several months were required to solve the various problems and difficulties mentioned and to obtain authorization to change the drawings. The improvements effected in the handling of bullet proof plate in the production of the Universal Carriers were adopted or extended in the fabrication of other vehicles later.

Bullet-proof plate for erection into armoured hulls has to be fairly flat, approximately within 1/32" out of flatness in a running foot. To straighten bullet proof plate much experience is necessary. The only experience in straightening steel plate was available in the saw manufacturing plants and it was mainly for that reason and partly because of the saw manufacturer's knowledge of heat treatment, that the treatment and straightening of bullet proof plate was commenced and extended at the 2 or 3 plants producing saws.

The improvements in the heat treatment of bullet proof steel have been many and since 1941 the production of straightened bullet proof steel of the requisite hardness has been carried out continuously and successfully. To produce bullet proof steel to resist bullets and to enable a contractor to fabricate the plate into hulls is now quite a simple procedure. The composition of the bullet proof plate matters little provided the plates are machined but the composition of bullet proof plate is a vital factor when welding is used instead of machining to effect the construction of armoured hulls. The range of composition of bullet proof plate will be discussed under welding.

Armour Plate - 15 mm. and over in thickness.

No armour plate had been produced in Canada previous to September 1940. Any details of manufacturing armour plate were obtained from representatives from England or from those who had visited that country. There seemed to be a mystery

surrounding the composition and manufacture of armour plate but it was not long before those responsible for the production of armour plate concluded that the factors to be observed in making satisfactory armour plate were first good steel making practice and a composition containing sufficient alloy to impart the necessary hardenability for the different thicknesses of plate. It took possibly a year or more to disseminate that knowledge and at present it is almost universally accepted. It was in the early experimental tests that lower alloy and lower hardnesses were suggested by the Division of Metallurgy for armour plate and the ballistic successes which resulted soon became known and the specifications to provide for the lower hardness alloy steel were changed for Canadian production and shortly afterwards for that produced in the United States and Great Britain. At the commencement of manufacture of armour plate a composition containing 5.5 per cent alloy was used, but early in 1941, this was reduced to approximately 3.5 per cent maximum.

The straightening of armour plate presented an additional problem in that whereas hammers could be used for straightening bullet proof plate, presses were necessary to flatten armour plate. At the commencement of operations for the production of armour plate presses already in steel plants had to be used until new press equipment could be obtained and installed. Practically eight to twelve months elapsed before suitable equipment could be obtained and installed. In the meantime, many make-shift types of equipment had to be utilized in order to produce sufficient plate to permit the fabricators to commence their machining and erecting operations in order to solve any possible production difficulties.

Welding of bullet-proof plate.

In developing the welding of bullet-proof and armour plate, it was necessary to solve difficulties in connection with electrodes, welding procedure and ballistic and physical properties. Through the co-operation of electrode manufacturers, improved austenitic electrodes were developed which met the ballfstic requirements. Later (1941) austenitic electrodes using the automatic process were adopted, followed by ferritic electrodes. In the final welding developments, a combination of automatic ferritic, manual austenitic and ferritic electrodes and also high-strength steel electrodes were used. It is not considered the correct procedure to specify a certain type of electrode without taking into consideration the type and location of joint and how the joint is backed up. These factors should be studied before specifying the most suitable electrode. Another factor which at times must be taken into consideration is the straightening of sub-assemblies. To accomplish such an operation most successfully, a rod with the highest ductility is advantageous, i.e. an austenitic rod. The use of ferritic electrodes possesses advantages in that alloy is conserved and that less than 5 per cent alloy is used instead of approximately 25 per cent in austenitic electrodes. The physical properties of ferritic electrodes are higher.

The improvements in the preparation of plate edges, sequence of welding joints to decrease distortion, and the more extensive use of jigs, fixtures and gauges contributed to the speed of welding as well as facilitating the construction of hulls to comply with dimensional measurements.

To control the physical properties of welded joints, the correct composition of plate is an essential requirement. Variations in the type of plate can be made but the composition must be such to give a controllable hardenability. If a composition of plate is used which possesses too high a hardenability, then brittle joints will result, if too low, then the welded adjacent zone will not possess properties sufficient to resist ballistic attack. As the carbon content controls hardness, it has been accepted that plate to be welded should not exceed 0.30 per cent carbon. Other alloys are present in bullet proof and armour plate but whether the alloys are mainly manganese, chromium, nickel or molybdenum or a combination of these makes little difference as the amount present is the determining factor. The amount of alloy present, along with the carbon, determines the hardenability and as mentioned above the composition of the bullet proof plate must be within a certain hardenability range to be weldable and at the same time be ballistically resistant.

ARMOURED VEHICLE DESIGN

The prime function performed by A.E.D.B. of interpreting the requirements of the "User" to Industry in connection with vehicle design involved considerable detail in connection with armoured vehicles. Not only did the phases of performance and reliability have to be considered, but to permit each vehicle to perform the many functions peculiar to it, attention had to be paid to many details of equipment, stowage, etc. - in other words it was not only necessary that the vehicle perform but also that the crew be able to perform their allotted functions.

This summary will not attempt to trace the story of components which were used on both M.T. vehicles and armoured vehicles but will rather stress the points which were experienced in applying these components to armoured vehicle design.

It is well to recognize, at this point, firstly, that armoured vehicle design represents the greatest departure from standard commercial design that is required for Army use; and, secondly, that each armoured vehicle is a vehicle unto itself with both chassis and hull forming complimentary parts of an especially designed whole. It is seldom possible to use the same chassis for more than one armoured vehicle, although minor variations in hull and chassis together with alterations in stowage and equipment may permit the vehicle to serve in different roles.

The first thing that had to be decided in starting the design of an armoured vehicle was the general size and type of the vehicle. Size of course was pretty well indicated by the necessity of providing accommodation for the number of crew and amount of equipment to be carried. Consistent with meeting these requirements the size of the vehicle was always kept to a minimum so as to present as small a target as possible, to make the vehicle as obscure as possible and to permit a maximum of manoeuvrability.

The question of whether a vehicle should be tracked or wheeled was determined by the roles the vehicle had to fulfil, with consideration being given to the fact that while a tracked vehicle can negotiate terrain impassable to a wheeled vehicle, it does so at the cost of speed and acceleration, quietness and greatly increased maintenance requirements, particularly of track and suspension.

It was found desirable in some instances to locate the engine in the rear. The principal advantage of this design was in improved weight distribution. Where the load was made up largely of armour plate, and the heaviest plate was required at the front it was possible to avoid the unhealthy condition of having the greatest load on the front axle, by placing the engine in the rear. Locating the engine at the rear also improved driver visibility by permitting the driver to sit practically over the front axle and with no engine hood or bonnet to obstruct his vision.

Early experience with "all wheel drive vehicles" demonstrated decisively that a vehicle with all wheels driving could get through many spots of bad going which would stop another wheeled vehicle. Consequently all wheeled armoured vehicles were all-wheel drive. (Those produced in Canada were all four-wheel drive.)

When the above factors had been determined it was then possible to proceed in greater detail.

When the general design had been sketched out the weight factors could be forecast with considerable accuracy providing due allowance was made for the overload of extraneous and surplus equipment which is always found in such vehicles when they are in the hands of the troops. A very large percentage of the weight is armour plate and this figure of course remains constant during the life of the vehicle. The remainder of the load is almost entirely made up of crew and specified equipment so that the

vehicle always operates at almost the same weight figure. This characteristic was, of course, of considerable help in developing design and works in two ways; while it controls the maximum loading to a certain extent it also means that the vehicle will almost always work at full load. When the original weight estimates were made, and these estimates must dictate the design of every major component, it was found advisable to allow for a gross weight increase of about twenty per cent to cover factors of weight which could not be estimated, as well as design changes and any addition called for by the User after design was started. It was also found advisable to allow for an additional weight increase of approximately 5% for the surplus or unspecified material which is usually carried. All the above are of course over and beyond the normal factors of safety which must be provided.

Two points had to be closely watched as the design developed. First these vehicles, destined for rigorous service had to be rugged to a degree never visualized in commercial vehicles. At the same time riding comfort was required to enable the crew to carry out their tasks with the greatest possible efficiency. Such points as ground clearance, angles of approach and departure and angles of overturn were carefully considered.

Design of chassis was usually formed around available commercial components. The first step was to determine the best available engine, transmission, transfer case, axles, tires and wheels available to give the desired performance and reliability. Not only the rating of components was considered but also their reputation as far as it was known. A gradeability of at least 5% in the highest gear and 60% in the lowest gear has been found to give a satisfactory performance. For specialized vehicles, into which class most armoured vehicles fall, it was usually necessary to design special frame, springs, shock absorbers and driveshafts at least. The hull of course was special for each type of armoured vehicle.

ENGINE

The choice of an engine, for any vehicle, merited a good deal of thought. We learned from sad experience the fallacy of using an engine not quite powerful enough. The first apparent result was poor performance and although this could be somewhat compensated for by gearing it was practically impossible to get both acceleration and top speed. The results were later apparent in shortened engine life and shortened transmission life caused by excessive shifting.

We found that the rigours of military service should be considered in selecting an engine. This made it still more important that the engine should not be overloaded. Wartime production conditions did not always produce engines which took full advantage of their design or which were always up to peacetime standards. Finally the dust conditions encountered, particularly in desert service, shortened the lives of engines tremendously even after the appreciation of this fact had led to great improvements in air cleaners. All the above taught us the value of an adequate engine.

However, engines of the desired power were not always available. Canadian plants produced a limited range of engines. Therefore, the Canadian designer was at times confronted with the following alternatives:

1. Making compromises by using a light engine in combination with the consequently necessary gear reductions and thus falling below certain desired performance characteristics.

2. Specifying an engine which must be imported from another country.

3. Advising against the manufacture of the vehicle in Canada.

COOLING

To get good cooling with a radiator protected by armour plate against enemy projectiles sometimes presented a problem. An adequate size radiator and fan together with pressure cooling (approx. 5 p.s.i.) and an overflow tank usually met the problem. Careful attention to cowling was necessary of course to properly direct the air-flow and prevent recirculation. The inverted "V" type louvre was found most successful for both front and rear engined vehicles. With rear engined vehicles some research was always necessary to take advantage of the air flow characteristics depending on which it could be determined if the air intake or outlet should be through the radiator. Louvres on top of the engine cover were often found desirable. Early cooling trials were run in deep sand but this was found to give very erratic results. The method found to give the most accurate results, in the absence of a chassis dynamometer, was the towed load method. By this method the vehicle being tested towed a second vehicle. The towing vehicle was run at wide open throttle. The towed vehicle with engine dead, by a combination of transmission, gears and throttle opening held the vehicle under test first at the point of max. torque and secondly at peak B.H.P. Level paved road and runs averaged in opposite direction were necessary for accurate results. It was found desirable to run the vehicle under test in a sufficiently low gear to obtain the desired condition around 10 m.p.h. The temperature differential between engine oil and air, and between water temperature and air were obtained under both conditions. It was generally considered satisfactory if an engine water T.D. of 110°F max. and an engine oil T.D. of 140 max. was obtained.

Experience showed that, whenever possible, the test should be run on a chassis dynamometer in a closed room, especially if the room was equipped with a draft system which would produce the equivalent of a following wind. Both the field test methods, mentioned above, introduced far more uncountrolable variables than this dynamometer method.

TRANSMISSION

A transmission must give the gear ratios required for performance as well as have adequate torque capacity. An undersize or overloaded transmission was found to cause jumping out of gear as well as premature failure of gears, bearings, etc. The advantages of synchronized shifting in ease of operation and increased gear life were very apparent from our experience with crash type boxes.

It was not only the performance which was produced by the high, or fourth, gear ratio which required careful study. It was especially important in armoured vehicles that the other ratios be selected wisely. A considerable portion of driving is always in third gear and thus consideration had to be given to speed vs acceleration in that range. The loss of an armoured vehicle could be serious and the low range had to be such as to permit a very low speed crawl with ample power to minimize the danger of bogging down or inability to climb.

These comments regarding gear ratios should, of course, be considered in conjunction with transfer case ratios and axle ratios.

TRANSFER CASE

Again an adequate size was necessary. As all armoured wheel vehicles are four-wheel drive a front axle declutch was necessary. The necessity for a one or two speed transfer case was determined by performance and top speed requirements.

AXLES

Front and rear axles of course had to provide the correct ratio to meet the requirements of performance. They required to have adequate torque capacity to transmit the drive as well as have sufficient beam strength to support the vehicle. Again the arduous, cross country type operation, to be provided for, was found to demand ruggedness far beyond commercial standards.

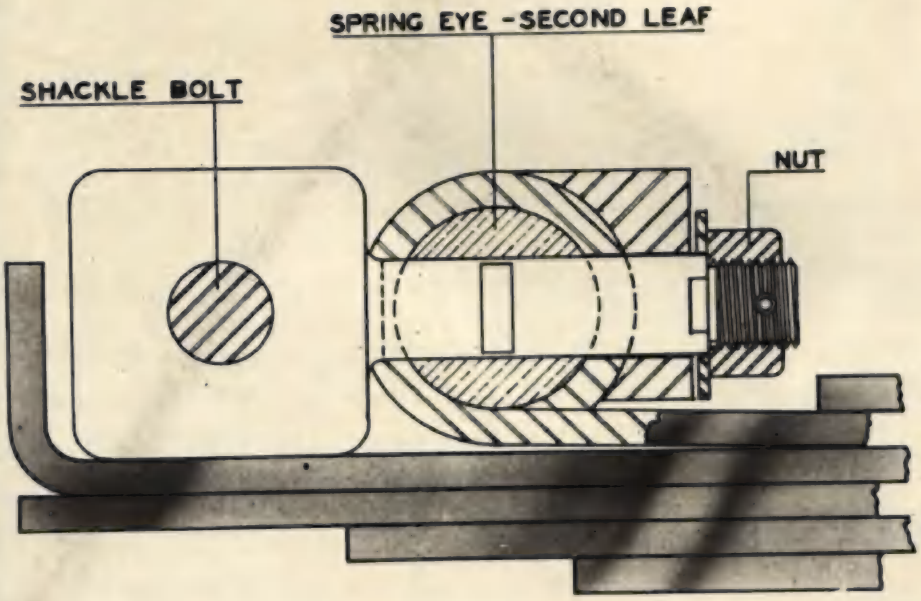
FRAME

The only comment on frames is that again we learned to provide for rough service and make the frame strong enough to carry the load.

Toward the latter part of the war two vehicles were in process of development in which the frame was eliminated. The hull of an armoured vehicle can be used, with comparatively little modification in basic design, to serve in a structural capacity. Experience with these two vehicles, which were both subjected in pilot form to considerable rugged testing, proved the advantage of this "frameless" type. One vehicle was provided with independent suspension; the other with conventional springing modified according to Woodhead trunnion design.

SPRINGS

Springs must have ample load carrying capacity to avoid excessive bumping through and also premature failure. At the same time moderate riding comfort is a necessity. Long, wide springs have been found to be beneficial. Also cast spring eyes and "Woodhead" type spring trunnions which can rotate about the spring longitudinal axes were useful in relieving or avoiding certain stresses in the springs.

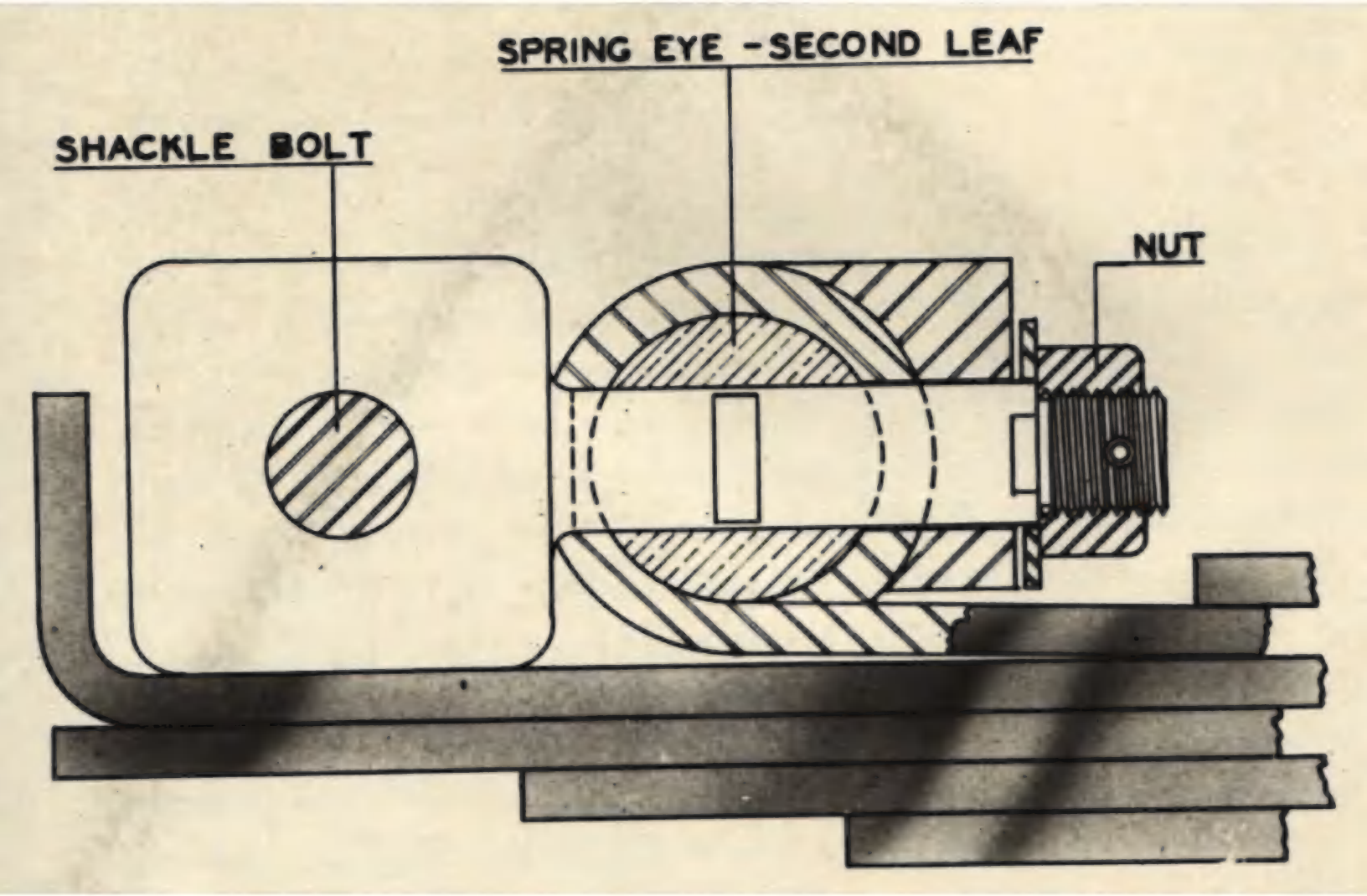


WOODHEAD SPRING TRUNNION

SHOCK ABSORBERS

Large size direct acting shock absorbers were found to give the best results. It was necessary to specify valving which was correlated with the performance characteristics of the springs.

The fact that chassis and hull were especially designed for the particular vehicle permitted, in some cases, mounting the shock absorbers farther from the fore and aft centre line of the vehicle. This not only helped control vertical ride under severe conditions of articulation but also controlled side-sway, a very important factor considering the high position of a heavy component such as a gun turret.


SPRING EYE - SECOND LEAF
SHACKLE BOLT
NUT

TIRES

The only way to avoid tire trouble was found to be by specifying tires with adequate load carrying capacity. Otherwise short life and poor flotation would result. R.F. tires were largely used on armoured vehicles. Aside from their value in being able to run flat there was usually the added advantage that a spare was not required. However R.F. tires, size for size do not have the same load carrying abilit, as pneumatics. Also they increase considerably the unsprung weight of a vehicle.

ELECTRICAL

A 12 volt system has proved most satisfactory. It permitted the operation of W/T equipment off the vehicle electrical system as well as providing greater power for starting. It was found necessary, in order to provide an adequate electrical system, to specify generators of 50-55 amp. capacity and batteries rated at at least 120 amp. hours. A battery isolation switch in the main battery cable was provided on all Armoured Vehicles. Approved bonding and suppression to permit W/T operation were provided.

Exterior lighting was always in accordance with Specification O.a. 62 to provide blackout type headlamp, clearance lamps and axle pot lamp. Interior lights were provided in accordance with the requirements of the vehicle occupants to permit map reading, etc. White or aluminum paint for interiors made the best use of available light.

STEERING

As in other vehicle components, in steering a combination of comfortable operation and ruggedness was required. Careful attention to steering geometry, wheel balance, etc. were found to be essential. In some cases a steering shock absorber was advantageous in reducing steering wheel kick.

WADING AND ARTICIZATION

Both Wade-Proofing and Arctic-Proofing were found to be applicable for Armoured Wheeled Vehicles on the basis developed for M.T. It was intended, however, that for any future design the hull itself would be watertight thus protecting both engine and crew. For the Universal and Windsor Carriers wading was carried out by sealing the hull thus protecting all chassis components, and by adding shields around the top edges to break the waves. Artic-Proofing was largely carried out on the Carriers by covering the top with a tarpaulin and providing an Evans heater in the rear compartment where it heated engine, batteries, etc.

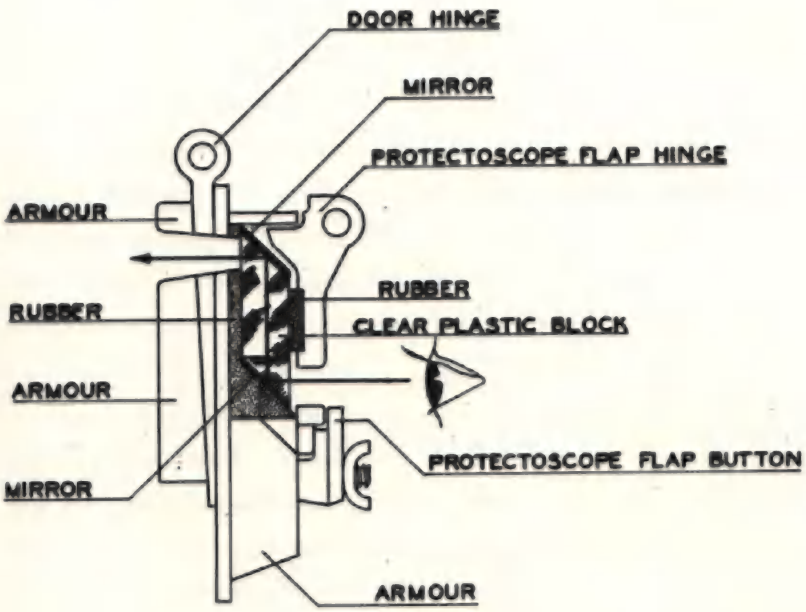
HULL

Hull design had to provide sufficient space for the allotted crew and equipment. Seating arrangements were provided having regard for all possible comfort and the efficient carrying out of his functions by each crew member. Placing and installation of equipment, such as W/T, armament, etc. was taken into account.

When the general outline had been determined the question of armour was the next consideration. The basis of protection is usually specified as immunity against a certain type of attack. As a rule a higher degree of immunity is provided for the front of a vehicle than for the sides or rear.

The thickness of each plate was determined from immunity graphs which show the plate thickness required for any given degree of immunity according to the angle of that plate to the vertical. The closer a plate approaches the vertical the greater the thickness of plate that is required to stop any given attack.

Vision ports had to be provided on a generous basis. We learned that particularly the front port should be as large as possible to permit adequate vision. For the closed down position of the front ports vision was either provided through slots backed up by a heavy laminated glass block or through a protectoscope which gave less restricted vision with more positive protection. However if a protectoscope is hit all vision is cut off. With regard to forward vision provision was made to permit the driver to get his eyes as close to the front port as possible to facilitate "closed down" driving. Removable windshields with electric defrosters proved useful.



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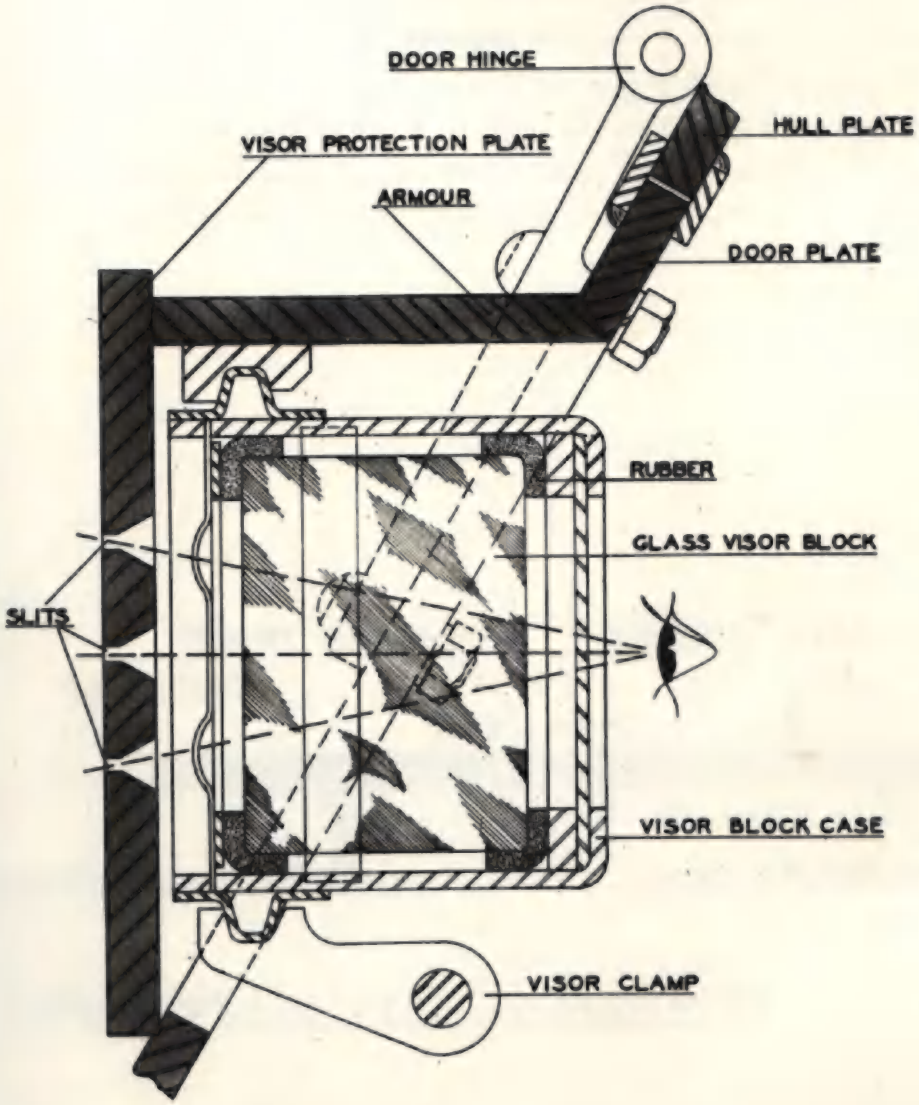
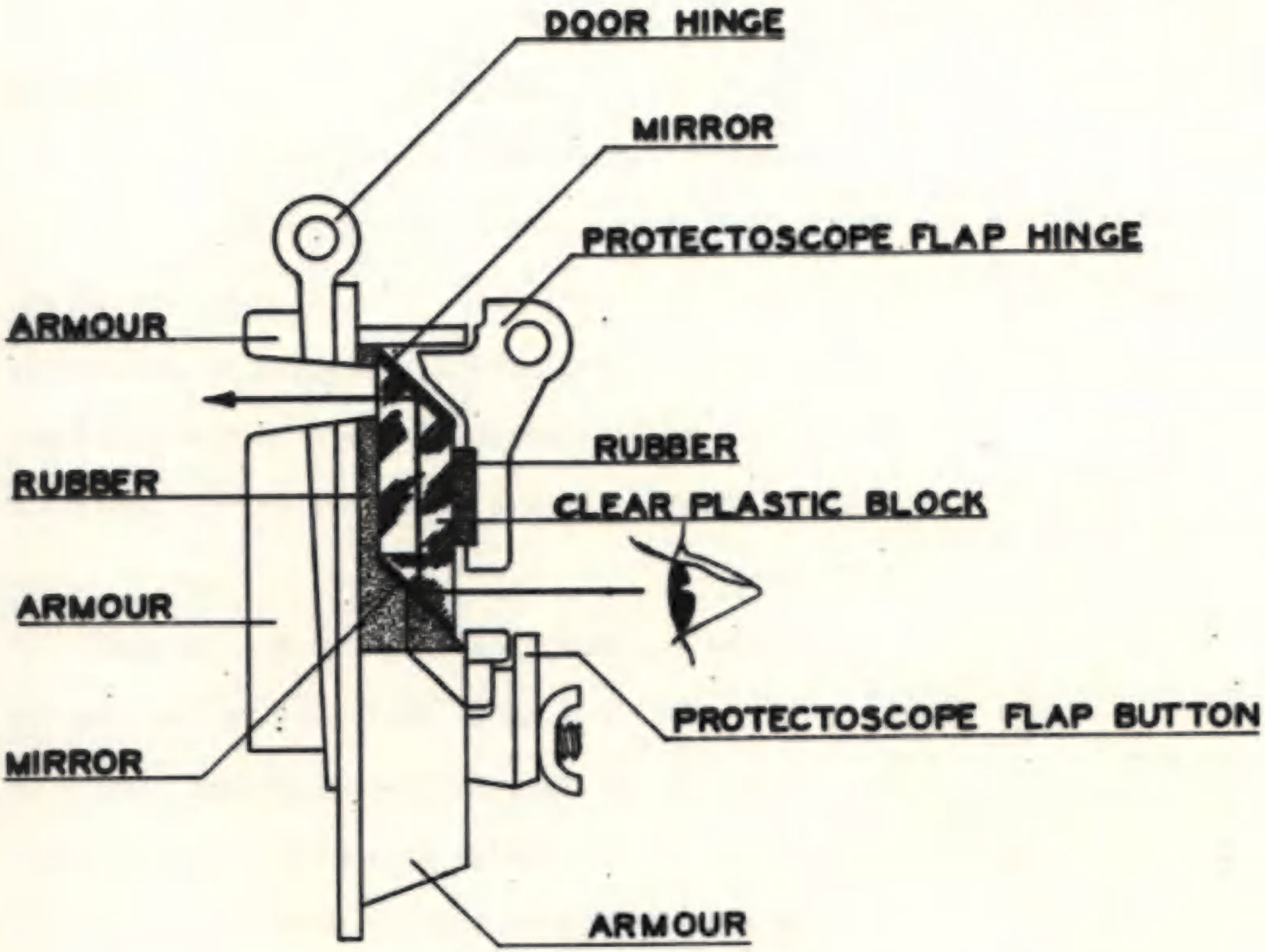


WINDOW VISOR



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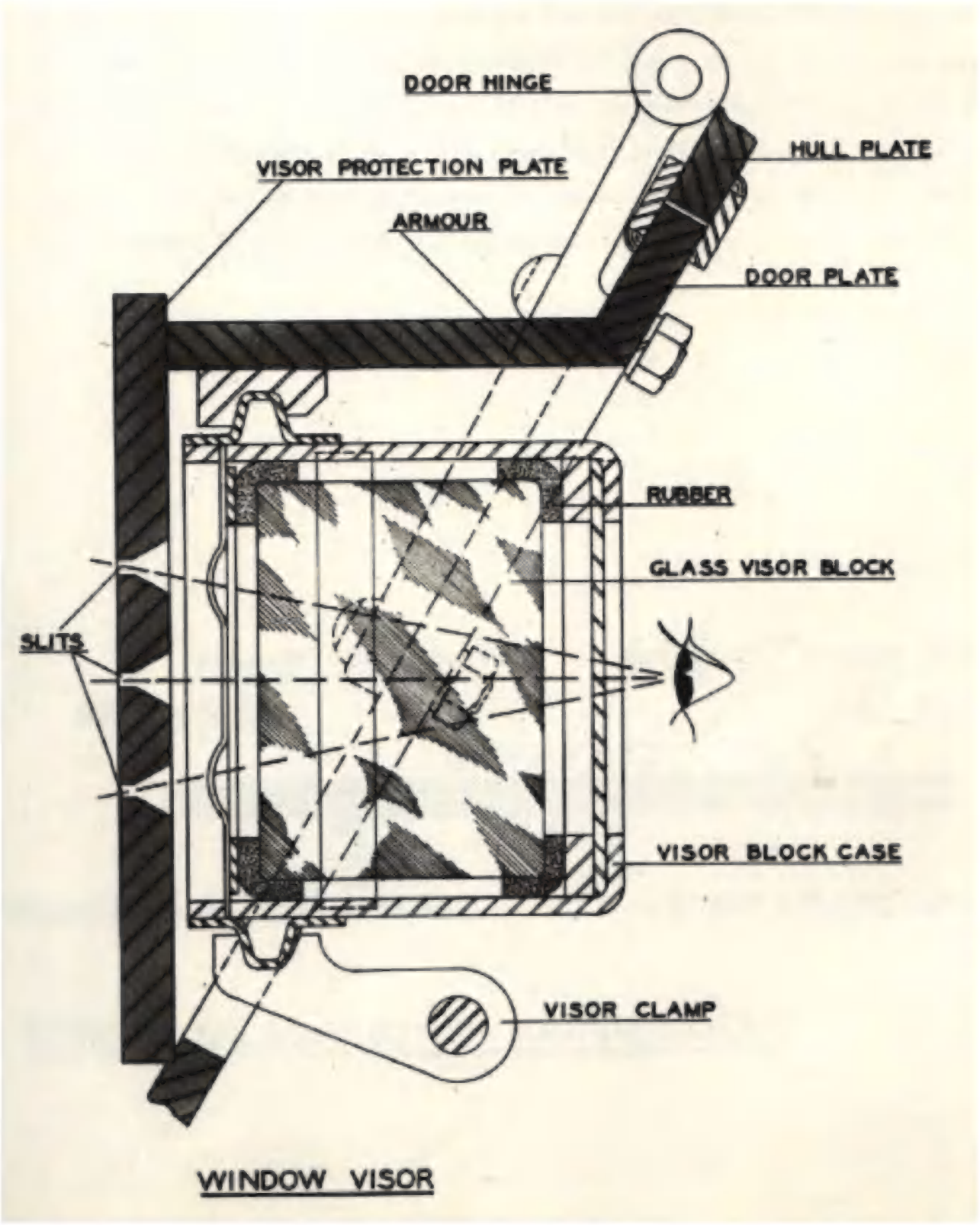


WINDOW VISOR

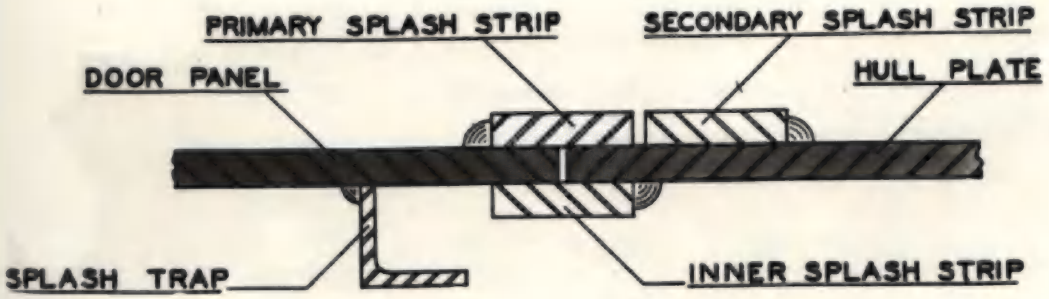
While in the closed types of vehicles entrance and exit was usually provided for via roof hatches it was found advisable to also provide escape doors in the sides.

