DESIGN RECORD

CANADIAN-DEVELOPED MILITARY VEHICLES WORLD WAR II

VOLUME VIII

MUD & SNOW VEHICLES

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

MUD & SNOW 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

DEC. 31ST 1945

INDEX

COMMERCIAL VEHICLES

Commercial Background

Before the war little Canadian military interest appears to have been shown in self-propelled vehicles designed primarily for travelling over snow or ice covered terrain.

However, in the fall of 1941, when the British authorities requested that a survey of snow traversing equipment be made, it was found that a large number of commercial types were available on this continent. Investigation showed that the various types developed were basically for localized application, and, while successful to a degree for the purpose intended, a vehicle suitable for all types of conditions incurred in military operation did not exist. Furthermore, the technical and manufacturing capacity of most of the sources were very limited. The experience, ingenuity and resourcefulness of the commercial designers were recognized and due credit must be given them for the assistance put forward to guide the personnel charged with the responsibility of developing a snow traversing vehicle for military purposes. In addition, the data of the National Research Council on the subject of ski design and certain other technical information relative to propeller driven vehicles from the Royal Canadian Air Force was made available for study.

The following is a brief description of the typical commercial vehicles that were available. These types may be divided into two classes, namely, air propelled vehicles and surface traction vehicles.

A Air Propelled Vehicles

This type of vehicle was designed primarily for travelling over relatively open flat country at a high speed. Light weight construction was used resulting in weights from 600 to 1000 pounds without personnel or payload.

Usually the general arrangement was a pusher propeller mounted at the rear of a closed-in type of body. Accommodation for from three to four passengers was provided and the whole assembly mounted on skis. Both three and four skis were in use and were either attached through coil or laminated leaf springs which were mounted in a variety of methods. In some cases retractible wheels were provided which could be lowered to contact the ground surface where snow or ice were not available. Steering was arranged by either conventional car steering gear or by cable and drum operating on the forward ski or skis.

Engines of various types were used; the most popular being the air-cooled light aeroplane and passenger car engines of approximately 50 - 85 H.P. Where the latter were employed, it was sometimes necessary to provide a speed reducer between the engine and propeller.

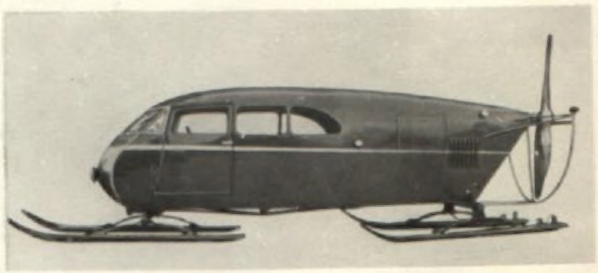
As an immediate potential military vehicle the propeller driven type appeared to have definite shortcomings, as follows:

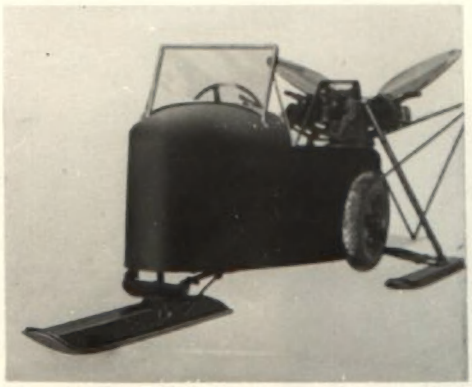
(a) gradeability was low

(b) manoeuvreability was poor

(c) propeller was susceptible to damage in wooded areas

(d) performance was seriously affected by head wind





(e) braking apparatus seemed inadequate

(f) convoy operations difficult due to flying snow.

European experience appears to have been with the propeller driven type of snow plane and this fact was reflected in the recommendations put forward by the Ministry of Supply when snow traversing vehicles subsequently became a requirement.

B Surface Traction Vehicles

Numerous types of surface traction vehicles had been developed in Canada and the United States. These may be divided into wheeled vehicle conversions and integral types. Integral types are those designed basically for snow traversing and may be further subdivided into screw, tracked and half tracked types.

(1) Wheeled Vehicle Conversions

These conversions were of various kinds using the driving axle of the vehicle as the motive means. Some varieties substituted a sprocket for the normal rear wheels while others provided a sprocket by using special lug tires on the vehicle rear wheels. A flexible track of considerable area was applied to the driving members of all types. Skis were used for front suspension and were in some cases attached to the vehicle wheels while in other cases they replaced the wheels and were attached to the front axle spindles.

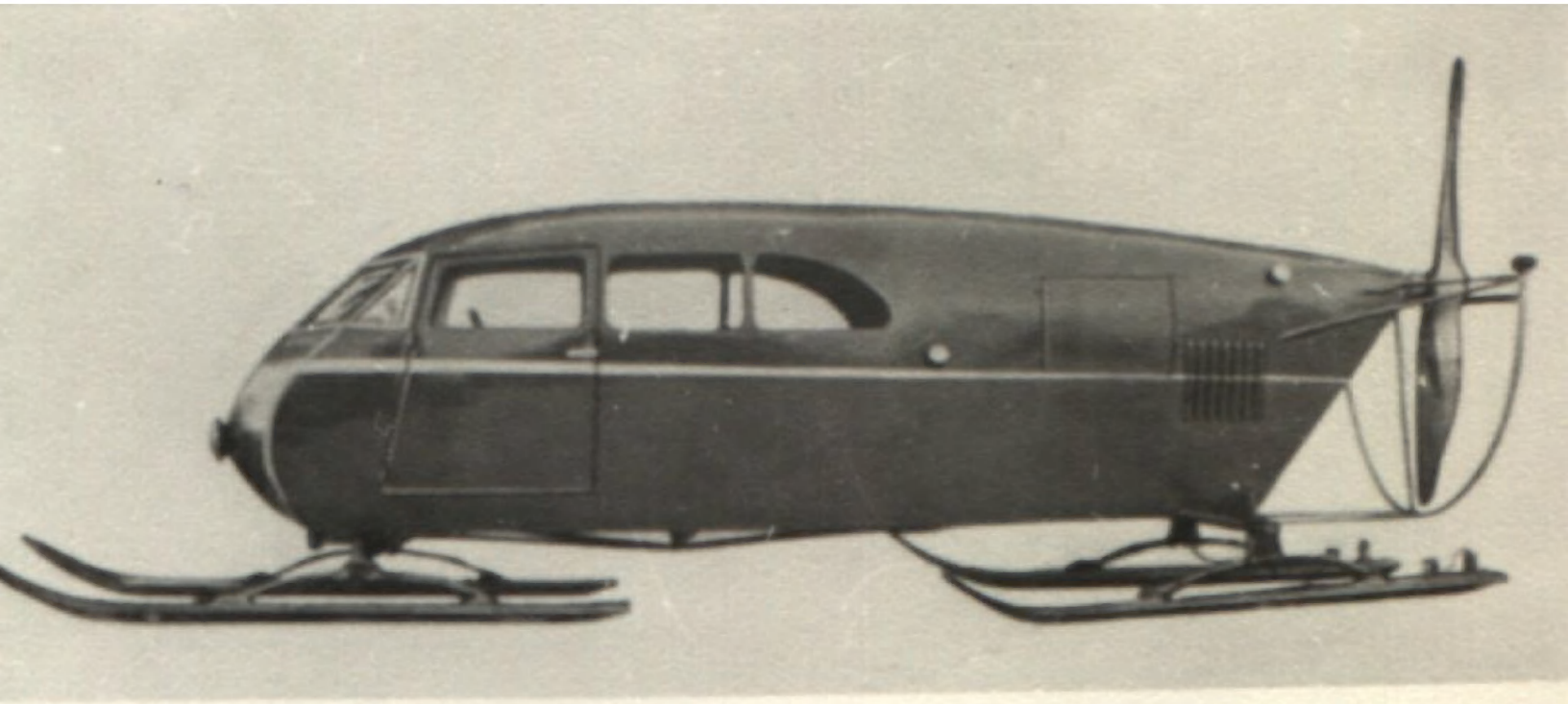
(2) Integral

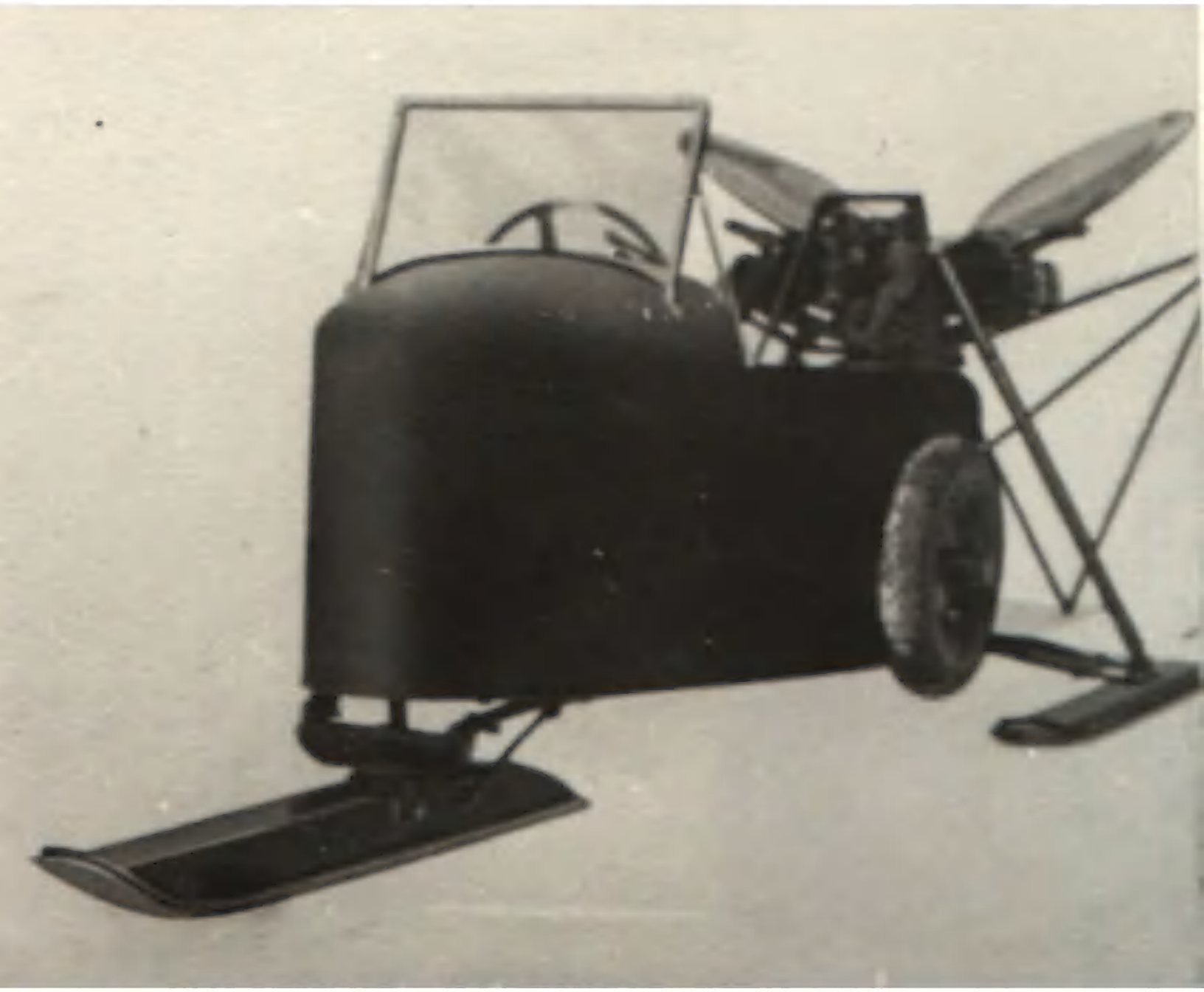
(a) Screw Type

This was a very light "Sportsman" type vehicle suspended on skis and driven by a spiral worm or worms mounted longitudinally and in contact with the snow surface. It was necessary for this type of vehicle to operate in deep snow otherwise the worm was subject to damage if rocks or bare ground were encountered.

(b) Tracked Type

Two tracked types existed in the





United States.

