DESIGN RECORD

CANADIAN-DEVELOPED MILITARY VEHICLES WORLD WAR II

VOLUME III

TANKS AND TANK TYPE VEHICLES

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

TANKS
AND TANK TYPE VEHICLES

RESTRICTED

DESIGN RECORD
CANADIAN DEVELOPED
MILITARY VEHICLES
WORLD WAR II

VOLUME Nº ....
OF 8 VOLUMES

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BY

ARMY ENGINEERING DESIGN BRANCH
DEPARTMENT OF MUNITIONS & SUPPLY
OTTAWA CANADA

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INDEX

HISTORY OF TANKS IN CANADA

Prior to the war it was considered that Canadian industry did not lend itself to tank production and it was not expected that war requirements would include the building of tanks in Canada. It was visualized that, in the event of war, Canadian Tank Battalions would be issued with tanks manufactured in United Kingdom.

Enemy tactics in Austria and Poland, however, demonstrated to British authorities that their plans for tank production would have to be greatly expanded. In the expansion program that followed, a British order for Valentine Tanks was placed with the Canadian Pacific Railway Company, Montreal, in the spring of 1940 and, in light of this, a Canadian order was immediately placed with this contractor to equip the Canadian Tank Brigade.

Since the Valentine Tank had just been piloted in United Kingdom at this time, many design details remained to be finalized; likewise there were numerous problems being encountered in the initial stages of production preparation. The need was soon evident, therefore, that a central government authority would be required to clarify the continuous flow of conflicting information on specifications, design, equipment and production as between the United Kingdom, the Department of National Defence and the contractor. Inasmuch as similar confusion was being experienced on lighter armoured vehicles and that further tank orders were expected, an INTER-DEPARTMENTAL TANK COMMITTEE was set up in August 1940.

With the fall of France and the serious disruption of British Industry by bombing, together with the possibility of invasion, it became advisable that Canada be established as a source for production of light armoured vehicles and tanks.

The authorization of two Canadian Armoured Divisions in the Summer of 1940 necessitated a requirement for over 1,000 Cruiser type tanks. This was in addition to the demands already raised for Valentine or Infantry Tanks, and it was obvious that these could not be provided through United Kingdom production. Similarly, production facilities in the United States were extremely limited and, even though plans were underway for their expansion, there was no immediate hope of relief due to existing British and American orders. Hence, a decision was made at this time to enlarge tank production facilities in Canada by the construction of a tank arsenal to be administered by the Montreal Locomotive Works with the assistance of the parent organization, The American Locomotive Company. It was further decided that the Canadian built Cruiser Tanks would be produced to the United States Ordnance M3 Medium Tank design, then in its piloting stage. This type was selected due to the availability of heavy components, notably the engine and the transmission and also in light of heavy commitments by the British for the same vehicle from American production sources.

During the Summer of 1940 a British Tank Mission was established in Washington to advise on the design and also to speed up the production of tanks in the United States for United Kingdom account. It became evident, during the late Fall of 1940, from reports of this committee and our own Liaison Officers in Washington, that various design features being finalized and approved for the Medium Tank M3 by United States Ordnance engineers would be far from satisfactory to British and Canadian Users. The Main features objected to were: (a) extremely high silhouette; (b) mounting of the main armament in a sponson with very limited traverse and observation; (c) lack of provision for wireless in the turret bulge, and (d) inadequate armour protection.

After lenghty consideration a decision was made by the INTER-DEPARTMENTAL Tank Committee in January 1941, to develop and produce in Canada a tank utilizing the mechanical components of the United States design, but including turret hull and armament features of Canadian design, together with standard British main armament, this vehicle to be known as the "RAM" Tank. In brief, these features included: low silhouette, cast armour turret with 360° traverse, 6 Pr. tank gun, cast armour upper hull and provision for #19 radio set. The responsibility for developing the Canadian design was placed with the Montreal Locomotive Works, directed by the Department of Munitions and Supply with the British Tank Mission and the Department of National Defence acting in an advisory capacity. The United States War Department was advised of this action and were in full agreement.

A running prototype was completed in June of 1941. This was loaned to the United States War Department for observation and test and we are authoritatively assured that their staff observations and tests on this vehicle contributed materially to their development of the Medium M4 (Sherman) Tank.

During the Summer and Fall of 1941, design details and the stowage of British type equipment were finalized. The general procurement of armour in Canada, its heat treating, forming and machining presented a formidable problem which was eased by the provision of the large turret and upper hull castings for RAM Tanks from the GENERAL STEEL CASTINGS COMPANY in the United States.

It had been anticipated that production drawings of the 6 Pr. gun mount would be provided from the United Kingdom, and when it was found that these were not forthcoming, it became necessary to design and prove the mount, cradle and the elevating gear in Canada. Consequently, mount production was delayed and it was necessary to equip a limited number of the first production tanks with 2 Pr. rather than 6 Pr. guns. The tank equipped with 2 Pr. was known as the Ram I, and that with the 6 Pr. as the Ram II. The latter came into full production early in 1942.

During 1941 the activities of the INTER-DEPARTMENTAL TANK COMMITTEE and the loan of a Vickers engineer from United Kingdom greatly assisted the contractors in the production preparation for the Valentine Tank. Although at the start serious delays were encountered due to the fitting of an American engine, added requirements, and difficulties in establishing local sources, a production prototype was made available in June of 1941 followed by full production in the late Fall at the Angus Shops of the Canadian Pacific Railway Company.

In December 1941, on the formation of the Army Engineering Design Branch and its acceptance of responsibility for design and co-ordination, the INTER-DEPARTMENTAL TANK COMMITTEE was dissolved.

As a result of Service Reports on the Valentine, studies were made considering its re-design to mount the 6 Pr. gun and include a three-man turret. It was agreed, however, that such a major design change would take considerable time and that it was not advisable to develop major modifications for a vehicle already obsolete. As a result, throughout Valentine production, Canadian design development as opposed to minor changes requested from United Kingdom for tactical improvement, was concentrated on projects which made for easier and better production. Notable among these were the elimination of the fabricated turret and hull nose in favour of armoured castings.

The Ram design, on the other hand, was continuously changed and improved to meet User requirements and to incorporate new devices and components as they became available from the United States.

Major changes in the RAM included the mounting of the 6 Pr. gun, the addition of a transmission oil cooler, modification of the top hull to eliminate the sponson doors, fitting of the gyro stabilizer, further modification to the top hull to eliminate cupola, addition of floor escape hatch and change in the engine for operation on 80 octane fuel.

Consideration had been given to mounting the 75 mm. gun in the turret, but acting on British advice, the 6 Pr. was retained.

In 1942, the United States brought into production the M4 (Sherman) Tank to supersede the M3. This vehicle incorporated all the features of the Ram and met British requirements. Consideration was given to manufacturing it in Canada (concurrently with United States production) at the Angus Shops, where the Valentine contract was nearing completion, and without disturbing Ram production at the Montreal Locomotive Works.

This plan was discarded due to increased orders for Valentine Tanks, and expanded tank arsenal facilities in the United States.

It was agreed, however, that at the earliest practical date without too seriously disrupting production, the Ram Tank at Montreal Locomotive Works would be superseded by M4A1 Sherman. The specifications were laid down in September 1942 for Canadian produced M4A1's to be known as "Grizzlies", but the demand for tanks was so heavy that it was not until August 1943 that the changeover in production was made. This was after 1900 Ram Tanks had been built.

The Grizzly Tank conformed almost completely to the specifications of the United States Medium M4A1 with the addition of a smoke mortar in the turret. (Later adopted by the United States) and changes to accommodate Canadian stowage equipment.

Tank production facilities in the United States had been greatly expanded and by the Fall of 1943 were able to supply all Medium Tank requirements for the United Nations. Hence, Grizzly Tank production in Canada was limited to 188 vehicles which were completed in early 1944. The Command O.P. Tank (Ram) was also developed and entered production during 1943.

Meanwhile, reports on enemy activities and United States developments made it desirable to consider the production of self-propelled guns in Canada. In 1942, at the request of the Department of National Defence, a vehicle was piloted combining the basic 25 Pr. field piece on a modified Ram running gear with a box type armour hull. This pilot was tested and approved in the United Kingdom and entered production at the Montreal Locomotive Works, Tank Arsenal as the 25 Pr. S.P.Sexton in the Summer of 1943. It proved immediately popular on reaching the field and sufficient orders were placed by the British to keep it in continuous production until late 1945.

During this period design changes and improvements were continually being initiated, based on requests from users and available production facilities, etc. In all, over 500 changes, each involving from 1 to approximately 200 details, were made.

It will be of interest that the Canadian Dry Pin Track was used throughout the production of this vehicle. This track was developed as an alternative for the very expensive and heavy United States Steel Rubber Bushed Track and was introduced only after a lengthy and thorough development and test programme. Varying reports of its success in the field have been received but, in general, its service acceptability is now established.

Synthetic rubber bogie tires which presented a difficult development programme were proved and introduced on the Sexton.

Pilots of G.P.O. (Gun Positioning Officer) and ammunition carrying companion vehicles were developed and forwarded to the United Kingdom. The G.P.O. design was adopted and provision made in the field by conversion from Sextons.

In 1943 a requirement was laid down for an anti-aircraft tank. A very satisfactory pilot, the "Skink" mounting four 20 mm A.A. guns, was developed at the Waterloo Manufacturing Company, resulting in production orders in early 1944. However, complete Allied air superiority developed about this time in Europe, and resulted in a very limited production.

Briefly, prior to 1940, tank design and production was an unknown quantity in Canada, but demands soon after hostilities started resulted in the establishment of facilities and solution of production problems. The deficiencies of current tanks forced a co-operative design programme with the result that the Canadian contribution to the war effort on tanks both in quantity and up-to-date design was of definite value.

TECHNICAL NOTES

Tanks are produced for the prime purpose of facilitating the ultimate destruction of the enemy. To do this a tank must carry sufficient armament and crew and be able to negotiate ground normally considered impassable. Likewise, the construction must be such as to make it capable of inflicting casualties with a minimum of damage to itself and crew.

In tank design, consideration must be given to possible terrain in regard to approach and battle, enemy obstacles, enemy weapons and tactics, all of which are constantly changing. Consequently, the history of tank design in World War II was one of constant progress with some successes and many disappointments.

In light of the above and on account of the time required for development, piloting and production preparation and also the lack of production experience, it was decided that tanks built in Canada would follow the basic design of the then current allied vehicles. Variations to this procedure were dictated by the necessity for improved tactical features or to utilize available facilities. Lack of experience in the great variety of highly specialized technical devices carried in tanks also contributed largely to the desirability of initiating production on the basis of existing tank designs.

Notwithstanding that, previous to 1940, no tanks or vehicles of a similar nature had ever been manufactured in Canada, approximately six thousand tanks and tank type vehicles were produced during the war period.

The Canadian tank programme involved two phases. The first phase covered the period of the Valentine Tank which was produced to the design of the Valentine being manufactured in the United Kingdom. The second phase was the design and production of medium tanks and variations thereto. In this phase vehicles were designed and modified during production to include tactical features demanded by the Canadian User.

Vehicles Generally

Tanks and tank type vehicles include tanks and self-propelled guns.

The distinguishing characteristics of a tank from a self-propelled gun mount are that a tank provides complete and adequate armour protection from all attack with suitable vision devices and generally with 360° traverse for the main armament whereas Self-Propelled Guns and "Tank Destroyers" usually have limited gun traverse, limited upper armour and no roof armour. However, with the rapid increase of gun size in tanks and the demand for more protection on Self-Propelled Mounts, this distinction tended to disappear.

TANK, CRUISER, RAM

Tanks, Generally

The second great war proved to be a war of movement and was featured by Tank v. Tank battles. For this type of warfare early Allied Tank Types proved inadequate with the result that design emphasis was toward the following:

(a) Improved mechanical reliability.

(b) Improved armour protection consistent with reasonable power weight ratio.

(c) Development and installation of more powerful main armament, able to fire high explosives as well as heavy high velocity armour piercing projectiles.

Inasmuch as enemy development was along the same lines, Allied Tank Design was constantly improved to counter and defeat the enemy's improvements.

In this connection it is interesting to note that the heaviest Allied tank armament used in 1940 was a 2 Pr. or 37 mm. gun as compared with the 17 Pr. or 90 mm. gun in 1945, with even heavier guns being piloted.

Throughout the course of the war a variety of basic tanks and tank type vehicles were developed in the United Kingdom, United States and Canada. Basic types include light, medium and heavy tanks of which the medium tank only was built in Canada.

Variations from the basic tank include the Command, Anti-Aircraft, Troop Carrying, Flame Throwing, Close Support, Gun Towing, Recovery and Demolition tank type vehicles. Of these the Command and Anti-Aircraft Tanks were the only ones developed and produced in Canada.

25 PR. S.P. TRACKED-SEXTON

Self-Propelled Gun Mounts

Self-Propelled Gun Mounts divide themselves into two classes, Self-Propelled Artillery and Tank Destroyers. Both types were developed during World War II.

Self-propelled Artillery types include guns intended to be used in the normal artillery role but mounted on a self-propelled vehicle to keep pace with mechanized forces and avoid delay in coming into action.

Tank Destroyer types carry the highest possible velocity gun and are usually employed in the support of tanks in direct fire against enemy armoured vehicles.

Two types of self-propelled mounts were piloted in Canada; a 3.7 which was not found acceptable for various reasons, and a 25 Pr. Sexton. The 25 Pr. Sexton proved very popular and took its place as recognized equipment throughout British establishments. This was the first Canadian or British made vehicle of its type and was designed to General Staff specifications as laid down by the Department of National Defence.

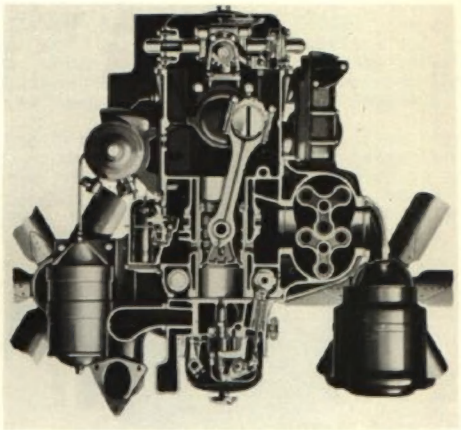
COMPONENTS

The following summary of prominent factors to be taken into consideration in the design and selection of components during the overall design of tank and tank type vehicles, is not submitted to leave the impression that a successful tank design may be based wholly on the items hereunder mentioned. The following notes are merely reflections of some of the outstanding items that required special attention in ensuring the success of the Canadian Tank Programme.

Engine

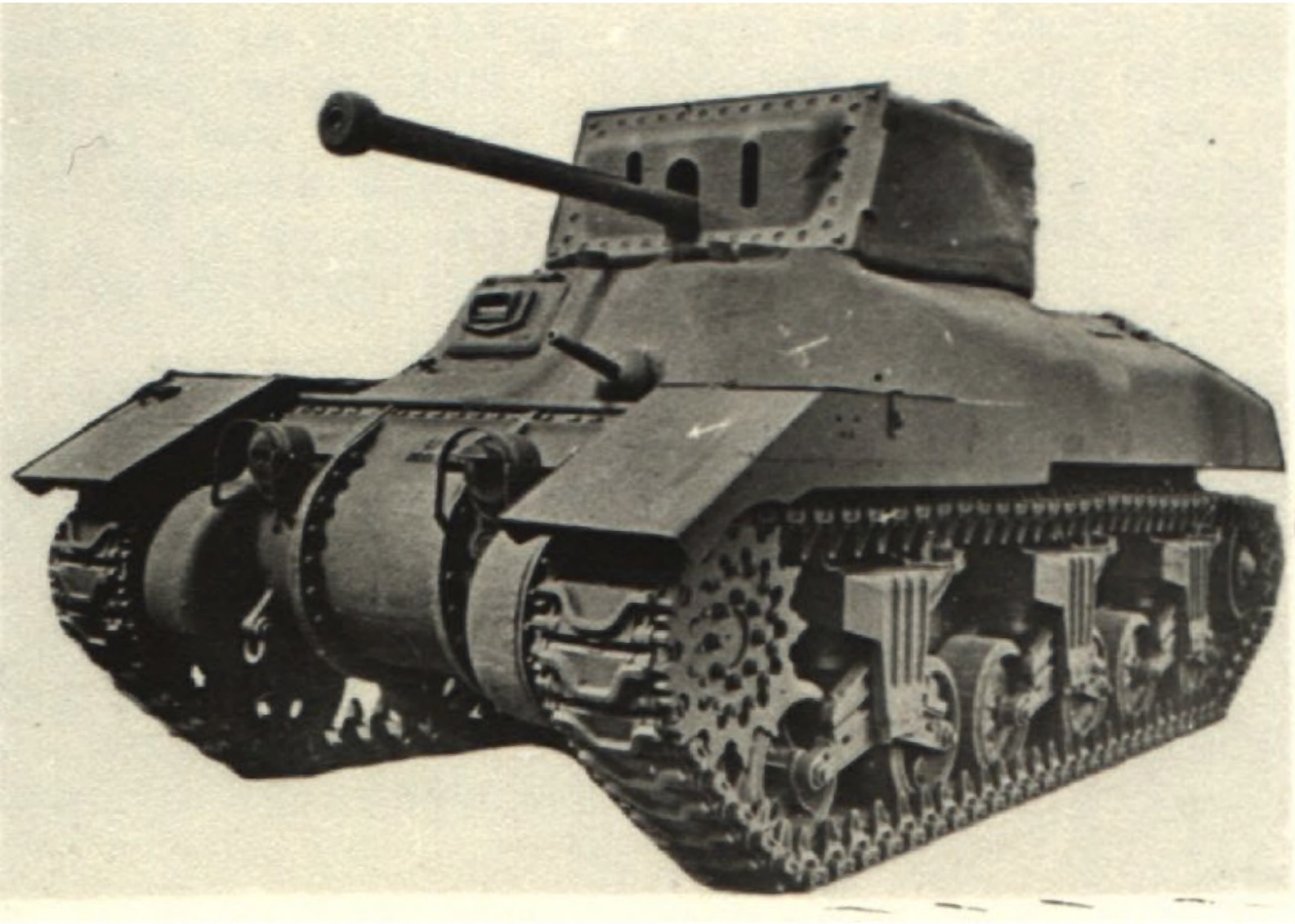
Factors governing the selection of an engine include adequate horse-power and torque, durability and reliability and reasonable power to weight ratio. Other characteristics, on which opinions differ, relate to the use of oil fuel rather than petrol, the demand for the ability to operate with low octane petrol fuel, the method of air cooling to avoid the complication and necessary protection of water connections and radiators; and in design, low height to achieve low vehicle silhouette, flat torque curve to minimize gear changing, etc. etc.

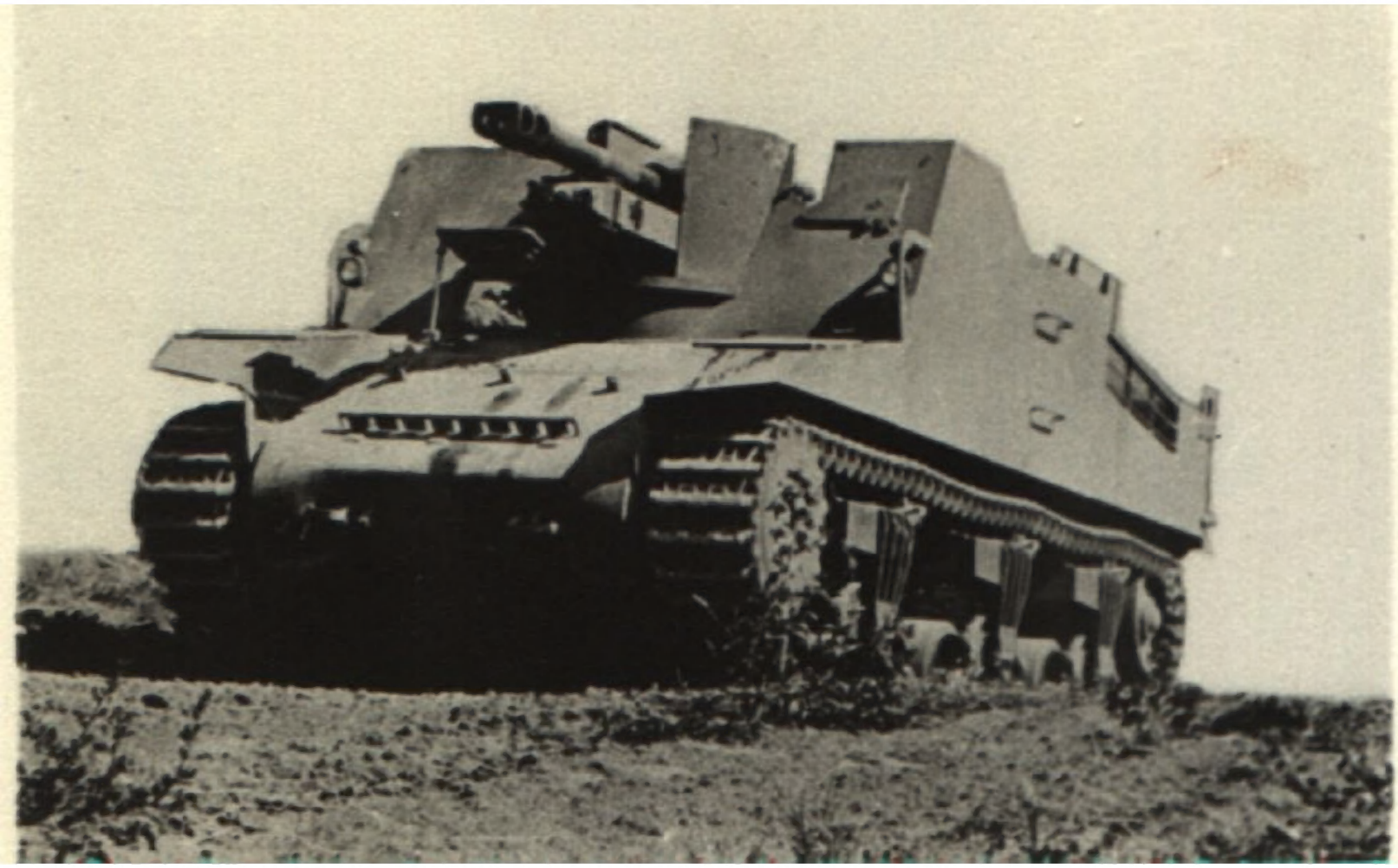
To design, tool, build and test a new engine is a long expensive process which can rarely be accomplished in the time available. As a result, it is normal for the tank designer to select a proved engine in current production.

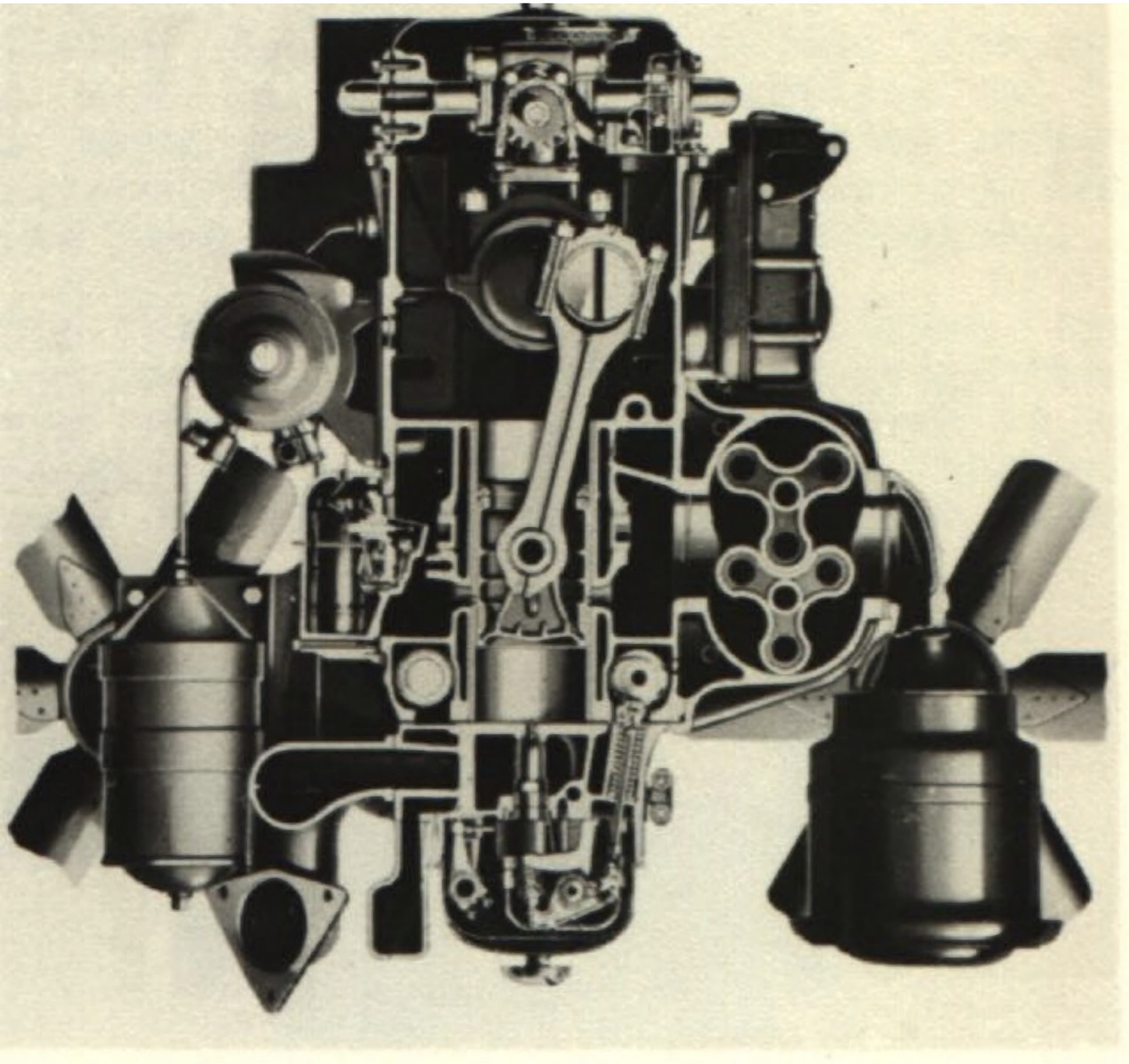


G.M. DIESEL - REAR VIEW

Only two engines have been used in Canadian tanks, the G.M.C. 6-cylinder, 2-cycle Diesel, normally used in peace-time for industrial and heavy transport purposes and the Wright (Continental) 9-cylinder, radial, air-cooled engine. The Diesel engine proved very satisfactory and its use in Canadian Valentine Tanks led to its adoption by the United States in a twin installation in Medium tanks. The Wright (Continental), radial engine was used in all Canadian Medium tanks and Self-Propelled Mounts. This engine, having been developed and produced for aircraft, was

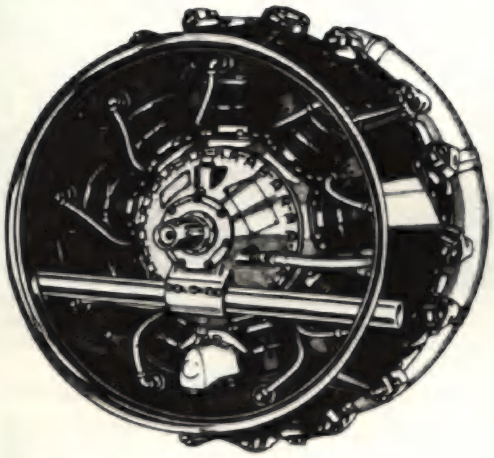






available in quantity, which was a large factor in its selection, although serious consideration was given, however, to the use of the Guiberson air-cooled radial Diesel engine, also a V-8 water-cooled engine similar to that used in British tanks.

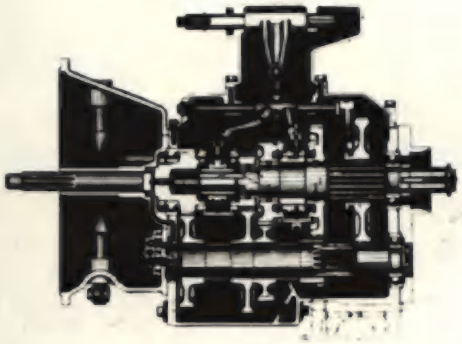
Early fears were expressed as to the reliability and life of the Continental engine, however, its performance in the field proved satisfactory and certain design improvements and modifications introduced during production further assured its retention rather than being replaced in Canadian production by the twin Diesel, Multi-bank or Ford V-8 engines, which later became available.



WRIGHT (CONTINENTAL) RADIAL ENGINE

Gearbox

Factors governing the design or selection of a gearbox include availability, type, ruggedness and suitable ratios. As in the case of an engine, the design, tooling and production of a new gearbox is a lengthy process, consequently it is desirable, if possible, to select one already being manufactured. For this reason only two gearboxes have been used in Canadian production. The Spicer Synchromesh was selected for Valentines as a suitable substitute for the Crash type gearbox originally specified and used in the United Kingdom and the United States Medium Tank type Synchromesh gearbox was selected for Medium tanks and tank type vehicles. The Valentine gearbox is coupled to the engine, whereas the Medium Tank or tank type transmission was attached directly to the differential and final drive mechanism, thus forming a single unit.



GEARBOX AND CLUTCH
(VALENTINE TYPE)

During the war there was a great deal of interest shown in the development of fluid couplings, torque converters and self-changing gearboxes, to relieve the driver of excessive gear changing normal to heavy tracked vehicles. The earliest experiments in this connection resulted in the installation of Chrysler engines with fluid fly-wheels in light tanks. This experiment was carried out at Camp Borden in 1940 and 1941. Further, along these same lines was the development of the SSS (self-changing gearbox) in England. This box was installed in pilot Churchill Tanks and was proposed for use in Rams. The SSS box performed well but could not be taken into production owing to the necessary tooling involved.

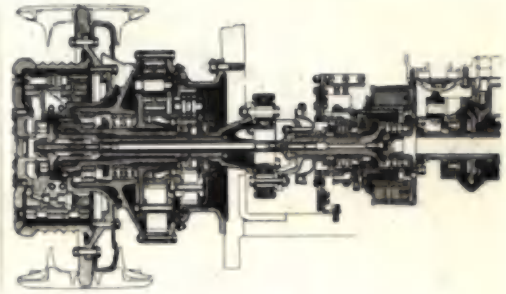
United States developments also included the hydromatic transmission used with excellent success in their light tanks M5 and M24 and the hydraulic torque converter used in current heavy tanks.

An Electric Drive was also developed in the United States and put into limited production. This drive provided excellent control and operation but was discarded in view of the weight complication, shortage of copper and expected service trouble due to unfamiliar principles involved.

Final Drive

Three types of final drive have been used for tanks by the Allied Nations. These include Controlled Differential, Clutch Brake and Merritt-Brown.

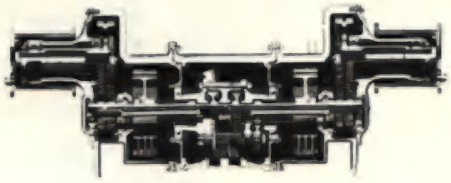
Controlled Differential steering is used as standard on all United States tracked vehicles and Canadian Rams and Sextons. While it does not allow skid or short radius turns and demands a cooling arrangement for the oil, it has the advantage of being reliable and trouble free.



TRANSMISSION AND FINAL DRIVES-VALENTINE
(SECTIONAL VIEW-LEFT SIDE ONLY)

Clutch Brake Steering allows for skid turns and positive manoeuvreability but demands more maintenance and, under certain conditions, would give reverse steering. This type is used in Canadian built Valentines.

The feature of the Merritt-Brown type is that the radius of the turn is determined by the gear ratio engaged, and power is not dissipated in turning. This type has been standard on modern British and German Tanks, with success.

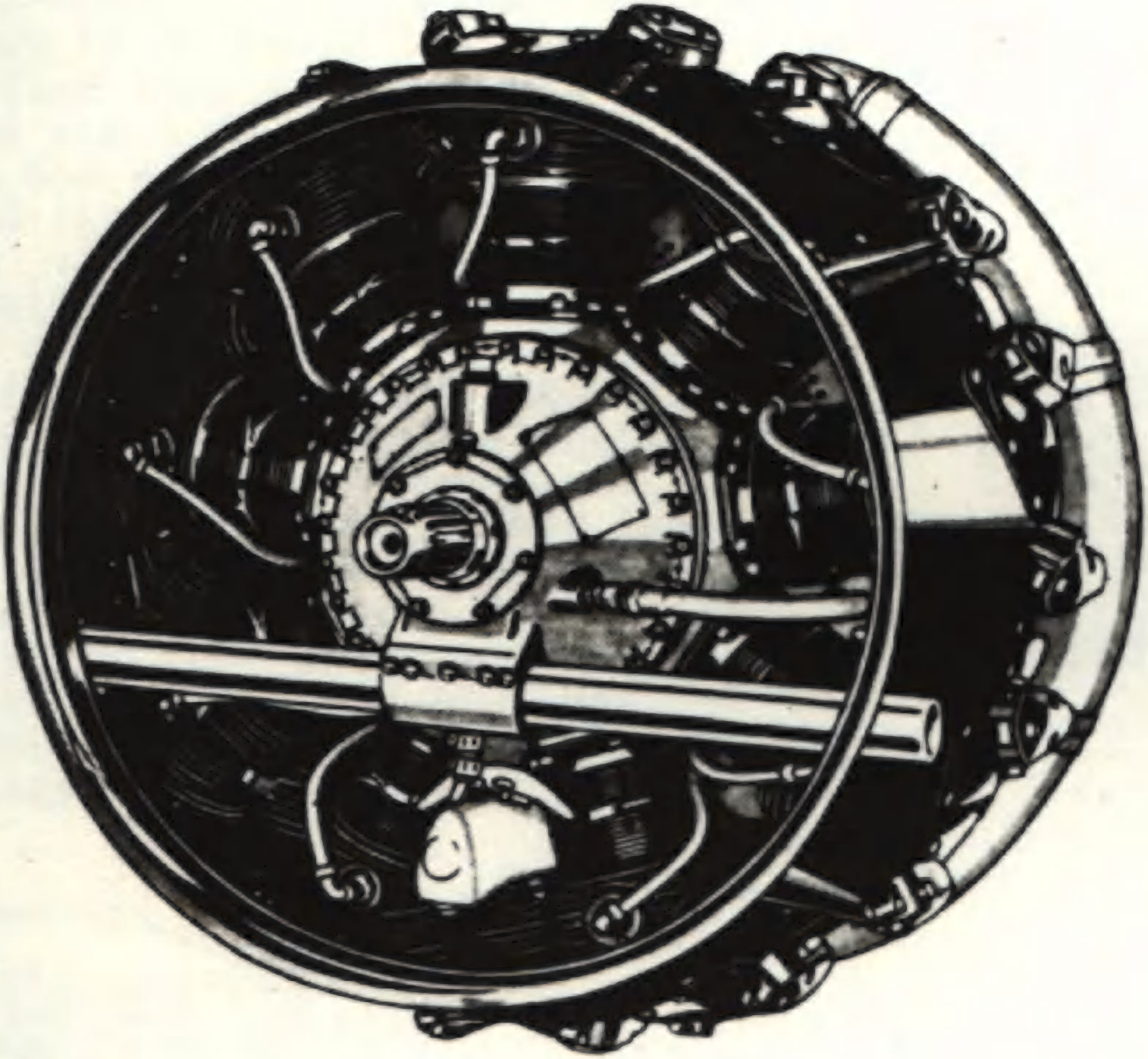


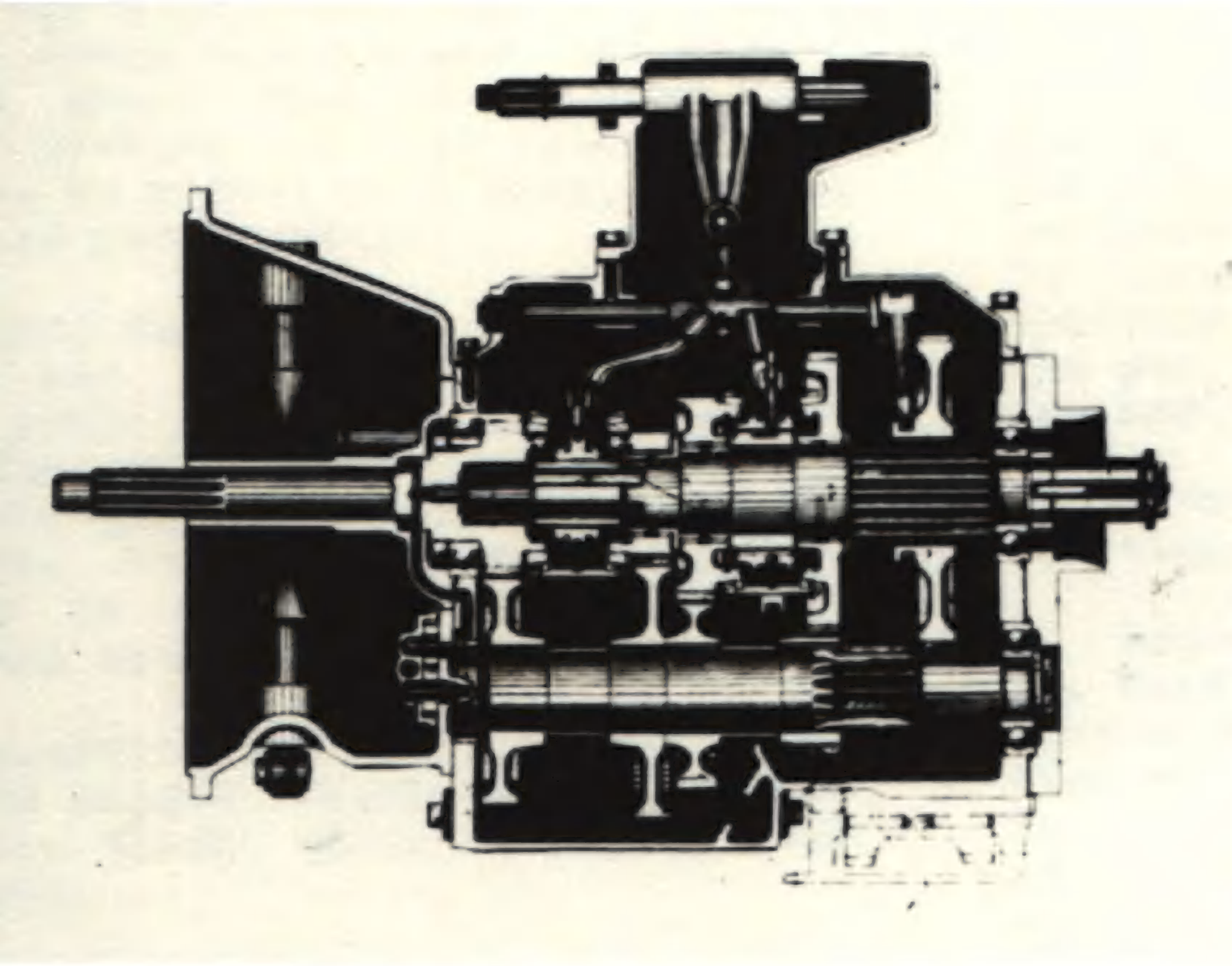
DIFFERENTIAL AND FINAL DRIVES-RAM

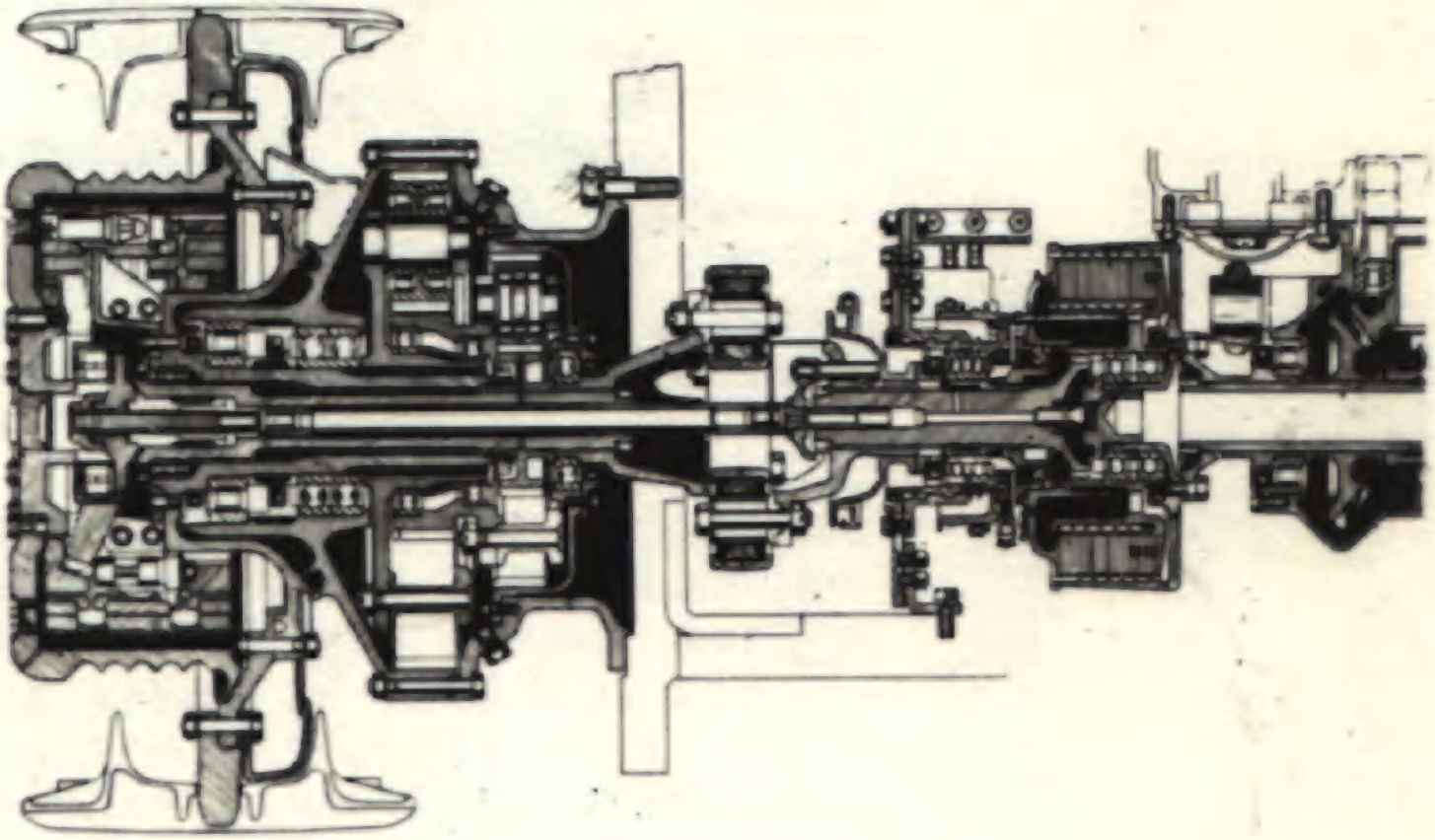
British tanks normally drive through a rear sprocket and, in American tanks, the sprockets are located at the front. There is no evidence, however, to indicate that either is more successful in service although the front final drive has been found to be more easily maintained.

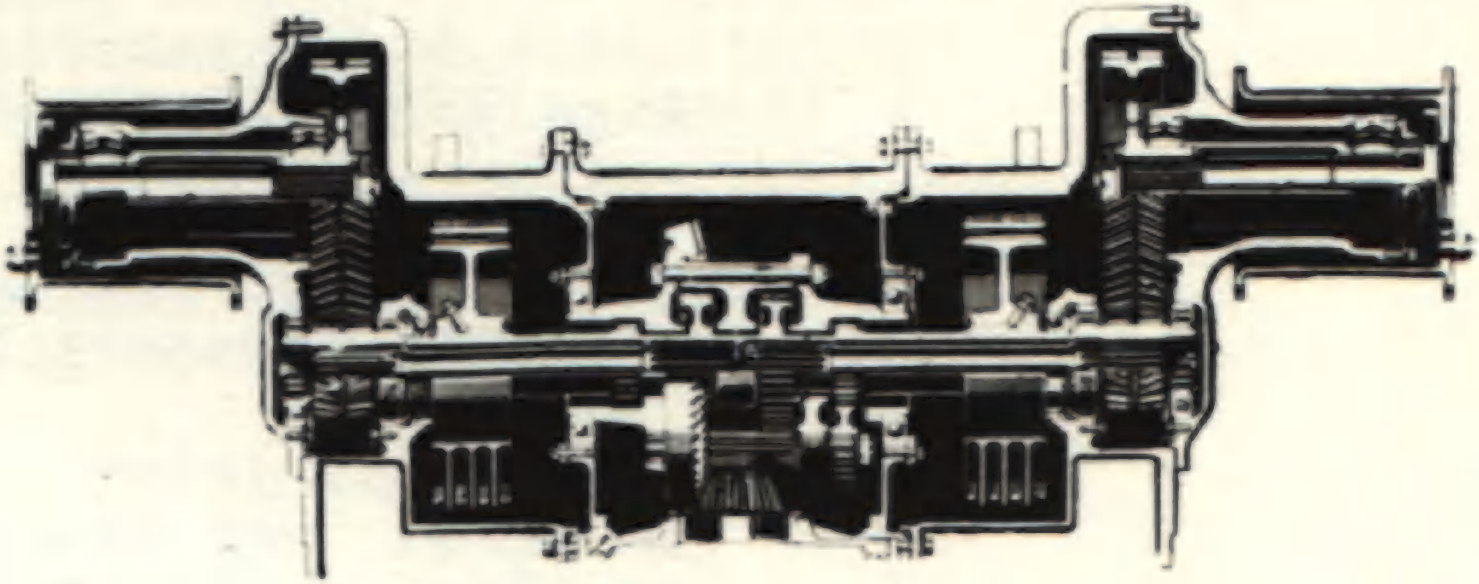
Suspension

Two types of suspension have been used in Canadian vehicles. The Valentine type has two



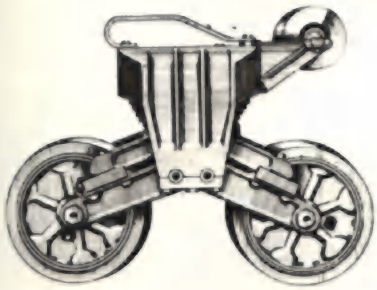






SUSPENSION SYSTEM-VALENTINE TYPE

three-wheeled bogies per side, each having a single coil spring and hydraulic shock absorber to cushion the load and reaction from all three wheels. This suspension gave a good ride and gun platform but was fairly complicated and would not be suitable for a heavier vehicle. The United States type has three two-wheeled bogies per side, in which the sum of the loads on the two articulated bogie wheels is carried through two volute springs in parallel. The virtue of this type is its simplicity and, while it was used very extensively (all Rams and and Sextons), was not considered completely satisfactory principally due to the lack of cushioning and control. Various alternate improved suspensions for this type of vehicle were developed and tested; the Horstman in the United Kingdom and Canada and the Horizontal Volute Suspension in the United States. The present trend toward improved suspensions is the use of torque rods which appeared in the latest United States design.



SUSPENSION ASSEMPLY-ALL LESS VALENTINE

Track

All tank tracks fall into two basic classifications - Dry Pin and Rubber Bushed. All European vehicles employ Dry Pin Track and all United States vehicles employ Rubber Bushed type.

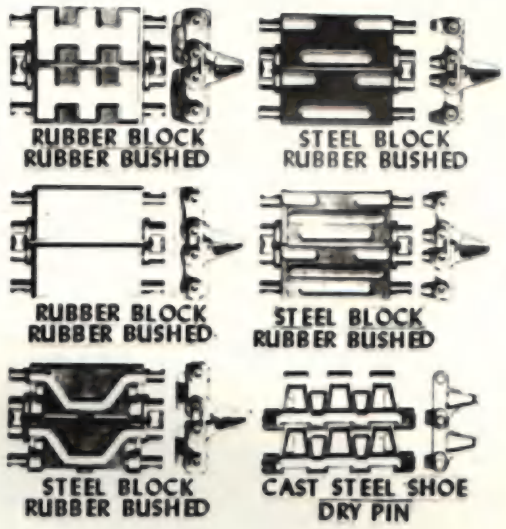
Dry Pin Track employs cast blocks with cored or machined hinge holes to accept a hard steel pin with no provision for bearings or lubrication. Pin breakage was frequently experienced and the normal pin and pin hole wear was high, resulting in frequent adjustment for track tension and relatively short life. A great deal of research has been done to develop the best material for shoes and pins to reduce road wear, pin and pin hole wear and pin breakage.

Prior to World War II, the United States had developed and released, as standard equipment, a rubber block track with rubber bushed pins. The rubber block cushioned the suspension of the tank, had long life and did not damage roads. The rubber bushing allowed adjacent shoes to flex without metal to metal contact and consequent wear.

With the scarcity of rubber, optional steel cast and welded fabricated shoes replaced the rubber block, while retaining the rubber bushed pin.

Production of these shoes was difficult and also very expensive, their weight was excessive and out of balance with the other tank components and their life and serviceability were questionable.

As a result, an alternate short pitch dry pin track was developed, proved and put into production in Canada. In the process, a new steel technique (9255 steel homogeneously hardened) was developed for track pins which practically eliminated the breakage hazard. The shoe design following European practice was cast from manganese steel and had a minimum weight consistent with strength.



RUBBER BUSHED TYPES AND
DRY PIN TYPE TRACKS
(ALL LESS VALENTINE)

The chief advantages of the track were its simplicity, low comparative weight, ease and and low cost of production, ease of maintenance and improvement in traction. Its drawbacks were exposed pin retention, necessity for tension adjustment with wear, undue strain on idler bearings with sand or mud packing, non-standard sprockets and increased track friction under heavy loads.

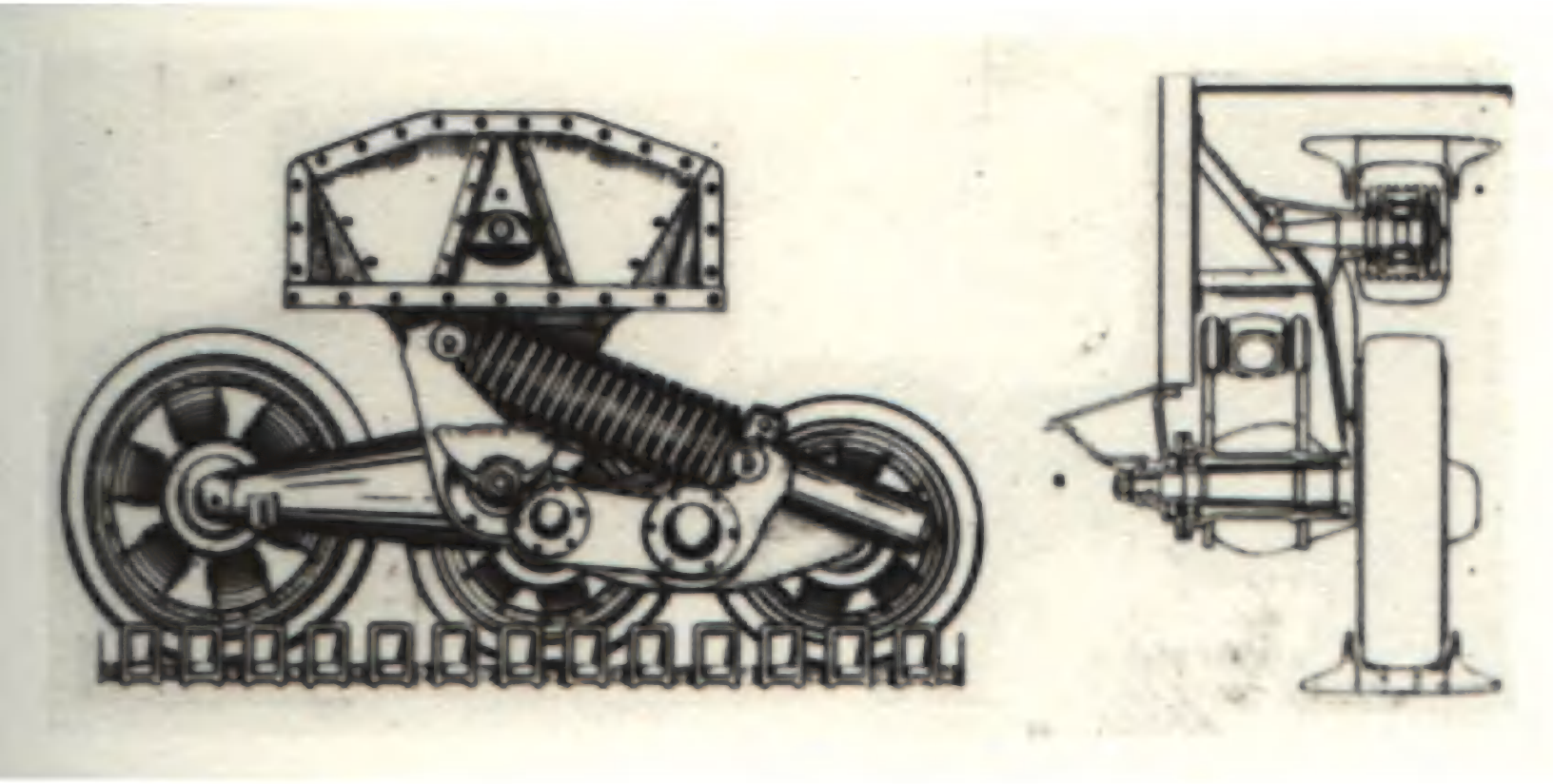
Next to reliability and life, flotation and traction have been found to be the most important factors in track design. Final design trends were toward a track of adequate width, preferably with a centre guide for dual bogie wheels, using the rubber bushed principle and including a maximum depth of integral grouser compatible with reasonable road damage. Steel blocks with rubber facing next to the bogie wheels appear to give the best chance for long life of both track and tires.

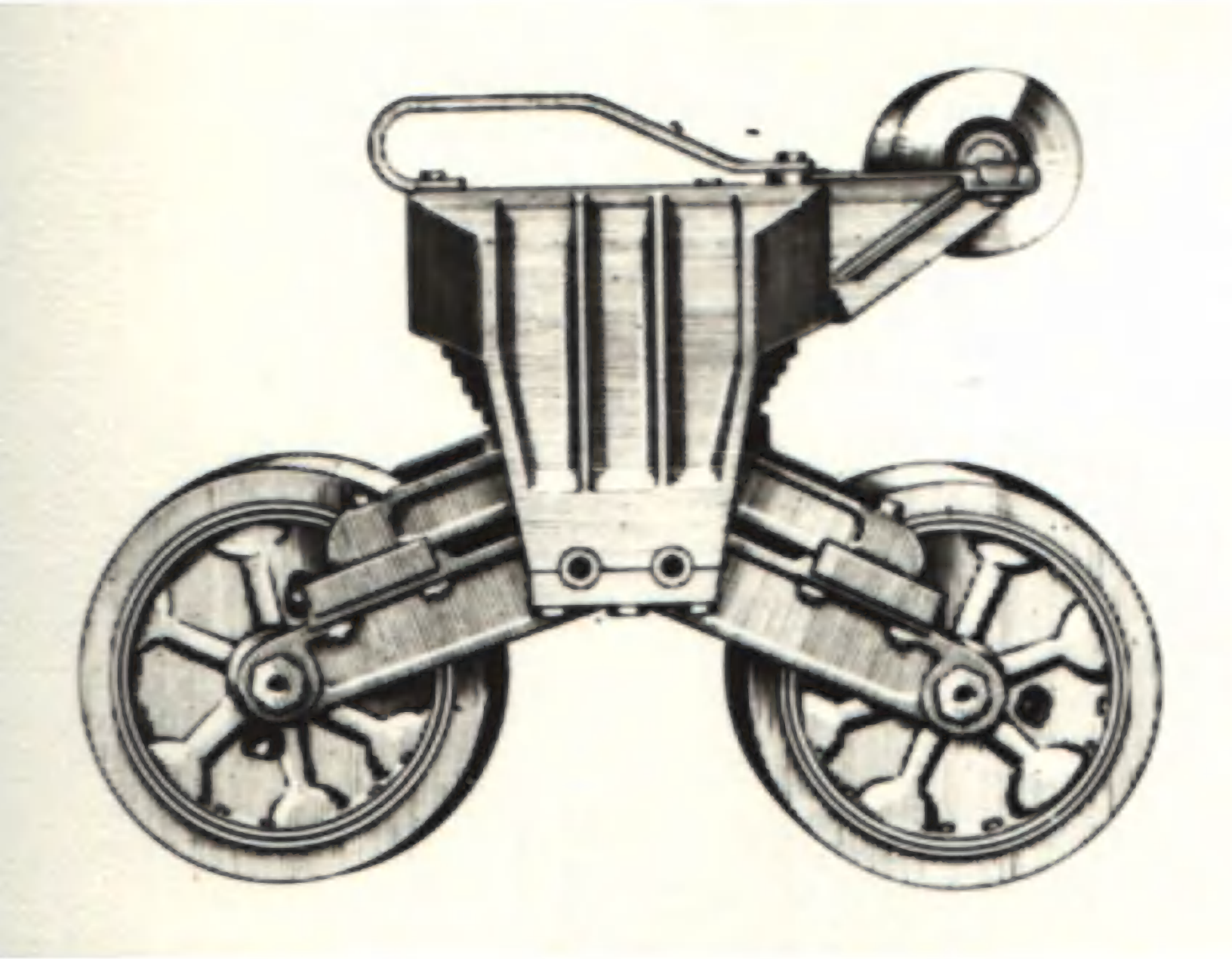
Main Armament

Tank armament has increased very rapidly in size and power. This trend has been accelerated by the fact that tank versus tank battles have proved the rule rather than the exception. This trend has presented a serious problem for the tank designer as well as the gun designer inasmuch as larger guns have proved the necessity for larger, heavier gun mounts, larger turrets and turret rings, and the resulting need for a much larger, heavier and greater variety of ammunition to be carried. To conform to the heavier armament necessitates suitable means for elevating and stabilizing the gun and mount, improved sighting facilities and indirect fire apparatus.

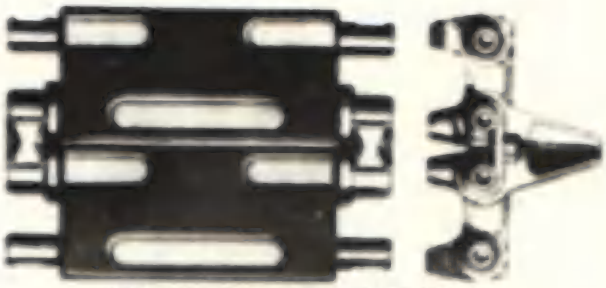
Development of armament has not been a function of the Army Engineering Design Branch.

However, the 2 Pr. Marks IX and X, the 6 Pr. Marks III and IV and the 75 mm. M3 have been mounted in Canadian tanks and consideration given to the use of the 17 Pr. The 25 Pr. Mk. II has been mounted in a self-propelled mount and pilot work was also done on 3.7 S.P. and the 17 Pr. Paper studies have been made of the mounting of the 25 Pr. in the United States Gun Motor Carriage M-37 and the 5.5 in the United States Gun Motor Carriage M-41.