It was never considered feasible, from the weight standpoint, to protect the tires with armour plate but an attempt was always made to carry the armour plate down as far as possible to protect the chassis components. Gas tanks were always protected by armour plate.

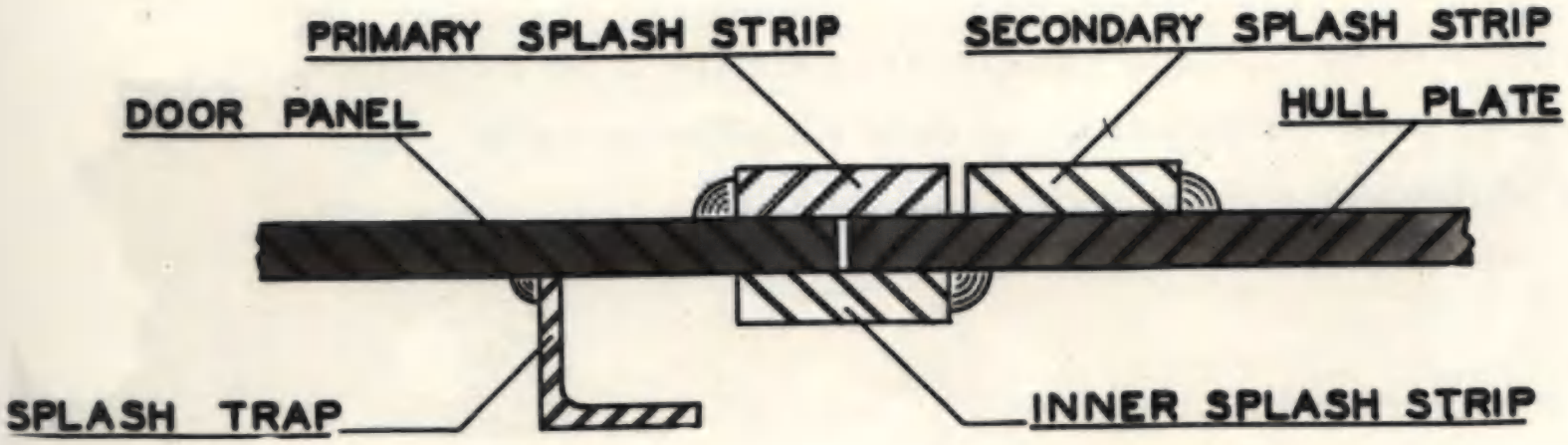
Hulls of a welded construction were found to be preferable to rivetted as there was always a danger of rivets coming loose under attack and hitting the vehicle occupants as "secondary projectiles". The same thing held in using bolts through the hull plates for attachment of hinges, fitments, etc. Where bolts were used it was found advisable to weld the bolt head to the hull plate and the nut to the bolt and hull plate. A small guard over the inner end of the bolt also proved a useful precaution.

SPLASH STRIPS

When a lead bullet hits armour plate (or any other sufficiently hard surface) the lead becomes molten and flows along the plate. This molten lead will enter the crack of a door or a port and do considerable damage to the occupants of the vehicle. To prevent this splash strips were provided. A splash strip usually about 1" wide x 6 mm thick was welded to the outside of the door so that it covered the crack. This was known as a primary splash strip. A second similar strip was welded to the hull plates parallel to the primary strip and separated from it by about 1/16 of an inch. This was known as a secondary splash strip. This strip stopped any splash getting under the primary strip except by a direct hit between the primary and secondary strips. A further similar strip was welded to the hull plates on the inside to cover the crack between the door and hull plates. To finally trap the splash a formed sheet metal strip was welded to the door to form a trap for any splash which came out between the inner splash strip and the door plate. Similar provision was made for vision ports. Firing trials with heavy paper placed around the door openings were always carried out to prove any splash strip design. The door cracks were held to about 1/32 and the primary splash strips flat to the hull within about .015".



TYPICAL SPLASH STRIP ARRANGEMENT



TYPICAL SPLASH STRIP ARRANGEMENT

STOWAGE

The development of stowage accommodation in an Armoured Fighting Vehicle entailed a comprehensive study of the vehicle in relation to the armament, ammunition, personnel and variety of Ordnance and vehicle equipment specified to be carried in the vehicle.

Armament and equipment generally that must be readily accessible to the crew were distributed throughout the vehicle in positions adjacent to the crew member who would normally operate or use this equipment. All other stores were carried in Stowage bins in or on the exterior of the vehicle. Obviously the first stage in development was to obtain sample pieces of all Ordnance and vehicle equipment, having scale wooden mock-ups made of the heavier weapons for ease of handling. Where equipment was to be mounted on hull side panels and/or turret where clearances must be considered, it proved to be a decided advantage to have a scale mock-up of the hull made up in wood, including engine enclosure, fenders, crew and driver's seats and any other interior or exterior fitments pertaining to the vehicle. Where numerous small articles were located in one area, it was a simple matter to assemble such items on a Stowage panel which could be bolted to the hull plate. The above procedure facilitated design and positioning of stowage brackets, bins, etc. thereby permitting to a great extent the finalization of stowage accommodation prior to their installation on a steel pilot hull.

Weights of materials used in the construction of bins, etc. were of course an all important item and every precaution was taken to design these fitments to combine lightness and strength. This was obtained in some instances by the use of moulded plywood. Magnetic compass brackets and binnacles have been successfully made from moulded plywood.

CONCLUSION

While this summary, in some instances, may seem to verge on the elementary and self evident, and while some of it may seem somewhat theoretical it is based on our actual experiences. The first model of the Ford Scout Car (The Lynx I), for instance, was considered to be a reasonably robust vehicle when the pilots were built. When this vehicle got into production and production vehicles were exposed to the rigors of army service it was found sufficiently unreliable to warrant stopping production. A general strengthening of the chassis components, with no radical change, was found to be sufficient to make it a definitely satisfactory vehicle. The G.M. Armoured Car was generally reliable but lacked acceleration. The G.M. Reconnaissance Car was generally satisfactory although some improvements were necessary to the design as incorporated in the first pilots, to make it able to withstand the rigorous service for which it was required. The G.M. Armoured Truck, which was designed after we had learned some of these lessons, entered production with very few modifications and has proven satisfactory both as to performance and reliability.

NOTE:- During the war a Weekly Progress Report was made by D.A.D. on projects in hand. This information has since been extracted and copied in grouped form for each project and it is suggested that this data be consulted for additional information, if required.

FINAL DEVELOPMENT TRENDS

Towards the end of the War in Europe we worked on two vehicles which only progressed to the pilot stage. These vehicles were known as Universal Scout Car and Caplad.

UNIVERSAL SCOUT CAR

The Universal Scout Car was based on a general design provided by Director of Tank Design, Ministry of Supply in England as an ideal vehicle for scouting and reconnaissance work. This was a small, low, three man vehicle designed to have speed, performance and manoeuvrability of a very high order. While the gross weight of the vehicle was estimated at about 10,000 pounds we were planning on using either a newly developed high powered Ford engine or a Dodge engine, either of which would develop approximately 120 B.H.P. The engine was mounted in the rear. Both synchro-mesh and automatic transmissions were considered. A special transfer case was developed for this vehicle which incorporated a reverse gear so that the full range of forward transmission speeds was available in reverse. Four wheel independent springing was used along with large aeroplane type direct acting shock absorbers.

In this vehicle the hull and frame were a unit so that the frame members were actually mounted above the hull floor, thus lowering the vehicle considerably as all the crew seats could be mounted level with the bottom of the frame. The entire hull, including the engine compartment was made as an enclosed unit very similar in principle to a boat, with a sheet metal bulkhead between engine and crew compartments. Thus the engine, transmission, transfer case and axles were mounted on the floor of the hull, with only the axle shafts passing through the sides of the hull. This design afforded the maximum protection to chassis components as well as making wading a very simple matter.

This vehicle, with its very low centre of gravity, independent wheel suspension and large shock absorbers had remarkable stability even in short fast turns. The performance and manoeuvrability were also exceptionally good.

Files Series

D.M.S. 141-14

Photo File A-8

Drawing Schedule 20064

CAPLAD

The Caplad hull design was based on a U.K. design for a rear engined, all purpose armoured vehicle. The roles envisaged were Command, Armoured Lorry, Personnel, Light Aid Detachment, Armoured Ambulance, Demolition and Compressor Vehicle.

The hull design was generally similar to the Armoured Car (Fox I) without the turret. It developed however that with the wheelbase held to 101" and the width extended even to 90 inches there was not sufficient space to properly fulfil the required roles. The sloping sides and driveshaft floor tunnels cut up the available space badly. A study of the actual pilot built in U.K. concurrently with our development was carried out by the various interested Army Branches in U.K. and it was decided that the vehicle would not satisfy any of the requirements and it was therefore dropped.

While we had been following U.K. design for the hull we developed the chassis in Canada. The first major point on which we settled was to eliminate the chassis frame and mount all chassis components directly to the hull in which provision was made to carry this load. The main feature of the hull in this connection was two continuous full length longitudinal members which closely resembled the side rails of a chassis frame. This design of course lowered the centre of gravity by the depth of a frame.

The other outstanding feature of this vehicle was the springing. The springs were long and wide, giving a remarkably soft yet stable ride. The front springs were 45½" long by 2½" wide. The rear springs were 50" long by 2½" wide. These springs also were fitted with "Woodhead" trunnions.

The new design features outlined above all showed indications of definite merit and would be well worth consideration in developing any future vehicles.

Files Series

D.M.S. 141-15

Photo File A-10.

UNIVERSAL SCOUT CAR

CAPLAD

CARRIER, UNIVERSAL
NO. 2 MK. II

CARRIER, UNIVERSAL NO. 2 MK II*

GENERAL:

An OPEN TYPE LIGHT ARMOURED FULLY TRACKED VEHICLE for transporting FOUR TO SIX MEN ACROSS DIFFICULT TERRAIN UNDER SMALL ARMS FIRE.

Accommodation for DRIVER and MATE IN FRONT COMPARTMENT. Space for TWO MEN on each side of engine enclosure in rear compartment. PROTECTION all around AGAINST .303 attack with 50% safety factor in front plates. Protection head or shoulder high for driver and mate depending on seat positions. Head high protection for men in rear by crouching, no overhead protection. Driver's vision through slit.

SPECIAL ROLES produced included:

CARRIER 2 PDR EQUIPPED (mounting a 2 pdr. gun)
CARRIER 3" MORTAR (stowage for 3" mortar)

All vehicles suitable for installation of Ronson Flame Thrower.

STOWAGE

Armament normally carried consists of Bren M.G., Thompson S.M.G., Sten Carbine, Boys A/T Rifle (later replaced by P.I.A.T. weapon), the 4" Smoke Discharger or the 2" Mortar and 2 Rifles G.S. "Ready position" brackets, clips, etc. are provided in front compartment for the Bren M.G. and the Boys A/T Rifle (or P.I.A.T. on later vehicles) in addition to "Stowed Position" accommodation in rear compartment. Ammunition for all weapons is stowed adjacent to users in front and rear compartments. Installation facilities are provided in the rear compartment for the No. 19 W/T set and charging unit, with W/T portable batteries carried in bin in front compartment. Personnel equipment is stowed in large exterior bin and vehicle Tools & Equipment in front compartment floor bin and in bins over gas tanks are on floor in rear compartment. Spare bogie wheel, tow chains, picks, etc. are mounted on exterior front and rear of vehicle.

NOTE: The MK II Carrier differed from the MK I only in the stowage accommodation. The MK II incorporated the "Welsh Guard Stowage".

VEHICLE PERFORMANCE

POWER/WEIGHT - 17 H.P per short ton

GRADEABILITY - Low gear Theoretical - 54%
Actual - 50%
High gear Theoretical - 6%

PERFORMANCE

Governed speed - 29 to 32 M.P.H.

¼ Mile Run	Time	Average Speed	Speed at end of run
Standing start	43 sec.		30 M.P.H.
Flying start	29 sec.		31.5 M.P.H.

40 Mile Cross Country -

Speed - 12.1 M.P.H. average.

(Fuel consumption - 4.2 m.p.g.)
(Oil consumption - 350 m.p.g.)

100 Mile Run -

Speed - 31.25 M.P.H. average

(Fuel consumption - 8 m.p.g.)
(Oil consumption - 400 m.p.g.)

CRUISING RANGE - Highway 160 miles
Cross Country - 76 miles

STABILIZED TEMPERATURE DIFFERENTIALS

	Max. Torque at 2150 R.P.M.	Peak B.H.P. at 3200 R.P.M.
Water	122°F	113°F
Engine oil	122°F	131°F
Trans. oil	137°F	114°F
Diff. oil	179°F	132°F

Note: Cooling Trial Figures arrived at by Towed Load Method.

BRAKE EFFICIENCY

	Distance to Stop	Ft. Per Sec. Per Sec.
10 M.P.H. Hand	25 feet	17 ft/sec/sec
30 M.P.H. Foot	71 feet	13 ft/sec/sec

FORDING DEPTH - 20"

DITCH CROSSING - span crossed - 5' 3"

VERTICAL WALL CLIMBING - 28½"

TILTING ANGLES -

Vehicle facing up, satisfactory engine performance up to 38° angle

Vehicle facing down, satisfactory engine performance up to 30° angle

Across slope at 15° angle L & R side satisfactory.

ANGLE OF OVERTURN - 46°

VEHICLE DATA

MANUFACTURER - Ford Motor Co. of Canada, Windsor

HULL MANUFACTURER - Canadian Bridge Co.

MAXIMUM GROSS WEIGHT - 9885 pounds

LOAD CARRYING CAPACITY - 2085 pounds

OVERALL LENGTH - 148"
WIDTH - 83"
HEIGHT - 65"

TURNING CIRCLE L.H. - 17' 4"
TURNING CIRCLE R.H. - 17' 4"

TRACKBASE - 62.5"

FINAL DRIVE - Through full floating rear axle, sprockets and tracks.
Ratio 5.83:1

DRIVE - Male and female gear coupling between main transmission shaft and rear axle pinion shaft. This coupling also incorporates the speedometer drive gears.

BRAKES -

SERVICE - Internal expanding in rear drums. (Mechanical)

PARKING - Same as service.
Through Rods and Hand Lever
Drum size 14"
Lining size 3/8" x 2 3/4" x 12 1/4"
(2 of above in each drum)

Total brake area 135 sq. in.

ENGINE - Ford V8 90° L. Head
Displacement 221 cu. in.
Peak B.H.P. 85 at 3600 R.P.M.
Max. Gross Torque 156 ft. lbs. at 2150 R.P.M.

lubrication - Pressure 40 lbs. at 2000 R.P.M.
Capacity of system - 9 1/4 Pts.
Pump - Bevel gear 1.57 gal. per min at 2000 R.P.M.
Oil Cooler - Tube and circular fin in front of radiator. Cooling effect approximately 25°F

FUEL SYSTEM -

Carburetor - Down draft Zenith
Governor - On side of carburetor set at 2900 to 3200 R.P.M. 29 to 32 M.P.H.
Pump - Diaphragm, drive off camshaft
Tanks - 2 - capacity 10 imp. gal. each made of terne plated #18 ga. sheet metal.

HULL - Construction - Riveted
Material - Bullet-proof steel

FRAME - Engine bearer channels only.

SUSPENSION - Of the "slow motion" type, consisting of front or main bogie assembly, and rear bogie assembly, a track adjusting wheel is mounted at the front of the hull.

Track guide roller is mounted on top of front bogie assembly.
Bogie wheels - 3 on each side,
Diameter 20" Solid rubber tires

CLUTCH - Semi-centrifugal dry single 11" plate
Facing - woven
Area - 123.7 sq. ins.

COOLING SYSTEM -

Circulating liquid pressure type
Centrifugal type pumps (2) driven by two V belts from crankshaft.
Capacity 37.5 g.p.m. at 3000 R.P.M. (each pump)
Total capacity of system - 5 gals.
Radiator - Plate tube and fin.
Size of core - 19 3/4" wide x 22 1/2" high x 2 3/4" thick.
Mounted on front of engine.
Thermostat - type - Bellows
location - cylinder heads.

ELECTRICAL SYSTEM -

Generator - 6 volt, three brush type with adjustable third brush
Drive - 2 V fan belts from fan driving pulley on front end of crankshaft.
Current output at 2300 R.P.M. is 23 amps.
Lights - Including Blackout Equipment in accordance with Spec. O.A. 62.

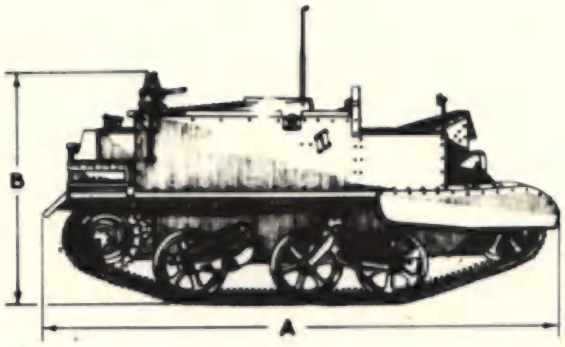
STARTER - Make - Electric Auto Lite
Drive - Bendix Solonoid Control
Number of teeth in flywheel - 112
Number of teeth in starter pinion - 10
Current (maximum) - 560 amps.
Average Torque output at 35 R.P.M - 15 ft. lbs.

STEERING - Gear of the cam and lever design. Steering operation involves two entirely separate stages of actuation which are referred to as "initial" and "second" stages. The initial stage of operation involves lateral or sidewise movement of steering cross tube on which are mounted the front bogie wheel assemblies (one at either end) with a resultant change in direction of vehicle. Control of cross tube is through steering wheel and linkage to cam and rollers on cross tube. The second stage of operation involves actuating of brakes against the drums of the track driving sprockets. By the braking of one sprocket, the vehicle is caused to perform a "skid turn". This stage is also controlled by the movement of the steering wheel, however, the brakes are not applied until after the "initial" stage has taken place.

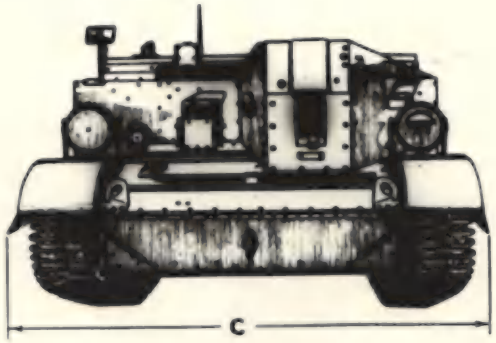
TRANSMISSION - Make - Ford
Type - Spur gear
Forward gears - 4
Reverse - 1

Ratios -	4th.	1 to 1
	3rd.	1.69 to 1
	2nd.	3. to 1
	1st.	6 to 1
	Reverse	[illegible] to 1

FINAL DRIVE RATIOS -	4th.	5.83 to 1
	3rd.	9.85 to 1
	2nd.	18.0 to 1
	1st.	37.3 to 1
	Reverse	45.6 to 1



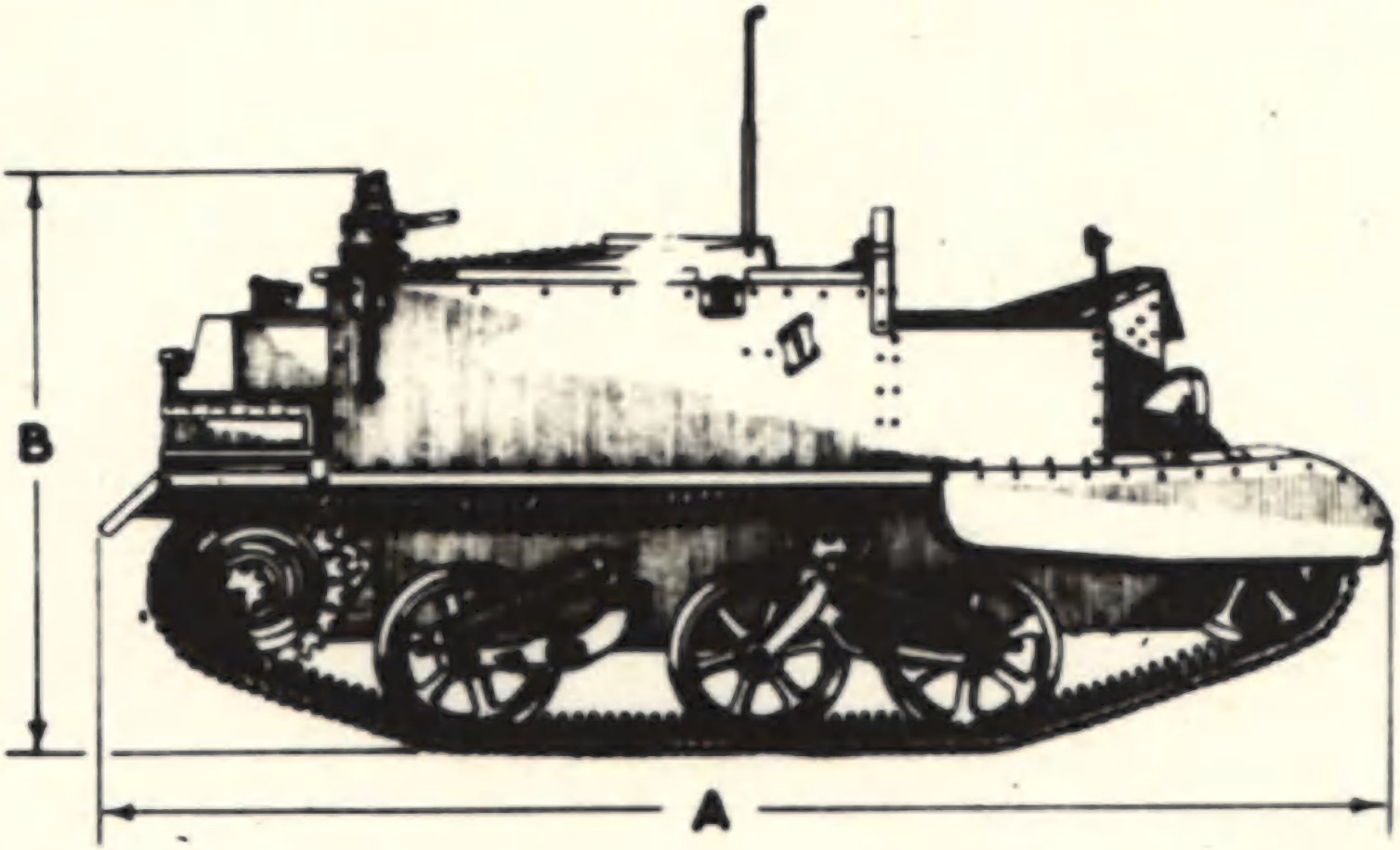
(SIDE VIEW)



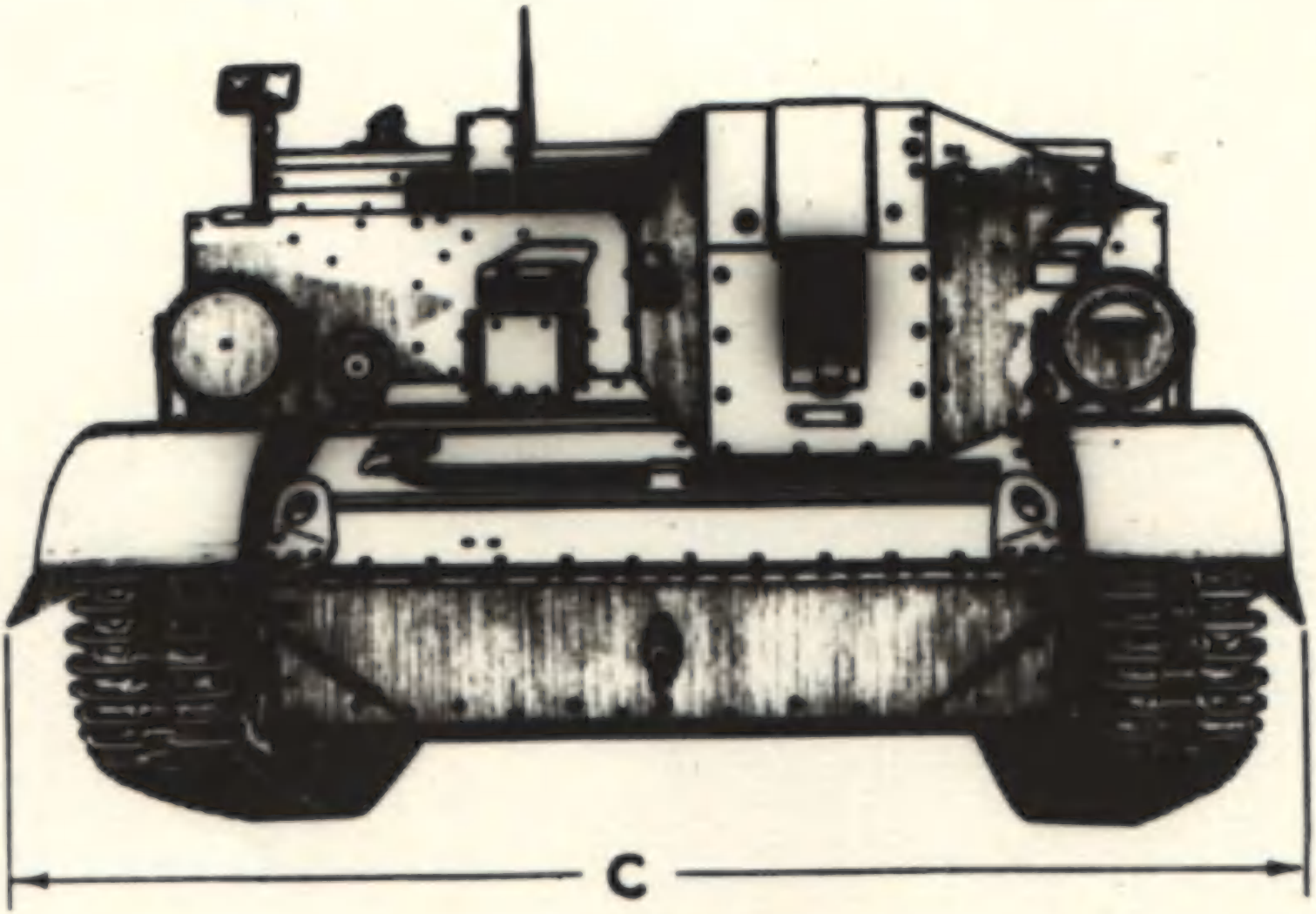
(FRONT VIEW)

DIMENSIONS

A - Overall Length	148"
B - Overall Height	63"
C - Overall Width	83"



(SIDE VIEW)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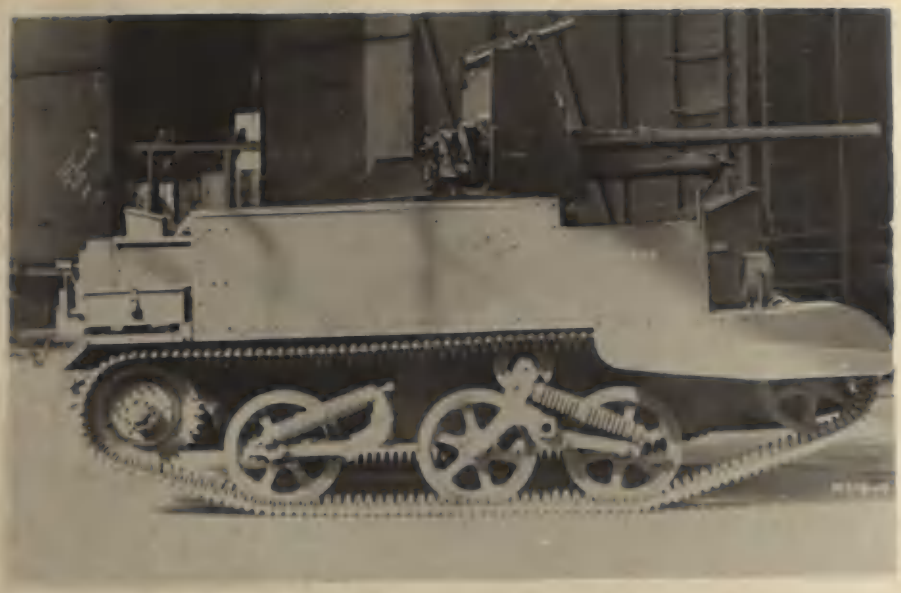
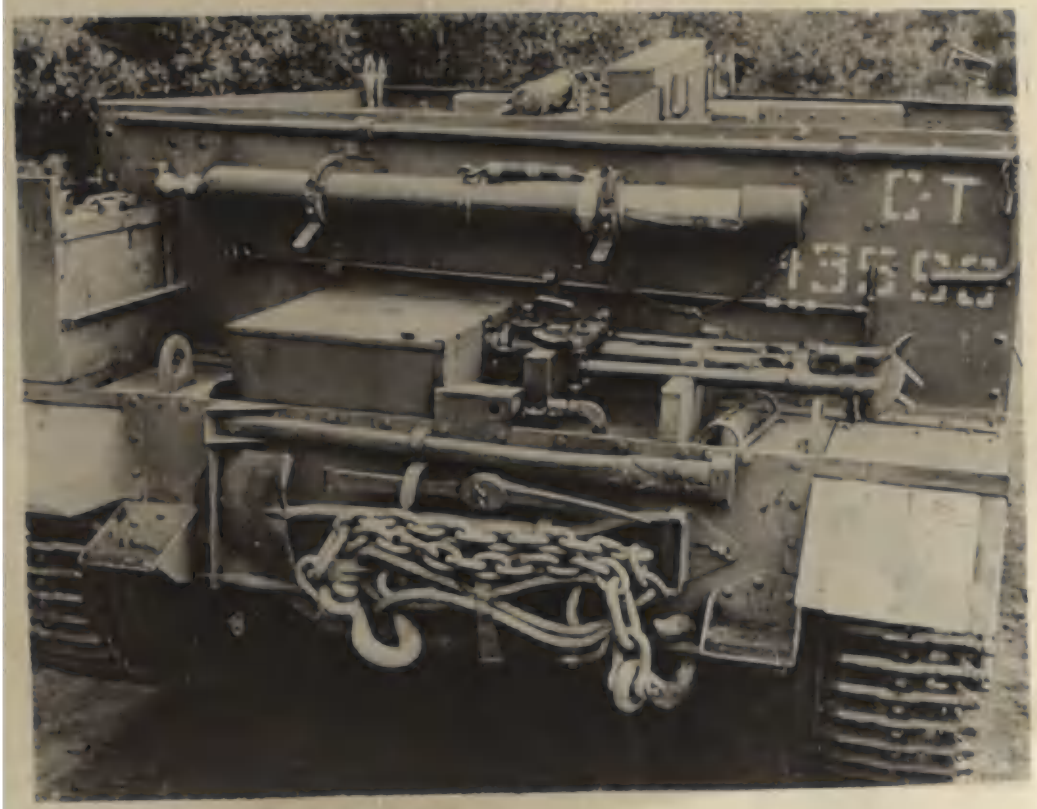
WEIGHTS