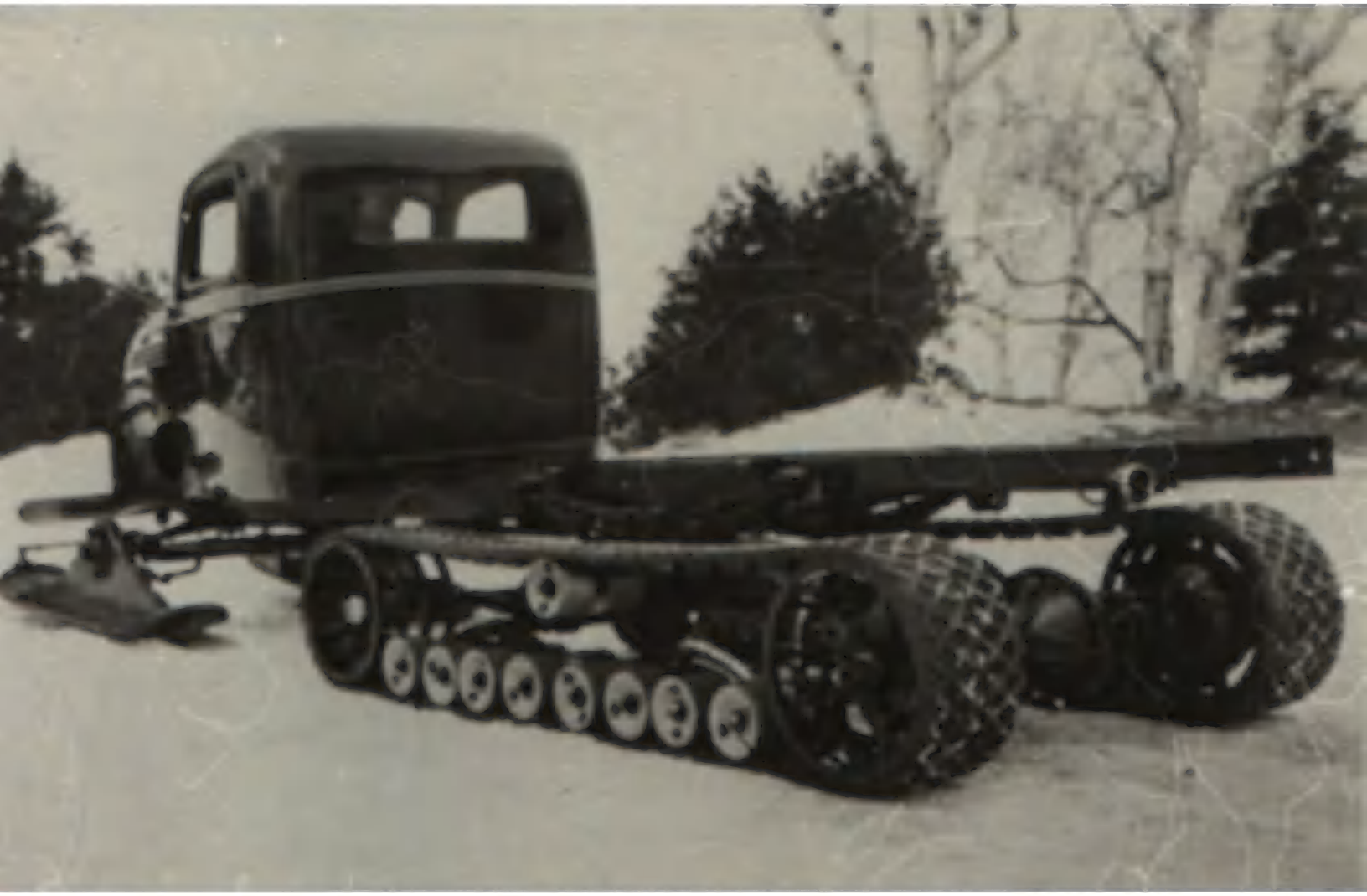
(i) The first was an open toboggan type of two passenger capacity. The motive unit consisted of a belt driven by a small air-cooled engine and located on the longitudinal axis of the vehicle projecting below the toboggan contact surface.

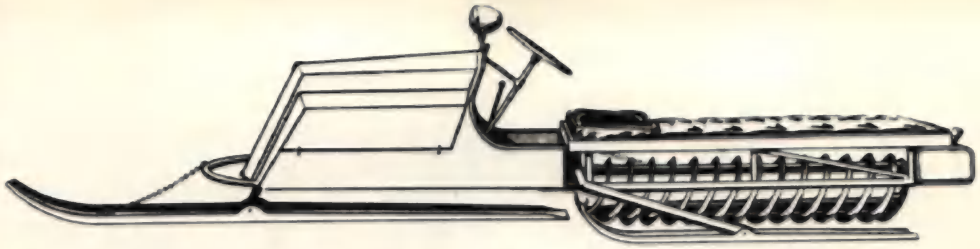
(ii) The other vehicle was a tractor which consisted of a single track with the engine inside of this track. Payload and personnel were carried on a barge-like sled towed behind the tractor. The barge was arranged to create eccentric drag for the purpose of steering the train.

(c) Half Tracked Type

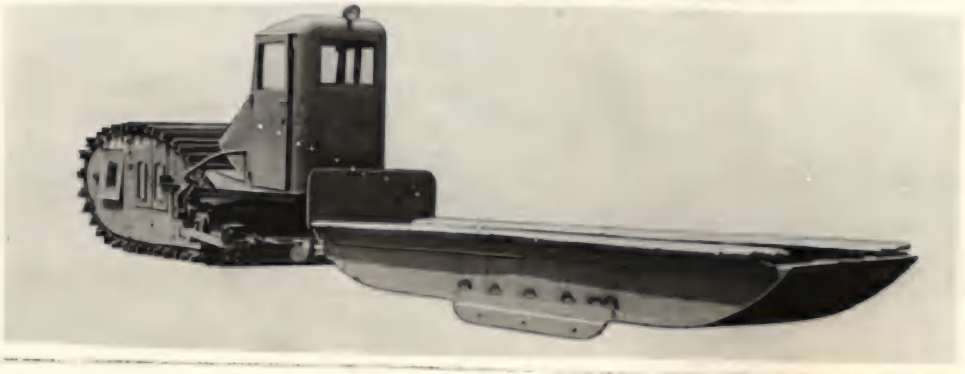
This consisted of fully enclosed type, in two sizes 4 or 8 passenger, powered with an automotive engine, transmission and axle. Tracks were independently sprung on each side and the vehicle was steered through two skis mounted on the forward end.

Extensive study was made on the above vehicles. After consideration was given to performance, availability of components; manufacturing facilities and possible practical modifications to suit a military role it was decided that the integral half track type possessed the greatest possibility of success as a military snow traversing vehicle. On this basis two Commercial Bombardier Snowmobiles were purchased and placed on test, to record their ability and to prove the components with military type usage..