RUBBER BLOCK
RUBBER BUSHED



STEEL BLOCK
RUBBER BUSHED

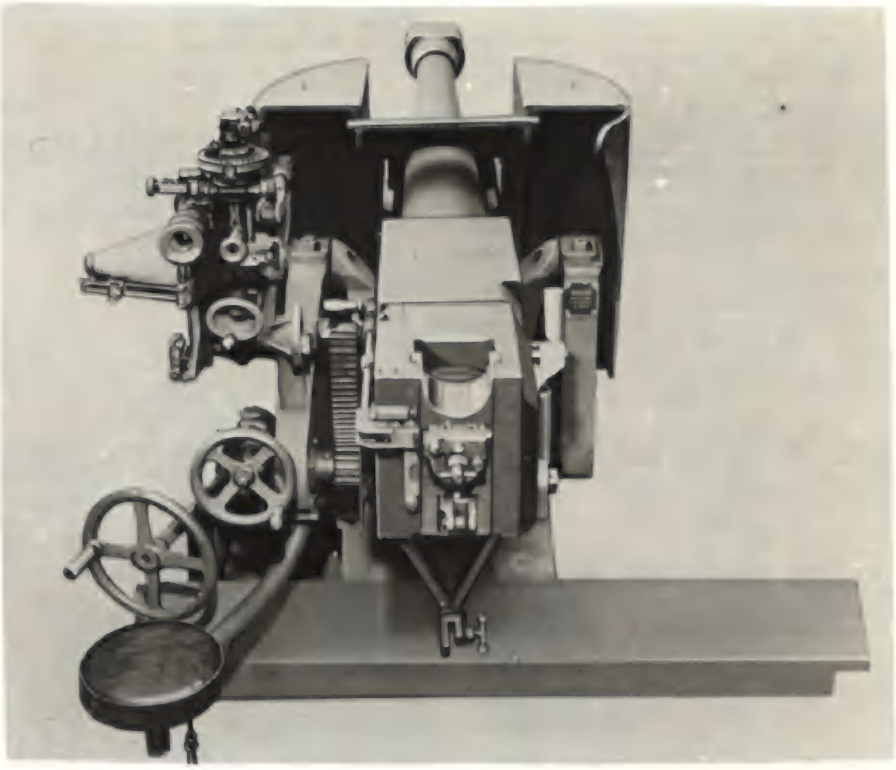
RUBBER BLOCK
RUBBER BUSHED

STEEL BLOCK
RUBBER BUSHED

STEEL BLOCK
RUBBER BUSHED

CAST STEEL SHOE
DRY PIN

RUBBER BUSHED TYPES AND
DRY PIN TYPE TRACKS
(ALL LESS VALENTINE)



25 PR. AS MOUNTED IN SEXTON

6 PR. AS MOUNTED IN RAM

munition

Ammunition sizes and types have increased th main armament. This has introduced prob- ms in turret arrangement to allow adequate

TYPICAL 25 PR. A. P. SHELL
(Carried in Sexton)

loading room, also in the stowage arrangement in order to carry a maximum of rounds, both stowed and "ready". The introduction of H.E. and Smoke ammunition has also demanded further developments on gun sighting and laying to allow for indirect and high angle fire.

Armoured ammunition bins were introduced into Canadian tanks in an effort to decrease the incidence of ammunition fires or "brew-ups".

Gun Mounts and Gear

The Valentine used a one-piece mantlet with shoulder controlled elevation and pistol grip firing. This same mount was used for Ram I.

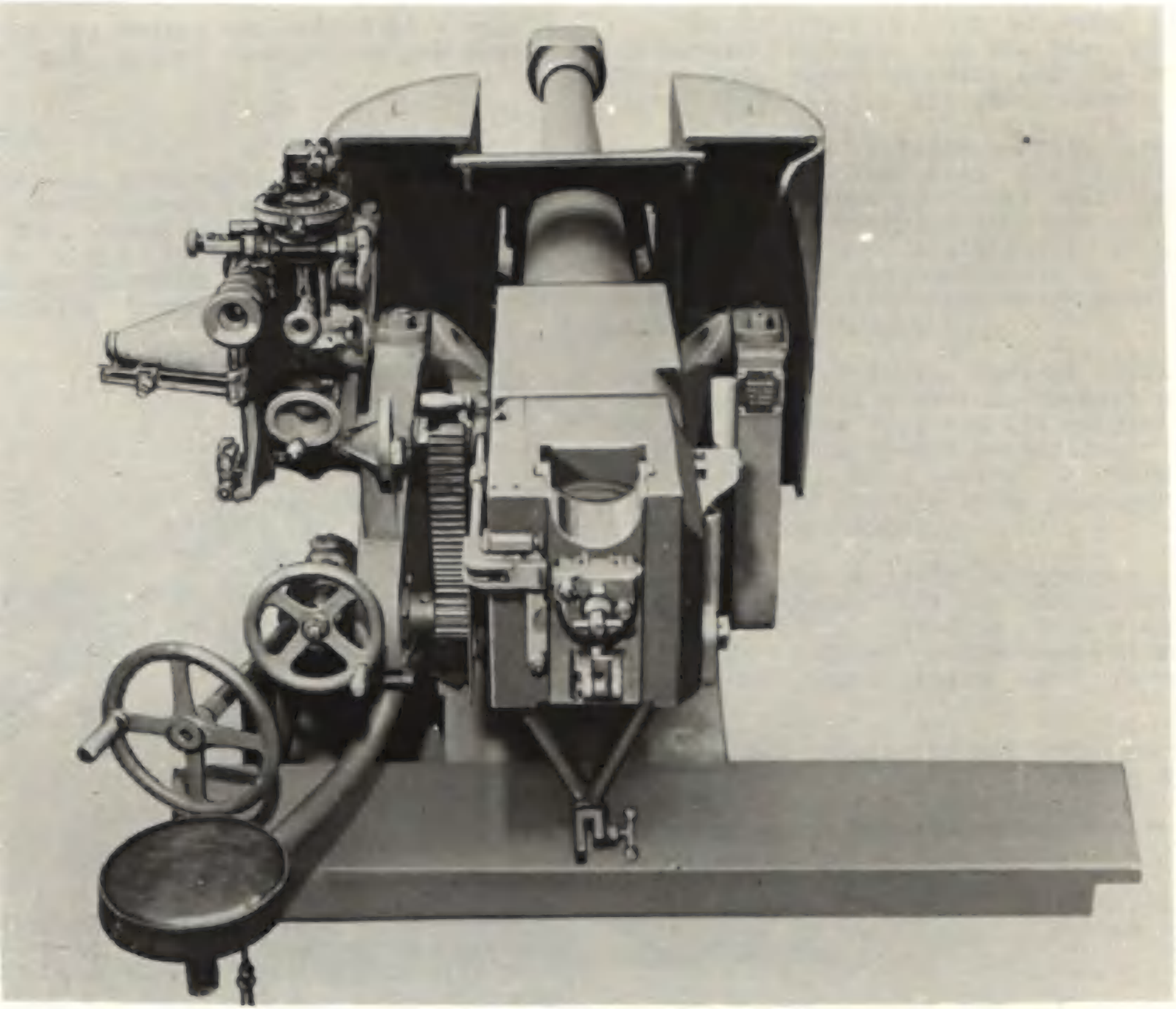
For the Ram II, a special mount was designed and produced in Canada. This included a detachable turret face plate with trunnions carrying an internal mantlet and gun cradle along with the cradle for the coaxally mounted machine gun, also brackets for the direct sighting telescope. The elevating wheel and gear box, carried on the cradle, rotated a threaded rod which acted in a split nut fixed to the turret floor. The opening of the split nut allowed controlled elevation of the gun by the gyro stabilizer.

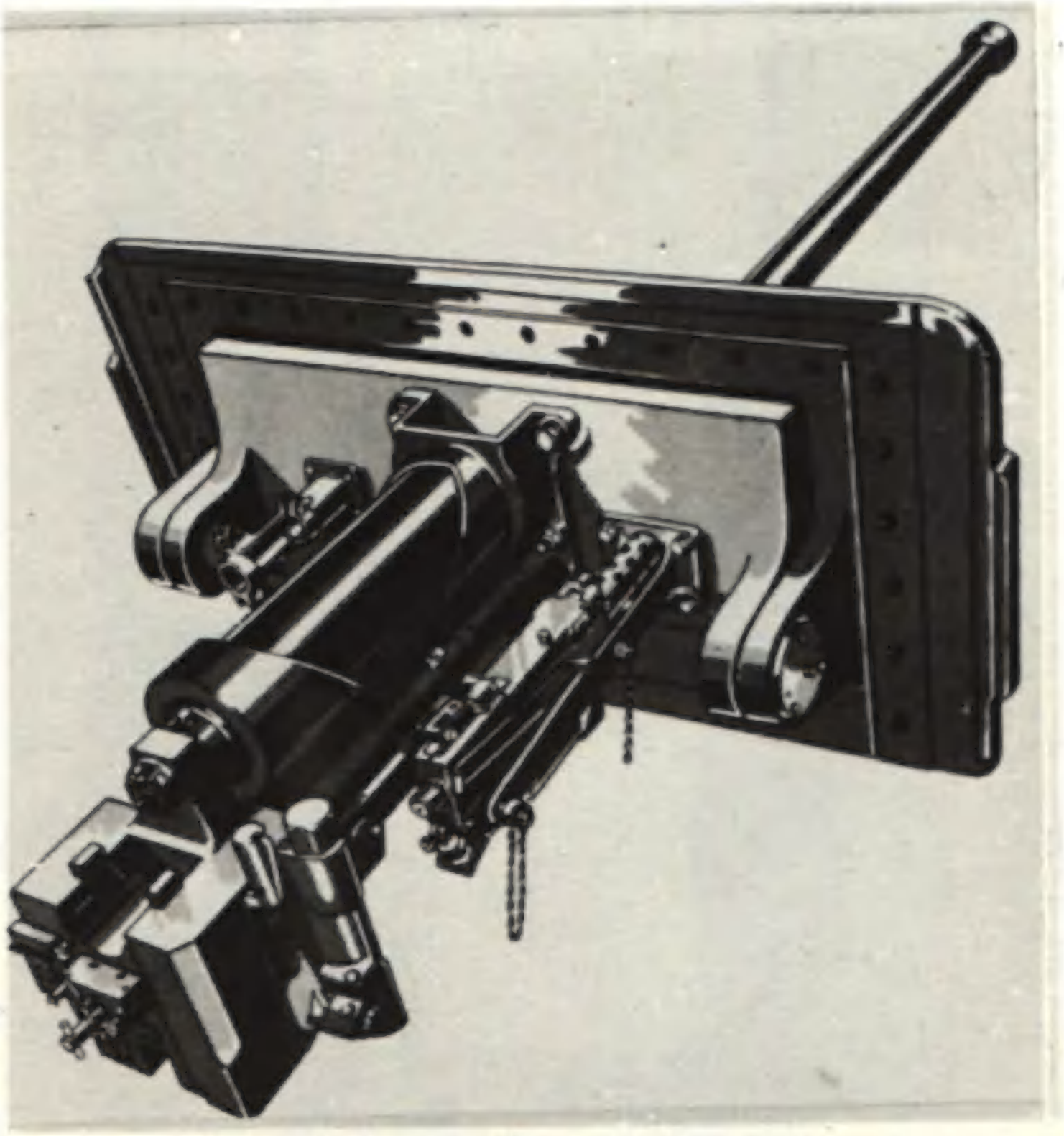
Grizzly Tanks built in Canada had the later type external mantlet equipped with trunnions having anti-friction bearings. Elevation was of the normal pinion and quadrant type with the pinion readily movable out of engagement for gyro stabilized control. A direct sighting telescope is mounted in the cradle and additional periscopic sight is linked to the cradle.

In the Skink, it was necessary to use four internal mantlets held in parallel with themselves and the sight, by suitable linkage. Elevation is by power only from hydraulic rams, but, in an emergency, guns can be quickly put in free elevation by opening valves.

The mount of the Sexton is very similar to the 25 Pr. field mount except that an improved traverse gear is used.

Considerable effort was spent on details





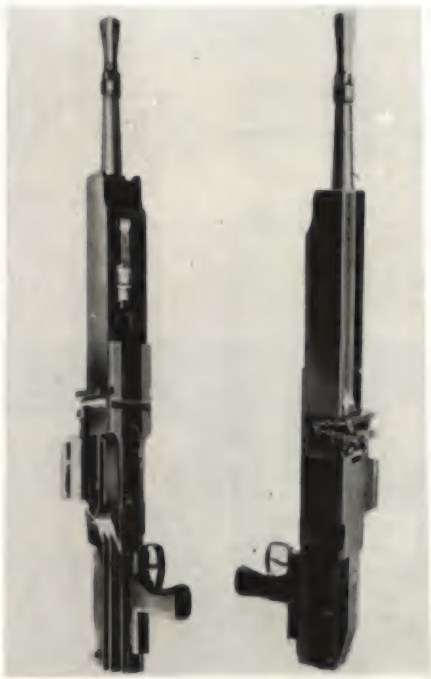
on all jobs to reduce the effect of small arms fire and splash through the gun mount openings.

Machine Guns

One of the first problems after the decision to build tanks in Canada, was to arrange for the substitution of the Browning .30 calibre m.m.g. 1919A4 for the 7.92 Besa which was the standard British weapon. This was successfully accomplished in the Valentine.

.30 CALIBRE BROWNING

The principle of mounting a medium machine gun coaxial with the main armament was followed throughout, although many problems in ammunition feed, firing means, etc., were encountered.



7.92 MM. BESA MACHINE GUN

The Ram carried a Browning .30 calibre in the forward cupola with traverse and elevation for observed fire. When the cupola was removed, the gun was mounted in a ball and socket joint similar to the M-4 and Grizzly. Although much thought was given to sighting devices for the bow machine gun, no practical means was found to accomplish this.

Machine guns were carried for mounting on the commander's hatch for local anti-aircraft protection, but their value was doubtful.

Hull

At the commencement of the war, all British and American tank hulls were fabricated from rolled armour plate, machined, formed, fitted and rivetted.

The manufacture and erection was a long laborious process and the User objected to the large plane surfaces and the tendency of rivet heads to fly off under shock.

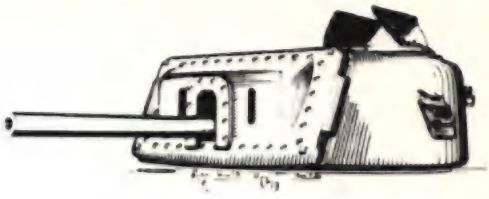
Peace-time experience with large locomotive castings indicated that hulls could be successfully cast of armour steel greatly reducing the production time and cost and that they would be more satisfactory ballistically, in that plane surfaces could be avoided and the sections increased where greatest protection is desired.

Working with the General Steel Castings Company, U.S.A., a cast upper hull was piloted for the Ram Tank and its complete success, both ballistically and production-wise, led to its adoption. This type of construction was later adopted for a large portion of United States Medium tanks.

Meanwhile, welding technique was becoming highly developed and the use of plate, flame cut to pattern avoiding close fitting, considerably reduced production time. Sexton lower and upper hulls were fabricated by welding.

The Ram originally had doors on the upper hull sponsons to serve for loading ammunition and for escape. These were found to be vulnerable and were eliminated and replaced by an escape hatch in the floor.

A floor hatch was also provided for the attachment of the "Snake" - a long pipe demolition device.



CAST ARMOUR TURRET-LESS BASKET
(RAM TYPE)

Turret

Turret design is necessarily dependent on the main armament and turret crew.

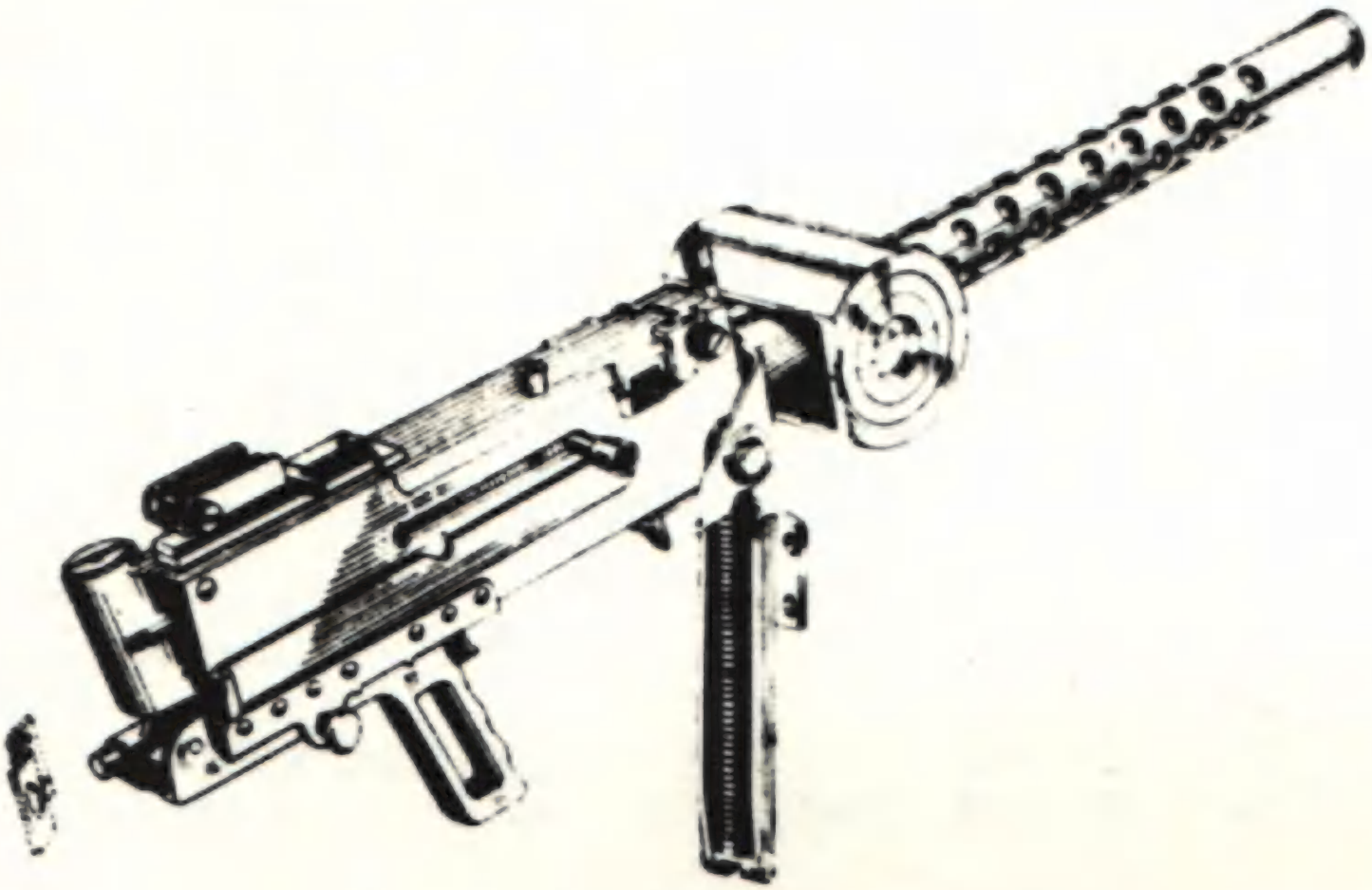
The Valentine originally had a fabricated rivetted turret, later changed in Canada to a casting with a 50" ring, which allowed a turret crew of two men only. It was soon realized that this turret was too small, both for mounting larger main armament and accommodating an adequate crew. The Ram turret was based on the M-3 ring with 60" diameter and the Grizzly was further improved with a 69" internal diameter.

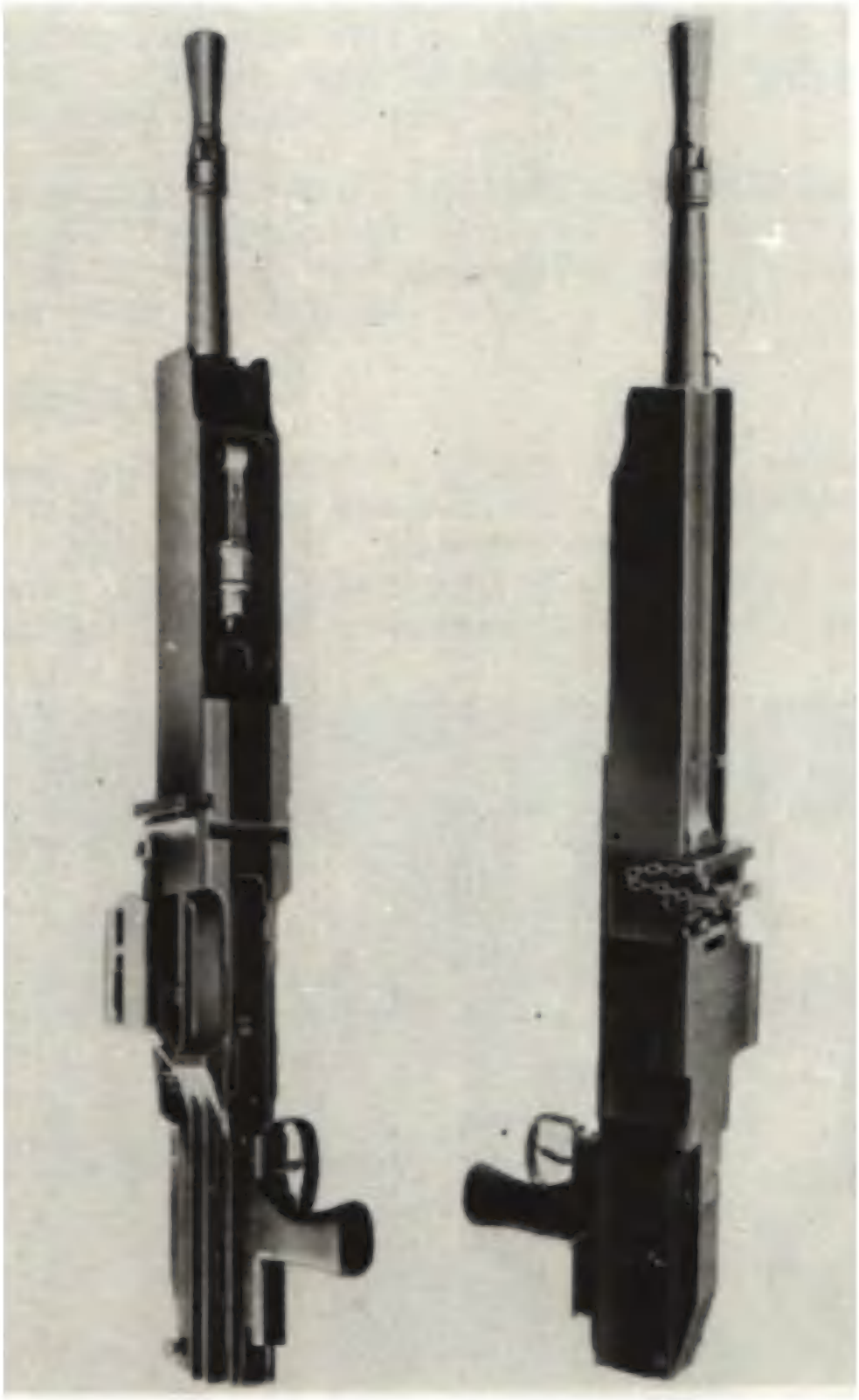
Early turrets had almost completely enclosed baskets to avoid injury to the crew due to interference with static tank components on traverse. However, to provide access to stowed ammunition and escape hatches, baskets were progressively skeletonized until only the floor and supports remained. Current United States and British designs have now removed the floor, carrying the crew on suspended seats and foot rests.

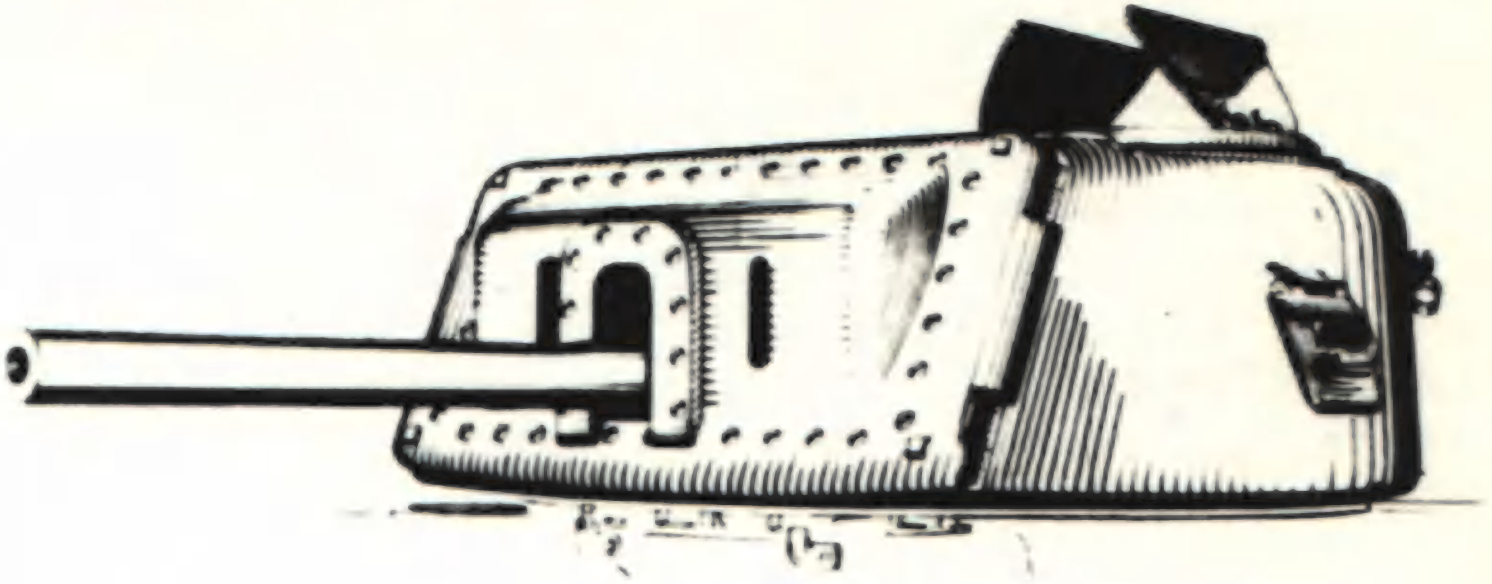
One turret hatch only was provided in Canadian built tanks. This proved inadequate for escape purposes, and current designs, including the Skink, provide a hatch for each member of the crew.

The placing of the armament, traverse and elevating gear, ventilating devices, vision devices, radio and intercommunication, ready ammunition, small arms and stowage within the turret must all be considered in detail and as a whole in the turret design.

Opinions varied on the necessity for, and the value of, pistol ports. However, it became generally considered that they are desirable but must be invulnerable. The tapered plug type used on later Rams met with satisfactory User acceptance.







Turret Traverse Systems

All tanks are provided with means for traversing the turret and the main armament manually or with power.

The Valentine used an electrical (Lucas) traverse which derived its power from a generator mounted on the main engine and hence would not operate with the main engine stopped.

The Ram used the Logansport hydraulic which included an electrically driven gear pump on the floor of the turret driving a gear motor through controlled variable throttling valves. This type while generally satisfactory, was lacking in "creep" speed and fine fire control. A development programme, initiated in the United Kingdom, resulted in a re-design of the throttling valves with some improvement, but it was agreed that the ultimate in fire control could not be achieved due to the slight leakage characteristics of a gear type hydraulic motor.

The Grizzly used the oil gear hydraulic system, adopted as standard for all United States tanks.

This system employs an electrically driven multiple piston pump, driving direct to a multiple piston motor. Control is effected by varying the throw of the pump pistons. Complete satisfaction was enjoyed with this gear and a variation using two pumps, one driving a piston motor for traverse and one for hydraulic rams for elevation, was included in the Skink.

All turret traverse systems are carried in the turret and drive a pinion which engages a large toothed ring integral with the static turret ring of the hull.

Current designs include, in addition to the gunner's traverse control, an over-riding control by which the commander can bring the gun to bear on the target.

Gyro Stabilizer

Ram and Grizzly Tank gun mounts were fitted with a gyro stabilizer, the purpose of which is to hold the gun on the target regardless of the fore and aft pitching of the tank. It did not compensate for roll or slewing.

INSTALLATION OF GYRO CYLINDER AND PISTON ASSEMBLY

This device includes a pendulum and an electrically driven gyroscope which actuates valves controlling the pressure to a hydraulic cylinder attached to the gun mount. A manual control coupled to the stabilizer governs the powered elevation or depression for laying while on the move.

Observation Devices

Canadian tanks were provided with normal vision devices. The Triplex block and Vickers periscope were used on the Valentine while protectoscopes and periscopes were used on the Ram, Grizzly and Skink. Early Rams suffered from too little closed down observation, which was later corrected by providing every member of the crew with at least one periscope.

The Vickers periscopes have given uniform satisfaction although the rear view feature is of doubtful value. The early Minneapolis-Honeywell periscope was not a success but their later type, as used on Grizzly, was completely satisfactory, particularly in that it included a large field of view.

Extended periscopes, to raise the object prism high enough to give vision close to the vehicle, were used on the Ram, with limited success due to the restriction in field of view with the increased length of instrument.

The all-round vision cupola in the central turret hatch was not developed in time to be used in Canadian production.

Electrical

The United Kingdom Valentine design included a 12 volt system which was re-designed in Canada to supply 24 volts required for the Diesel engine starting system and for the radio. Although a certain amount of unbalance existed, due to servicing some 12 volt accessories and the No. 19 Mk. I Set, the system gave satisfaction in service. No auxiliary generator was carried, the electric power for the traversing motor being supplied from the main engine driven generator. All other tanks had a basic 24 volt system supplied by a main engine generator and an auxiliary generator (Homelite) in parallel with two 12 volt batteries floating in the circuit. Voltage and reverse current limit controls were used and thermo overload limit cut-outs were included in all heavy circuits.

Numerous changes were made in the main and auxiliary generators to improve their reliability and increase their output. However, under static conditions without benefit of the main engine, an auxiliary generator with a longer life than the Homelite is desirable.

To serve the extra wireless in the Command and O.P. Tank, two 24 volt banks of 6 volt batteries were carried. All banks were interchangeable by switching when charging from engine generator or the auxiliary generator, and for serving the vehicle or either of the wireless sets. While the circuits were rather involved, switching was simple and Users were satisfied.

The very heavy power draw for high turret acceleration on the Skink with simultaneous elevation demanded a more adequate current supply. This was accomplished by developing a 2000 watt Homelite and modifying the engine generator to improve its output. New voltage and reverse current controls were developed to handle the heavier currents. The complete electrical design for this vehicle was a very involved, interesting and apparently successful project.

Electrical firing was used in all Grizzlies, with stand-by foot firing. The Ram used foot firing throughout production.

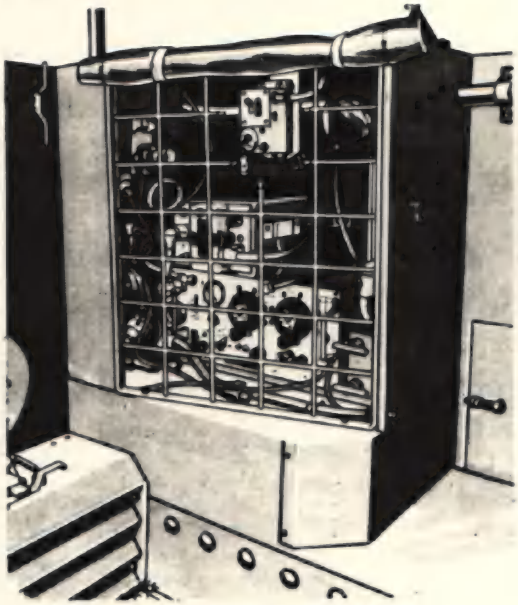
The original Sexton design did not include an auxiliary generator. It differed from the tanks in having no electrical turret traverse load, but at the request of the User to provide more adequate power for the wireless, the Homelite was introduced early in production.

The No. 19 Mk. I Set required a 12 volt supply and a battery balancing switch was installed in the Sexton to switch this load from one battery to the other, as required, to keep them in balance.

As a matter of interest, the normal electrical devices on a medium tank include the following: Engine Starter, Headlights, Marker Lamps, Spot Lamp, Trouble Lamps, Interior Light, Wireless, Intercommunication, Traverse Mechanism, Gyro Stabilizer, Siren, Firing Solenoids, Instruments, Ventilating Fans, Illuminated Sights, etc. etc.

Communication

In every vehicle provision was made for the No. 19 Wireless Set (in the turret in tanks and at the rear in the Sexton) and appropriate intercommunication stations.



RADIO INSTALLATION -SEXTON

Care was taken in production and inspection to suppress all vehicle radio interference to an acceptable level.

P 8 TYPE COMPASS

Compass

All vehicles were provided with magnetic compasses of various types in various locations, but their value was extremely doubtful with the exception of the P.B. Binnacle and Compass which was installed in the Sexton.

This instrument raises the compass proper, away from the shielding and magnetic effects of the metal hull and projects the reading periscopically on a screen at the driver's eye level.

Early work was done in Canada on a directional gyroscope. This instrument is remarkably stable on turns, but its precision characteristics demand that it be referred to a master magnetic compass periodically.

PIONEER TYPE COMPASS

Projects in the United Kingdom and the United States were looking to the use of a directional gyro and a P.B. Compass in navigational vehicles, but did not reach the production stage.

WD-32 COMPASS AND "C" TYPE
P B BINNACLE EQUIPMENT

Ventilation

Rams and Grizzlies were provided with fans to exhaust concentration of carbon monoxide from the turret.

Splash Protection

Considerable study was devoted to the prevention of entry of splash into the hull, with varying success. Gun Mount and telescope openings are particularly difficult to splashproof, but quite successful labyrinths were developed and used. To direct splash in harmless directions is just as satisfactory as to prevent its entry entirely and usually much easier to accomplish.

Smoke Generators

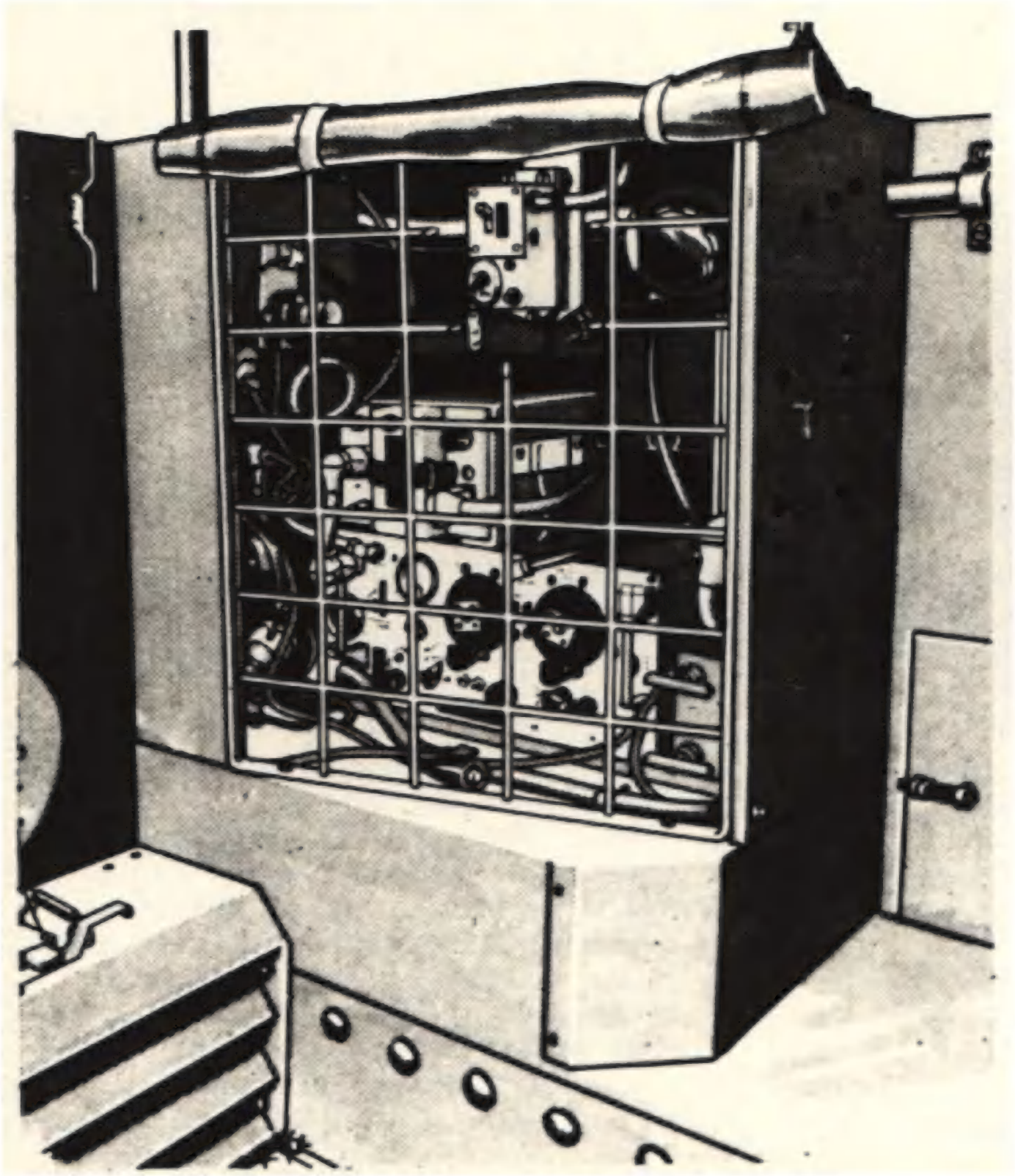
All tanks carried 2" Smoke Mortars in the turret.

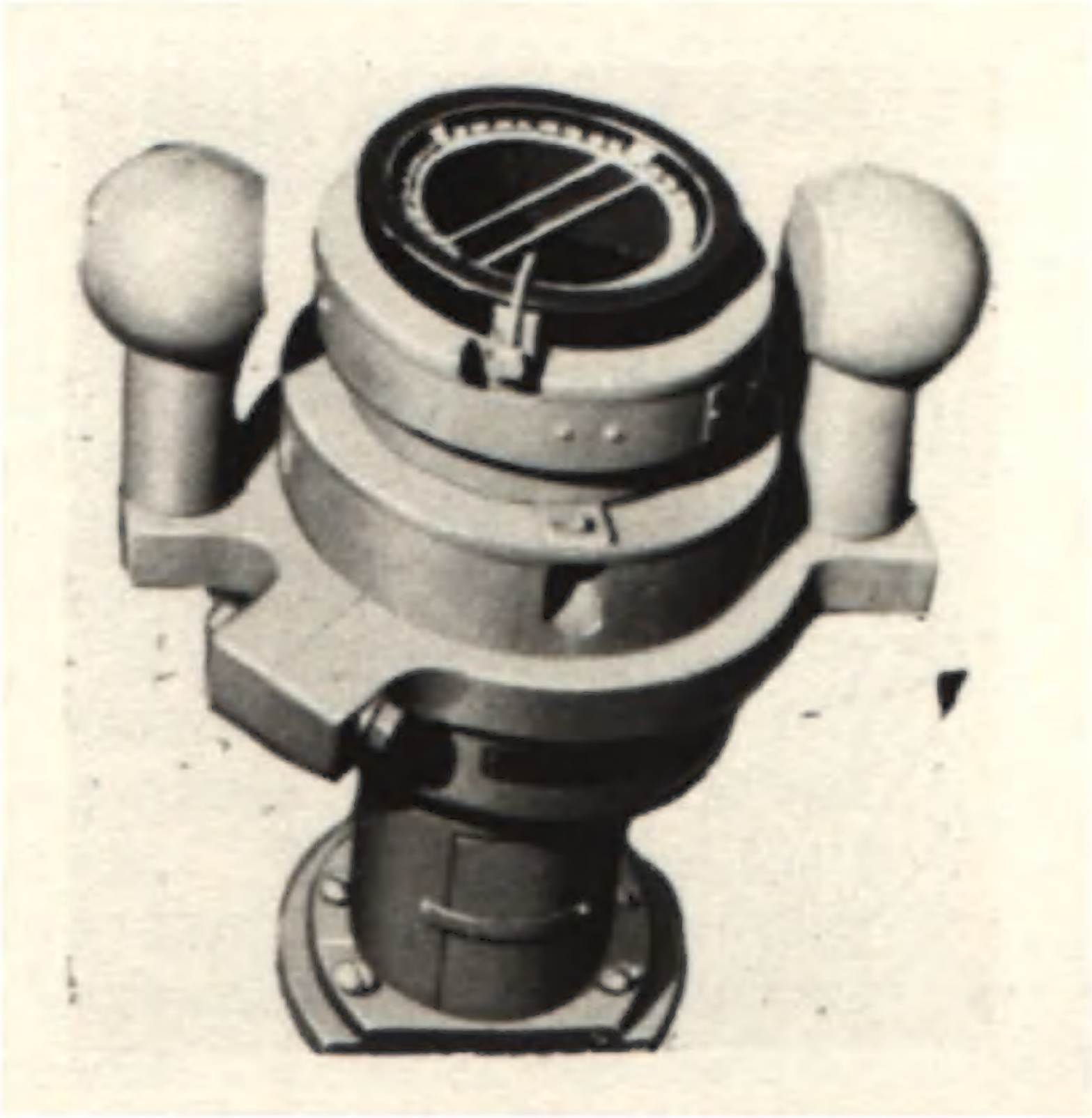
Tail smoke was a G.S.requirement and in service was accomplished by carrying electrically fired, jettisonable No. 8 smoke generators.

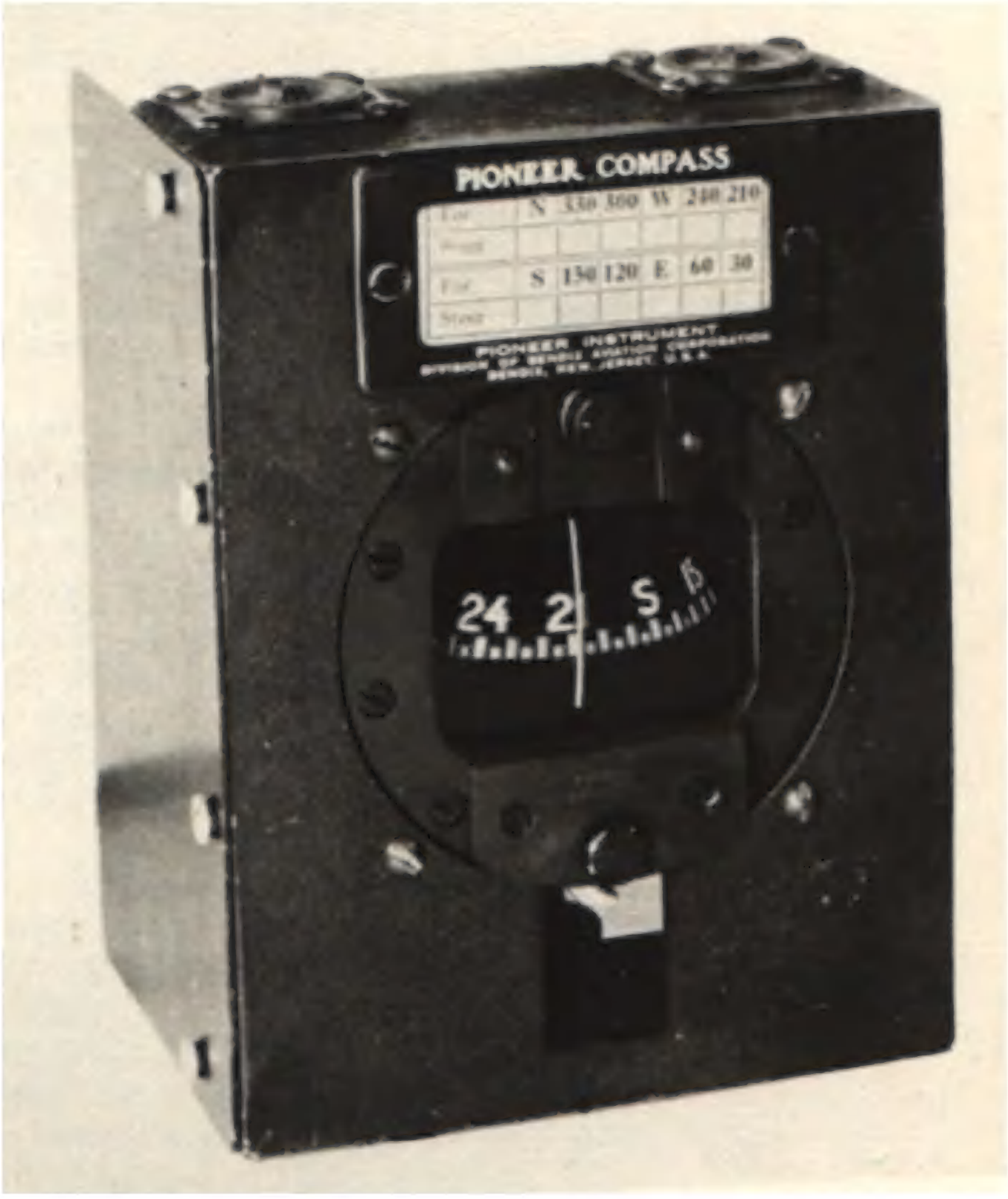
Considerable work was done on the development of continuous tail smoke from oil sprayed into the engine exhaust.

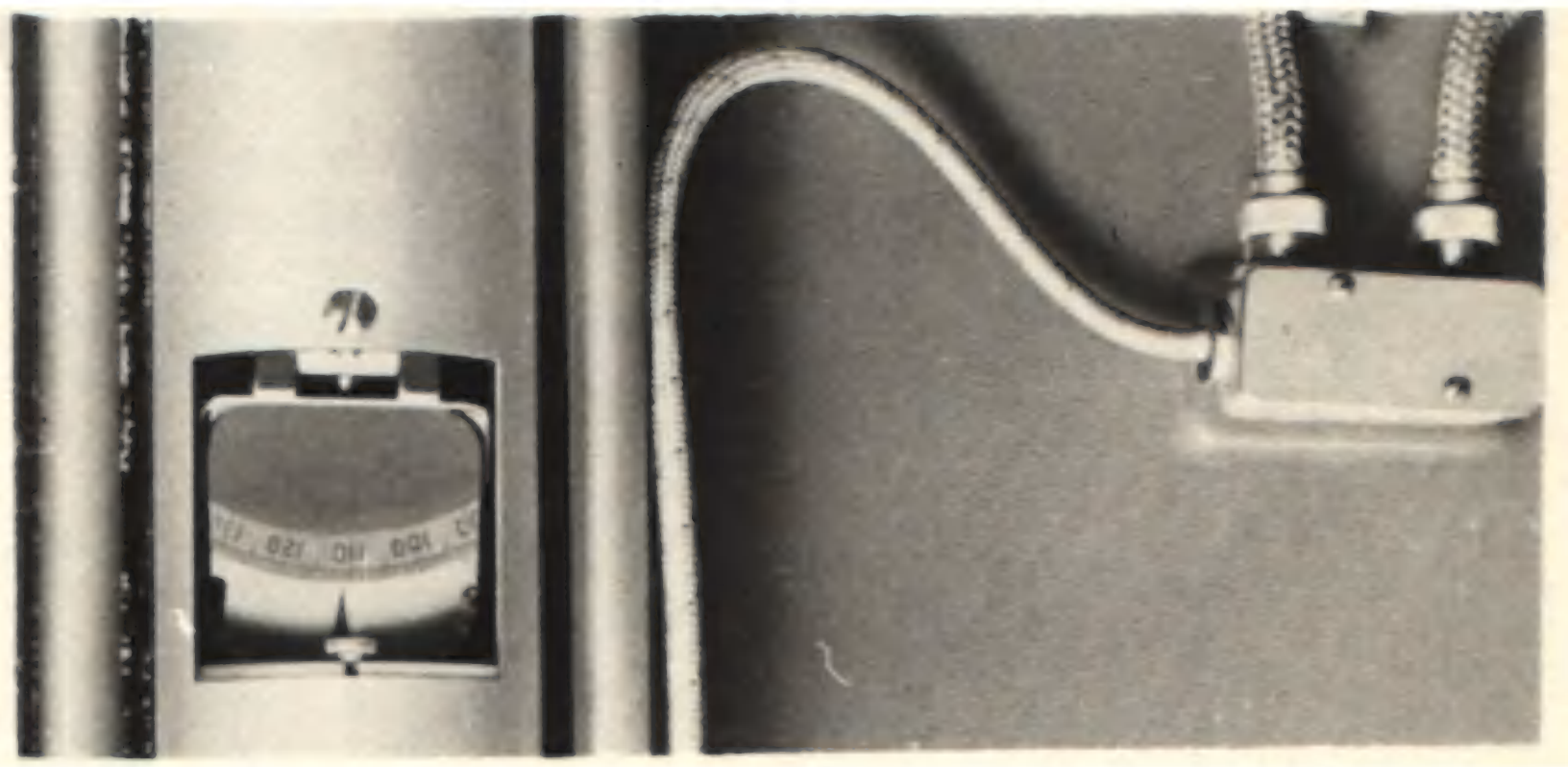
Pilots were built and reported on favourably, but were not adopted in production because tactical requirements were not clear.

The device consisted of an electric motor connected directly to a small pump driving oil from a tank in the engine compart-






PIONEER COMPASS
N 330 300 W 240 210
S 150 120 E 60 30
PIONEER INSTRUMENT
24 27 S



sent and forcing it through nozzles into the hot exhaust pipes.

Protection Against Gas and Lethal Fluids

A great deal of study was devoted to the protection of tank crews against gas and lethal fluids. The ideal, which is apparently impossible of practical accomplishment, is to maintain a positive pressure of filtered air within the vehicle.

Working with D.C.W.&S. the problem was attacked in two phases:

For protection against lethal fluids, methods were developed and kits prepared for positively sealing by flexible materials all openings and interstices.

For protection against gas, a fan delivering air under pressure through individual filters to a transparent face piece for each member of the crew, was developed. It was very favourably reported on in User tests. This apparatus was not developed beyond proof of the principle.

Winterization

The starting of Canadian made tank-type vehicles at temperatures above zero degrees Fahrenheit presented no unusual difficulties and called for no special winterizing equipment although the following systems passed through several stages of development before being regarded as satisfactory.

1. Oil Cooling
2. Priming
3. Oil Dilution

When oil in coolers of early production tanks was sufficiently chilled to offer great circulation resistance, a relief valve opened allowing the oil to by-pass the cooler. Subjected to the continual rush of cold outside air, the cooler frequently would not warm up enough to permit the valve to close even when the by-passed oil reached or exceeded safe temperature limits. By placing temporary shields over the cooler grills, crews did what they could to prevent engine damage, but the defect continued to be troublesome until a cooler was introduced in which the by-passed oil was led through ducts within the cooler itself.

An engine priming system which sprayed fuel under pressure from a hand-operated plunger pump through atomizing nozzles located near the intake ports, was included in early production. Production changes later improved the efficiency of the system through use of a larger capacity pump spraying fuel through improved nozzles to seven instead of five ports.

The temporary dilution of engine oil with fuel was practiced for starting temperatures below 32 degrees Fahrenheit. On early production tanks a solenoid-operated valve passed fuel by gravity from the fuel tanks to the oil reservoir. To thoroughly mix fuel and oil, the addition was made some minutes before stopping the engine. This system had no fuel measuring device and that, together with the gravity feed, introduced uncertainties which were not overcome until the solenoid operated valve was replaced by a manually-operated two-way valve passing fuel under pressure from the fuel pump into a visable-level measuring tank, which could be filled and drained by the turret crew as often as required for expected starting temperatures from 32°F to -40°F.

The anticipated use of Canadian made tanks in countries where starting temperatures might fall to -40°F or lower, led to the investigation of special winterizing devices for application only to tanks destined for such use. Winterizing kits developed by United States Ordnance and used as a basis for Canadian work contained the following principal items:

1. Exhaust Damper
2. Engine Intake Air Damper
3. Oil Dilution System
4. Shutters for Engine Oil Cooler
5. Shutters for Transmission Oil Cooler.
6. Priming Equipment
7. Calrod Heater for Oil Tank
8. Electric oil pressure Gauge
9. Engine Compartment heater
10. Battery Heater

The kits were intended for modification of a wide range of M4 tanks and consequently included some items which already were standard equipment on the latest vehicles. Attention will be drawn to this in discussing the ten Winterizing devices.

The exhaust damper consisted of hinged flap which could be closed at will over engine cooling air exhaust and acted as an air deflector when open. This damper was standard equipment on Grizzly tanks but extended experience showed that crews were inclined to forget opening the flap before driving away. The frequency with which vehicles were damaged through this neglect led to abandoning the damper in favour of an open vane assembly.

The Engine Air Intake Damper could be operated by the crew within the vehicle to control the intake of engine cooling air. The controls of the damper supplied by the kit interfered with internal parts of the Sexton to such an extent that a new damper assembly was developed with controls located at the outside of the rear bulkhead. The Engine Air Intake Damper never was supplied in production but continued in use for winterizing.

As mentioned in earlier paragraphs, the oil dilution system was applied at production. It was also included in the United States kit in order that certain early American vehicles might be modified.

Shutters for the transmission and engine oil coolers were in the form of roller blinds which could be drawn to prevent circulation of air through the coolers.

Priming equipment, as already mentioned, was provided during production. The United States winterizing kit contained the large priming pump and improved atomizing nozzles for tanks not already equipped with those items.

A 600 watt heating element was supplied in the winterizing kit for the purpose of heating engine oil. The element was slightly flexible for immersion in the engine oil reservoir when in use.

Oil pressure gauges operating by direct pressure through long exposed tubes were commonly used in early production tanks. Low temperature operation emphasized the disadvantage of this type of instrument where a vehicle might run for hours before the gauge could register correctly. Winterization therefore included replacement of the direct acting gauge with an electrical instrument, the sending unit of which could be located directly on the engine where pressure readings would be little affected by temperature. The uncertain performance, even at moderately low temperatures, of instruments operated directly by fluid pressure through long tubes led to their general replacement in production with electrical or mechanical instruments.

Tanks equipped with the foregoing devices could be started without great difficulty at temperatures down to -20°F. Where difficulty was encountered or where temperatures were lower, an engine compartment heater was used. This electrically-ignited heater in the engine compartment burned fuel (gasoline or diesel oil) supplied by an automatic pump which operated for a ten minute period only in order that fire hazard might be reduced, should the crew neglect to extinguish the burner.

At starting temperatures below -20°F. the tank storage batteries required to be heated for efficient operation. The winterizing kit provided for this by utilizing heat from the exhaust of the auxiliary generator engine. On Sexton, however, where both the batteries and the auxiliary generator equipment, were in

compartments in the rear rather than in the body of the vehicle, new battery heating facilities had to be developed.

Synthetic Rubber Bogie Tires

The urgent need of conserving crude for use only where synthetic proved completely impracticable, led to experiments with synthetic bogie tires aimed at determining:

Firstly, whether or not they would have an expected life great enough to maintain allowable minimum fighting efficiency of a tank or self-propelled gun.

Secondly, what manufacturers could supply suitable tires without further delays in development of compounds or processes.

The manufacturers' task of producing reliable synthetic tires of the size common to M4 and Ram Tanks and to Sexton S.P.G.M. was difficult because the weight of those vehicles particularly the tanks, was in excess of that for which the suspensions were originally designed, consequently, the pressure on the tires was very high even for natural rubber. This knowledge forecast little hope for use of synthetic tires of size 20 x 9 x16 on tanks, but it was anticipated that they would give reasonable service on the somewhat lighter Sexton.

By the time experimental tires were produced Winter in Canada was near, and since it was essential that tests be made without delay under highly detrimental hot-weather conditions which the tires would encounter in service, test equipment and personnel were sent, through co-operation of American Authorities, to Camp Seeley, California, and Phoenix, Arizona.

Ram II Tanks ballasted to 68,000 pounds and Sextons to 53,000 pounds, were driven a total of 26,000 miles in testing and comparing several tire constructions from each of three Canadian manufacturers. Test course surfaces were largely sand and gravel or crushed rock with rocky cross country making up about four percent of the total run. Over the former, vehicles were driven at their full speed of 24 M.P.H. for a maintained average of 20-22 M.P.H.,and on the latter, speeds were 3-8 M.P.H. Tem-

PERFORMANCE OF SYNTHETIC TIRES ON RAM II TANK (68,000 LBS.)

Tire Composition	Mileage at time of failure		
	Manufacturer "A"(Goodyear)		
	HIGH	LOW	Average for all tires
(C.S.G.50)	194	33	99
(C.S.G.54)	184	36	80
x (C.S.G.77)	1284	23	280
	Manufacturer "B" (Firestone)		
(C.S.F. 7988)	397	221	272
(C.S.F. 7962)	425	178	308
	Manufacturer "C" (Dominion)		
(C.S.D.10)	694	31	176
(C.S.D. 8)	697	26	262

PERFORMANCE OF NATURAL RUBBER TIRES ON RAM II TANK (68,000 LBS.)

Tire Composition	Mileage at time of failure		
	HIGH	LOW	Average of all tires
Natural Rubber	1540	125	531

PERFORMANCE OF SYNTHETIC TIRES ON SEXTON S.P.G.M. (53,000 LBS.)

Tire Composition	Mileage at time of failure		
	Manufacturer "A" (Goodyear)		
	HIGH	LOW	Average for all tires
(C.S.G.54)	1024	48	435
x (C.S.G.77)	2523	163	1864
	Manufacturer "B" (Firestone)		
(C.S.F.7988)	2205	428	1609
	Manufacturer "C" (Dominion)		
(C.S.D.10)	2625	35	813
(C.S.D 8)	2749	105	1393

PERFORMANCE OF NATURAL RUBBER TIRES ON SEXTON S.P.G.M.(53,000 LBS.)

Tire Composition	Mileage at time of failure		
	HIGH	LOW	Average of all tires
Natural Rubber (Goodyear)	1918	180	879

x This compound was released for production on Sexton only.

peratures ranged from 50° to 112°F. with daily averages frequently 90° to 100°F. Steel tracks (Canadian Dry Pin) were used on tanks and Sextons for all tire comparisons although in testing a synthetic rubber track some indication was seen of the probable behaviour of synthetic tires on rubber backed tracks.

The steel tracks together with high operating temperatures and speeds were calculated to place the tires at disadvantages comparable with those of service conditions.

The first test result noted on synthetic tires was a slight transverse cracking which appeared after 50 to 100 miles of running. The cracking did not extend with service nor was it believed to influence greatly the ultimate failure of tires. Neither did tires fail through wearing of the tread surface, in fact, even the mould register marks usually were visible to the end. Almost without exception, tires failed from within where either simple mechanical action or the heat generated by working of the rubber, or both started separations which spread through zones of least resistance loosening masses of rubber which then were torn away in the course of running.

While the initial seat of rupture might be anywhere within the tire, final destruction often followed surfaces representing divisions in processing. Splice failures, separations of rubber from steel, parting between base and tread stocks occurred frequently. The breaking down of the cohesive strength of the rubber sometimes was followed by deeply seated blisters extensive enough to permit the dislodging of large pieces of tread. On several tires, shelling and undercutting of the edges was observed. This gave the tire edges the appearance of a chipped flint, and although it did not represent failure in itself it probably hastened destruction through reducing the amount of load supporting rubber.

The life of synthetic tires in terms of miles was exceedingly variable. It varied with the manufacturers construction, compounding and process control, with operating temperature and with vehicle weight and speed.

The table shown on the previous page indicates something of the variations in synthetic tire life as shown by the Camp Seeley and Phoenix trials. Figures are included also for the natural rubber control tires run at the same time, and it may be noted that variation in life is not confined to synthetic tires.

The next five paragraphs are quoted (incompletely) from the official report on bogie tire tests, and, in general, includes some of the results obtained.

1. "All synthetics, when tested on fully stowed RAM II Tanks (68,000 lbs.) equipped with steel (C.D.P.) Tracks, had a high failure frequency as compared to the natural rubber control tires".

2. "Synthetics, when tested on RAM II Tank (68,000lbs.) equipped with T-51 synthetic tracks, had a low failure frequency. The track blocks, however, had high failure frequency beyond 1500 test miles".

3. "Vehicle weight had a most detrimental effect on synthetic performance". "For example, one brand of synthetic tires was noticeably superior to all others when run on Sexton (53,000 lbs.) However, when tested on Tanks (68,000 lbs.) performance "levelled" off" to a point where it was only slightly superior to the others".

4. "Synthetic bogie tires of one brand were released for production on Sexton as a direct result of their excellent performance on that vehicle at low and high temperatures."

5. "With increase in operating temperature there was proportionate increase in failures of both synthetic and natural rubber tires."

The effect of temperature on synthetic tires may further be observed in trials carried out at Ottawa. There, tires were run on a fully stowed Sexton for 1470 miles at average speeds of 22-24 M.P.H., over terrain consisting of 20% pavement, 75% gravel and 5% rough dirt road with rock outcropping. No tires failed in this 1470 mile test, which was run in cold wet weather at temperatures of 30° to 60°F. Tires of a very similar composition averaged only 435 miles at Camp Seeley-Phoenix trials, with one failing at 48 miles. Even in the moderate ambient temperatures of the Ottawa test, rubber temperatures of 300°F were recorded. In the natural rubber control tires, used in the same run, temperatures did not exceed 215°F.

While the abrasion resisting qualities of synthetic bogie tires appear to be satisfactory, development is needed in the control and quality of the bonding of base stock to steel, and tread to base stock. The tank designer might add something to the life of synthetic tires by using two large diameter narrow bogie wheels, after the fashion of the recently produced American M24 light tank, and the new United States double bogie medium tank suspension. A narrower tread would give better heat dissipation, and a larger diameter would reduce tread pressure and, consequently, the rate of heat generation.
(D.T.D. Report Bogie Tests - Camp Seeley, Cal. and Phoenix, Ariz.)