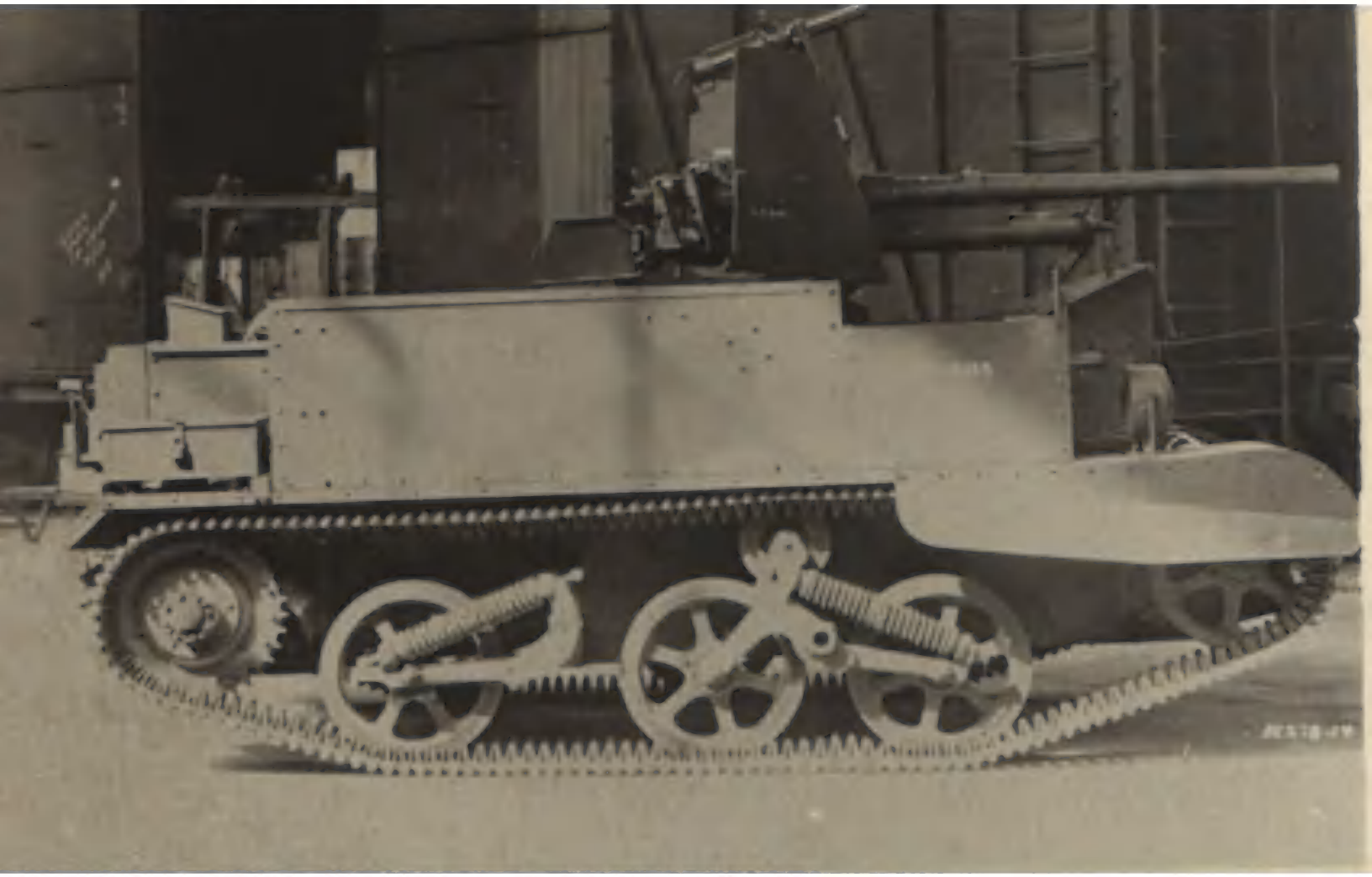
	Front	Rear	Total
Curb Weight (Vehicle complete with maximum amounts of gasoline, oil and water and with vehicle tools and equipment in accordance with List "A" of Table No. 1001)			8105
Stowed Weight (Vehicle complete with maximum amounts of gasoline, oil and water, also vehicle tools and equipment and Ordnance equipment in accordance with Stowage List No. 1502)			8775
Gross Weight (Vehicle complete as described in "Stowed" Weight above but with crew of 5 men, @ 215 lbs. each, including driver)	5825	4025	9850

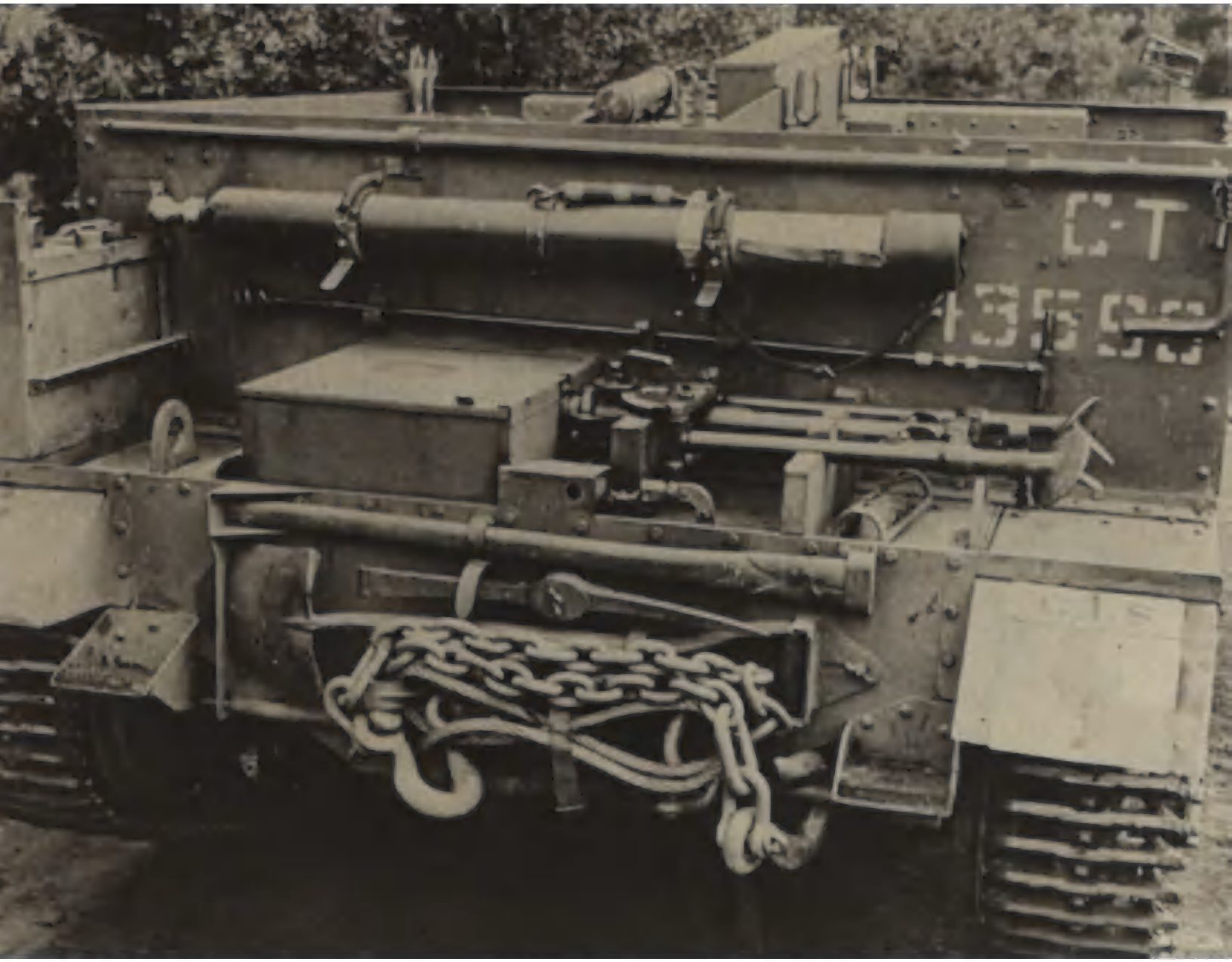


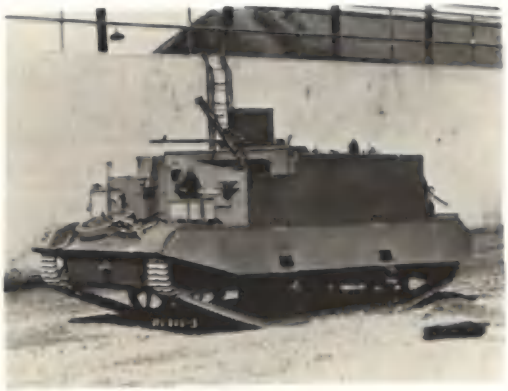
SIDE VIEW CARRIER
2 PDR. EQUIPPED.



REAR VIEW CARRIER (MK I)
3" MORTAR MOUNTING

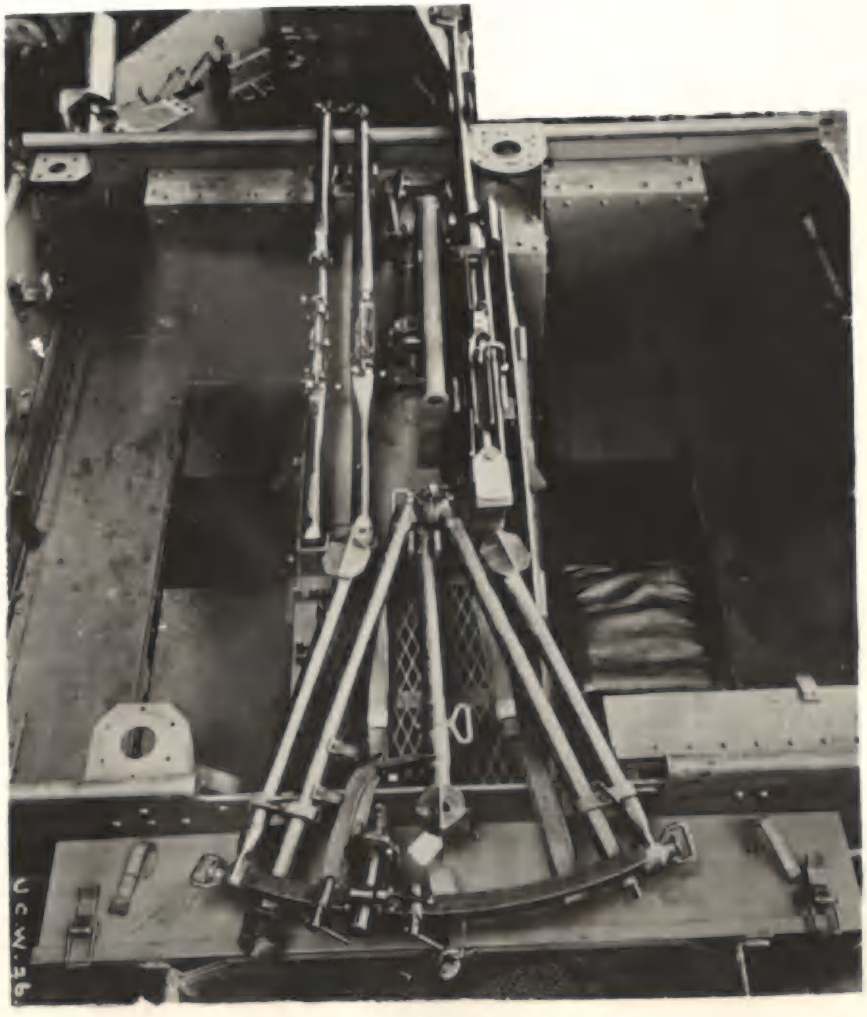




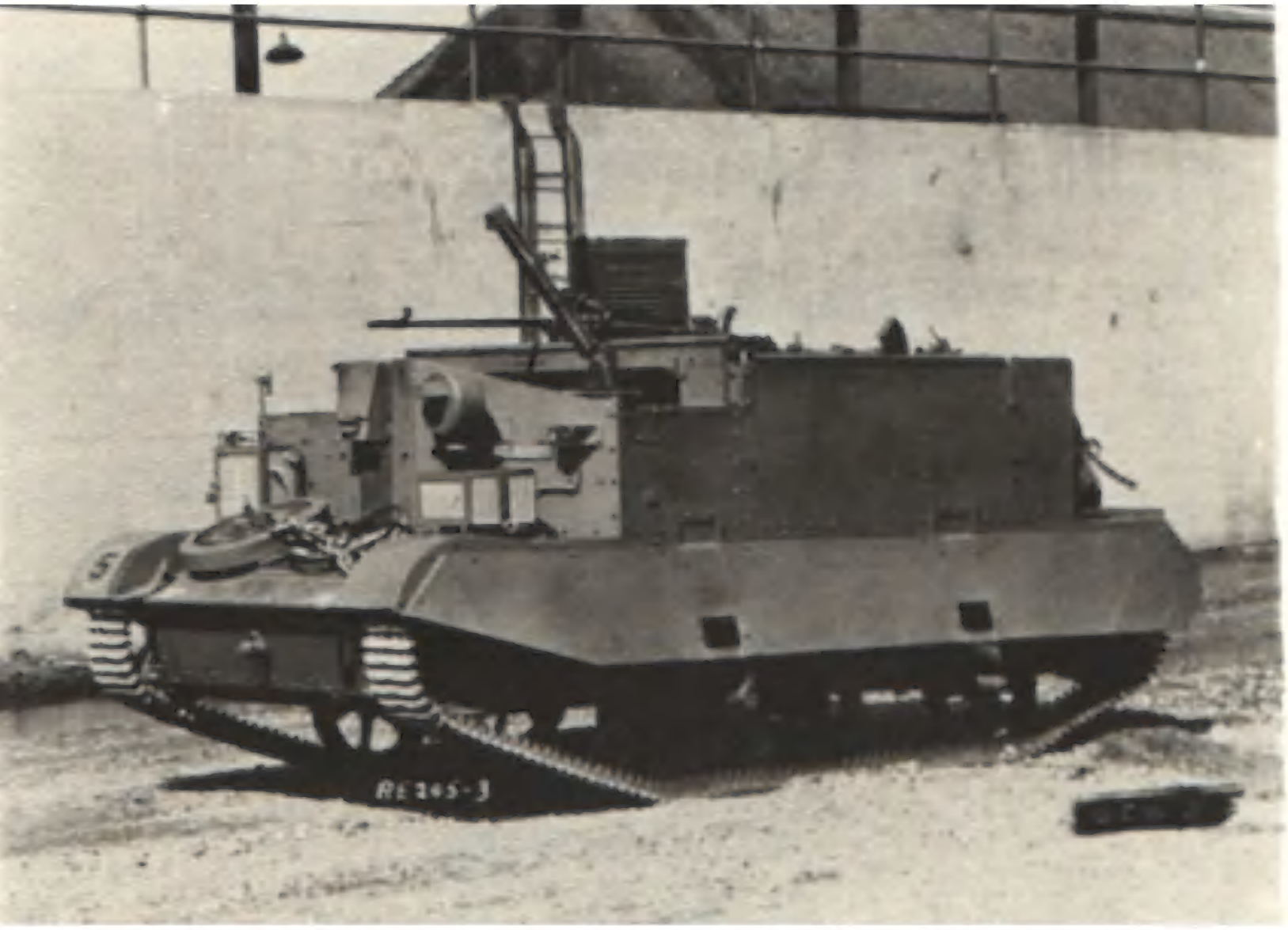


FRONT QUARTER VIEW

FRONT TOP VIEW



TOP VIEW SHOWING REAR COMPARTMENT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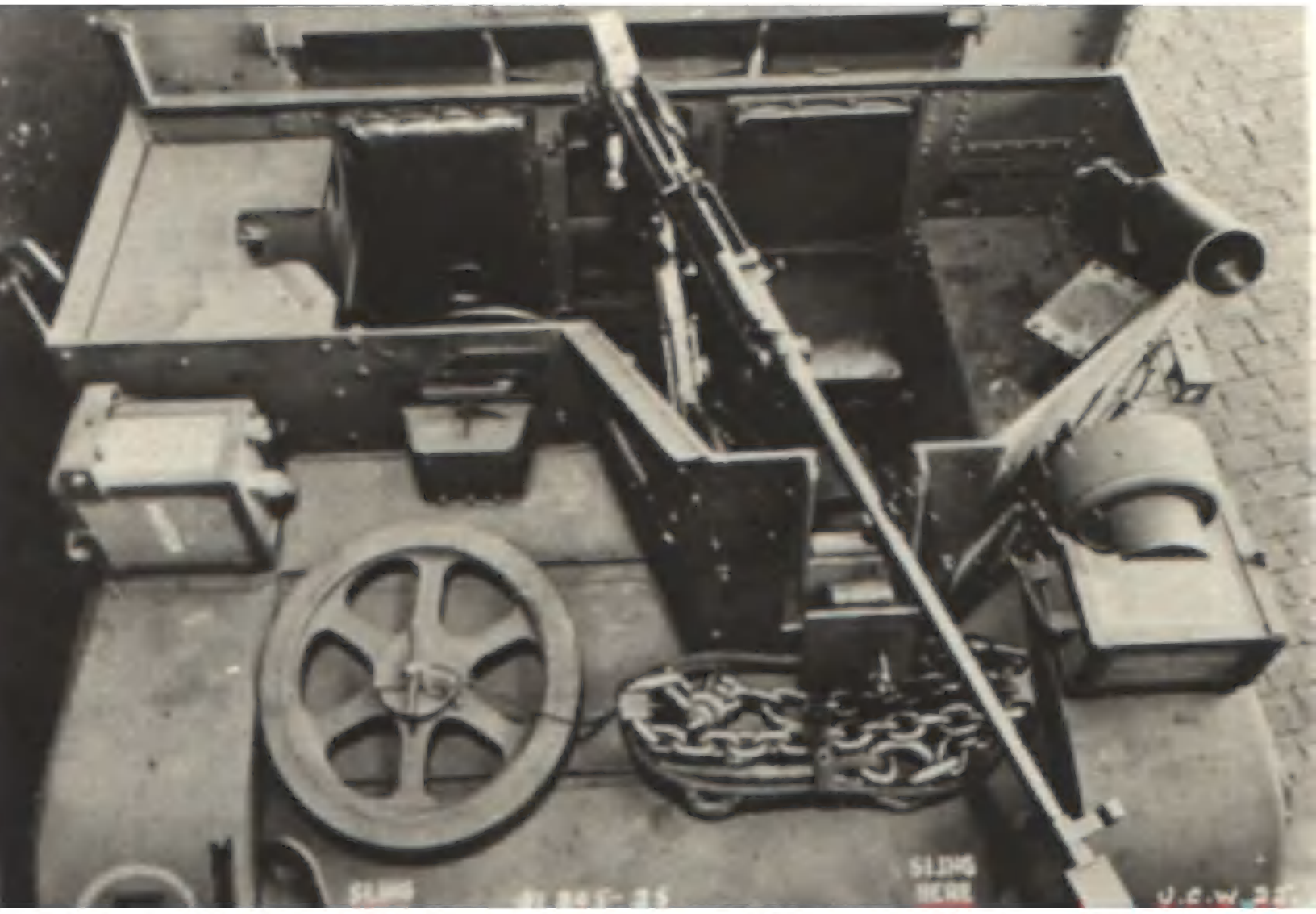
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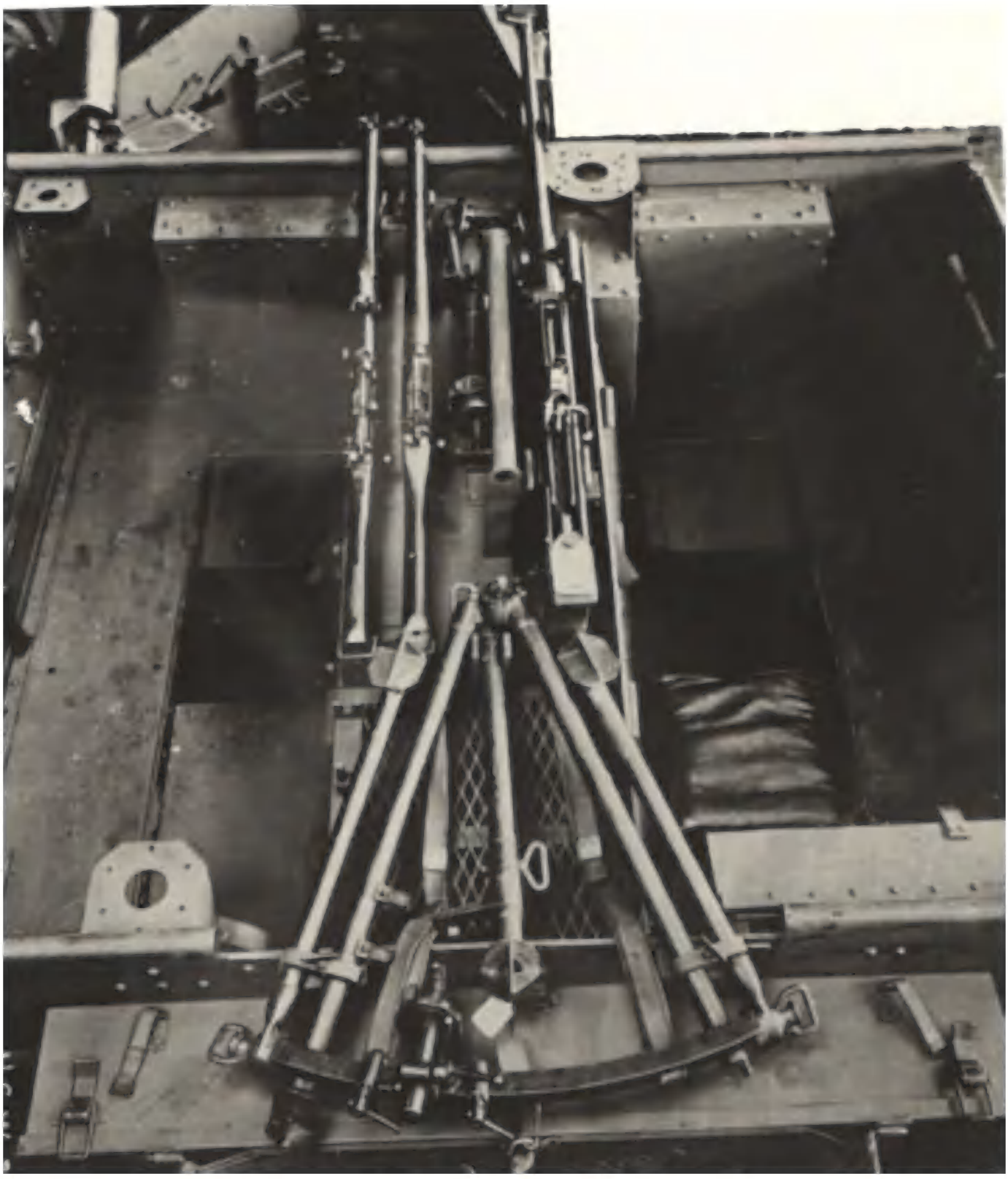


REFERENCES

DAD Specification O.A. 201-A

Ford Operator's Manual - Publication number UC-OM1

Ford Maintenance Manual - Publication number UC-F2

Ford Operating Instructions and Maintenance Manual - Publication number UC-F1

Ford Spare Parts List - Publication number FUC-03

Files Series

D.M.S.-141-5-1,2,3,4, etc.
D.N.D.-H.Q.S. 33-52-28(H.Q.466-51-69-1)
M.O.S.-D.T.D. 300/OSEAS/117
300/OSEAS/123
300/OSEAS/160
300/OSEAS/166
300/OSEAS/272
D.M.S.-D.A.D. Photo File No. A-1.

D.T.D. Field Trial Reports:

No. 200 - Performance Trials of Canadian and British Production Universal Carrier - 4/12/41.

No. 329 - Bogie Wheel Tires for Universal Carriers (Canadian Tires) - 12/5/42.

No. 645 - Comparative Trials on Canadian Carriers - 21/4/43.

No. 1256- Brake Drum Sealing on Universal Carrier (Canadian Method of Sealing) - 29/4/44.

F.T.753/1 - Performance and Reliability Tests - 20/7/43.

No. 1175 - Kapok Flotation Brackets Fitted to Universal Carriers, MK I (Includes fitting to Canadian Universal Carrier) 2/3/44.

A.E.D.B. Experimental Engineering Reports:

E38 - Bogie Spring
E62 - 85 H.P. vs. 95 H.P. Engines
E64 - 10" All Steel Experimental Idler Wheel
E100- U.C. Brake Seals

A.E.D.B. Experimental Engineering Reports (cont'd):

E102 - Sandguards
E103 - Loyd Non-Skid Attachments
E109 - Water Drainage
E114 - Russian Non-Skid Track
E121 - Flanged Sprocket (Australian)
E125 - Brake Seal
E126 - 2" Bomb Thrower
E181 - Performance Test 85 H.P. vs 95 H.P. Engines
E187 - Cooling Differential - 85 H.P. Engine
E214 - Steel Bogie Wheel
E220 - Brake Seals
E232 - Bren Gun Spare Barrel Bin
E274 - Oversize Sprockets
E327 - Disc Type Bogie Wheel
E333)- Synthetic Tires on Bogie Wheels
E341)
E343 - Clutch Control Springs
E354 - Bogie Spring Guide Rod Removing Tool
E395 - Rolling Resistance
E429 - Smoke Emitter Universal Carrier (6 Volt 3 Piston Pump)
E441 - Synthetic Bogie Tires
E461 - Performance Trials (Welsh Guard)
E530 - Turning Circle of Welsh Guard Carrier

Production Orders:

Canadian	British
CD 73	WSL 72-2
CD 259	WSL 72-7
CD 422	S/M 1282 WSL 72-250
CD 423	S/M 1301 WSL 72-251
CD 445	S/M 1026
CD 58	S/M 1447
CD 213	S/M 1440
CD 1518	205-15
CD 1555	
CD 435	
CD 537	
CD 2609 (Welsh Guards)	
CD 213 (2 Pdr.)	
CD 213 (3" Mortars)	
CD 1565 (3" Mortars)	
CD 1708 (3" Mortars)	

Approx. Price per unit - less equipment supplied by Ordnance - $3,000.

CARRIER, WINDSOR, MK.I

GENERAL

An OPEN type LIGHT ARMOURED FULLY TRACKED VEHICLE for transporting FIVE OR MORE MEN and TOWING A GUN across DIFFICULT TERRAIN UNDER SMALL ARMS FIRE.

Accommodation for DRIVER AND MATE IN FRONT COMPARTMENT. Removable seats for THREE MEN beside engine IN REAR compartment. CAN ACCOMMODATE MORE without seats. PROTECTION all around FROM .303 attack with 50% safety factors in front plates. Protection head or shoulder high for driver and mate depending on seat positions. Shoulder high protection for men seated in rear. Head high protection by crouching. OVERHEAD PROTECTION FROM WEATHER BY TARPAULIN AND SUPERSTRUCTURE. Driver's vision through slit.

Vehicle equipped for any of following roles:

6 PDR. ANTI-TANK GUN TOWER
6 PDR. ANTI-TANK GUN AMMUNITION CARRIER
4.2 MORTAR PLATOON - SENIOR SECTION COMMANDER'S CARRIER
4.2 MORTAR PLATOON - JUNIOR SECTION COMMANDER'S CARRIER
4.2 MORTAR PLATOON - MORTAR CARRIER (In this role the 4.2 mortar trailer is towed)

STOWAGE

The stowage arrangement of this vehicle such that accommodation is afforded for equipment specified in any one of all five (5) roles. Superstructure and Tarpaulin stowed on rear of all vehicles when not in use. Personnel equipment according to number of crew carried in large interior and/or exterior rear stowage bins. Vehicle tools & equipment in floor bins in front and rear compartments while spare Bogie wheel, Tow cable, picks, etc. are carried in front of the vehicle. A large bin for camouflage nets and miscellaneous equipment is located behind engine enclosure in rear compartment. P.O.W. cans for oil and water on front trackguards. Stowage arrangements peculiar to each role are as follows:

(a) 4.2" Mortar Platoon, Mortar Carrier

Carries 22 rounds 4.2 mortar ammunition on trackguards in rear compartment.

(b) 4.2" Mortar Platoon - Senior Commander's Vehicle

Carries 20 rounds 4.2 mortar ammunition, Sten carbine and 3 rifles G.S. in rear compartment. Bren M.G. and ammunition stowed in front compartment. Provision for installation of a No. 19 or No. 22 W/T set in right hand rear compartment with spares and accessories stowed adjacent to W/T operator. W/T batteries carried in bin to right of driver in front compartment. Telephone loudspeaker control unit with portable batteries stowed in bin at rear of engine enclosure.

(c) 4.2 Mortar Platoon - Junior Commander's Vehicle

Carries 48 rounds 4.2 mortar ammunition in rear compartment and Bren M.G. with ammunition in front compartment.

(d) 6 Pr. A/T Gun Towing Role

Carries 4 boxes 6 Pr. ammunition and gun and detachment stores in boxes in rear compartment. Cleaning rod with brush, sponge and cap mounted on brackets on exterior left side of vehicle. Sten carbine and three rifles G.S. stowed in rear compartment with ammunition stowed adjacent to users. Netting, wire, steel wool garnished is stowed in rear exterior bin.

(e) 6 Pr. Ammunition Carrier Role

Carries 4 boxes 6 Pr. ammunition, one rifle G.S., Sten carbine and 2" mortar plus ammunition in rear compartment. Bren M.G. with ammunition stowed in front compartment. Detachable (spare) wheel and castor trail for 6 pr plus auxiliary shields are carried in rear compartment with main shield supported on brackets on R.H. exterior of vehicle.

NOTE: The Windsor Carrier is essentially the same as the Universal Carrier except that it is longer, has one extra bogie wheel per side and has a more powerful engine and 2 speed rear axle.

VEHICLE PERFORMANCE

POWER/WEIGHT - 16.28 B.H.P. per short ton.

GRADEABILITY -

Gravel slope 1:2.43 - 40% Track slipped
" " 1:2.74 - 37% No slip of track
Speed on grade 1:10 length 515 yards
Standing, start, speed 11.49 M.P.H. - 12.05 M.P.H.
Gears used - 2nd and 3rd
Theoretical - high gear - high axle range - 5.9%
- low gear - low axle range - 70%

PERFORMANCE

Speed - Governed at 29 to 33 M.P.H.

¼ Mile Run	Speed at end of run
Standing start	23.84 m.p.h.
Flying start	30.25 m.p.h.

25 Mile Cross Country Run -

Speed - 10.77 m.p.h. average

(Fuel consumption - 2.44 m.p.g.)
(Oil consumption - negligible)

100 Mile Road Run - Speed - 25.75 m.p.h. average

(Fuel consumption - 6.9 m.p.g.)
(Oil consumption - 800 m.p.g.)

CRUISING RANGE - Cross Country 98 miles
Road 276 miles

STABILIZED TEMPERATURE DIFFERENTIALS

	Max. Torque @ 1850 R.P.M.	Peak B. @ 3200 R
Water out of engine	118°F	85°
Oil out of engine	147°F	132°
Transmission	137°F	102°
Differential (rear axle)	100°F	97°

BRAKE EFFICIENCY

Foot brake - 42%
efficiency (recorded on Tatley meter)
13.5 ft. per sec per sec.

FORDING DEPTH - 48"

RAMP CLEARANCE - Full tracked vehicle

TILTING ANGLES -

Vehicle Facing up. Satisfactory engine performance up to 38°.

Vehicle Facing down. Satisfactory engine performance up to 30°.

Across Slope at 15° Angle R & L. side satisfactory.

VERTICAL WALL CLIMBING - 28½"

ANGLE OF OVERTURN - Left Side up - 45°
Right Side up - 45°

VEHICLE DATA

MANUFACTURER - Ford Motor Co. of Canada

HULL MANUFACTURER - Canadian Bridge Co.

LOAD CARRYING CAPACITY - 2100 lbs.