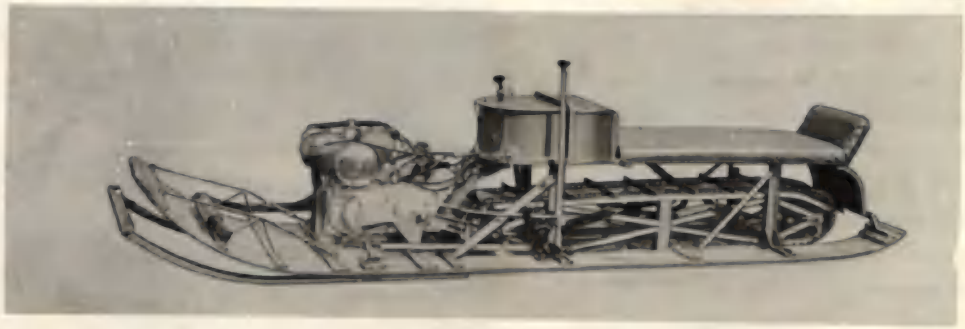




SNOW SLED

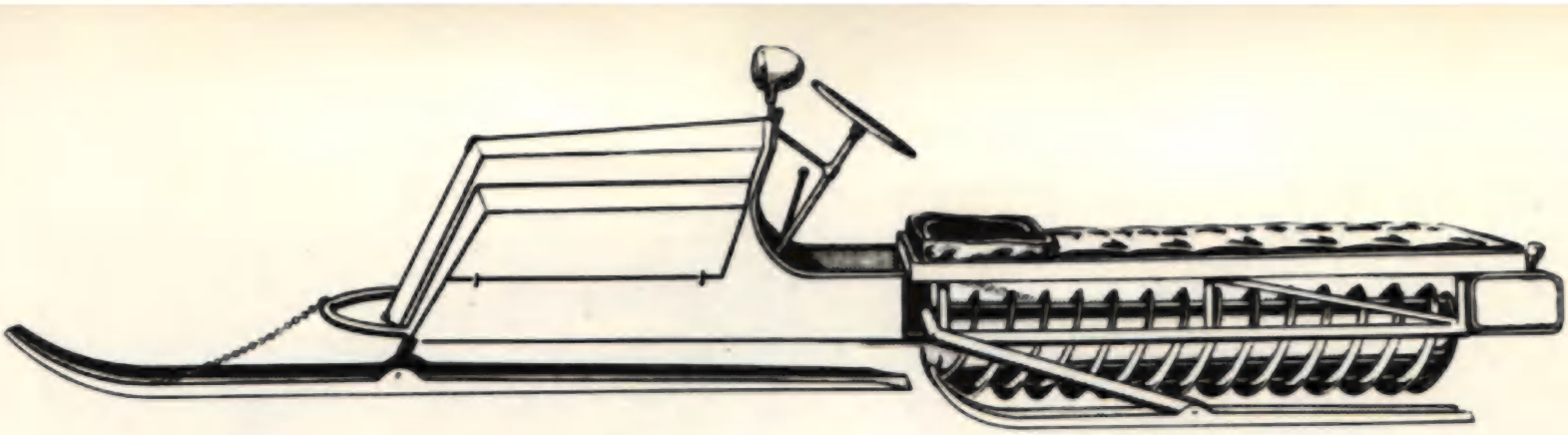


SNOW TRACTOR

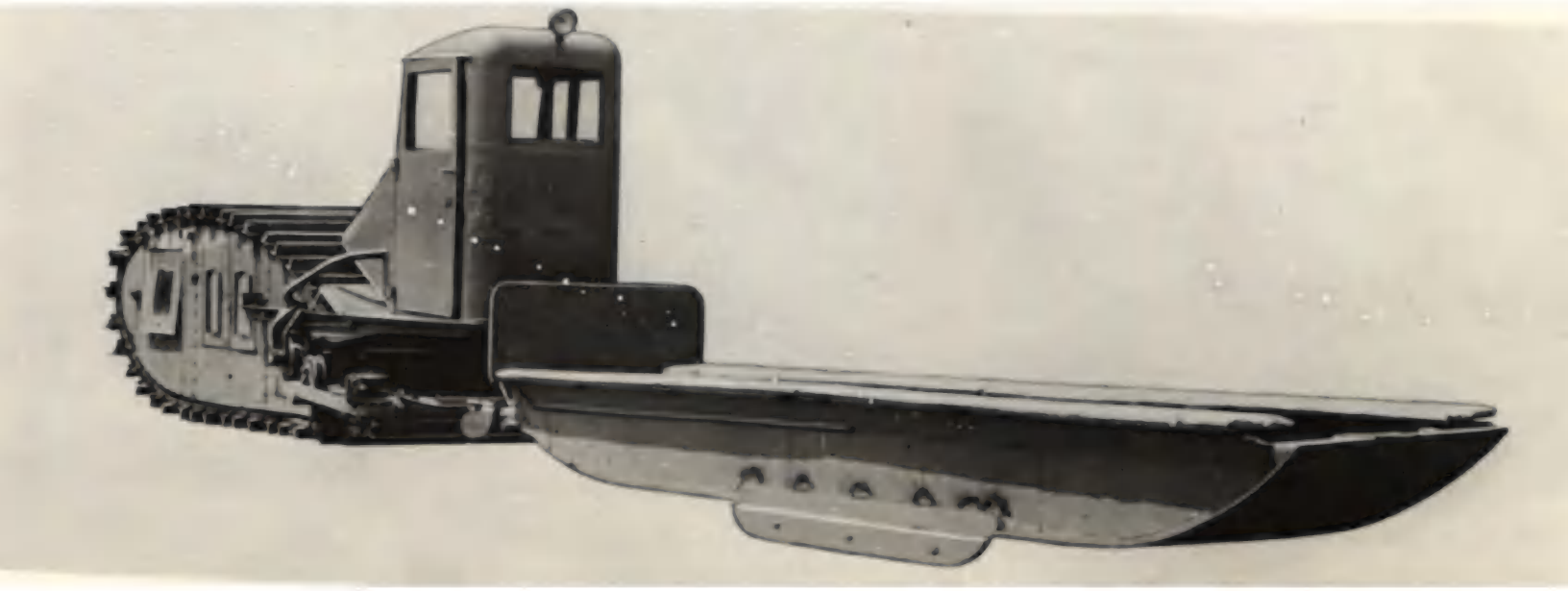


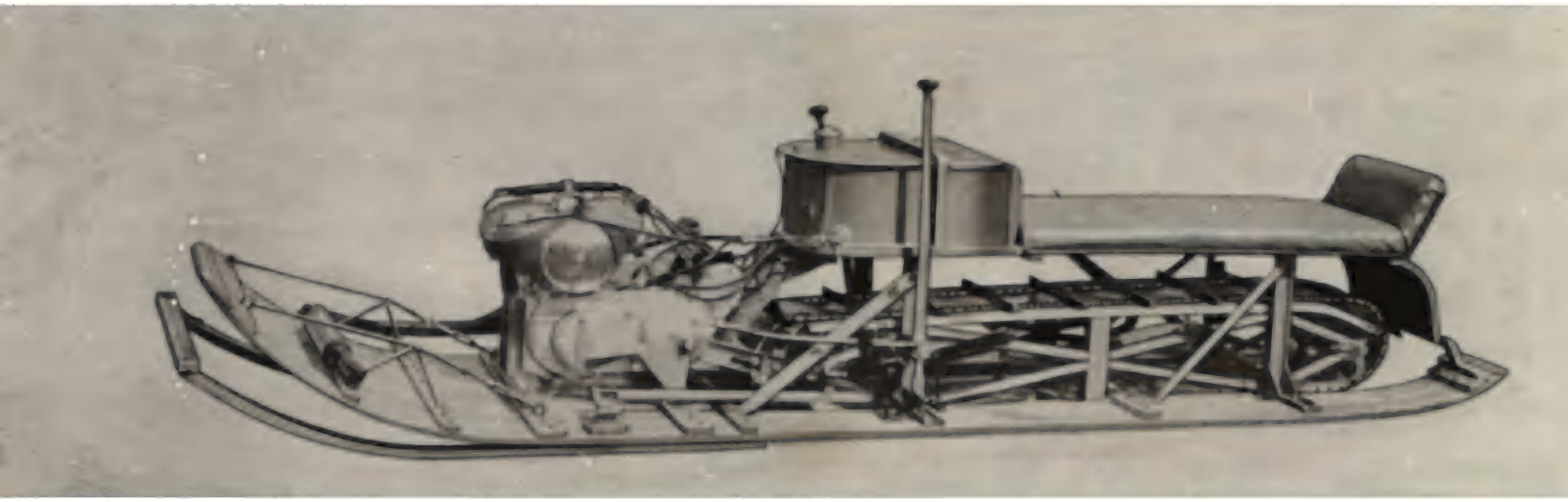
MOTOR TOBOGGAN

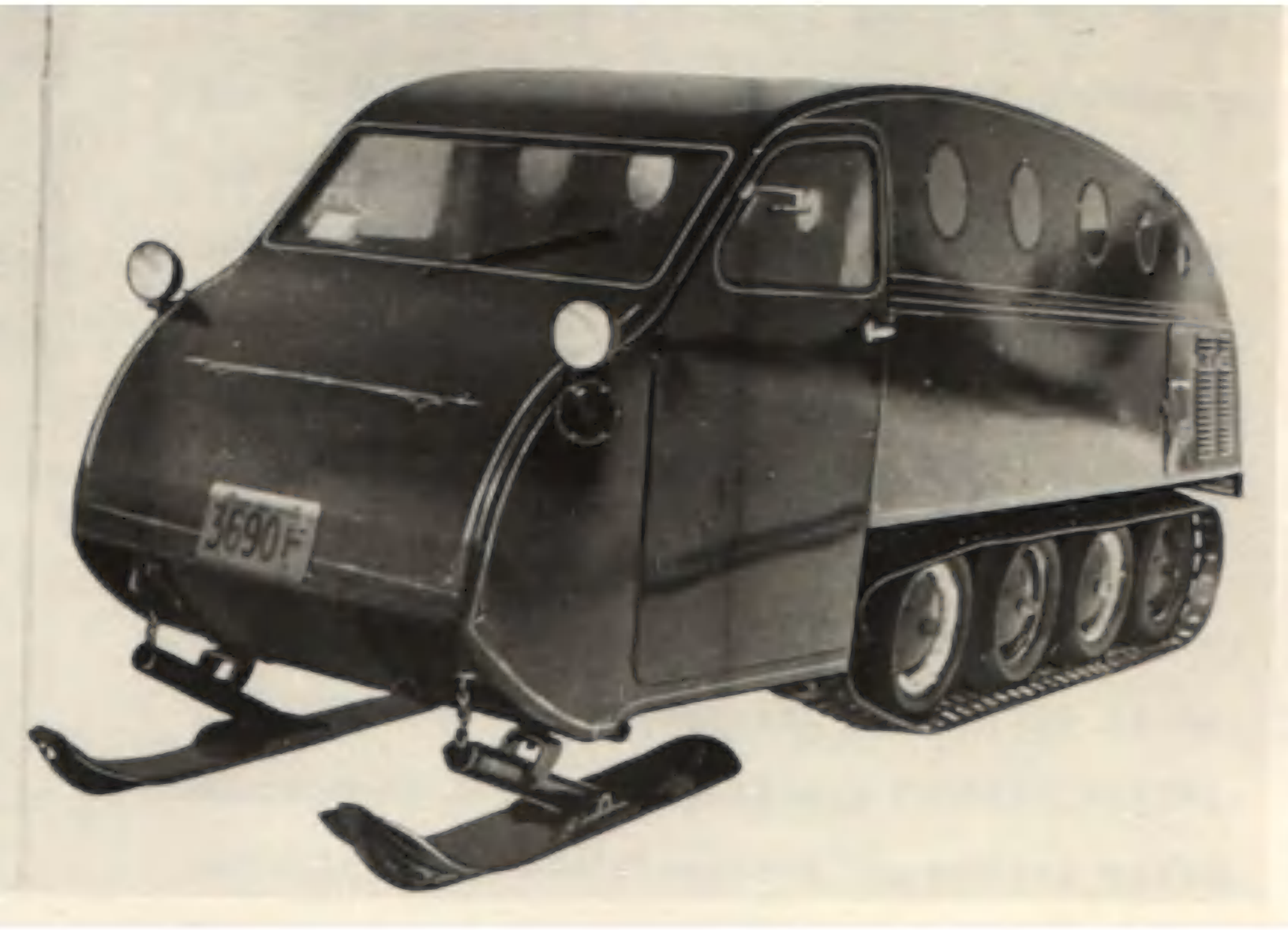
BOMBARDIER COMMERCIAL SNOWMOBILE



SNOW SLED



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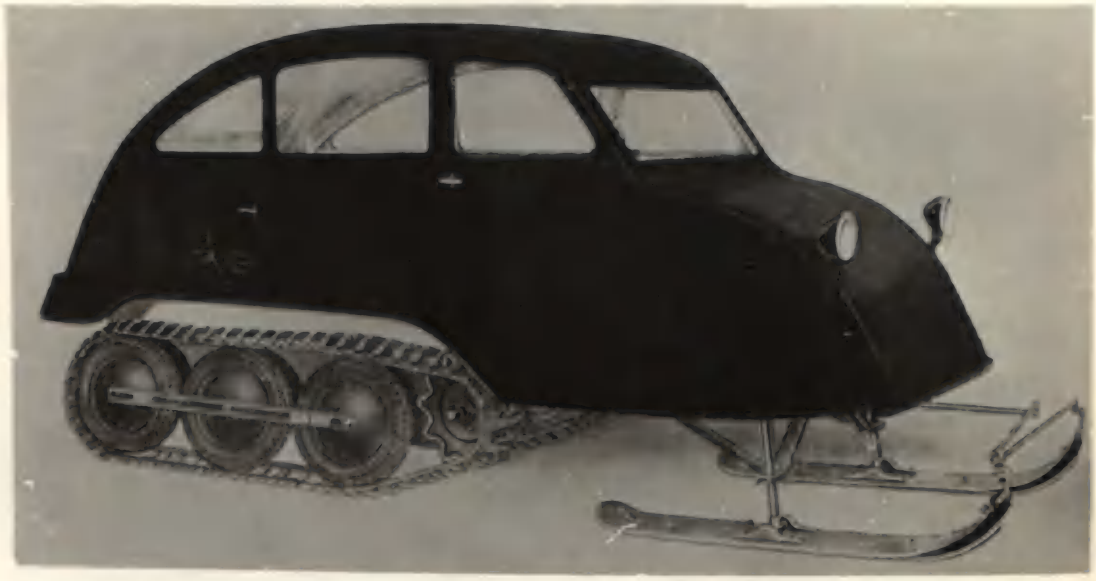


General Description of Bombardier Commercial Half Tracked Snowmobile.

The commercial Snowmobile was built with a tread width of 38 inches, both for skis and track. This width was used to coincide with the runner tread of commercial sleighs, as the greatest mileage was on roadways in civilian use. Early in the testing programme it became apparent that greater lateral stability was required, particularly during travel along an inclined plane.

The track width was thirteen inches which resulted in ground pressures and rolling resistance on unbroken deep snow such that operation in second and low gears occurred a considerable portion of the travelling time. Low cross country miles-in-the-hour was experienced.

The axle Brakes on this vehicle were mechanical, operated through cable linkage and were not completely sealed. Some difficulty was soon experienced with the cables and the brake assemblies becoming in-operative at low temperatures, particularly after standing in the open after an operation.

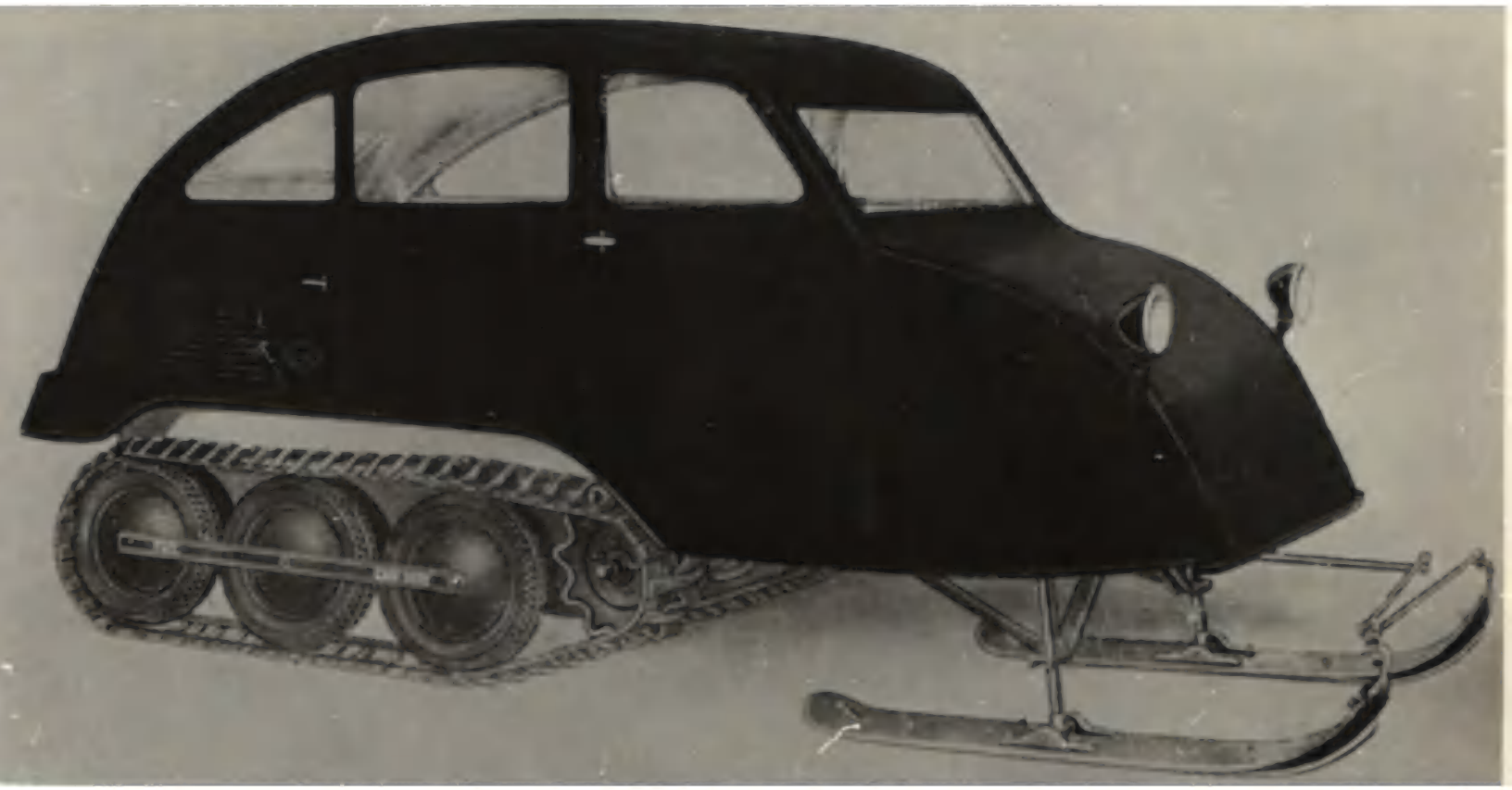
The steering skis were supported to allow for some unevenness of the ground surface. The basic design was unique but the ruggedness of the commercial pattern was insufficient to withstand continued cross country running. The reader is referred to the description of the military Bombardier Snowmobile for details of this suspension.