EQUIPMENT AND STOWAGE

The material specified for each vehicle for its maintenance during operation, and the material requirements of the vehicles' crew is classified as equipment. The disposition of the equipment in the vehicle is known as stowage.

Equipment

The following paragraphs describe briefly the equipment carried in Canadian Tanks and Tank Type Vehicles.

Armament

Below is a list of the ammunition carried in the various Canadian Tank Vehicles produced, and specifies the primary armament and secondary arms carried as part of tank equipment.

Valentine

1 - Ordnance Q.F. 2 Pr. (Rounds - 79)
1 - B.E.S.A. 7.92 mm. M.G. or Browning Cal. .30 (Mounted coaxially with 2 Pr. in turret) (Rounds - 3500)
1 - Bren .303 M.G. (A.A.) (Rounds - 336)
1 - Thompson Cal. .45 S.M.G. (Rounds-240)
1 - Bomb Thrower 2-inch (Rounds - 18)
1 - Signal Pistol - 1-inch (Rounds - 12)

Ram I

1 - Ordnance Q.F. 2 Pr. (Rounds - 171)
1 - Browning Cal. .30 M.G. (Mounted coaxially with 2 Pr. in turret) Rounds - included in next item.
1 - Browning Cal. .30 M.G. (Mounted in bow cupola) (Rounds - 4275)
1 - Browning Cal. .30 M.G. (A.A.) (Mounted in turret hatch) (Rounds - 440)
1 - Thompson Cal. .45 S.M.G. (Rounds-440)
1 - Bomb Thrower 2-inch (Rounds - 44)
1 - Signal Pistol 1-inch (Rounds - 20)
6 - Hand Grenades

Ram II

1 - Ordnance Q.F. 6 Pr. (Rounds - 92)
1 - Browning Cal. .30 M.G. (Mounted coaxially in turret) Rounds - included in next item
1 - Browning Cal. .30 M.G. (Mounted at front hull) (Rounds - 4000)
1 - Browning Cal. .30 M.G. (A.A.) (Mounted on turret hatch) (Rounds - 440)
1 - Bomb Thrower 2-inch (Rounds - 43)
1 - Signal Pistol 1-inch (Rounds - 20)
6 - Hand Grenades

Grizzly

1 - Gun, 75 mm. (Rounds - 78)
1 - Browning Cal. .30 M.G. (Mounted coaxially in turret)
Rounds - included in next item
1 - Browning Cal. .30 M.G. (Mounted in bow) (Rounds 4750)
1 - Browning Cal. .50 M.G. (A.A.)(Mounted on turret hatch ring)(Rounds-300)
2 - Thompson Cal. .45 S.M.G.(Rounds-440)
1 - Bomb Thrower 2-inch (Rounds - 12)
1 - Signal Pistol 1-inch (Rounds - 20)

Command O.P.

1 - Browning Cal. .30 M.G. M1919A4(Mounted at front hull) (Rounds - 2000)
1 - Browning Cal. .30 M.G. (A.A.)(Mounted on turret hatch) (Rounds - 440)
2 - Thompson Cal. .45 S.M.G. (Rounds-440)
1 - Bomb Thrower 2-inch (Rounds - 43)
1 - Signal Pistol, 1-inch (Rounds - 20)
6 - Hand Grenades

Sexton

1 - Ordnance Q.F. 25 Pr. (Rounds - 112)
2 - Sten 9 mm. M.G. (Rounds - 448)
2 - Rifles .303 (Rounds - 100)
2 - Bren .303 inch M.G. (Rounds - 1500)

Skink

4 - Guns, Machine, Polsten 20 mm. (Rounds-1920 in 30 round clips)
1 - Browning Cal. .30 M.G.(Mounted in bow) Rounds -2250
2 - Thompson Cal. .45 S.M.G. (Rounds-440)
1 - Signal Pistol, 1-inch (Rounds - 20)
12 - Hand Grenades

Armament Spare Parts, Tools and Ancillaries

While small attempt was made to carry spare parts as security against unpredictable enemy-action damage to weapons, care was taken in supplying replacements for parts which experience showed as having strong tendencies toward breaking or wearing during normal operation. Thus spare strikers, springs, small breech parts, delicate buffer and recuperator pieces were carried for main armament, and breech mechanisms and barrels for frequently used machine guns. Tools for replacing those parts were carried along with others needed for routine cleaning, adjusting, repairing and lubricating. Breech and muzzle covers were provided for protection against weather. Bags were supplied on rapidly firing machine guns for catching ejected cases which, if not contained, might endanger equipment or personnel.

Vehicle Maintenance Tools

Fighting crews were not expected to carry out higher echelon work. Tools for vehicle maintenance were chosen accordingly. Those needed for major repairs or adjustments were omitted, while complete facilities were provided for carrying out typical crew duties such as track maintenance or replacement. The fairly wide range of general purpose tools needed for ordinary maintenance made it possible for crews to effect emergency repairs to some extent.

Communication Equipment

With the electrical communication systems described elsewhere, only the spares carried will be mentioned here.

The extreme importance of conserving space in tanks, and the unknown quantity involved in battle damage made it impracticable to carry major components as spares. Communication equipment was given armoured protection, where feasible, while spares were carried only for the following:

1. Parts fragile by nature, such as tubes, head and microphone sets.
2. Exposed aerial rods and bases.
3. Fuses, dynamotor brushes and similar items subject to ordinary wear or destruction.

Expendable Vehicle Spares

Under normal operation certain vehicle components wear out, break or are consumed. Among these are track shoes, spark plugs, light bulbs, and mirrors and prisms of vision instruments. Spare track components were supplied on all vehicles, but crews in action often carried additional ones for emergencies or as extra armour. Also, crews advocated (and sometimes carried) a spare suspension assembly.

Personnel Equipment

Canadian Tanks were so equipped as to provide for needs of crews living for several days away from other supply sources. Not every country employing tanks believed that the extra mobility thus obtained outweighed the disadvantages of providing stowage space for the large amount of bulky material required for protection against exposure and other hazards, and preferred instead either to limit the range of their vehicles or to follow more closely with supplies.

Against the weather each member of the crew ordinarily was supplied with a greatcoat, blankets, ground sheet, knapsack raincoat, rain hat and rubber boots. Against gas attack - respirator, anti-gas cape, trousers, gloves and boots, bleach, detector paint and anti-gas ointment. To this can be added the first aid kit. Food for several days was carried in ration boxes, water in bottles and five gallon cans. A portable stove and a can of unleaded gasoline provided cooking facilities.

Miscellaneous Equipment

With a tank at rest a number of tools were required for performing outside tasks. Included were shovels, axes, mattock, matchets, wire cutters, wiring gloves, engine crank, funnels for transfer of liquids crowbar and towing cable. Tarpaulins were carried for protection of parked tanks against weather, and a camouflage net to prevent observation by enemy fliers. Sexton carried an emergency cable with which to transfer electrical energy from one vehicle to another for battery charging or engine starting.

Fire Extinguishers of the Carbon-Tetrachloride or Methyl-Bromide type were placed so that they could be used by tank crew before or after evacuating a burning vehicle. These were supplementary to the Carbon Dioxide extinguishing system built into vehicles.

Printed Instructions, Log and Parts Books

Some information concerning operation of vehicle parts was provided by instruction plates and by manufacturers pamphlets, but more extensive information was furnished by durable publications issued as part of Tank equipment. These included Instruction Books or Operators Manuals giving the details of tanks parts, their operation and maintenance in as far as they concerned the expected duties of the crew. Lubrication and stowage charts were inserted in pockets in the books.

When the crew of a tank change or when the tank undergoes repairs, knowledge of its history is of great importance, hence log books were supplied in which to record significant data on vehicle and armament.

The ordering of replacement parts for tanks can involve much annoyance, and loss of time unless the correct number is quoted on the order, because a part may have several numbers (Ordnance, Manufacturers, or Stock number). Also, the number stamped on the part is not always the one under which it is stocked. To alleviate these difficulties parts lists were issued with tanks.

Stowage

The requirements of heavy armour, heavy armament, plentiful ammunition, small silhouette, good mobility, adequate equipment and crew comfort all placed heavy demands upon stowage space. Not all items of equipment could be made accessible and, where at all practicable, preference of location had to be given in the following order:

(a) Ammunition and frequently used gun tools, spares and ancillaries.

(b) Auxiliary weapons and less frequently used gun tools and ancillaries.

(c) Fire extinguishers and first aid kits

(d) Wireless equipment

(e) Expendable vehicle stores

(f) Remaining items

Throughout the war, the stowage of ammunition received much attention because, in general, each succeeding tank design called for heavier and more rounds of ammunition to be carried. By the time early production tanks had seen considerable action, it was found that a very large number of them became casualties through ammunition fires started by attack that should not have interfered with their mobility in any way. Splinters from minor penetrations or even scale dislodged by non-penetrating shots had sufficient energy to pierce the brass cases of unprotected ammunition, and thus start fires and explosions that would destroy the vehicle. This experience gave rise to the practice of stowing ammunition in armoured bins or in cells surrounded by water or other fire-quenching substance. Hard plate about 3/16" in thickness was used for ammunition bins in Canadian tanks, and was found to give satisfactory results against attack that did not completely defeat the main vehicle armour. The use of armoured bins reduces accessibility of ammunition and decreases slightly the number of rounds that can be carried.

From the point of view of keeping equipment safe from damage, it would have been desirable to have given all of it the protection of vehicle armour, but with stowage space limited and with consideration given to crew comfort, it was necessary to place certain durable or uncritical material on the vehicle's exterior. Pioneer tools, towing cable, engine crank, cable reel, camouflage net, tarpaulin, track blocks and several other items were stowed externally. Compartment fires did not always give crews a chance to use the portable fire extinguishers carried within, therefore several were stowed on the outside of the vehicle from whence they could be used after the men had made exit.

Training and battle experience, also obsolescence in production, resulted in continually changing equipment needs. The adding, deleting and changing of items made it desirable to have stowage blankets and boxes in small units and bolted in place for easy removal.

ROTA TRAILER

Design and development of a trailer to carry an additional supply of fuel, ammunition and water, and to be towed by tanks, was undertaken in England during the North African Campaign. When drawings were sufficiently finalized they were forwarded to Canada to form a basis for production in this country.

The trailer consisted of a metal box or container mounted between two wheels fabricated in the form of drums, each capable of carrying 60 gallons of fuel. The box was designed to carry spare ammunition of various calibres, two five-gallon water containers, several .30 calibre ammunition boxes, one camouflage net and a diaphragm pump with hose, to be used to transfer fuel from the wheel drums to the vehicle. The wheels were mounted on two stub axles which fitted into the trailer frame. A seamless steel box-section tongue with a sprung swivel eye completed the general make-up of the trailer.

A pilot model was built and included some changes made necessary to meet Canadian production facilities, and to overcome some of the weaknesses experienced by the British in tests. These changes included:

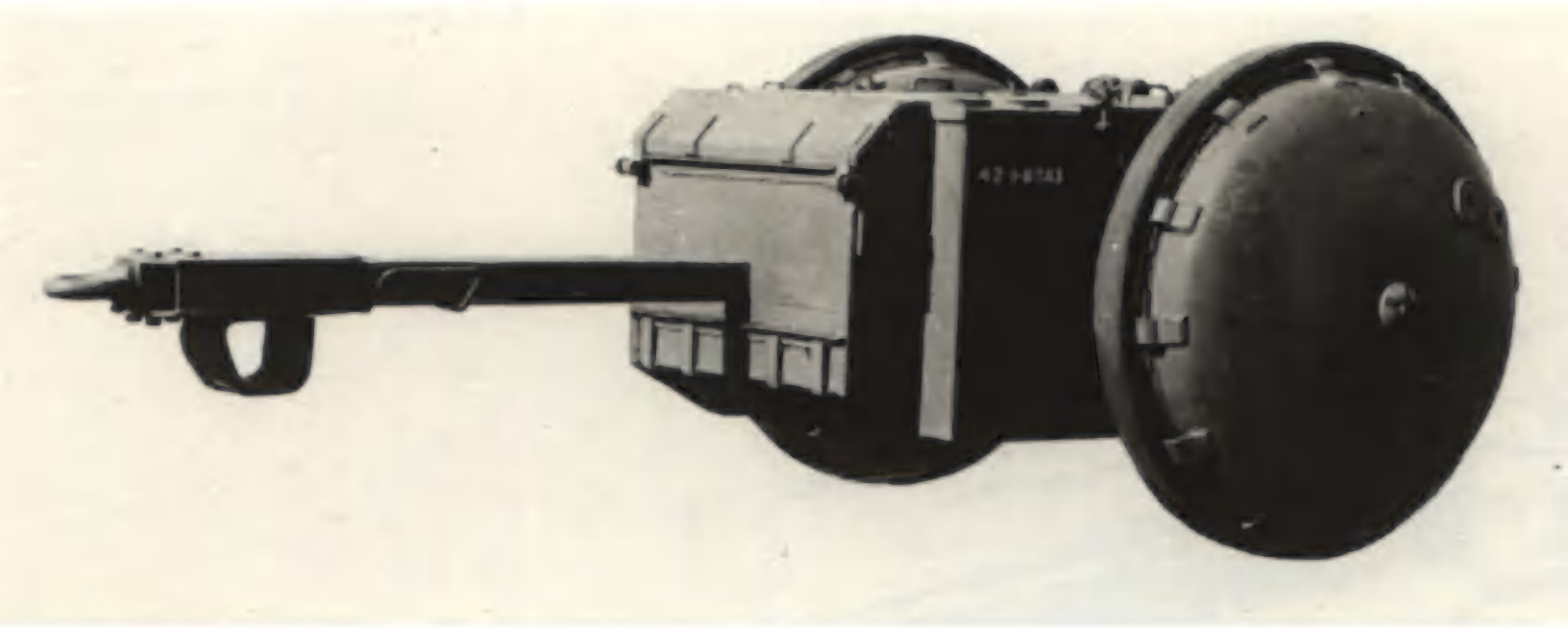
1. Reinforced leading edge to reduce danger of damage to container by striking rocks.
2. Enclosed Panniers for spare ammunition grids to prevent the ingress of water.
3. Revised hold-downs for ammunition boxes to prevent stripping of threads.
4. Shell crates instead of ammunition boxes- a more sturdy method of carrying ammunition.
5. Addition of Jerrican racks on the rear lid.

Weaknesses revealed by Pilot model tests:

1. Vulnerability to shell fire.
2. Hazardous to towing vehicle due to weight and tendency to skid sideways.
3. Inability of towing vehicle to back up due to trailer tongue fouling tank tracks.
4. Excessive weight imposed great loads on axle.
5. Excessive bouncing due to lack of springs.
6. Bolt threads of hold-downs stripped.
7. Capacity insufficient in respect of weight.

Development of this trailer in Canada was suspended and ultimately stopped with the successful conclusion of the North African campaign.

ROTA TRAILER - SIDE VIEW



TANK, VALENTINE

TANK, VALENTINE

This tank, designed for the support of infantry in attack, represented the most modern concept of that type of vehicle at the outbreak of war in 1939.

Its basic tactical features include Low Silhouette(7'5"),Medium Weight (39,000 lbs.), Heavy Armour (basic 60 mm.)according to 1939 Standards,Medium Speed 15 m.p.h. max. and 2-Man 360° Turret Mounting 2-Pr. with Co-axial Machine Gun.

Its basic mechanical features include a 6 Cyl. 2 cycle Diesel, liquid-cooled engine driving through a synchro-mesh 5-speed Gearbox and Clutch Brake Steering Transmission to Rear Sprocket,Dry Pin Track carried on slow motion coil spring suspensions and fabricated rivetted hull and turret.

Orders were placed in early 1940, and production commenced in 1941 at the Angus-Shops of the Canadian Pacific Railway. A total of 1420 vehicles were produced before production ceased in 1943, the great bulk of this production being shipped to Russia.

The basic pattern was provided by U.K., but considerable development work was necessary in Canada in view of the incompletness of the U.K. design, delay in transmitting of details from U.K., unavailability of British type components and the necessity to utilize Canadian production procedures and materials. In this connection, it was necessary to redraw all the British drawings and/or develop new drawings for parts on which U.K. drawings were not available.

An available North American Engine and Gearbox was fitted in lieu of the power plant specified by the British. This naturally involved re-design of mountings, propellor shafts, accessories, controls, etc., and led to the development and adoption of a 24 volt rather than a 12 volt electrical system.

A change was made from a Bess to a Browning machine gun in the co-axial mount which necessitated the design of suitable adapters, ammunition feed and stowage arrangements.

At the start of production,the #11 W.T. Set with Tannoy Intercommunication system was used. Design change permitted the use of the #19 MK.II Set with integral intercommunication after approximately the first 600 tanks. Improved standards and methods of suppression and interference were developed to accommodate the use of #19 MK. II wireless equipment.

A one-piece Cast Turret and a Cast Hull Nose were developed and put into production to replace the difficult fabricated U. K. design. In addition, it was necessary to design or re-design a multitude of detail parts.

The manufacture of this vehicle introduced production problems, which were new to Canadian industry,the early solution of which greatly assisted in later war production generally. Major problems encountered were the production and heat treating, forming, machining and fitting of armour plate and castings; the precision casting in quantity of Manganese steel track shoes; the manufacture of solid rubber bogie tires to satisfactory standards; the manufacture of optical equipment periscopes,telescopes,armour glass vision blocks, etc., the large scale manufacture of modern military wireless sets; the manufacture of peculiar electrical components for turret traverse mechanism;the production and assembly of complicated clutch brake transmission;and facilities for the erection, inspection,proof-testing, sealing and shipping of a vehicle of this type.

Original specifications called for a maximum of "free issue" equipment from U.K. In order to relieve British Industry, then under severe war conditions, specifications were constantly changed removing items from "free issue" list. This imposed great difficulties on the contractor to develop Canadian sources to provide highly specialized equipment on very short notice.

This tank proved mechanically reliable and very acceptable to the Users,but was discontinued when faster,more heavily armed and armoured tanks became available both to the enemy and ourselves.

TANK, VALENTINE

Tactical Data

PRODUCED BY - Canadian Pacific Railway, Angus Shops, Montreal.

PRODUCTION

Commenced - 1941
Finished - 1943

VEHICLES PRODUCED - 1420

SERIES - Valentine VI (Besa M.G.). Valentine VII (Browning).

TYPE - Infantry Tank.

BRIDGE CLASSIFICATION - 30

CREW - 3 - Driver, Gunner, Commander.

ARMOUR BASIS - Turret - front 65 m.m.
- sides 60 m.m.

- Hull - front 60 m.m.
- sides 45 m.m.

TURRET - 360° Traverse - 50" ring.

TRAVERSE - Lucas Electric - dependent on main vehicle engine, or hand.

GUN MOUNT - Shoulder controlled in elevation with individual pistol grips for firing of ordnance and co-axial m.g.

- Elevation 17°- Depression 8°. Exterior Mantlet.

ARMAMENT - Ordnance Q.F. 2-Pr. MK. IX, (79 rds.).
- Browning cal. .30 M.G. M1919A4 Co-axial.(Val.VII).
- BESA 7.92 mm. M.G. Co-axial (Val.VI) (3500 rds.).
- A.A. Bren .303" on Lakeman mounting (336 rds.).
- Thompson cal. .45 S.M.G. not mounted (240 rds.)
- Bomb Thrower 2" MK.I (Smoke - 18 rds.).
- Signal Pistol 1" (12 cartridges).

SIGHTING - 1 No.33 MK I Direct Sighting Telescope.
- Magnification 1.9.

PROTECTED VISION - 1 Triplex Block.
- 2 One-way Vickers Periscopes.
- Turret - Two - 2-way Vickers Periscopes.

COMMUNICATION - #11 WT Set with Tannoy intercommunication and #19 MK II WT Set with integral intercommunication.

COMPASS - P 8 for driver.

LIGHTING - Interior. 3 Feston Lamps, 1 Inspection Lamp.

- Exterior. 2 Head Lamps, 1 with ultra-violet bulb. 2 Side Lamps, 1 Tail Lamp.

PERFORMANCE DATA

POWER/WEIGHT - Net power to gross weight ratio 6.6 B.H.P. per short ton.

GROUND PRESSURE - 10.7 p.s.i.

GROUND CLEARANCE - 16-1/2".

GRADABILITY - Theoretical in 1st gear - 32° Ascending. 35° Descending.

MINIMUM TURNING RADIUS - 4'.

BRAKE EFFICIENCY - 5 m.p.h. - To rest on 1 in 4 downhill grade -
Foot brakes - 4'
Steering brakes - 2½'.

SPEED, MAXIMUM - 15 m.p.h.

TRENCH CROSSING ABILITY - 7'6".

VERTICAL OBSTACLE CLUMBING - 33".

FORDING DEPTH - At slow speed-36"

CRUISING RANGE - Highway - 95 miles.

FUEL CONSUMPTION - 2.20 m.p.g

OIL CONSUMPTION - .16 q.p.h.

MECHANICAL DATA

LADEN WEIGHT - 39,000 lbs.

OVERALL DIMENSIONS

Length - 17' 9".
Width - 8' 7½".
Height - 7' 5½".

ENGINE

Make - General Motors Corporation.
Model - 6004 special, 6-71 series engine modified for tank use.
Type - Two-cycle Diesel, 6-Cyl.
Displacement - 425.31 cu.ins.
Peak Gross B.H.P. - 130 @ 1900 r.p.m.
Torque - Max. - 475ft/lbs. @ 1000 r.p.m.
Lubrication - Dry Sump, full pressure lubrication gear box, oil pump, oil strainer, oil filter and an oil cooler, with relief valve.
Flame Primer Pump - electric ignition for cold weather engine starting.
Air Cleaners - Type - Oil Bath.
- No. - Three.

COOLING SYSTEM

Type - Water circulation through cylinder block, cylinder head and two radiators.
Method - Centrifugal pump driven by the lower blower rotor shaft through a coupling. Two belt driven fans.
Capacity - 9½ gallons (approx.).

FUEL SYSTEM

Type - Petroleum fuel oil. Minimum cetane rating - 40.
Tank Capacity - 46 gallons.
Tank Location - In engine compartment, left of engine.
Feed - From reservoir through primary filter to positive displacement vane type pipe through secondary filter to lower fuel manifold, then to injectors.

CLUTCH

Make -
Type - PTA-113 single plate dry disc, with multiple spring, fulcrum lever type pressure plate assembly. 17-inch diameter (13" drive plate).

GEAR BOX

Make - Spicer.
Type - Synchromesh. All gears synchronized except first and reverse.
Ratio - First gear - 6.17 : 1
Second gear - 3.40 : 1
Third gear - 1.79 : 1
Fourth gear - 1.00 : 1
Fifth gear - .78 : 1 overdrive
Reverse gear - 6.69 : 1
Lubrication - Pressure lubrication supplied by gear box oil pump.

STEERING AND FINAL DRIVE

Type - Clutch Brake
Ratio - Bevel gear - 1.32 : 1
At Sprocket -10.20 : 1
The drive to each sprocket incorporating a double epicyclic reduction gear.

STEERING CLUTCHES

Location - On each side of bevel drive.
Number - 2.
Multiplate. Compressed by toggle action through steering levers which give independent control of the power transmitted to the track, and by further movement apply the steering brakes.
Driver's seat in centre of driving compartment.

STEERING BRAKES

Location - Carried in a brake anchorage bolted to sprocket hub.
Number - 2
Type - Internal expanding Girling 4-shoe operated by push-rod passing through centre of brake drum shaft.

BRAKE DRUMS

Location - On outer end of each brake drum shaft, outside the sprocket.

AUXILIARY BRAKES

Location - On each side of Steering Clutch and Brake Assembly.
Number - 2.
Type - Foot operated independently of main braking controls. Carbon thrust ring gives lateral movement to a disc operating directly on the brake push rod.

SPROCKETS

Location - At rear. Sprocket ring bolted to sprocket hub in Final Reduction Drive.
Number - 1 on each side.
Diameter - 30".
Number of teeth - 20 (Teeth engage opening in centre of track shoe).
Pitch - 4.36".

TRACKS

Type - Manganese steel shoes- Dry pin, centre drive, 2-3 hinge.
Number of shoes - 103 per strand.
Tread (Centre to Centre) - 87"
Width of shoe - 14"
Length of Track -127" (On ground)
Grousers - None.

SUSPENSION

Type - Slow Motion.
Bogie Wheels - Two 24" and four 19½". Identical construction on each side.

SHOCK ABSORBERS

Canadian made, Newton and Bennett type A-T.I. Totally enclosed double action hydraulic shock absorber on each bogie assembly.

TOP ROLLERS

Type - Ball bearing, spindle mounted.
Number - 3 on each side.

TRACK ADJUSTING IDLER

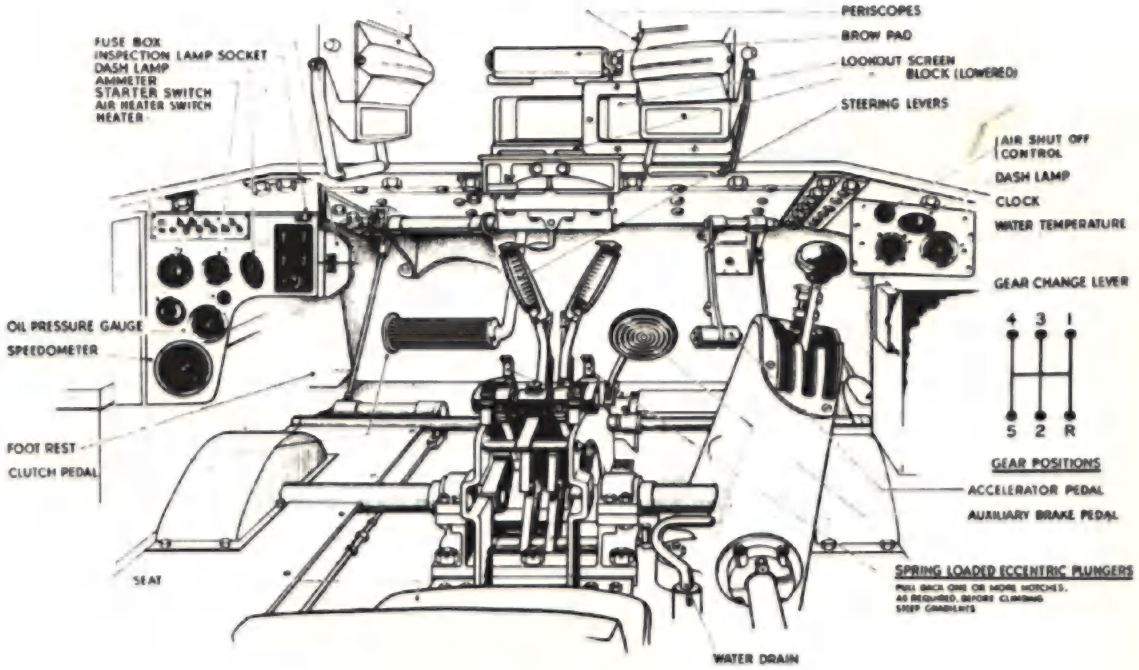
Type - 24" rubber tired steel idler wheels eccentrically mounted at front, on each side.
Adjustment - With pawl released, adjusting bracket is rotated about support bracket by lever.

ELECTRICAL

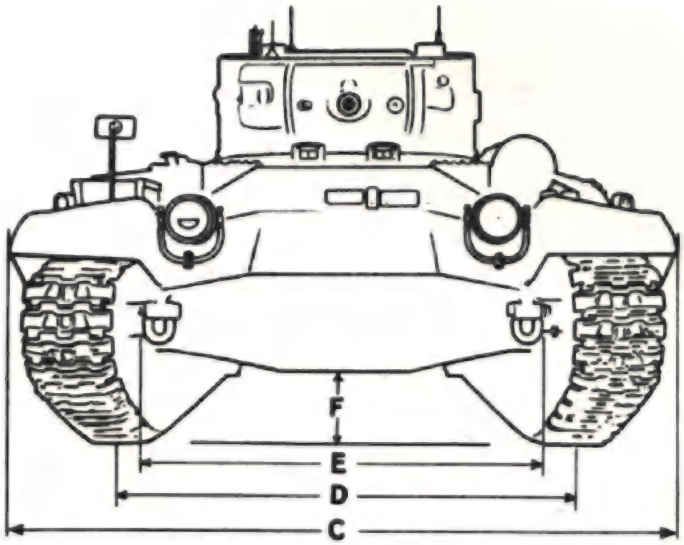
24-volt system.
Battery - Two, 12 volt Exide batteries (6-XH-25-38) 180 amp. hours at 10-hour rate.
Generator -(Main) - Delco Remy, Model 1106509, two-brush insulated, shunt unit.
(Auxiliary) - None.
Note: Turret traverse current supplied by main engine generator.
Starter - Delco Remy Model 1109308, 6-pole, 12-brush, 24-volt, series wound heavy-duty unit, equipped with solenoid operated Dyer drive.

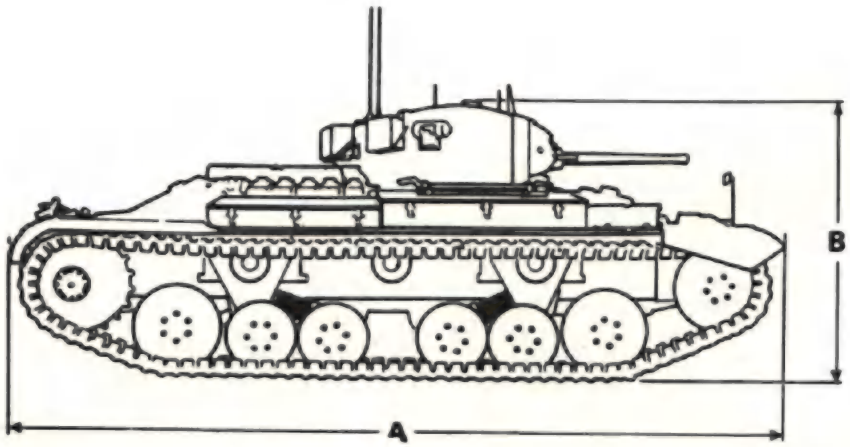
CANADIAN MODIFICATIONS FROM U.K. DESIGN

1. Engine - G.M. 6 Cyl. 2 cycle Diesel replaced A.E.C. 6 Cyl. 4 stroke Diesel or A.E.C. 6 Cyl. 4 stroke Petrol.
2. Gearbox - Spicer 5 speed Synchromesh replaced Meadows 5 speed Crash box.
3. Power Plant - Mountings, Controls and connections to correspond with Canadian type engine.
4. Browning Cal. .30 M.G. and Mount replaced Besa 7.92 mm.
5. One-piece Cast Armour Turret - To replace turret fabricated from rolled and formed plate.
6. One-piece cast armour hull nose to replace rivetted plates.
7. Cast Engine Louvres - replacing component type.
8. Installation of #19 Radio Set - to replace #11 set and Tannoy intercommunication.
9. Adequate radio suppression.
10. 24-Volt Electrical System and Components - to provide adequate power for engine and wireless in lieu of 12-volts.
11. Modified and improved electric turret traverse.
12. Socket for battery charging or engine starting from external source.
13. Commanders - Emergency Engine shut-down control.



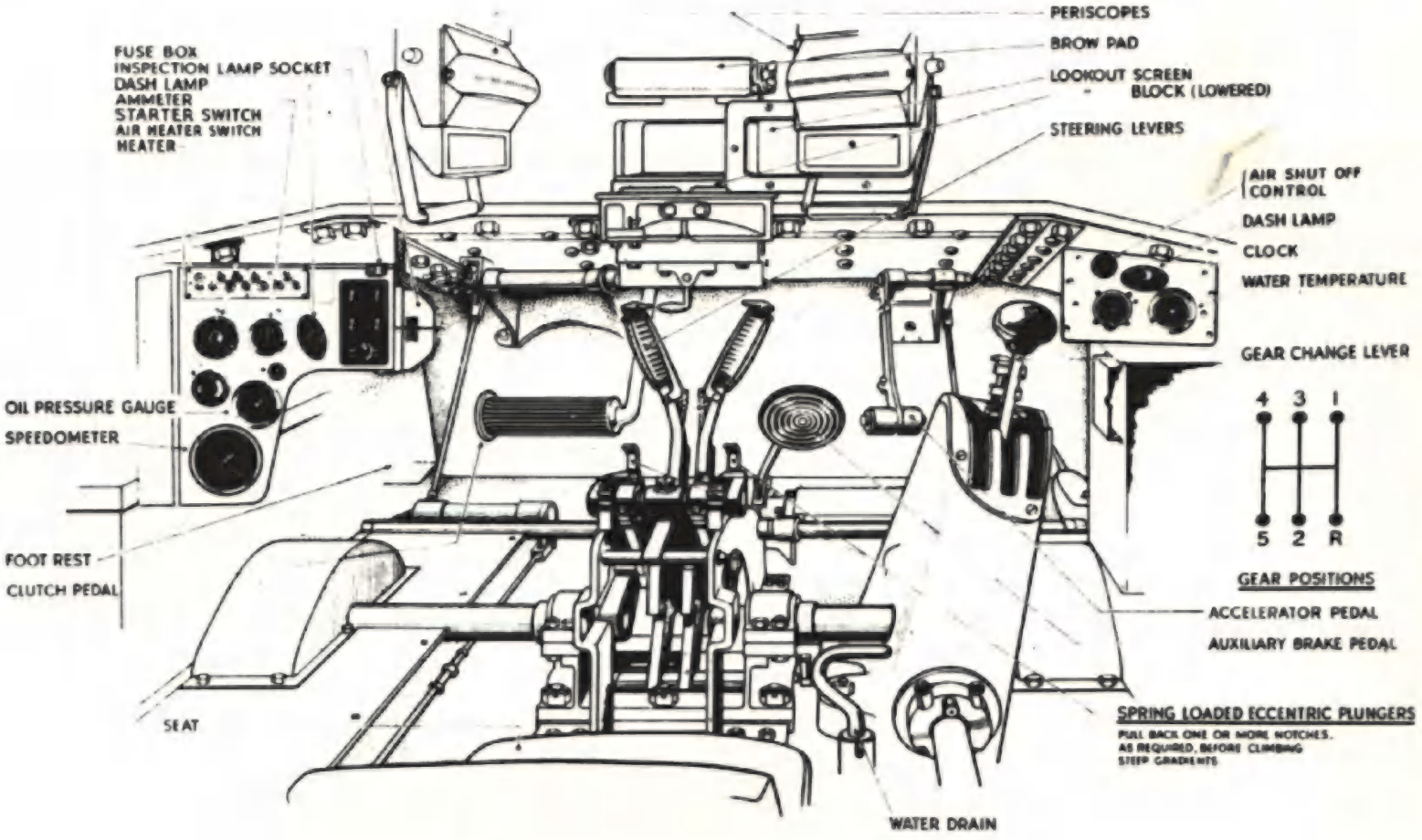
CONTROLS–DRIVER'S COMPARTMENT

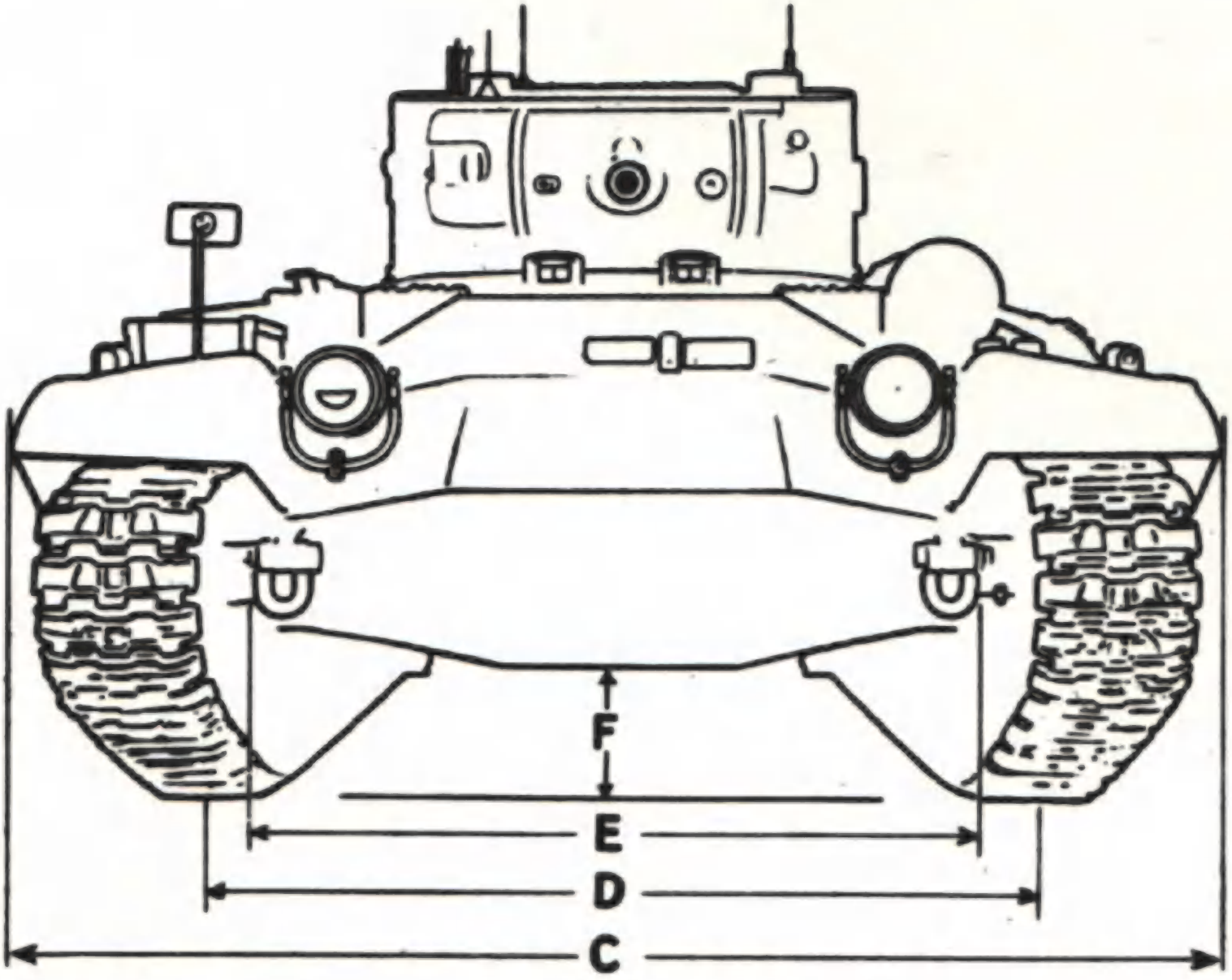


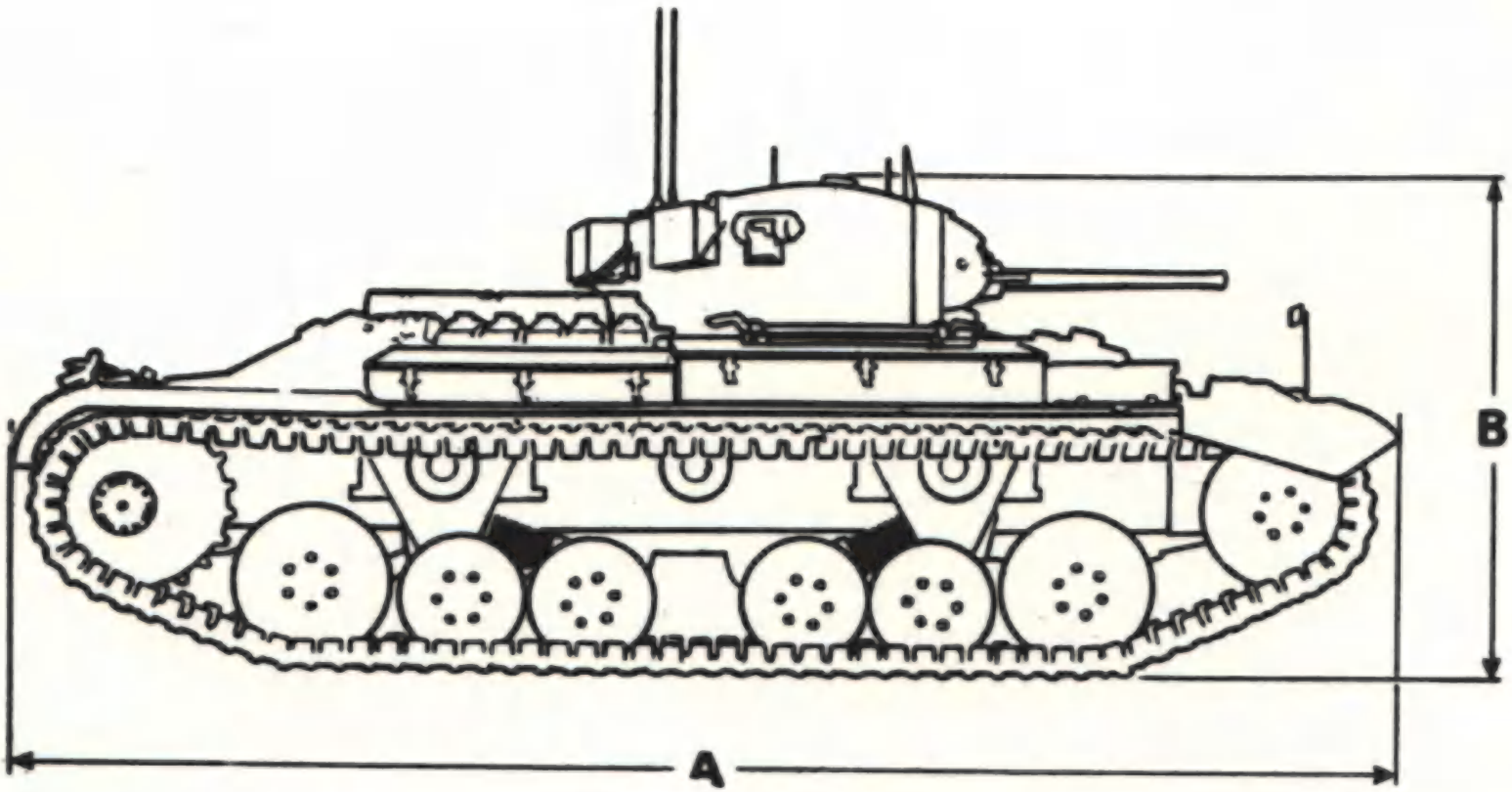


DIMENSIONS

A	B	C	D	E	F
LENGTH OVERALL	HEIGHT OVERALL	WIDTH OVERALL	TRACK CENTRES	LOWER HULL WIDTH	GROUND CLEARANCE
17' 9"	7'-5-1/2"	8'- 7-1/2"	7' 3"	5' 11"	16-1/2"


PERISCOPES
BROW PAD
LOOKOUT SCREEN
BLOCK (LOWERED)
STEERING LEVERS
AIR SHUT OFF CONTROL
DASH LAMP
CLOCK
WATER TEMPERATURE
GEAR CHANGE LEVER
4 3 1
5 2 R
GEAR POSITIONS
ACCELERATOR PEDAL
AUXILIARY BRAKE PEDAL
SPRING LOADED ECCENTRIC PLUNGERS
PULL BACK ONE OR MORE NOTCHES, AS REQUIRED, BEFORE CLIMBING STEEP GRADIENTS
FUSE BOX
INSPECTION LAMP SOCKET
DASH LAMP
AMMETER
STARTER SWITCH
AIR HEATER SWITCH
HEATER
OIL PRESSURE GAUGE
SPEEDOMETER
FOOT REST
CLUTCH PEDAL
SEAT
WATER DRAIN


F
E
D
C

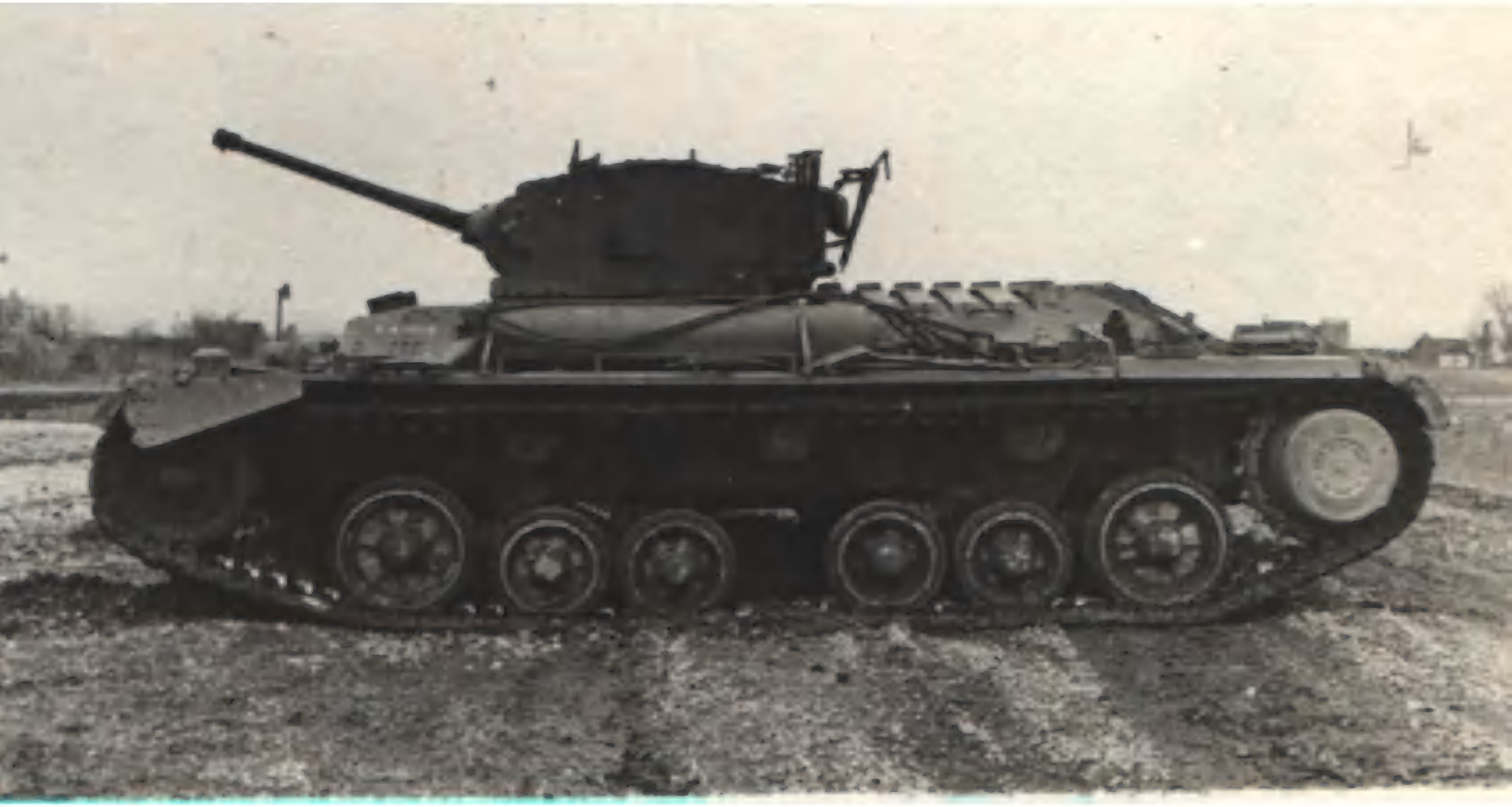

B
A

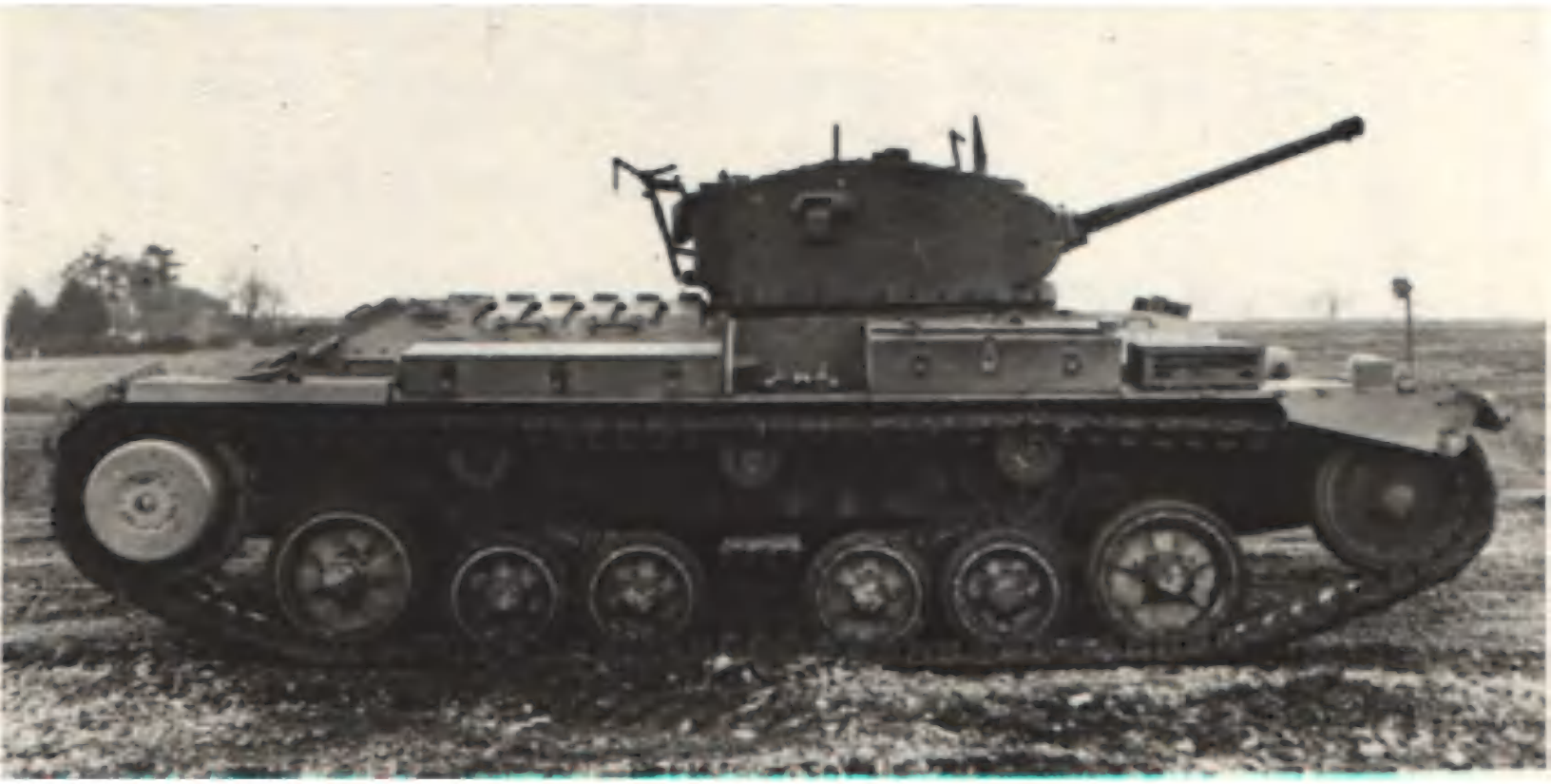
FRONT VIEW-Showing cast armour nose with driver's look-out open-Driver's, Gunner's and Commander's periscopes.

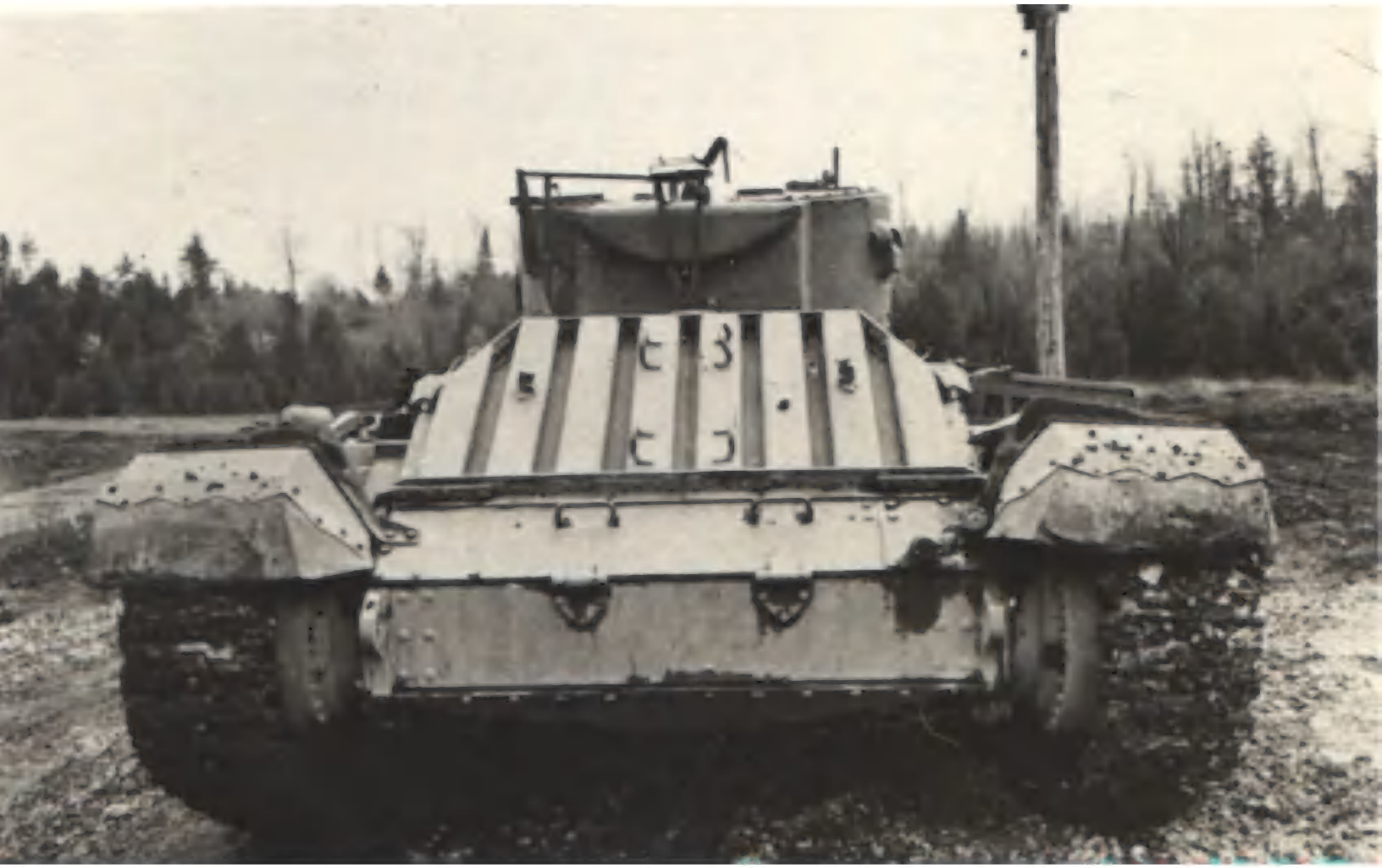
LEFT SIDE VIEW-Showing turret rea view Look-out in closed position (or side of cast armour turret)-towing cable and ancillary equipment in stowed position.

RIGHT SIDE VIEW - Showing pistol port in side of cast armour turret-tool boxes. spare track shoes and jack pads. stowed on track guard.

REAR VIEW - Showing cooling system air inlet louvres in closed position. an A.A. Bren mount at rear of turret.







USER COMMENTS

EXCERPTS FROM INTERIM REPORT #13 SEPTEMBER 2, 1942 - CAMP BORDEN (Our File - 73-4-25)

"Successful hill-climbing tests were completed on September 1st, 1942."
(1st gradient of 31° and 2nd on a gradient of 33°).

"The cooling system on this vehicle is most satisfactory in all kinds of weather and sets of conditions."

"These motors will start while vehicle is parked at any safe angle."

EXCERPTS FROM INTERIM REPORT #7 JUNE 30, 1942 - CAMP BORDEN

"Suspension tests were carried out over course No.1 (hard smooth road) at speeds from 5 to 15 m.p.h. and, as a result of these conditions, no criticism can be made..

"Suspension system in these tanks is considered satisfactory."

"Starter operated successfully in every position."

"A water crossing 75' wide and 34" deep at its deepest point was forded without difficulty."

EXCERPT FROM REPORT ON TANK PERFORMANCE DURING ARMY WEEK CONVOY - JUNE 30 - JULY 5, 1942. CAMP BORDEN (Our File 73-5-26).

"The four (4) Valentine tanks used on this convoy were found very reliable in their performance and operation."

EXCERPTS FROM INTERIM REPORT NO. 5 - JUNE 6, 1942 - CAMP BORDEN

"This vehicle is essentially fitted for tactical employment."

EXCERPT FROM LETTER FROM THE SOVIET GOVERNMENT PURCHASING COMMISSION IN THE U.S.A. 3355 - 16TH STREET, N.W., WASHINGTON, D.C., AUGUST 29, 1942. (SIGNED BY A.I. BELYAEV, MAJOR-GENERAL, CHAIRMAN

" I wish to request that you increase the number of tanks Mk.3, Valentine, and Spare Parts for same, to be shipped to the U.S.S.R., as these tanks have given a fine performance in combat action."

REFERENCES

Valentine VI and VII - Instruction Book 1942.

Valentine VI and VII - Illustrated Parts List August 1942.

Valentine VII - Illustrated Parts List November 1942.

Data Book - Tank Type Vehicles of Canadian Manufacture, January 1944 - Publication number M&S 1677.

Files Series
D.M.S. - 73-4-1, 2, 3, 4, etc.
D.N.D. - H.Q.S. 3352-1
D.M.S. - D.A.D. Photo.Files Nos. T-1,T-2.

D.T.D. Field Trial Reports:

Report No. 400 - Hylastic Manganese Type Tracks for Valentine Tanks.

Report No. 466 - Canadian Tracks for Valentine.

Report No. 475 - Birlec Treated Track for Valentine.

Report No. 524 - Auxiliary Fuel Tank, Tail Smoke Emitters and Rotatrailer Towing Attachment fitted to Valentine.

Report No. 529 - Flexible Oil Pipes on Valentine with G.M. Engine.

Report No. 636 - Track Pins Chrome Molybdneum "Tocco" for Valentine Tanks.

A.E.D.B. - Report on Cold Weather Test of Armoured Fighting Vehicles, Conducted at Kapuskasing, 1942. (Tanks and M/T Library Ref.1 AFV - I.B.U.K. & C.)

A.E.D.B. - Report on Cold Weather Tests, Conducted at Camp Shilo, Manitoba, Winter Season 1942-43, Part IX of seven volumes. (Tanks and M/T Library Ref.1 TST). (I.B.U.K. & C.) 3

Design Change Instructions.
Valentine Tanks D.C.I. No. 1 to D.C.I. No. 216.

Design Deviation Permits.
Valentine Tanks D.D.P. No. 1 to D.D.P. No. 45.

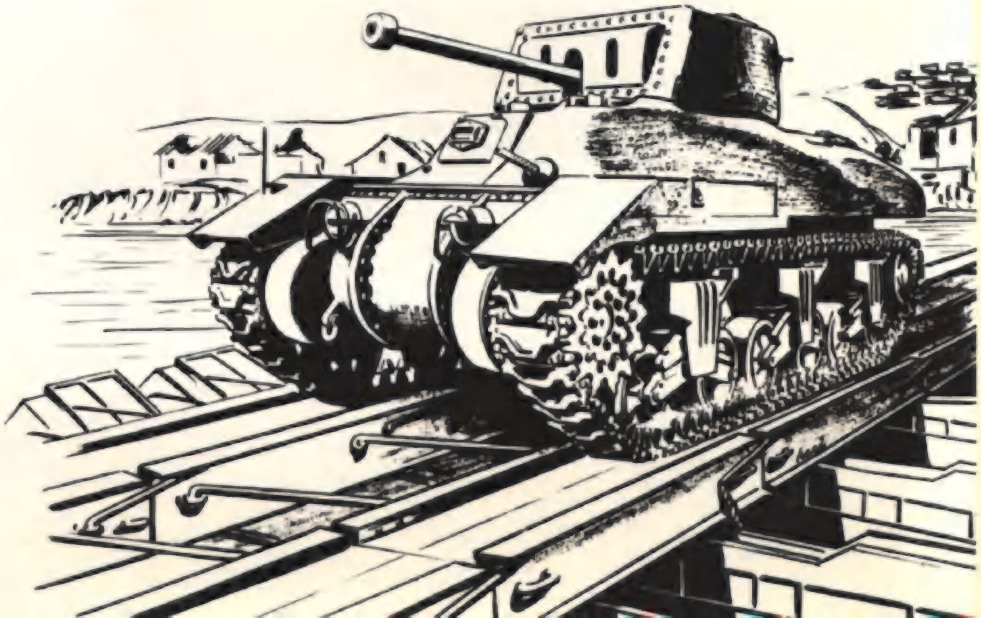
Design Change Requests.
Valentine Tanks D.C.R. No. 1 to D.C.R. No. 342.