PERMISSIBLE MAX. GROSS WEIGHT - 12180 lbs.

OVERALL LENGTH - 172.25"
WIDTH - 84"
HEIGHT - 57.25"

TRACK BASE - 62.5"

TURNING CIRCLE - L.H. 22' 3"
TURNING CIRCLE - R.H. 22' 3"

AXLE - REAR - Two speed (controlled from driver's compartment) driving through sprockets to tracks.

DRIVE - Short drive shaft with universal joints (spicer) from transmission to rear axle.

BRAKES - SERVICE - Mechanical internal expanding
Drum diameter - 14"
Lining size - 12½" x 3½" x 3/8"
Total Braking Area - 171.5 sq. in.

PARKING - Same as service. (Control lever between driver's legs.)
Note: See steering for explanation of part brakes play in steering operation.

CLUTCH - Single dry plate semi-centrifugal
Diameter of plate - 11"
Total area of facing - 120.7 sq. in.

COOLING SYSTEM - Circulating liquid pressure type.
Centrifugal type pumps (2) driven by two V belts from pulley on front of crankshaft capacity 37.5 g.p.m. at 3000 R.P.M. (each pump)
Total capacity of system 5½ gal (IMP)
Radiator - late tube and fin mounted on front of engine.

ELECTRICAL SYSTEM -

Generator - 12 volts
Drive (2) V belts driven from front of crankshaft.
Currant output 50 Amps. @ 1200 R.P.M.
Controls Voltage and Current
Battery - (2) 6 volts, total of both 12 volts
Number of cells - 3
Number of plates per cell - 17
Ampere hour capacity 120 amps at 20 Hr. discharge rate.
Total area of plates per battery 1418 sq. in.
Terminal grounded. Negative.
Lights - including blackout in accordance with Spec. O.A. 62
Starter - Sliding Gear
Control - Lever in center of driver's compartment.

VEHICLE DATA (Cont'd)

ENGINE - Ford V8 90° L. head
Displacement - 239 cu. in.
Peak gross B.H.P. 95 @ 3600 R.P.M.
Max. gross torque 178 ft. lbs. @ 1850 R.P.M.
Lubrication, full pressure type spiral gear
pressure - @ 60 lbs. 3000 R.P.M.

FUEL SYSTEM - Carburetor - down draft Holley with accelerating pump.
Fuel tanks (2) total capacity 40 gal. imp.
Fuel pump, driven from camshaft.
Governor set at 30 to 33 M.P.H.

HULL - Rivetted bullet proof steel plates.

FRAME - Engine bearer channels only.

SPRINGS - Spiral springs, incorporated in bogie assemblies.

STEERING - Gear of the cam and lever type. Steering operation involves two entirely separate stages of actuation which are referred to as "initial" and "second" stages. The initial stage of operation involves lateral or sidewise movement of cross tube on which are mounted the front bogie wheel assemblies (one on either end) with a resultant change in director of vehicle.

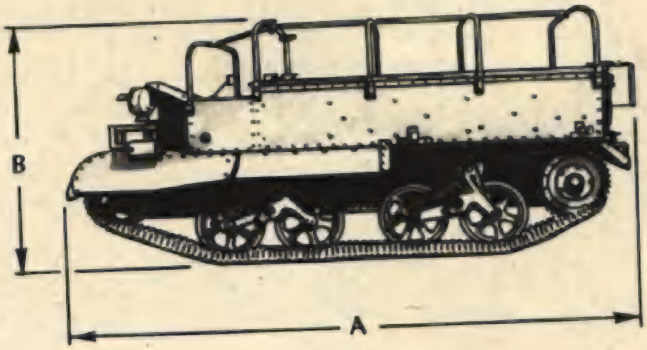
STEERING (cont'd) - Control of cross tube is through steering wheel and linkage to cam and rollers on cross tube. The second stage of operation involves actuating of brakes against the drums of the track driving sprockets. By the braking of one sprocket the vehicle is caused to perform a "skid turn". This stage is also controlled by movement of steering wheel, however, the brakes are not applied until after the "initial" is completed.

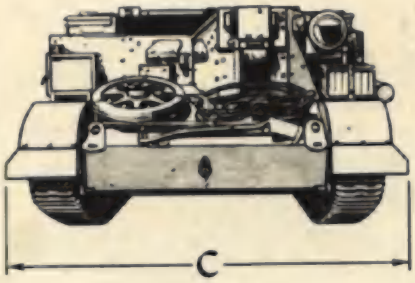
TRANSMISSION - Four speeds forward one reverse
Spur type gears
Mounted at rear of engine
Ratios:

1st	6.4 :1
2nd	3.09:1
3rd	1.69:1
4th	1 :1
Reverse	7.82:1

FINAL DRIVE RATIOS

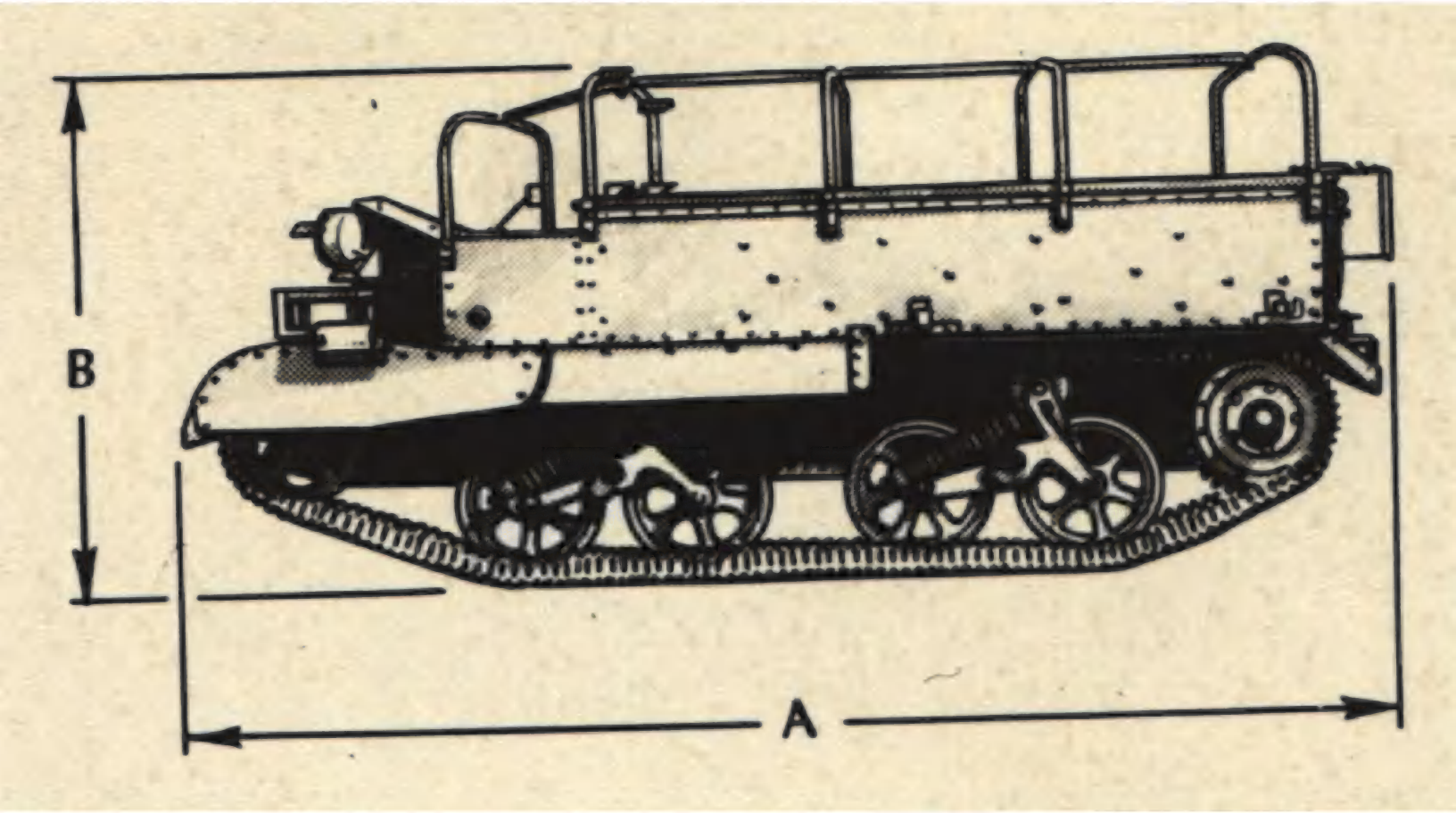
LOW GEAR		HIGH GEAR	
4th	5.83:1	4th	8.11:1
3rd	9.85:1	3rd	13.70:1
2nd	18.0 :1	2nd	25.0 :1
1st	37.3 :1	1st	51.9 :1
Reverse	45.6 :1	Reverse	63.4 :1





DIMENSIONS

A - Overall Length	172-1/4"
B - Overall Height	57-1/4"
C - Overall Width	83"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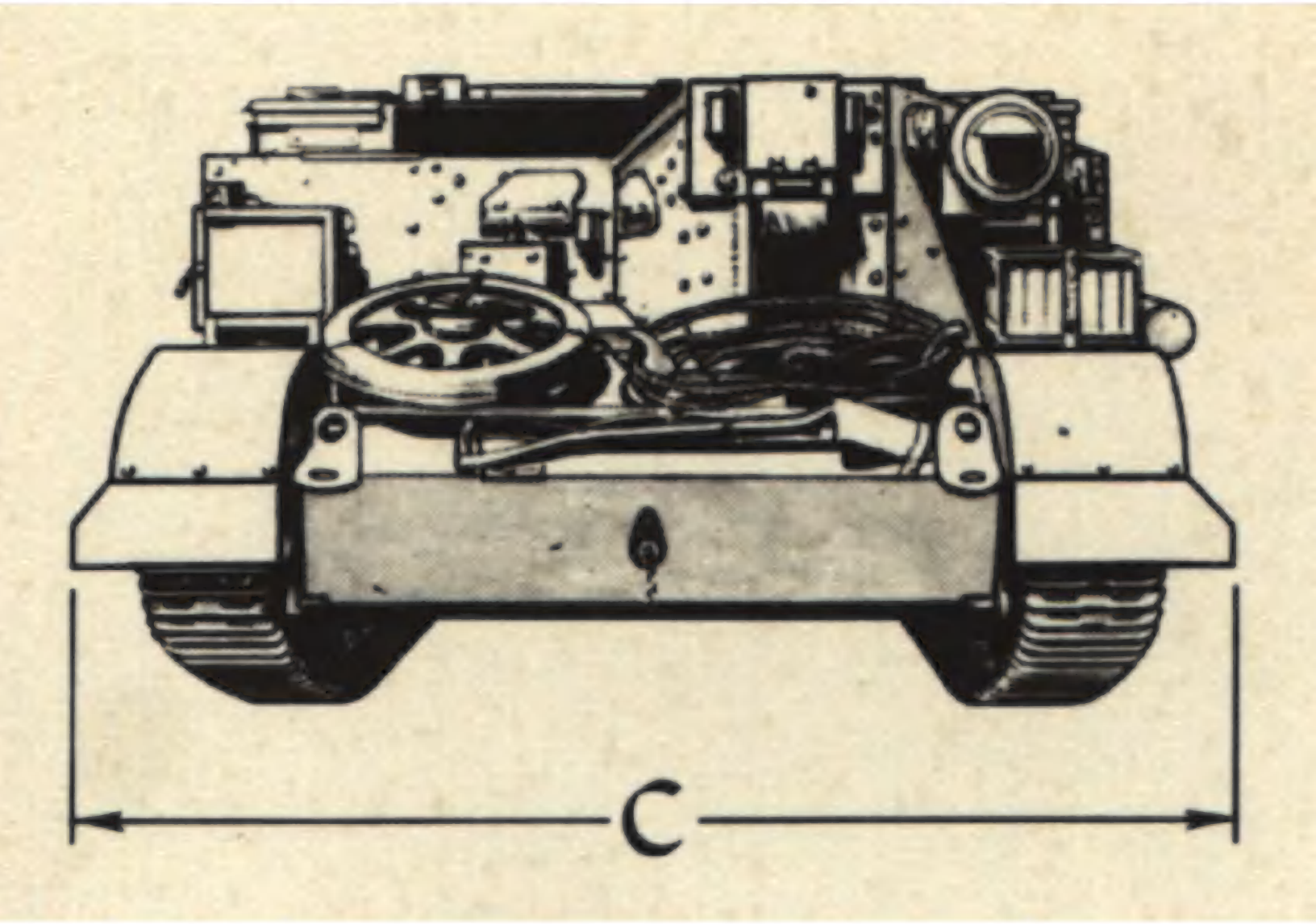
A


C

WEIGHTS

	BASIC # WEIGHT (ALL ROLES)	CURB ## WEIGHT (ALL ROLES)
Front	3885	4310
Rear	5735	5770
Total	9775	10075

4.2 Mortar Roles - Less Crew

	Mortar Carrier	Senior Comm'r Carrier	Junior Comm'r Carrier
Front	4680	4950	4915
Rear	6250	6575	6885
Total	11000	11510	11855

4.2 Mortar Roles - With Crew

	Mortar Carrier Crew - 5	Senior Comm'r Carrier Crew - 4	Junior Comm'r Carrier Crew - 2
Front	5075	5220	5250
Rear	6530	6770	6785
Total	11800	12120	12180

6 Pr. A/T Towing Role

	Less Crew	With Crew Crew - 5
Front	4605	5045
Rear	6320	6670
Total	11085	11890

6 Pr. Amm. Carrier Role

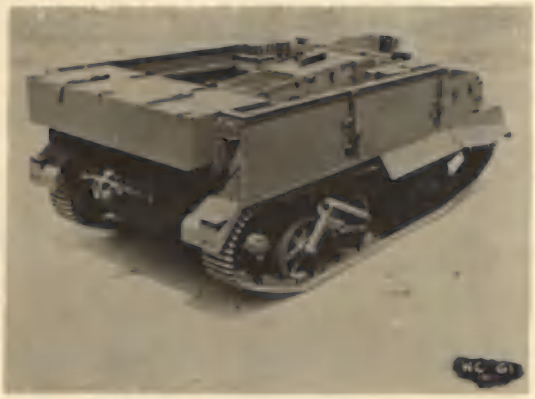
	Less Crew	With Crew Crew - 2
Front	4970	5150
Rear	6780	6700
Total	11735	12060

Notes # Basic weight = Vehicle with filled gas tanks, oil & water but less vehicle tools (as listed in List "A" of Table of Tools and Equipment Table No. 1004) including Spare Bogie.

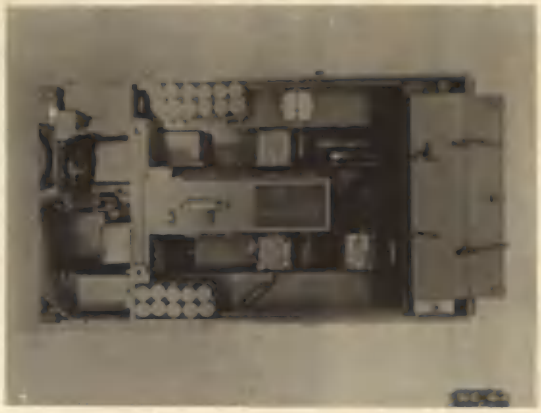
Curb weight = Vehicle with filled gas tanks, oil and water, vehicle tools as per List "A" of Table of Tools and Equipment, Table No. 1004, Spare Bogie Wheel and P.O.W. Cans.

Wading Shields - 241 ± lbs.

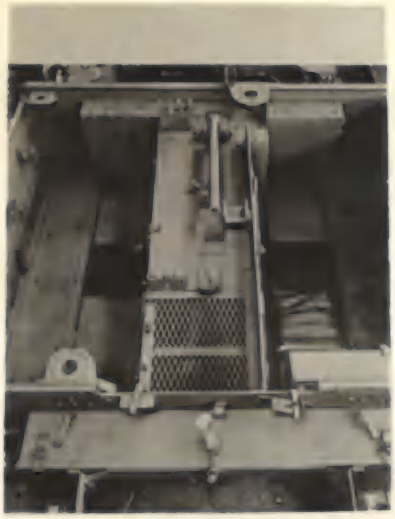
FRONT QUARTER VIEW



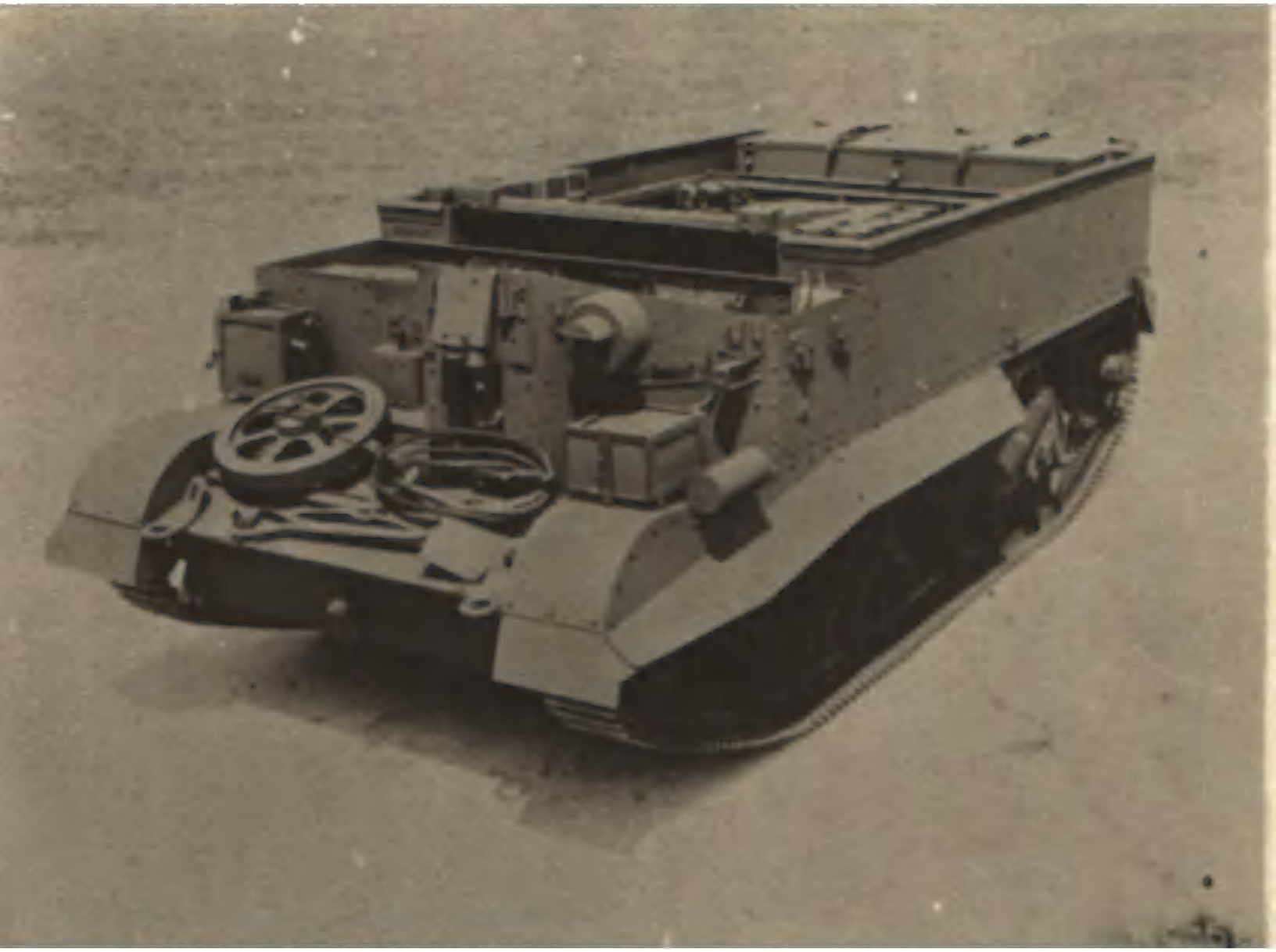
REAR QUARTER VIEW

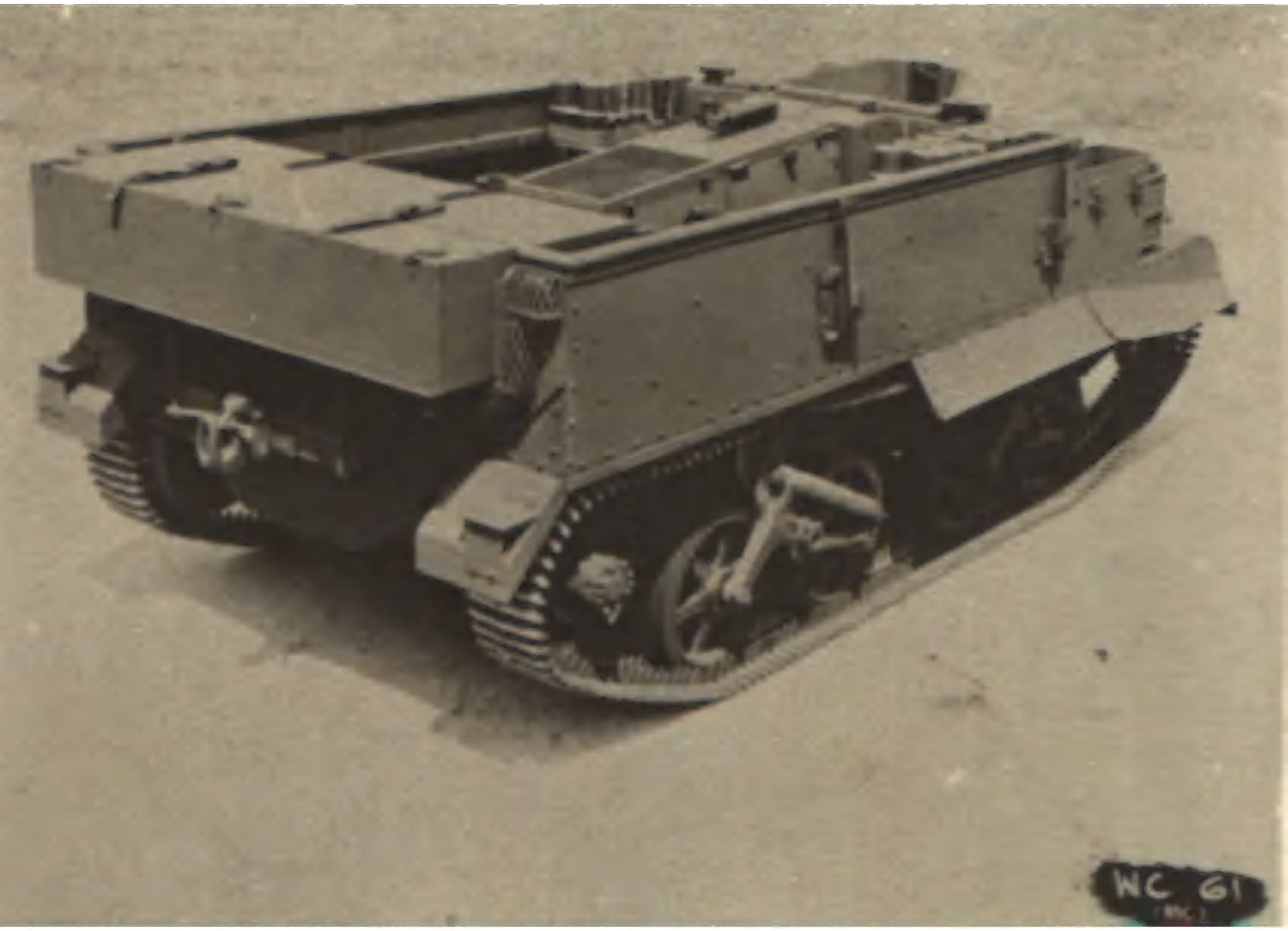


TOP VIEW SHOWING ENTIRE VEHICLE



TOP VIEW SHOWING REAR COMPARTMENT

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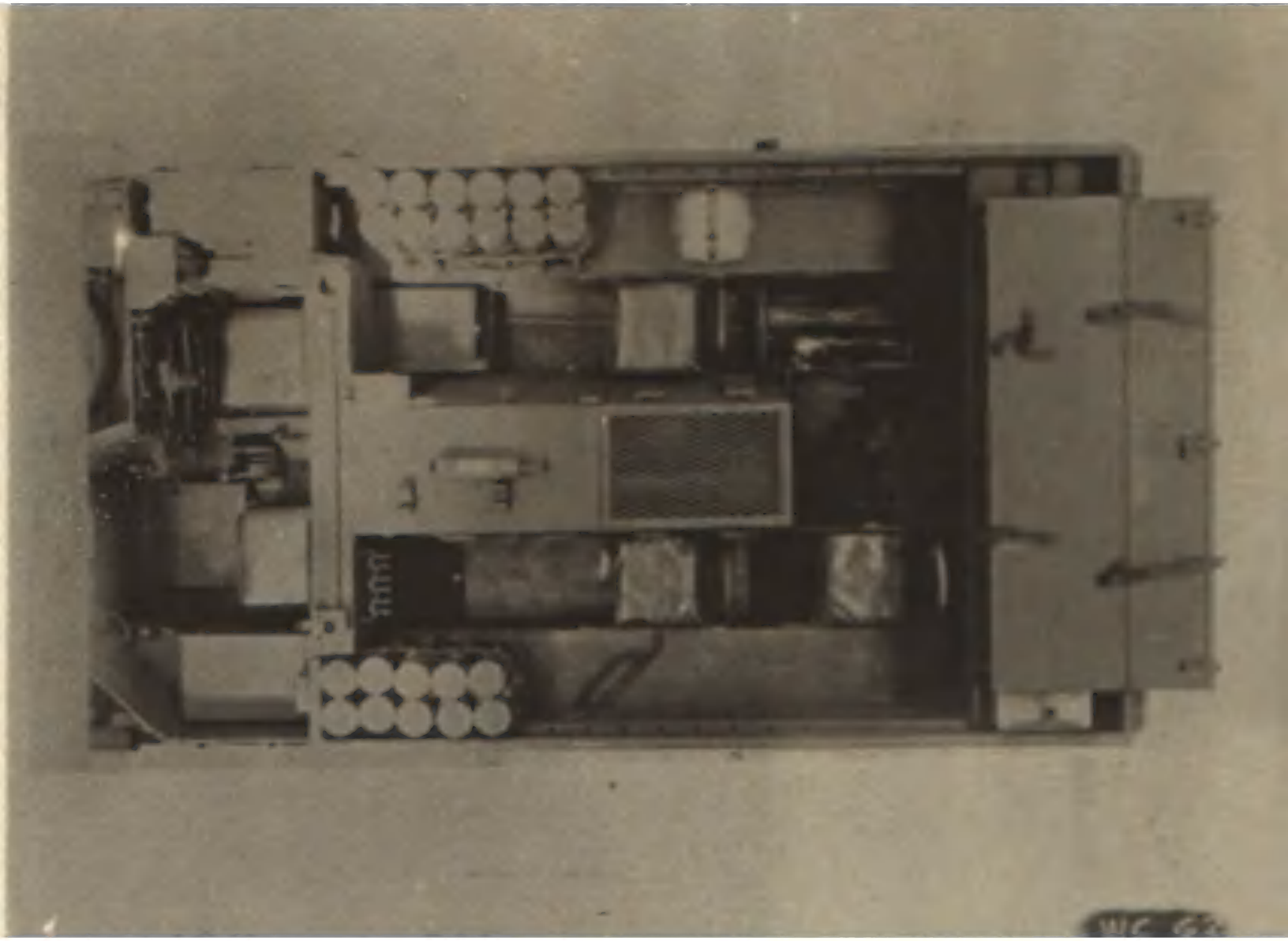
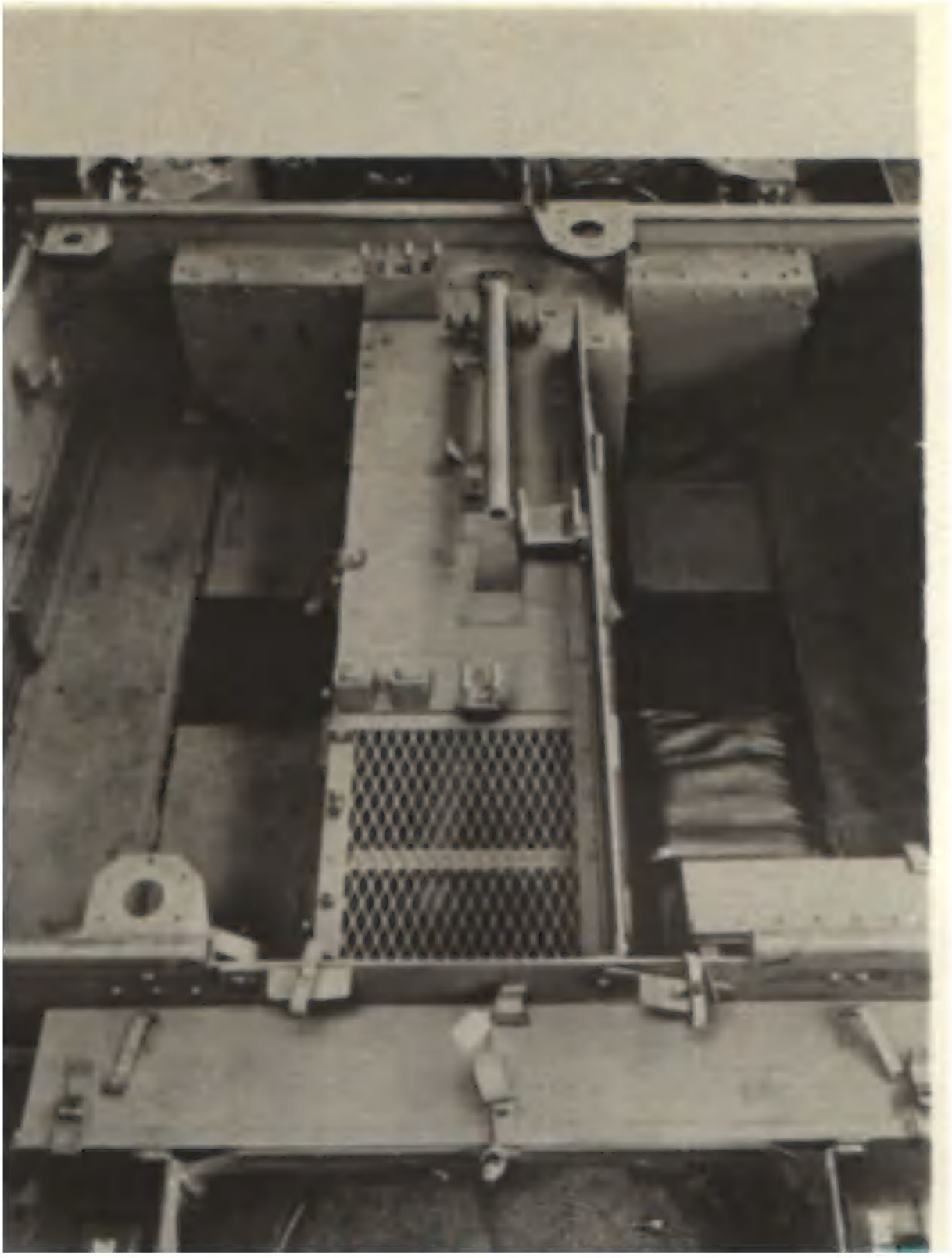




USER COMMENTS

EXCERPT FROM PERFORMANCE REPORT BY DRIVING AND MAINTENANCE SCHOOL (INFANTRY) ON TRIALS CARRIED OUT BY THEM ON THE WINDSOR CARRIER

General Conclusion: In our opinion the Windsor is a tremendous improvement on either the U.C. MK I and II or the Loyd, and regarding the latter a very much more reliable, practical vehicle.

EXCERPT FROM USER TRIALS - REPORT No. 2, DATED JULY 26, 1944

Conclusion: The "Windsor" as a towing vehicle for the 6 pdr., 4.2 mortar trailer, etc. is quite obviously, for the moment, the most ideal and easily produced vehicle. It is vastly superior in general performance, reliability, or structural assembly to the "Loyd". The "Windsor" is solidly constructed and does not suffer with components working loose, etc.

EXCERPT FROM TELVA 579, DATED APRIL 12, 1945

We have not received any complaints from battle areas re Windsor Carriers to date. Letter follows. Ends.

EXCERPT FROM U.K. REPORT, DATED MARCH 7, 1945

The following report from the C. in C., 21st Army Group has been received by the War Office:

EXCERPT FROM U.K. REPORT, DATED MARCH 7, 1945. (cont'd)

'User trials have now been completed with the two Windsor Carriers which were originally sent to this theatre in November, 1944.

It cannot be said that the Windsor Carrier supplies the complete answer to the problem of the 6-Pdr. Tower, but the Windsor is, however, generally preferred as a 6-pdr. tower, both to the Tracked Towing Loyd Carrier and the T-16 Carrier. It is therefore, proposed, as an interim measure to replace all Loyd Carriers with Windsors, priority being given to those Divisions which have been most strongly opposed to the Loyd.