The Track Suspension consisted of four independently suspended tired-wheels on each side of the vehicle set in-line ahead, around which ran a two section rubber belt with steel cross bars tying the belts together. The cross bars formed traction lugs also to driving lugs on engagement with a sprocket on the driving axle. This suspension is described in more detail under the Military Bombardier Snowmobile Section of this volume.

Continued operation over virgin snow brought to light that the openings in and around the engine compartment caused the snow to enter the compartment and on melting, created ignition hazards.

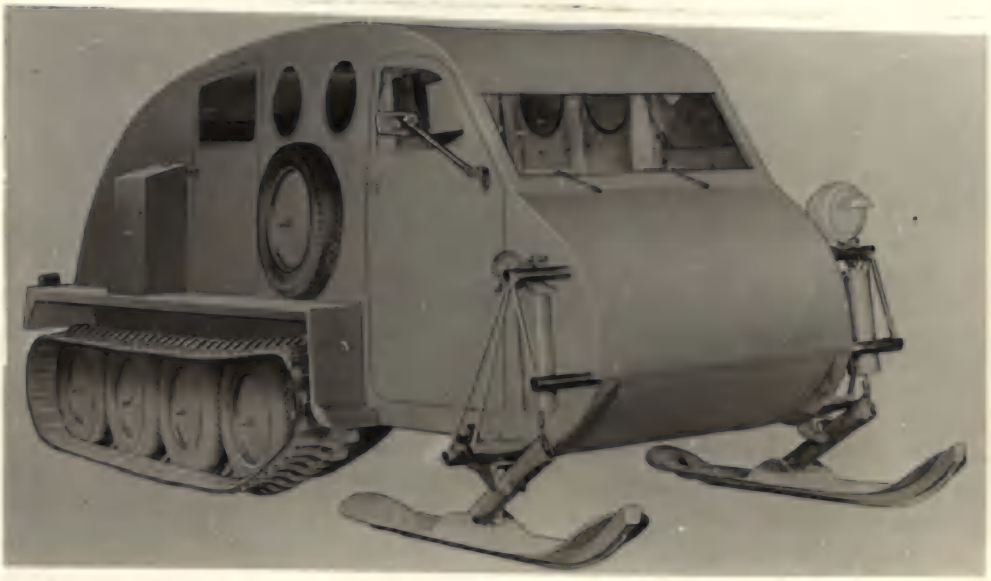
The engine fitted was a Ford 85 H.P. V-8. The Transmission was a Ford 3 Speed passenger car type. Each of these units was taxed in capacity when the vehicle operated over unbroken terrain. On highways already "trail broken", the power plant was adequate however with top speeds of 35 - 40 miles per hour possible.

As a result of the tests carried out by A.E.D.B. on the commercial Snowmobile it was decided to produce a Military Pattern vehicle which included modifications to, but was basically the same design as the civilian unit. This vehicle is more fully described in the section entitled "Snowmobile Bombardier Half Track".



HALF TRACK SNOW VEHICLES

MILITARY BOMBARDIER HALF TRACK SNOWMOBILE



The basic pattern for the military Snowmobile was the bus type 8 Passenger Bombardier commercial vehicle described in the previous section.

The Military Bombardier Snowmobile, designed for the transportation of personnel and/or supplies over snow-covered terrain, was a non-armoured ski-steering Half Tracked vehicle.

Its basic tactical features included

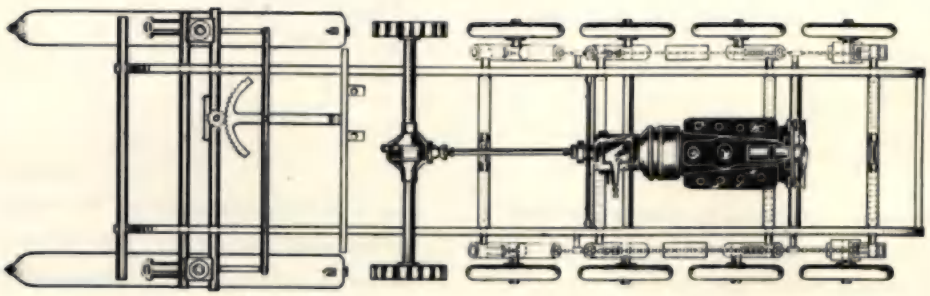
(a) medium high cruising range of approximately 200 miles,

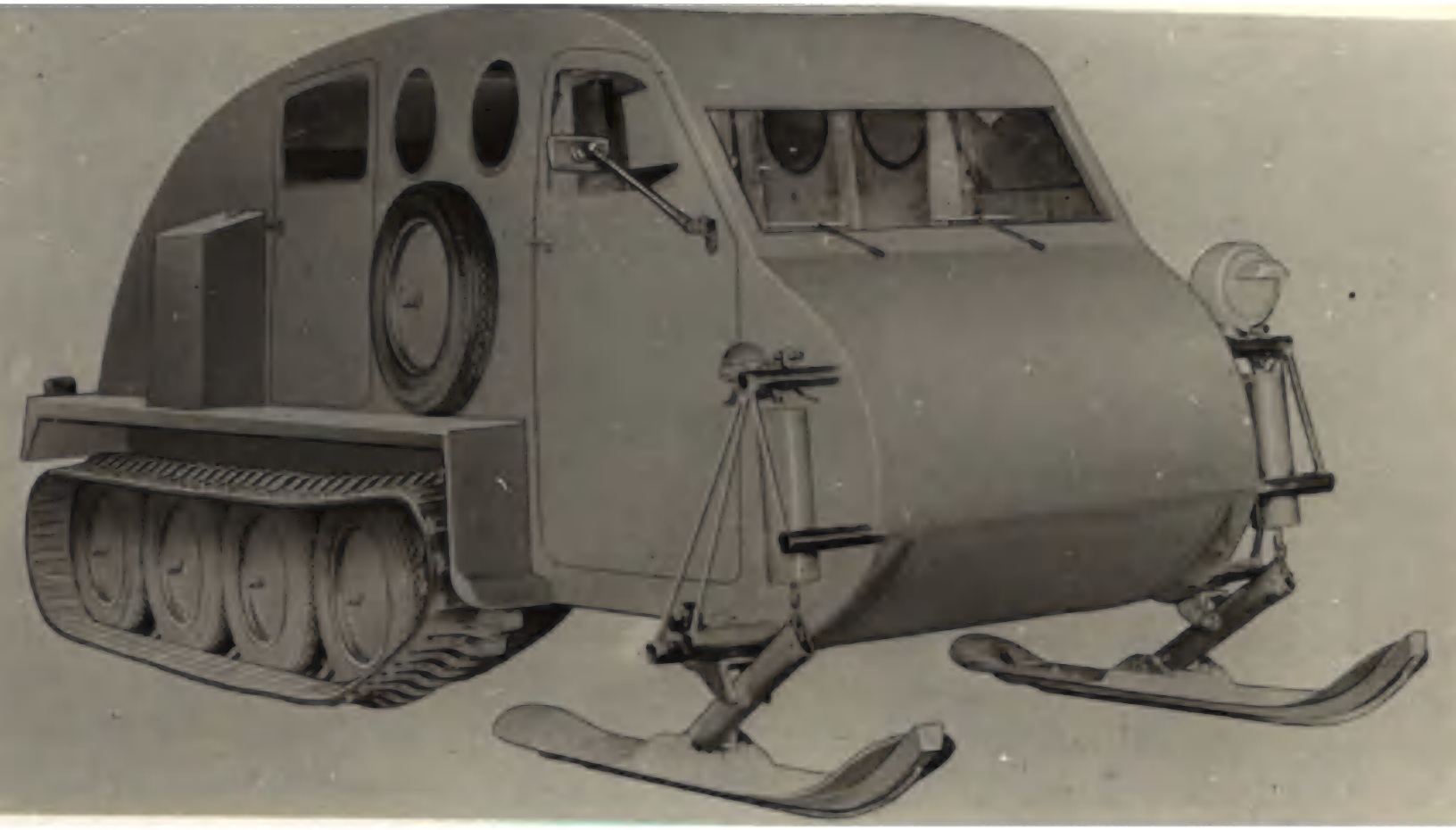
(b) light weight per unit area of ground contact allowing a top speed on the level of approximately 35 M.P.H.,

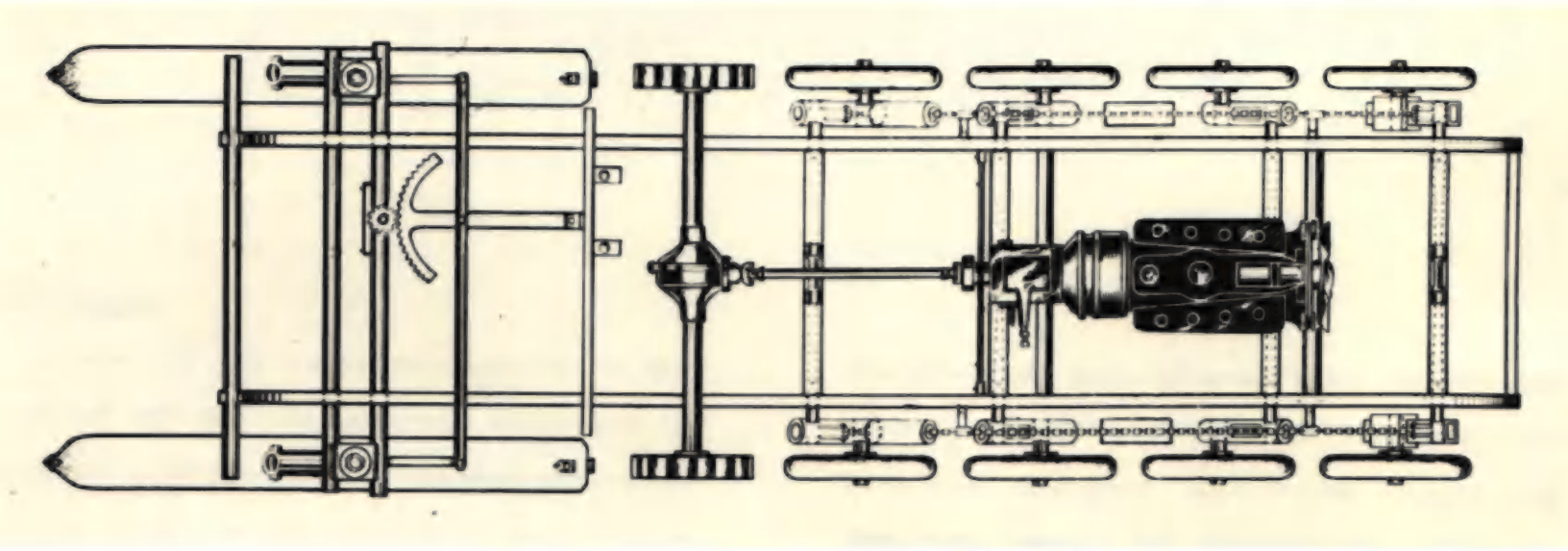
(c) 13 inch under-body ground clearance enabling the vehicle to negotiate snow-covered cross-country terrain with reasonable manoeuvreability,