Production Orders.

C.D. - L.V. 67	-	30
S/N. - 1021	-	1390

Approx. Price per unit - less equipment supplied by Ordnance $50,000.

TANK, CRUISER, RAM



TANK, CRUISER, RAM

The Ram Tank is a Medium or Cruiser Tank for use in armoured mobile formations. Its prime role is to exploit "break through".

Basic tactical features -

Medium to High speed (25 m.p.h.)
Medium Armour (2½"-3" frontal)
6 Pr. Gun with coaxial 30 Cal. M.G.
360° turret
Bow M.G. in ball mounting
5 Man Crew

Its mechanical features include 9-cyl. air-cooled radial, 400 HP engine, driving through conventional clutch and propeller shaft to a front 5-speed synchro-mesh gear box. Final drive is through a controlled differential steering transmission to front sprockets. The track is of the rubber bushed type with rubber or steel blocks. The Canadian Dry track, later developed, is interchangeable with the rubber bushed type, providing a corresponding change of sprocket is made. The lower hull is rolled plate rivetted, while the upper hull and turret are each one-piece armoured steel castings.

The vehicle was in production at the Montreal Locomotive Works, Tank Arsenal from the fall of 1941 until the summer of 1943 and a total of 1949 vehicles were produced.

The overall design was developed in Canada to incorporate the best United States, British and Canadian ideas of the time i.e. U.S. engine and power train (as used in M3), new cast upper hull and 360° cast turret, mounting main armament and W/T Set.

This involved new basic design for turret, upper hull, gun mounting, elevating gear, vision arrangements and stowage also modifications of controls, seating, electrical equipment, etc.

A limited number of vehicles were equipped with a 2 Pr. gun, shoulder-control, using a mount adapted from the Valentine Tank. This was an expedient adopted so that vehicles could be produced in advance of the availability of the 6 Pr. gun mount and elevating gear. This version is known as the Ram I. With the installation of the 6 Pr. gun, the vehicle was known as the Ram II.

The Drawing Office work was carried out at the Montreal Locomotive Works, with advice and assistance from the British and Canadian Army Staffs, and casting experts from the General Steel Castings Company. Design was directed by the Army Engineering Design Branch.

Hull and Turret casting design, while major, was fairly straightforward and made use of the existing U.S. M-3 turret ring.

The turret design incorporated a removable front adapter plate to allow flexibility in the type or size of main gun and mounting.

Some difficulty was encountered in the re-arrangement of the M3 driver's controls necessitated by the positioning of the driver's seat on the floor of the vehicle to allow low overall height.

A U.K. design with drawings for the 6 Pr. Mounting, Elevating Gear and Firing Mechanism failed to materialize as expected, and it was necessary to do this major job of design in Canada and working against time.

Similarily, the adoption of the turret traverse mechanism, basically designed for the U.S. M3 Tank, introduced complications.

Final design of vision devices, their number and location, ventilation, lighting, crew accommodation and equipment was made more difficult through the lack of available personnel with combat experience in tanks. Reports of actual actions were meagre and opinions were conflicting.

Determination of the equipment items, their proper location and method of securing was a study in itself which had to be completed before vehicles could be delivered.

During production, a great number of design changes, both major and minor were introduced to keep pace with mechanical developments in the United States and in response to User and production requirements. The 6 Pr. gun replaced the 2 Pr.; the Gyro Stabilizer was added; the C2 engine was replaced by the C1 for greater reliability and lower octane requirements; splash proofing was improved; turret ventilation provided; the co-driver's cupola replaced by an integral housing; side escape doors were removed and floor escape hatch provided; pistol ports were also improved; stowage was completely re-arranged to provide armoured bins for the ammunition. This involved re-location of the batteries and complete re-arrangement of the electrical components.

A new tank arsenal was built and tooled to produce this vehicle.

Although some assistance was given the contractor by the American Locomotive Works, who were concurrently building M-3 tanks in the United States, innumerable production difficulties were encountered. This was due to inexperience of the personnel, the want of correlation of component deliveries from the United States and Canada, and demand for design changes as early vehicles came into the hands of the User.

The Ram tanks performed a very useful function. They provided acknowledged incentive for the design and production of the U.S. M4 Sherman Tanks, a reserve for the defence of Britain and training vehicles for Canadian Armoured Troops in Canada and the United Kingdom. Various modifications of this tank used in action with notable success are as follows:

RAM - Command and Observation Post

RAM ARV - Armoured Recovery Vehicle

RAM AVRE - Armoured Vehicle Royal Engineers

RAM - Armoured Ammunition Carrier

RAM - Armoured Personnel Carrier - (Kangaroo)

RAM - 17 Pounder Tower

RAM - Flame Thrower (Wasp Equipment).

Tactical Data

PRODUCED BY - Montreal Locomotive Works, Tank Arsenal, Montreal

PRODUCTION
Commenced - 1941
Finished - 1943

VEHICLES PRODUCED - 1949 RAM I 50
RAM II 1899

SERIES - RAM I (2-Pr.)
RAM II (6-Pr.)

TYPE - Medium or Cruiser.

BRIDGE CLASSIFICATION - 30

CREW - 5 - Driver, Co-Driver, Gunner, Loader, Commander.

ARMOUR - Turret - Front - 3"
Rear - 2½"
Side - 3" - 2½"
Top - 1"
- Hull - Front - 3" - 2"
Rear - 1½"
Side - 2½" - 1½"
Top - 1½" - 1"
Bottom - 1" (front)
- ½" (rear)

TURRET - One-piece armour steel casting. 60" Ring.
Hatch with two-piece cover, latch and lock.
Hatch ring for A.A. gun mount.
Pistol port (right side)

TRAVERSE - 360° Hand or power.
Loganspport Hydraulic type.
Electric drive from vehicle generator and batteries.
Control by throttling valves in pressure circuit.

GUN MOUNTS - Coaxial
Elevation 20°
Depression - RAM I 10°
- RAM II 7½°
RAM I. Elevation by shoulder control with hand operated remote control pistol grips for firing.
Interior Mantlet.
RAM II. Geared elevation with Gyro Stabilizer, or hand. Mechanical foot firing. Later models, electric foot firing.
Interior Mantlet.

Bow (left)
Cupola Hatch RAM I & RAM II earlier models.
Elevation (by hand) 60°
Depression 8½°
or
Ball and socket mount, in front RAM II later models.

Turret Hatch. A.A. Bracket mount
Elevation (by hand) 60°
Depression 7½°

ARMAMENT RAM I
Ordnance Q.F.2-Pr.Mk.IX or X (171 rds.)
Browning cal. .30 M.G. M1919A4 (4275 rds.)
1 mounted coaxially in turret.
1 mounted in Cupola Hatch.
Free traverse 120°L, 50° R.
1 (AA) for mounting in turret hatch ring. (440 rds. 110 rd. reels)
Free traverse 360°.
Thompson cal. .45 S.M.G. (440 rds.)
2 (carried, not mounted)
Bomb Thrower 2" Mk.I Smoke (44 rds)
Signal Pistol 1" (20 cartridges)
Hand Grenades No.36 Mk.I (6 rds.)

- RAM II
Ordnance Q.F.6-Pr.Mk.III or V (92 rds.)
Browning cal. .30 M.G. M1919A4 (4000 rds.)
1 mounted coaxially in turret
1 (flexible type) in ball and socket mount, left bow - with elimination of cupola.
1 (AA) for mounting in turret hatch ring (440 rds. 110 rd. reels)
Free traverse 360°.
Thompson cal. .45 S.M.G. (440 rds.)
2 (carried, not mounted)
Bomb Thrower 2" Mk.I Smoke (43 rds.)
Signal Pistol 1" (20 cartridges)
Hand Grenades No.36 Mk.I (6 rds.)

SIGHTING - RAM I
C. No. 33 Direct Sighting Telescope Magnification 1.9
RAM II
C. No. 39 Direct Sighting Telescope Magnification 1.9

PROTECTED VISION - RAM I
Protectoscopes. In side doors. Rotor with protectoscope for driver and co-driver.
Periscopes. Vickers Type.
2 in Turret - Commander & Gunner
1 in Hull - Driver

RAM II
Protectoscopes. Only driver's protectoscope in later vehicles.
Periscopes. Vickers Type.
1 in Turret - Commander
2 in Hull - Driver & Co-Driver

COMMUNICATION - No. 19 Wirless Set with intercommunication to all crew members.

COMPASS - Pioneer 1828 or 1829 or 1830.

LIGHTING - Interior, Festoon lamps with Inspection lamp. Earlier vehicles-Wheat lamp.

Exterior, 2 Headlamps
2 Tail lamps and Convoy.

ESCAPE HATCH - In hull floor.

PERFORMANCE DATA

POWER/WEIGHT - Net power to gross weight ratio
RAM I 12.5 B.H.P. per short ton
RAM II 12.3

GROUND PRESSURE - RAM I 13.3 p.s.i.
RAM II 13.1 p.s.i.

GROUND CLEARANCE - 17"

GRADABILITY Theoretical in 1st. gear.
35° Ascending
35° - 40° Descending

MINIMUM TURNING RADIUS 31'

SPEED, MAXIMUM - 25 m.p.h.

TRENCH CROSSING ABILITY - 7' 5"

VERTICAL OBSTACLE CLIMBING - 24" (max.)

FORDING DEPTH - At slow speed - 40"

CRUISING RANGE - Highway 144 miles-8 miles @ 18 m.p.h.

FUEL CONSUMPTION - .90 m.p.g.

OIL CONSUMPTION - 1.65 q.p.h.

LADEN WEIGHT - RAM I 64,000 lbs.
RAM II 65,000 lbs.

OVERALL DIMENSIONS -
Length - 19' 0"
Width RAM I - 9' 5"
RAM II - 9' 10"-with doorvent
- 9' 6" -with vent (no door)
- 9' 1" -with bulge, later vehicles
Height - 8' 9"

CENTRE OF GRAVITY - 49" (from ground)

ENGINE
Location - At rear
Make - Continental Motrs Corp.
Model RAM I - R975-EC2
RAM II - R975-EC2 or R975-C1 (later vehicles)
Type - Static Radial air cooled 4-cycle petrol 9-cyl.
Peak Gross B.H.P. - 400 @ 2400 r.p.m.
Torque - Max. - 890 ft/lbs.@1800 r.p.m.
Lubrication - Engine oil tank capacity 30 qts.
Oil drawn from oil tank by gear type pressure pump, divided into two sections - a separate pressure pump delivering oil to all bearings and parts, and a scavenge pump returning the oil from the sump through oil filter to oil cooler and oil tank. The oil pump incorporates a pressure relief valve.
Ignition - Two magnetos (Scintilla-Bendix or Bosch Type)
Priming Pump - To facilitate starting engine
Air Cleaners - Type - Oil bath
Number - two. One at right and one at left, rear engine compartment.

COOLING SYSTEM - Type - Air-cooled.
Air ducts formed on engine by baffles bolted around and between each cylinder and cylinder head. A shroud forms a further duct for the inlet of air through the grill.
Method - Fan mounted on engine fly-wheel rotates in the shroud, drawing air through a grill in top upper hull and forcing it between and around the finned cylinders of the engine. The warm air passes through beffles and discharges above engine door at rear of vehicle.

FUEL SYSTEM
Type - Petrol. Commercial Motor Fuel,
- RAM I 91 octane rating or better
- RAM II 80 octane rating or better
Tank Capacity - Total - 146 gallons
Four fuel tanks, each having separate shut-off valve.
Location - Two V-tanks front corner engine compartment. Two H-tanks on each sponson in engine compartment.
Feed - Fuel flows from the tanks to central header, drawn through strainer by fuel pressure pump to carburetor. Excess fuel by-passed through relief valve and returned to header. A separate two-gallon fuel tank for auxiliary generator is located in sponson.
Fuel Cut-Off - Fuel can be cut off electrically at the carburetor by means of a toggle type switch on instrument panel.

CLUTCH
Make RAM I - Borg-Warner
RAM II- Borg-Warner, & Lipe (on later vehicles)
Type - Dry disc, built into engine fly-wheel. Pressure springs exert full pressure against clutch plates.
Borg-Warner Clutch. 3 Discs,2 Drive plates 16", enclosed pressure springs.
Lipe Clutch 2 Discs, 1 Drive plate 16", open type pressure springs.
Method - Depressing clutch pedal compresses springs and frees engine power from propeller shaft. Releasing clutch pedal transmits power through propeller shaft to input shaft of gear box.

GEAR BOX -
Type - Synchromesh
Ratio - First gear - 7.56 : 1
Second gear - 3.11 : 1
Third gear - 1.79 : 1
Fourth gear - 1.11 : 1
Fifth gear - .73 : 1
Reverse gear - 5.65 : 1
Lubrication - Oil circulated by small pump built into the transmission case.
RAM II provided with oil cooler. The oil being drawn from transmission and differential sumps passes to oil cooler at rear of fighting compartment, returning to transmission and differential cases to lubricate the gears and bearings.

STEERING AND FINAL DRIVE -
Type - Controlled Differential
Ratio Bevel Gear - 3.53 : 1
At Sprocket - 9.88 : 1

STEERING CLUTCHES -
Location - One each side of bevel drive
Type - Controlled Differential
Incorporated in the controlled differential, on each side, is the steering device, each of which consists of a brake drum and brake shoe, actuated by a lever. When the speed of one brake drum is reduced by pressure of shoes, the speed of other is increased.
Driver's seat on right of transmission.

STEERING BRAKES -
Band type controlled by steering levers
Parking brake - Transmission type

SPROCKETS
Location - At front
Number - Two twin driving sprockets (interchangeable)
The twin driving sprockets are bolted on each end of the detachable hub assemblies of the final drive shafts.

	Standard	C.D.P.
Diameter	27 9/32"	26 1"
Number of teeth	13	17
	(Teeth engage end connectors of track shoes)	(Teeth mesh on outboard lugs of track)

TRACKS

Type (T54E1,T49,	A.S.F.)	C.D.P.
No. shoes per strand	79	103
Tread(centre to centre)	83"	83"
Width of track	16½"	16½"
Length of track(ground)	147"	147"

SUSPENSION -
Type - Vertical volute springs.
Suspension brackets bolted to lower hull bottom and side plates provide upper seats for the volute springs to react on the bogie wheel lever arms and rubber-tired bogie wheels which run on the track.
Number - 3 bogie or suspension assemblies on each side of vehicle, 2 volute springs in each assembly.
Diameter of bogie wheels - 16"
RAM II - Improved suspension units with stronger volute springs and offset top rollers in later vehicles.

TOP ROLLERS -
Number - One on each bogie assembly to support the upper (returning) portion of track.
Location - RAM I On bracket bolted in seats top of bogie frame.
RAM II (later vehicles) Roller bracket assembly bolted to rear side of each bogie frame, the bracket having a spacer for the roller bearing. A track skid is bolted on top of the bogie frame.

TRACK ADJUSTING IDLER -
Type - Steel idler wheels, 22" diameter, eccentrically mounted on each side of vehicle, at the rear.
Adjustment - By turning hexagon end of spindle shaft, after spreading split housing and driving collar off serrations of spindle.

MECHANICAL DATA (cont'd.)

ELECTRICAL SYSTEM -

24-Volt System

Battery - Two 12 volt, 168 ampere hour storege batteries.

Generator - Main. 30-volt, 50 ampere, driven from main engine.
Auxiliary 2-cycle, single cylinder, air cooled petrol engine, 30-volt, 50 ampere, Homelite Model H.R.H., equipped with blower and duct containing heater element, between the unit and engine compartment.

Both generators have control boxes with voltage regulator, current limiter and reverse current relay with generator filter to reduce redio interference.

Starter -Direct electric starter, Eclipse type 617-1A, with hand attachment.
Starter solenoid switch, Eclipse type 518-21-A.

Fuel cut-off solenoid, Eclipse type 500-15-A, operated by a toggle switch on instrument panel.

Traverse Motor - Electric motor mounted on floor of turret basket, directly connected to hydraulic pumo for the power traversing system.

RAM II (later vehicles) - Auxiliary Generator, Homelite Model H.R.U.H. 30-volt, 50 ampere (without heating element), replaces Model H.R.H.

Power for the oil pump of the gyro stabilizer unit is supplied from the same electric motor that drives the hydraulic pump for the power traversing system.

Klixon Circuit Breakers replace all fuses in later vehicles.

MAJOR CHANGES INTRODUCED DURING PRODUCTION

Side doors in hull eliminated.

Pistol ports in turret replaced doors; Later eliminated.

Rear opening in turret casting eliminated.

Escape hatch provided in floor of hull.

Improved suspension units with stronger voluted springs & offset top rollers.

Eliminated cupola (left bow) to improve contour.

Improved clutch (Lipe).

Transmission oil cooler.

New engine oil cooler (improved control).

Continental engine R975-C1 adopted, with compression ratio to operate on 80 octane motor fuel.

Conversion of engine priming system from 5-cylinder to 7-cylinder.

New type Air Cleaners.

New mufflers.

Improved Logansport Traverse control.

Pioneer Compass located in turret.

6-Pr. recoil system improved.

Exhaust fan in turret.

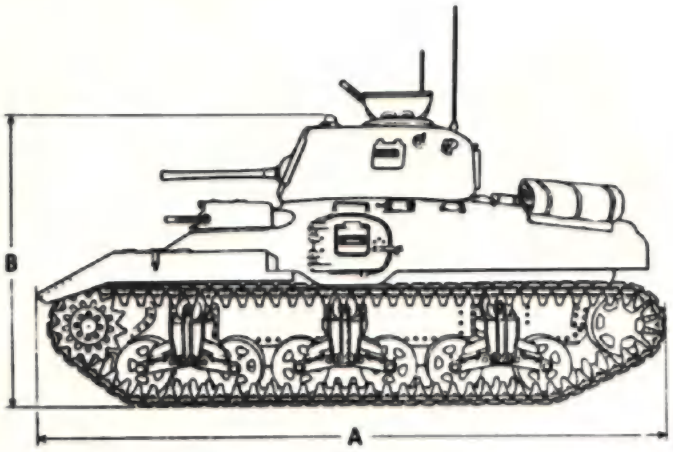
Armoured 6-Pr., Ammunition rack.

Batteries moved from hull floor to sponson plate.

Redesign of Instrument Panel.

Methyl Bromide fire extinguishers introduced.

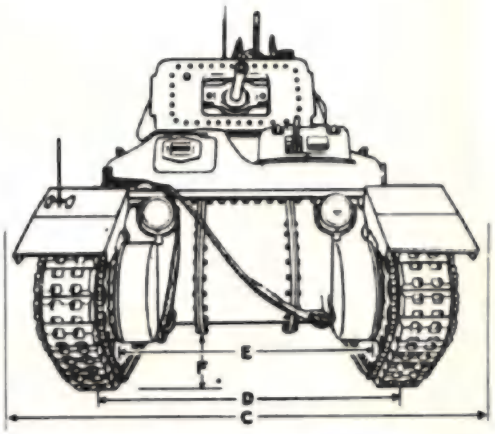
U.S. PROTOTYPE FOR CANADIAN BUILT RAM

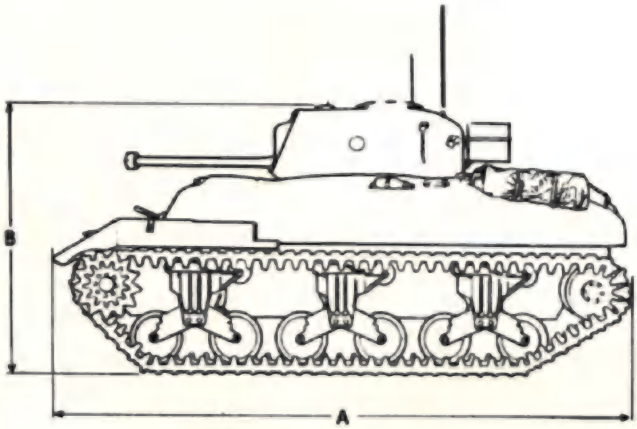


TANK, CRUISER, RAM I

DIMENSIONS

A	B	C	D	E	✱F
LENGTH OVERALL	HEIGHT OVERALL	WIDTH OVERALL	TRACK CENTRES	LOWER HULL WIDTH	GROUND CLEARANCE
19' 0"	8' 9"	9' 5"	6' 11"	5' 3"	17"
✱F - THREE PIECE FINAL DRIVE					

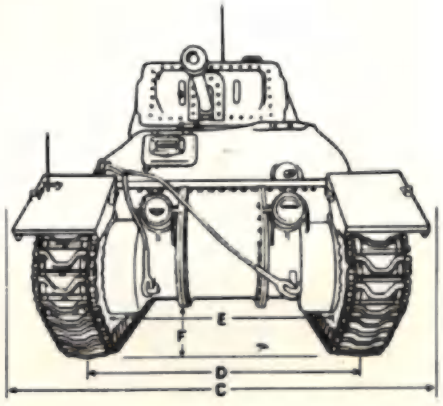


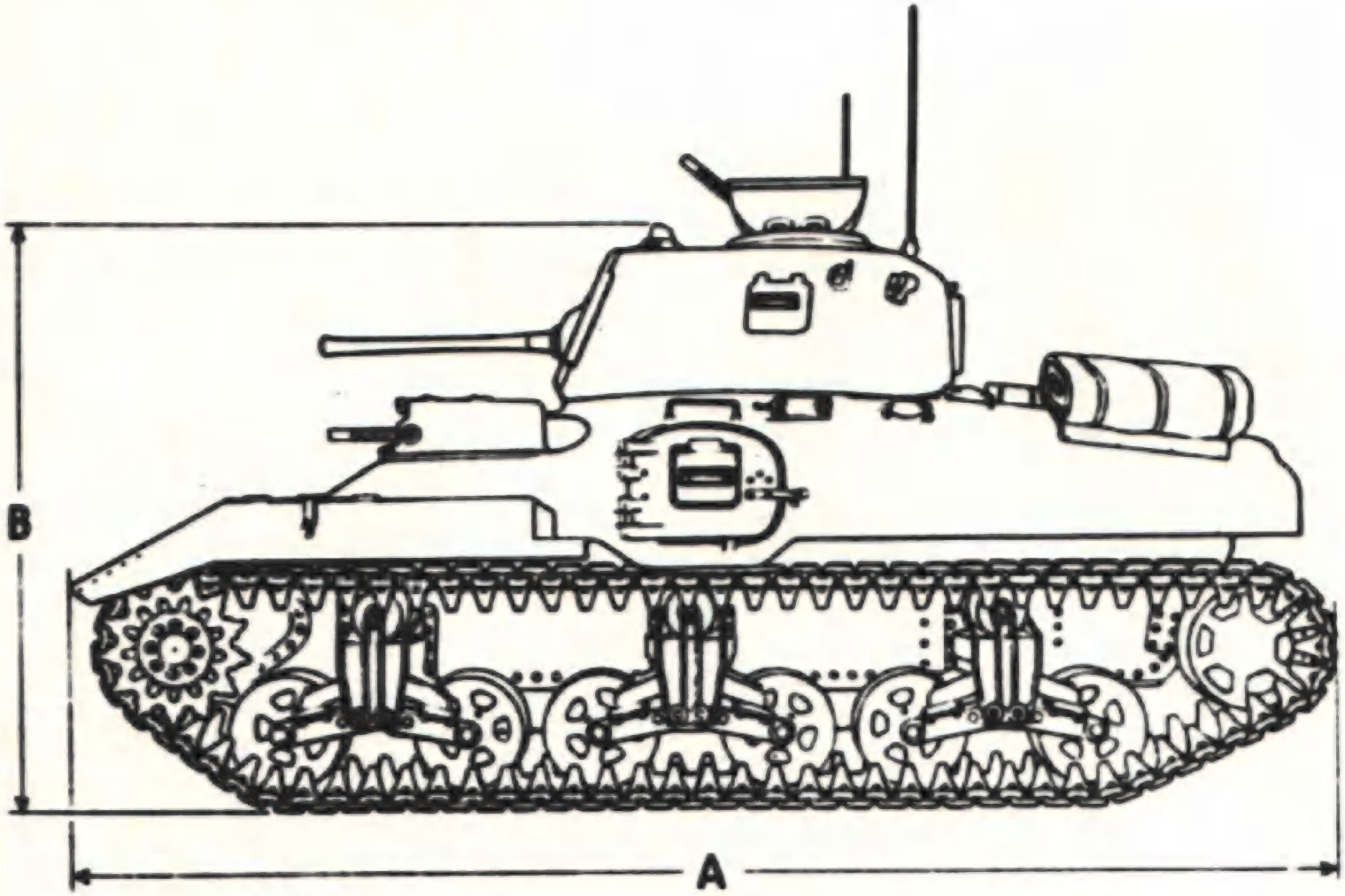


TANK, CRUISER, RAM II

DIMENSIONS

A	B	✱C	D	E	✱F
LENGTH OVERALL	HEIGHT OVERALL	WIDTH OVERALL	TRACK CENTRES	LOWER HULL WIDTH	GROUND CLEARANCE
19' 0"	8' 9"	9' 1"	6' 11"	5' 3"	17"
✱C-WIDTH 9' 10" WITH DOOR AND VENT-VEHICLES CT39831 TO CT40100 WIDTH 9' 6" WITH VENT(NO DOOR)-VEHICLES CT40101 TO 40480 WIDTH 9' 1" WITH BULGE -VEHICLES CT40481 TO CT160143					
✱F-WITH ONE PIECE FINAL DRIVE 18-5/16"					

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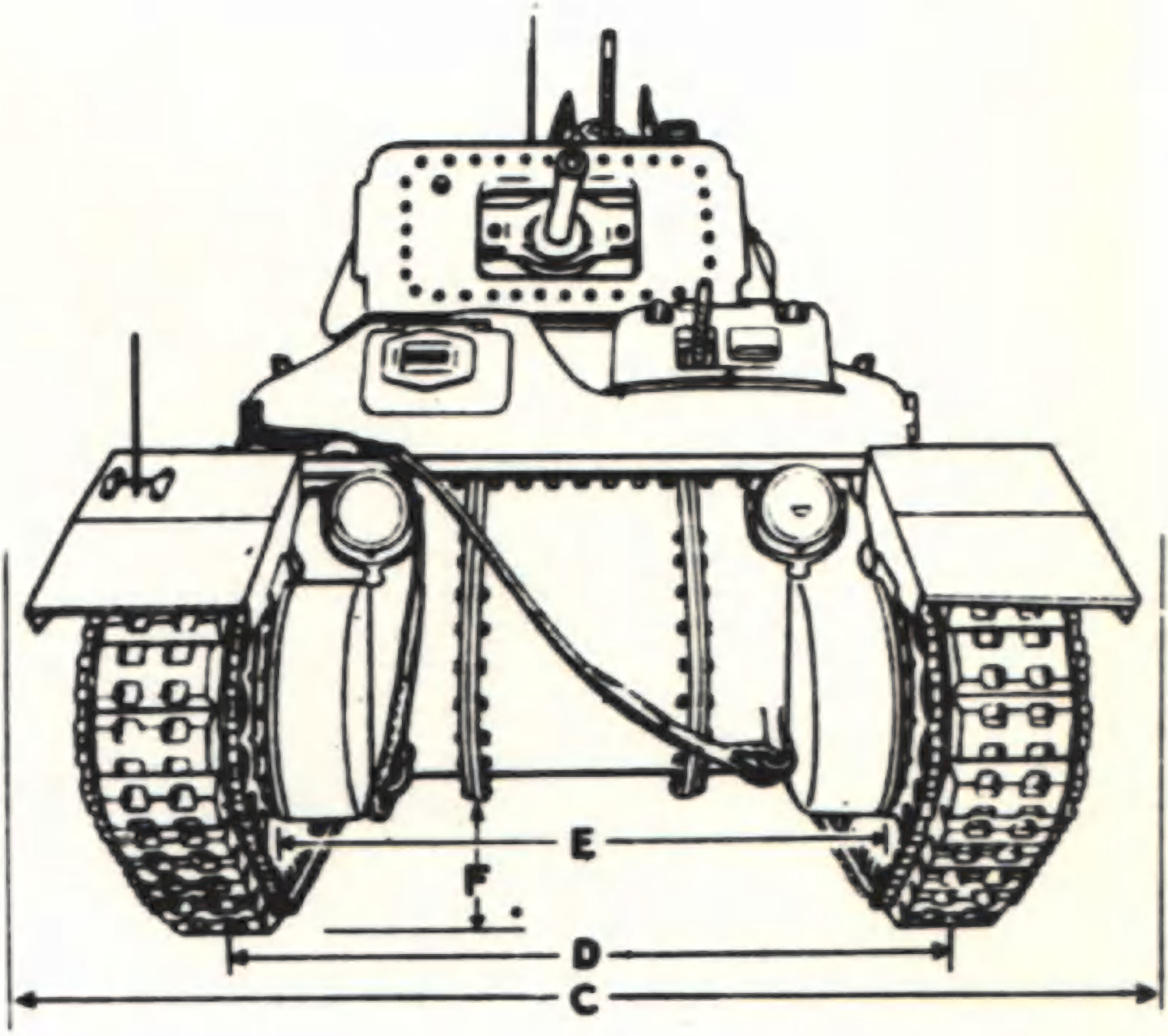
E
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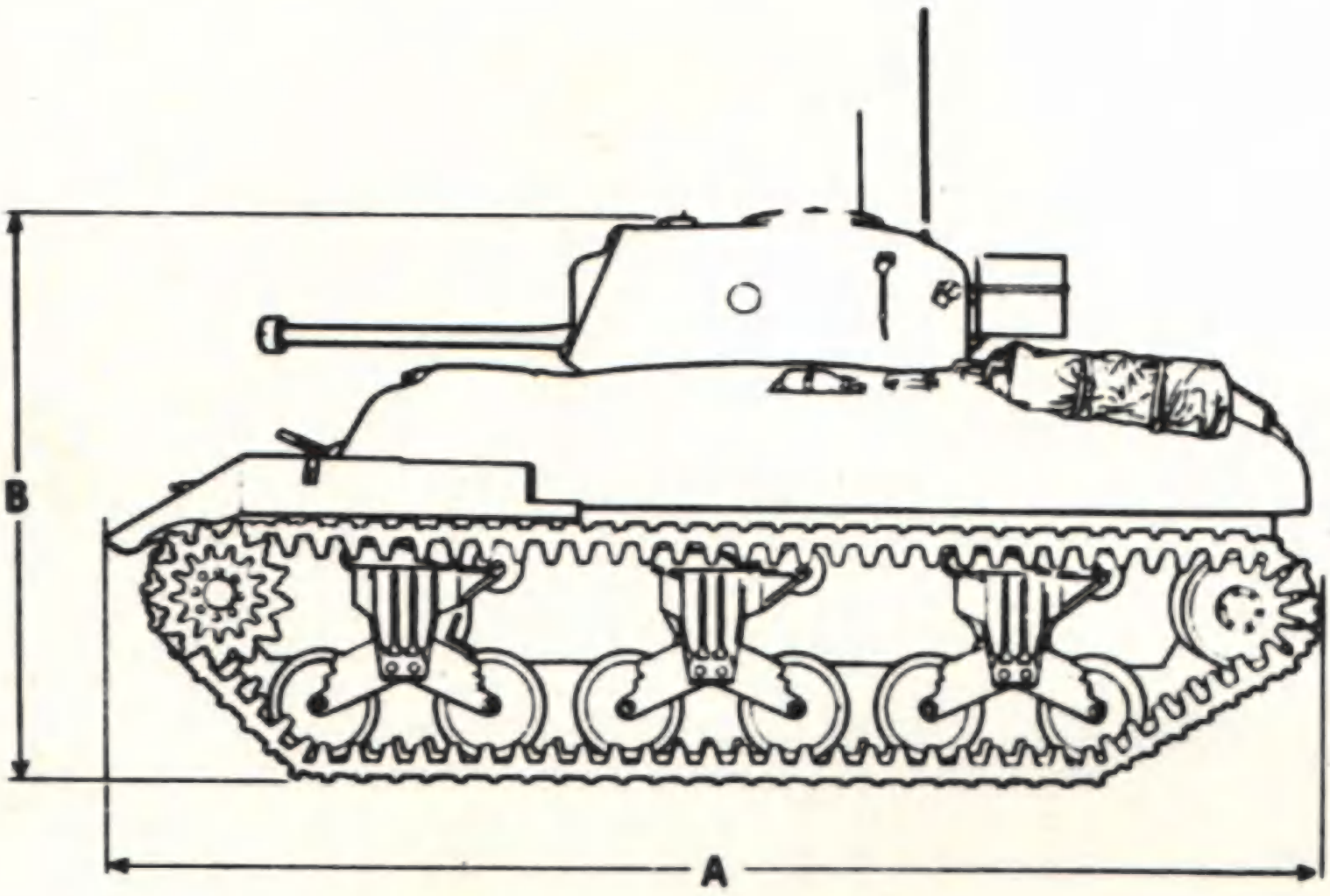
D
C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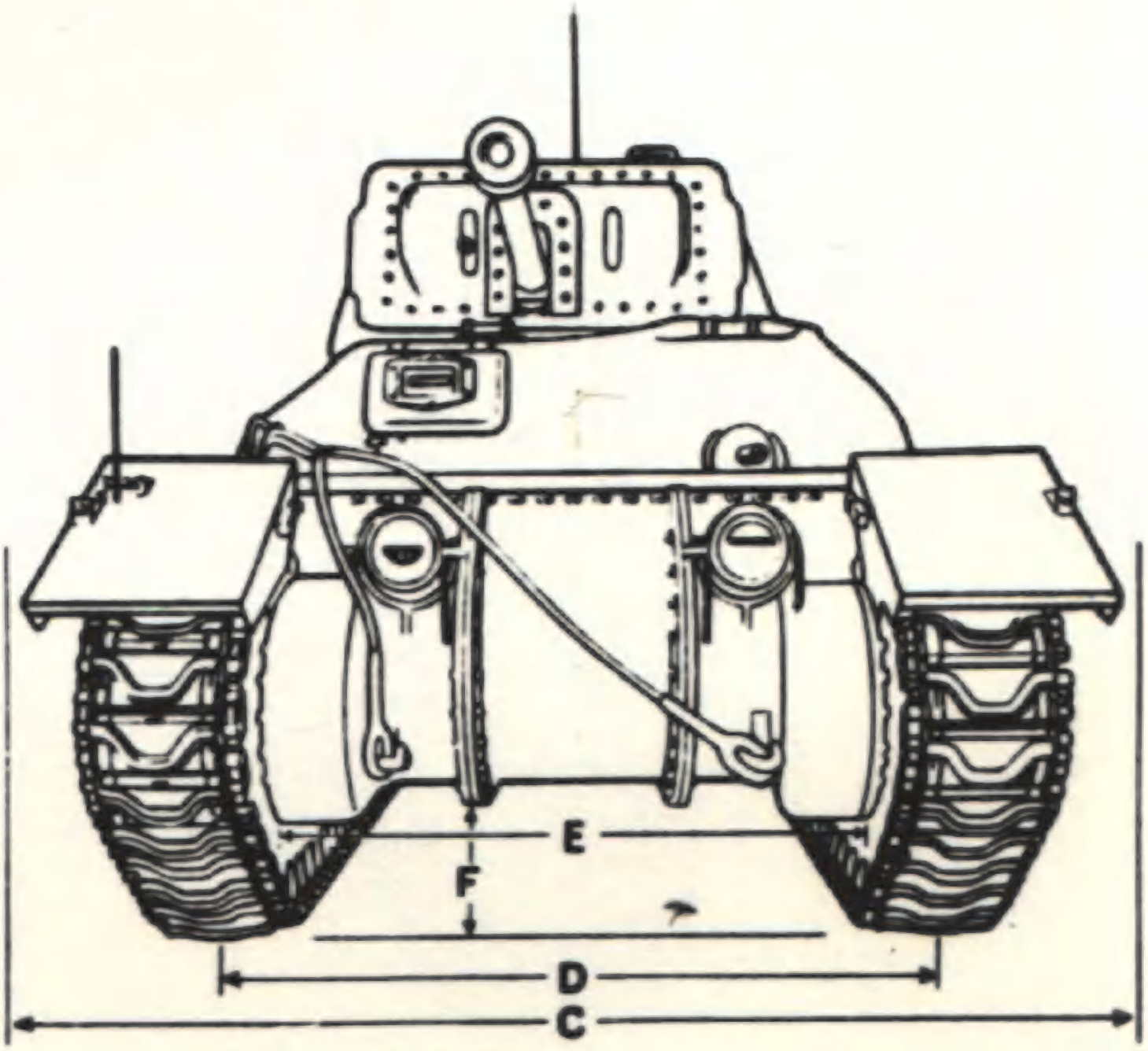
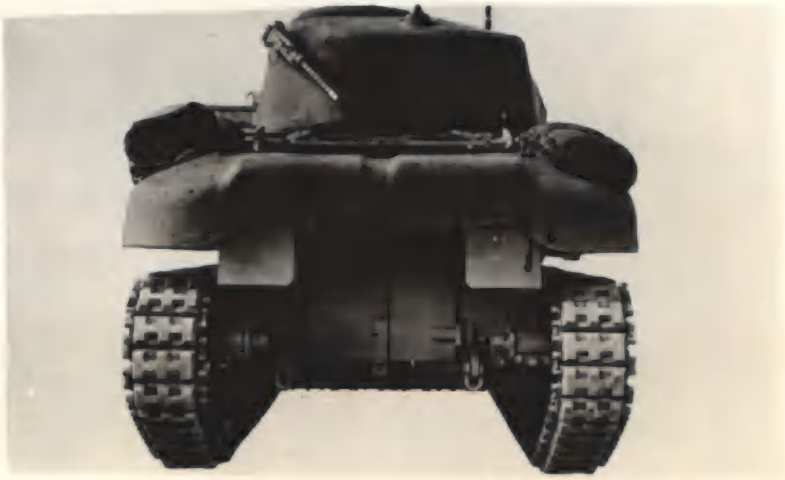

E
F
D
C

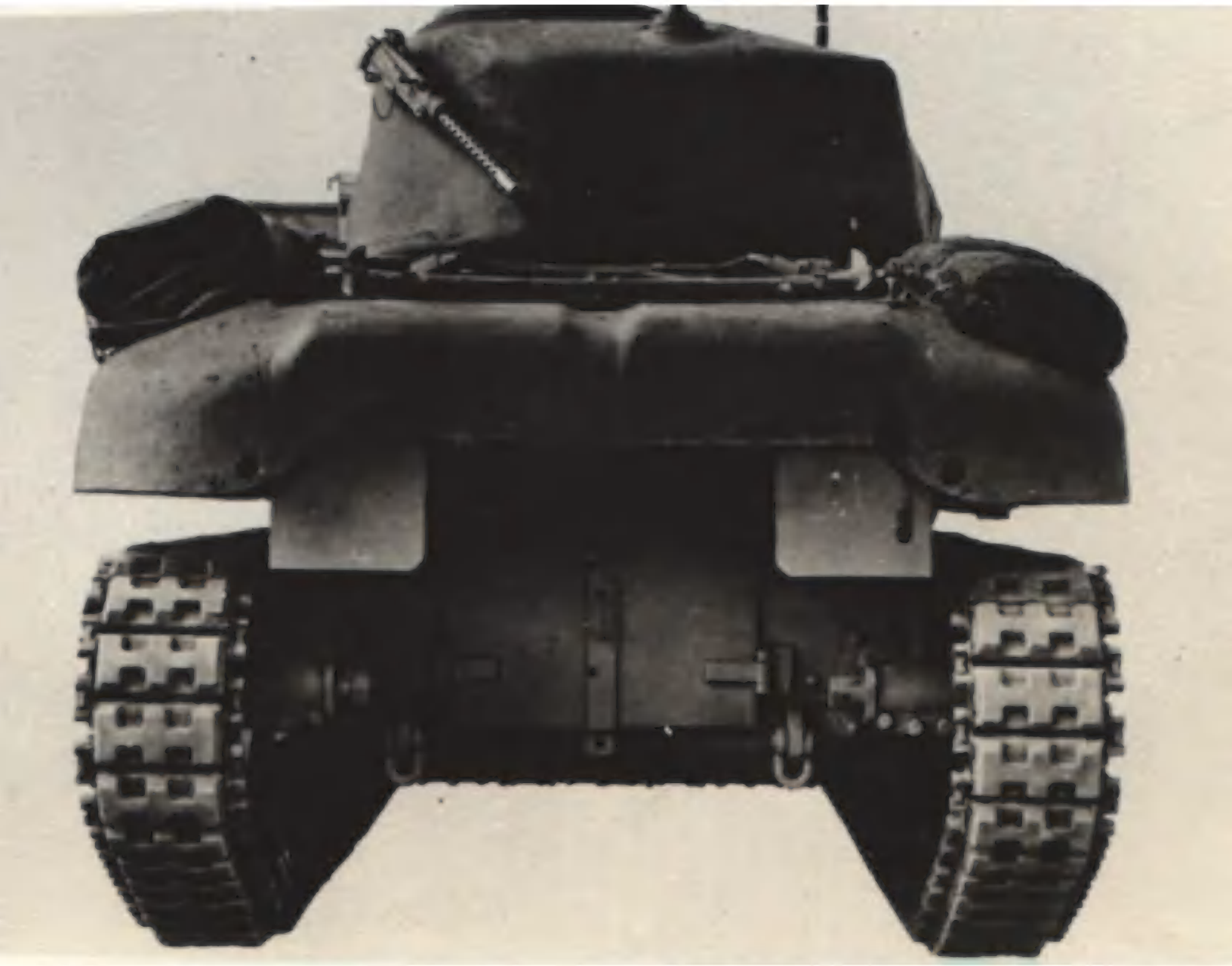
REE-QUARTER RIGHT FRONT
EW-Showing driver's indirect
ision door and rotor open.
-driver's compartment hatch
en, and rubber bushed T54E1
type track.

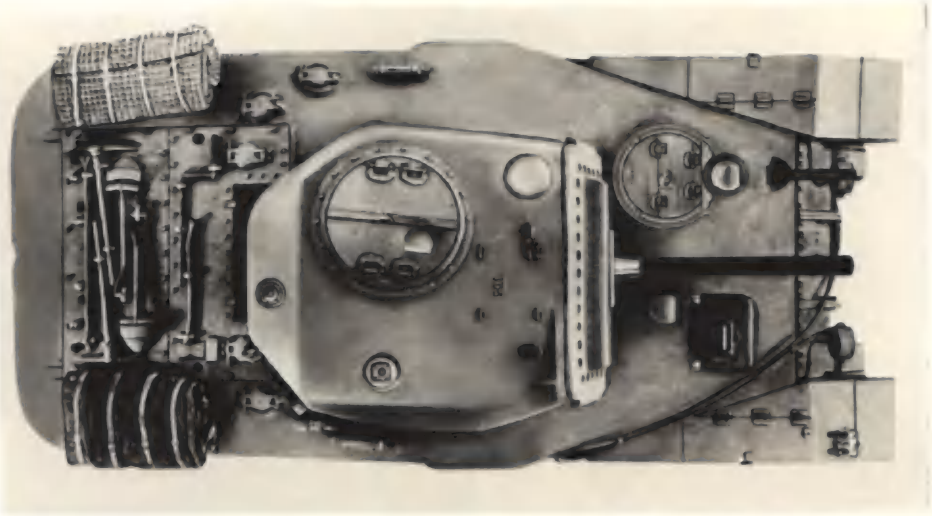
THREE-QUARTER LEFT FRONT VIEW - Showing tool box on left track guard, bow gun, 6-Pr. elevated,-Driver's indirect vision door and rotor in closed position and driver's and co-driver's periscopes.

RIGHT SIDE VIEW - Showing driver's indirect vision door and rotor in the raised position, pistol port on side of cast armour turret and tool box on track guard.



REAR VIEW - Showing machine in stowed position on turret, e compartment doors closed and bushed WE 210 type track

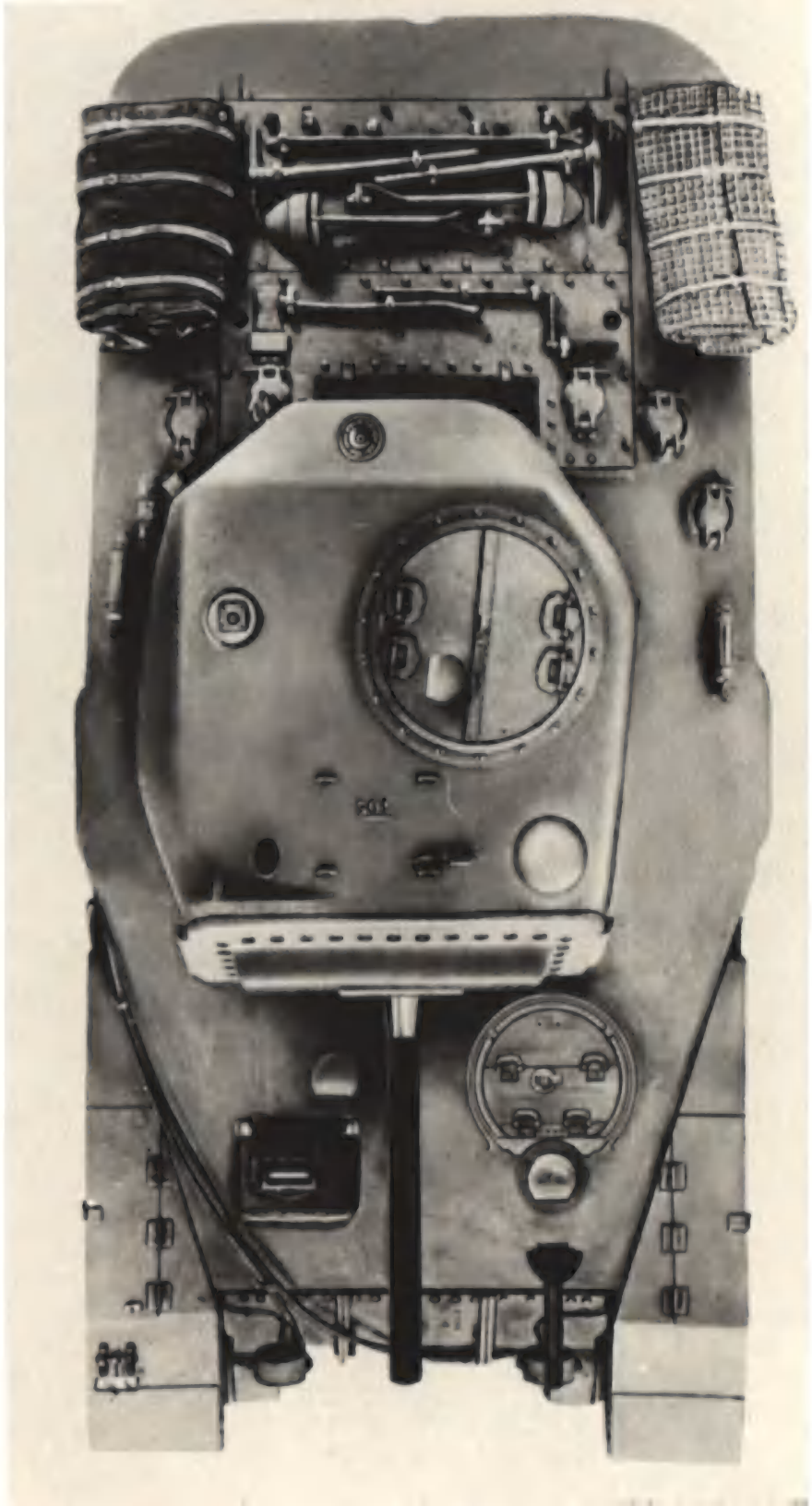


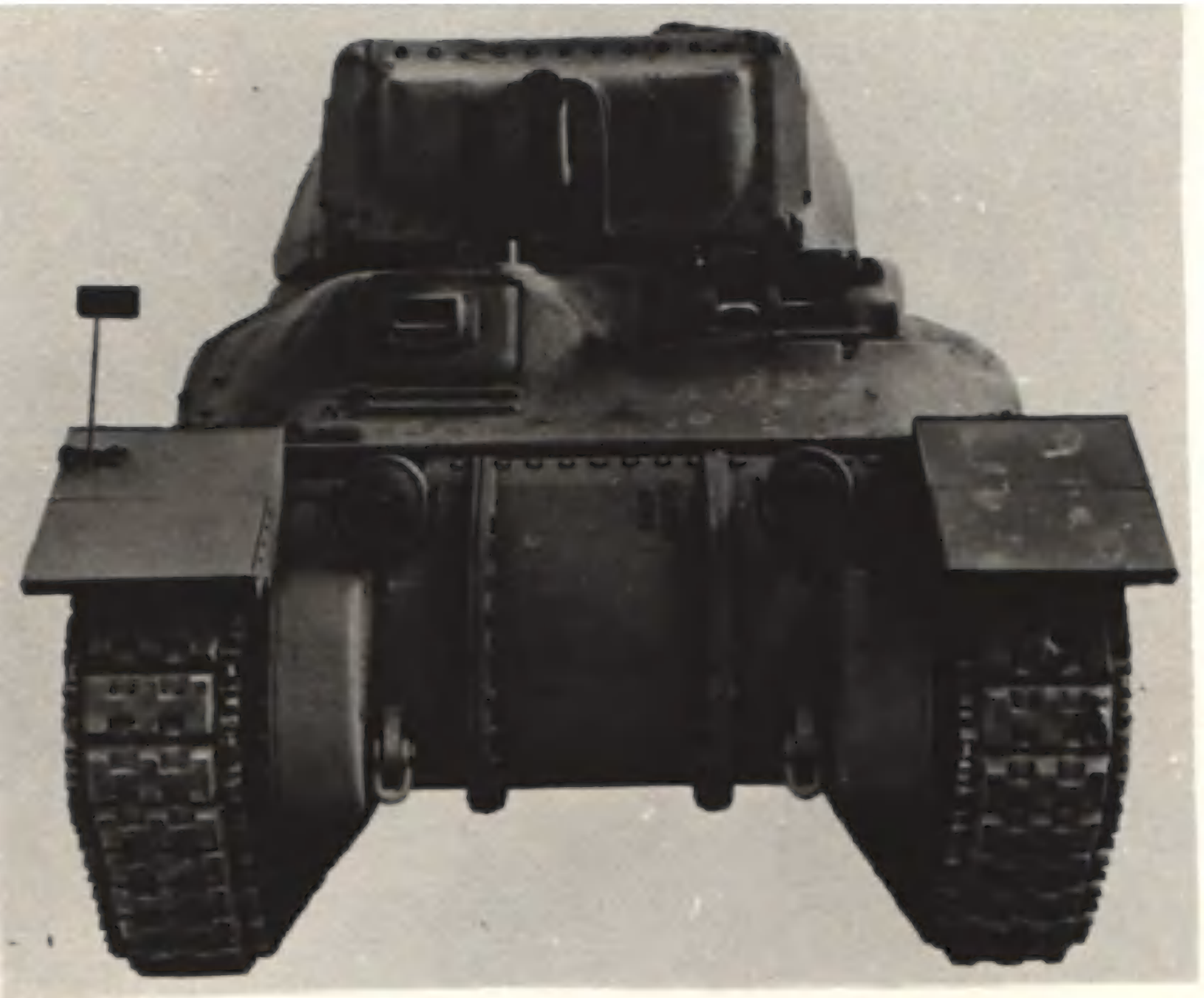


PLAN VIEW - Showing driver's compartment hatch, turret hatch, periscopes & stowage arrangement of towing cable, tarpaulin, camouflage net & ancillary equipment.

ONT VIEW - (early type hull) - Showing cupola type w gun mounting (Cupola later replaced by ball and socket type mounting.)

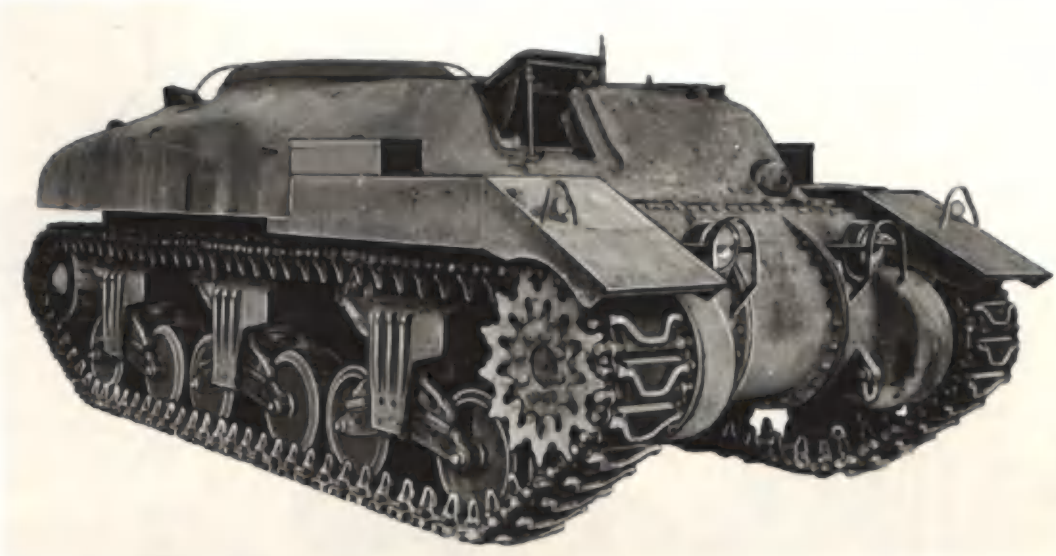
RIGHT SIDE VIEW - (early type) - Showing utility door in side of hull, pistol port and protectoscope on side of turret. (C.D.P. track and matching sprocket shown installed.)



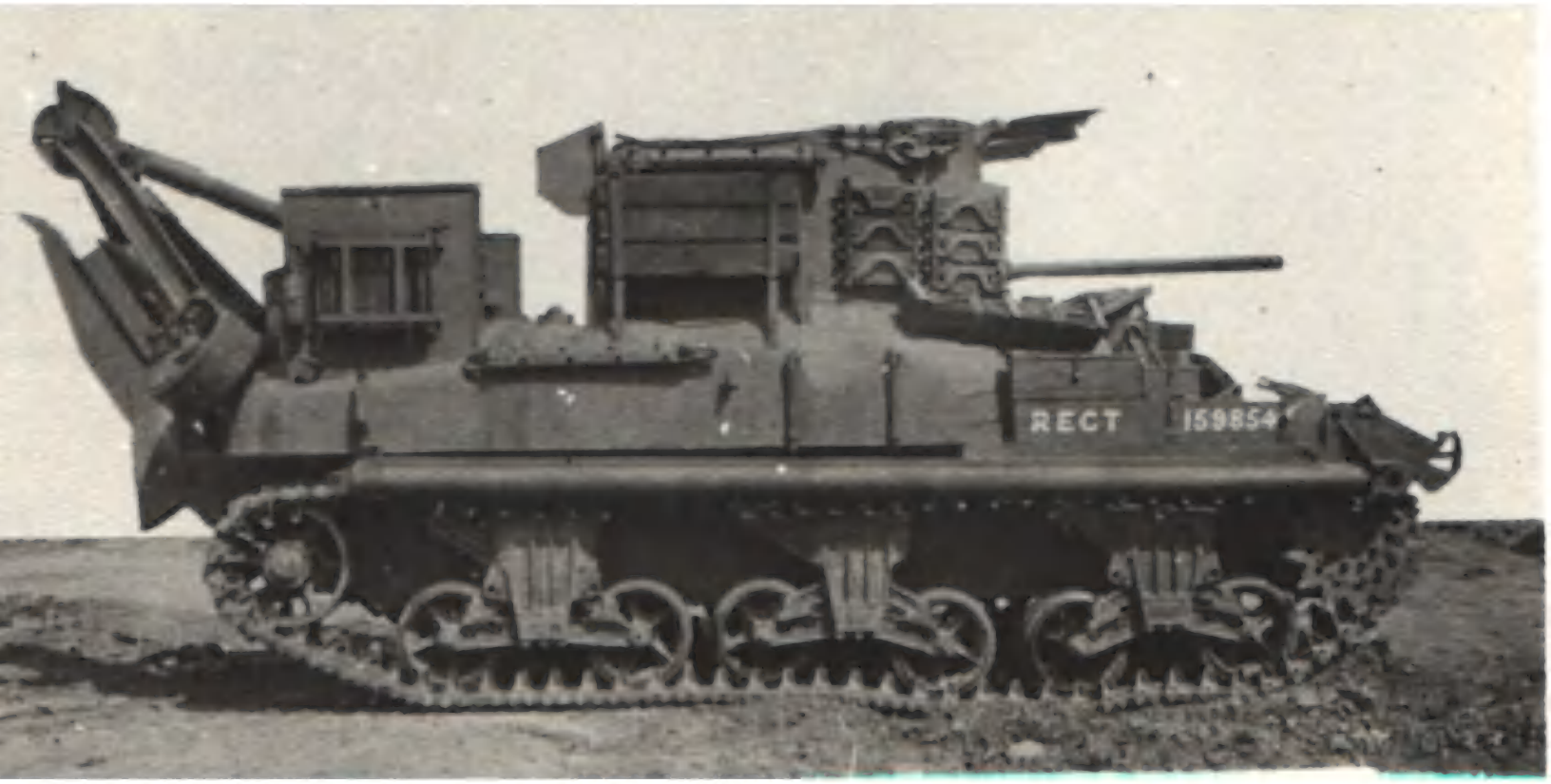



D.N.D
42-1-3259
CT-60021

RAM II–MODIFIED AS ARMOURED RECOVERY VEHICLE
Used for recovery of bogged vehicles also to recover casualties out of range that are to be returned for repair. Vehicle shown is fully stowed.