A 2,000 mile test is now being undertaken under arrangement by D.M.E. 21 Army Group, and it is probable that following this test certain modifications are likely to include:

a) A detachable protector plate over the control rods in the driver's compartment.

b) Armoured grill or deflector plate to the front of the radiator.'

The above report is for information only and no action should be taken with reference to the suggested modifications.

REFERENCES

DAD Specification O.A. 200

Ford Workshop Manual - Publication number WC-F1

Ford Operator's Manual - Publication number WC-OM2

Ford Spare Parts List - Publication number FWC-01

Files Series

D.M.S. - 141-17
D.N.D. - H.Q.S. 33-52-28-G
M.O.S. - D.T.D. 300/OSEAS/292
A.C.D./160/4/3/35
FFB/160/4/3/32
JMD/165/4/3/32
D.M.S. - D.A.D. Photo File No. A-9.

D.T.D. Field Trial Reports:

W/S. 341/1 - Windsor Carrier with Two Speed Axle P.E. No. 2738 5/4/44

W/S. 1138) Trials to Determine
W/S. 1138/1)-Suitability of Windsor
W/S. 331/1) Carrier for Towing and Ammunition Carrier Roles -9/3/44.

D.T.D. Field Trial Reports (Cont'd)

F.T. 1157) Windsor Carrier with Two
W/S. 341)-Speed Axle Towing 6 Pdr.
W/S. 341/1) Anti-Tank Gun - 15/2/44
F.T. 1361) - Windsor Carrier Pilot III -
W/S. 418) 3000 Miles Performance and Reliability Trials - 23/8/44.

A.E.D.B. Experimental Engineering Reports:

E339 - Performance and Reliability Tests
E395 - Rolling Resistance
E441 - Synthetic Bogie Tires
E484 - Fuel Tanks - Overflow Angles
E529 - Turning Circle and Ditch Crossing Ability

D.V.A. Report

Project D.V.A. - 6 - 312

Production Orders:

S/M 1349

Approx. Price per unit - less equipment supplied by Ordnance - $4,000.

CAR, SCOUT, FORD II
(LYNX II)

CAR, SCOUT, FORD II (LYNX II)

GENERAL

A light, fast, OPEN type ARMOURED, WHEELED, VEHICLE for SCOUTING and RECONNAISSANCE, and CARRYING TWO MEN. Mounted on a REAR ENGINED 4x4 chassis, designed for ROAD AND CROSS COUNTRY OPERATION.

The driver occupies the right hand seat, the driver's mate the left hand seat. DRIVER'S FORWARD VISION is THROUGH a FRONT PORT equipped WITH a removable WINDSHIELD. For CLOSED DOWN DRIVING the driver's port flap is equipped with a PROTECTOSCOPE. Alternately the DRIVER AND DRIVER'S MATE'S SEATS are ADJUSTABLE TO the "UP" position allowing vision over the front face plate for ordinary driving.

Provision is made for equipping the vehicle with a TWO-WAY WIRELESS. The vehicle is PROOF AGAINST SMALL ARMS FIRE:- FRONTAL .5 A.P., SIDES AND REAR .303 A.P. ESCAPE DOORS are provided one on each side of the hull. A TARPAULIN COVER provides overhead protection from weather.

STOWAGE

Armament consisting of Bren M.G. and rifle G.S. with ammunition is carried in fighting compartment accessible to crew. Provision made for No. 19 W/T installation and stowage of anti-gas equipment, magnetic compass, first aid kit, etc. Personnel equipment for the crew of 2 men and the usual complement of tools and equipment are carried in exterior side and front bins. Containers for extra oil and water provided in R.H. exterior bin and on front fenders respectively.

VEHICLE PERFORMANCE

POWER/WEIGHT - Net power to gross weight ratio per ton (2000 pounds) 20.2 B.H.P.

GRADEABILITY - Theoretical percentages
Maximum grade low gear 63%
" " high gear 5%
Actual by test low gear 50%

PERFORMANCE -

Speed - Governed at 3500 - 3900 R.P.M. - 50 to 57 M.P.H.

¼ Mile Run	Time	Average Speed
Standing start	32 sec.	28.13 M.P.H.
Flying start	18.2 sec.	49.45 M.P.H.

20 Mile Cross Country Run -
Speed - 13.3 m.p.h. average

(Fuel consumption - 3.26 m.p.g.)
(Oil consumption - 107 m.p.g.)

100 Mile Road Run -
Speed - 48.0 m.p.h. average

(Fuel consumption - 3.80 m.p.g.)
(Oil consumption - 239 m.p.g.)

CRUISING RANGE

Cross Country - 68.20 miles
Highway - 196.0 miles

STABILIZED TEMPERATURE DIFFERENTIALS

	100 Mile Road Run	Peak B.H.P.	Max. Torque
Water	111°F	102°F	109°F
Engine oil	136°F	130°F	105°F
Transmission oil	115°F	112°F	127°F
Transfer case oil	225°F	112°F	87°F

Note: Peak B.H.P. and Max. Torque results obtained by towed load method.

BRAKE EFFICIENCY

Service brakes	16.6 F.S.S.	52% Efficiency
Hand brake	11.2 F.S.S.	36% Efficiency

FORDING DEPTH - 18"

GROUND CLEARANCE (lowest point) 8.9"
under axle housings
Angle of approach 53°
Angle of departure 44°

TILTING ANGLES -

Satisfactory Engine performance -

front of vehicle up - 40°
rear of vehicle up - 40°

ANGLE OF OVERTURN R. - 45°
L. - 45°

VEHICLE DATA

CHASSIS MANUFACTURER - Ford Motor Co.

HULL MANUFACTURER - International Harvester Co.

LOAD CARRYING CAPACITY - 1400 pounds

MAXIMUM GROSS WEIGHT

	Front axle	Rear axle	Total
with Desert Equipment	4180	5230	9410

WHEELBASE - 82"

OVERALL LENGTH - 141"
with sandchannels 152"
WIDTH - 72⅛"
HEIGHT - 68¼"

TURNING CIRCLE - R.H. 40' 0"
TURNING CIRCLE - L.H. 40' 0"

ANGLE OF APPROACH - 53°
ANGLE OF DEPARTURE - 44°

AXLE - FRONT - Driving type.
Rezeppa joints
Spiral bevel gear
Ratio - 6.66 to 1

AXLE - REAR - Full floating
Spiral bevel gear
Ratio - 6.66 to 1

DRIVE - Hotchkiss type. Drive shafts going from transfer case to front and rear axles.

BRAKES - SERVICE - Internal expanding Hydraulic 4 wheel
Drum diameter - 14"
Lining area - 218.2 sq. in.

HAND - Mechanical control by cables on service brake-shoes of rear wheels.
Lining area - 112.96 sq. in.

CLUTCH - Type - Heavy duty semi-centrifugal dry single plate.
Size - 11"
Frictional area - 123.7 sq. in.

COOLING SYSTEM -

Circulating liquid pressure type.
Centrifugal type pump driven by two V fan belts front crankshaft.
Radiator - Tube and pin type
Frontal Area - 559 sq. in.
Capacity of cooling system 23 pints (imp.)
Thermostat, two bellows type.

ELECTRICAL -

Battery - (Amp. Hrs. 120 @ 20 hr. rate) Two 17 Plates.
Generator - 12 volt with current and voltage regulator.
Starter - Ford with solenoid control. Ratio - 11.2:1
Lights including blackout equipment in accordance with Spec. O.A. 62.

ENGINE - Ford V8 - 8 cylinder 90° L.Head
Displacement 239 cu. in.
Peak gross B.H.P. 95 @ 3600 R.P.M.
Max. Gross Torque 178 ft. lbs. @ 1850 R.P.M.
Lubrication, full pressure type spiral gear 40 pounds pressure @ 2000 R.P.M.

FUEL SYSTEM - Down Draft Ford Holley carburetor with accelerating pump.
Fuel tanks (2) total capacity 20 gal. imp.

FRAME - Type - channel side members
Number of cross members - 5
Max. depth of channel - 6"

VEHICLE DATA (Cont'd)

SPRINGS - Semi elleptic - Front - underslung
Rear - overslung

Material - carbon chromium alloy steel

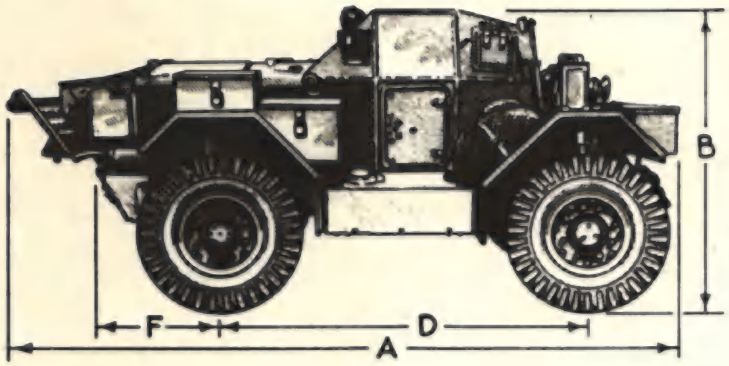
	Front	Rear
Length	35.50"	36"
Width	2"	2"
No. of leaves	11	14
Rate of deflection	1060#	1268"

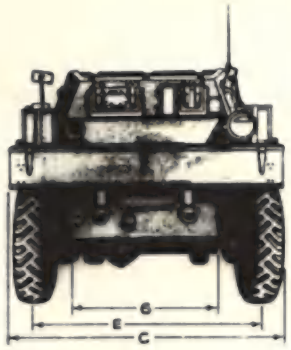
STEERING - Type - worm and roller
Ratio - 16.75 to 1

TRANSMISSION - Four speeds forward
One reverse

Ratios 1st.	6.4 :1
2nd.	3.09:1
3rd.	1.69:1
4th.	1 :1
Reverse	7.82:1

TRANSFER CASE - One speed.
Drive shafts running to front and rear axles.



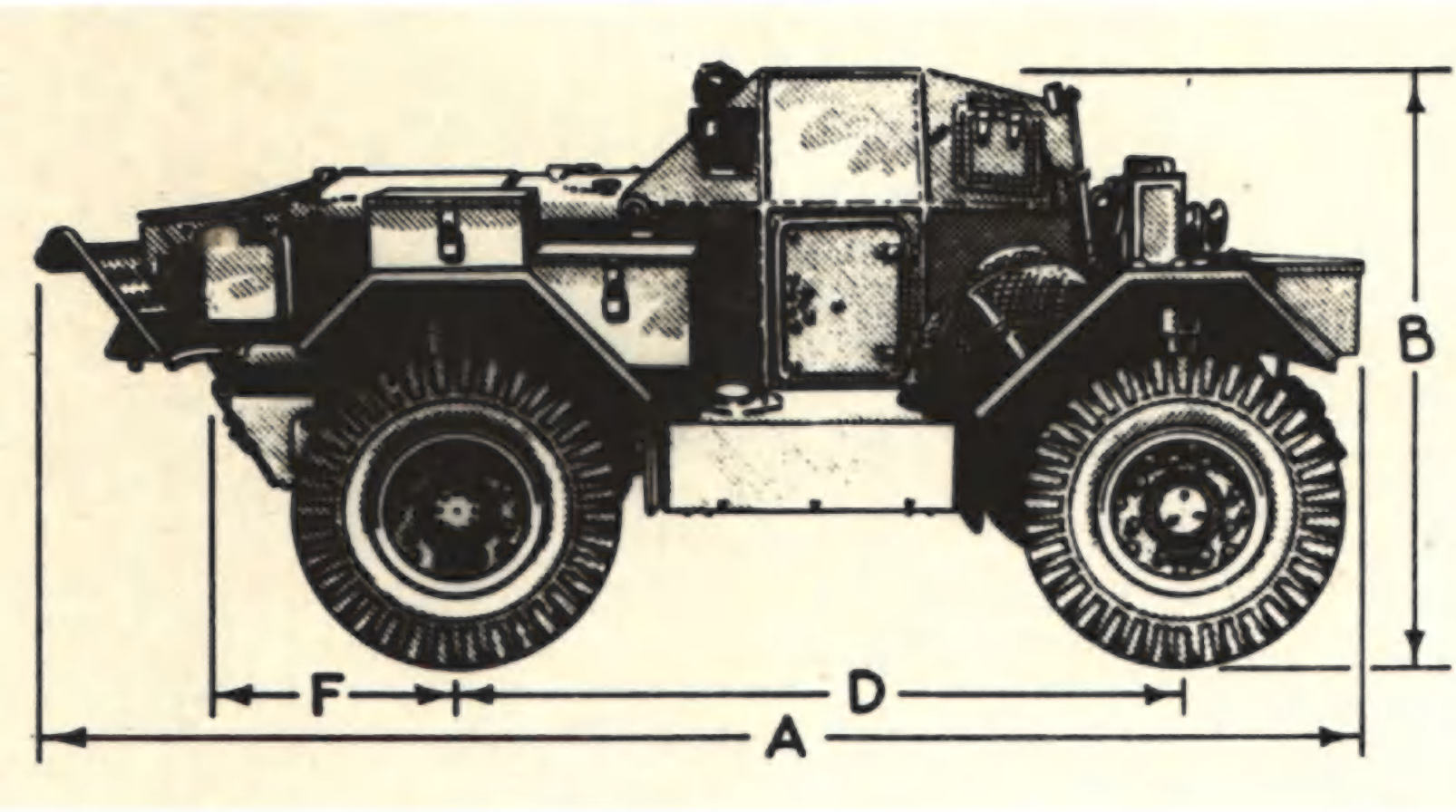


A	B	C	D	E	F	G	Maximum Height
141"	68 1/4"	72 1/2"	82"	63"	21.86"	32"	68 1/4"
Ground Clearance under Axles: Frt. at Bell Hsg. 8.9"							
" " " " : R.R. at Bell Hsg. 8.9"							
" " At Centre: 16 3/4"							
Above Clearances are based on a rolling radius of 16.34"							

WEIGHTS

	Front	Rear	Total
Curb Weight (Vehicle complete with maximum amounts of gasoline, oil and water, and vehicle tools and equipment in accordance with List "A" of Table No. 38)	3770	4700	8560
Stowed Weight (Vehicle complete with maximum amounts of gasoline, oil and water, vehicle tools and equipment, and Ordnance equipment in accordance with Stowage Equipment List No. 202.)	3962	4908	8900

	Front	Rear	Total
Gross Weight (Vehicle complete as described in "Stowed" Weight above but with crew consisting of driver and mate, @ 165 lbs. each, added.)	4160	5040	9230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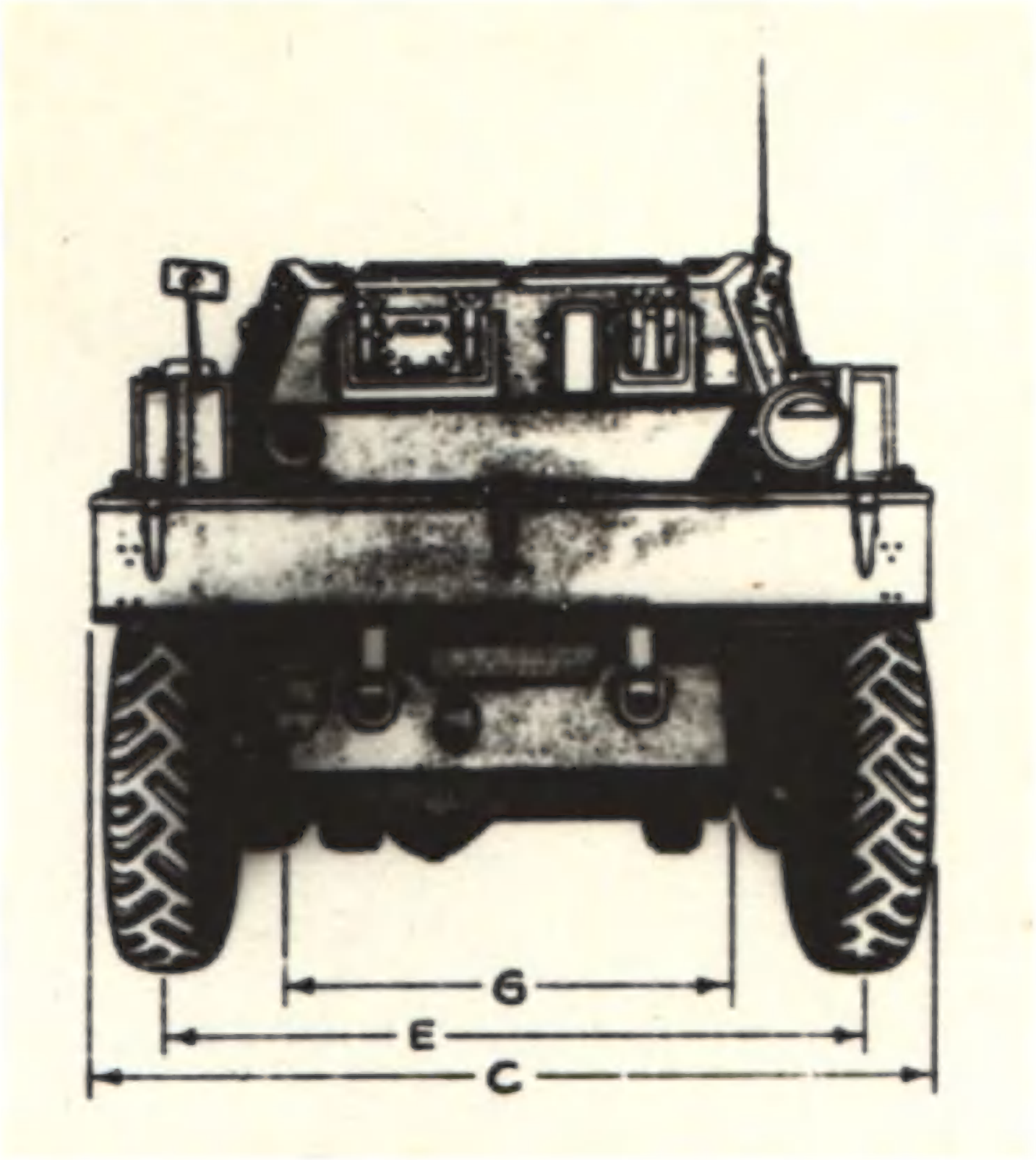
F
D
A


G
E
C

FRONT TOP VIEW

REAR QUARTER VIEW

INTERIOR VIEW (SHOWING CONTROLS)


3000

USER COMMENTS

EXCERPT FROM AIRL 1057,
APRIL 13, 1944 (FROM D.D.E.M.)

Refers to D.T.D. report F.T. 1147 which states requirements have been met on practically all major points. However, experiments should still continue to obtain consistently good oil consumption, also development work should still continue to prevent transmission slipping out of reverse gear. D.T.D. also suggest that the suspension should receive further attention. In conclusion D.T.D. state that the revised Scout Car should prove to be a most useful and popular vehicle in the services.

EXCERPT FROM AIRL 1479,
OCTOBER 25, 1944 (FROM D.D.E.M.)

Both D.T.D. and F.V.P.E. have stated on several occasions that they consider the vehicles now in their hands to be the most reliable Scout Cars tested to date. D.T.D. feel that the vehicle will be extremely popular with the Users as it is so similar to the Daimler II.

EXCERPT FROM AIRL 1684,
JANUARY 9, 1945 (FROM D.D.E.M.)

Refers to F.V.P.E. report No. F.T. 1439/1 which concludes as follows:

"The vehicles have been used in normal operations and have covered up to 1000 miles on roads and cross country; the performance to date is considered to be very good. There have been no mechanical breakdowns. The rear axle has given no trouble. The new generator is very well liked as it maintains the batteries without the use of a Chore Horse when the No. 19 set is used. The new seating arrangement is satisfactory. The vehicle is more manoeuvreable than the Lynx I. The new stowage arrangements are well liked."

Also refers to report No. W.S. 478 which states the condition of the Scout Car, Ford II, Lynx II was most satisfactory on the completion of the performance and reliability trials.

REFERENCES

DAD Specification O.A. 202-A

Ford Operator's Manual - Publication number LNX-OMI

Ford Workshop Manual - Publication number SC-F3

Ford Spare Parts List - Publication number FSC-03

Files Series

D.M.S.-141-2-1,2,3,4, etc.
D.N.D.- H.Q.S. 33-52-12
M.O.S. - D.T.D. 300/OSEAS/125
D.M.S. - D.A.D. Photo File No. A-4

D.T.D. Field Trial Reports:

Report No. 1147 - Performance and Reliability Trials in Canada on A.F.V.'s W 94; Ford Scout Cars II - 3/3/44.

Report Nos. 1439 and 1439/1 - Performance and Reliability Trials of the Ford II Scout Car - 6/10/44 and 22/11/44.

Report No. 1500 - Engine Fan Manual Control Fitted to the Ford II Scout Car - 21/11/44.

A.E.D.B. Experimental Engineering Reports:

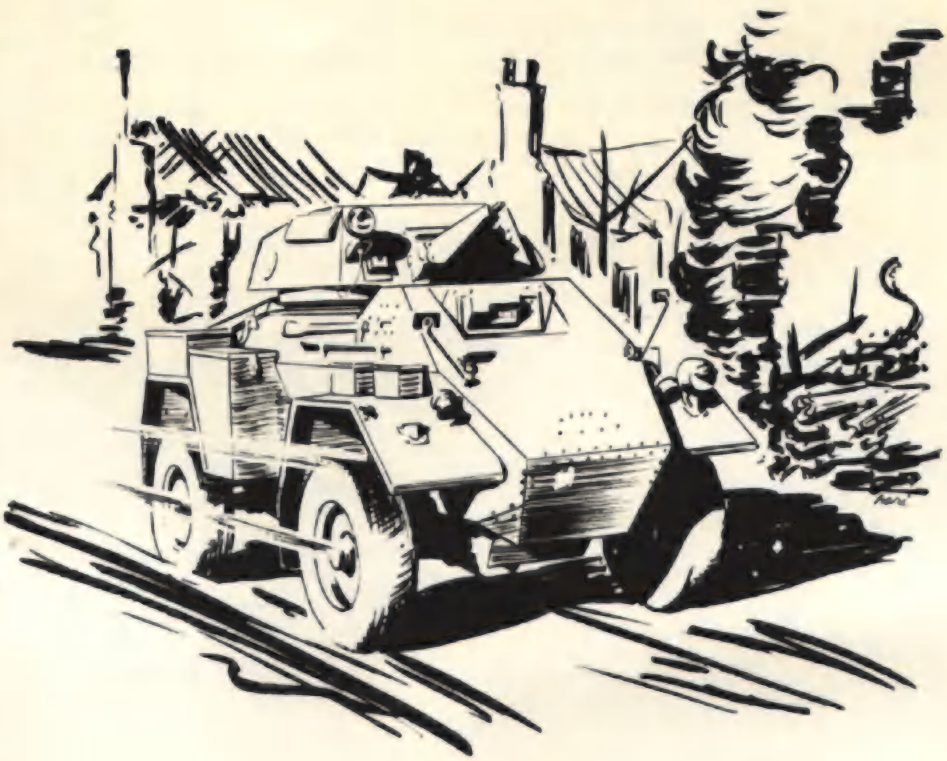
E108 - Illustrations of New Stowage Bins & Sun Compass
E138 - New Type Axle Assemblies
E149 - Bracket - Magnetic Compass
E338 - Crash Pads
E397 - Expanded Metal Panels - Anti Grenade
E400 - Rolling Resistance
E434 - Special Bearings & Pistons Ford Car Scout Engine
E319)- Performance and Reliability Trials
E320)
E449 - Scout Car, Lynx II - Manually Controlled Declutchable Fan
E536 - Loaded Weights - Scout Car, Lynx II

Production Orders.

CD. - L.V. 126
L.V. 226
L.V. 540
S/M 1048
S/M 1444

Approx. Price per unit - less equipment supplied by Ordnance - $4,000.

CAR, ARMOURED, G.M. MK.I
(FOX I)



CAR, ARMOURED G.M. MK I, FOX I

GENERAL:

A CLOSED, TURRET MOUNTING, 4x4 REAR ENGINED ARMOURED WHEELED VEHICLE, for RECONNAISSANCE and PATROL for armoured formations, designed for ROAD AND CROSS COUNTRY OPERATION, and CARRYING A CREW OF FOUR including the driver. PROTECTION AGAINST SMALL ARMS FIRE - FRONTAL AGAINST .303 A.P., SIDE, REAR AND ROOF AGAINST .303 BALL. Armament of ONE .30 CALIBRE AND ONE .50 CALIBRE BROWNING MACHINE GUN, co-axially mounted in the front of the turret - ONE SUB-MACHINE GUN AND ONE BREN GUN carried, also TWO 4" SMOKE DISCHARGERS. Provision for MOUNTING A #19 TWO-WAY WIRELESS and crew inter-communication. Completely enclosed turret can be rotated through 360° by means of a hand traverse. The Commander occupies the right hand turret seat, the Gunner the left hand turret seat, the Wireless Operator the rear turret seat. HATCHES located IN TURRET ROOF above Commander and Gunner.

An AUXILIARY STEERING WHEEL is located adjacent to the wireless operator's seat to facilitate reversing the vehicle.

The DRIVER'S VISION is THROUGH a LOOKOUT PORT equipped with a REMOVABLE WINDSHIELD. With flap closed, VISION is THROUGH horizontal SLITS; behind the slits is a TRIPLEX GLASS BLOCK. Driver's side vision is through two small vision ports, one on either side of the hull. TWO PERISCOPES provided in the turret roof, one at the front and one at the rear. Access to the vehicle through the TWO SIDE ESCAPE DOORS and through TWO HATCHES ON TOP of the turret.

STOWAGE

Bren M.G., Thompson S.M.G. Bins, boxes, racks, etc. for ammunition and gun spares, etc. located within easy reach of user. Provision made for W/T installation in turret with control units adjacent to crew and driver. A 4 gal. water tank plus 4 standard water bottles stowed in the turret and fighting compartment. Anti-gas equipment is carried in Driver's compartment.

Personnel equipment, vehicle tools and equipment, shovels, etc. are carried in bins, brackets and clips on the exterior of the vehicle.

VEHICLE PERFORMANCE

POWER/WEIGHT - 11.3 B.H.P. per short ton

GRADEABILITY - Theoretical in low transfer case ratio:

1st.	2nd.	3rd.	4th.
53%	25.4%	12.3%	6.7%

Actual - by test - 50% on concrete grades.

PERFORMANCE

Governed speed - 3000 Engine R.P.M. - 44 M.P.H.

¼ Mile Run	Time	Average Speed	Speed at end of run
Standing start	41 sec.	22 M.P.H.	36 M.P.H.
Flying start	21 sec.	43 M.P.H.	44 M.P.H.

40 Mile Cross Country - Speed - 21.4 M.P.H. average

(Fuel consumption - 7.1 m.p.g.)
(Oil consumption - Nil.)

100 Mile Run - Speed - 40 M.P.H. - average

(Fuel consumption - 6.8 m.p.g.)
(Oil consumption - Nil.)

CRUISING RANGE

Highway - 207.40 miles
Cross Country - 216 miles

STABILIZED TEMPERATURE DIFFERENTIALS

	Max. Torque at 1350 R.P.M.	Peak B.H.P. at 2750 R.P.M.
Water	73°	97°
Engine oil	109°	172°
Trans. oil	139°	167°
Diff. oil	120°	123°

NOTE: Cooling Trial Figures arrived at by Towed Load Method.

BRAKE EFFICIENCY

	Distance to Stop	Ft. Per. Sec. Per. Sec.
20 M.P.H. Hand	61'	7.08 Ft/sec/sec
20 M.P.H. Foot	19' 5"	21.6 Ft/sec/sec

FORDING DEPTH - 24"

TILTING ANGLES -

Vehicle facing up - 15° - satisfactory
Vehicle facing down - 15° - satisfactory
Across slope - 15° - satisfactory

ANGLE OF OVERTURN - 30° (R. and L. sides)

VEHICLE DATA

CHASSIS MANUFACTURER - General Motors of Canada Ltd.

HULL MANUFACTURER - Hamilton Bridge Co.

LOAD CARRYING CAPACITY - 1875 pounds

PERMISSIBLE MAX. GROSS WEIGHT - 16520 pounds

Front Axle - 7879 pounds
Rear Axle - 8690 pounds

WHEELBASE - 101"

TRACK - Front - 78"
Rear - 78"

TIRES - 10.50 x 20 R.F.

OVERALL - LENGTH - 176¼"
WIDTH - 89¼"
HEIGHT - 97⅜"

TURNING CIRCLE - R. - 47' 9"
L. - 49' 2"

AXLE - FRONT - Spiral bevel gears
Housing Banjo
Ratio 7.16 to 1
6" Bendix Joints

REAR - Spiral bevel gears
Housing Banjo type
Ratio 7.16 to 1

DRIVE - Hotchkiss type. Propeller shafts and universal joints (constant velocity) going from transfer case to front and rear axles.

BRAKES - SERVICE - 4 wheel hydraulic internal expanding with hydrovac booster unit.
Front drum diameter - 15"
Rear drum diameter - 15"
Lining area front - 198 5/8 sq. in.
rear - 198 5/8 sq. in.
NOTE: Front wheel and rear wheel brakes are the same size.

HAND - External band type at rear of transfer case.
Drum diameter - 9½"
Brake area - 87 sq. in.

CLUTCH - Single plate dry disc type.
Outside diameter - 11½"
Total area - 136.170 sq. in.
Operation through hydraulic slave valve and pedal.

COOLING SYSTEM -

Radiator Core Harrison fin and tube
Frontal area - 479.19 sq. in.
size 22 7/8" x 26½" x 3 7/8"
Pump - Centrifugal - driven by fan belt from crankshaft.
Thermostat in cylinder head water outlet.

ELECTRICAL SYSTEM -

Battery - make Prestolete
2 batteries used
Terminal grounded, negative
Ampere hours @ 20 hr. rate 95
6 volts - plates per cell 15

ELECTRICAL SYSTEM (Cont'd)

Generator - make Delco Remy
Voltage 12
Amperes 40 @ 1250 Engine R.P.M.

Controls - voltage and current regulator.

Starter - make - Delco Remy Bendix drive magnetic switch controlled from dash.
Gear reduction, fly wheel teeth - 139
Starter pinion teeth 9

Lights - blackout equipment in accordance with Spec. O.A. 62

ENGINE - Type G.M. 270 Valve in head 6 cylinders.
Piston displacement - 269.62 cu. in.
Gross B.H.P. 104 @ 3000 R.P.M.
Torque 220 ft. lbs. @ 1800 R.P.M.

FUEL SYSTEM - Carburetor, Down draft Zenith
Fuel Pump A.C.
Total fuel capacity - 30½ imp. gals.
Governor - King Seeley, Velocity type set at engine 3000 R.P.M.

FRAME - Ladder type
Material H.R. Steel pickled
Number of cross members - 6
Maximum depth - 8"

SPRINGS - Semi elleptic

	Front	Rear
Length loaded	40"	50"
Width	2"	2½"
Number of leaves	15	15
Rate	1686 lbs. per in.	1085 lbs. per in.

NOTE: Deflection rates are with the two auxiliary leaves in both front and rear springs.

STEERING -

Type - recirculating ball
The vehicle is equipped with two steering gear assemblies, both connected through linkage to front axle. The forward gear is for the use of the driver and is located in driver's compartment. The auxiliary gear is located in the hull and is to be used only when vehicle is being driven in reverse direction.