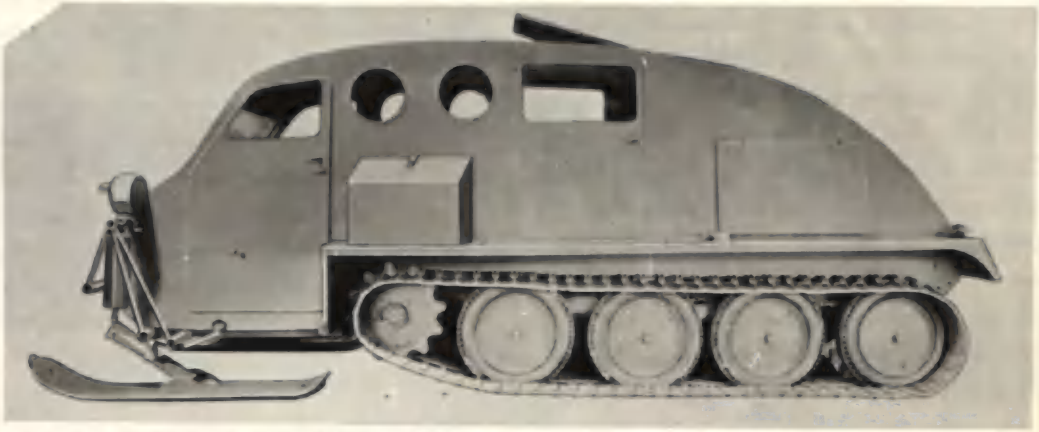
(d) protection against the elements by providing a totally enclosed plywood body and hot water heating equipment for the two-man crew and six passengers.

Its basic mechanical features included a rear mounted liquid cooled 95 H.P. V-8 Ford engine; a heavy duty semi-centrifugal, dry, single plate clutch; a Ford transit bus modified 3-speed synchro-mesh in-line transmission with remote control; a standard Ford 1-ton full floating rear axle fitted with two rubber faced 12-tooth sprockets. Each track, ladder-like in construction, consisted of two rubber belts with steel cross links and was carried on 4 bogie wheels mounted on opposed oscillating crank arms with interconnected compression springs. Two skis at the front were pivotted on rocker arms and also compression springs suspended from a tubular cross member. Steering was accomplished through a conventional steering wheel and column, having a special pinion which engaged a curved rack pivotted to the frame, and thus controlled the skis through tie rods and levers.









Production of Military Bombardier Snowmobiles commenced at Valcourt and Montreal (Que.) in the spring of 1942 and was completed during the winter of 1942-43. A total of 129 vehicles was produced.

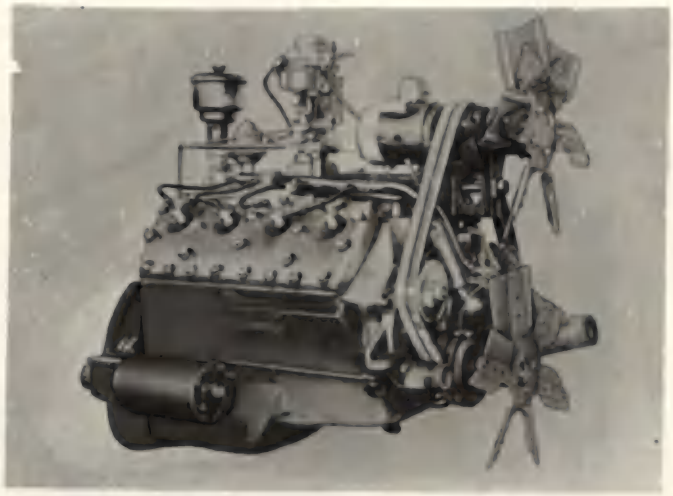
The major differences between the Bombardier Military and Commercial Bus Type Snowmobiles were:

ENGINE AND CLUTCH

A top high speed of 35 M.P.H. or better, good acceleration and a reasonable engine life were basic requirements in producing a military type Snowmobile. Tests indicated that the 85 H.P. Ford engine, as used in the Bombardier Commercial vehicle did not have the capacity to give these results. Therefore, it was decided to use the Ford 95 H.P. C.M.P. type engine. With this change a clutch of greater capacity was provided.

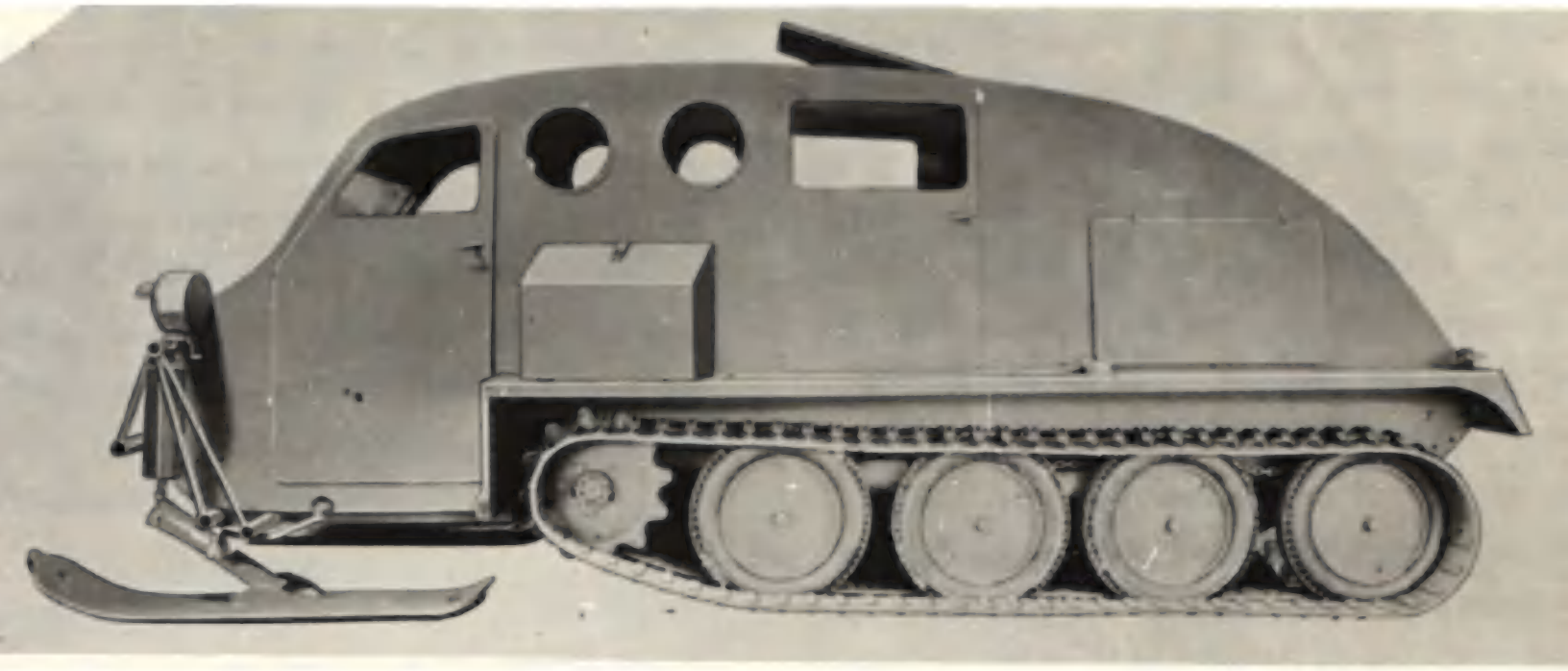
COOLING

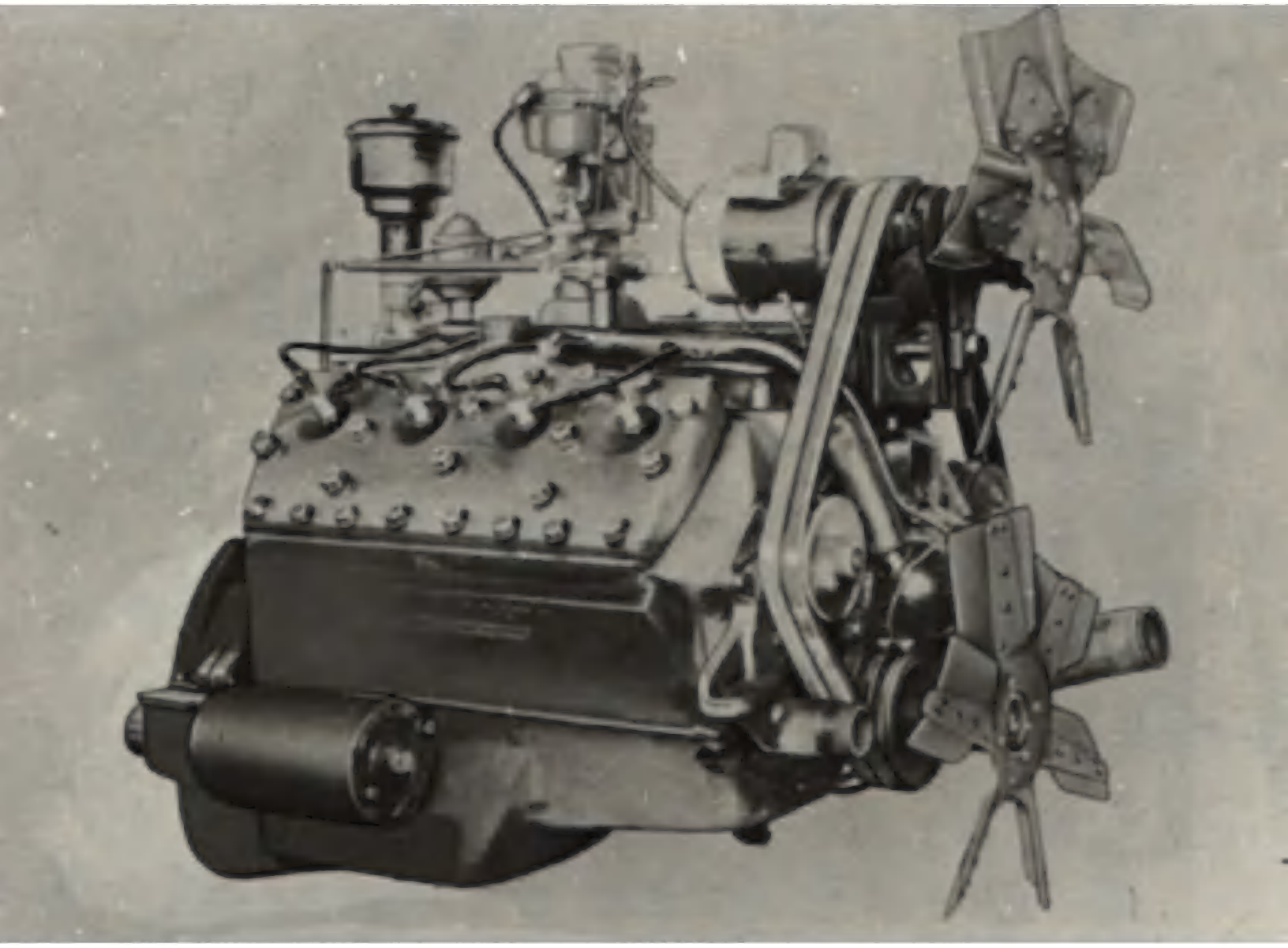
Increased fan cooling efficiency was obtained by using the Universal Carrier type generator mounting and adding a fan to this shaft. Also, an extension was added to the crankshaft to bring the lower fan in alignment with the upper fan.