RAM II–MODIFIED AS ARMOURED PERSONNEL CARRIER (KANGAROO)
Used as armed personnel carrier to carry infantry forward for the assault; carries eleven men in battle order besides crew; has tow hook installed and can be used alternatively as a gun tower.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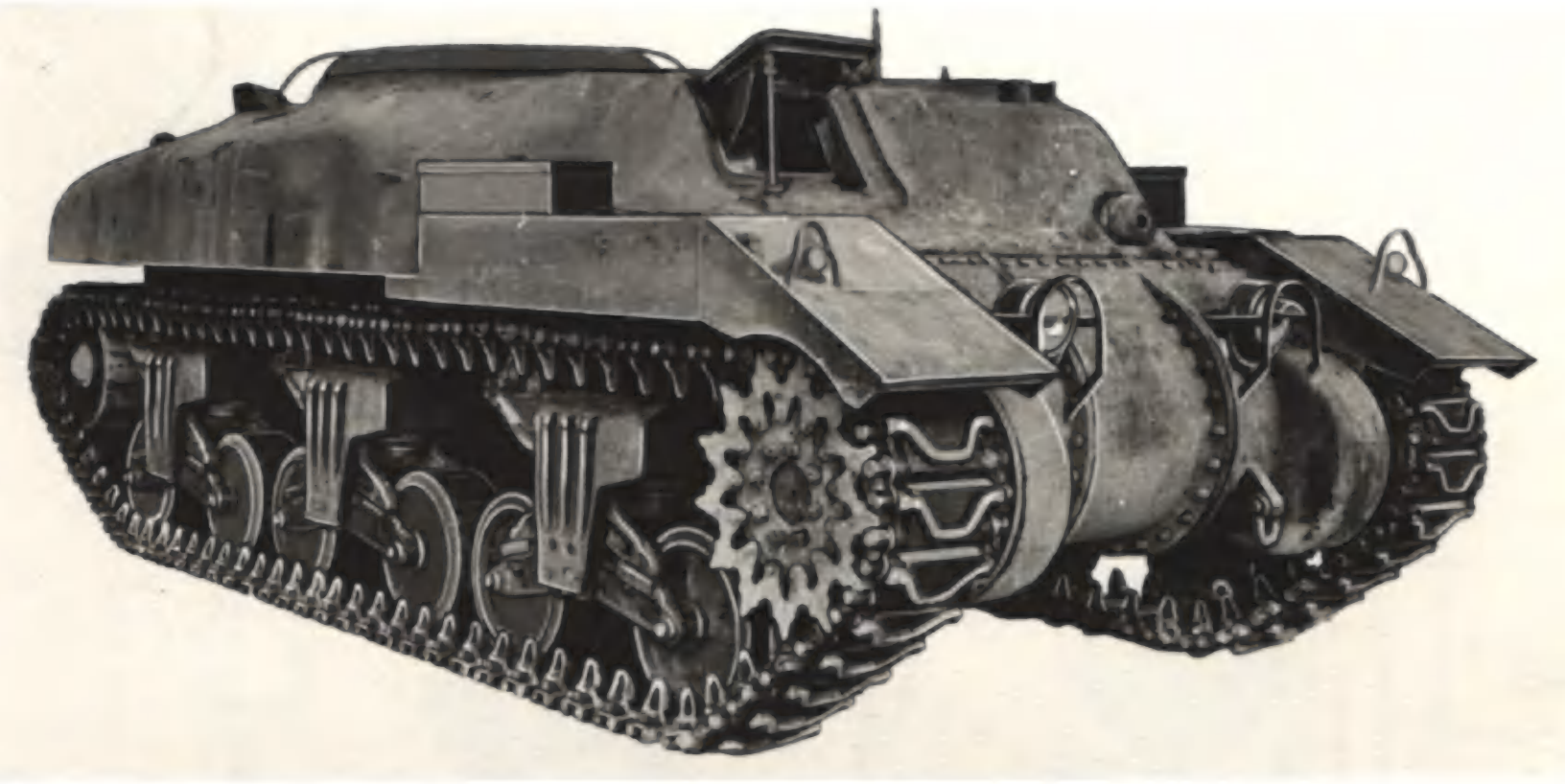
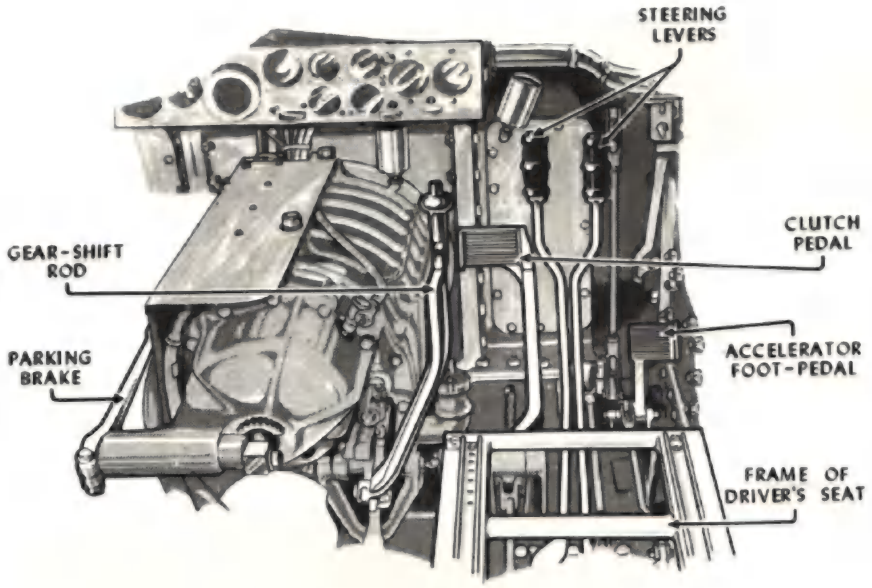
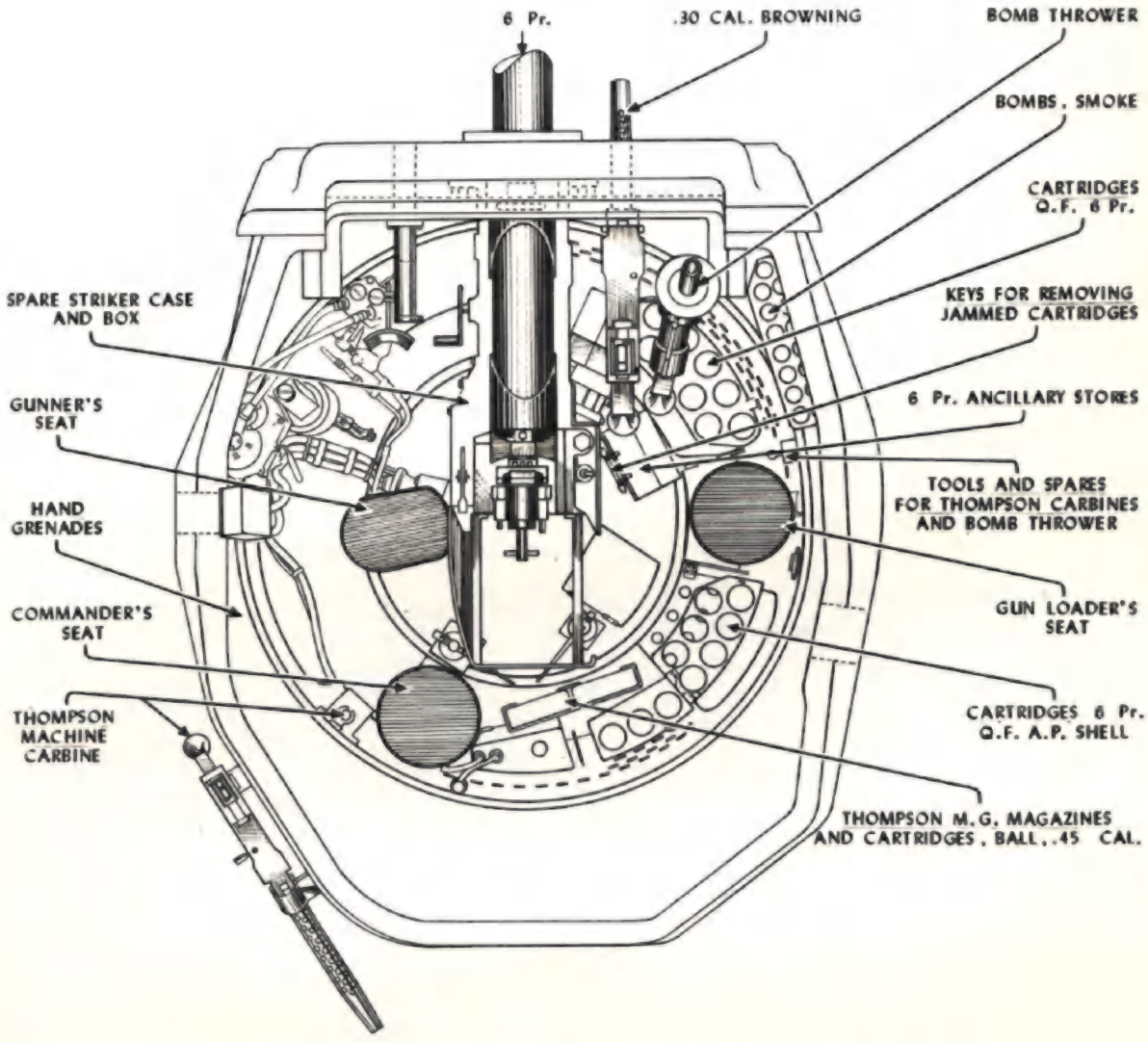
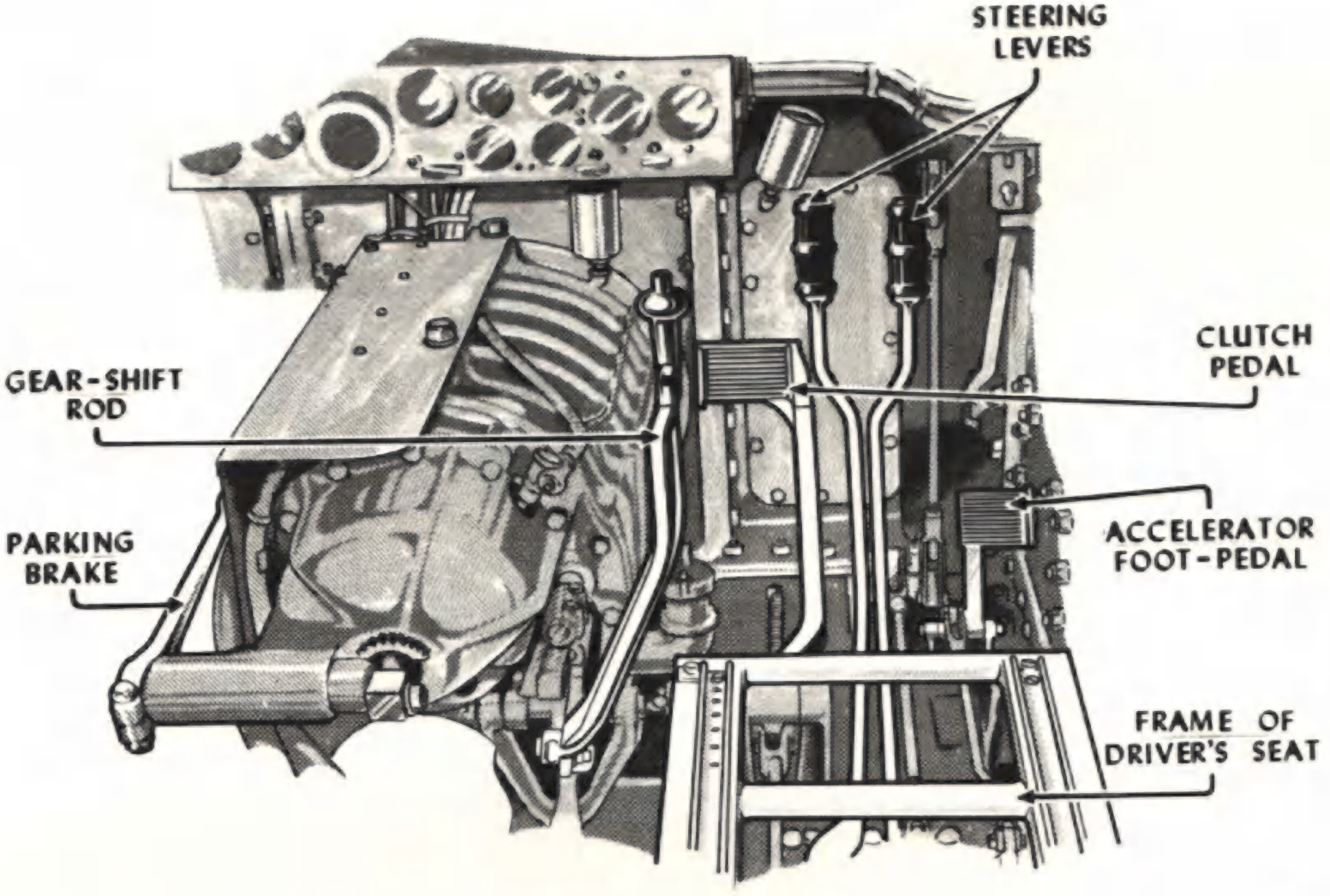


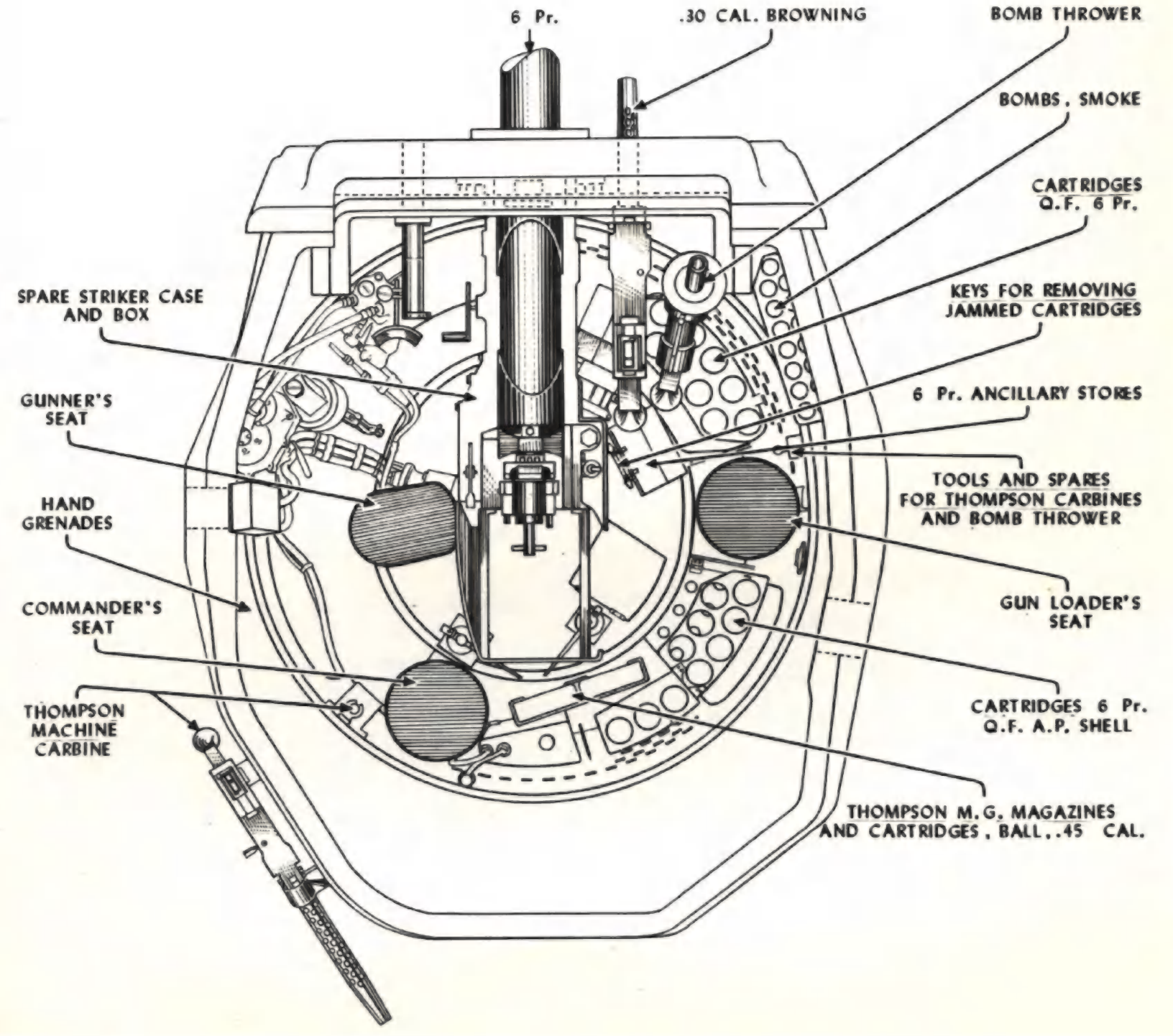


CONTROLS – DRIVER'S COMPARTMENT



ARMAMENT ARRANGEMENT IN TURRET


STEERING LEVERS
CLUTCH PEDAL
GEAR-SHIFT ROD
ACCELERATOR FOOT-PEDAL
PARKING BRAKE
FRAME OF DRIVER'S SEAT


6 Pr.
.30 CAL. BROWNING
BOMB THROWER
BOMBS, SMOKE
CARTRIDGES Q.F. 6 Pr.
KEYS FOR REMOVING JAMMED CARTRIDGES
SPARE STRIKER CASE AND BOX
6 Pr. ANCILLARY STORES
GUNNER'S SEAT
TOOLS AND SPARES FOR THOMPSON CARBINES AND BOMB THROWER
HAND GRENADES
GUN LOADER'S SEAT
COMMANDER'S SEAT
CARTRIDGES 6 Pr. Q.F. A.P. SHELL
THOMPSON MACHINE CARBINE
THOMPSON M.G. MAGAZINES AND CARTRIDGES, BALL, .45 CAL.

USER COMMENTS

EXCERPT FROM D.D.E.M.LETTER MST/ARM.VEH/28/2 17 AUGUST, 1942 - (OUR FILE 73-5-26)

"Ram I Tanks have recently undergone extensive service during firing training in Wales.
(July 1 - Aug. 4 1942)."

"On the whole, the Rams were found to be quite dependable and and gave no serious trouble, etc."

EXCERPT FROM AIRL 409(D.D.E.M.) 25, MARCH,1943 MINUTES OF 24TH MEETING CANADIAN A.D.V.USERS' COMMITTEE - (OUR FILE 141-53-1)

RAM AS ARMOURED PERSONNEL CARRIER - (KANGAROOS)

"These in use in 21st Army Group, and have come to stay. 75 mm. gun installed in Ram Tank No. CT159506 - most satisfactory."

21 ARMY GROUP A.F.V. TECHNICAL REPORT NO. 23 - APRIL 1945

RAM FITTED WITH WASP II F.T. EQUIPMENT

GENERAL USE

"In the capture of the strongpoint at Minnethal, an entire German parachute battalion is said to have been wiped out by these vehicles. Their medical officer is reported to have stated that the casualties were of the order of 300 out of an original strength of 500. The flame crews stated that after one shot of flame, complete confusion and panic occurred and that a quick follow-up with machine gun fire completed the demoralization."

REFERENCES

D.T.D. Specification No. O.A. 212.

Ram I & II Instruction Book, May 1942.

Ram II Instruction Book, April 1943.

Ram II Illustrated Parts List, January 1943.

Data Book - Tank Type Vehicles of Canadian Manufacture, January 1944 - Publication number M&S 1877.

Files Series
D.M.S. 73-5-1, 2, 3, 4, etc.
D.N.D. H.Q.S. 3352-11
D.M.S. D.A.D. Photo.Files Nos.T3,T4,T5.

D.T.D. Field Trial Reports:

Report No. 474 - Air Cleaner Intake on M.3 Medium Tanks.

Report No. 476 - Ram I Acceptance Trial.

Report No. 489 - Lifting Eye Plates, Ram I and II Tanks.

Report No. 564 - Modified Air Intake and Exit Louvres, Ram I.

Report No. 582 - Petrol Filters, Ram I and II Tanks.

Report No. 591 - Transmission Oil Coolers, M.3 Medium Tanks.

Report No. 715 - Ram II, 6 feet Wading, Air Intake and Turret Ring Sealing.

Report No. 1218/5 - Towing Trials 17 Pr. Anti-Tank Gun Towed by Ram II.

Report No. 1591 - Cooling Performance of Ram II before Conversion to Armoured Recovery Vehicle.

Design Change Instructions.
Ram I and II D.C.I. No.1 to D.C.I.No.420

Design Deviation Permits.
Ram I and II D.D.P. No.1 to D.D.P.No.118

Design Change Requests.
Ram I and II D.C.R. No.1 to D.C.R.No.576

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

E. 124 - Smoke Emission Trials.

E. 132 - C.D.P. Track Pinning Methods.

E. 133 - Donco Track (Dominion Rubber Company)

E. 134 - Removal of 6-Pr. Gun from Tank.

E. 137 - Evans Heater Installation.

E. 144 - Solenoid Bracket for 6-Pr. and Browning M.G.

E. 158 - Dead Man Switch.

E. 167 - C.D.P. Track on Test.

E. 213 - Bogie Wheel Tire Test.

E. 224 - Life Service Bogie Tires.

E. 227 - R.975 - C1 Engine, Oil Consumption.

E. 229 - Turret lubrication.

E. 246 - Dominion "Soft Black" Tires with C.D.P. Tracks.

E. 247 - Oversize Goodyear Bogie Tire.

E. 252)
E. 253)- C.D.P. Track Peening.
E. 255)
E. 262)

E. 301 - British Type Towing Hook.

E. 312 - Gradability, on 20% Clay.

E. 314 - Rear Smoke Emitters Performance, (Stewart-Warner).

E. 347 - Reliability of C.D.P. Track Pins Inspected by Dr. Drury.

E. 348 - Solenoid Firing Gear 6-Pr. and M.G.

E. 369 - Track Adjustment

E. 390 - Pilot Models, Rear Smoke Emitters.

REFERENCES (cont'd.)

A.E.D.B. - Report on Cold Weather Test of Armoured Fighting Vehicles, Conducted at Kapuskasing, 1942. (Tanks and M/T Library Ref.1 AFV). (I.B.U.K &C)

A.E.D.B. - Report on Cold Weather Tests, Conducted at Camp Shilo, Manitoba, Winter Season 1942-43, PartIX of seven volumes. (Tanks and M/T Library Ref.1 TST). (I.B.U.K. & C.)

Firing Trial Report.

Proof Test No. V.309 - Valcartier Artillery Report of Firing Trials Against Ram II Tank. February 1943.

D.T.D. Bogie Tests conducted by the Canadian Proving Ground Detachment at Camp Seeley, California and Phoenix, Arizona, 1944: (D.M.S. File No. 141-50-44).

20x9x16 Synthetic Bogie Tests on Ram II Tanks.

20x9x16 Rubber Bogie Test on a Ram II Tank.

20x9x16 Synthetic Bogie Test on a Ram II Tank, equipped with T-51 Synthetic Track.

RAM II, 6 Feet Wading Instructions, I.F.V. 1st. Edition, June 1943.

RAM II, Fording Test Report made at Alliston - (D.N.D.File No. C.A.C.(E) 1-A)

D.V.A. Reports:

Project D.V.A. 6 - 246

Project D.V.A. 6 - 246B

Project D.V.A. 6 - 382 - 1

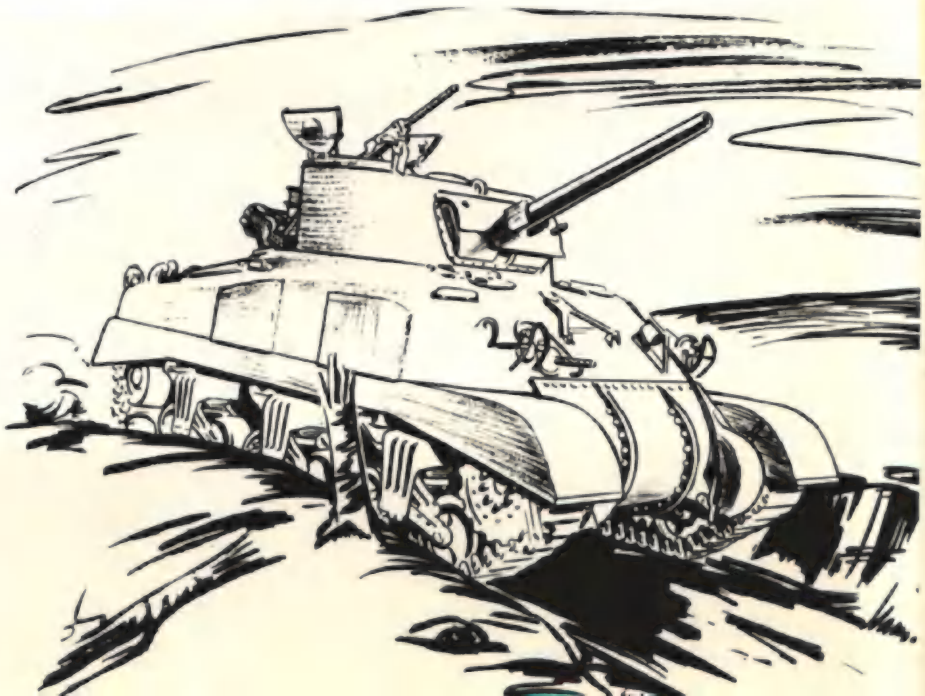
Project D.V.A. 6 - 443 and 444.

Production Orders:

C.D. - L.V. 283	50
L.V. 283	1107
L.V. 558	792

Approx. Price per unit - less equipment supplied by Ordnance $60,000.

TANK, CRUISER, GRIZZLY



TANK, CRUISER, GRIZZLY

The Grizzly is the Canadian version of the U.S. Medium Tank M4A1 "Sherman", which represented the most modern and successful medium tank available to the allies in World War II and can be considered the standard medium tank of the 1943 - 1945 period.

A number of variations of the Sherman Tank was built in the United States. The Grizzly is based on the M4A1 series, and differs little from it in design and detail features.

The Grizzly was produced at the Tank Arsenal, Montreal Locomotive Works during 1943, and in all, 188 vehicles were built.

Current U.S.Ordnance designs were accepted almost in toto to cover Canadian production. Certain revisions were necessary, however, such as installing the two inch Smoke Mortar, the #19 Wireless Set and other items of equipment and stowage to conform with British and Canadian standards.

The tactical features of the Grizzly include a 75 mm. gun with a coaxially mounted .30 calibre Browning, in a roomy cast turret with oilgear power traverse and gyro stabilizer for mobile action, also an azimuth indicator and clinometer for indirect fire. It has both direct sighting telescope and a periscopic sight. Armour piercing high explosive and smoke shells can be fired. A two inch smoke mortar is mounted in the turret.

The armour was found to provide reasonable protection against 75 mm. guns in enemy vehicles but inadequate against larger calibre anti-tank guns particularly at the shorter ranges encountered in North West Europe.

A #19 Wireless set is carried in the turret bulge with intercommunication to the 5 crew members. An adequate number of Minneapolis Honeywell periscopes provide indirect vision for each member of the crew with hatches closed. With hatches open the driver and co-driver, with their seats in a "raised" position, by completely exposing their heads, obtain excellent direct vision. Only one turret hatch was provided on the Grizzly.

There are no mechanical differences from the M4A1 Sherman which has a cast hull, a radial, air-cooled petrol engine driving through a synchro-mesh 5 speed gearbox and a controlled differential in front sprockets. Suspensions were vertical and both the dry pin type and the steel rubber bushed type tracks were used.

The Grizzly has a left hand drive which is contrary to all other Canadian and British tank type vehicles with the exception of the "Skink" which conforms to the Grizzly design, apart from the turret. This vehicle has proved to have excellent mechanical reliability.

All Grizzly tanks were built in Canada at the Tank Arsenal of the Montreal Locomotive Works, production starting in August 1943 and being completed about the end of that year.

Inasmuch as the current U.S. Ordnance drawings and specifications were followed almost completely, few basic design problems arose in Canada beyond those necessary to install the 2 inch smoke mortar, the #19 wireless and other items of equipment and stowage to conform with British and Canadian standards.

Similarily, as the vehicle was being produced in quantity in the United States, few new production problems arose beyond the difficulty in arranging to have Canadian vehicles include the latest U.S. design modifications.

While it had been planned to build large quantities of the Grizzly tanks in Canada, orders were cut back when it became apparent that the supply of Shermans from U.S. arsenals would be sufficient for all requirements.

Of the tanks produced in Canada some were retained for training and some were allocated to British forces.

TANK, CRUISER, GRIZZLY

Tactical Data

PRODUCED BY - Montreal Locomotive Works, Tank Arsenal, Montreal.

PRODUCTION
Commenced - Latter half of 1943
Finished - End of 1943

VEHICLES PRODUCED - 188

SERIES - Grizzly I

TYPE - Medium Tank for offensive combat

BRIDGE CLASSIFICATION - 30

CREW - 5 - Driver, Co-driver, Gunner, Loader, Commander.

ARMOUR - Turret - Front - 3"
Rear - 2"
Side - 2"
Top - 1"
- Hull - Front - 2"
Rear - 1½" - 1"
Side - 2" - 1½"
Top - 2" - 1"
Bottom - 1" (front)
½" (rear)

TURRET - One-piece armour steel casting. 69" Ring.
Hatch with two-piece cover, latch and lock.
Hatch ring for A.A. gun mount.
Pistol port (left side)

TRAVERSE - 360° Hand or power.
Oilgear hydraulic type.
Electric drive from vehicle generator and batteries.
Control by throttle valves in pressure circuit.

GUN MOUNTS - Coaxial.
Elevation 25° Depression 12°
Exterior mantlet.
Geared elevation with gyro stabilizer, or hand.
Electric foot firing.

- Bow (right) Ball and socket mount

- Turret Hatch. A.A. Bracket mount on turret hatch ring.

ARMAMENT - Gun, 75 mm. M3 (78 rds.)
- Browning, cal. .30 M.G. M1919A4 (4750 rds.)
1 mounted coaxially in turret
1 (flexible type) ball & socket mount (right bow)
- Browning, cal. .50 M.G. M1919A4 (300 rds.)
1 (A.A.) for mounting in turret hatch ring - free traverse 360°
- Thompson, cal. .45 S.M.G.
1 carried, not mounted
- Bomb Thrower 2" Mk.I Smoke (43 rds.)
- Signal Pistol 1" (20 cartridges)

SIGHTING - M70F (U.S.A.) Direct Sighting Telescope.
Magnification 3.0.

PROTECTED VISION - Periscope
1 - U.S.O.-M6-Commander (Turret Hatch)
1 - U.S.O. - M4 with Telescope M38 - Gunner (Turret)
1 - U.S.O. - M6 - Gun Loader (Turret)
2 - U.S.O. - M6 - Driver and Co-Driver (Direct Vision Slot)
2 - U.S.O. - M6 - Driver and Co-Driver (Hatches)

COMMUNICATION - No. 19 W/S with I.C. amplifier

COMPASS - Pioneer Type 1829

LIGHTING - Interior, Dome Lamps with Inspection lamp.
Exterior, 2 Headlamps
4 Tail lamps
1 Blackout lamp

ESCAPE HATCH - In hull floor.

PERFORMANCE DATA

POWER/WEIGHT - Net power to gross weight ratio 11.9 B.H.P. per short ton.

GROUND PRESSURE - 13.5 p.s.i.
(14.4 p.s.i. C.D.P. track)

GROUND CLEARANCE - 17"
18 5/16" (with one-piece Final Drive)

GRADABILITY - Theoretical in 1st gear -
30° Ascending
30° Descending

MINIMUM TURNING RADIUS - 31'

SPEED, MAXIMUM - 19.3 m.p.h.

TRENCH CROSSING ABILITY - 7' 5"

VERTICAL OBSTACLE CLIMBING - 18"

FORDING DEPTH - At slow speed - 36"

CRUISING RANGE - Highway - 130 miles

FUEL CONSUMPTION - .90 m.p.g.

OIL CONSUMPTION - 1.58 q.p.h.

LADEN WEIGHT - 67,000 lbs.

OVERALL DIMENSIONS
Length - 20' 1" (with sand shields)
- 19' 1" (from rear mudguard to front sprocket)

Width - 8' 8"
Height - 9' 10"

CENTRE OF GRAVITY - 45" (from ground)

ENGINE
Location - At rear
Make - Continental Motors Corp.
Model - R975-C1
Type - Static Radial air-cooled 4-cycle petrol, 9-cyl.
Displacement - 973 cu. ins.
Peak Gross B.H.P. - 400 @ 2400 r.p.m.
Torque - Max. - 890 ft/lbs. @ 1800 r.p.m.
Lubrication - Engine oil tank capacity-30 qts. Oil drawn from oil tank by gear type pressure pump divided into two sections - a separate pressure pump delivering oil to all bearings and parts; a scavenge pressure pump returning the oil from the sump through oil filter to oil cooler and oil tank. The oil pump incorporates a pressure relief valve.
Ignition - Two magnetos (Scintilla-Bendix or Bosch)
Priming Pump - To facilitate starting engine.
Air Cleaners - Type - Oil bath
Number - two. At rear of engine compartment.

Modifications in R975-C1 engine:
Compression ratio changed from 6.3 : 1 to 5.7 : 1 to permit the use of 80 octane motor fuel.
The C1 engine also includes new design carburetor incorporating an electric idle fuel cut-off, a built-in degasser, a diaphragm type (A.C.) fuel pump, which obviates need of a fuel relief valve.
A manual visual type of oil dilution system, independently operated booster coil and starter switches, engine oil pressure gauge with low oil pressure signal lamp.
A new type Cuno oil filter, automatic or hand-cleaning; and high idling mechanism linking accelerator pedal with throttle controls to facilitate gear shifting.

COOLING SYSTEM - Type - Air-cooled. Air-ducts formed on engine by baffles bolted around and between each cylinder and cylinder head. A shroud forms a further duct for the inlet of air through the grill.

Method - Fan mounted on engine fly-wheel rotates in the shroud, drawing air through a grill in top upper hull and forcing it between and around the finned cylinders of the engine. The warm air passes through baffles and discharges above engine at rear of vehicle.

FUEL SYSTEM
Type - Petrol. Motor fuel 80 octane rating or better.
Tank Capacity - Total - 146 gallons. Four fuel tanks, each having separate shut-off valve.
Location - Two V-tanks front corner engine compartment. Two H-tanks on each sponson in engine compartment.
Feed - Fuel flows from the tanks to central header, drawn through strainer by fuel pressure pump to carburetor. A separate four-gallon fuel tank for auxiliary generator is attached to the sponson ceiling.
Fuel Cut-Off - Fuel can be cut off electrically at the carburetor by means of a toggle type switch on instrument panel. A Cuno type fuel filter is supplied.

CLUTCH
Make - Lipe
Type - Dry disc, built into engine fly-wheel.
2 discs, 1 drive plate 16", open type pressure springs
Method - Depressing clutch pedal compresses springs and frees engine power from propeller shaft. Releasing clutch pedal transmits power through propeller shaft to input shaft of gear box.

GEAR BOX
Type - Synchromesh
Ratio - First Gear - 7.56 : 1
Second Gear - 3.11 : 1
Third Gear - 1.79 : 1
Fourth Gear - 1.11 : 1
Fifth Gear - .73 : 1
Reverse Gear - 5.65 : 1
Lubrication - Oil circulated by small pump built into the transmission case. Oil drawn from transmission and differential sumps passing to oil cooler at rear of fighting compartment, returning to transmission and differential cases to lubricate the gears and bearings.

STEERING AND FINAL DRIVE -
Type - Controlled Differential
Ratio Bevel Gear - 3.53 : 1
At Sprocket - 9.88 : 1

STEERING CLUTCHES -
Location - On each side of bevel drive.
Type - Controlled Differential.
Incorporated in the controlled differential, on either side, is the steering device, each of which consists of a brake drum and brake shoe, actuated by a lever. When the speed of one brake drum is reduced by pressure of shoes, the speed of the other is increased.
Driver's seat on left of transmission.

STEERING BRAKES -
Band type controlled by steering levers.
Parking brake - Steering lever type controlled by foot pedal operating ratchet quadrants.
1-piece Final Drive equipped with Double Anchor type control brakes.
3-piece Final Drive equipped with Single Anchor type control brakes.

SPROCKETS
Location - At front
Number - Two twin driving sprockets (interchangeable)
The twin driving sprockets are bolted on each end of the detachable hub assemblies of the final drive shafts.

	Standard	C.D.P.
Diameter	27 9/32"	26 $\frac{1}{2}$"
Number of teeth	13	17
	(Teeth engage end connectors of track shoes)	(Teeth mesh on outboard lugs of track shoes)
Pitch	6"	4.6"

TRACKS

Type	(T54E1, T49, A.S.F.)	C.D.P.
No. shoes per strand	79	103
Tread (centre to centre)	83"	83"
Width of track	16$\frac{1}{2}$"	16$\frac{1}{2}$"
Length of track (ground)	147"	147"

SUSPENSION
Type - Vertical volute springs. Suspension brackets bolted to lower hull bottom and side plates provide upper seats for the volute springs to react on the bogie wheel lever arms and rubber-tired bogie wheels which run on the track.
Number - 3 bogie or suspension assemblies on each side of vehicle, 2 volute springs in each assembly.
Diameter of bogie wheels - 16"
Improved suspension units with stronger volute springs and offset top rollers.

TOP ROLLERS
One on each bogie assembly to support track. Roller bracket assembly is bolted to rear side of each bogie frame, the bracket having a spacer for the roller bearings. A track skid is bolted on top of the bogie frame.

TRACK ADJUSTING IDLER -
Type - Steel idler wheels, 22" diameter, eccentrically mounted on each side of vehicle, at the rear.
Adjustment - By turning hexagon end of spindle shaft, after spreading split housing and driving collar off serrations of spindle.

ELECTRICAL SYSTEM

Battery - Two 12-volt, 168 ampere hour storage batteries.

Generator - (Main) - 30-volt, 50 ampere, driven from main engine.

(Auxiliary) - 2-cycle, single cylinder, air-cooled petrol engine 30-volt, 50 ampere Homelite Model H.R.U.H.

Both generators have control boxes with voltage regulator, current limiter and reverse current relay with generator filter to reduce radio interference.

Starter - Direct electric starter, Eclipse type 617-1A, with hand starting attachment. Starter solenoid switch, Eclipse type 518-21A. Fuel cut-off solenoid, Eclipse type 500-15-A, operated by a toggle switch on the instrument panel.

Traverse Motor - Electric motor mounted on floor of turret basket, directly connected to hydraulic pump for the power traversing system. This same motor drives the gyro stabilizer pump.

Klixon Circuit Breakers.

MAJOR CHANGES INTRODUCED DURING PRODUCTION

Turret Exhaust Fan

Azimuth Indicator

New Turret Lock

Travelling Lock for Mount Combination Gun M34A1 incorporates remote control of the lock operated from the inside of the turret.

2 Brackets installed on engine bulkhead for Case Spare Valves and Spare Parts.

Gunner's Foot Rest.

1 M9 Elevation Quadrant with bracket.

Index Finger Firing Gear.

Commander's Traverse Control.

A Light, Instrument M32, for illuminating the Direct Sight Telescope M70F.

A Light, Instrument M30, for illuminating the M9 Elevation Quadrant.

Telescope Assembly Mount on 75 mm gun cradle.

Impulse Solenoid Relay and Harness Unit.

Periscope with new style reticle and instrument light for illuminating the reticle.

Gunner's Periscope Spring.

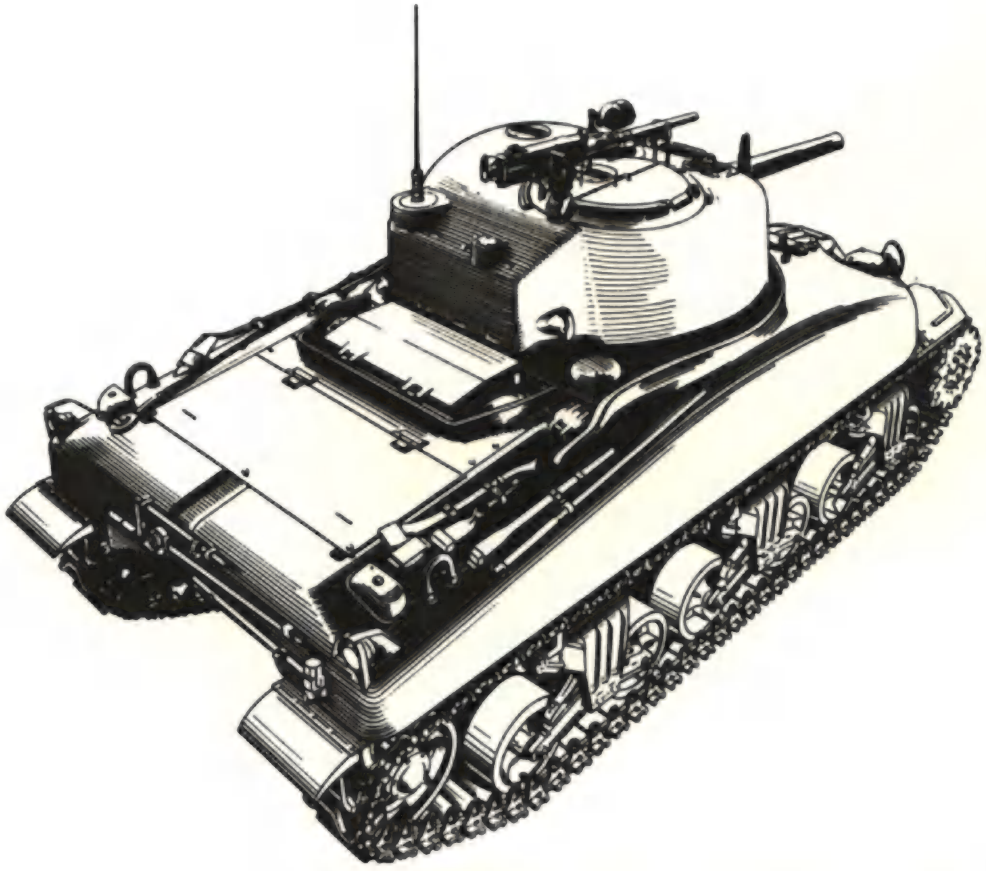
Reworking M19 Azimuth Indicator.

Oil Dilution Instruction Plate.

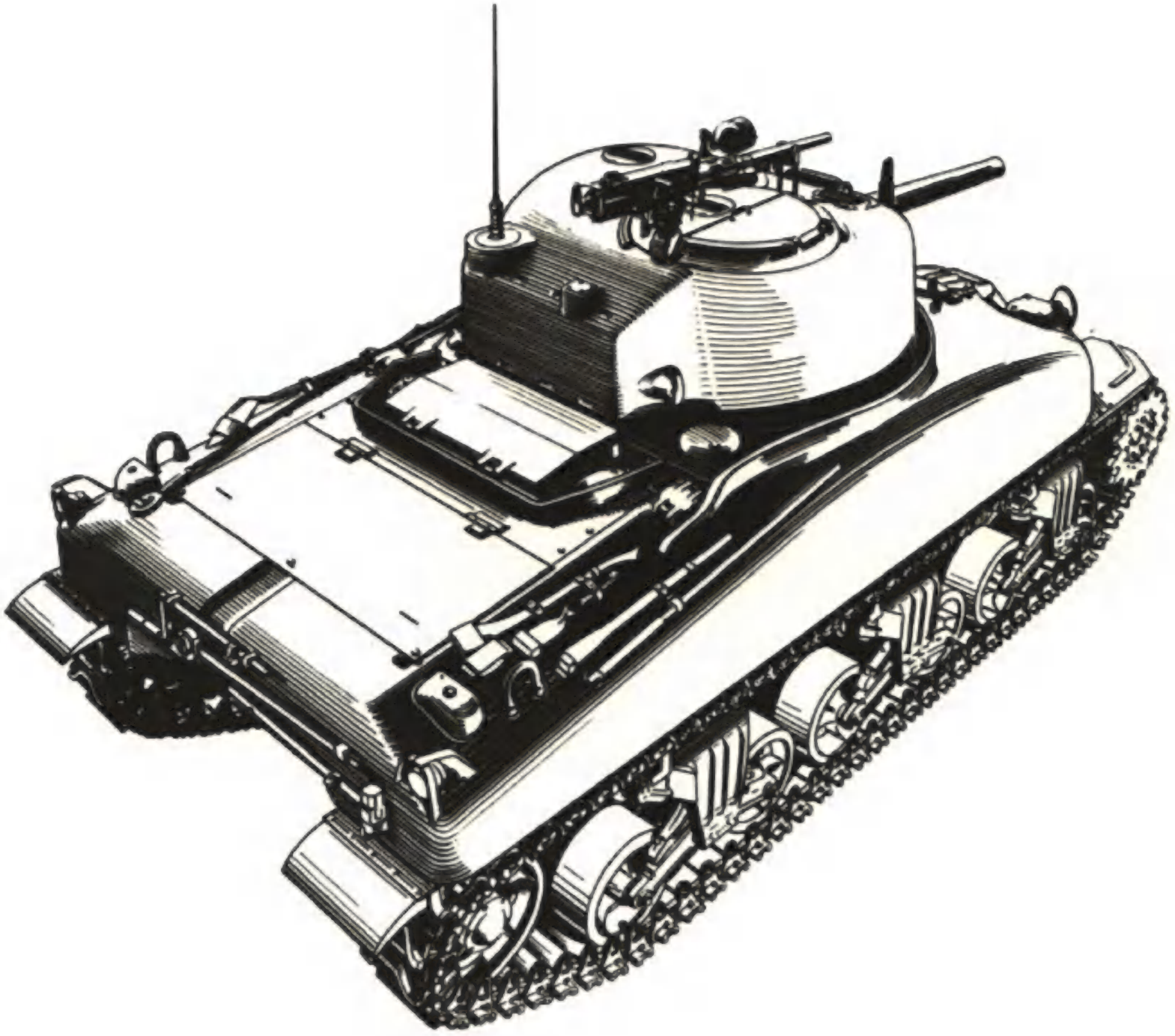
Clutch Dust Cowl.

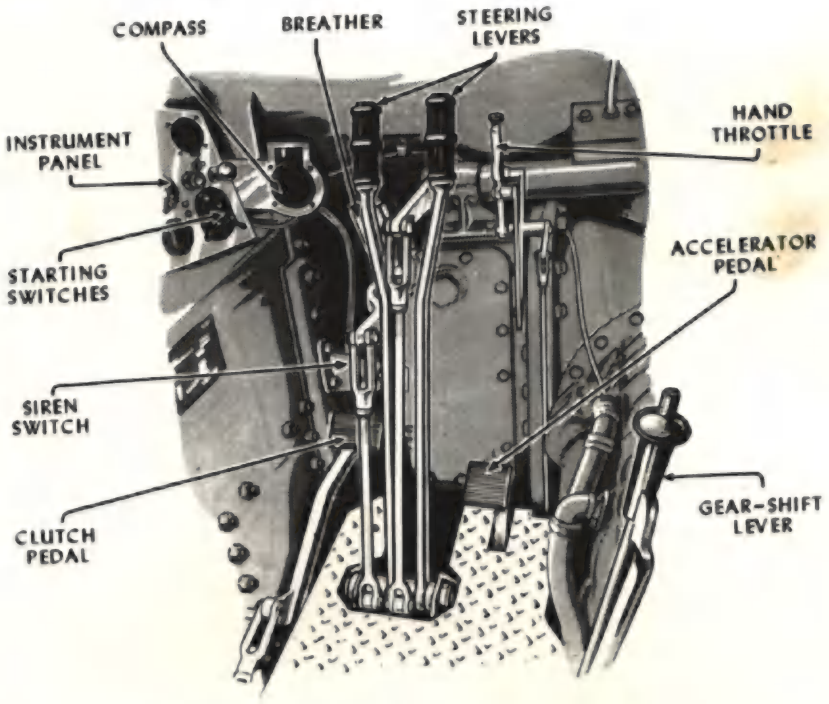
Reworking Engine Compartment Door Hinges.

Commander's 360° Vision Cupola.

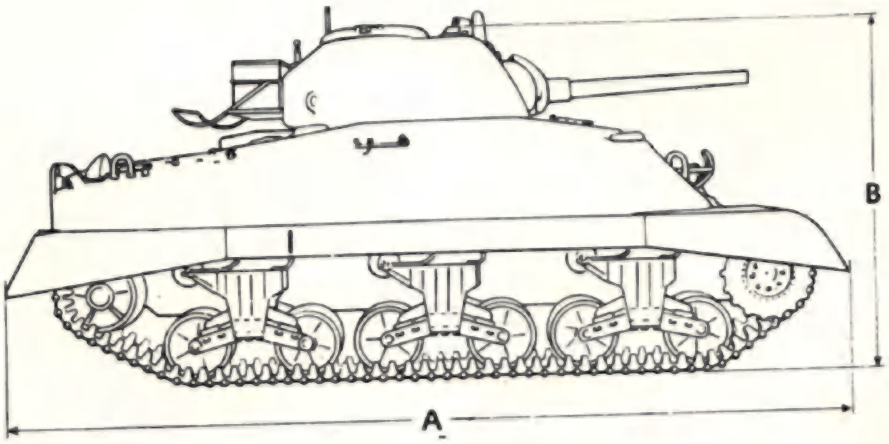


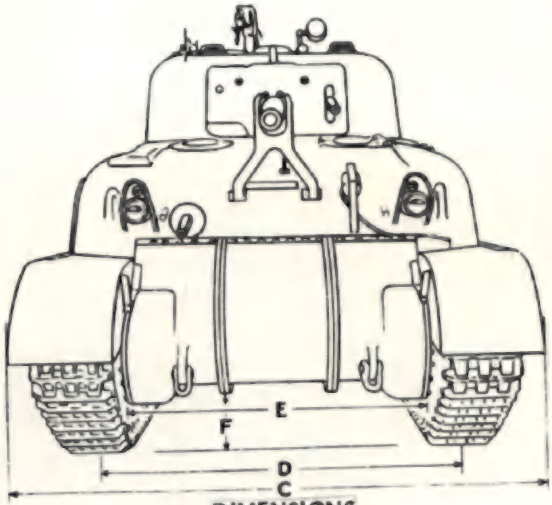
U.S. PROTOTYPE FOR CANADIAN BUILT GRIZZLY





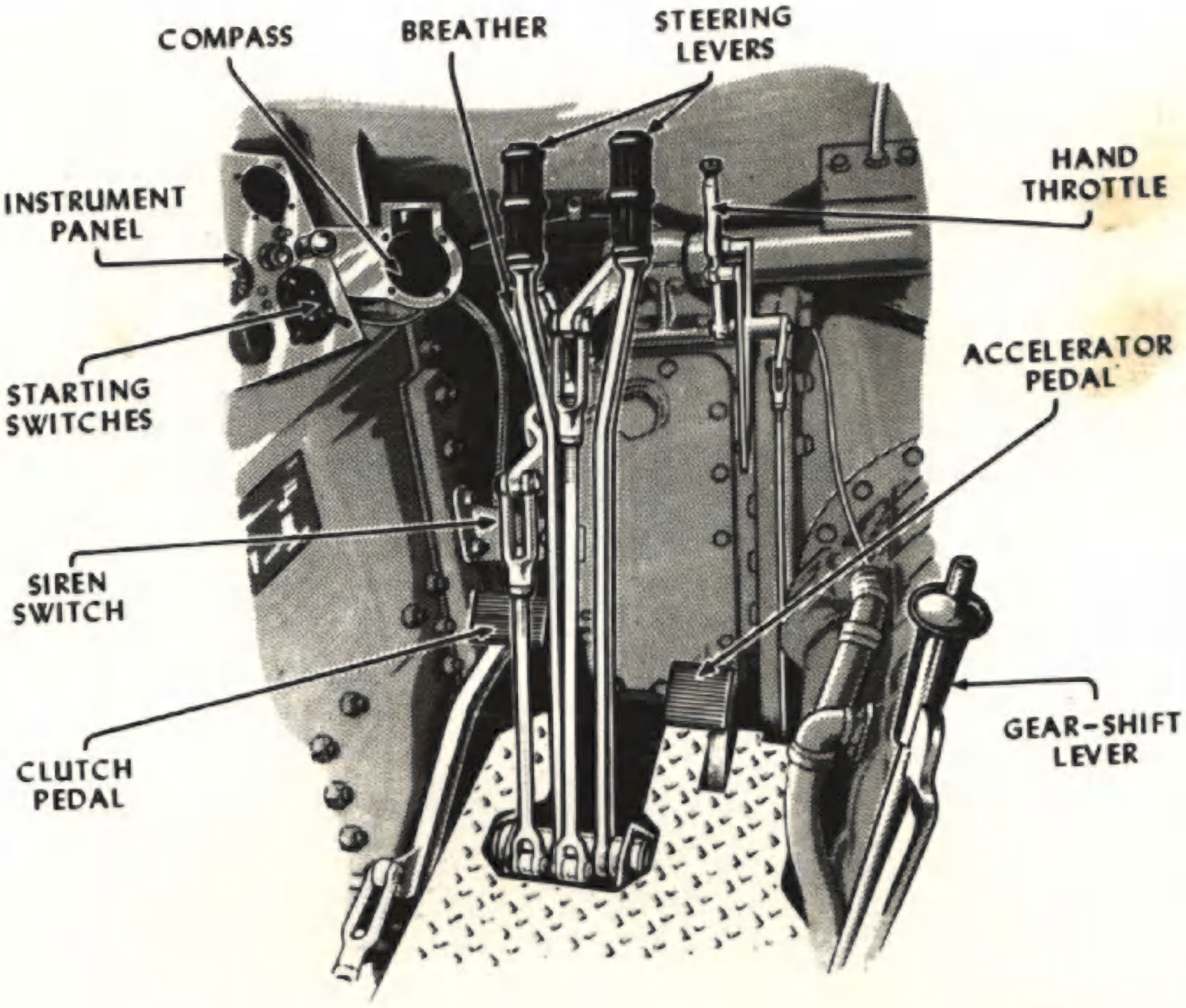
CONTROLS - DRIVER'S COMPARTMENT

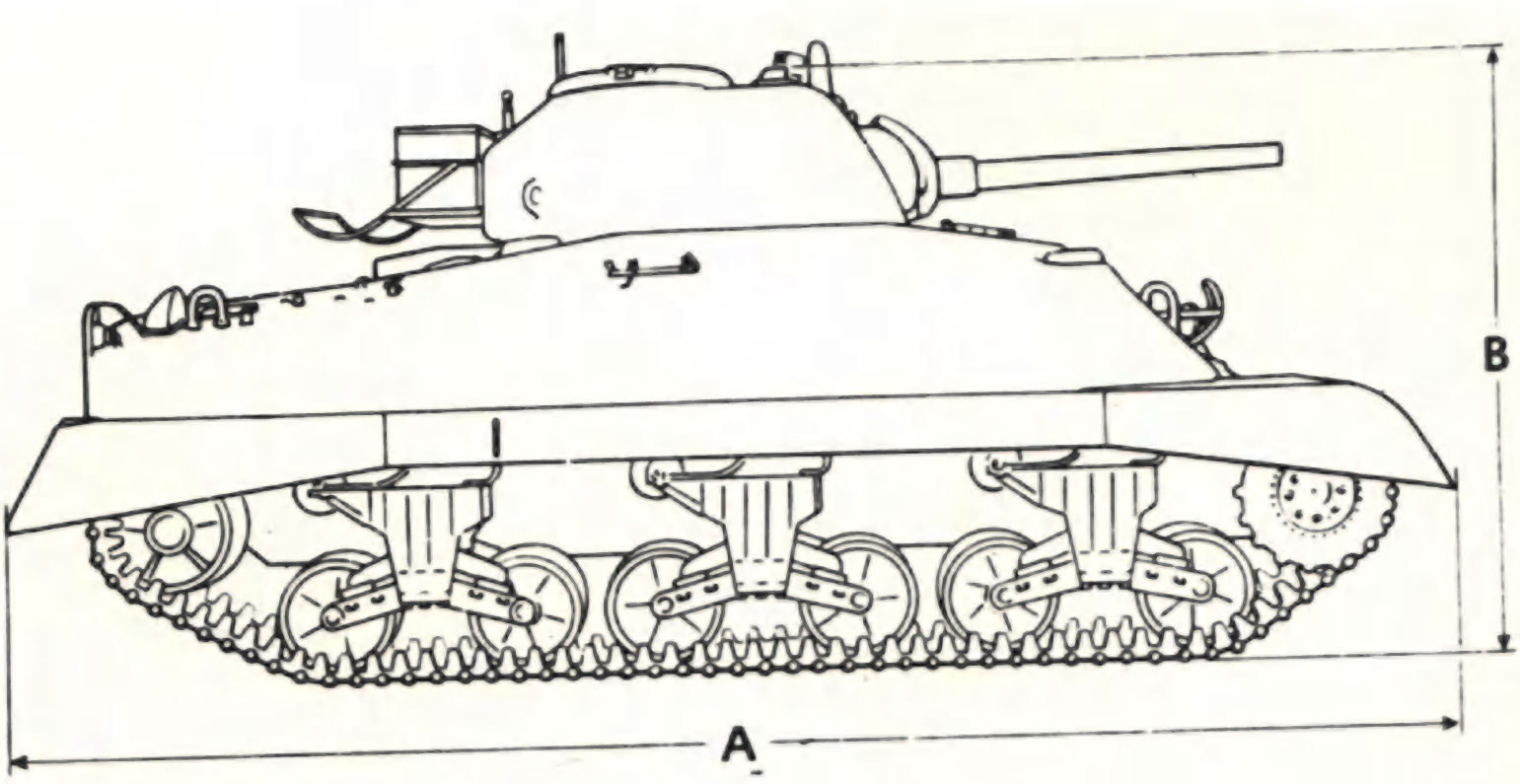


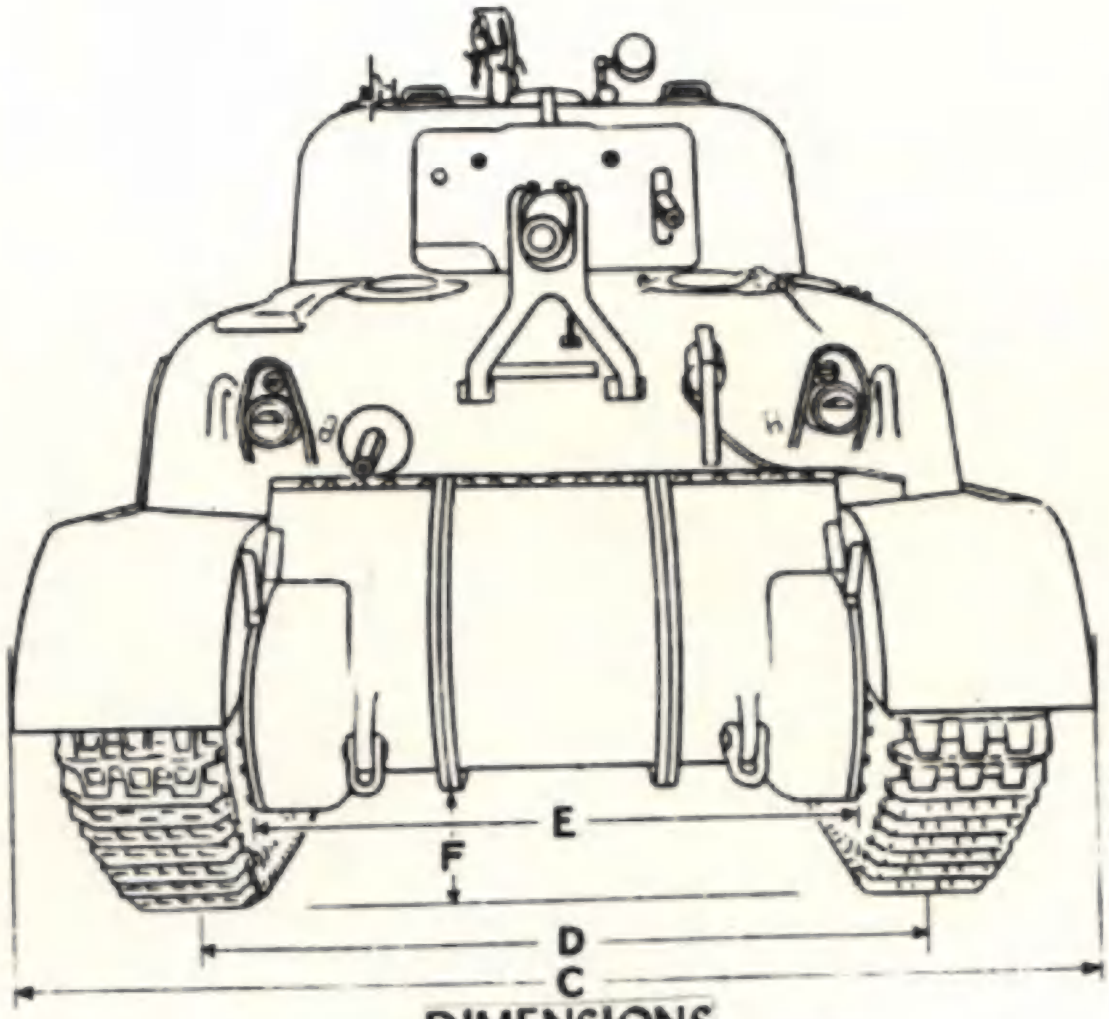


DIMENSIONS

★A	B	C	D	E	★F
LENGTH OVERALL	HEIGHT OVERALL	WIDTH OVERALL	TRACK CENTRES	LOWER HULL WIDTH	GROUND CLEARANCE
20' 1"	9' 10"	8' 8"	6' 11"	5' 3"	17"
★A - WITHOUT SAND SHIELDS 19' 1" (FROM REAR MUD GUARD TO FRONT SPROCKET)					
★F - WITH ONE PIECE FINAL DRIVE 18-5/16"					


COMPASS
BREATHER
STEERING LEVERS
HAND THROTTLE
INSTRUMENT PANEL
STARTING SWITCHES
ACCELERATOR PEDAL
SIREN SWITCH
CLUTCH PEDAL
GEAR-SHIFT LEVER


B
A



DIMENSIONS

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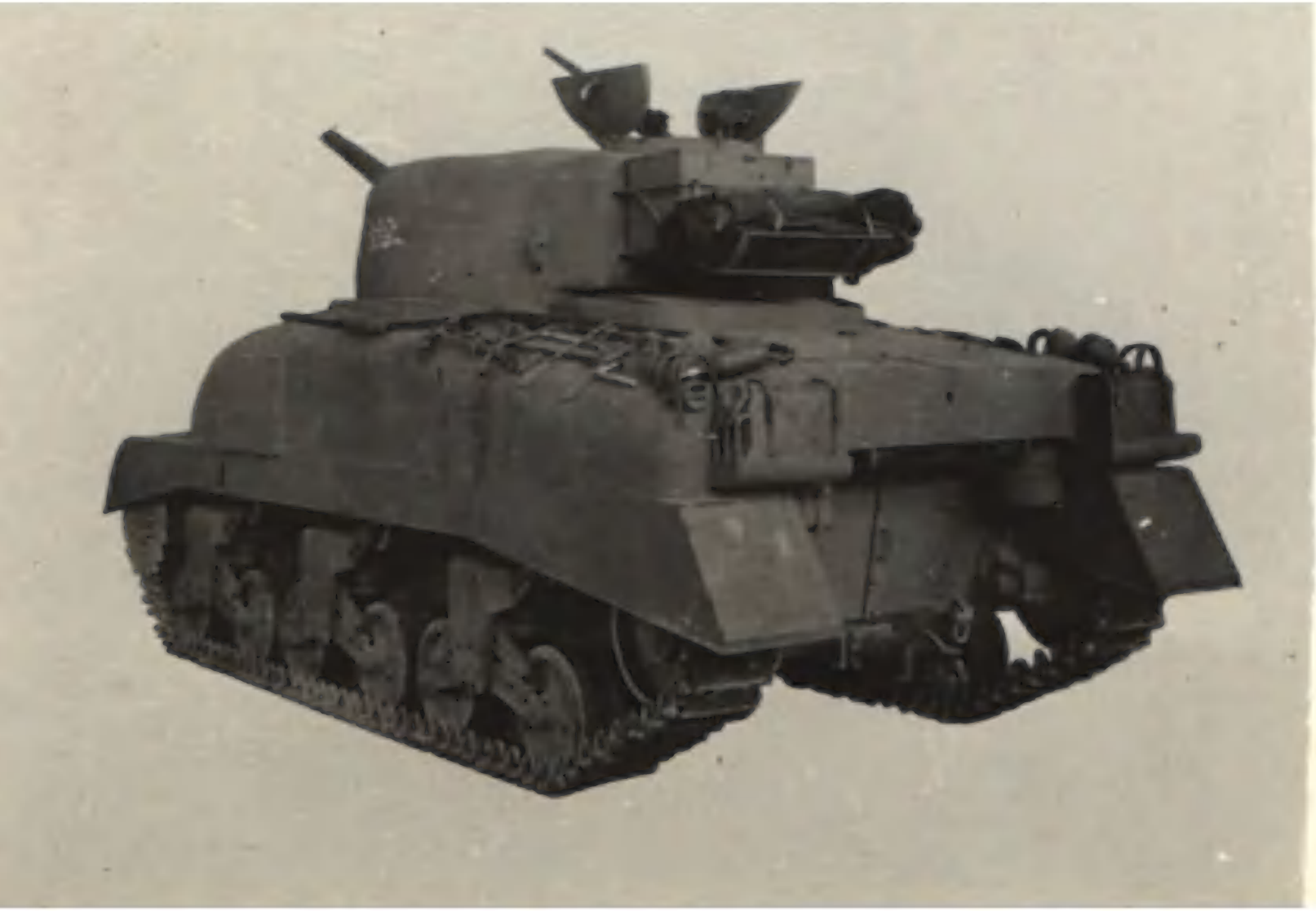
★A – WITHOUT SAND SHIELDS 19' 1"
(FROM REAR MUD GUARD TO FRONT SPROCKET)

★F – WITH ONE PIECE FINAL DRIVE 18-5/16"

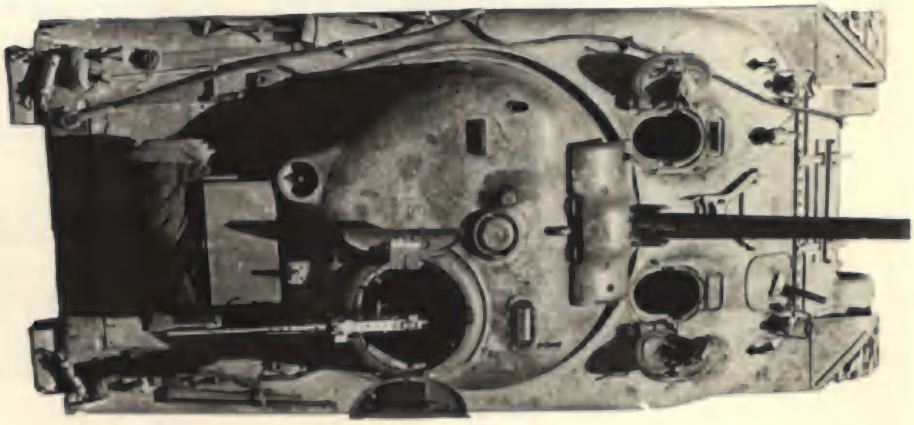
3/4 RIGHT FRONT VIEW
Showing 75 mm. gun at maximum elevation with co-axial mounted .30 calibre machine gun also .30 bow machine gun. The .50 calibre machine gun used for anti-aircraft is shown mounted on the turret hatch ring

FRONT VIEW
Showing all crew hatches open and travelling lock on front of hull casting to secure 75 mm. during routine movement.