Ratios - Front - 25.6:1
Rear - 23.6:1

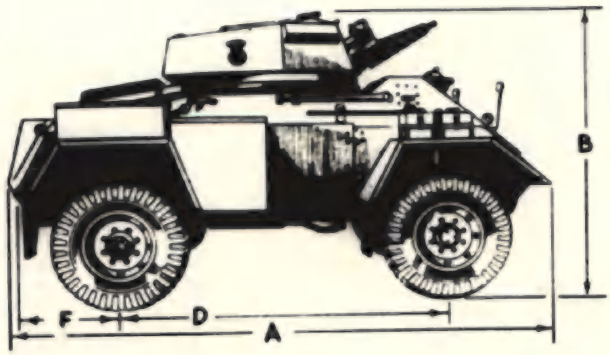
TRANSMISSION - Type - 4 speed helical
Speeds - 4 - forward
1 - reverse
Ratios

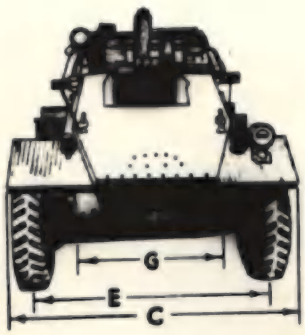
1st.	6.35:1
2nd.	3.31:1
3rd.	1.75:1
4th.	1.00:1
Reverse	7.64:1

TRANSFER CASE -

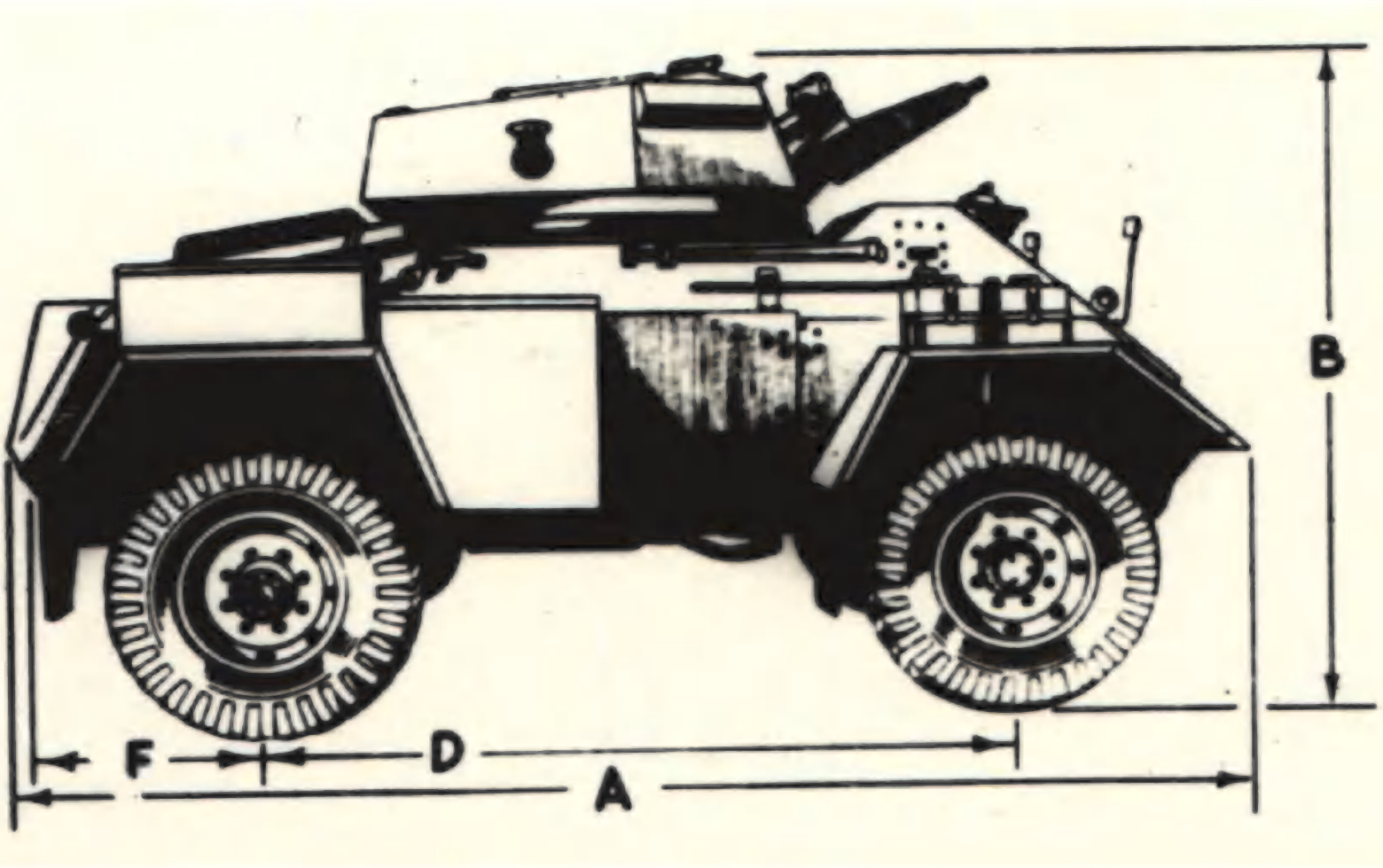
2 speed with front axle de-clutch
Mounted amidship of frame

Ratio - Low - 1.87:1
High - 1:1





A	B	C	D	E	F	G	Maximum Height Top of Turret 96"
176 1/4	96"	91 1/2"	101"	78"	30 1/8"	27"	
Ground Clearance under Axle: Front - 11 3/8"							
" " " " Rear - 11 3/8"							
" " at Centre: - 18 1/2"							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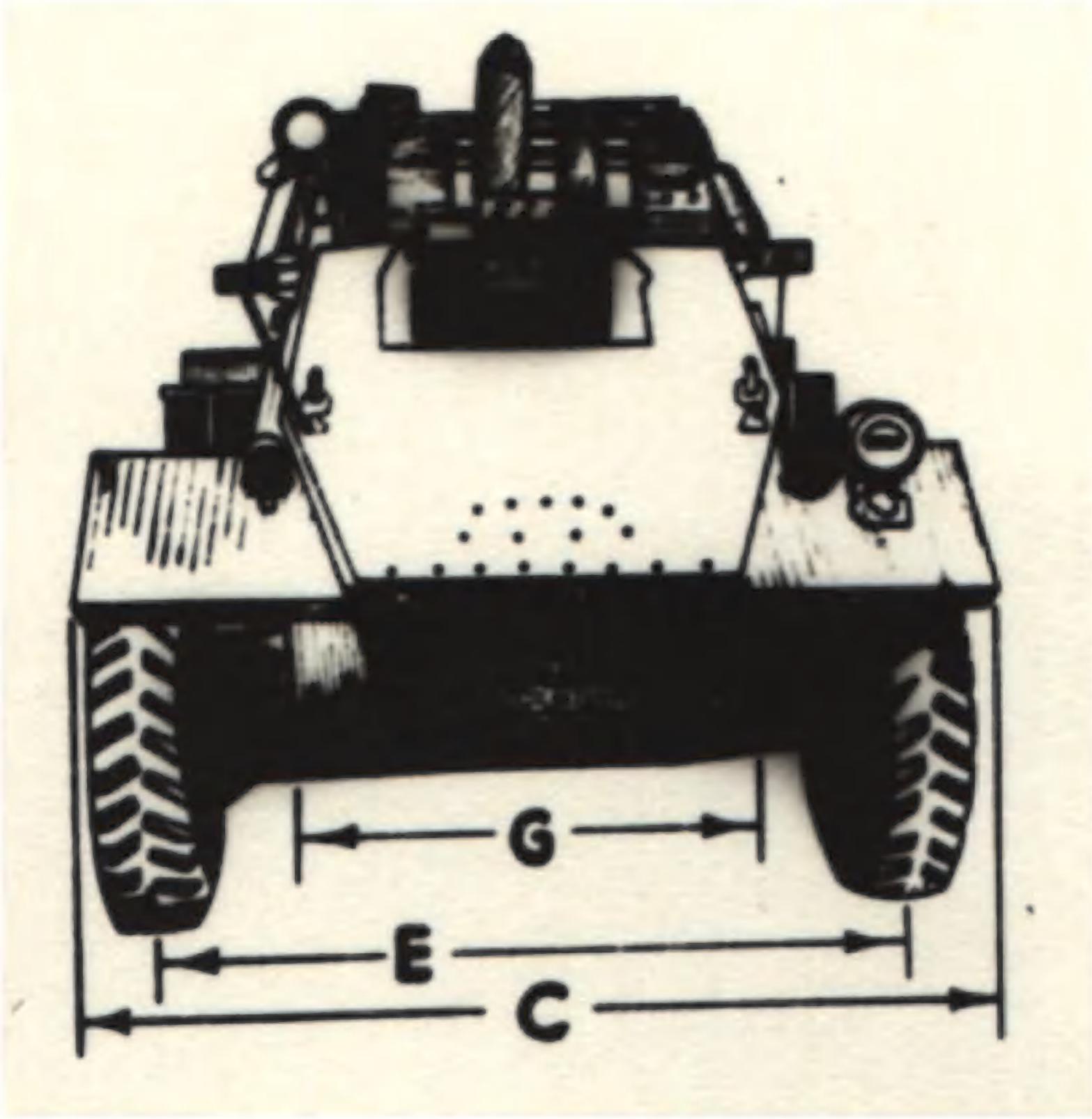
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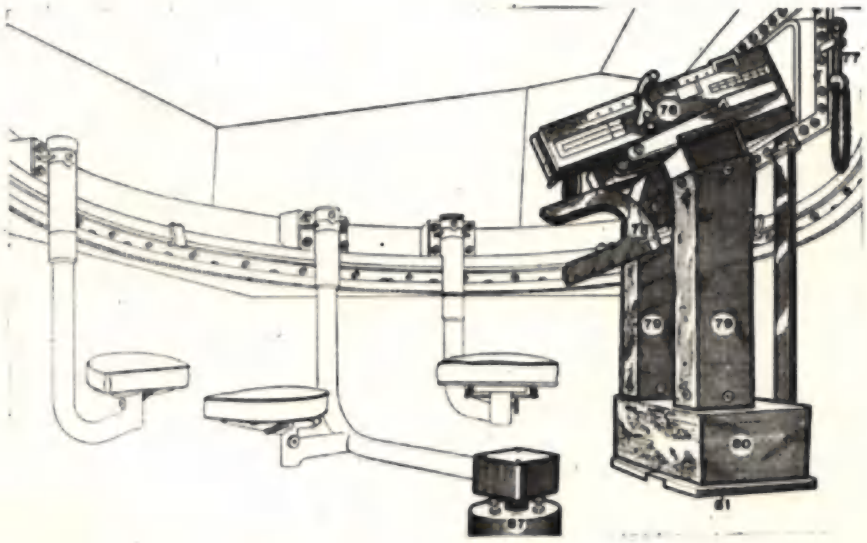
WEIGHTS

	Front	Rear	Total
Curb Weight (Vehicle complete with maximum amounts of gasoline, oil and water and with vehicle tools and equipment in accordance with List "A" of Table 51)	6940	7990	14920
Stowed Weight (Vehicle complete with maximum amounts of gasoline, oil and water, vehicle tools and equipment and Ordnance equipment in accordance with Stowage List No. T.D. 970)	7430	8460	15860

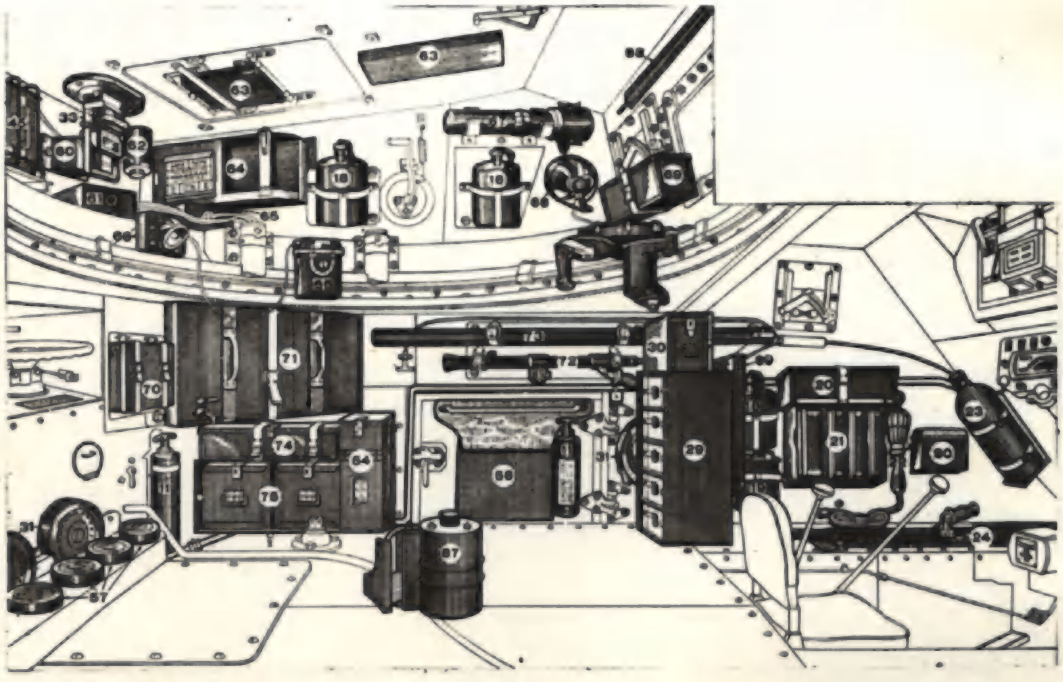
	Front	Rear	Total
Gross Weight (Vehicle as equipped for "Stowed" weight but with driver and crew of 3 men @ 165 lbs. each, added.)	7879	8690	16520

FRONT QUARTER VIEW

REAR QUARTER VIEW

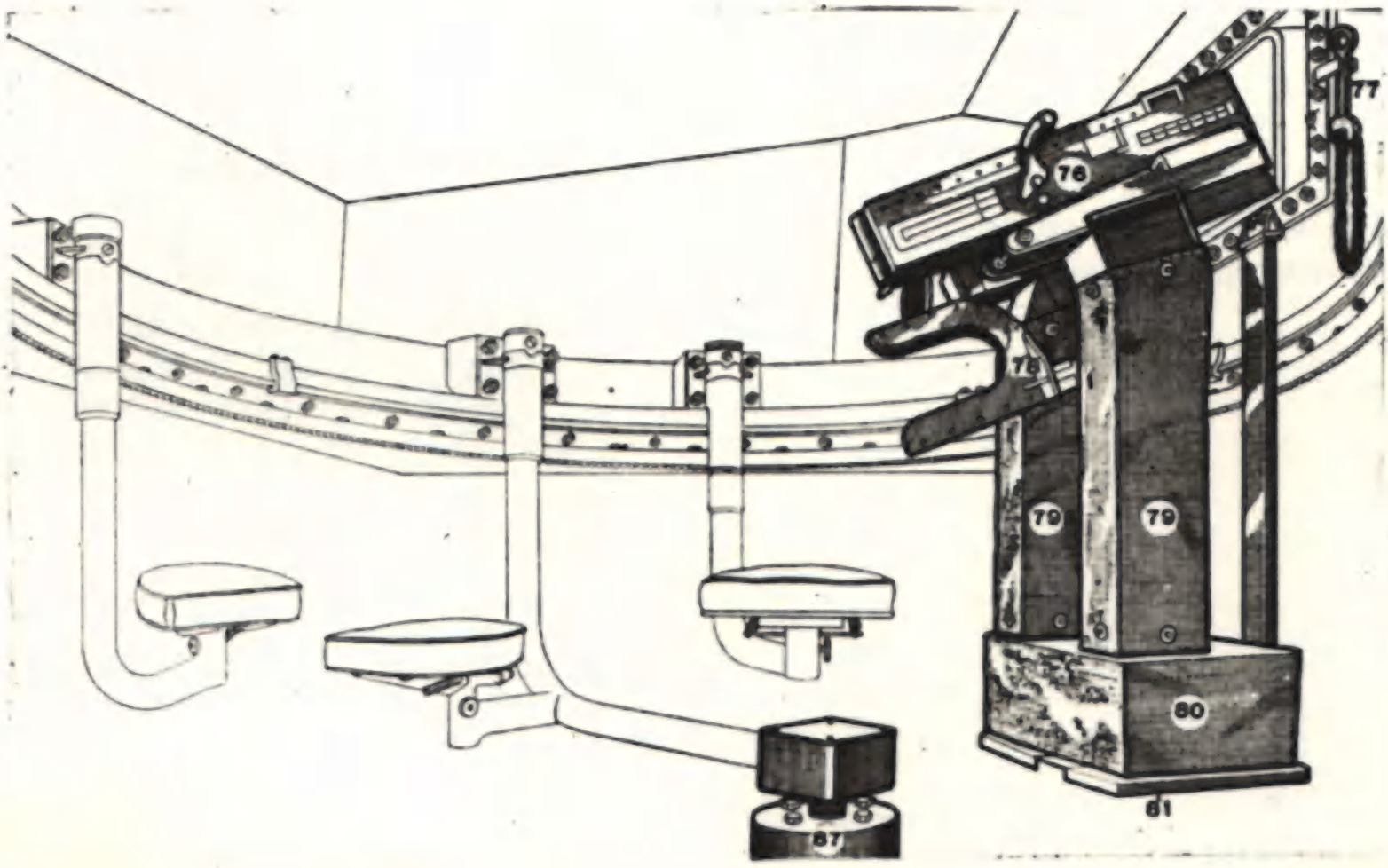


INTERIOR - SHOWING GUNS AND TURRET SEATS



INTERIOR (LESS GUNS AND TURRET SEATS)


MC 13049-2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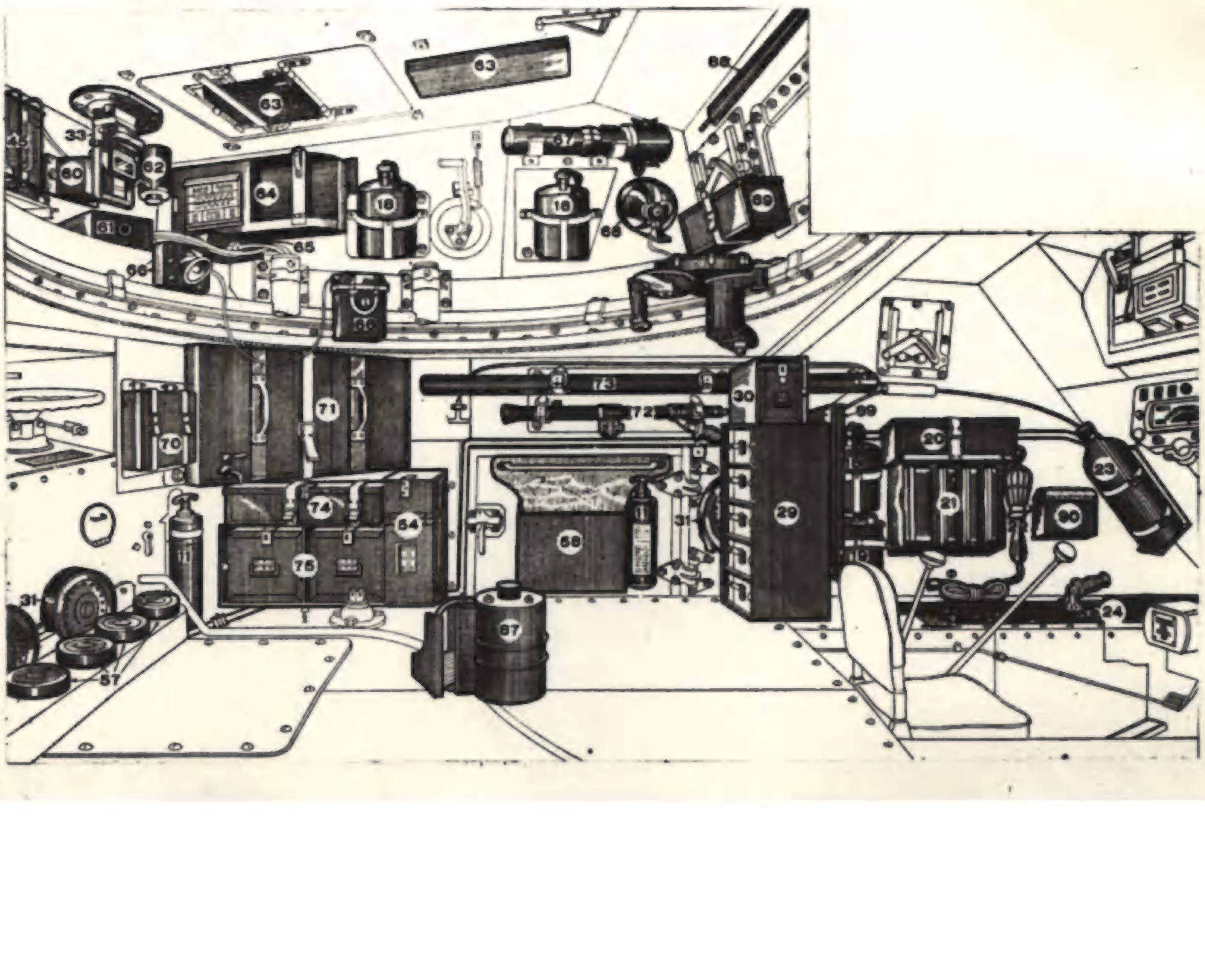

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USER COMMENTS

EXCERPT FROM AIRL 874-B
JANUARY 18, 1944

Technical Report No. 17 from the Mediterranean Area. - The Fox Armoured Car seems to have lived up to its reputation as a reliable vehicle.

EXCERPT FROM F.V.P.E. REPORT NO. F.T. 662/1
MAY 5, 1943

Conclusions: Except for the failure of the rear differential unit at 987 miles and of the engine at 4375 miles, the Armoured Car, Canadian (G.M.) MK I (FOX I) has proved most reliable and has a performance superior to that of the Armoured Car, Humber, MK IV.

REFERENCES

DAD Specification O.A. 203
Hull Drwg. Schedule 20060
General Motors Maintenance Manual - Publication number AC-C1

General Motors Spare Parts List - Publication number CAC-02

Files Series
D.M.S. 141 - 4 - 1, 2, 3, 4, etc.
D.N.D.-H.Q.S. 33-52-2
H.Q.S. 33-52-2-1
M.O.S.-D.T.D. 300/OSEAS/125
D.M.S.-D.A.D. Photo File No. A-6

D.T.D. Field Trial Reports

F.T. 662/1 - Performance and Reliability Trials of the Canadian Armoured Car - 19/6/43.
F.T. 662 - Clutch Component of the Armoured Car - 18/2/43.
W.S. 141 - Performance and Reliability Trials - 14/7/43.

A.E.D.B. Experimental Engineering Reports:

E48 - Installation of Smoke Mortar
E160 - Bracket - Magnetic Compass
E180 - Water and Oil Cooling Differential
E217) Cooling Differential Chrysler
E219) - 251 cu. in. engines.

Production Orders:

C.D. - L.V. 125
L.V. 227
L.V. 539
L.V. 640
L.V. 1557
L.V. 472
S/M 1077
Aust. 278 CA 652

Approx. Price per unit - less equipment supplied by ordnance - $9,600.

CAR, LIGHT RECONNAISSANCE
G.M. MK.I (OTTER I)

LIGHT RECONNAISSANCE CAR MK I

GENERAL

A CLOSED 4x4 ARMOURED WHEELED VEHICLE FOR THREE MEN, mounted on a FRONT ENGINED CHASSIS and designed for ROAD AND CROSS COUNTRY OPERATION. The Driver and Commander occupy the two forward seats. The Gunner occupies the seat in the turret. The TURRET is small, open topped and can be REVOLVED MANUALLY through 360°. BREN GUN can be MOUNTED on variable elevation mount IN TURRET and BOYS A.T. GUN can be MOUNTED on pivot THROUGH FRONT PORT. PROTECTION IS PROVIDED AGAINST SMALL ARMS FIRE, FRONTAL .303 A.P., SIDE, REAR AND ROOF .303 BALL. Provision is made for equipping this vehicle with A #19 WIRELESS SET AND INTER-COMMUNICATION. Entrance to and from the vehicle is through TWO DOORS, one on each side.

DRIVER'S VISION is THROUGH a PORT in the front of the vehicle which has a REMOVABLE WINDSHIELD. When the flap is closed VISION is THROUGH SLITS, which are protected by a THICK TRIPLEX GLASS BLOCK. A similar FRONT PORT is provided FOR the COMMANDER. Driver's side vision is through front quarter ports in the side doors and rear vision is through a port in the rear of the hull.

STOWAGE

Accommodation for rifle, Bren M.G. and Boys A/T rifle in fighting compartment. Ammunition and spares for armament located adjacent to user in racks, clips, etc. Personnel equipment, rations, etc. stowed in bin at rear of fighting compartment and vehicle tools and equipment carried in external rear compartment and fender bins. Tow cables, picks, shovels, etc. carried on the rear exterior of the vehicle. Extra petrol, oil and water carried in standard 2 gallon cans in external rear compartment bin.

VEHICLE PERFORMANCE

POWER/WEIGHT - Net power to gross weight ratio 16.5 B.H.P. per short ton.

GRADEABILITY - Theoretical percentages-

1st.	2nd.	3rd.	4th.
47.5%	23.7%	11.3%	6.0%

- Actual by test:-

1st. - 40° concrete slope.

PERFORMANCE

Top Speed:- Governed at 45 m.p.h.

¼ Mile Run	Time secs.	Average Speed	Speed at end of run
Standing start	37	24.3 m.p.h.	35 m.p.h.
Flying start	23	39.2 m.p.h.	45 m.p.h.

40 Mile Cross Country Run -
Speed - 14 m.p.h. average

(Fuel consumption - 5 m.p.g.)
(Oil consumption - nil.)

100 Mile Road Run -
Speed - 43 m.p.h. average

(Fuel consumption - 10.3 m.p.g.)
(Oil consumption - nil.)

CRUISING RANGE

Highway - 261.6 miles
(131 out and 131 return)
Cross Country - 127 miles
(63.5 out and 63.5 return)

STABILIZED TEMPERATURE DIFFERENTIALS

	Max. Torque At 1350 R.P.M.	Peak B.H.P. At 2750 R.P.M.
Water	91°	137°
Engine oil	155°	235°
Trans. oil	153°	179°
Diff. oil	126°	106

NOTE: Condition of high oil temperature was corrected by deeper oil pan on Armoured Truck. High water temperature was also thereby corrected. Cooling trial figures arrived at by towed load method.

BRAKE EFFICIENCY:

	Distance	Deceleration Rate
20 M.P.H. Hand	45'	9.65 f/s/s
20 M.P.H. Foot	19'	22.5 f/s/s

FORDING DEPTH - 18"

TILTING ANGLES -

Vehicle facing up 40° slope satisfactory
Vehicle facing down 40% slope satisfactory
Across slope 25° satisfactory R. & L. side

ANGLE OF OVERTURN -

Right Side up - 40°
Left Side up - 40°

VEHICLE DATA

CHASSIS MANUFACTURER -
General Motors of Canada Ltd.

HULL MANUFACTURER - Hamilton Bridge Co.

LOAD CARRYING CAPACITY - 1648 pounds.

PERMISSIBLE MAX. GROSS WEIGHT -

without desert equipment -	10961
front axle -	5301
rear axle -	5600

WHEELBASE - 101½"

TRACK - Front - 70"
Rear - 70½"

TIRES - 9.00 x 16 - 8 ply Run Flat

OVERALL LENGTH - 14' 9"
WIDTH - 7'
HEIGHT - 8'

TURNING CIRCLE R. - 49'
L. - 47' 11"

AXLE - FRONT - Spiral bevel gear
5" constant velocity
Bendix steering ends
Ratio - 6.5 to 1

REAR - Spiral bevel gear
Full floating
Ratio 6.5 to 1

DRIVE - Hotchkiss type. Propeller shafts and universal joints, going from transfer case to front and rear axles.

BRAKES - SERVICE - 4 wheel hydraulic internal expanding with Vacuum booster cylinder.
Front drum diameter - 14"
Rear drum diameter - 15"
Lining area - 197 sq. in.
(each axle)

BRAKES - PARKING - Band type at rear of transfer case
Drum diameter - 9½"
Lining Area 87 sq. in.

CLUTCH - Single plate dry disc.
Total facing area - 136.170 sq. in.

COOLING SYSTEM - Circulating liquid pressure type.
Centrifugal type pump driven by V fan belt from crankshaft.
Radiator pin and tube, frontal area 432.96 sq. in.
Capacity of system - 14.8 qts.
Thermostat - yes

ELECTRICAL SYSTEM -

Generator - Delco Remy
Voltage - 12
Controls, Voltage and Current Regulator
Amperage - 40

Battery - Prestolete 2 batteries
6 volts - plates per cell 15
Terminal grounded, negative
Ampere hours 95 @ 20 hr. rate.

Starter - Delco Remy
Bendix drive magnetic switch, controlled from dash.
Ratio 15.44 to 1
Flywheel teeth - 13
Pinion - 9

Lights - Blackout equipment in accordance with Spec. C.A. 62.

ENGINE - G.M. 270 type overhead valves
6 cylinder
Displacement - 269.5 cu. in.
Peak gross B.H.P. 104 @ 3000 R.P.M.
Max. Gross Torque 220 ft. pounds @ 800 - 1800 R.P.M.
Lubrication - full pressure type, normal operating pressure 35 - 40 p.s.i. @ 1000 R.P.M.

VEHICLE DATA (Cont'd)

FUEL SYSTEM -

Carburetor - Down draft Zenith with accelerating pump.
Governor - Velocity type (setting 3000 R.P.M.)
Make - King Seeley
Pump - Diaphragm type driven off camshaft.
Fuel tanks capacity - 26.4 gal. (imp.)

FRAME - Ladder type - high carbon steel
Cross members - 4
Maximum depth of side rail - 8"

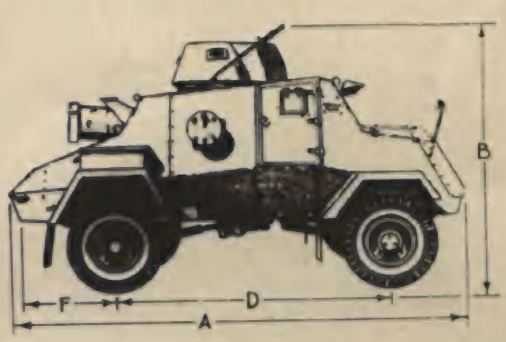
SPRINGS - Semi elleptic overslung
Alloy spring steel

	Front	Rear
Length (loaded)	40"	50"
Width	2"	2½"
No. of leaves	13	12
Rate of deflection	1022 # per. in.	833 # per in.