TRANSMISSION

Snowmobile transmission operation in normal travel off the broken trail indicated the likelihood of prolonged periods when the second-speed gear would be in operation at peak torque. The basic requirement in the transmission was therefore a unit of generally rugged design with particular emphasis on the torque capacity for the gear next below direct drive. The Ford transit bus three-speed transmission most nearly met the known specific requirements





and was then in production. However, as the output shaft of this Transmission was made to operate at 90° to the engine crankshaft, it was necessary to design a new rear bearing retainer and motor mounting plate to meet the in-line output shaft requirement in Snowmobile application. Conventional passenger car steering column gearshift control was used and the additional mechanical advantage necessary to shift the heavier transmission gears was built into the control linkage:

TREAD AND DRIVE

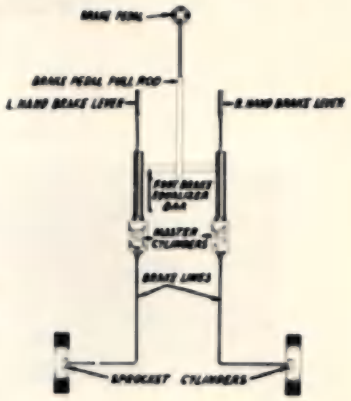
In order to provide satisfactory lateral stability of the vehicle during cross-country operation the tread width was increased from 38 ins. to the standard automotive tread width of 57 ins. This change permitted the use of the standard Ford 1-ton full-floating rear axle but due to the Snowmobile having the engine mounted at the rear, inversion of the complete driving member was necessary to obtain correct sprocket rotation. In addition, the brake backing plates were interchanged and rotated 180°.

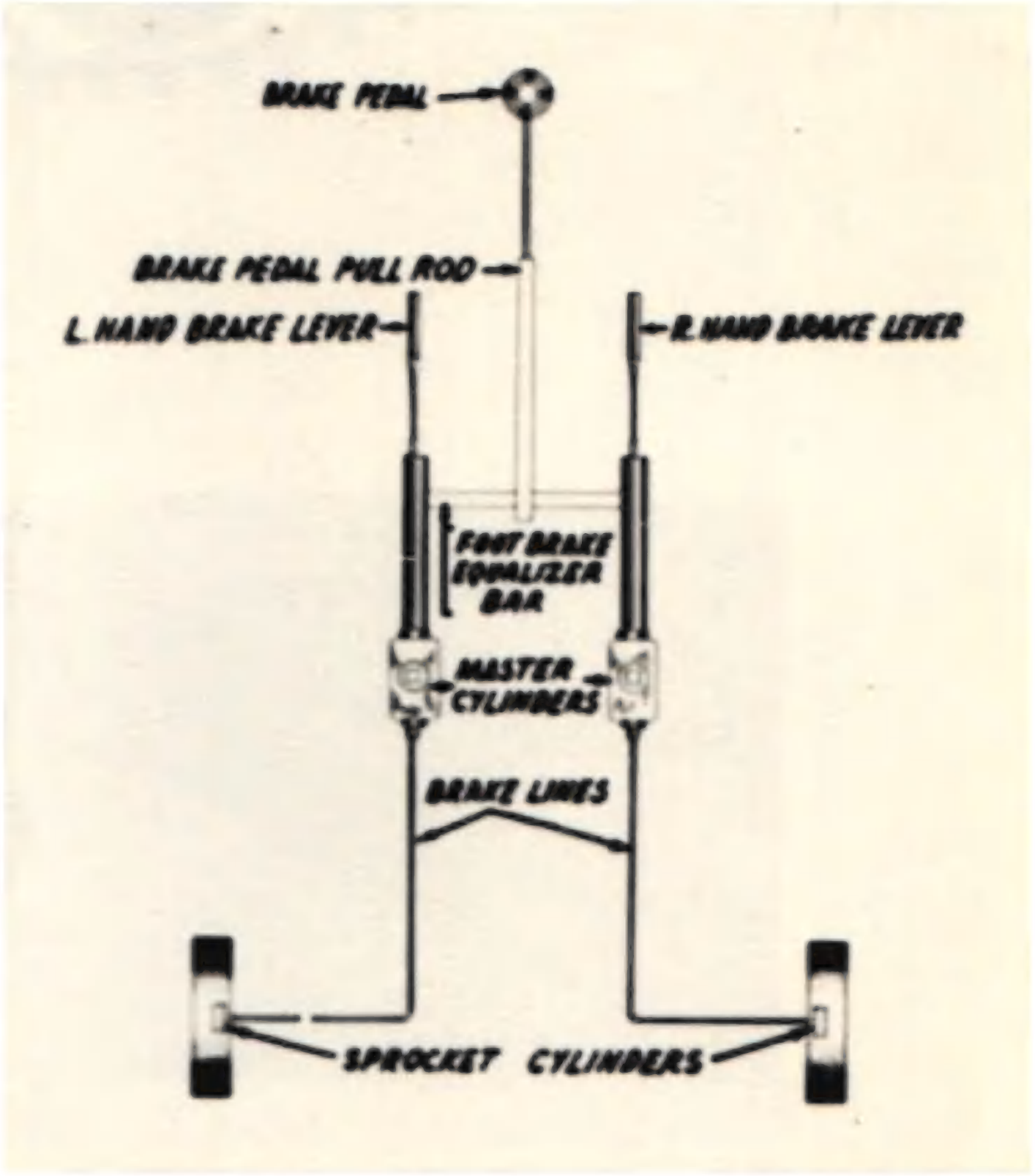
SUSPENSION - FRONT

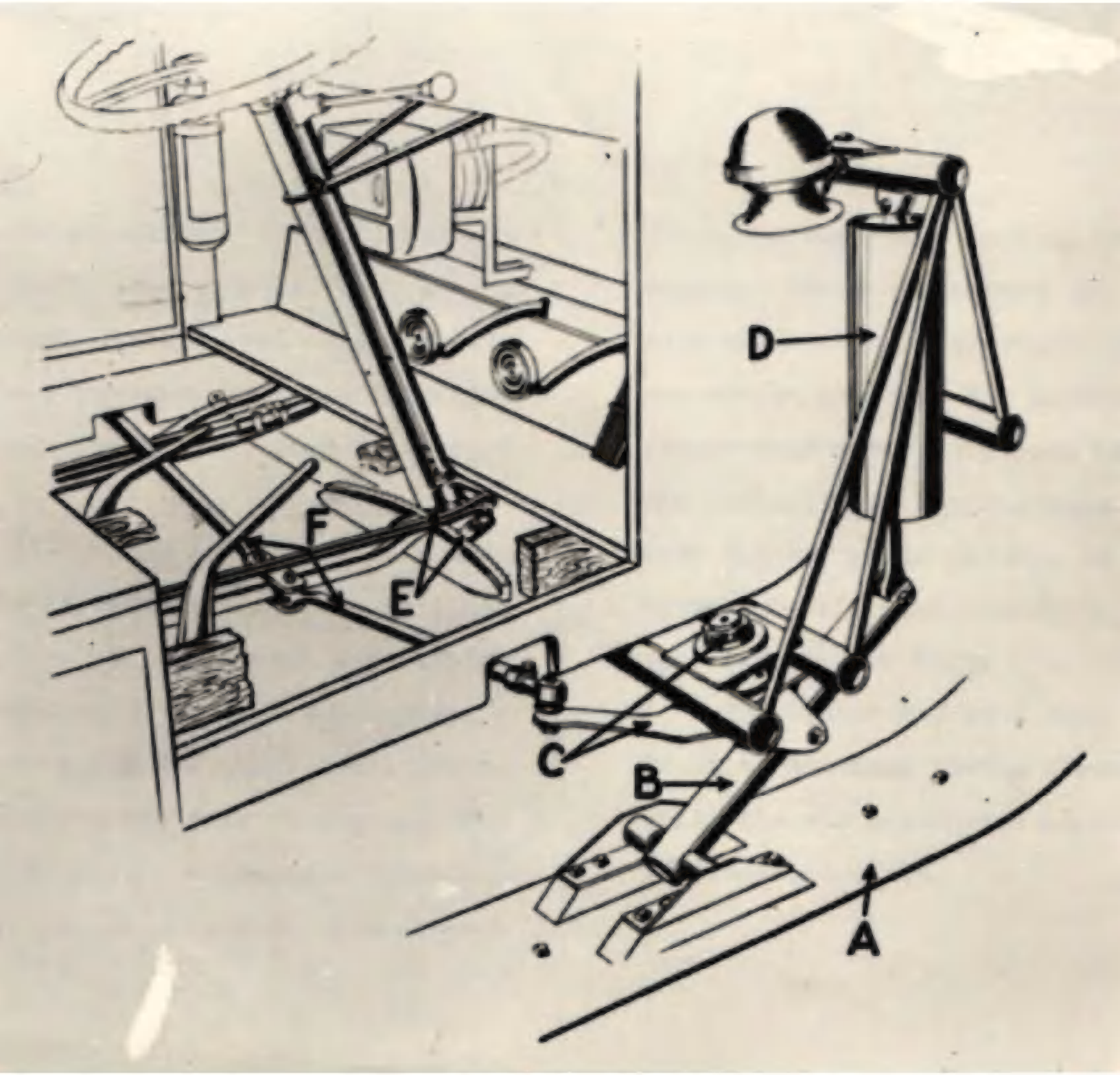
Increased loading necessitated more rugged rocker bracket yokes and steering arms, as well as the use of opposed taper roller bearings to support the king pins. The ski plate width was increased to provide greater flotation and the suspension point changed from inside the body to an external position, also heavier compression springs were installed. In addition, the ski pivot point was positioned so that the skis would hang horizontally when suspended in mid-air and thus give maximum ditch crossing performance.

STEERING

Ski-steering in soft packed snow was considered adequate but tests indicated that it was highly desirable to have individual track steering when travelling over ice or hard packed snow where the skis would have very little directional effect. To assist the steering individual track controls were installed by providing a master cylinder to brake each sprocket independently by manipulation of hand levers located conveniently to the driver. Foot pedal braking, through an equalizing bar, operated both master cylinders to retard the vehicle.




BRAKE PEDAL
BRAKE PEDAL PULL ROD
L. HAND BRAKE LEVER
R. HAND BRAKE LEVER
FOOT BRAKE EQUALIZER BAR
MASTER CYLINDERS
BRAKE LINES
SPROCKET CYLINDERS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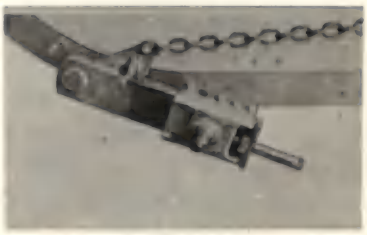
SUSPENSION - REAR (including track)

Basically, the commercial Snowmobile rear suspension design was retained although some modifications were made to give increased serviceability. These included a change to heavier compression springs and greatly improved bogie axle shafts by the use of better quality heat-treated material. Also, standard commercial needle bearings, instead of roller steel rod pins, were used to carry the radial load. To compensate for overall load increase and provide a reasonable floatation, the track belts were made wider and stronger and the cross links strengthened by increasing the thickness from 1/8 ins. to 3/16 ins.