3/4 LEFT REAR VIEW
Showing commander's hatch open, blanket box and camouflage net stowed at rear of turret and jerricans on rear hull plate.

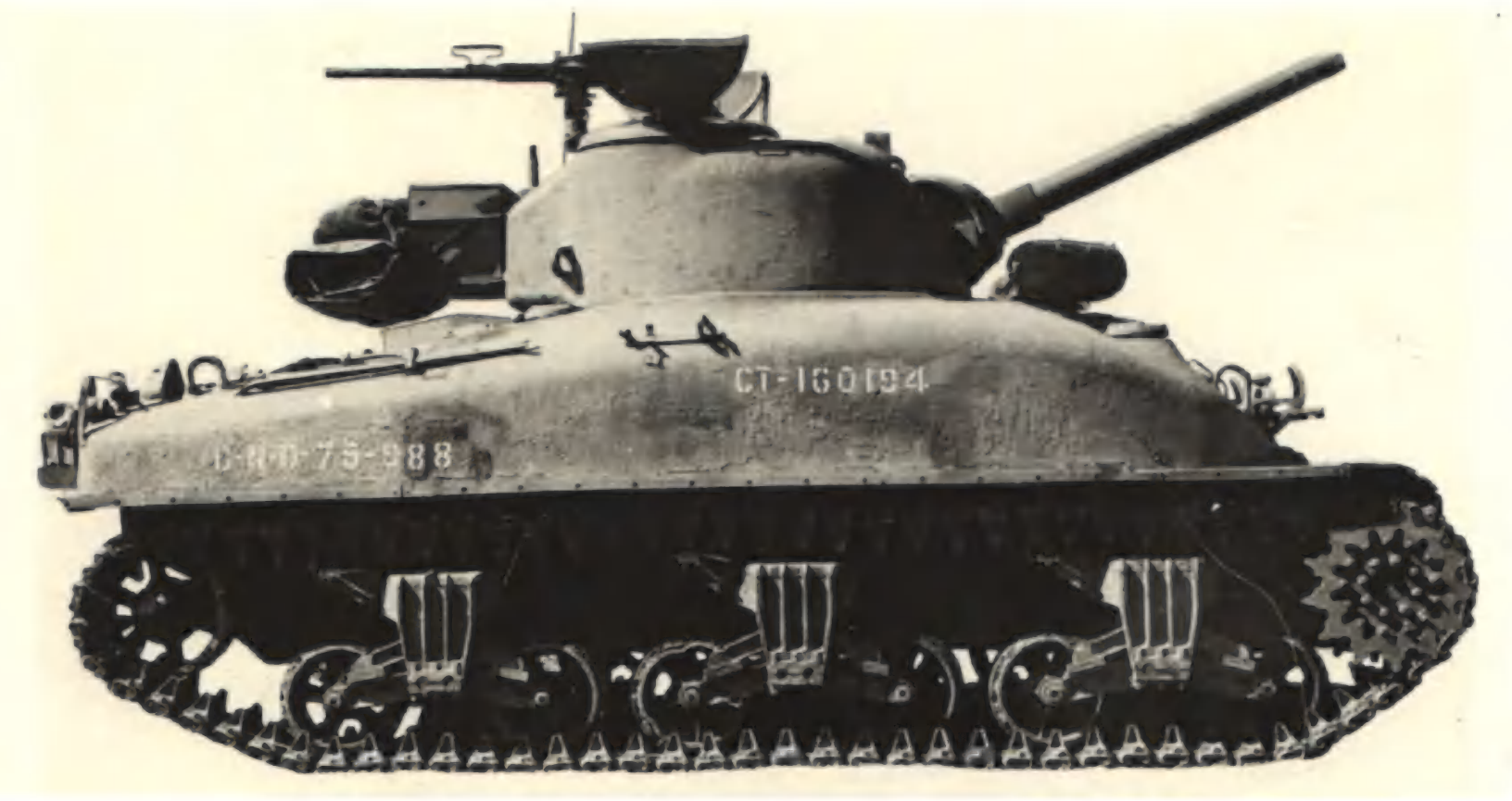


RIGHT SIDE VIEW(TRACK GUARD REMOVED)-Showing track and suspension arrange -ment.



PLAN VIEW-Showing all hatches onen, arrangement of turret periscopes and ventilator, aerial bases at rear of turret and general stowage arrangement of ancillary equipment.

REAR VIEW-Showing general stowage arrangement at rear of turret and rear deck also .50 calibre anti-aircraft gun in position.


CT-160194
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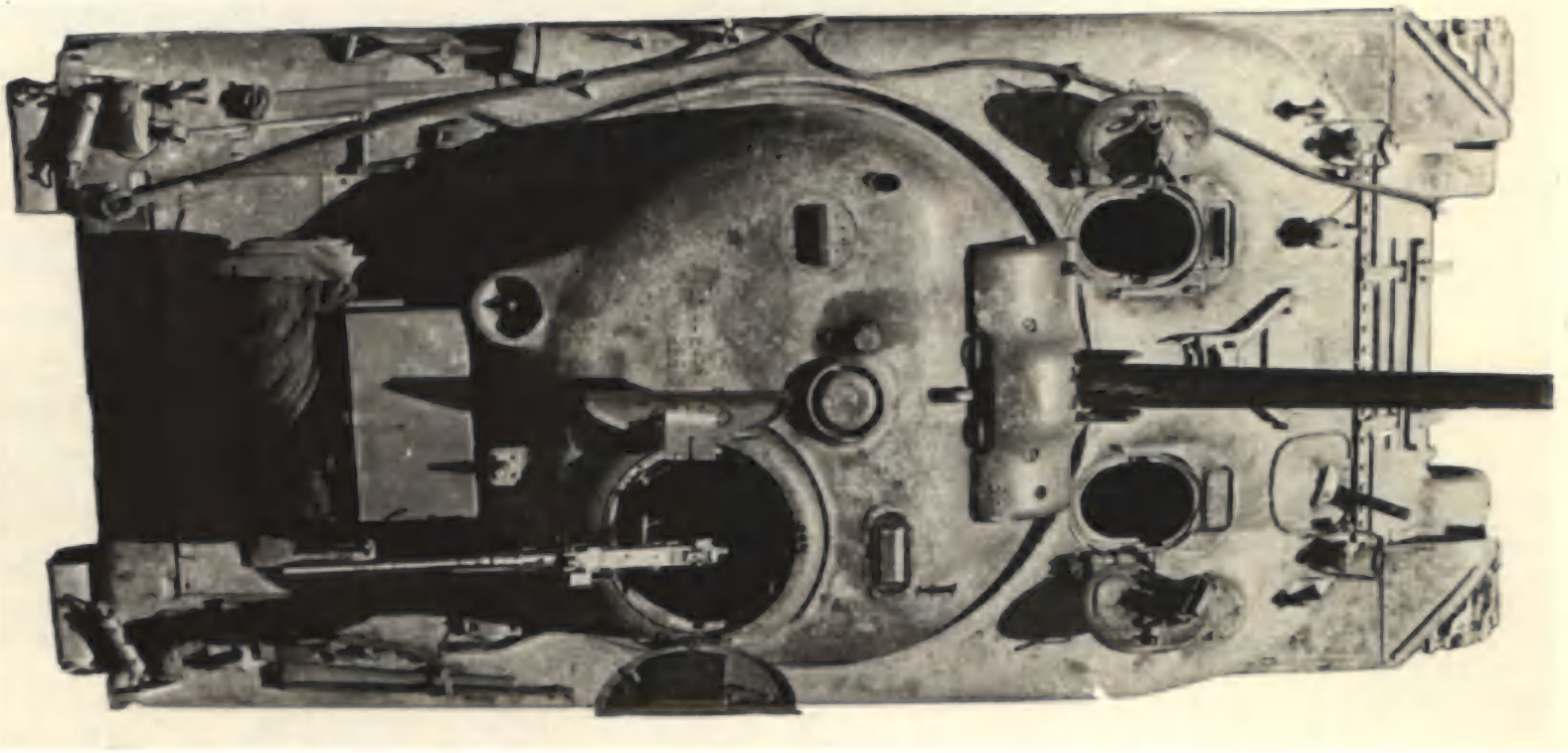


REFERENCES

D.T.D. Specification No. O.A. 213.

M4A1 Tank (Grizzly I) Illustrated Parts Catalogue, July 1943.

Data Book - Tank Type Vehicle of Canadian Manufacture, January 1944 - Publication number M&S.1877.

U.S.A. War Department Technical Manuals:

TM9 - 731A - Medium Tanks M4 and M4A1, December 1943.

TM9 - 1731G - Hydraulic Traversing Mechanism (Oilgear) for Medium Tanks M4 and Modifications, May 1943.

TM9 - 1750 - Power Train Unit, Three-piece Differential Case, for Medium Tanks M4 and Modifications, March 1942.

TM9 - 1751 - 9, Cylinder, Radial, Gasoline Engine (Continental Model R975-C1) April 1944.

Files Series
D.M.S. - 73-7-1, 2, 3, 4, etc.
D.N.D. - H.Q.S. 3352-58.
D.M.S. - D.A.D. Photo File No. T-6.

Design Change Advices:
Grizzly I, D.C.A. No. 1 to D.C.A. No.21.

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

E. 245 - Steel Bogie Wheels

E. 253 - C.D.P. Track Peening.

E. 267 - Production Track Shoes, Electric Steel.

E. 322 - Electric Steel Track Shoe Salvage Investigation.

E. 342 - Comparison Test, Rubber Block and T54E1.

E. 347 - Reliability of C.D.P.Track Pins, Inspected by Dr. Drury.

E. 368 - Efficiency of C.D.P.Track Operating in Snow and on Ice.

E. 388 - Hollebone Draw Bar.

E. 496 - Resistance to Skidding.

E. 527 - Heating Crew Compartment.

Firing Trial Reports:

Proof Test No. V.352 - Valcartier Artillery Proof Establishment Report of Firing Trial Against M4 Hull (Lower) as welded by General Motors Products of Canada, August 1943.

Proof Test No. V.396 - Valcartier Artillery Proof Establishment Report of Firing Trial Against M4 Hull (Lower) as welded by General Motors Products of Canada, August 1943.

D.V.A. Reports:

Project D.V.A. 6 - 413

Project D.V.A. 6 - 415

Production Orders:

C.D. - L.V. 558 188

Approx. Price per unit - less equipment supplied by Ordnance $60,000.

TANK, COMMAND/O.P.

TANK, COMMAND/O.P.

This is a Ram Tank modified to serve as a Command Vehicle or an Armoured Observation Post.

For tactical purposes in this role it provides maximum protected observation and interior unrestricted space for command purposes. Additional wireless and line communication equipment is provided, two (2) #19 sets being mounted and a #58 set carried. Provision is also made for mounting artillery observation equipment and the rotating hatch is calibrated so that the hatch periscope can be used as a direction-finder. A dummy main gun is mounted as camouflage. Browning Machine guns are carried in the bow and turret hatch for protection against enemy ground personnel and low-flying aircraft.

Mechanically, the vehicle is similar to the Ram Tanks, except for the deletion of the turret basket and power traverse equipment. Manual traverse is restricted to a total of 90°. The electrical system is completely rearranged to service adequately the additional W/T equipment.

Eighty-four vehicles were produced at the Tank Arsenal, Montreal Locomotive Works during 1943.

This vehicle was developed and piloted by Army Engineering Design Branch at the request of the Canadian Army Overseas and was released for production on their acceptance.

The major design work was involved in fitting the second #19 W/T set and arranging adequate electrical supply, comprising extra batteries and rather complicated wiring and switching arrangements.

Elimination of the turret basket, gun and power traverse gear and restriction of the turret traverse to 90° made the hull sufficiently roomy to allow satisfactory seating of the command staff as well as the installation of the necessary seats and tables.

Considerable modification was necessary in order to mount the dummy gun. A forward observation post was positioned in the turret, requiring complete rearrangement of all turret stowage.

No new production problems were involved beyond those of introducing a non-standard vehicle into a full production line.

The Canadian built Command/OP Tanks were used with success in action in North West Europe, and it is understood that further Ram Tanks were modified in United Kingdom to this type.

TANK, COMMAND/O.P.

Tactical Data

PRODUCED BY - Montreal Locomotive Works
Tank Arsenal, Montreal.

PRODUCTION
Commenced - During 1943
Finished - 1943

VEHICLES PRODUCED - 84

SERIES - Tank Command/O.P.

TYPE - Armoured Observation Post (O/P) or Command Vehicle

BRIDGE CLASSIFICATION - 30

CREW 6

ARMOUR - Turret - Front - 3"
Rear - 2½"
Side - 3" - 2½"
Top - 1"
- Hull - Front - 3" - 2"
Rear - 1½"
Side - 2½"-1½"
Top - 1½"- 1"
Bottom - 1" (front)
½" (rear)

TURRET - One-piece armour steel casting. 60" Ring.
Gun accessories and basket eliminated.
Hatch with two-piece covers, latch and lock.
Hatch ring for A.A. gun mount.
Pistol port.
Turret hatch graduated underneath in degrees for use in conjunction with an azimuth scale around the commander's periscope for rough angle measurements.

TRAVERSE - Hand 45° in either direction.

GUN MOUNTS - Dummy gun in place of actual 6-pr.
Bow (left)
Ball and socket mount in front hull.
Turret Hatch. A.A. Bracket mount.
Elevation (by hand) 60°
Depression 7½°

ARMAMENT - Main nil
- Browning, cal. .30 M.G. M1919A4
1 (flexible type) in ball and socket mount, left bow, (2000 rds)
1 (A.A.) for mounting in turret hatch ring (440 rds. in 110 round reels)
- Thompson, cal. 45 S.M.G. (440-20 rd. mag.)
2 carried, not mounted
- Bomb Thrower 2" Mk. I Smoke (43 rds)
- Signal Pistol 1" (20 cartridges)
- Hand Grenades No. 36 Mk.I (6rds.)

SIGHTING - 6 Periscopes, Vickers type.
1 Telescope, Steroscopic No. 1B Mk. I, stored in turret for mounting on the arti air-craft gun mount (For use as periscope or as an artillery observation instrument).
Special Observation Post with sliding door type cover is provided under dummy 6-pr. gun.

PROTECTED VISION - 1 Protectoscope, indirect vision on driver's door, mounted in rotor.
Periscopes, Vickers type.
2 - Commander (turret hatch), one with graduated azimuth scale.
2 - Turret Roof (for general use)
2 - Driver and Co-driver.

COMMUNICATION - 2 Sets No. 19 W/S.
One in turret, one in hull.
2 Cables on drums for remote telephone.

COMPASS - Pioneer 1830 Compass mounted on turret roof in (interior) front of Commander.

LIGHTING - 2 Head lamps.
2 Tail lamps and 1 Convoy lamp.
2 Side lamps.

GENERAL - Map and Record boards.

ESCAPE HATCH - In hull floor.

PERFORMANCE DATA

POWER/WEIGHT - Net power to gross weight ratio 12.5 B.H.P. per short ton.

GROUND PRESSURE - 12.9 p.s.i.
(13.8 p.s.i. in C.D.P. track).

GROUND CLEARANCE - 17".

GRADABILITY - Theoretical in 1st. gear -
30° Ascending.
30° Descending.

MINIMUM TURNING RADIUS - 31'

SPEED, MAXIMUM - 25 m.p.h.

TRENCH CROSSING ABILITY - 7' 5".

VERTICAL OBSTACLE CLIMBING - 18".

FORDING DEPTH - At slow speed - 36".

CRUISING RANGE - Highway - 144 miles
(8 hours @ 18 m.p.h.)

FUEL CONSUMPTION -.90 m.p.h.

OIL CONSUMPTION - 1.65 q.p.h.

LADEN WEIGHT - 64,000 lbs.

OVERALL DIMENSIONS
Length - 19' 0"
Width - 9' 1"
Height - 9' 0"

CENTRE OF GRAVITY - 49" (from ground)

ENGINE
Location - At rear.
Make - Continental Motors Corp.
Model - R975-C1
Type - Static Radial air cooled 4-cycle petrol, 9-cylinder.
Displacement - 973 cu. ins.
Peak Gross B.H.P. - 400 @ 2400 r.p.m.
Torque - Max. 890 ft/lbs. @ 1800 r.p.m.
Lubrication - Engine oil tank capacity - 30 qts. Oil drawn from oil tank by gear type pressure pump divied into two sections : - a separate pressure pump delivering oil to all bearings and parts: a scavenge pump returning the oil from the sump through oil filter to oil cooler and oil tank. The oil pump incorporates a pressure relief valve.
Ignition - Two magnetos. (Scintilla-Bendix or Bosch type).
Priming Pump - To facilitate starting engine.
Air Cleaners - Type - Oil bath. Number - Two(at rear of engine compartment).

COOLING SYSTEM - Type - Air-cooled. A fan mounted on engine fly-wheel rotates in a shroud, drawing air through a grill in top upper hull and forcing it between and around the finned cylinders of engine. The warm air passes through baffles and discharges above engine doors at rear of vehicle.

FUEL SYSTEM
Type - Petrol. Commercial Motor fuel with an octane rating of 80 or better.
Tank Capacity - Total - 146 gallons. Four fuel tanks, each having separate shut-off valve.
Location - Two V-tanks front corners engine compartment. Two H-tanks on each sponson in engine compartment.
Feed - Fuel flows from the tanks to central header, drawn through strainer by fuel pressure pump to carburetor. A separate two-gallon fuel tank for auxiliary generator is located in sponson. The C1 engine incorporates a diaphragm type fuel pump which maintains a constant pressure thus avoiding need of relief valve.
Fuel Cut-Off - Fuel can be cut off electrically at the carburetor by means of a toggle type switch on instrument panel.

CLUTCH
Make - Lipe
Type - Dry disc, built into engine fly-wheel. 2 discs, 1 drive plate 16", oper type pressure springs
Method - Depressing clutch pedal compresses springs and frees engine power from propeller Shaft. Releasing clutch pedal transmits power through propeller shaft to input shaft of gear box.

GEAR BOX - Make - Crash
Type - Synchromesh
Ratio - First Gear - 7.56 : 1
Second Gear - 3.11 : 1
Third Gear - 1.79 : 1
Fourth Gear - 1.11 : 1
Fifth Gear - .73 : 1
Reverse Gear - 5.65 : 1
Lubrication - Oil circulated by small pump built into the transmission case. Oil drawn from transmission and differential sumps passing to oil cooler at rear of fighting compartment, returning to transmission and differential cases to lubricate the gears and bearings.

STEERING AND FINAL DRIVE -
Type - Controlled Differential
Ratio Bevel Gear - 3.53 : 1
At Sprocket - 9.88 : 1

STEERING CLUTCHES
Location - On each side of bevel drive
Type - Controlled Differential
Incorporated in the controlled differential, on either side, is the steering device, each of which consists of a brake drum and brake shoe, actuated by a lever. When the speed of one brake drum is reduced by pressure of shoes, the speed of the other is increased.
Driver's seat on right of transmission.

STEERING BRAKES

Band type controlled by steering levers.

Parking brake - Transmission type.

SPROCKETS
Location - At front
Number - Two twin driving sprockets (interchangeable)
The twin driving sprockets are bolted on each end of the detachable hub assemblies of the final drive shafts.

	Standard	C.D.P.
Diameter	27 9/32"	26 5/8"
Number of teeth	13 (Teeth engage end connectors of track shoes)	17 (Teeth mesh on outboard luge of track shoes)
Pitch	6"	4.6"

TRACKS

Type	(T54E1,T49, A.S.F.)	(C.D.P.)
No. shoes per strand	79	103
Tread(centre to centre)	83"	83"
Width of track	16½"	16½"
Length of track(ground)	147"	147"

SUSPENSION
Type - Vertical volute springs. Suspension brackets bolted to lower hull bottom and side plates provide upper seats for the volute springs to react on the bogie wheel lever arms and rubber-tired bogie wheels which run on the track.
Number - 3 bogie or suspension assemblies on each side of vehicle, 2 volute springs in each assembly.
Diameter of bogie wheels - 16"
Improved suspension units with stronger volute springs and offset top rollers.

TOP ROLLERS
One on each bogie assembly to support track. Roller bracket assembly is bolted to rear side of each bogie frame, the bracket having a spacer for the roller bearings. A track skid is bolted on top of the bogie frame.

TRACK ADJUSTING IDLER -
Type - Steel idler wheels, 22" diameter, eccentrically mounted on each side of vehicle, at the rear.
Adjustment - By turning hexagon end of spindle shaft, after spreading split housing and driving collar off serrations of spindle.

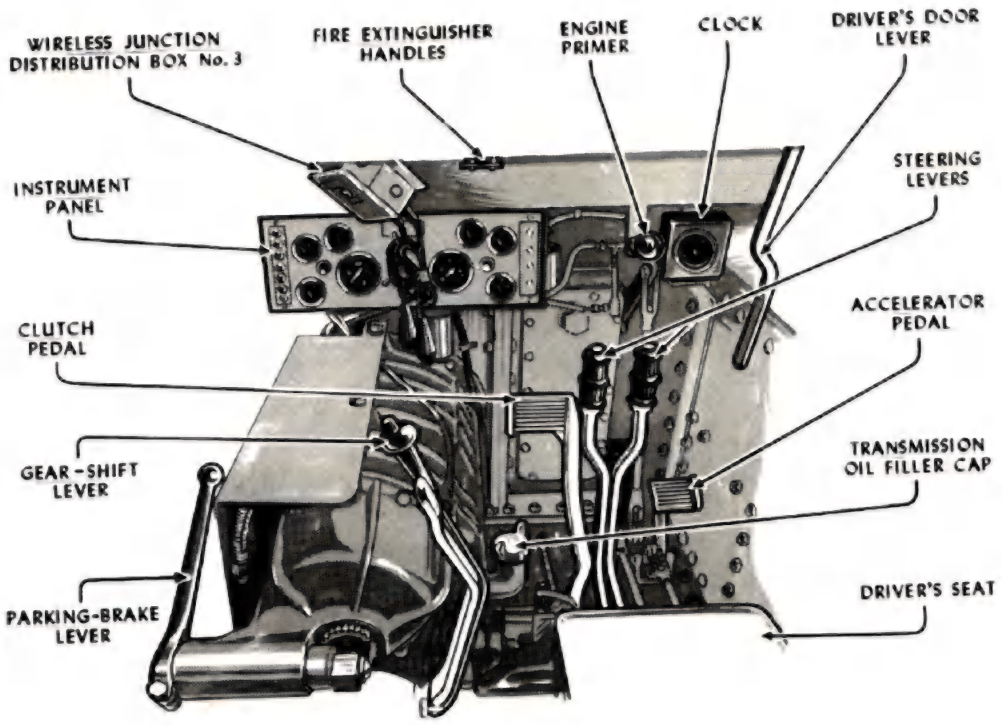
ELECTRICAL SYSTEM - 24-volt system.
Battery - Two 12-volt, 168 ampere hour storage batteries.
Two banks of 6-volt batteries on floor for wireless set.
Generator (Main) - 30-volt, 50-ampere, driven from main engine.
(Auxiliary) - 2-cycle, single cylinder, air-cooled petrol engine, 30-volt, 50-ampere Homelite Model H.R.U.H. for charging any of the three banks of batteries.
Both generators have control boxes with voltage regulator, current limiter and reverse current relay with generator filter to reduce ratio interference.

Starter - Direct electric starter, Eclipse type 817-1A, with hand attachment.

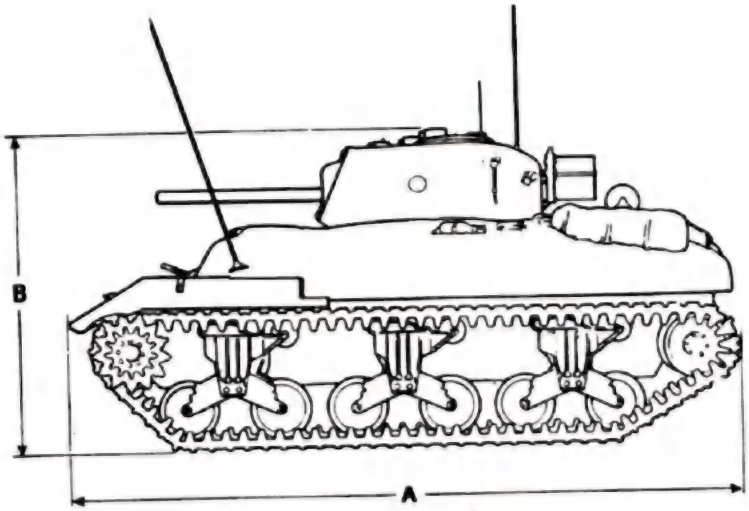
Starter solenoid switch, Eclipse type 518-21-A.

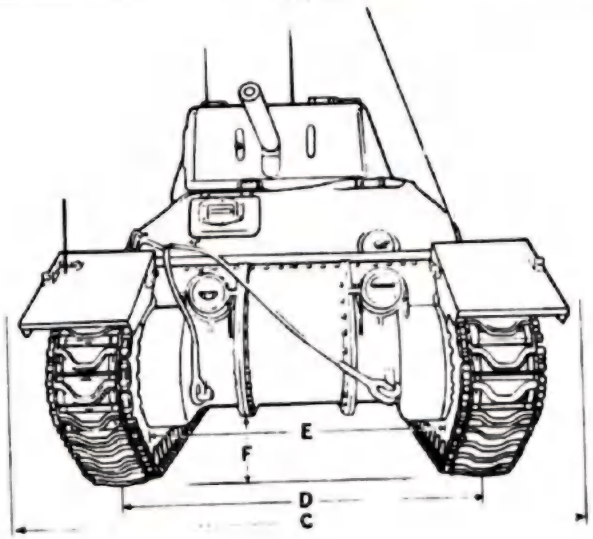
Fuel cut-off solenoid, Eclipse type 500-15-A. operated by a toggle switch on the instrument panel.

Klixon Circuit Breakers.



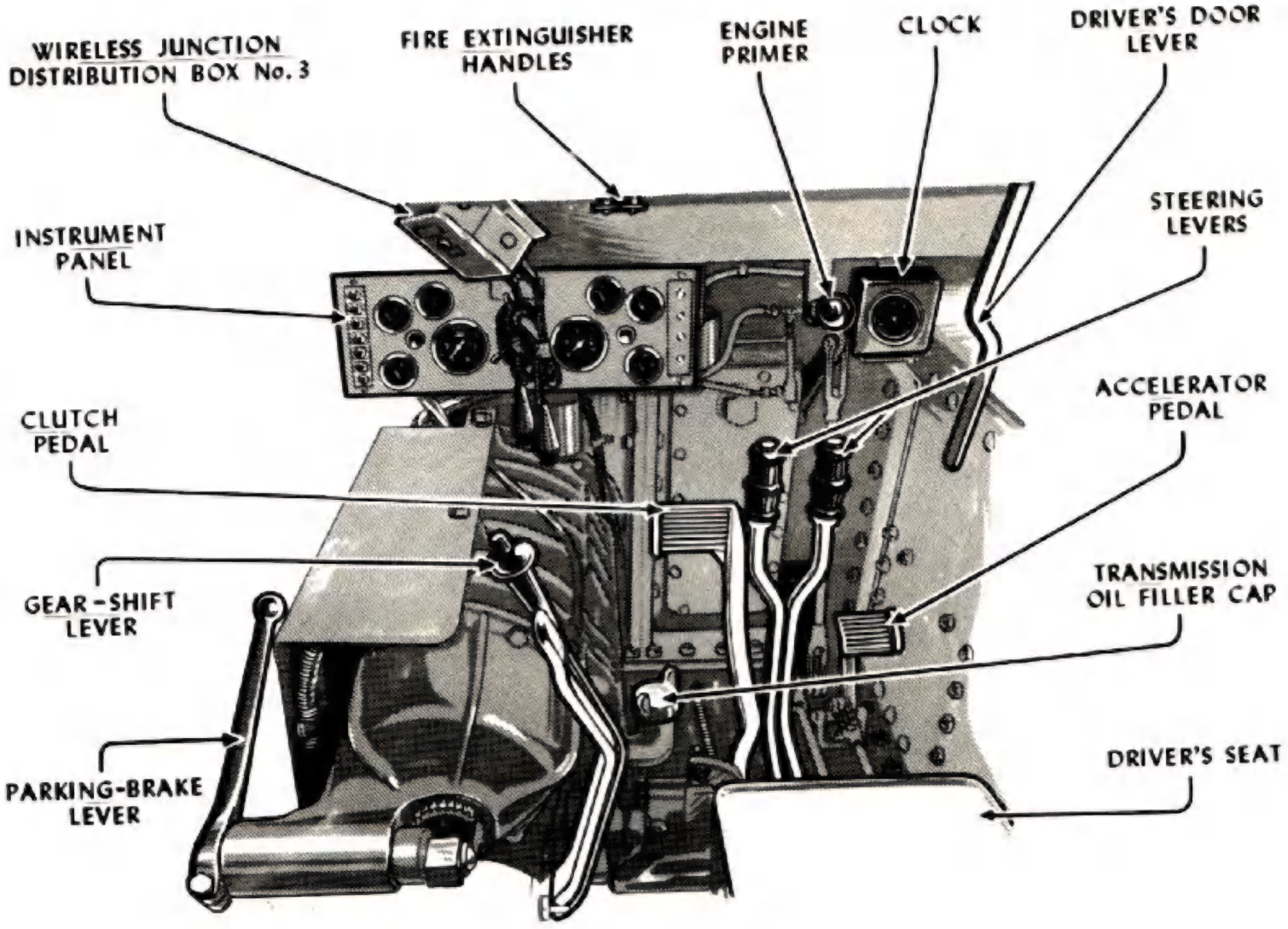
CONTROLS - DRIVER'S COMPARTMENT

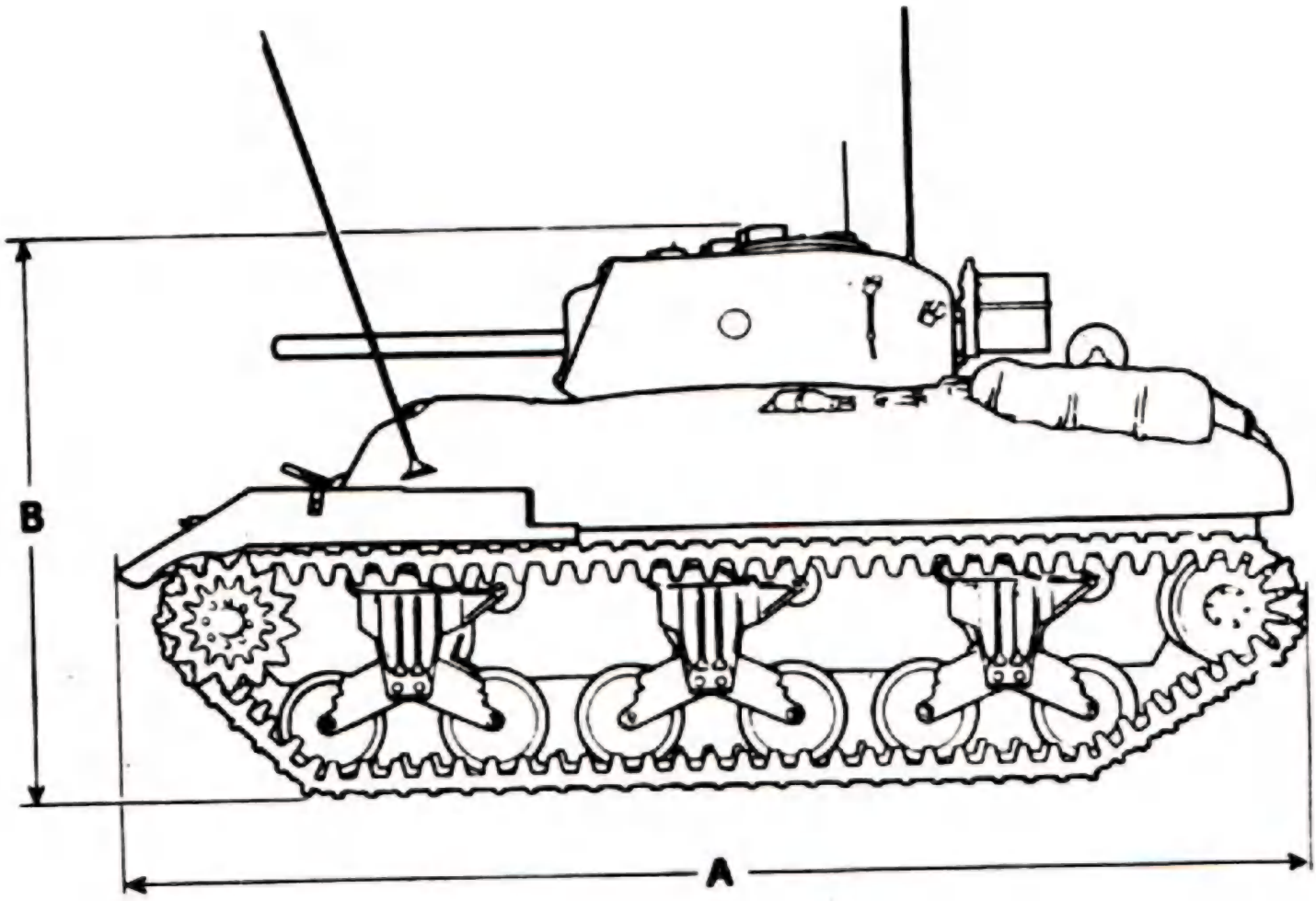




DIMENSIONS

A	B	C	D	E	*F
LENGTH OVERALL	HEIGHT OVERALL	WIDTH OVERALL	TRACK CENTRES	LOWER HULL WIDTH	GROUND CLEARANCE
19'0"	9'0"	9'1"	6'11"	5'3"	17"
*F - WITH ONE-PIECE FINAL DRIVE 18-5/16"					


WIRELESS JUNCTION DISTRIBUTION BOX No. 3
FIRE EXTINGUISHER HANDLES
ENGINE PRIMER
CLOCK
DRIVER'S DOOR LEVER
INSTRUMENT PANEL
STEERING LEVERS
ACCELERATOR PEDAL
CLUTCH PEDAL
TRANSMISSION OIL FILLER CAP
GEAR-SHIFT LEVER
DRIVER'S SEAT
PARKING-BRAKE LEVER


B
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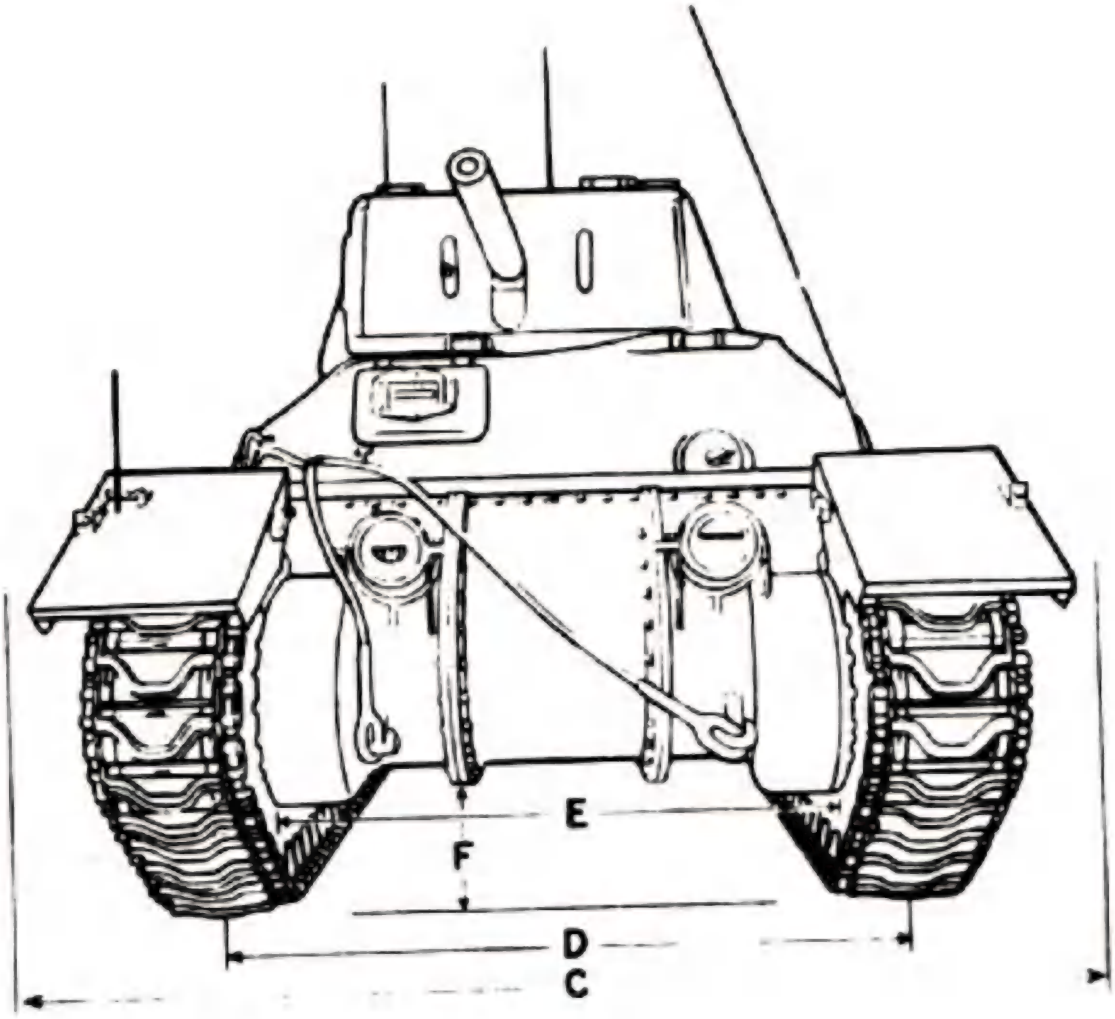

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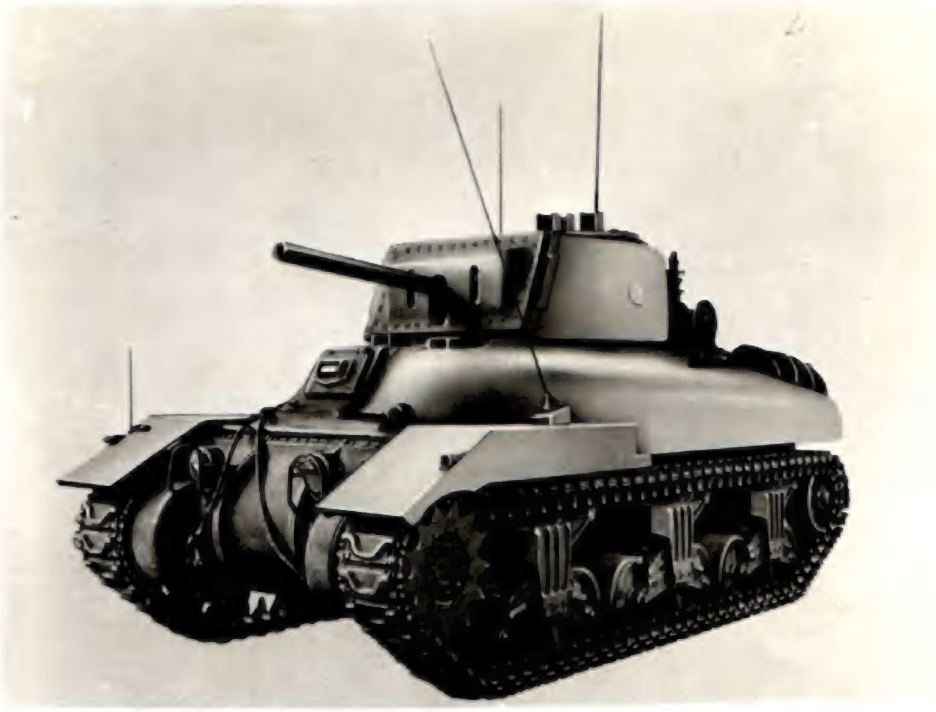
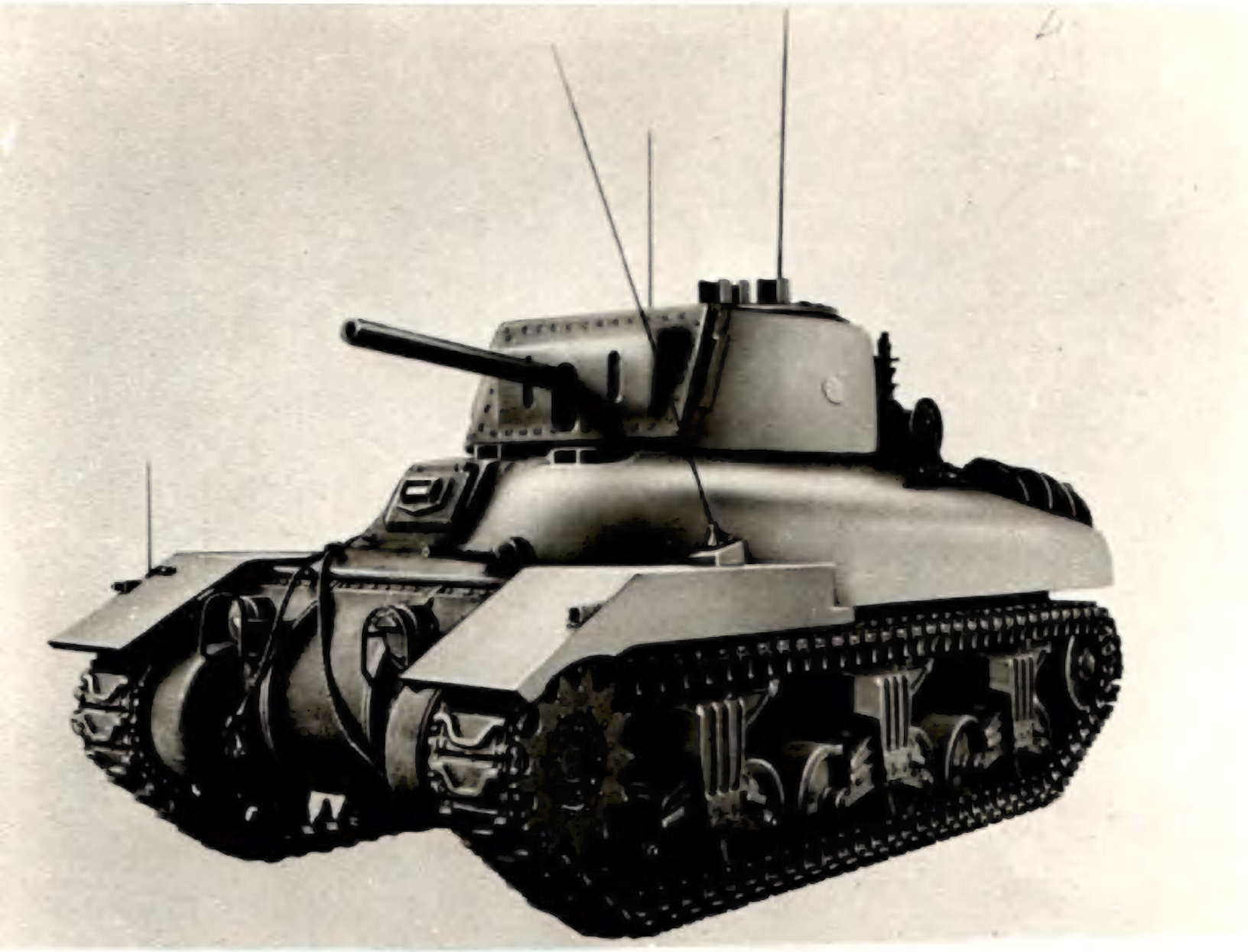


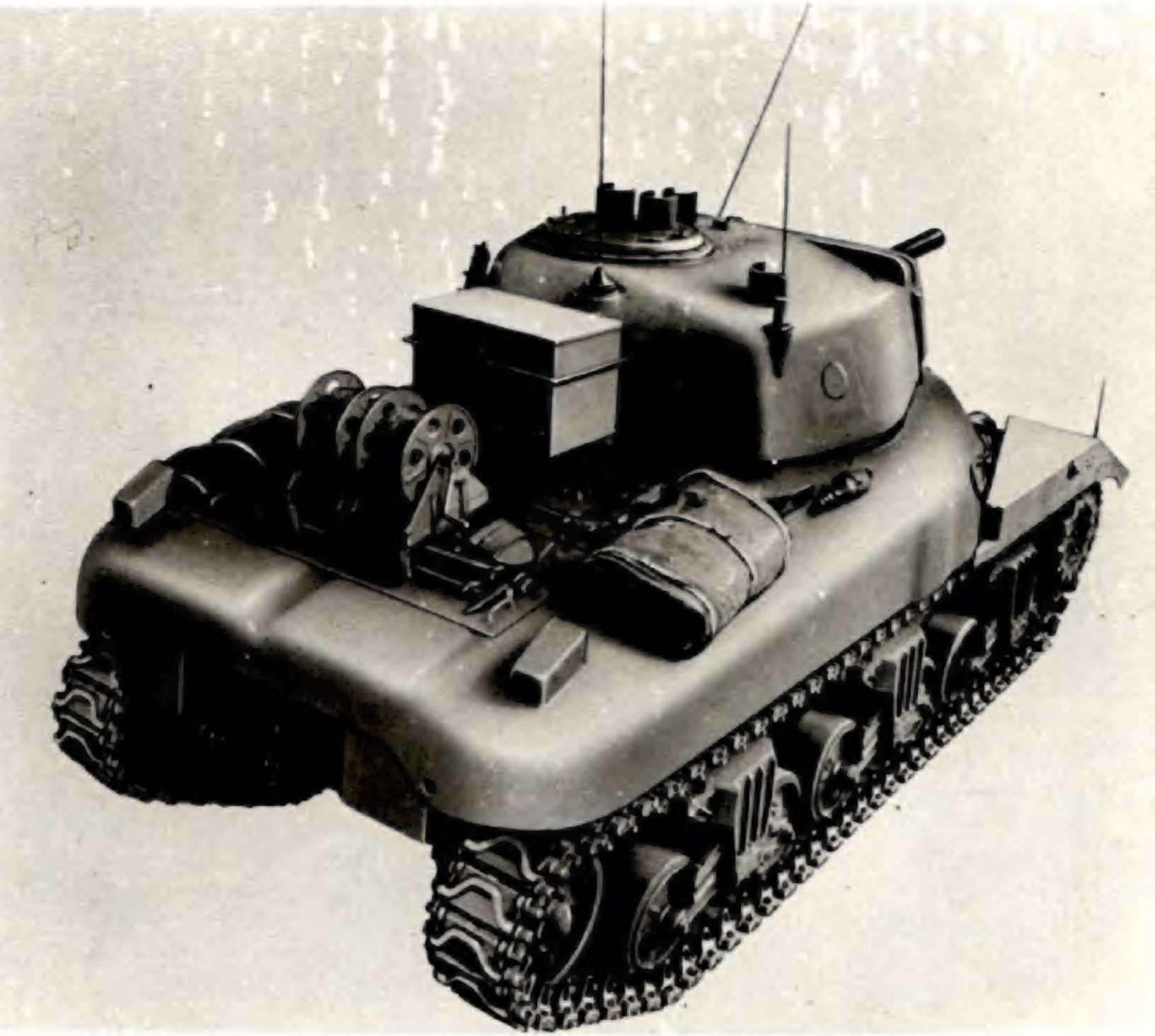
3/4 LEFT FRONT VIEW

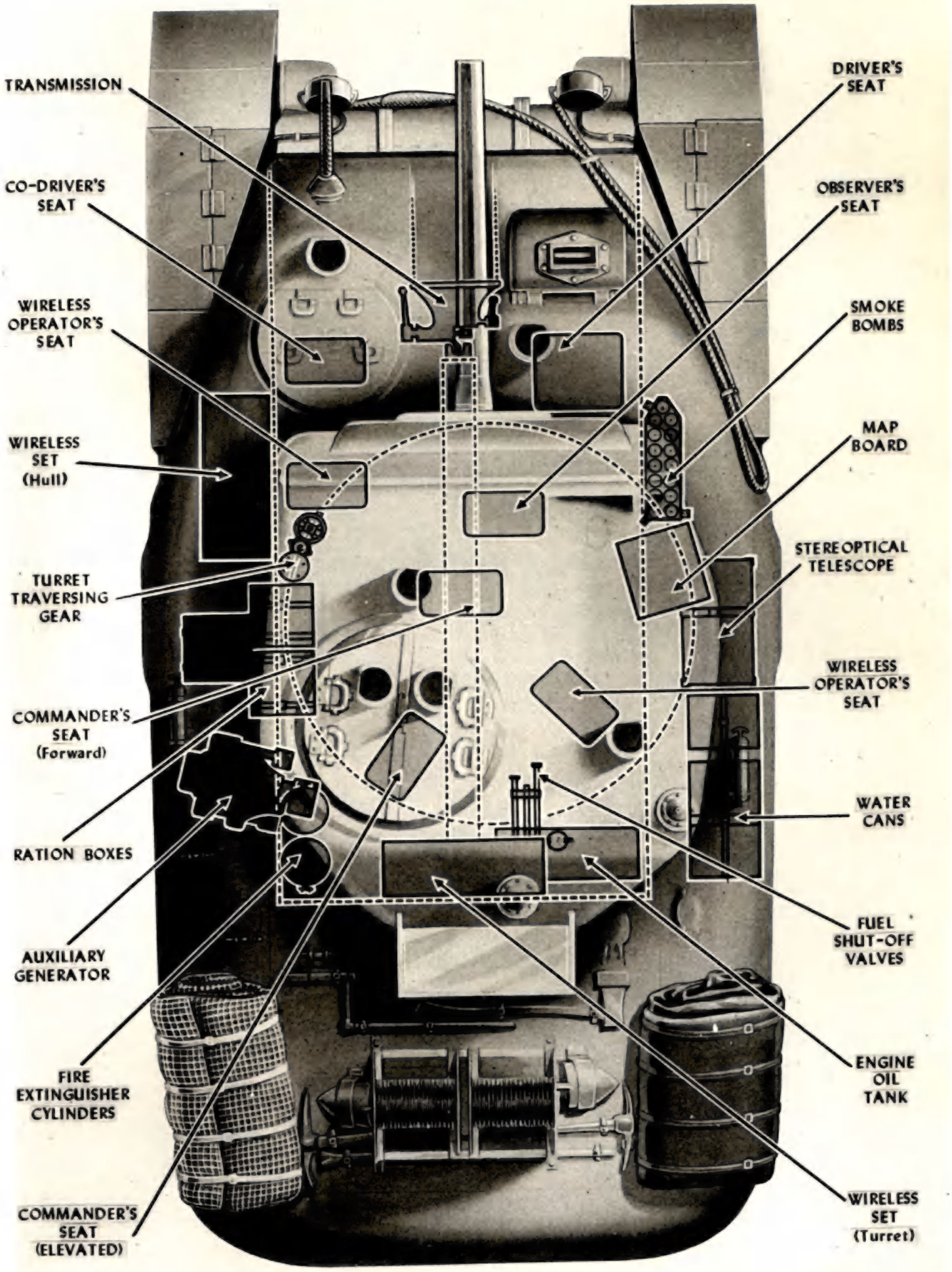
Showing forward aerial mount on left track guard, bow gun, driver's vision door closed, dummy gun in turret and stowage of towing cable at front of tank.

3/4 RIGHT REAR VIEW

Showing position of periscopes on turret, location of rear aerials, blanket box at rear of turret and stowage arrangement on rear deck.







GENERAL ARRANGEMENT

MODIFICATIONS FROM TANK CRUISER RAM II AND MAJOR PRODUCTION CHANGES

Turret manually traversed 45° in either direction.

Turret basket eliminated.

Dummy gun in place of actual 6 Pr.

Observation Equipment:
Stereoscopic telescope for use as periscope or as an artillery observation instrument.
Observation Port.
Periscopes.

Turret Hatch is graduated underneath in degrees for use in conjunction with an Azimuth scale around the Commander's periscope for rough angle measurements.

Compass - Pioneer type No.1830 in turret.

Two Wireless Sets #19-1 in turret bulge.
1 on left sponson.

Maps and records boards.

Engine Oil Tank - to minimize foaming.

New Instrument Panel.

Rear Idler - Stronger type wheel.

REFERENCES

D.T.D. Specification No. O.A. 217.

Command O/P - Operators' Manual, December 1943. Publication number CMD-LW1.

Command O/P - Illustrated Parts List Supplement. This contains only the parts which are used solely for Tank Command O/P., and must be used in conjunction with the Illustrated Parts List of Ram II Cruiser Tank.

Data Book - Tank Type Vehicles of Canadian Manufacture, January 1944 - Publication number M&S 1877.

Files Series
D.M.S. - 73-5-69.
D.N.D. - H.Q.S. 3352-59.
D.M.S. - D.A.D. Photo. File No. T-7.

Design Change Instructions:
Command/O.P, D.C.I. No. 1 to D.C.I. No.17.

Design Deviation Permits:
Command/O.P. D.D.P. No. 1 and D.D.P. No.2.

Design Change Requests:
Command/O.P. D.C.R. No. 1 to D.C.R. No.22.

Production Orders:

C.D. - L.V. 1672 84.

Approx. Price per unit - less equipment supplied by Ordnance $40,000.

25 PR. S.P.TRACKED, SEXTON

25 PR. S.P. TRACKED - SEXTON

The 25 Pr. Sexton is a self-propelled field artillery unit developed to replace the conventional 25 Pr. field gun and carriage together with its limber and field artillery tractor in field regiments employed with mobile formations.

It is a self-contained mobile unit carrying its own gun, crew, ammunition, W/T and armour and can come into action immediately on reaching the firing point.

Its tactical features include a normal 25 Pr. field piece and sighting equipment, front mounted on a tank type chassis with open-top fighting compartment. The gun has 40° elevation, 9° depression, 25° left traverse, and 15° right traverse. It carries a crew of six including the driver, protection being afforded by welded hull plates of bullet proof steel 1/2" thick on sides and rear and 3/4" thick on front. The lower hull, which also forms the chassis frame, is the same as the lower hull of the Grizzly Tank and consists of 1" floor plate at front under the driver, 3/8 plate floor behind this, and 1½" plate sides and rear, all of B.F. armour. A removable canvas hood is supplied for protection against weather. It carries an accurate magnetic compass, #19 W/T set with intercommunication, cable for line communication and Tannoy. Over 100 complete rounds of various types of 25 Pr. ammunition can be carried.

Mechanically, the vehicle is based on the Ram Tank with right hand drive incorporting the Sherman M4A1 engine, clutch, transmission, suspension, etc. Except for early production, all vehicles have been equipped with Canadian Dry Pin Track. A Homelite auxiliary generator is carried.

The vehicle entered production at Montreal Locomotive Works, Tank Arsenal early in 1943 and continued until late 1945, with a total of 2150 produced.

This vehicle was designed by A.E.D.B. at the request of the Department of National Defence and was the first British vehicle of its type.

The piece is completely similar to that used in the field carriage of the 25 Pr. It was necessary, however, to completely redesign the saddle and pintle to increase their strength structurally, and thus compensate for the lack of a trail. The pintle is carried in bronze bearings in a bolster and bolster beams rigidly welded to the hull.

In order to provide the required elevation, it was found necessary to limit the recoil to 20 inches rather than the normal 36 inches.

Considerable planning and trial and error was necessary to provide maximum traverse as restricted by driver and gunner positions.

The box type upper hull was a straightforward design problem but the development of traverse shields introduced complications, due to the front plates being sloping and the mounting pintle being vertical.

The field piece traverse gear was replaced by a specially designed gear to provide less effort and smoother action.

Various minor changes were added to the gun and recoil mechanism to improve protection on exposed portions and to provide correct balance.

An auxiliary generator, not originally required was added early in production and the batteries and electrical system rearranged to conform.

The vehicles were manufactured in the Tank Arsenal concurrently with Ram and Grizzly Tanks. This introduced problems of component scheduling and stock segregation inasmuch as many parts were similar to, but not identical with, those that were used in the tank vehicles. The training of welders and quality control on the welding for the beams, bolsters and upper hull demanded very close supervision until experience was gained.