STEERING - Type, recirculating ball
Gear ratio 23.6 to 1

TRANSMISSION - 4 speed forward
1 reverse

Ratios:	4th	1 to 1
	3rd	1.73 to 1
	2nd	3.31 to 1
	1st	6.36 to 1
	Reverse	7.64 to 1

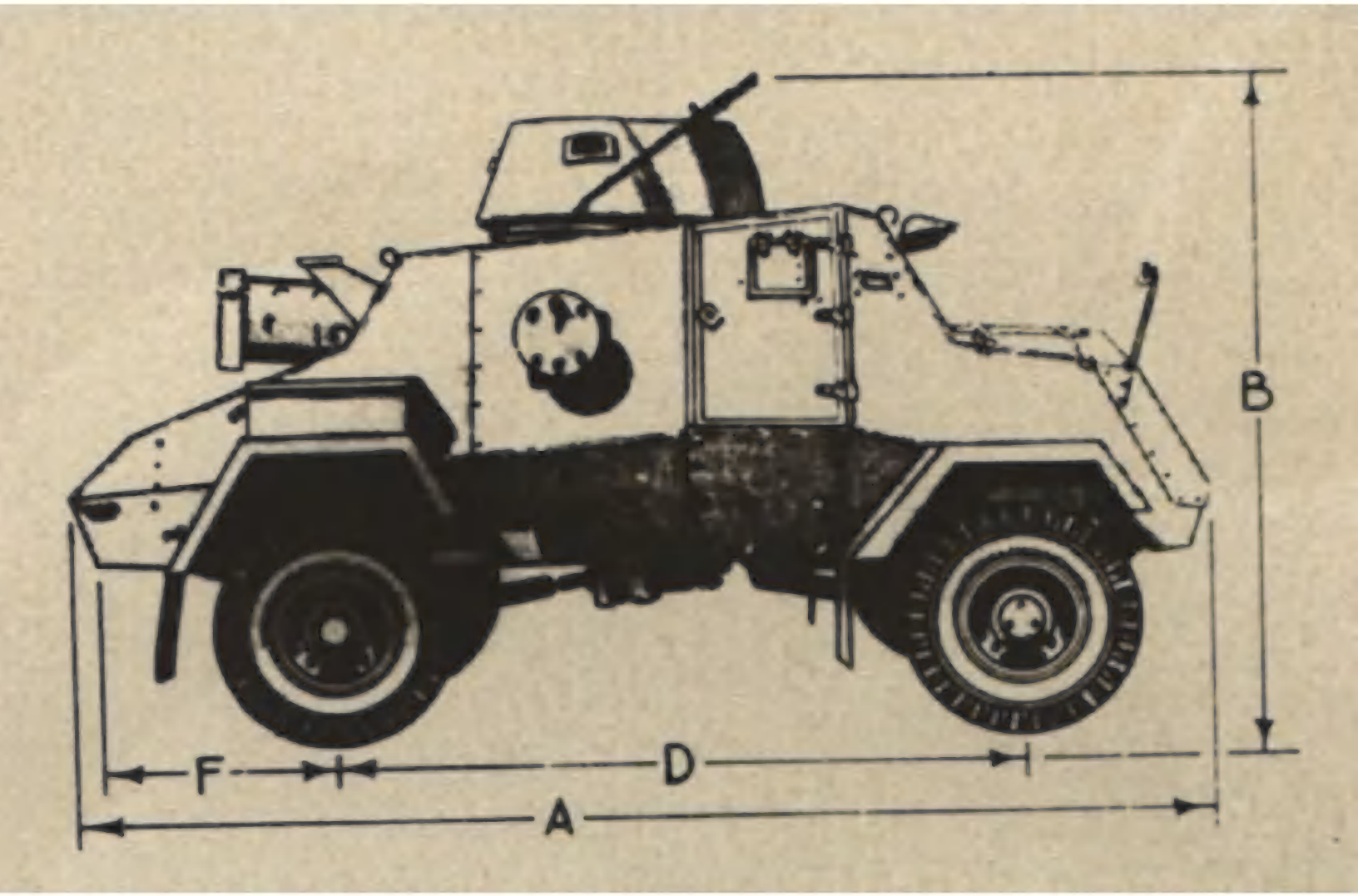


A	B	C	D	E	F	G	Maximum Height
178 3/4"	94 1/2"	84"	101 1/2"	70"	38 1/4"	31 5/8"	94 1/2"
Ground Clearance under Axles: Front 8 3/4"							
" " " " : Rear 8 3/4"							
" " At Centre: 1/4"							
Above Clearances are on a rolling radius of 16.34							

WEIGHTS

	Front	Rear	Total
Curb Weight (Vehicle complete with maximum amounts of gasoline, oil and water and vehicle tools and equipment in accordance with Table No. 50).	4864	4974	9868
Stowed Weight (Vehicle complete with maximum amounts of gasoline, oil and water, vehicle tools and equipment and Ordnance equipment in accordance with Stowage List No. T.D. 138)	4994	5374	10368

	Front	Rear	Total
Gross Weight (Vehicle complete as described in "Stowed" Weight above but with driver and crew of 2 men, @ 165 lbs. each, added.)	5264	5544	10868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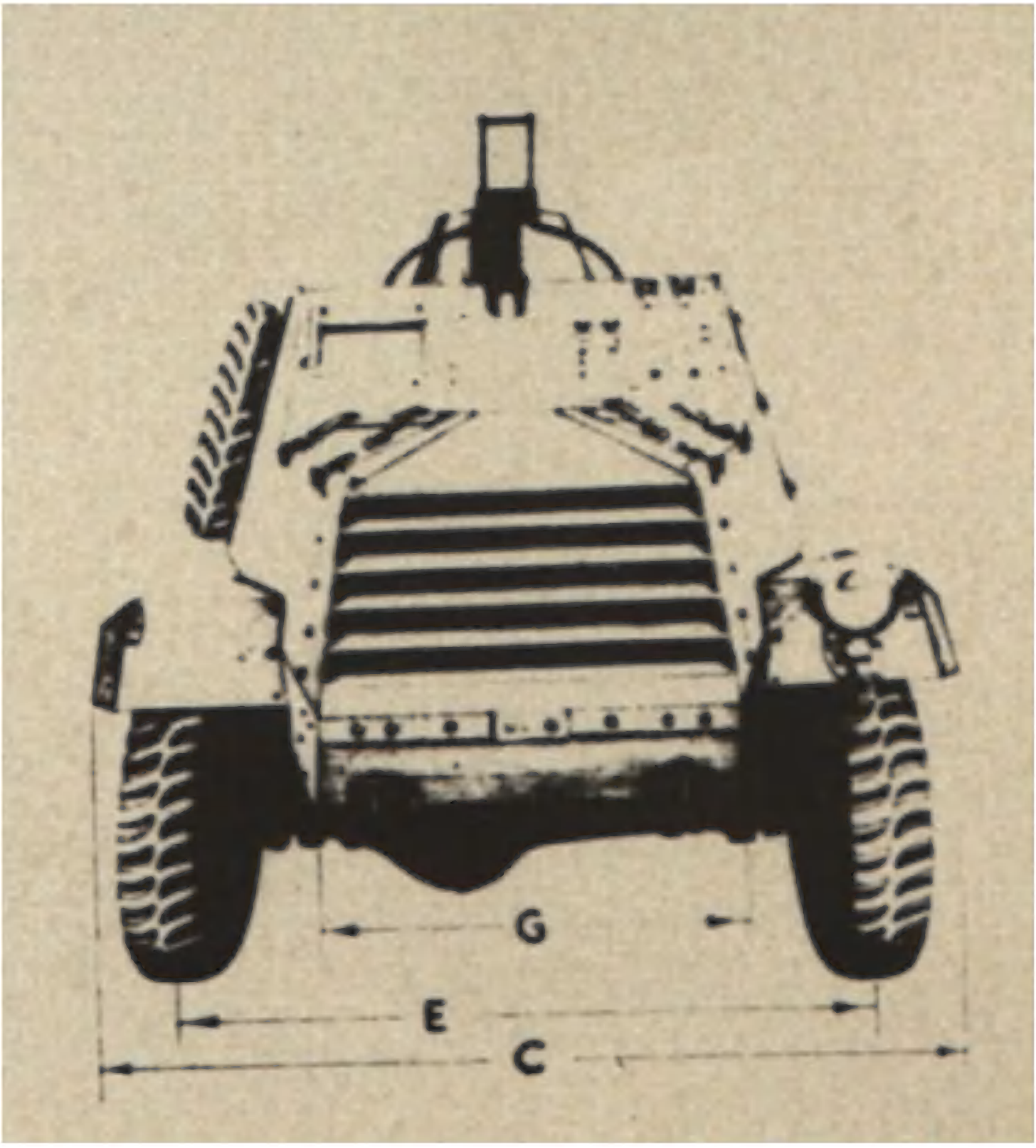
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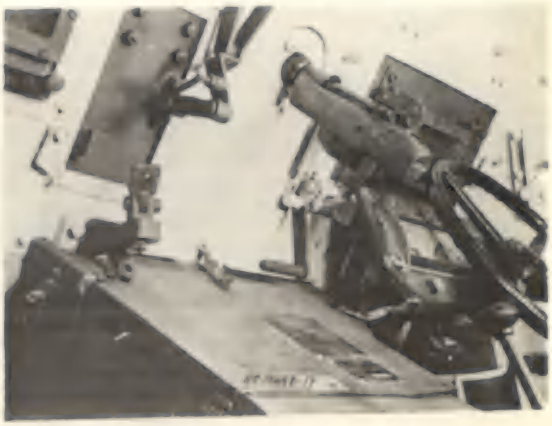
FRONT VIEW

LEFT SIDE (SHOWING SAND CHANNELS)

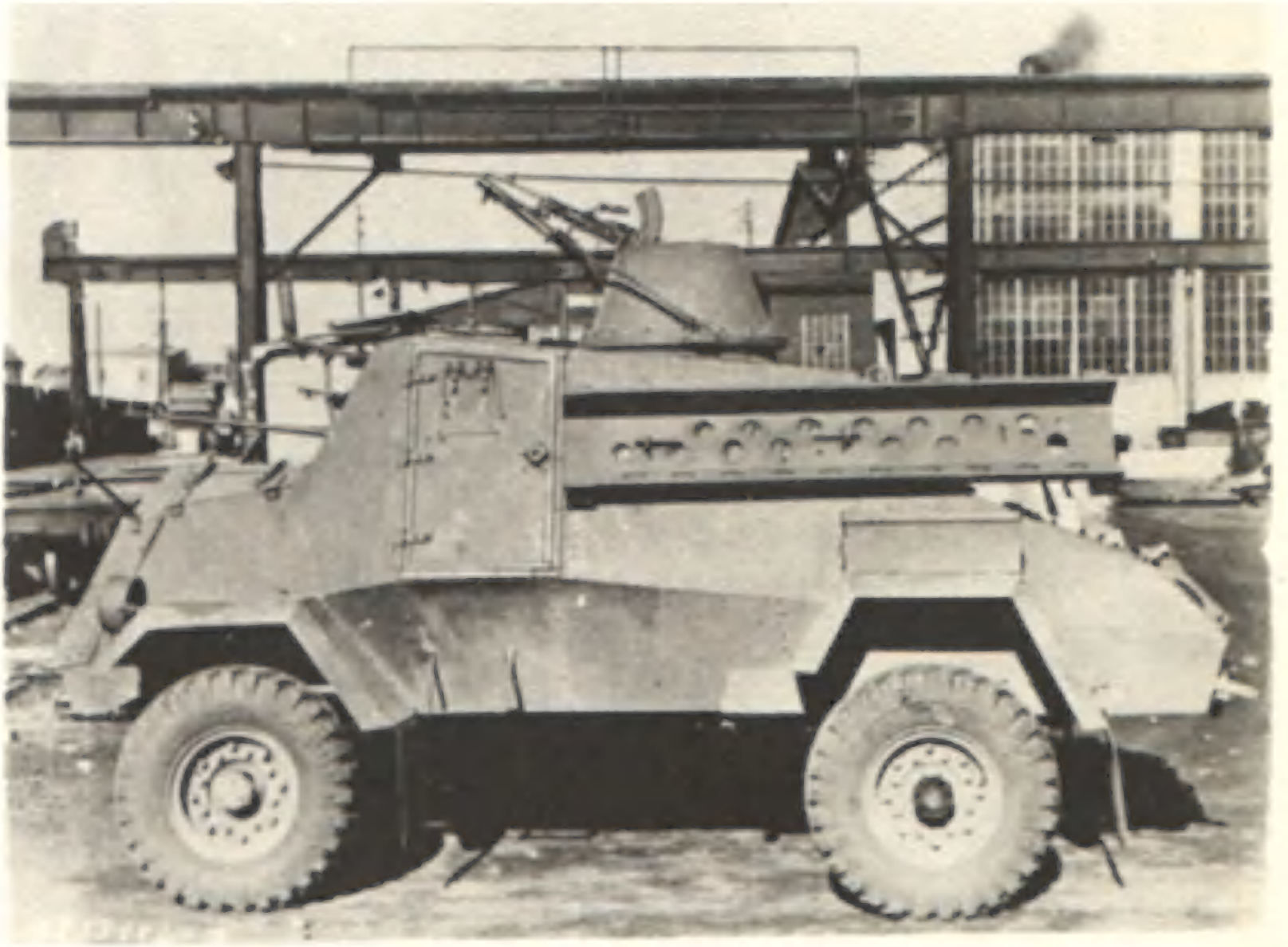
RIGHT SIDE

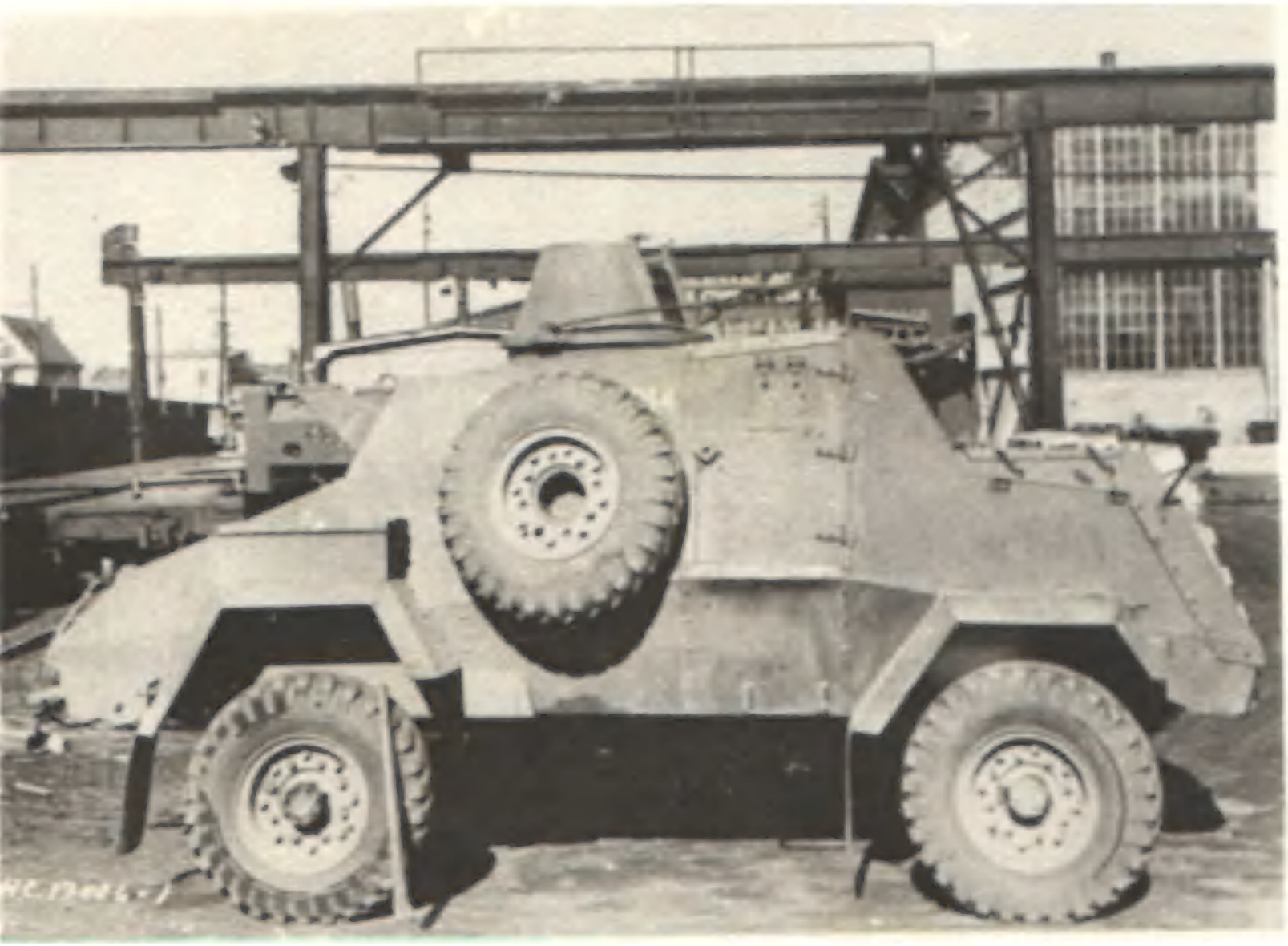
REAR VIEW

TURRET SEAT (LOOKING DOWN THROUGH TURRET)



INSIDE VIEW (SHOWING CONTROLS)



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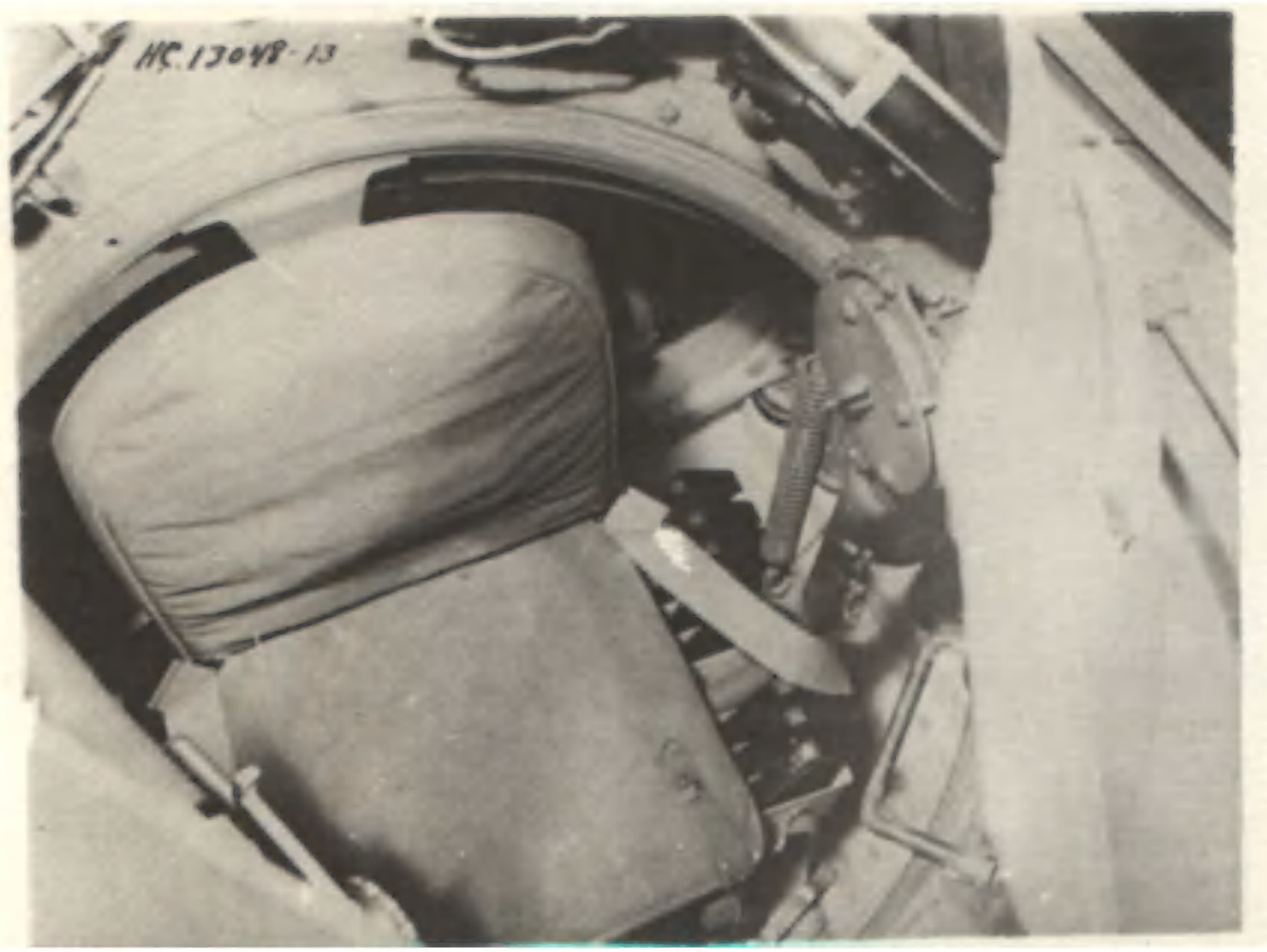
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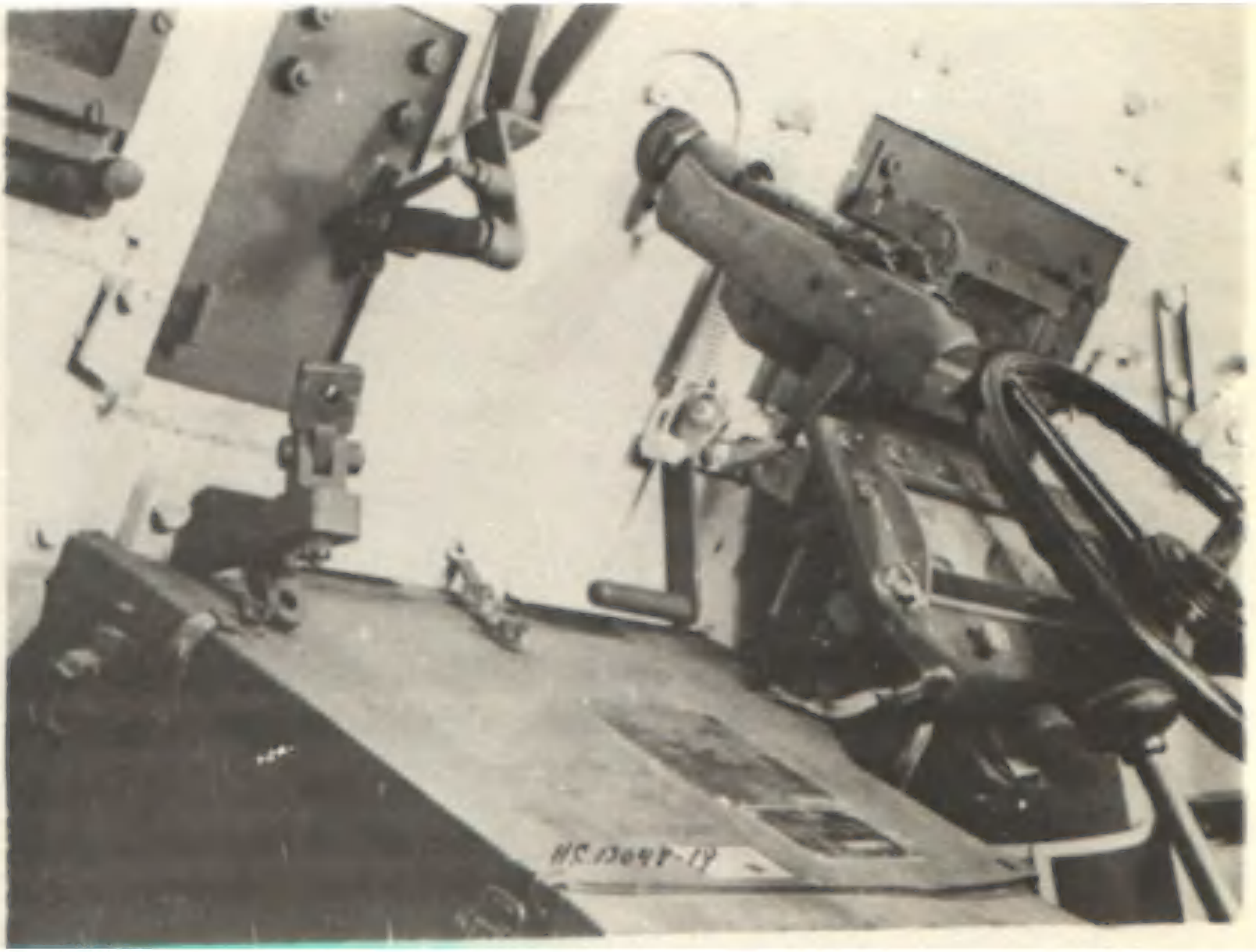


USER COMMENTS

EXCERPT FROM W.V.E.E. REPORT NO. B949/1
JULY 18, 1942

Observations and conclusions of T.T.2. This vehicle now in current production in Canada, was designed as an alternative to the Humber Light Reconnaissance Car, Mark III and is now being issued for Service use, Sply/Mech/2424 refers.

Whilst its general performance is satisfactory, it suffers from the following disadvantages when compared with the Humber:

1. The maximum speed and top gear performance is well below that of the Humber, due mainly to its greater weight.
2. The maximum speed on cross country and on hilly roads is also limited by the fact that no auxiliary gear box is fitted.
3. The driving vision is poor both with the vizors open and shut.
4. The handbrake is of the parking type.

REFERENCES

DAD Specification O.A. 204

Hull Drwg. Schedule 20061

General Motors Maintenance Manual - Publication number RAC-C2

General Motors Spare Parts List - Publication number CRAC-02

Files Series
D.M.S.-141-3-1,2,3,4, etc.
D.N.D.-H.Q.S. 33-52-17
H.Q.S. 33-52-17-1
M.O.S.-T.T.2. 257/Veh/2567
D.M.S.-D.A.D. Photo File No. A-5

W.V.E.E. Reports.

949/1)
949/2) - Experimental Report on Performance Trials of
949/3) G.M. Light Reconnaissance Car, No. 2 - 18/7/42 and 12/9/42.

1961 - Damper for Steering Column to C.M.H.Q. Design fitted to G.M. Light Reconnaissance Car, MK I - 14/6/44.

B949/3 - Condition of Components of the G.M. Reconnaissance Car - 16/4/43.

A.E.D.B. Experimental Engineering Reports:

E48 - Installation of Smoke Mortar
E330 - Barrel Protector - 2" Smoke Mortar

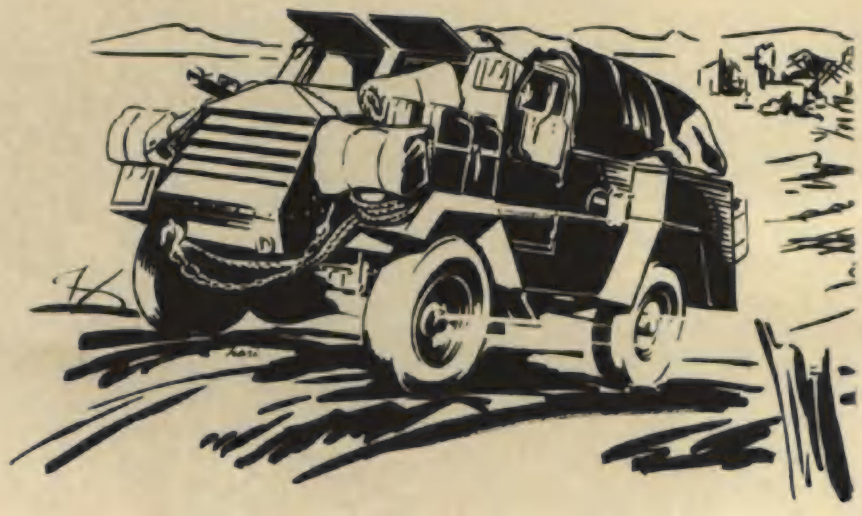
Production Orders:

C.D. - L.V. 127
L.V. 225
L.V. 1556
L.V. 1594

S/M - 2424

Approx. Price per unit - less equipment supplied by Ordnance - $5,300.

TRUCK, ARMOURED
15 CWT. 4x4 (G.M.)



TRUCK, ARMOURED, 15 CWT 4x4 G.M.

GENERAL:

AN OPEN TYPE FRONT ENGINED ARMOURED WHEELED CROSS COUNTRY VEHICLE of which the chief role is the carrying of personnel. Will carry eight men, including driver, and their equipment. Can alternatively be used for CARRYING TWO STRETCHERS by folding down seats and moving stretcher brackets into place. By removing crew seats vehicle can be used as ARMOURED LOAD CARRIER or to MOUNT A GUN in the four foot diameter clear floor space available.

SEATING ARRANGEMENT FOR EIGHT MEN provided for maximum comfort by means of individual seats and adequate foot wells. Seats and height of hull sides arranged to permit shooting over the sides of hull. FULL HEIGHT FRONTAL PROTECTION provided AGAINST .303 A.P. Driver's and mate's forward vision ordinarily through large front ports which are provided with glass windshields. For "closed down" driving front vision through protectoscopes. SIDE AND REAR PROTECTION AGAINST .303 BALL. FULL HEIGHT SIDE DOORS protect driver and mate. Remainder of SIDE AND REAR PROTECTION SHOULDER HIGH for sitting men. Rear entry through wide rear door. Roof bows and tarpaulin provide OVERHEAD PROTECTION FROM WEATHER.

STOWAGE

Accommodation for armament i.e. G.S. rifles, Thompson or Sten carbines provided adjacent to crew and driver. Steel mesh removable bins over gas tanks in rear compartment carry respirators, haversacks and blankets with packs and camouflage nets stowed in exterior side bins. Vehicle tools and equipment in front and rear floor compartments, with pick, shovel, jerricans, etc. stowed on rear exterior of the vehicle.

VEHICLE PERFORMANCE

POWER/WEIGHT - Net power to gross weight ratio 1b.3 B.H.P. per short ton.

GRADEABILITY - Theoretical percentages:- in low transfer ratio

1st.	2nd.	3rd.	4th.	Reverse
61.6%	29%	20%	10.6%	73.6%

Actual by test:-
Successful climbs of 60% gradient (No. 1 O.P.C.) in both low and reverse gears.
Successful stops & restarts on 60% gradient in both low and reverse gear.
Note: 60% gradient is maximum prepared gradient available.

PERFORMANCE

Top Speed:- Governed at 45 m.p.h.

¼ Mile Run

	Time	Average Speed	Speed at end of run
Standing start	35 sec.	26 m.p.h.	37 m.p.h.
Flying start	20 sec.	45 m.p.h.	45 m.p.h.

40 Mile Cross Country Run - Speed - 12.3 m.p.h. average.

(Fuel consumption - 6.66 m.p.g.)
(Oil consumption - Nil.)

100 Mile Road Run - Speed - 42.8 m.p.h. average.

(Fuel consumption - 11.1 m.p.g.)
(Oil consumption - 1600 m.p.g.)

CRUISING RANGE - Highway 444 miles (222 out and 222 back)
Cross Country 266 miles (133 out & 133 back)

STABILIZED TEMPERATURE DIFFERENTIALS

	100 Mile Road Run	Max. B.H.P.	Max. Torque
Water	79°	98°	96°
x Engine Oil	142°	167°	124°
xx Engine Oil	87°	85°	84°
Transmission Oil	76°	122°	82°
Transfer Case Oil	128°	108°	96°
Differential Oil	89°	86°	62°

x Engine equipped with original shallow oil pan.
xx " " " revised deep " "

BRAKE EFFICIENCY

		Distance	Deceleration Rate	% efficiency
10 M.P.H.	Hand	17.6 ft.		
30 M.P.H.	Foot	36.7 ft.	26.1 f.p.s.	78%

FORDING DEPTH - 16"

RAMP CLEARANCE -

TILTING ANGLES - Satisfactory engine performance.

Idling for 5 minutes in following positions.

Front up 60%, Front down 60%.
Right side up 15°, Left side up 15°

ANGLE OF OVERTURN - Right Side up 39°,
Left Side up 40°

VEHICLE DATA

CHASSIS MANUFACTURER - General Motors of Canada Ltd. (G.M. model 8649)

HULL MANUFACTURER - Hamilton Bridge Co. Ltd.

LOAD CARRYING CAPACITY - 1750 pounds.

PERMISSIBLE MAX. GROSS WEIGHT - 11175 pounds.

front axle - 4655
rear axle - 6545

WHEELBASE - 101" TREAD - front - 70, rear - 70.5

TIRES - 10.50 x 18 pneumatic (1 spare carried on left side.)

OVERALL LENGTH - 187"
WIDTH - 90"
HEIGHT - 89½"

ANGLE OF APPROACH 50° 30'
ANGLE OF DEPARTURE 36° 20'

TURNING CIRCLE L.H. 48' 3"
R.H. 50' 2"

AXLE - FRONT - Driving type - 5" Bendix joints.
Spiral bevel ring gear and pinion, 6.5:1 ratio

REAR - Full floating - spiral bevel ring gear and pinion of 6.5:1 ratio.

BRAKES - SERVICE - 4 wheel hydraulic internal expanding.
Front drum diameter 14"
Rear drum diameter 16"
Lining width front 2" - rear 3.5"

PARKING - Driveshaft type mounted on rear.
Drum diameter 9½"
Lining width 3".

CLUTCH - Single dry plate - disc diameter 11½".

COOLING SYSTEM - Circulating liquid pressure type.
Centrifugal type pump driven by double V belt from crankshaft.
Radiator - tube and fin type - 3 3/8" thick
frontal area 433 sq. ins.
- Capacity - 14.8 qts. (IMP)
Pressure - 3¼ - 4½ P.S.I.
Thermostat - yes

DRIVE - Hotchkiss type. Drive shafts going from transfer case to front and rear axles.
Universal Joints - open type (Spicer).

ELECTRICAL SYSTEM - (First Production) - 6 volt single wire.
Battery - 3 cell 90 amp. hr. capacity.
Generator - 35 amp. air cooled driven by double V. belt from crankshaft.

- (Later Production) - 12 volt single wire.
Battery - two - 3 cell 125 amp. hr. capacity
Generator - 55 amp. air cooled driven by double V belt from crankshaft.

Lights (including blackout equipment) - in accordance with Spec. O.A. 62.

ENGINE - Make - General Motors.
6 cylinder - valve in head.
Displacement - 269.5 cu. ins.
Peak Gross B.H.P. 104 at 3000 R.P.M.
Max. Gross Torque - 220 ft. pounds at 800 - 1800 R.P.M.
Lubrication - Full Pressure type - normal operating pressure 35 - 40 p.s.i. at 1000 R.P.M.

FUEL SYSTEM - Carburetor - Down Draft Zenith with acceleration pump.
Governor - Velocity type (Setting - 2750 R.P.M.)
Pump - Diaphragm type driven off camshaft.
Fuel Tanks - two - one in each rear corner of hull, each 20 gal. (IMP) capacity.

FRAME - Ladder type - high carbon steel.
Cross members - 4
Max. depth of side rail - 8"

SPRINGS - Semi elliptic - overslung.
(Front springs have cast eye.)
Material - alloy Spring steel.

	Front	Rear
Length (loaded)	40"	50"
Width	2"	2½"
No. of leaves	13	12
Rate	1078 # per in.	833 # per in.

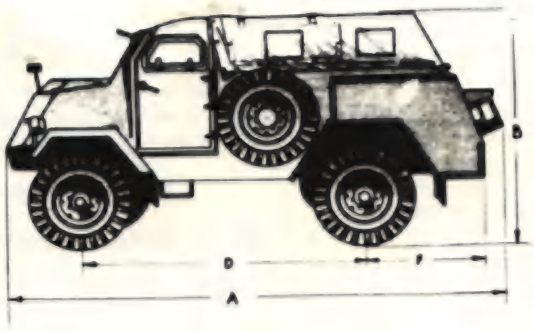
STEERING - Type - worm and roller (recirculating ball).
Gear ratio - 23.6:1
Turning diameter right - 50' 2"
left - 48' 3"

TRANSMISSION - 4 speed crash type
Ratios - 4th speed 1:1
3rd " 1.89:1
2nd " 2.61:1
1st " 6.00:1
Reverse 6.94:1

Mechanical Tire Pump - driven off transmission

TRANSFER CASE - 2 speed type with declutch on front axle drive.