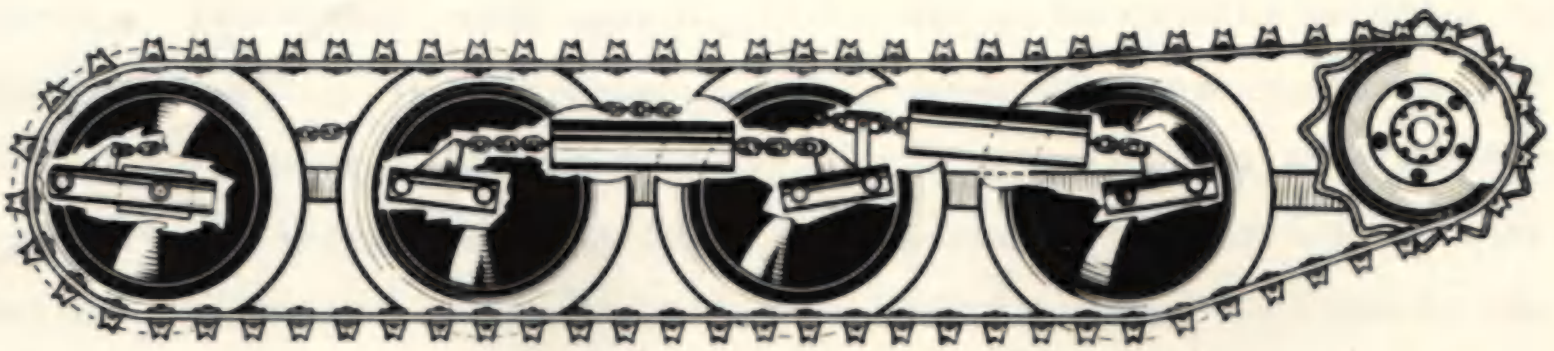


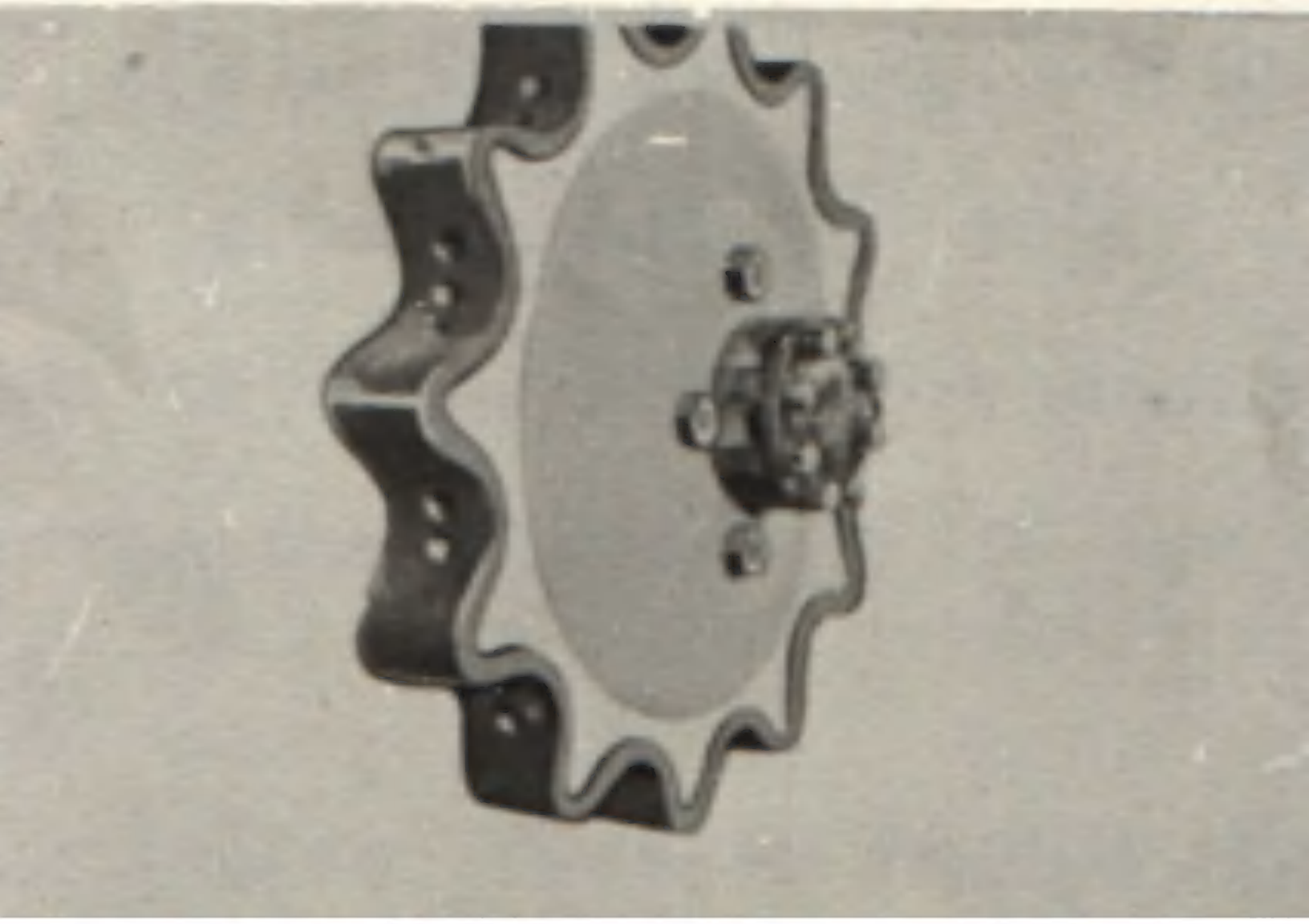
FRAME AND BODY

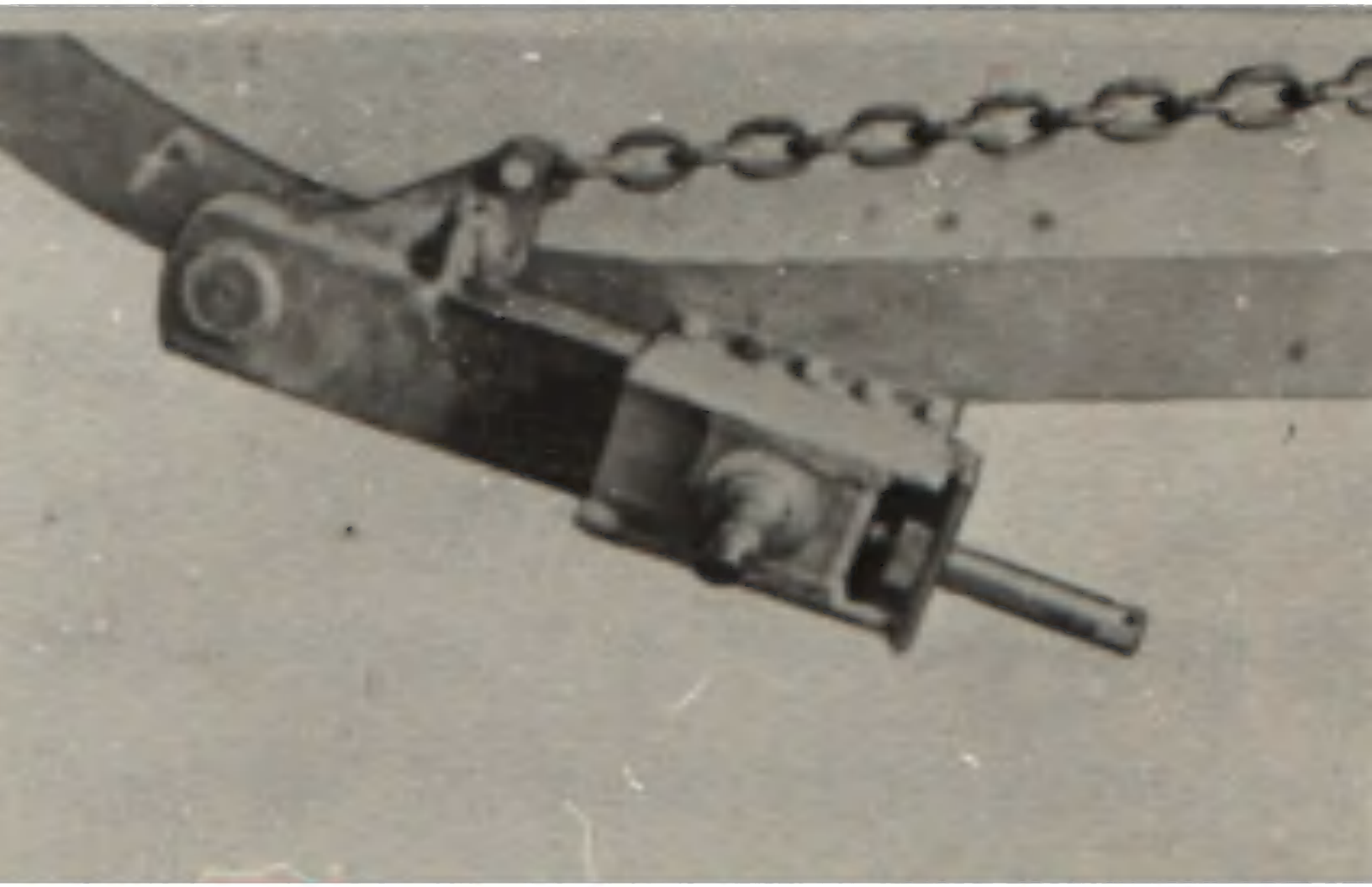
The structural make-up of the frame remained essentially the same as that of the commercial vehicle except that two channel-type steel cross members replaced the hardwood cross members previously used to support the engine.

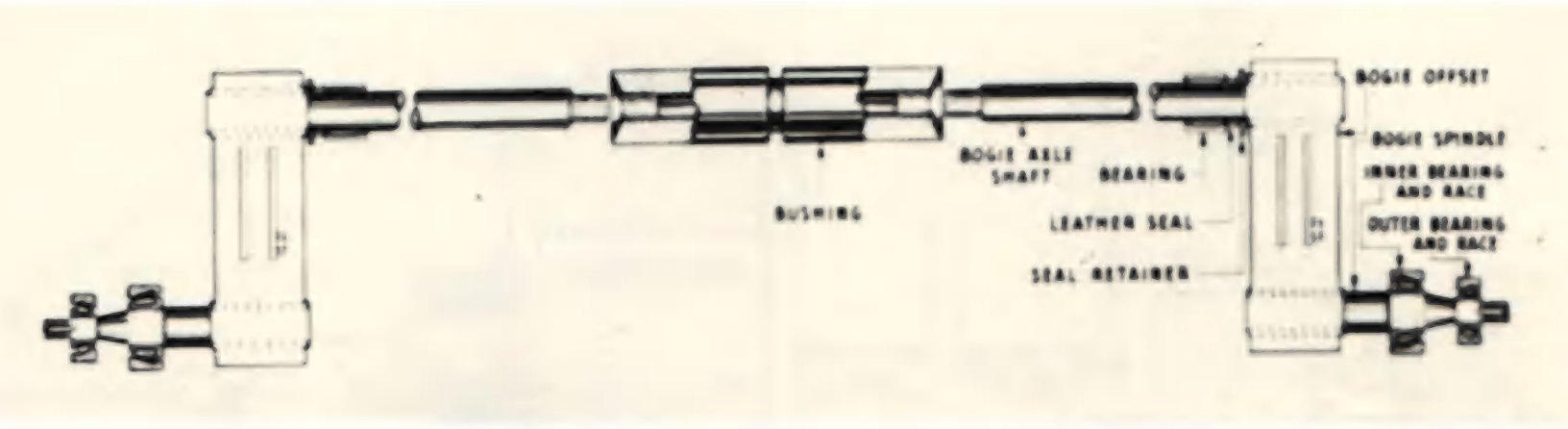
The contour and the plywood construction of the commercial vehicle body were retained with the addition of an aerial observation hatch in the roof; an exit door in the passenger compartment; and a #19 ga. sheet steel reinforcement on the vehicle nose as a protection against branches, etc. Rectangular windows, were installed in the passenger compartment doors for maximum lighting, and plywood housings were added to protect the engine compartment heater fuel tank, engine primer fuel tank, and POL can stowage. The louvres in the engine compartment side doors were eliminated due to the necessity of keeping these doors open whenever the engine was running; also a wheel mount to accommodate a spare wheel and tire assembly was added to the right side of the body.

The Driver and Mate were situated at the front of the body facing forward side by side while the six passengers were facing inward on longitudinal seats.








BOGIE OFFSET
BOGIE SPINDLE
INNER BEARING AND RACE
OUTER BEARING AND RACE
BOGIE AXLE SHAFT
BEARING
BUSHING
LEATHER SEAL
SEAL RETAINER

ELECTRICAL

In order to prevent interference with wireless vehicles, the Snowmobile electrical system was supressed in accordance with Specification O.S. 19 and, in addition, standard blackout lighting equipment, as laid down in Specification O.A. 62, was installed.