After the first few vehicles, all parts of the gun mount (except beams and bolsters) were manufactured in the gun plant at Sorel. This proved a very satisfactory arrangement.

As in all other tank type vehicles, the continuing design changes necessitated by improvement in U.S. mechanical components or User demands created numerous production problems.

The Sexton was used in considerable numbers in action in Italy and North West Europe with good effect and is standardized as British Army artillery equipment.

A G.P.O. (Gun Position Officer) Vehicle was developed in Canada as a companion vehicle to the Sexton. On this vehicle additional communication equipment was installed, tables and seats added, and a modified Sexton hood provided for protection against weather. This vehicle has also been accepted as standard by the War Office.

25 PR. S.P. TRACKED SEXTON

Tactical Data

PRODUCED BY - Montreal Locomotive Works
Tank Arsenal, Montreal.

PRODUCTION
Commenced - Early in 1943.
Finished - 1945

VEHICLES PRODUCED - 2,150

SERIES - 25 Pr., S.P.Tracked Sexton

TYPE - Self-propelled field artillery.

BRIDGE CLASSIFICATION - 30

CREW - 6 - including driver and co-driver.

ARMOUR - Upper Hull
Front, flat fixed - 1"
curved movable - 1"
Sponson Plates - 3/8"
Sides - 1"
Lower Hull
Sides and rear - 1 1/8"
Floor and bulkhead - 1"

GUN MOUNT - Standard recoil mechanism and armoured cradle assembly. Elevation 40°; Depression 9°.

TRAVERSE - Hand 25° left; 15° right.

ARMAMENT - Main - Ordnance Q.F.,25 Pr. "C" Mk.II or C Mk. III on mounting 25 Pr., S.P. "C" Mk. I.
Cartridges - 112
H.E. or Smoke Projectiles - 87
A.P. Projectiles - 18

ARMAMENT (cont'd.)
- Two Bren .303" M.G. (1500 rds.in 50,30-rd.magazines).
Two Sten 9 mm. M.G. (448 rds. in 32-rd. magazine).
Two Rifles No. 4. (100 rds. .303",2,50-rd.bandoliers).
One Signal Pistol,20 cartridges,1".
12 Grenades, Hand.

SIGHTING - Telescope, Sighting, C No.41,for Direct Sighting. Magnification - 1.9
Sight, Dial, C No. 9, for Indirect Gun laying.

PROTECTED VISION - Protectoscope - Driver's Door.

COMMUNICATION - No.19 W/S. Mk. II or Mk. III.
Loudspeaker (Part of Telephone).
Loudspeaking, No. 2 (Canadian).

COMPASS - Binnacle Equipment. C type P.B., with W.D. 32 Compass in W.D. 150 Binnacle. C.P., mounted on Sponson Plate to right of driver.

LIGHTING - 2 Head Lamps.
1 Blackout Drive Lamp.
2 B.O. Marker Lamps.
2 Tail Lamps.
1 Convoy Lamp.
2 Inspection Lamps.

PERFORMANCE DATA

POWER/WEIGHT - Net power to gross weight ratio.
14.0 B.H.P. per short ton - R975-C1.
16.6 B.H.P. per short ton - R975-C4.

GROUND PRESSURE - 11.5 p.s.i.
12.2 p.s.i. (C.D.P.track).

GROUND CLEARANCE - 17"
18-5/16" (with one-piece Final Drive).

GRADABILITY - 1st. Gear
Theoretical
Ascending 35°
Descending 35° - 40°

Actual on concrete
Ascending 26°
Descending 30°

MINIMUM TURNING RADIUS - In sand.
18' to Right,21½' to Left.
(measured from inside centre suspension frame to the centre of turning circle made by inner track).

SPEED, MAXIMUM - 25 m.p.h.

TRENCH CROSSING ABILITY - 8' 3"

VERTICAL OBSTACLE CLIMBING - 24"

FORDING DEPTH - At slow speed - 46"

CRUISING RANGE - Highway - 180 miles. (10 hour run,max. speed 20 m.p.h., with 60 minutes idling).

FUEL CONSUMPTION - .98 m.p.g. (average).

OIL CONSUMPTION - 1.95 g.p.h.(average).

MECHANICAL DATA

LADEN WEIGHT - 57,000 lbs.

OVERALL DIMENSIONS

Length	- 20' 1".
Width	- 8' 11"
Height	- 8' 0" 9' 5"(with canvas top)

CENTRE OF GRAVITY - 40" approx.

ENGINE

Location	- At rear
Make	- Continental Motors Corp.
Model	- R975-C4. R975-C1. (earlier vehicles)
Type	- Static Radial air-cooled 4-cycle petrol, 9-cylinder.
Displacement	- 973 cu. ins.
Peak Gross B.H.P.	- 484 @ 2400 r.p.m. (R975-C4) 400 @ 2400 r.p.m. (R975-C1)
Torque (Max.)(C4)	- 1075 ft/lbs.@ 1900 r.p.m.
(C1)	- 890 ft/lbs.@ 1800 r.p.m.
Lubrication	- Engine oil tank capacity - 30 qts. Oil drawn from oil tank by gear type pressure pump divided into two sections: - a separate pressure pump delivering oil to all bearings and parts; a scavenge pump returning the oil from the sump through oil filter to oil cooler and oil tank. The oil pump incorporates a pressure relief valve.
Ignition	- Two magnetos.(R975-C4) Scintilla-VAG9-DFA. (R975-C1) Scintilla-Bendix or Bosch.
Priming Pump	- To facilitate starting engine.
Air Cleaner	- Type - Oil bath. Number - two. At rear of engine compartment.

Modifications - In R975-C1 engine compression ratio changed from 6.3 : 1 (R975-EC2) to 5.7 : 1, to permit the use of 80 octane motor fuel.

The C1 engine also includes new design carburetor incorporating an electric idle fuel cut-off; a built-in degasser; a diaphragm type (A.C.) fuel pump which obviates need of fuel relief valve; a manual visual type of oil dilution system; independently operated booster coil and starter switches; engine oil pressure gauge with low oil pressure signal lamp; new type Cuno oil filter - automatic or hand-cleaning; and high idling mechanism linking accelerator pedal with throttle controls to facilitate gear shifting.

- The (R975-C4) engine, which replaces the (R975-C1)engine, in later Sexton models, has additional improvements, such as increased power and greater durability, providing improved cylinder cooling through increased cylinder head fins and muffed cylinder barrels, together with redesigned cylinder head and barrel air deflectors, which permit of a manifold pressure increase sufficient to obtain a rated 484 gross h.p. at 2400 r.p.m.

The oil sump is removed from the main crankcase section and two sumps placed between the rocker boxes of No. 5 and 6 cylinders,to make provision for drainage of the rocker boxes.

The R975-C4 engine is completely interchangeable with the R975-C1 model, except for minor interferences in movable accessories.

COOLING SYSTEM - Type - Air-cooled. Air-ducts formed on engine by baffles bolted around and between each cylinder and cylinder head. A shroud forms a further duct for the inlet of air through the grill.

Method - Fan mounted on engine fly-wheel rotates in the shroud, drawing air through a grill in top upper hull and forcing it between and around the finned cylinders of the engine. The warm air passes through baffles and discharges above engine at rear of vehicle.

FUEL SYSTEM

Type - Petrol. Motor fuel 80 octane rating or better.

Tank Capacity - Total - 146 gallons.
Four fuel tanks, each having separate shut-off valve.

Location - Two V-tanks front corners engine compartment. Two H-tanks on each sponson in engine compartment.

Feed - Fuel flows from the tanks to central header, drawn through strainer by fuel pressure pump to carburetor. The fuel pressure pump is a diaphragm type which maintains a constant pressure, thus avoiding need of a relief valve. A separate 1½-gallon fuel tank for auxiliary generator is located in the auxiliary generator compartment.

Fuel Cut-off - Fuel can be cut off electrically at the carburetor by means of a toggle type switch on instrument panel.

CLUTCH -

Make - Lipe.

Type - Dry disc, built into engine flywheel. 2 discs - 1 drive plate 16".

Open type pressure springs exert full pressure against the clutch plate.

Depressing clutch pedal compresses springs and frees engine power from propeller shaft. Releasing clutch pedal transmits power through propeller shaft to input shaft of gear box.

(Note) - On later Vehicles - Lipe clutch replaced in production by the Borg and Beck clutch with enclosed pressure springs.

GEAR BOX

Type - Synchromesh

Ratio -		
First Gear	-	7.56 : 1
Second Gear	-	3.11 : 1
Third Gear	-	1.79 : 1
Fourth Gear	-	1.11 : 1
Fifth Gear	-	.73 : 1
Reverse Gear	-	5.65 : 1

Lubrication - Oil circulated by small pump built into the transmission case. Oil drawn from the transmission and differential sumps passing to oil cooler at rear of fighting compartment, returning to transmission and differential cases to lubricate the gears and bearings.

STEERING AND FINAL DRIVE -

Type - Controlled Differential

Ratio Bevel Gear	-	3.53 : 1
At Sprocket	-	9.88 : 1

STEERING CLUTCHES

Location - On each side of bevel drive.

Type - Controlled Differential.

Incorporated in the controlled differential, on either side, is the steering device, each of which consists of a brake drum and brake shoe, actuated by a lever. When the speed of one brake drum is reduced by pressure of shoes, the speed of the other is increased.

Driver's seat on right of transmission.

STEERING BRAKES

Band type controlled by steering levers.

Parking brake - Steering lever type controlled by foot pedal operating ratchet quadrants.

1-piece Final Drive equipped with Double Anchor type control brakes.

3-piece Final Drive equipped with Single Anchor type control brakes.

SPROCKETS

Location - At front

Number - Two twin driving sprockets (interchangeable).

The twin driving sprockets are bolted on each end of the detachable hub assemblies of the final drive shafts.

	Standard	C.D.P.
Diameter	27 9/32"	26 ½"
Number of teeth (Teeth engage end connectors of track shoes)	13	17 (Teeth mesh on outboard lugs of track)
Pitch	6"	4.6"

TRACKS

Type (T54E1,T49, A.S.F.)		(C.D.P.)
No. shoes per strand	79	103
Tread(centre to centre)	83"	83"
Width of track	16½"	15½"
Length of track(ground)	147"	147"

MECHANICAL DATA (cont'd.)

SUSPENSION

Type - Vertical volute springs. Suspension brackets bolted to lower hull bottom and side plates provide upper seats for the volute springs to react on the bogie wheel lever arms and rubber-tired bogie wheels which run on the track.

Number - 3 bogie or suspension assemblies on each side of vehicle, 2 volute springs in each assembly.

Diameter of bogie wheels - 16"

Improved suspension units with stronger volute springs and offset top rollers.

TOP ROLLERS

One on each bogie assembly to support track. Roller bracket assembly is bolted to rear side of each bogie frame, the bracket having a spacer for the roller bearings. A track skid is bolted on top of the bogie frame.

TRACK ADJUSTING IDLER

Type - Steel idler wheels, 22" diameter, eccentrically mounted on each side of vehicle, at the rear.

Adjustment - By turning hexagon end of spindle shaft, after spreading split housing and driving collar off serrations of spindle.

ELECTRICAL SYSTEM

Battery- Two 12-volt, 168 ampere hour storage batteries.

Battery Balancing Switch - For transfer of radio load.

Generator -

Main - 30-volt, 50 ampere, driven from the main engine.

Auxiliary - Homelite Model H.R.U.H. without heating element.

Both generators have control boxes with voltage regulator, current limiter and reverse current relay with generator filter to reduce radio interference.

Starter - Direct electric starter, Eclipse type 817-1A, with hand attachment.

Starter solenoid switch, Eclipse type 518-21-A.

Fuel cut-off solenoid, Eclipse type 500-15-A, operated by a toggle switch on the instrument panel.

Thermal Type Circuit Breakers.

Later vehicles - Headlamps changed to U.S. Medium Tank demountable type with a Blackout Lamp carried for installation as required. Headlamps relocated near the sides of the upper hull.

MAJOR CHANGES INTRODUCED DURING PRODUCTION

Booster Coil and Starter switches to operate as independent units.

Emergency receptacle and cable to transfer electric power between vehicles.

New Instrument Panel and the following electrical changes:-
Engine Oil Pressure Gauge.)
Transmission Oil Temp. Gauge)Electrical
Low Oil Pressure Signal Lamp) type.

Telephone, Loud Speaker No. 2 Can. Tannoy

Oil Dilution (Manual-Visual Type).

Redesigned Clutch Release Mechanism.

Engine Accessory changes:-
New Carburetor including,
Built-in Idle Fuel Cut-off, and
Degasser.
A.C. Fuel Pump.

Batteries moved to left rear of vehicle.

Auxiliary Generator - right rear.

Towing Hook and Bracket for British or Standard U.S. type hook.

Rear Mud Guards.

Water Cans 5 gallons - (rear stowage).

Sten Machine Carbine Stowage Box moved to left front.

Two Bren L.M.G. Mk. II.

Hand Throttle.

Two Methyl Bromide Fire Extinguishers replaced 2 Pyrene.

Brake Lock Mechanism (Replacing Transmission Parking Brake).

Double Anchor Brakes.

One piece Final Drive Housing

Carrier, Cable Reel No. 5 and Mounting.

Splash Proof Oil Cooler Grill.

Tachometer, new drive off Transmission.

High Idling Mechanism.

Booster Clutch Controls with Adjuster Clutch Controls.

Exhaust Deflector Assembly.

W.D. 32 Compass and Binnacle C Type P.B., replacing P-8 Compass and Binnacle.

Ammeter Shunt. Ammeter to Shunt Leads changed.

U.S. M4 Type Head Lamps replace Automotive Type Head and Side Lamps.

Engine R975-C4 replaces R975-C1.

Airflow Vanes, (Engine Compartment).
New Style Exhaust Pipes.
New Style Air Intake Pipes.

Splash Protection Gun Shield Revised.

Oil Pressure Warning Light, 30 lb. type.

Box, Switch and Terminal.

Battery Balancing Assembly.

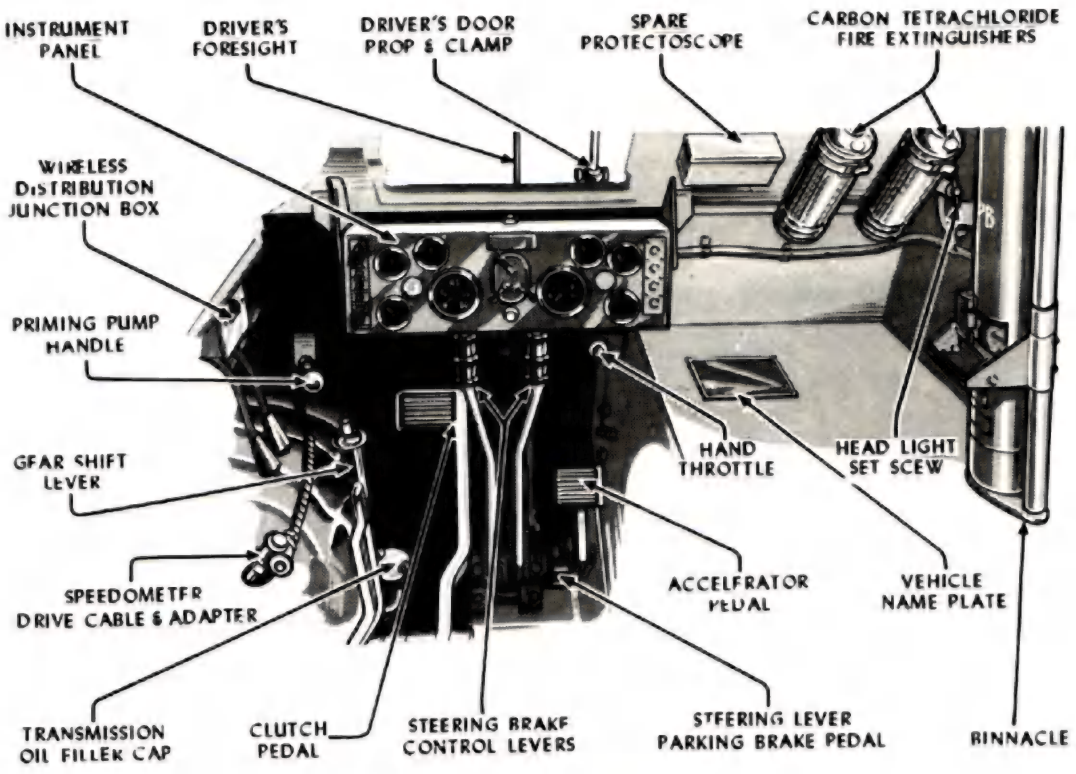
Provision for 17-Pr. Towing Attachment replacing U.S. type Hook and Bracket.

Driver's Indirect Vision Device - New Type.

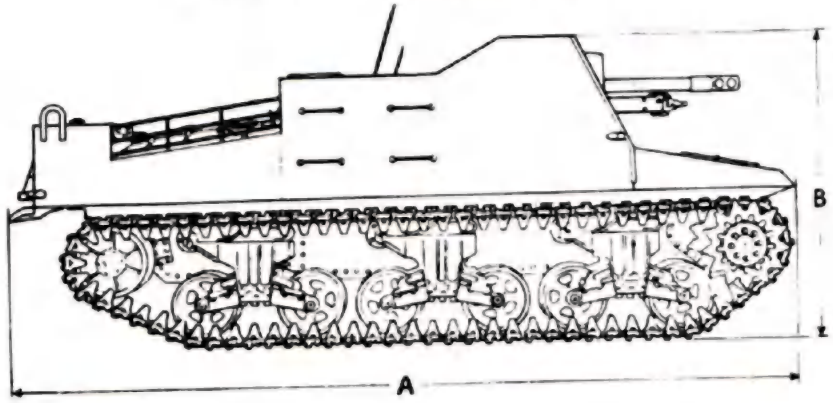
New Clutch - (Borg and Beck).

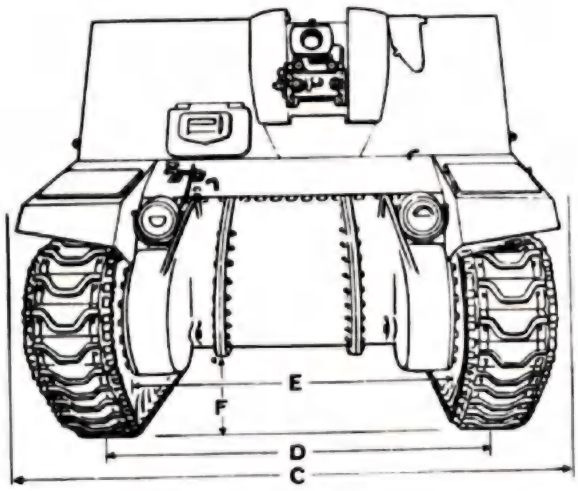
Accelerator Pedal Stop.

New Purolator Oil Filter replaced old Cuno Filter.



CONTROLS-DRIVER'S COMPARTMENT



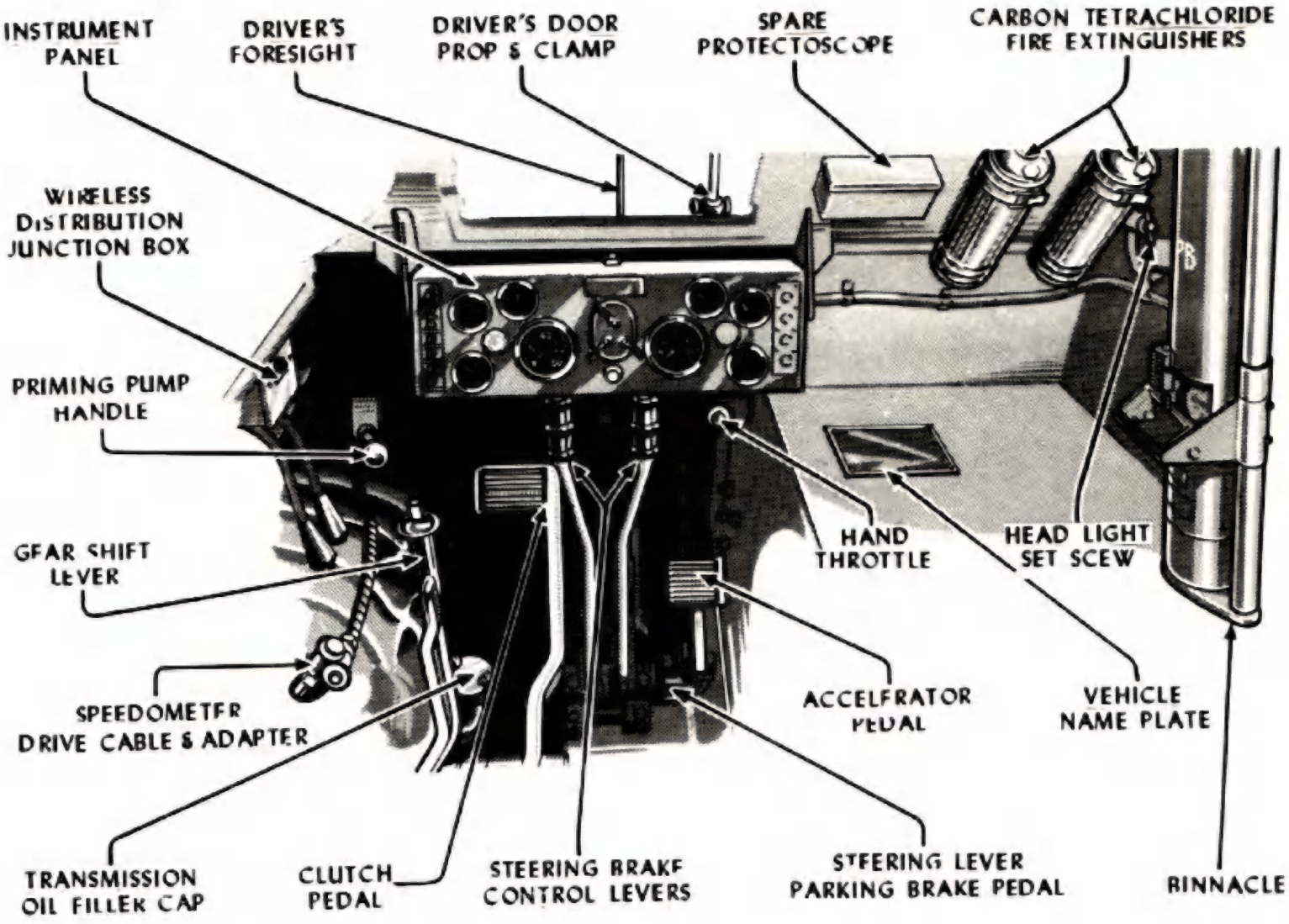


DIMENSIONS

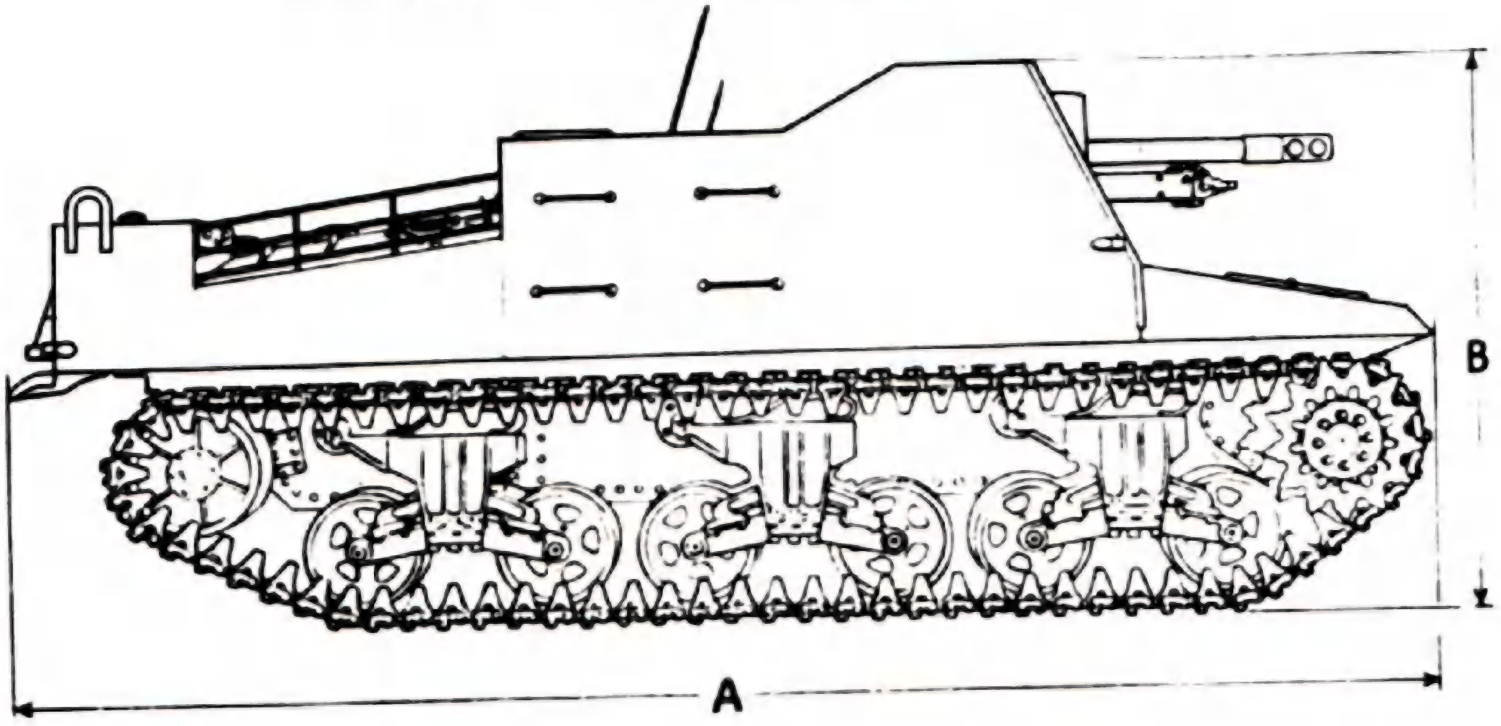
A	✱B	C	D	E	✱F
LENGTH OVERALL	HEIGHT OVERALL	WIDTH OVERALL	TRACK CENTRES	LOWER HULL WIDTH	GROUND CLEARANCE
20' 1"	8' 0"	8' 11"	6' 11"	5' 3"	17"

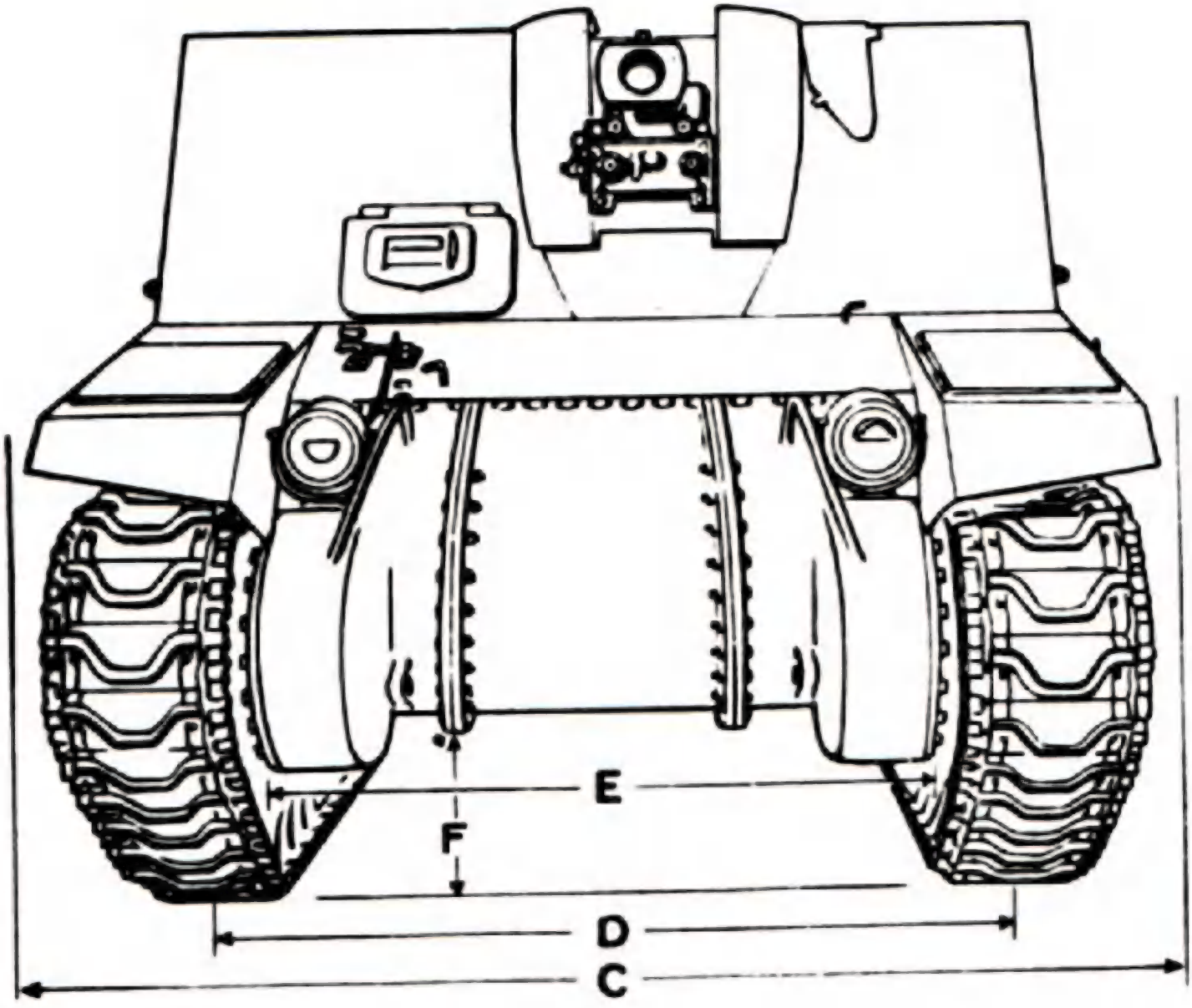
✱B – WITH CANVAS TOP UP 9' 5" HEIGHT

✱F – WITH ONE-PIECE FINAL DRIVE 18-5/16"


INSTRUMENT PANEL
DRIVER'S FORESIGHT
DRIVER'S DOOR PROP & CLAMP
SPARE PROTECTOSCOPE
CARBON TETRACHLORIDE FIRE EXTINGUISHERS
WIRELESS DISTRIBUTION JUNCTION BOX
PRIMING PUMP HANDLE
GEAR SHIFT LEVER
SPEEDOMETER DRIVE CABLE & ADAPTER
TRANSMISSION OIL FILLER CAP
CLUTCH PEDAL
STEERING BRAKE CONTROL LEVERS
HAND THROTTLE
HEAD LIGHT SET SCEW
ACCELERATOR PEDAL
STEERING LEVER PARKING BRAKE PEDAL
VEHICLE NAME PLATE
BINNACLE

CONTROLS-DRIVER'S COMPARTMENT




E
F
D
C

DIMENSIONS

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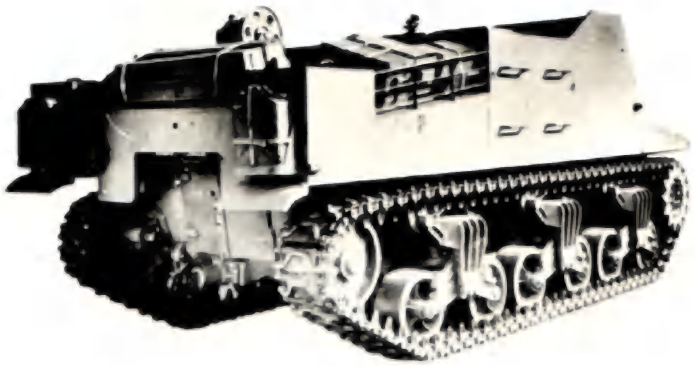
LENGTH OVERALL	HEIGHT OVERALL	WIDTH OVERALL	TRACK CENTRES	LOWER HULL WIDTH	GROUND CLEARANCE
20' 1"	8' 0"	8' 11"	6' 11"	5' 3"	17"

✱B – WITH CANVAS TOP UP 9' 5" HEIGHT

✱F – WITH ONE-PIECE FINAL DRIVE 18-5/16"

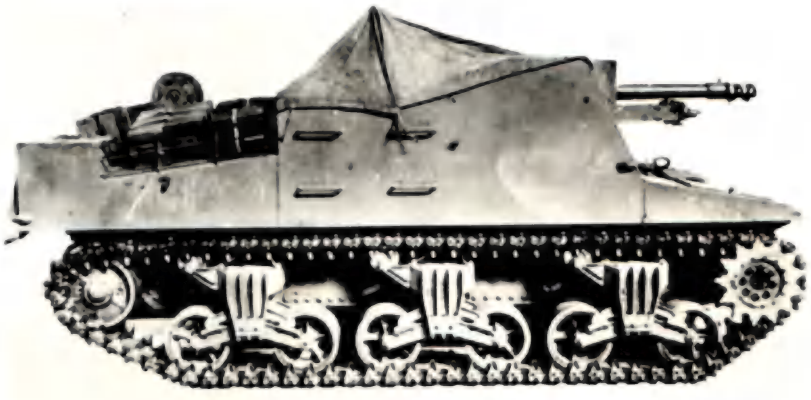
THREE-QUARTER LEFT FRONT VIEW -Action View. (Vehicle fitted with one-piece transmission and final drive, M4 type headlamps and stowage rack for spare track shoes.)

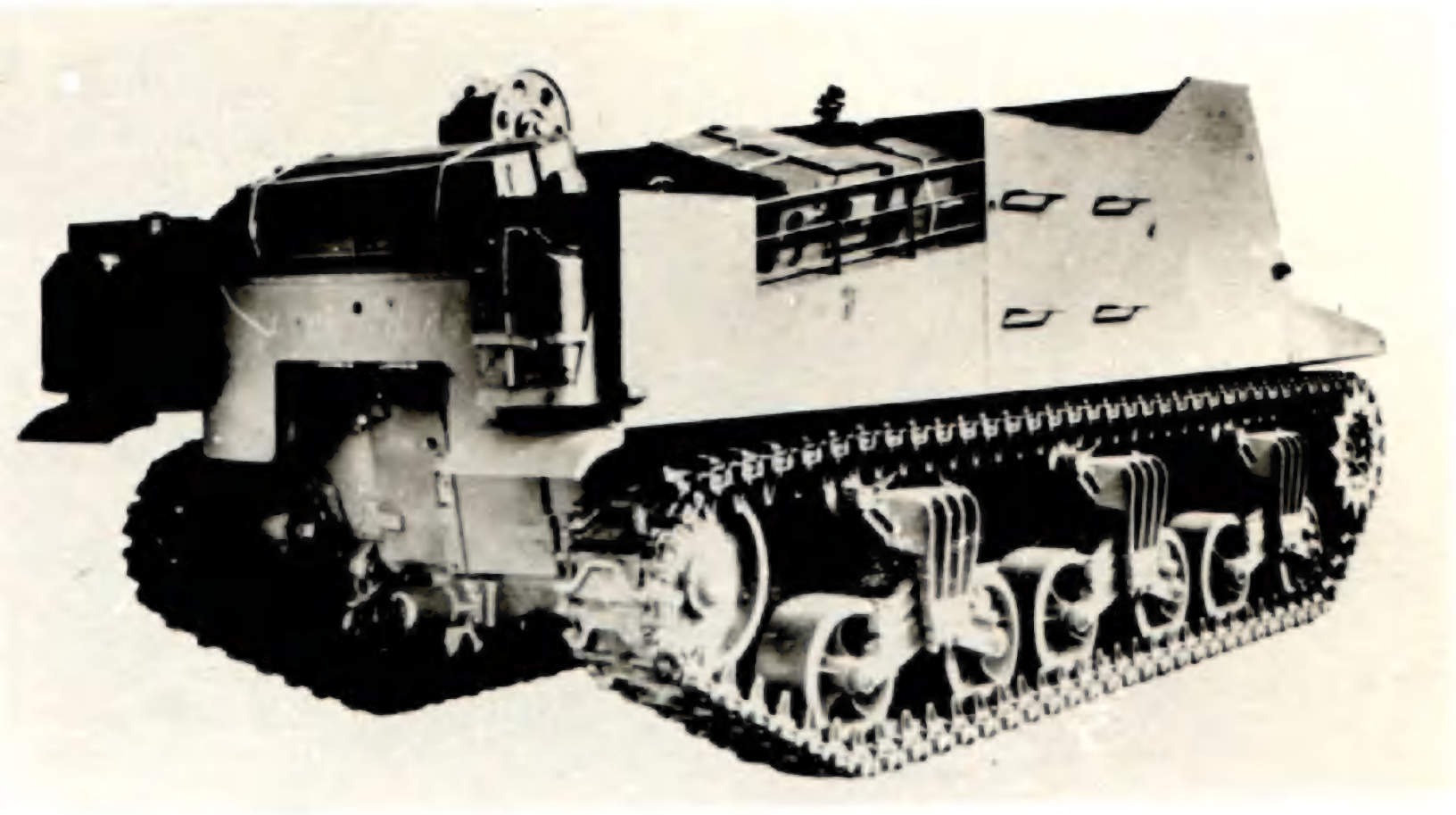
THREE-QUARTER RIGHT REAR VIEW -Showing water carriers mounted at rear of battery and auxiliary generator compartments, Bren guns and ammunition stowed above engine compartment and cable reel for line communication.

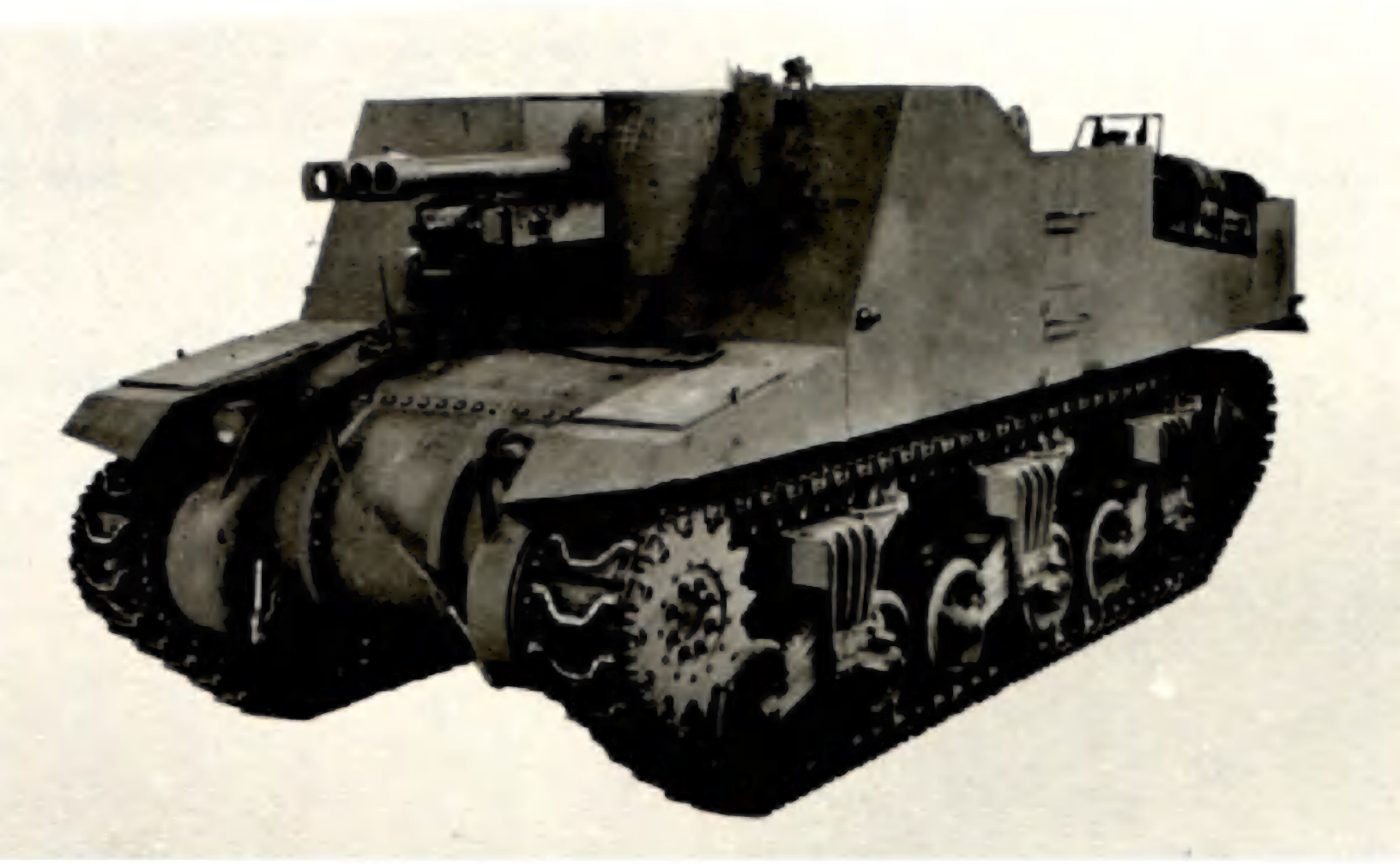


THREE-QUARTER LEFT FRONT VIEW -Showing vehicle fitted with three piece transmission and final drive, early type headlamps with towing cable in stowed position.

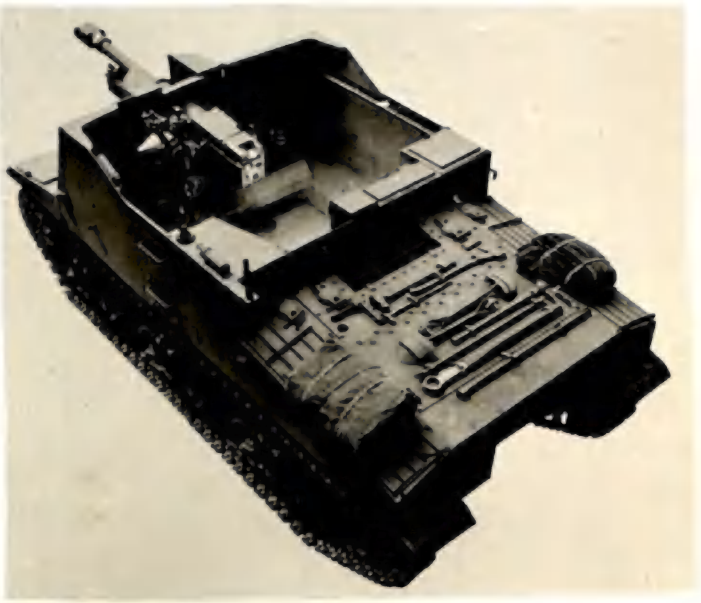
RIGHT SIDE-VIEW-Showing Bren guns and ammunition stowed on rear deck and canvas hood for crew compart -ment installed.





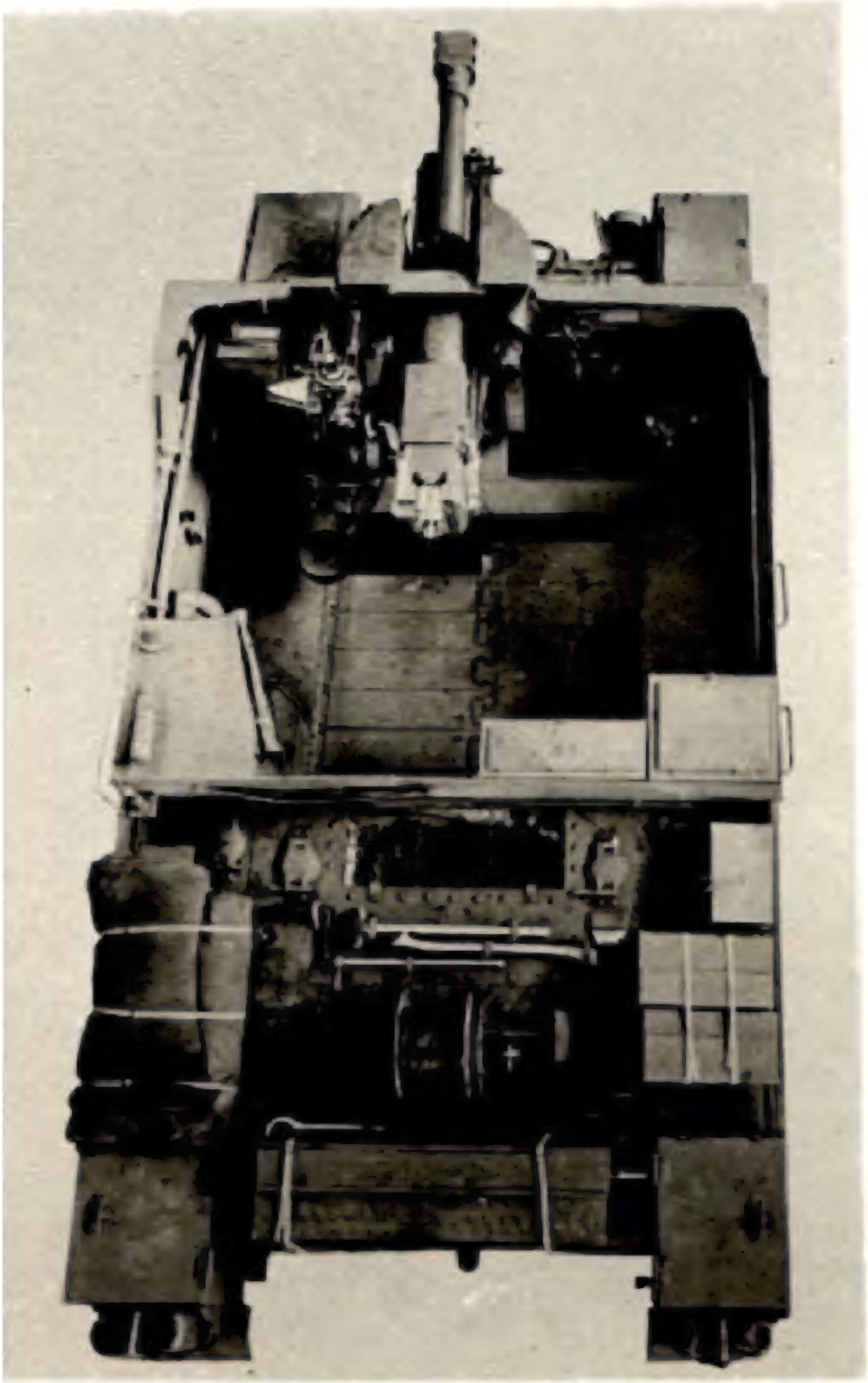


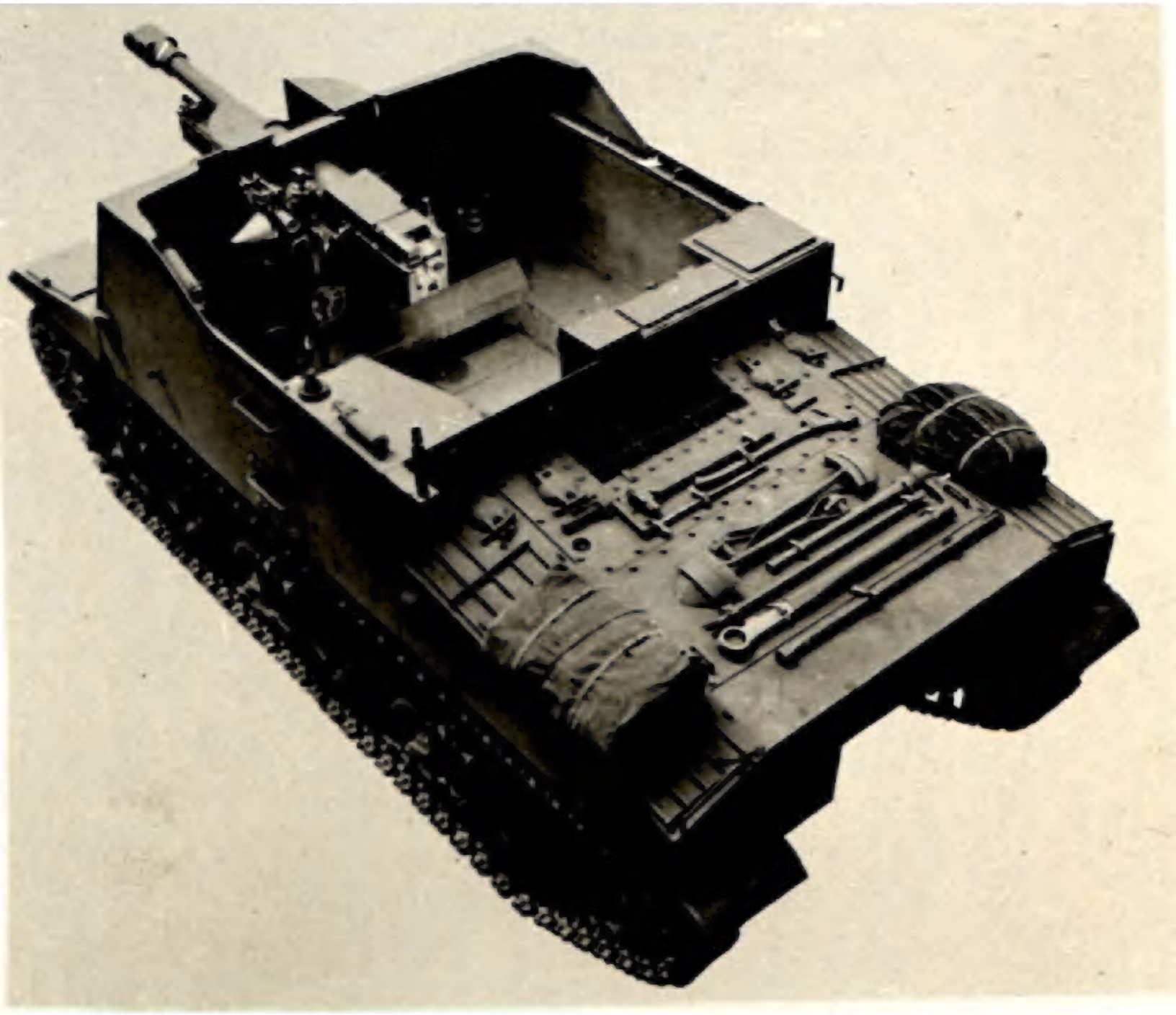
PLAN VIEW-Showing interior of crew compartment also tarpaulin, camouflage net, cable reel, Bren guns and ammunition and ancillary equipment stowed on rear deck. (Vehicle fitted with battery and auxiliary generator.)

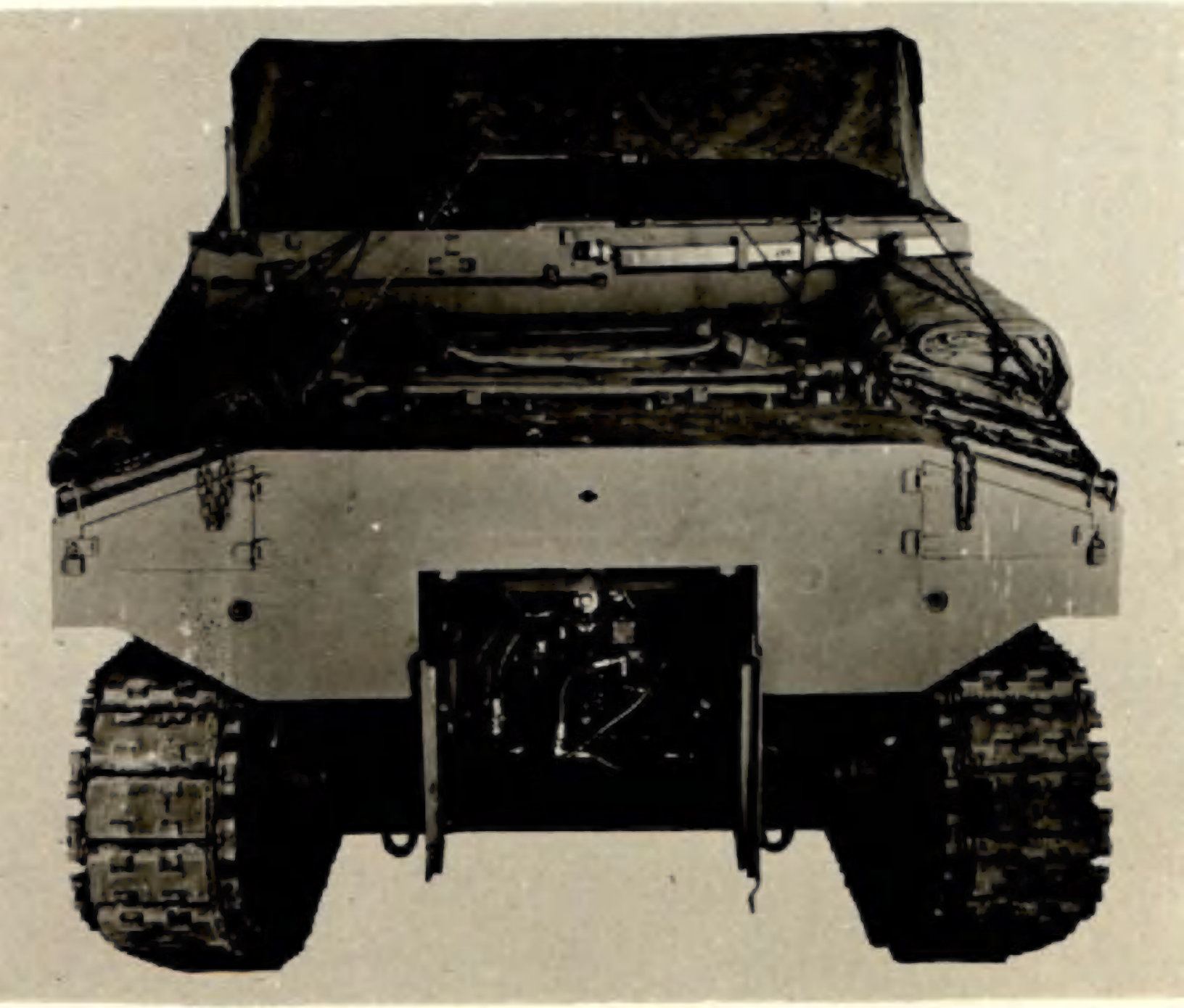


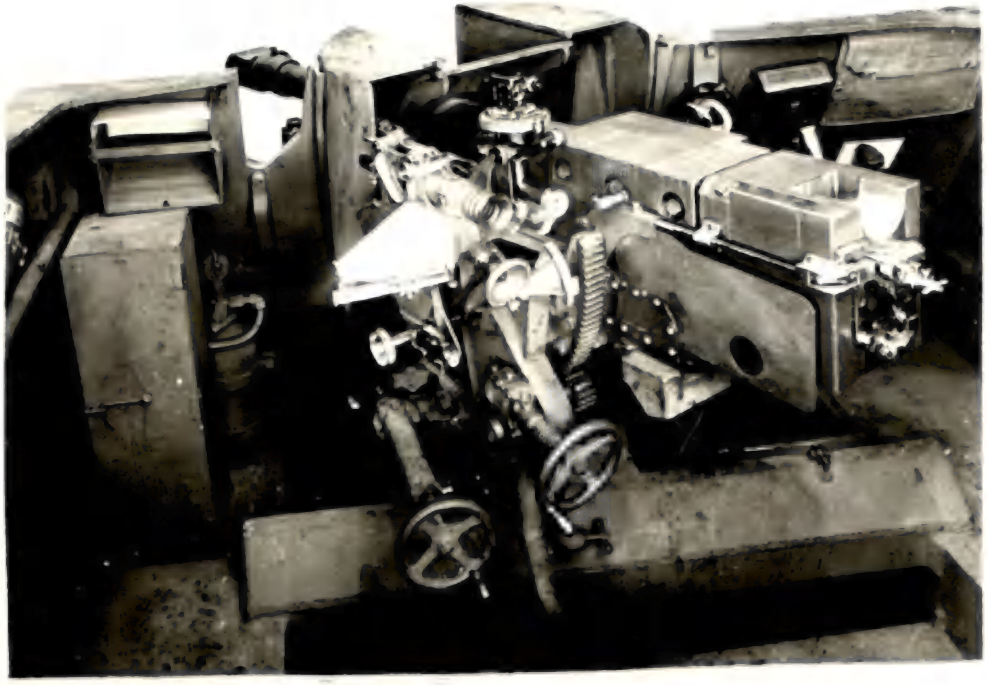
THREE-QUARTER LEFT PLAN VIEW-Showing interior of crew compartment also rear deck stowage arrangement on vehicles not fitted with battery and auxiliary generator

REAR VIEW-(early type)-Showing stowed ancilliary equipment, tool compartments at each rear corner, canvas hood in position and engine compartment doors open.



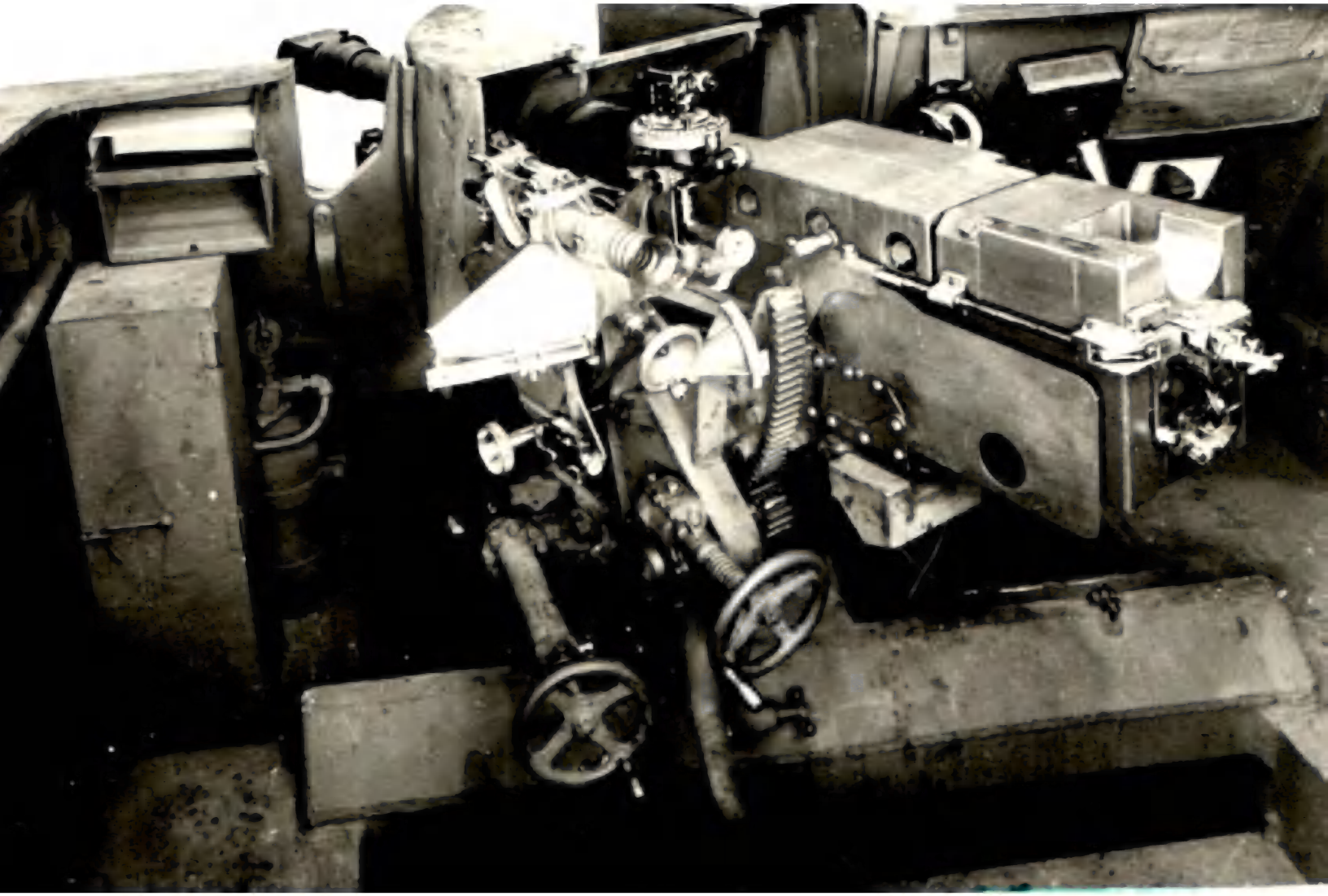






CLOSE UP OF LEFT REAR OF 25 Pr. GUN OPERATING MECHANISM–Showing dial sight, telescope, elevation quadrant and range scale cone, etc. also traversing mechanism control wheels in the foreground.