Ratios - High range - 1:1
Low range - 1.87:1

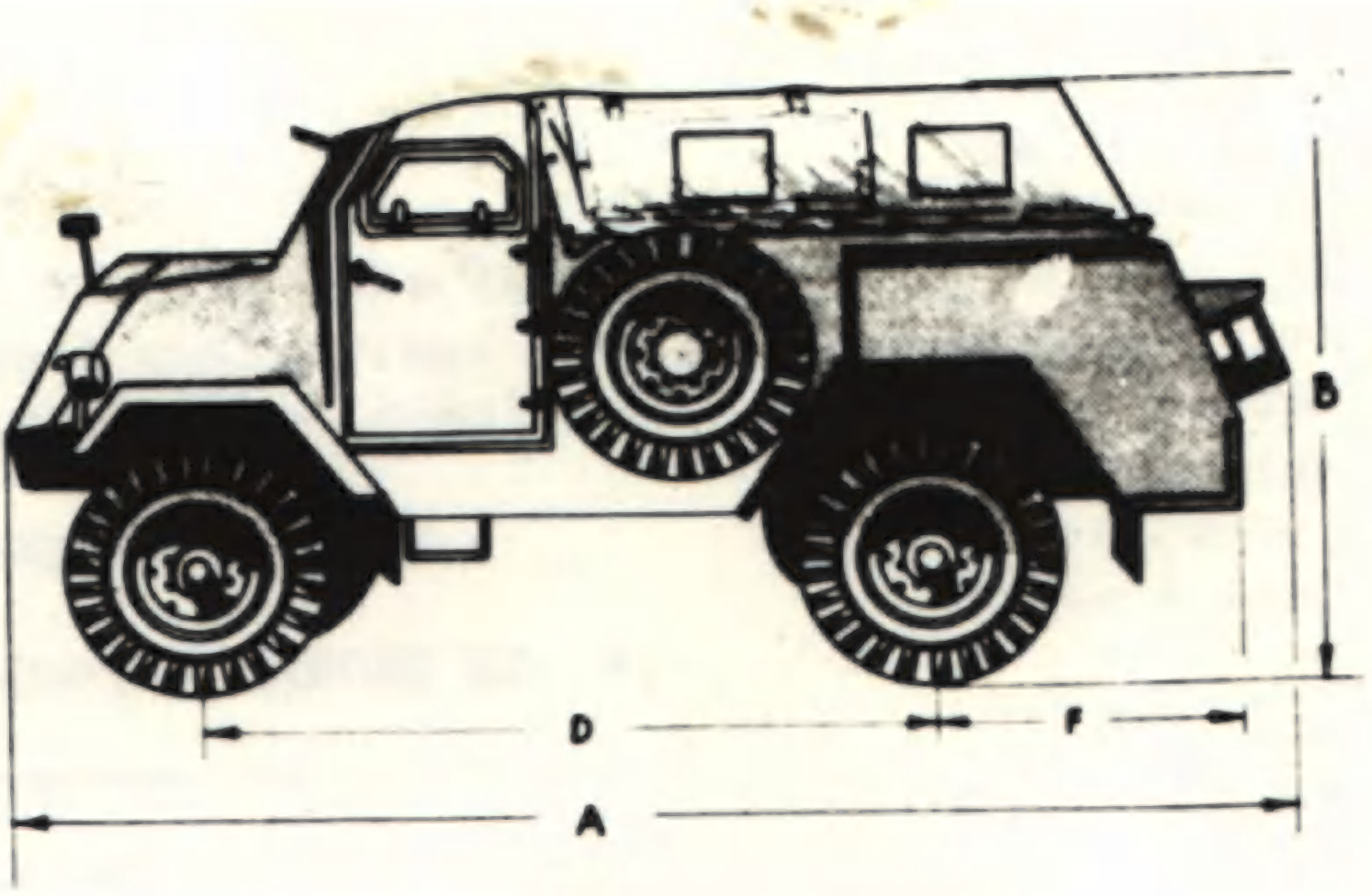


A	B	C	D	E	F	G	Maximum Height
187"	83 1/2"	92"	101 1/2"	70°	40°	33 15/16"	Tarpaulin Top 89 1/2"
Ground Clearance under Axle: Front - 9 9/16"							
" " " " : Rear - 9 9/16"							
" " At Centre: 18 1/2"							
Above Clearances are on a rolling radius of 17.54							

WEIGHTS

Vehicle equipped with Pneumatic Tires.

	Front	Rear	Total
Curb Weight (Vehicle complete with maximum amounts of gasoline oil and water and vehicle tools and equipment in accordance with Table No. 52)	4405	5625	10040
Stowed Weight (Vehicle complete with maximum amounts of gasoline, oil and water and vehicle tools and equipment and Ordnance equipment in accordance with Stowage List No. 211)	4485	5980	10455
Gross Weight (Vehicle complete as described in "Stowed" weight above but with crew of 8 men, including driver, @ 165 lbs. each.	4855	6945	11775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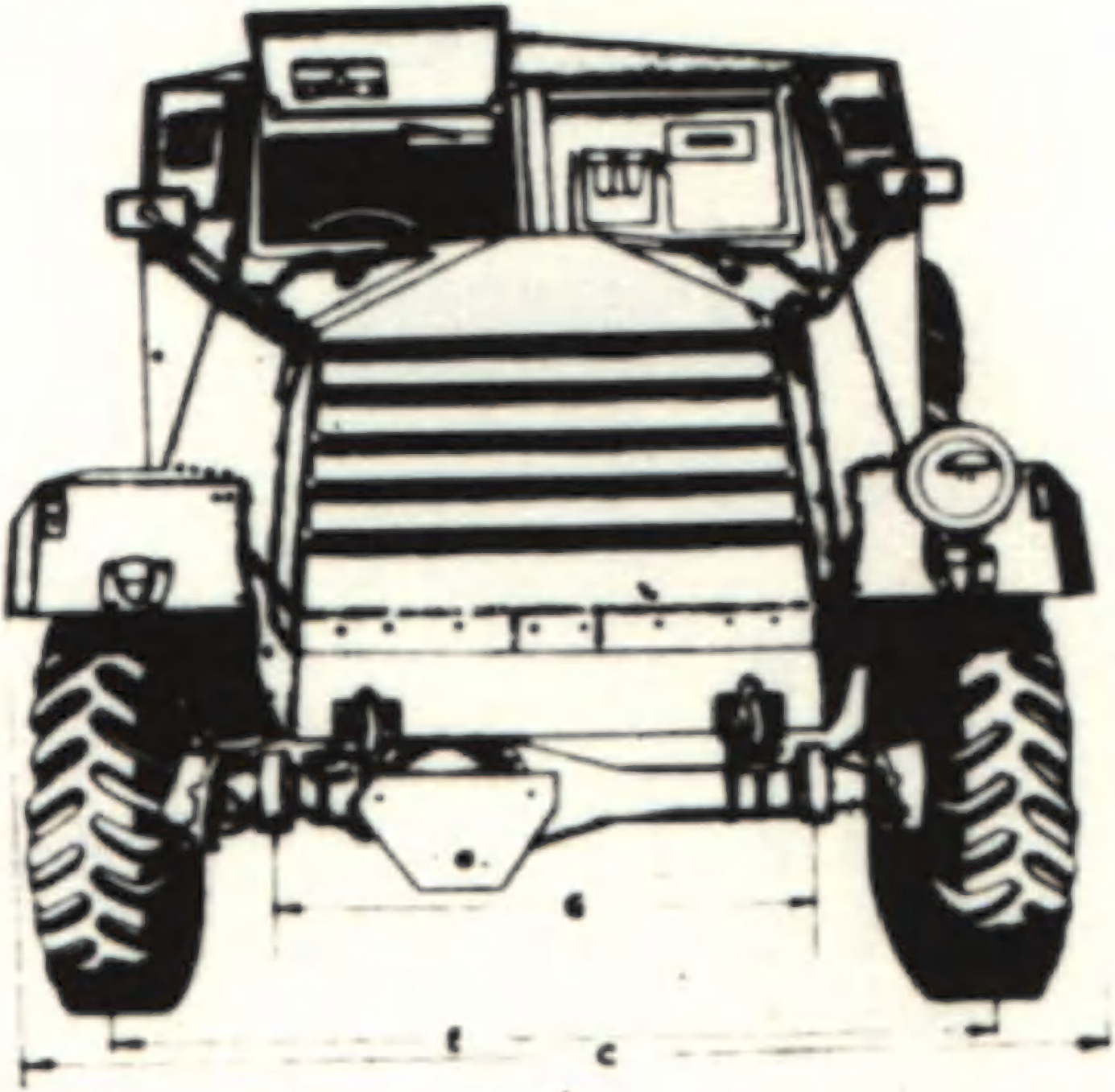
D
F
A



USER COMMENTS

EXCERPT FROM AIRL 1227
JULY 10, 1944 (FROM D.D.E.M.)

In record of meeting held at W.V.E.E. on Wednesday, June 14 to investigate the comparative riding qualities of existing Ambulance types, it is stated that the Truck, Armoured 15 Cwt. 4x4 afforded the greatest average degree of comfort under all conditions.

EXCERPT FROM 257/VEH/2796
JULY 18, 1944 (FROM M.O.S.)

1. "Original performance trials now completed and earlier impressions that the vehicle has very good cross country performance and that suspension is satisfactory are confirmed."

2. "As a personnel carrier the vehicle was generally acceptable."

3. "Comfort afforded stretcher patients (in Ambulance role) is comparable with that afforded by the best of our standard ambulances."

EXCERPT FROM AIRL 1345,
AUGUST 23, 1944 (FROM D.D.E.M.)

"You will be pleased to note that the armour plate is of good quality and complies with the requirements of Specification I.T. 100 D."
(Refer D.T.D. Test Report AT 218).

EXCERPT FROM C.M.H.Q. MONTHLY REPORT NO. 8,
SEPTEMBER, 1944.

"Trucks 15 Cwt. 4x4 Armoured are being called forward by First Canadian Army to replace White 4x4 Scout Cars and a proportion of the 15 Cwt. half tracks."

EXCERPT FROM C.M.H.Q. MONTHLY REPORT NO. 9
OCTOBER, 1944.

"Attention is drawn to the following comment, contained in 1 Canadian A.F.V. (T) Report No.2 Appendix C. Visit to Seventh Canadian R.E.C.C.E. Regiment forwarded to Canada (D.S.D. (W)) 28 Oct.'44, File 55/563/9 FD 7, the 15 cwt. 4x4 Armoured Canadian is very well liked as a Command Vehicle, an N.O.'s vehicle and for the assault squadron. This vehicle is preferred to the half track and the White Scout Car because of its shorter wheel base and better manoeuvreability."

EXCERPT FROM ALFSEA ARMOURED CORPS LIAISON LETTER NO. 4, AUGUST 10, 1945 (para. 179) (covering operations in Burma).

"One of these vehs whi h was sent to Fourteenth Army for trials was used for approx. three months by PAVO Cav during recent ops in BURMA. During this period, it covered approx. 2500 miles and acquired a very high reputation for itself. It was used continuously on very bad roads and tracks, and did a certain amount of cross-country work. It was also employed for towing other vehs, incl armd cars, in which role it acquitted itself entirely satisfactorily. Its armour afforded adequate protection against small arms fire and its accommodation was ample for a rifle sec complete with kit. No fittings for the installation of a No. 19 wireless set were incorporated on the vehicle, which would be required if it were used for the carriage of rifle tps in Armd Car or Recce regts, but otherwise it proved itself to be a very suitable veh for this role."

REFERENCES

DAD Specification O.A. 208.

Hull Drwg. Schedule 20062.

General Motors Production Parts List (Model 8449) for Chassis Parts.

Hamilton Bridge Production Parts List (Contract 7653) for Hull Parts.

General Motors Maintenance Manual - Publication number TA-C1.

General Motors Driver's Handbook - Publication number C15TA-HB1.

General Motors Illustrated Parts Catalogue - Publication number C15TA-01

Files Series

D.M.S. - 141-6-1,2,3, etc.
D.N.D. - H.Q.S. 54-27-18-53-10
M.O.S. - T.T.2. 257/Veh/2796
257/Veh/2233
257/Veh/1681
D.M.S. - D.A.D. Photo File No. A-7.

A.E.D.B. Experimental Engineering Reports:

E 257 - Performance
E 362 - Performance and Reliability
E 359 - Jerrican and P.O.W. Container Tests
E 381 - Check of Tools for Maintenance Tasks.
E 400 - Rolling Resistance.
E 405 - Check of Gun Clips.
E 414 - Experimental Fuel Tank Cover Tests.
E 417 - Bolted Type Jerrican Brackets.
E 420 - Performance Trials.

D.V.A. Report - Project D.V.A. - 6 - 368.

Production Orders:

S/M 2611		3000
C.D. -	L.V. 2524	800
	L.V. 1530	2
	L.V. 2613	100
	L.V. 3504	600

Approx. Price per unit - less equipment supplied by Ordnance.....$4,500.

FRONT QUARTER VIEW

SIDE VIEW.

REAR VIEW (TARPAULIN IN PLACE)

REAR VIEW (TARPAULIN REMOVED)

INSIDE VIEW LOOKING FORWARD

VIEW LEFT SIDE SHOWING STRETCHER BRACKETS IN USE


HC 12802-10

AMBULANCE, ARMOURED
4x4 (G.M.)

AMBULANCE, ARMOURED (4 STRETCHER) C.M.

GENERAL

A FRONT ENGINED ARMOURED 4 WHEEL DRIVE vehicle designed to CARRY FOUR STRETCHERS, with provision for attendant. GOOD HIGHWAY and CROSS COUNTRY performance.

"Carter" type STRETCHER GEAR which provide BERTHS FOR FOUR STRETCHERS and permit loading stretchers for all positions by men on the ground through back door and at shoulder height for upper berths.

Ambulance compartment has CANVAS AND PLYWOOD ROOF with SKYLIGHT and ROOF HATCH. Interior LINED WITH PLYWOOD for insulation. Large hot water HEATER and FOUR VENTILATING FANS provided. Lighting provided by TWO DOME LIGHTS and one LIGHT OVER EACH BERTH.

FULL FRONTAL PROTECTION AGAINST 303 A.P. and SIDE AND REAR PROTECTION AGAINST .303 BALL attack. Driver's and Mate's FORWARD VISION. Ordinarily THROUGH LARGE FRONT PORTS which are provided with glass windshields. For "CLOSED DOWN" DRIVING forward VISION THROUGH PROTECTOSCOPES.

STOWAGE

Vehicle tools and equipment are stowed in floor compartments located in the left front and centre rear floor of the vehicle with pick, shovel, jerricans carried on the rear exterior of the vehicle. A 4 gallon water container is mounted in the front compartment above the driver and medical stores, blankets, respirators and groundsheets are carried inside the vehicle in readily available location.

NOTES: 1. Due to cessation of hostilities production orders for this vehicle were cancelled.

2. For any future development of this type of vehicle the following points should be given consideration.-

(a) Ideally the height for loading of the stretcher should be such that a 5'7" man can lift the stretcher into position before he loses the strength of his arm through bending them.

(b) Although the present stretcher retaining straps of aircraft quick release buckle type have proved satisfactory under tests, further investigations should be made so that an automatically adjustable cam type locking clamp would be incorporated.

(c) Also further development should be instituted to incorporate an automatic lock for the upper stretcher frame to prevent the unloading of the upper stretcher before the lower stretcher is removed.

→ AMBULANCE, ARMOURED (PAGE 1) OF 6 PAGES

VEHICLE PERFORMANCE

POWER/WEIGHT - Net power to gross weight ratio 15 B.H.P. per short ton.

GRADEABILITY - Theoretical percentages:- in low transfer case ratio

1st.	2nd.	3rd.	4th.
58%	29%	21%	10%

- Actual by test:- Successful climbs of 60% in both low and reverse gears.

PERFORMANCE

Top speed - Governed at 45 M.P.H.

¼ Mile Run	Time secs.	Average Speed m.p.h.	Speed at end of run m.p.h.
Standing start	36.5	24.6	36
Flying start	22	41	48

50 Mile Cross Country Run - Speed - 13.4 m.p.h. average

(Fuel consumption - 5.57 m.p.g.)
(Oil consumption - nil.)

100 Mile Road Run - Speed - 41.5 m.p.h. average

(Fuel consumption - 8 m.p.g.)
(Oil consumption - nil.)

CRUISING RANGE

Highway - 184 (92 out and 92 back)
Cross Country - 125 miles (62 out and 62 back)

STABILIZED TEMPERATURE DIFFERENTIALS

	100 Mile Road Run	Max. B.H.P.	Max. Torque
Water	79°	98°	96°
xx Engine oil	67°	83°	84°
Transmission oil	76°	122°	82°
Transfer case oil	128°	138°	96°
Differential oil	59°	66°	62°

xx Engine equipped with revised deep oil pan

BRAKE EFFICIENCY

	Distance	Deceleration rate	% efficiency
20 M.P.H. Hand	38 ft.	11 ft/sec/sec	35%
20 M.P.H. Service		27.1 ft/sec/sec	84%

FORDING DEPTH - 18"

RAMP CLEARANCE -

TILTING ANGLES - Satisfactory engine performance.

Idling for 5 minutes in following positions

Front up	- 60%
Front down	- 60%
Right Side up	- 45°
Left Side up	- 45°

ANGLE OF OVERTURN -

Right Side up	- 39°
Left Side up	- 40°

VEHICLE DATA

CHASSIS MANUFACTURER - General Motors of Canada Ltd. (G.M. model 8449)

HULL MANUFACTURER - Hamilton Bridge Co. Ltd.

LOAD CARRYING CAPACITY - 1260 pounds (Including men)

PERMISSIBLE MAX. GROSS WEIGHT - 12080 pounds

Front axle -	5000
Rear axle -	7080

WHEELBASE - 101"

TREAD - front - 70
rear - 70.5

TIRES - 10.50 x 16 pneumatic (1 spare carried on left side.)

OVERALL LENGTH - 187"
WIDTH - 90"
HEIGHT - 97½"

ANGLE OF APPROACH - 50° 30'
ANGLE OF DEPARTURE - 36° 30'

TURNING CIRCLE - L.H. - 48' 3"
R.H. - 50' 2"

AXLE - FRONT - Driving type - 5" Bendix joints
Spiral bevel ring gear and pinion, 6.5:1 ratio

REAR - Full floating - Spiral bevel ring gear and pinion of 6.5:1 ratio

BRAKES - SERVICE - 4 wheel hydraulic internal expanding.
Front drum diam. - 14"
Rear drum diam. - 15"
Lining width -
front - 2"
rear - 3.5"

BRAKES (Cont'd)

PARKING - Driveshaft type mounted on rear.
Drum diameter - 9½"
Lining width - 3"

CLUTCH - Single dry plate - disc. diam. 11½"

COOLING SYSTEM -

Circulating liquid pressure type
Centrifugal type driven by double V belt from crankshaft.
Radiator - tube and fin type - 3 3/8" thick
frontal area 433 sq. ins.
Capacity - 14.8 qts. (IMP)
Pressure - 3½ - 4½ P.S.I.
Thermostat - yes

DRIVE - Hotchkiss type.
Drive shafts going from transfer case to front and rear axles.
Universal Joints - open type (Spicer).

ELECTRICAL SYSTEM -

12 volt single wire
Battery - two 3 cell 128 amp. hr. capacity
Generator - 55 amp. air cooled driven by double V belt from crankshaft.
Lights - (including blackout equipment) - in accordance with Spec. O.A. 62.

ENGINE - Make - General Motors
6 cylinder - valve in head.
Displacement - 269.5 cu. ins.
Peak Gross B.H.P. 104 @ 3000 R.P.M.
Max. Gross Torque - 220 ft. pounds 800 - 1800 R.P.M.
Lubrication - Full Pressure type
- normal operating pressure 35 - 40 p.s.i. @ 1000 R.P.M.

FUEL SYSTEM -

Carburetor - Down Draft Zenith with acceleration pump.
Governor - Velocity type (Setting - 2750 R.P.M.)
Pump - Diaphragm type driven off camshaft.
Fuel Tanks - two - one on each side of hull, below floor, ahead of wheel house - each 12 gal. capacity.

FRAME - Ladder type - high carbon steel.
Cross members - 4
Max. depth of side rail - 8"

SPRINGS - Semi elliptic - overslung
(Front springs have cast eye.)
Material - Alloy Spring steel.

	Front	Rear
Length (loaded)	40"	50"
Width	2"	2½"
No. of leaves	13	12
Rate	1075 # per in.	833 # per in.

STEERING Type - Worm and roller (Recirculating ball).
Gear ratio - 23.6:1
Turning diameter - right - 50' 2"
left - 48' 3"

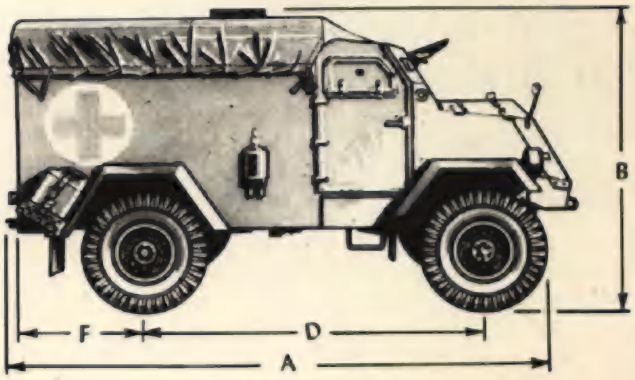
TRANSMISSION - 4 speed crash type
Ratios - 4th speed 1 :1
3rd speed 1.89:1
2nd speed 2.61:1
1st speed 5.00:1
Reverse 6.94:1

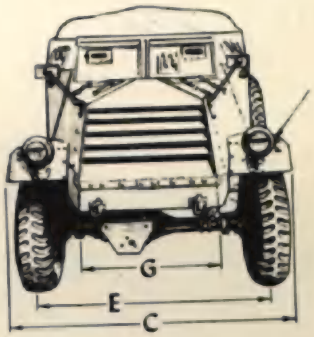
Mechanical Tire Pump - driven off transmission.

TRANSFER CASE - 2 speed type with declutch on front axle drive.

Ratios -

High range - 1 :1
Low range - 1.87:1





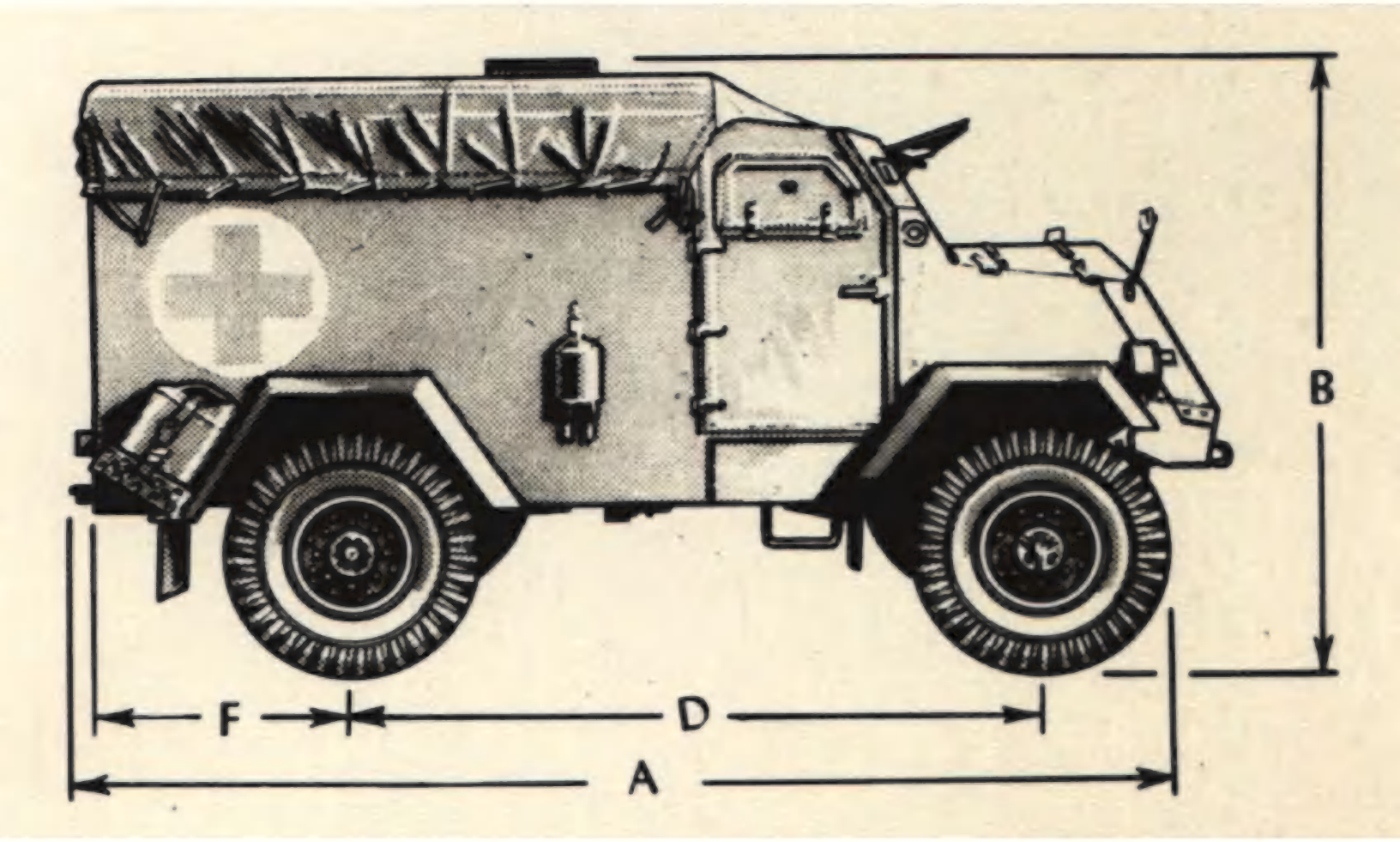
A	B	C	D	E	F	G	Minimum Height Top Roof Hatch
187"	97-1/2"	91"	101-1/2"	70"	38-1/4"	33-15/16"	97-1/2"

Ground Clearance under Axle: Front - 9-9/16"

" " " " : Rear - 9-9/16"

" " At Centre : 18-1/2"

Above Clearances are on a rolling radius of 17.64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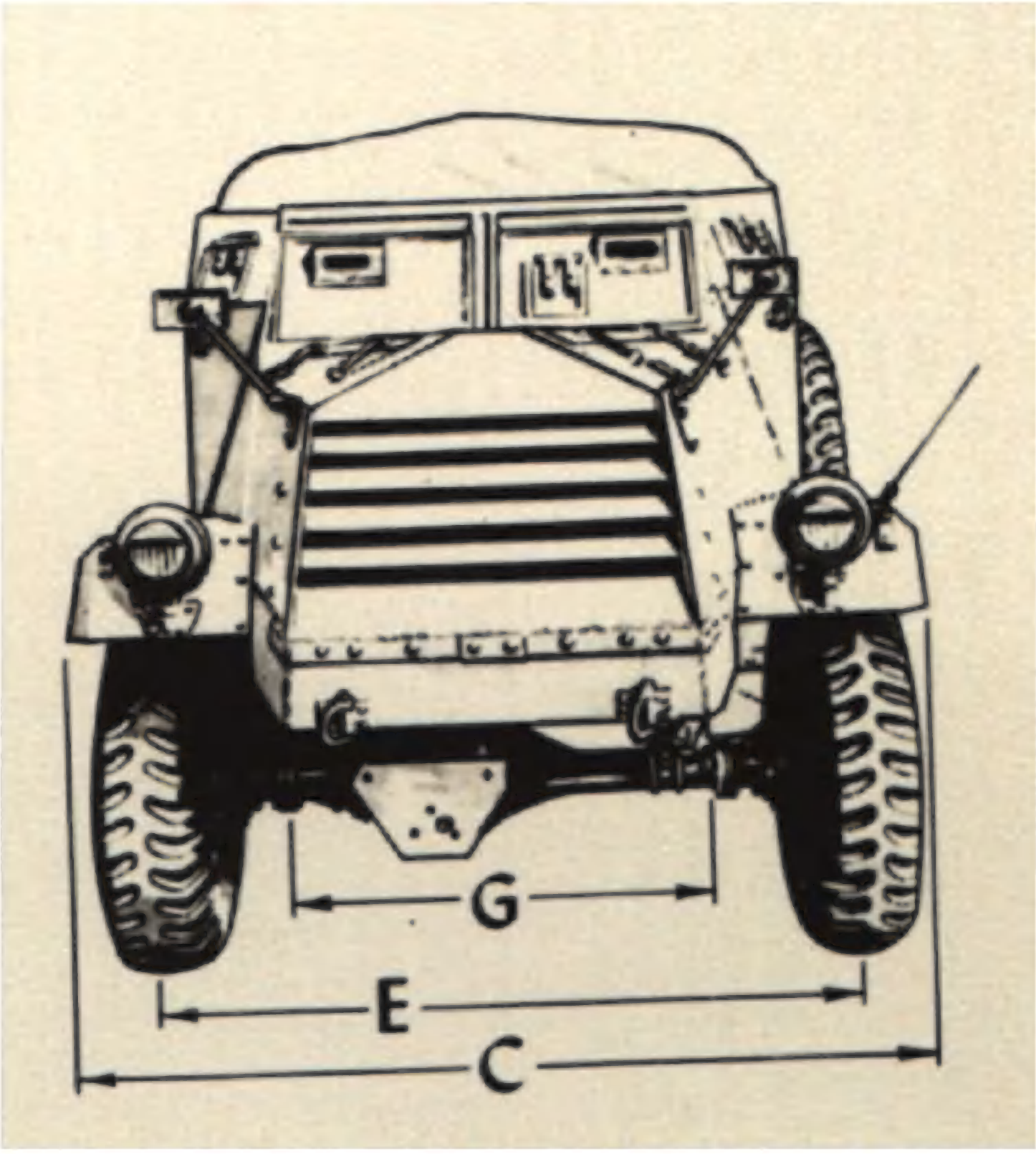
G
E
C

WEIGHTS

Vehicle Equipped with Pneumatic Tires.

	Front	Rear	Total
Curb Weight (Vehicle complete with maximum amounts of gasoline, oil and water and vehicle tools and equipment in accordance with Table No. 52)	4720	5960	10830
Stowed Weight (Vehicle complete with maximum amounts of gasoline, oil and water, vehicle tools and equipment and Ordnance equipment in accordance with Stowage List No. 211).	4730	6200	11120
Gross Weight (Vehicle complete as described in "Stowed" Weight above but with driver, attendent and 4 stretcher cases, @ 165 lbs. each, added).	5000	6780	12080

FRONT VIEW - LOOKING DOWN

LEFT SIDE

REAR VIEW (STEPS FOLD DOWN FOR LOADING)

REAR INTERIOR VIEW (SHOWING UPPER BERTH LOWERED FOR LOADING)

REAR INTERIOR VIEW (SHOWING STRETCHER REAR RAILS TO CENTRE OF VEHICLE FOR LOADING)

REAR INTERIOR VIEW (DOUBLE BERTH STRETCHER MECHANISM SHOWN IN R.H. SIDE - SIMILAR INSTALLATION AS IN R.H. SIDE MAKING ADDITIONAL FOR 4 STRETCHERS.)


OIL

USER COMMENTS

EXCERPT FROM AIRL 1609, DECEMBER 6, 1944

An official demonstration of the Armoured Ambulance was held at W.V.E.E. yesterday, December 5th. Both the War Office General Staff and Medical Branches were represented at this demonstration and were extremely pleased with the vehicle. They were not too pleased with the method of loading the stretchers and felt that it was too complicated for the average operator, especially in forward areas.

EXCERPT FROM C.M.H.Q. LETTER 55/1107/1 (SD4), JANUARY 17, 1945

Preliminary trials on the No. 1 Pilot now in U.K. have shown that the vehicle performance is excellent and that the vehicle ride is considered to be much superior to many existing types of ambulances.

EXCERPT FROM M.O.S. LETTER 257/Veh/2796, JANUARY 29, 1945

We can now confirm that this vehicle has, in general, been very favourably received in this country after demonstration to all interested Users.

EXCERPT FROM M.O.S. LETTER 257/Veh/2796, FEBRUARY 2, 1945

The vehicle has been favourably received by Users following the replacement of the equipment provided for loading and carrying the stretchers by a new mechanism to simplify loading.

REFERENCES

D.A.D. Specification O.A. - 228

Hull Drwg. Schedule 20063

Files Series

D.M.S.- 141-22
D.N.D.- H.Q.S. 8186-28-1
M.O.S.- T.T.2. 257/Veh/2796
D.M.S.- D.A.D. Photo File No.A-7.

A.E.D.B. Experimental Engineering Report:

E 606 - Scale of Weights

Production Orders:

S/M 6528

Approx. Price per unit - less equipment supplied by Ordnance - $4,600.