INTERIOR RIGHT FRONT CLOSE UP-Showing driver's seat, operating controls, instrument panel, driver's visor (open) and intercommunication headphones. (Binnacle Type P.B. compass shown at right front.)



USER COMMENTS

EXCERPT FROM D.D.E.M. LETTER AIRL 742, 22 NOVEMBER, 1943 - "A.F.V. TECHNICAL REPORT (Our File 141-51)

"It appears likely that the Sexton will prove a more satisfactory vehicle than the Priest, and 92 of the first 124 received in this country for the C.A.O. are being turned over to the British to meet their urgent requirements."

EXCERPT FROM A.F.V.(T) TECH. REPORT NO. 14 14 OCTOBER, 1944. (Our File 141-56-09).

"Both these regts. are fully satisfied with the immunity of Ram Sexton against H.E. shell and mortar bomb attack."

EXCERPT FROM AIRL.1129 (D.D.E.M.) MAY 17,1944 (Our File 141-50-16)

"The users are quite pleased with the Sexton and state that, to date, very few field performance reports have been received in proportion to the vehicles issued. This is the reason for complaints being conspicuous by their absence, and which we believe you will be pleased to learn."

EXCERPT FROM 21 ARMY GROUP A.F.V. TECHNICAL REPORT NO. 26

Units are unanimous in praising the mechanical reliability of these vehicles. Mechanical failures have been extremely few.

REFERENCES

D.T.D. Specification No. O.A. 218.

25 Pr., S.P., Tracked Sexton-Operator's Manual, December 1943. Publication number SXN-LW1.

25 Pr., S.P., Tracked Sexton-Supplementary Operator's Manual, November 1943. Publication number SXN-LW2.

25 Pr., S.P., Tracked Sexton-Operator's Manual, December 1944. Publication number SXN-LW3.

25 Pr., S.P., Tracked Sexton - Illustrated Parts List, December 1943.

25 Pr., S.P. Tracked Sexton - Illustrated Parts List, December 1944.

Data Book - Tank Type Vehicles of Canadian Manufacture, January 1944. Publication number M.&S.1877.

Files Series
D.M.S. - 141-56-1, 2, 3, 4, etc.
D.N.D. - H.Q.S. 3352-34-4.
D.M.S. - D.A.D. Photo. File No. B-4.

D.T.D. Field Trial Reports:

Report No. 1218 - Towing Trials on 17 Pr. Anti-Tank Gun towed by the 25 Pr., S.P., Tracked Sexton.

Report No. 1257 - Lifting Trials of 25 Pr., S.P., Tracked Sexton.

Report No. 1376 - Canadian Dry Pin Track fitted to 25 Pr., S.P. Tracked Sexton.

Report No. 1387 - Improvements to Driving Position on the 25 Pr., S.P., Tracked Sexton.

Report No. 1473 - Pack Flat Design Hardware for the 25 Pr., S.P., Tracked Sexton

Report No. 1512 - Canadian Dry Pin Track fitted to 25 Pr., S.P., Tracked Sexton.

Report No. 1518 - Front Hooks for the 25 Pr., S.P., Tracked Sexton.

Design Change Instructions:
Sexton D.C.I. No. 1 to D.C.I. 566
Sexton D.C.I. No. 1000 to D.C.I. 1056
Sexton D.C.I. No. 2001 to D.C.I. 2038

Design Deviation Permits:
Sexton D.D.P. No. 1 to D.D.P. 19
Sexton D.D.P. Nos. 1000 and 1001

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Sexton D.C.R. No. 1 to D.C.R. 185
Sexton D.C.R. No. 1001 to D.C.R. 1040

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

E. 224 - Life Service Bogie Tires

E. 248 - Goodyear Synthetic Bogie Tires

E. 253) - C.D.P. Track Peening
E. 255)

E. 318 - R975-C1 Cold Starting Tests with Winterized Kit.

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

E. 318B - Efficiency of Winterized Kit - W.K.O. 201.

E. 325 - Method of Track Tightening.

E. 360 - Efficiency of Anti-Splash Protection plates.

E. 368 - Efficiency of D.C.P. Track Operating in Snow and on Ice.

E. 369 - Track Adjustment.

E. 388 - Hollebone Draw Bar.

E. 390 - Pilot Models - Rear Smoke Emitters.

E. 393 - Splash Protection Strips.

E. 401 - Recoil Interference, Investigation.

E. 408 - Driver's Door Visors.

E. 409 - Individual Bogie Wheel Loading.

E. 418 - Battery Compartment Temperatures.

E. 423 - Gradability.

E. 445 - Stowage, Weights and Photographs.

E. 451 - Gun Laying Segment.

E. 473 - Heat Transfer from Engine to Battery Compartment.

E. 480 - Rear Idler Bearings.

E. 482 - C.D.P. Track Pin and Shoe Wear when operating with Track Sag.

E. 489 - Stowage Bin Door.

E. 493 - Lubrication, Homelite Generator Engines.

E. 496 - Resistance to Skidding.
E. 505 - Sand & Snow Packing on Idlers.

E. 511 - Dominion C.S.D.-10 Synthetic Bogie Tires.

E. 549 - Modified Grease Fittings on Recoil Slides.

E. 596 - Sprockets Teeth Extension.

E. 597 - Cause for Extensive Wear of Sprockets.

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TANK, A.A., 20 MM. QUAD., SKINK

TANK, A.A. 20 MM., QUAD. SKINK

This is an anti-aircraft tank whose primary role is to provide protection for armoured columns against low flying enemy air-craft. In its secondary role it is very effective against soft ground targets.

The vehicle is similar in appearance and armour protection to a Grizzly Tank, but mounts four 20 mm. cannon operating in parallel. Guns have high elevation (-5 to 80°) and 360° traverse. Adequate power control permits ready aiming and facilitates concentration of guns on fast moving targets. Sighting is by a reflector sight, requiring the gunner's head to be exposed but observed tracer fire against ground targets can be carried out completely under cover.

A crew of five is carried; driver, co-driver, gunner, loader and commander. The latter three operate in the turret.

Guns can be fired simultaneously, singly, or in banks of two. Ammunition is carried in thirty round magazines, replaceable in twenty seconds.

The 20 mm. cannon firing control is electric-hydraulic operated through handle bar grips.

Chief considerations in the development were: (a) Grizzly (M4) lower hull and chassis be used with a minimum of modification; (b) a practical gang mounting of the four guns in a very limited space be arranged; (c) the turret crew be arranged to avoid undue restriction; (d) sufficient ammunition be carried and magazines easily and quickly changeable; (e) adequate acceleration and speed in gun traverse and elevation be provided with fire control; and (f) the turret protection be similar to that on medium tanks.

The final design includes a cast armour steel turret, mounting four individual gun cradles and mantlets all linked in parallel to a pair of hydraulic elevating rams. The gunner sits forward between the guns with the loader and commander at the rear. All are provided with hatches. Loaded magazines are carried in readily reached armoured bins in the sponsons.

Individual "Oil Gear" pumps (with special control cams) driven from a common high duty electric motor provide hydraulic power for the turret traverse and gun elevation.

The handle bar control operates the pump cams mechanically and includes electric palm and finger switches for supplying current to the traverse motor and energizing the firing solenoids.

To provide sufficient turret acceleration, it was found necessary to modify the engine driven generator, develop a new high output auxiliary generator and design a new electrical system with adequate switching, balancing and control units.

In the development of the turret, it was necessary to pay particular attention to: (a) design, counter-balancing and locating of hatches; (b) type, number and location of vision and sighting devices, and (c) ammunition and ancillary stowage.

A change in the G.S. requirement from Hispano to Polsten Guns during the piloting invalidated much previous design work.

Constant valuable advice on tactical requirements from resident D.V.S.A. officers must be acknowledged.

The major manufacturing difficulty encountered in Canada was the casting and machining of the armoured steel cast turret, particularly with reference to the fine dimensional balance, and proof limits required.

The reworking of the Grizzly Tank hull to accommodate the Skink electrical system and to conform to stowage requirement was straightforward although considerable development work was necessary.

Although the vehicle was highly commended by most senior War Office officials, complete allied air supremacy in North West Europe after D-Day eliminated the tactical demand for Anti-Aircraft Tanks, and production ceased after three vehicles and eight conversion kits had been completed in 1944.

TANK, A.A., 20 MM., QUAD., SKINK

Tactical Data

PRODUCED BY - Montreal Locomotive Works, Tank Arsenal, Montreal, and Waterloo Manufacturing Co.

PRODUCTION
Commenced - January 1944.
Finished - Production suspended.

VEHICLES PRODUCED - 3 Complete Vehicles
- 8 Turret Kits complete for assembling on Grizzly Chassis.

SERIES - Tank A.A.,20 MM.Quad.Skink.

TYPE - Anti-aircraft tank (F/V to protect armoured units and assault troops against low flying aircraft).

BRIDGE CLASSIFICATION - 30

CREW - 5, Driver, Co-driver,Gunner, Loader, Commander.

ARMOUR -

Turret,	Front	2½"	- 2"
	Rear	1½"	- 1"
	Side	2"	- 1"
	Top	1½"	- 1"
Hull,	Front	2"	
	Rear	1½"	- 1"
	Side	2"	- 1½"
	Top	2"	- 1"
	Bottom	1"	

TURRET - One-piece armour steel casting 69" Ring.
Hatch for each member of turret crew.
Hatches can be closed down for ground targets. For observation and sighting, hatches open in A.A. role.

TRAVERSE - 360° Hand or power (Oilgear). Continuous traversing in either direction obtainable at variable speeds up to 60° per second.
Electric Oilgear Hydraulic type. Electric drive from engine driven (Autolite) generator, or auxiliary (Homelite) generating unit.
Control by hand grips on gunner's control column.

GUN MOUNTS - Main - Four interior mantlets in parallel, each carry a cradle mounting a gun. Elevation (guns) Hand or Power (Hydraulic rams). 80° to -5° obtainable at speeds up to 45° per second.
Bow (right) Ball & Socket Mount.

ARMAMENT - Polsten 20 mm. Mk.I & AN-M2 M.G. 2 banks of 2 guns each mounted in front of turret (1920 rds., in 64, 30 rd. magazines).
Browning cal. .30 M.G.M1919A4, 1 (flexible type) mounted in right bow -Ball&Socket Mount. (2250 rds. in 9,250 rd.boxes)
Thompson cal. .45 S.M.G. (440 rds.)
2 carried, not mounted.
Signal Pistol, 1"(20 cartridges)
12 Hand Grenades

CONTROLS - Traverse, elevation and firing all by handle bar.

SIGHTING - Sight Illuminated, Mk.IX (U.S.Navy) Model "O", 24-volt, carried on mounting and moves with the guns.

PROTECTED VISION - Periscopes
4-U.S.O.M6 (2 for driver,2 for co-driver)
2-Vickers type, armour shield, 360° rotation, rear vision device(1 for commander and 1 for loader)
1-Vickers type, no shield, no rotation, no rear vision. (for gunner)

COMMUNICATION - No. 19 Wireless,Mk.II or Mk.III
Internal, 1 C. Amplifier
5 Crew Stations

COMPASS - Pioneer Type No. 1829.

LIGHTING - Interior - 3 Dome lights(hull)
3 Dome lights(turret)
Individual switches
1 Light for illuminated sight
1 Inspection lamp w/cord
Exterior - 4 Tail lamps(1-32 CP)
2 Head lamps

ESCAPE HATCH - In hull floor.

PERFORMANCE DATA

POWER/WEIGHT - Net power to gross weight ratio 13.0 B.H.P. per short ton.

GROUND PRESSURE - 12.7 p.s.i. (13.6 p.s.i. with C.D.P.track).

GROUND CLEARANCE - 17".

GRADABILITY - Theoretical in 1st. gear - 30° Ascending. 30° Descending.

MINIMUM TURNING RADIUS - 31'.

SPEED, MAXIMUM - 20 m.p.h.

TRENCH CROSSING ABILITY - 6' 2".

VERTICAL OBSTACLE CLIMBING - 24".

FORDING DEPTH - At slow speed - 36".

CRUISING RANGE - Highway - 125 to 145 miles.

FUEL CONSUMPTION - .90 m.p.g.

OIL CONSUMPTION - 2 q.p.h.

LADEN WEIGHT - 63,100 lbs.

OVERALL DIMENSIONS
- Length - 20' 4" (without sand shields 19' 1").
- Width - 8' 9".
- Height - 9' 4" (with guns fully elevated 11' 11").

CENTRE OF GRAVITY -

ENGINE
- Location - At rear.
- Make - Continental Motors Corp.
- Model - R975-C1.
- Type - Static Radial air-cooled 4-cycle petrol, 9-cyl.
- Displacement - 973 cu. ins.
- Peak Gross B.H.P. - 400 @ 24 r.p.m.
- Torque (Max.) - 965 ft/lbs. @ 2100 r.p.m.
- Lubrication - Engine oil tank capacity-30 qts. Oil drawn from oil tank by gear type pressure pump divided into two sections: a separate pressure pump delivering oil to all bearings and parts; a scavenge pressure pump returning the oil from the sump through oil filter to oil cooler and oil tank. The oil pump incorporates a pressure relief valve.
- Ignition - Two magnetos. (Scintilla-Bendix or Bosch)
- Priming Pump - To facilitate starting engine.
- Air Cleaners - Type - Oil bath. Number-Two. At rear of engine compartment.

Modifications in R975-C1 engine:
Compression ratio changed from 6.3:1 to 5.7:1 to permit the use of 80 octane motor fuel. The C1 engine also includes new design carburetor, incorporating an electric idle fuel cut-off, a built-in degasser, a diaphragm type (A.C.) fuel pump, which obviates need of a fuel relief valve.
A manual visual type of oil dilution system, independently operated booster coil and starter switches, engine oil pressure gauge with low oil pressure signal lamp. A new type Cuno oil filter, automatic or hand-cleaning; and high idling mechanism linking accelerator pedal with throttle controls to facilitate gear shifting.

COOLING SYSTEM - Type - Air-cooled. Air-ducts formed on engine by baffles bolted around and between each cylinder and cylinder head. A shroud forms a further duct for the inlet of air through the grill.

Method - Fan mounted on engine fly-wheel rotates in the shroud, drawing air through a grill in top upper hull and forcing it between and around the finned cylinders of the engine. The warm air passes through baffles and discharges above engine door at rear of vehicles.

FUEL SYSTEM
- Type - Petrol. Motor fuel 80 octane rating or better.
- Tank Capacity - Total - 146 gallons. Four fuel tanks, each having separate shut-off valve.
- Location - Two V-tanks front corners engine compartment. Two H-tanks on each sponson in engine compartment.
- Feed - Fuel flows from the tanks to central header, drawn through strainer by fuel pressure pump to cerburetor. A separate three and one-half gallon fuel tank for auxiliary generator is attached to the sponson ceiling.
- Fuel Cut-Off - Fuel can be cut off electrically at the carburetor by means of a toggle type switch on instrument panel. A Cuno type fuel filter is supplied.

CLUTCH
- Make - Lipe.
- Type - Dry disc, built into engine fly-wheel. 2 discs, 1 drive plate 16" open type pressure springs.
- Method - Depressing clutch pedal compresses springs and frees engine power from propeller shaft. Releasing clutch pedal transmits power through propeller shaft to input shaft of gear box.

GEAR BOX
- Type - Synchromesh.
- Ratio - First Gear - 7.56 : 1
  Second Gear - 3.11 : 1
  Third Gear - 1.79 : 1
  Fourth Gear - 1.11 : 1
  Fifth Gear - .73 : 1
  Reverse Gear - 5.55 : 1
- Lubrication - Oil circulated by small pump built into the transmission case. Oil drawn from transmission and differential sumps passing to oil cooler at rear of fighting compartment, returning to transmission and differential cases to lubricate the gears and bearings.

STEERING AND FINAL DRIVE -
- Type - Controlled Differential.
- Ratio Bevel Gear - 3.53 : 1
  At sprocket - 9.88 : 1

STEERING CLUTCHES -
- Location - On each side of bevel drive.
- Type - Controlled Differential.

Incorporated in the controlled differential, on either side, is the steering device, each of which consists of a brake drum and brake shoe, actuated by a lever. When the speed of one brake drum is reduced by pressure of shoes, the speed of the other is increased.
Driver's seat on left of transmission.

STEERING BRAKES
Band type controlled by steering levers.
Parking brake - Steering lever type controlled by foot pedal operating ratchet quadrants.
1-piece final drive equipped with double anchor type control brakes.
3-piece final drive equipped with single anchor type control brakes.

SPROCKETS -
- Location - At front
- Number - Two twin driving sprockets (interchangeable)

The twin driving sprockets are bolted on each end of the detachable hub assemblies of the final drive shafts.

	Standard	C.D.P.
Diameter	27 9/32"	26 2"
Number of teeth	13	17
	(Teeth engage end connectors of track shoes)	(Teeth mesh on outboard lugs of track)
Pitch	6"	4.6"

TRACKS -

Type	(T54E1, T49, A.S.F.)	(C.D.P.)
No. shoes per strand	79	103
Tread (centre to centre)	83"	83"
Width of track	16½"	15½"
Length of track (ground)	147"	147"

SUSPENSION -
- Type - Vertical volute springs. Suspension brackets bolted to lower hull bottom and side plates provide upper seats for the volute springs to react on the bogie wheel lever arms and rubber-tired bogie wheels which run on the track.
- Number - 3 bogie or suspension assemblies on each side of vehicle, 2 volute springs in each assembly.
- Diameter of bogie wheels - 16"
- Improved suspension units with stronger volute springs and offset top rollers.

TOP ROLLERS -
One on each bogie assembly to support track. Roller bracket assembly is bolted to rear side of each bogie frame, the bracket having a spacer for the roller bearings. A track skid is bolted on top of the bogie frame.

TRACK ADJUSTING IDLER -
- Type - Steel idler wheels, 22" diameter eccentrically mounted on each side of vehicle, at the rear.

Adjustment - By turning hexagon end of spindle shaft, after spreading split housing and driving collar off serrations of spindle.

ELECTRICAL SYSTEM

24-Volt System

Battery - Two 12-volt 168 ampere hour storage batteries(Weight-175 lbs. each)

Battery Balancing Switch for transfer of radio load.

Generator.- Main -(Autolite) driven from main engine. 2000 W. Belt-driven from pulleys attached to front propeller shaft universal joint flange.

Circuit breaker and filter box.

Auxiliary (Homelite 7D28-14) generating unit, 2000 W., with control box containing load limit resistor, automatic reset overload circuit breakers and filter.

Both generators controlled by carbon pile voltage regulators (Eclipse) with interlocked circuits capable of parallel operation.

Note: The larger capacity of electric power provided for the high speeds and ratio of acceleration required both for traverse and elevation.

Starter - Direct electric starter, Eclipse type 817-1A, with hand starting attachment.

Starter solenoid switch, Eclipse type 518-21-A

Fuel cut-off solenoid, Eclipse type 500-15-A, operated by toggle switch on the instrument panel.

Traversing Motor - Emerson Electric 3 H.P. 3800 r.p.m. Type D-50-EY-217-E430.

Thermal Type Circuit Breakers.

Generator Control Panel.

MODIFICATIONS FROM TANK, CRUISER, GRIZZLY AND MAJOR PRODUCTION CHANGES

Fluid power supplied by 2 two-way variable displacement hydraulic pumps driven by a single electric motor.

Changeover from 20 mm. Hispano to 20 mm. Polsten guns.

Amendment to Mantlet, Lower Cradle.

New Design Slip-Ring.

New Design Sight Bracket.

Increase Stroke Ram Elevating Gun Assembly.

New Design Lock, Turret, Assembly.

Mechanism Cocking.

New Design Hatch, Gunner's Assembly.

Addition of a Battery Balance Switch.

New Design Lever for Co-driver's Hatch.

Improved arrangements of stowage.

Realignment of Dome lights.

To provide gas and water tight seal similar to that recently added to M4 Tanks.

Change Ammunition Stowage.

Relocation of Bow Machine Gun travelling lock bracket on right side plate.

Clutch Booster Assembly and High Idle Mechanism, to improve ease of clutch operation and Control Adjustment.

Clutch Dust Cowl

Auxiliary Generator. Model 7D28-14.

Towing lugs for quick release towing.

Periscope Support, Driver's and Co-driver's Hatch Assembly.

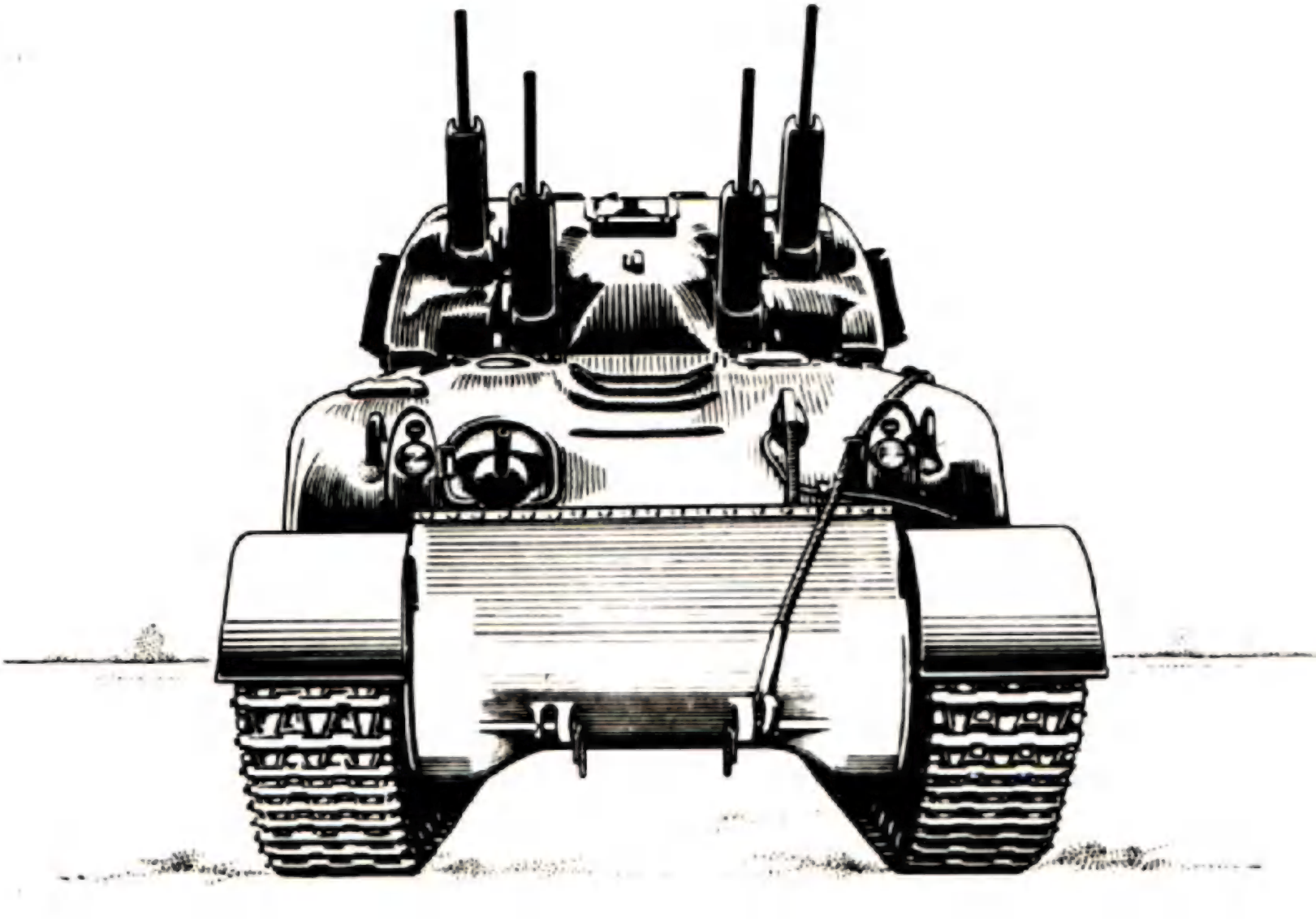
Armoured Stowage for Polsten 20 mm. Magazines.

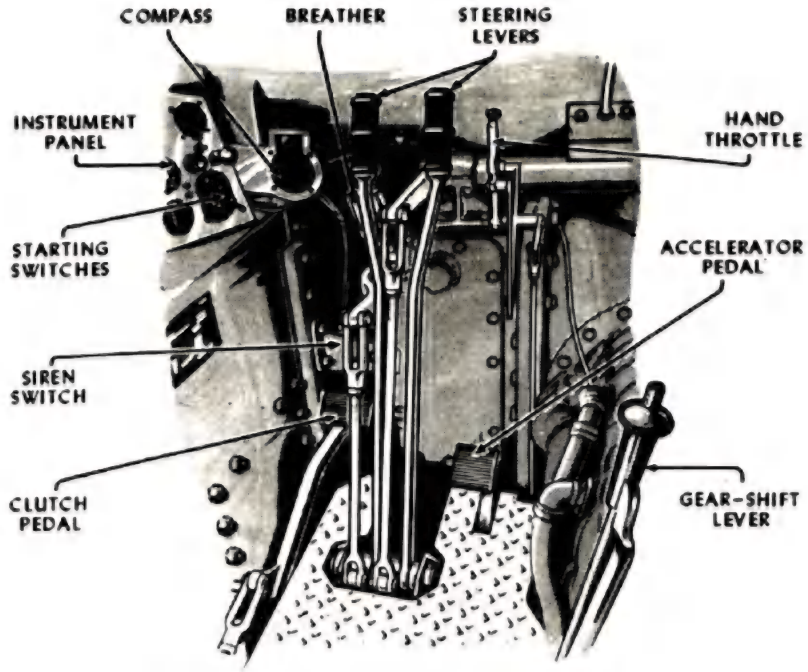
Unarmoured Bins Stowage, for .30 cal. Ammunition and Polsten 20 mm. Magazines.

Bendix-Stromberg N.A.R. 9G Carburetors, to improve engine performance.

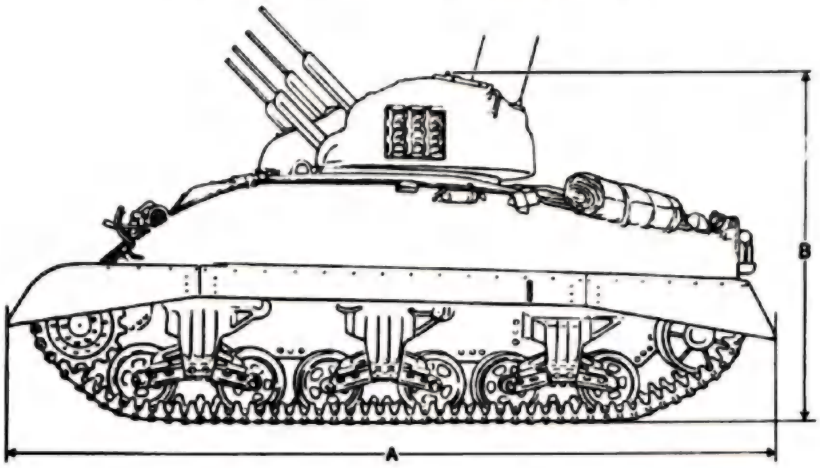
New Installation of Bow Machine Gun.

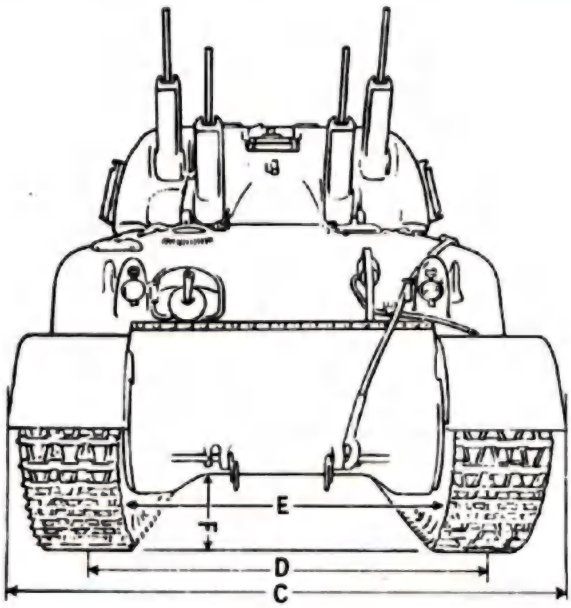
Improved Pad, Ground Strap, Auxiliary Generator added.





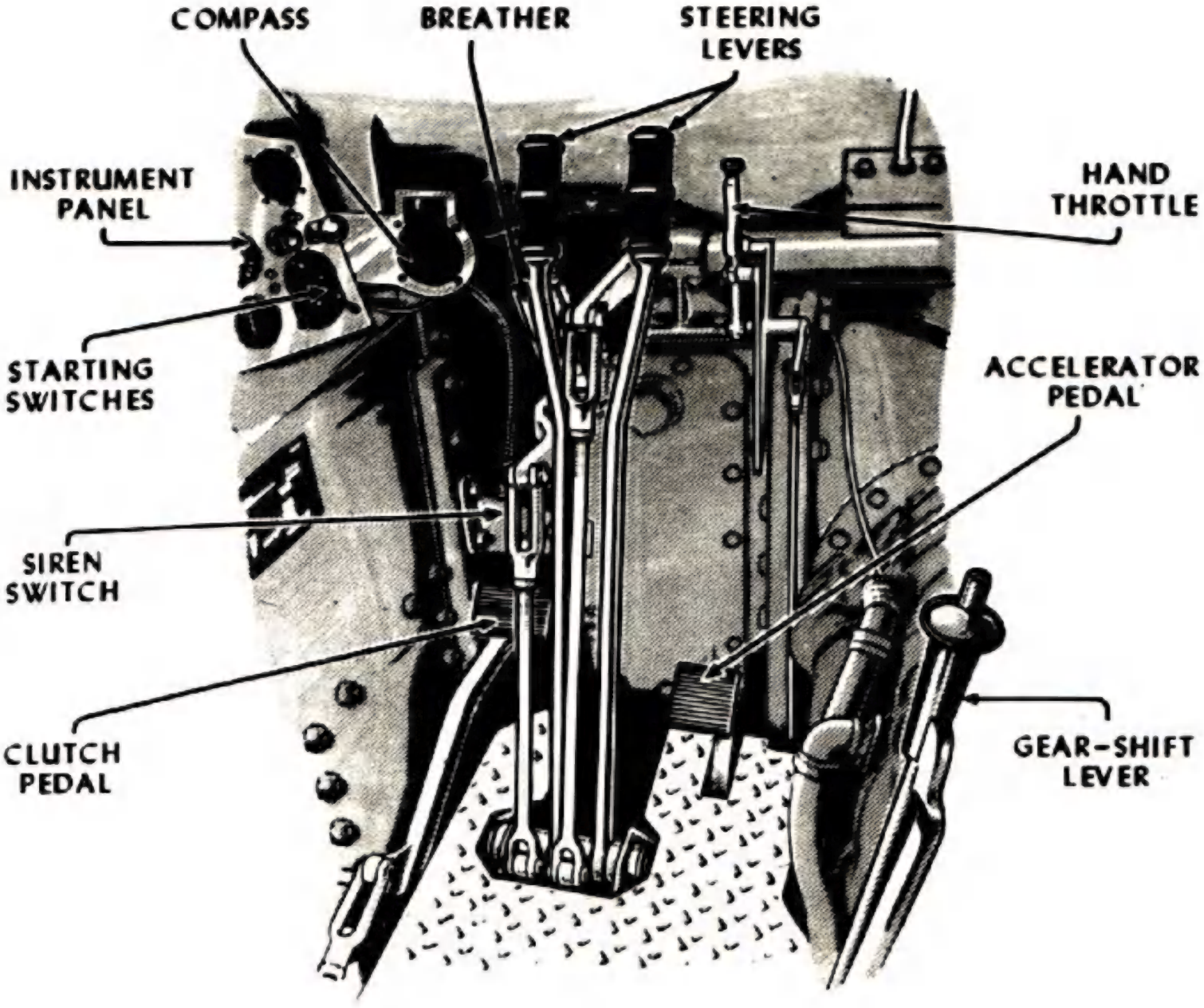
CONTROLS - DRIVER 'S COMPARTMENT

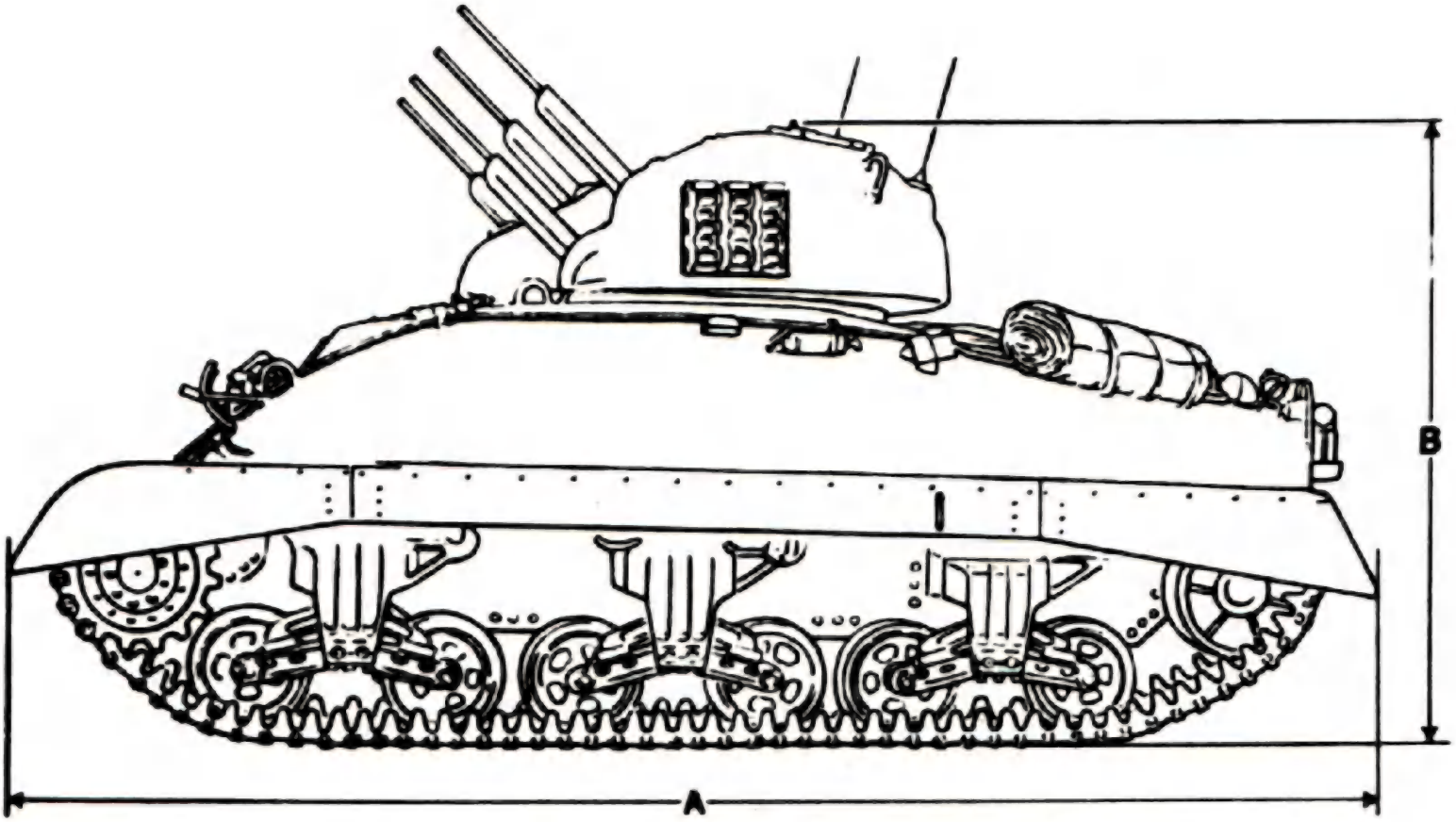


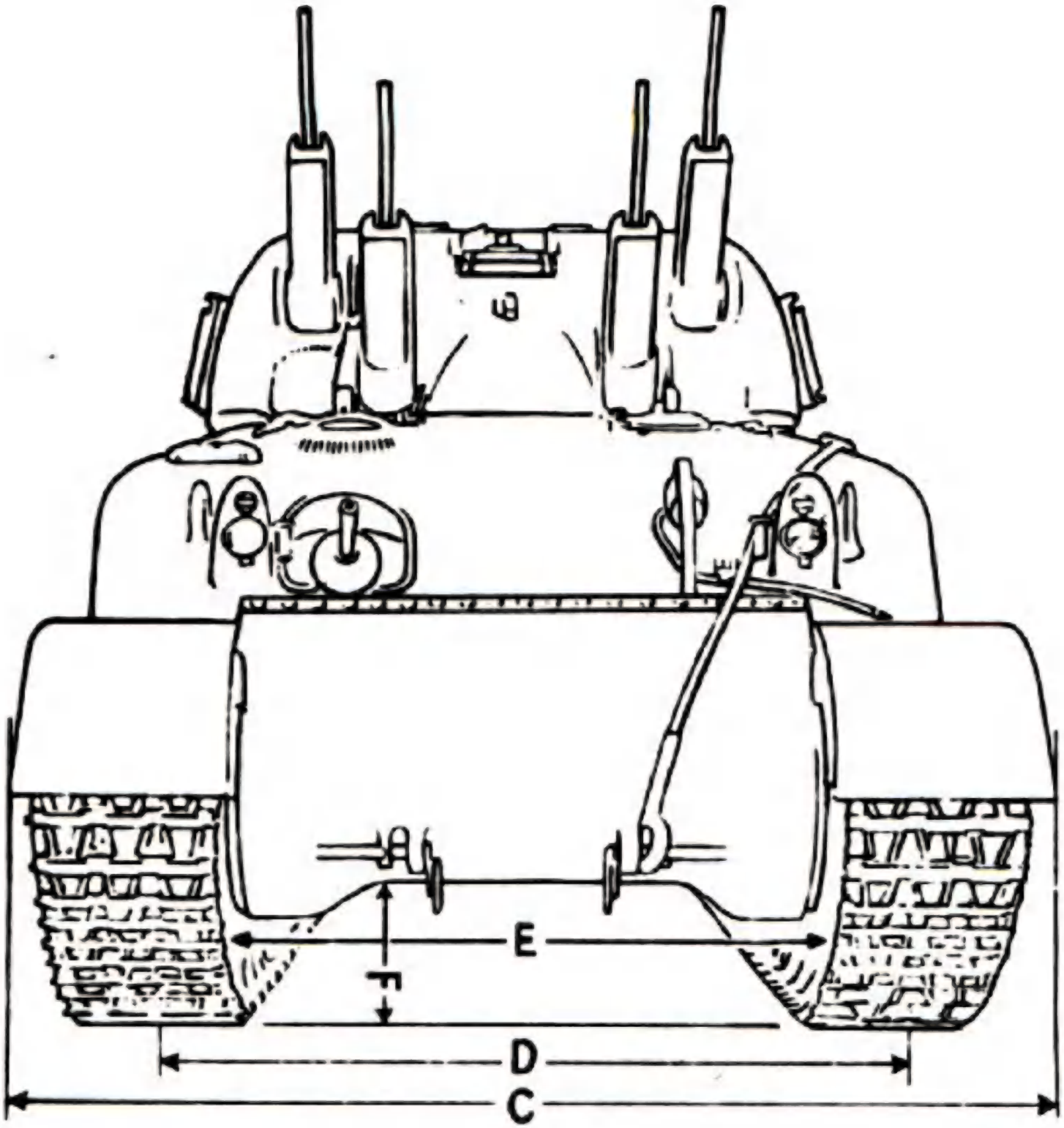


DIMENSIONS

★A	★★B	C	D	E	F
LENGTH OVERALL	HEIGHT OVERALL	WIDTH OVERALL	TRACK CENTRES	LOWER HULL WIDTH	GROUND CLEARANCE
20' 4"	9' 4"	8' 9"	6' 11"	5' 3"	17"
★ LENGTH OVERALL WITHOUT SAND SHIELDS 19' 1"					
★★HEIGHT OVERALL WITH GUNS FULLY ELEVATED 11' 11"					


COMPASS
BREATHER
STEERING LEVERS
INSTRUMENT PANEL
HAND THROTTLE
STARTING SWITCHES
ACCELERATOR PEDAL
SIREN SWITCH
CLUTCH PEDAL
GEAR-SHIFT LEVER


B
A


E
F
D
C

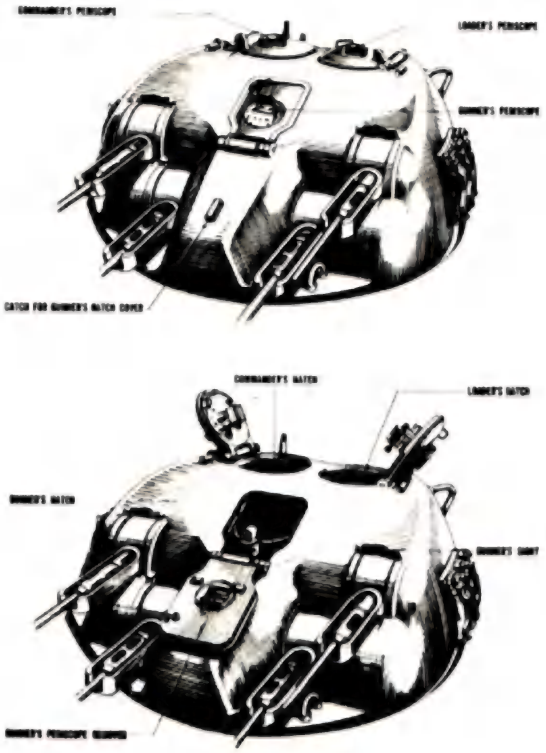
DIMENSIONS

★ A	★★ B	C	D	E	F
LENGTH OVERALL	HEIGHT OVERALL	WIDTH OVERALL	TRACK CENTRES	LOWER HULL WIDTH	GROUND CLEARANCE
20' 4"	9' 4"	8' 9"	6' 11"	5' 3"	17"
★ LENGTH OVERALL WITHOUT SAND SHIELDS 19' 1"					
★★ HEIGHT OVERALL WITH GUNS FULLY ELEVATED 11' 11"					

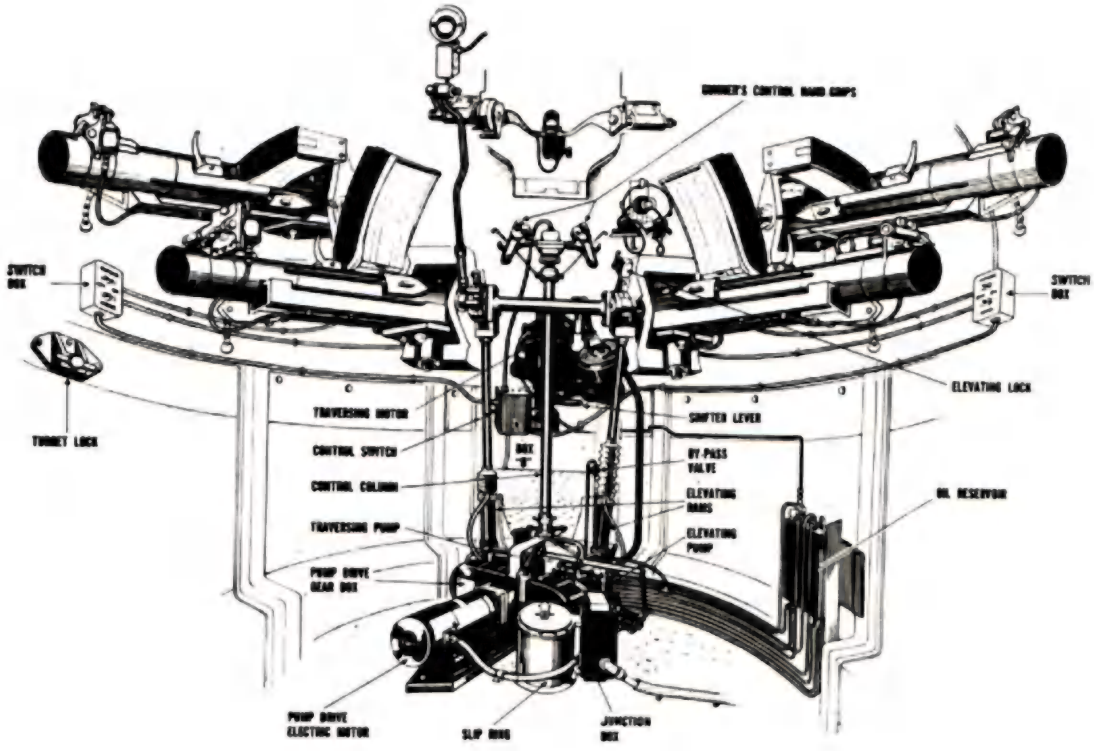
FRONT SILHOUETTE-Showing turret, gunner's hatch (closed) ,Polsten machine guns, bow gun, siren at left, M4A1 blackout and driving lights with weather seal plug housing shown on light guards (Plug to be used when lights are removed)

LEFT SIDE VIEW-Showing spare track shoes on side of cast armour turret and Polsten guns elevated. Ancillary equipment and towing cable in stowed position.

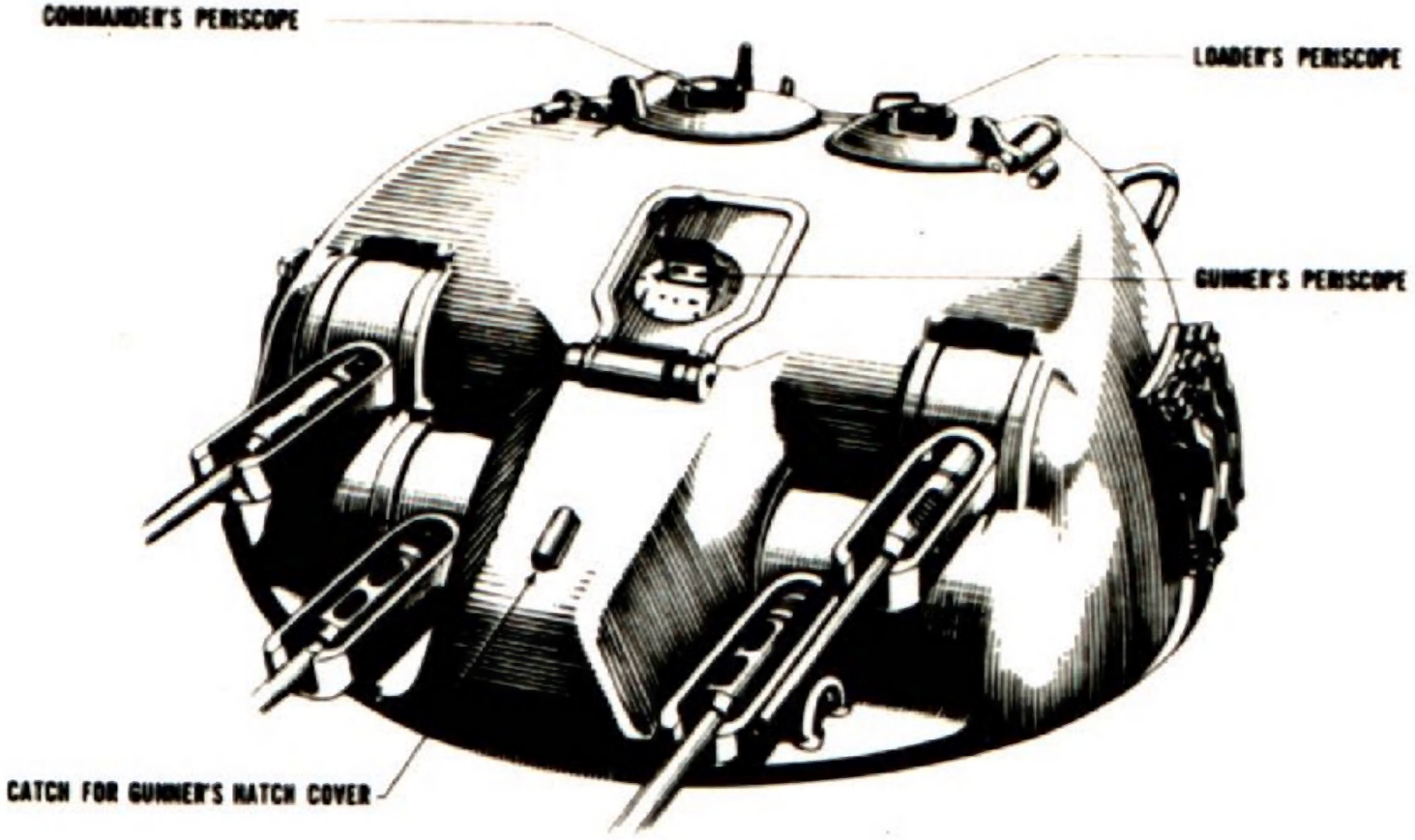
THREE-QUARTER LEFT REAR VIEW-Showing Base Aerials at rear of turret, water containers on rear of upper hull and air cleaners at rear of engine compartment.

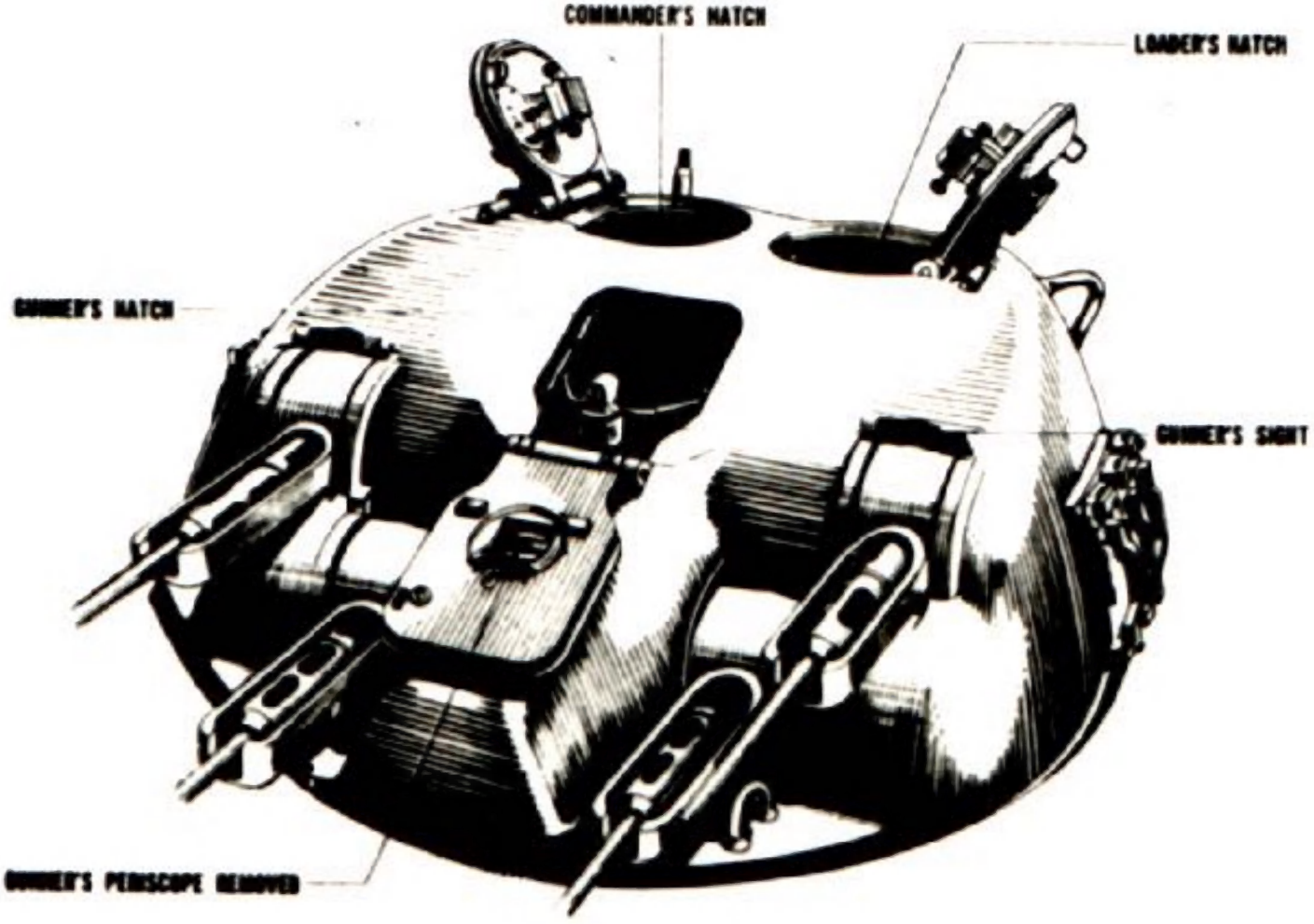


TURRET
Showing Hatches Open and Closed



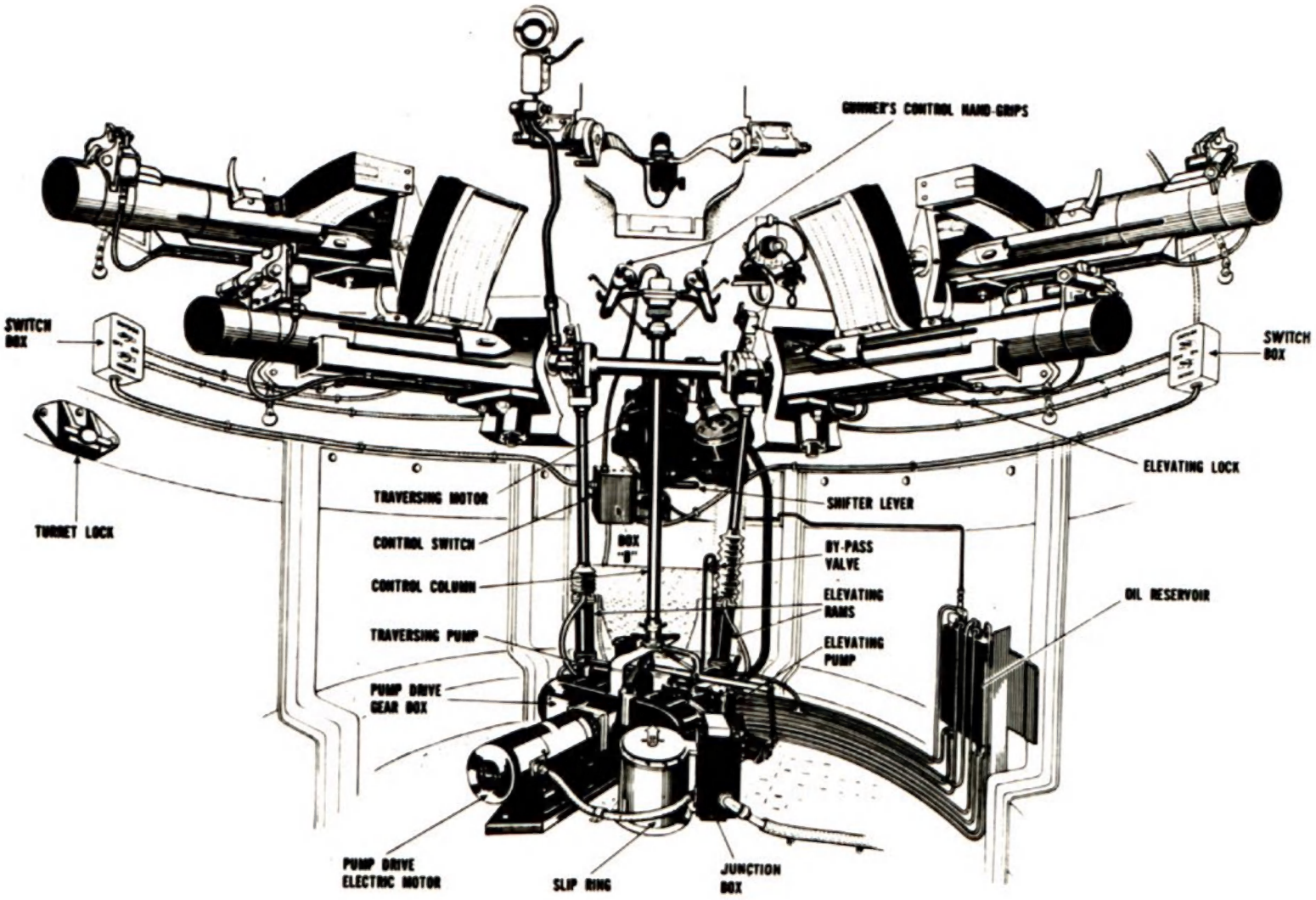
TURRET CONTROLS AND MECHANISM


COMMANDER'S PERISCOPE
LOADER'S PERISCOPE
GUNNER'S PERISCOPE
CATCH FOR GUNNER'S HATCH COVER



TURRET

Showing Hatches Open and Closed



TURRET CONTROLS AND MECHANISM

USER COMMENTS

REPORT ON FIRING TRIALS(PROJECT NO. 237/S/44)
EXPERIMENTAL WING AFVG SCHOOL, LULWORTH.
7 JANUARY 1945

This report comments favorably on many features of the vehicle such as:-

(a) General Layout of the Turret
(b) General Layout of the Guns.
(c) General Layout of Ammunition Stowage
(d) Ability to engage a target without the use of the main engine, etc.

The report criticizes certain features which should be improved such as:-

(a) Limitation of 150 m.p.h. Sight
(b) Short duration of fire.
(c) High creep speeds in the controls
(d) Lag in response of the controls, etc.

COMMENTS ON PERFORMANCE OF SKINK AA TANK IN OPERATIONAL TRIALS AND DEMONSTRATIONS CARRIED OUT IN NORTH WEST EUROPE, FEBRUARY-MARCH 1945, WITH ARMOURED REGIMENTS OF 1ST CANADIAN ARMY

The Skink was considered by all units to be a vast improvement over the Crusader A.A. Tanks.

The vehicle has proven mechanically reliable.

In a ground role, the vehicle was used as an infantry mopping up weapon and advanced with the second wave of armour to clean out infantry positions by-passed by the first wave.

The Skink using HEIT ammunition proved most valuable in setting fire to the buildings and thus forcing the enemy out into the open.

DEPARTMENT OF NATIONAL DEFENCE, OTTAWA,
SEPTEMBER 13, 1944, -
FILE HQS 3352-31-2 FD 17
"R.P. Brown" FOR DEPUTY MINISTER,(ARMY)

A.A. Tank "Skink"

"You will no doubt be interested to know that we have received from the War Office a letter congratulating us on the marginally noted development."

"I am quoting relative extracts from the letter"

"The rocket firing aircraft must be considered to be one of the most effective anti-tank weapons yet produced, and clearly shows that armoured vehicles will be subject to concentrated air attack.

I wish, therefore, to express on behalf of the War Office, our appreciation of the speed and efficiency with which the Skink turret was produced to meet what was, at that time, an important requirement."

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Skink, A.A. 20 mm.,Quad. Conversion Instructions from Tank, Medium, M4A1, 75 mm.- September 1944.

U.S.A. War Department,Mechanical Manual TM9 - 731A, Medium Tanks M4 and M4A1 - December 1943.

Data Book - Tank Type Vehicles of Canadian Manufacture, January 1944. Publication No. M&S 1877.

Files Series -
D.M.S. 141-55-1, 2, 3, 4, etc.
D.N.D. H.Q.S. 3352-31-1
D.M.S. D.A.D. Photo. File No. B-11

Design Change Instructions.
Skink D.C.I.No. 1 to D.C.I. No.390
Skink D.C.I.No. 1001 to D.C.I.No.1087

Design Deviation Permits.
Skink D.D.P. No. 1 to D.D.P.No.191
Skink D.D.P. No. 1001 to D.D.P. No. 1005.

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

E. 490 - Table of Weights and Photographs of Stowage.

Firing Trial Reports:

Skink, A.A. 20 mm., Quad. Firing Trial Report Against Cast Turret held at Valcartier Proof & Development Establishment, February 1944.

Skink, A.A., 20 mm., Quad. Firing Trial Report by the Directorate of Development of 'A' and 'B' vehicles and Small Arms at the Hamilton Artillery Proof, May 1944.

Skink, A.A.,20 mm., Quad. - Report on Splash Trials Against Turret held at Valcartier Proof & Development Establishment, October 1944.

D.V.A. Report -
Project D.V.A. 6 - 363

Production Orders:
C.D. - L.V. 3565 - 3 Tanks (complete)
8 Turrets(for kits).