WINTERIZATION EQUIPMENT

In addition to the normal starting equipment the Snowmobile was fitted with special units to facilitate starting in temperatures as low as -40°F. This equipment consisted of:

(a) a Dole primer which drew high test gasoline from a special fuel tank and injected an atomized fuel spray into the intake manifold directly below the carburetor;

(b) a Prediluter system, consisting of an electric fuel pump, time clock and safety switch, to inject raw fuel into the crankcase and thereby reduce the viscosity of the engine oil;

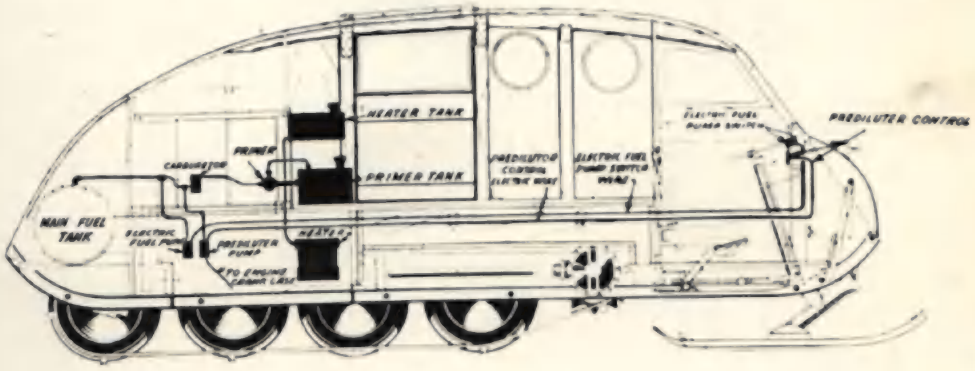
(c) a gasoline burning engine-compartment heater which could be turned on several hours before the vehicle was to be started;

(d) a toggle switch controlled electric pump to ensure a sufficient flow of fuel to the carburetor until the engine reached normal operating temperature;

(e) the battery case made of hard rubber to lessen the likelihood of battery damage due to freezing temperaturew in the engine compartment.

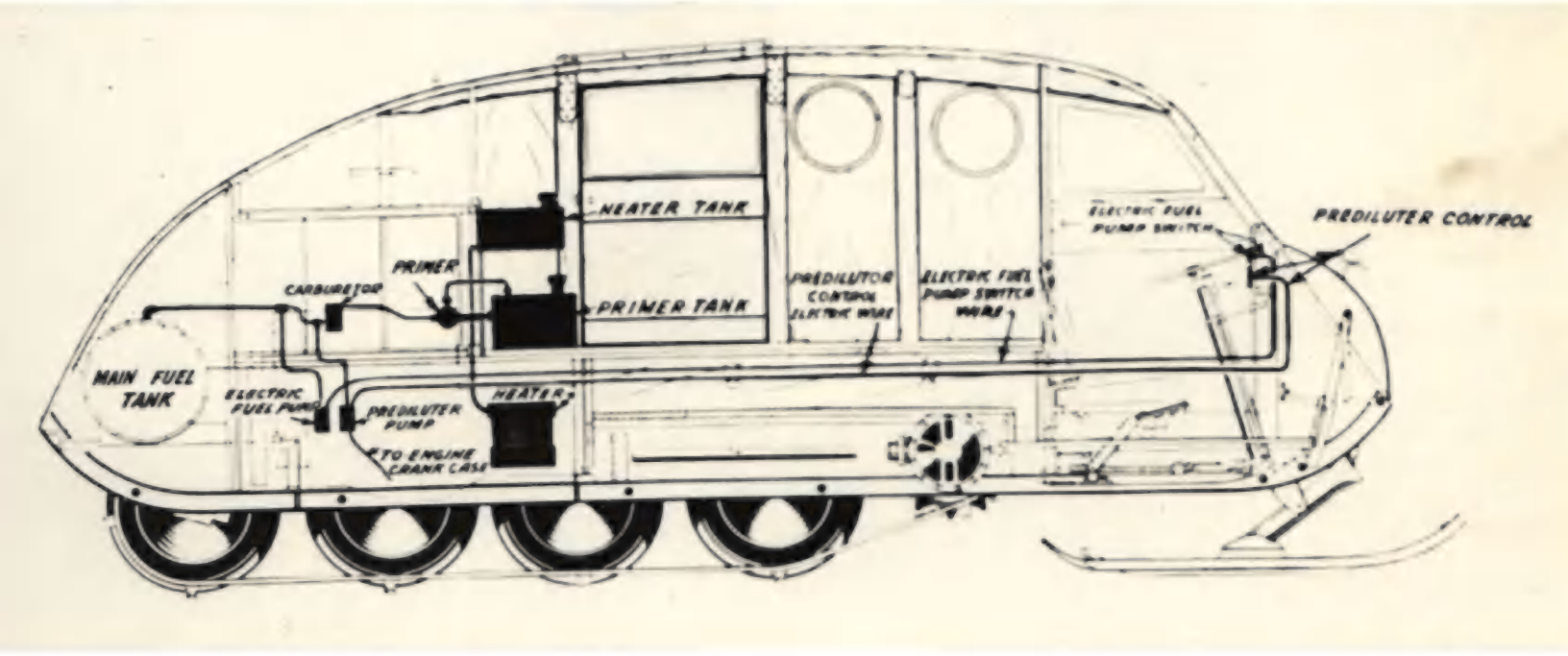
All of the above equipment was totally enclosed and no tarpaulins or other special protective coverings were required.

In locating the heater in the engine compartment it was found that the feed valve could not be placed too close to the heater element, due to absorbed heat vaporizing the fuel and cutting off the flow necessary for a steady flame. Overflow pipes were added to the burners to minimize accidental overflow with resultant flare-up and, as a precautionary measure, the adjacent plywood body walls were covered with asbestos and sheet steel. The special 1-gallon heater fuel tank was of shallow construction to minimize fuel flow variation due to sensitivity in fuel level changes and was placed high up on the side of the body to give maximum steady gravity feed. The heater operated from 12 to 14 hours on one filling of the tank.



TIRE PERFORMANCE

With proper inflation the Snowmobile tires gave exceptionally long life, due to all eight wheels being well protected from sidecuts and bruises by the track rubber belts and from ground contact by the cross links. Under-inflation increased the tire side wall contact with the rubber belts and caused excessive wear, as did also operation of the vehicle with too much slack in the tracks. The tires on this vehicle were of crude rubber, as were the track belts and drive sprocket facings.


HEATER TANK
PRIMER
CARBURETOR
PRIMER TANK
PREDILUTOR CONTROL ELECTRIC WIRE
ELECTRIC FUEL PUMP SWITCH WIRE
ELECTRIC FUEL PUMP SWITCH
PREDILUTER CONTROL
MAIN FUEL TANK
ELECTRIC FUEL PUMP
PREDILUTER PUMP
HEATER
TO ENGINE CRANK CASE

EQUIPMENT AND STOWAGE

Vehicle equipment included conventional tool requirements, cans of petrol, oil and anti-freeze, 2 spare ski runners, towing cable, screw type bumper jack with jack block, square-mouthed shovel and four 3 ins. x 3 ins. x 42 ins. hardwood sills. The sills and square mouthed shovel were included to help extricate the vehicle should it become bogged down in soft spots, etc. The hardwood blocks could be placed cross-wise under the tracks to provide increased floatation and thus enable the vehicle to gain a firm footing. The tools, jack, towing cable, etc., were stowed on the shelf over the engine compartment and the POW cans and spare runners were carried on the left running board. Instruction Manual, Spare Parts Book, and Log Book were provided and stowed in a rack over the driver's head and a fire extinguisher was located in the left front corner of the driver's compartment.

PERFORMANCE

While the performance of the Military Bombardier half track Snowmobile was reasonably satisfactory it became apparent through extensive tests that the following shortcomings existed.

1. The use of skis increased the resistance to motion under many conditions.
2. The ski life was relatively short on open ground.
3. The skis were sometimes damaged through lack of vertical articulation.
4. Under certain conditions skis made the vehicle difficult to manoeuvre.

DISTRIBUTION

All Bombardier Half Track Snowmobiles built against British orders were shipped to Scotland to permit training of army personnel during the winter of 1942-3. It is understood, however, that there was no snow in Scotland that winter and that the Army was unable to commence their training program. The writers have been unable to obtain any record of these vehicles ever having been placed in operational use.

Vehicles supplied against Canadian military orders were shipped to C.M.D., London, Ontario, and allocated to snow region training areas from whence available reports indicate reasonable satisfactory operation.

No information is available on the operational use of the three Bombardier Snowmobiles furnished to the U.S.S.R.

SNOWMOBILE - BOMBARDIER, HALF TRACK DATA

PRODUCED BY:

Bombardier Snowmobile Ltd., Valcourt, Que.

PRODUCTION:

Commenced: 1942
Finished: Winter 1942-3.

NO. VEHICLES PRODUCED: 129.

SERIES:

R.H. Drive, Symbol B-1
L.H. Drive, Symbol B-2

TYPE:

Half Track, with front skis or runners.

CREW:

Driver and Driver's Mate.

ARMOUR:

Non-Armoured Vehicle.

GUN MOUNTS: Nil.

ARMAMENT: Nil.

SIGHTING: Nil.

PROTECTED VISION:

Laminated safety glass windshield (approx. 44 x 15). Armour plate glass in driving and passenger compartment door.

COMMUNICATION: Nil.

COMPASS: Nil.

LIGHTING:

One headlamp, two side lamps, two tail lamps, one stop lamp, one instrument panel lamp.

PERFORMANCE DATA

POWER/WEIGHT:

31.6 B.H.P. per short ton (Laden weight into gross B.H.P.)

GROUND PRESSURE:

Theoretical - at approx. 2 ins. grd. penetration and at 1200# payload, skis - 1.5#, Track 1.5#.

GROUND CLEARANCE:

Vehicle Road Clearance - 13 inches approx.
Sprocket Road Clearance - 8 inches approx.

GRADEABILITY:

Theoretical percentages:
Maximum grade, Low Gear - 35.4%.
Maximum grade, High Gear - 6.3%.
By Test, Maximum grade - Low Gear - 40.0%.

MINIMUM TURNING RADIUS:

Skis alone : 65 ft. 5 ins.
Skis & Track : 40 ft. approx.

SPEED MAXIMUM: 35 M.P.H.

TRENCH CROSSING: 6 feet.

VERTICAL OBSTACLE CLIMBING: 10 ins.

FORDING DEPTHS: 15 ins. approx.

CRUISING RANGE: 200 miles approx.

FUEL CONSUMPTION: 9 M.P.G. (optimum).

OIL CONSUMPTION: 400 M.P.G.

MECHANICAL DATA

LADEN WEIGHT: 6000 lbs.approx.

OVERALL DIMENSIONS:

Height: 80 ins.
Length: 206 ins.
Width: 77 ins.

ENGINE

Location	-	Rear Mounted
Make	-	Ford
Model	-	Canadian Military Pattern
Type	-	V-8 90° L head
Displacement	-	239 cu. ins.
Peak Gross BHP	-	95
Torque	-	178 at 1850 RPM.

LUBRICATION:

Pressure type - relief valve opening 30 - 35 lbs. Crankcase capacity 4 imp. qts.

COOLING SYSTEM:

Liquid type - capacity with heater - 20 qts. without heater - 18 qts.

FUEL SYSTEM:

Cylindrical tank of 33 gals. (imp.) capacity and other normal units plus an electric fuel pump, prediluter and primer to assist in starting.

CLUTCH:

Ford heavy duty, semi-centrifugal, dry single plate.

TRANSMISSION:

Ford, transit bus type, with in-line drive - 3 speed forward, 1 reverse.

GEAR RATIOS:

First	-	3.81 to 1
Second	-	1.87 to 1
Third	-	1 to 1
Reverse	-	5.17 to 1

DRIVING MEMBER:

Ford modified 1-ton truck axle, full floating ratio 4.87:1.

STEERING BRAKES:

Hand levers through master cylinders to sprocket brake cylinders.

SPROCKETS:

Location - Front, Sprocket bolted to driving axle hub.

SPROCKETS (Continued)

Type	-	Nickel cast-iron with resilient rubber facing on teeth.
Number	-	One on each side.
No. of Teeth	-	12
Pitch, dia.	-	15 ins.
Rolling Circum.	-	48 ins. (pitch of cross links x No. teeth)

TRACK:

Type	-	Two rubber belts bolted together in parallel by crosslinks at a pitch of 4 ins. with reinforcement plates under boltheads.
No. of Links per Strand	-	69
Width of Track	-	17.5 ins.
Length of Track	-	23 ft.
Tread Width (Overall)	-	71 ins. approx.
Center to Center	-	57 ins. approx.
Grousers	-	Nil
Construction		
Belts	-	5-ply with breaker strip construction 5/8 ins. thick x 6 ins. wide.
Crosslinks	-	Plain carbon spring steel, 3/16 ins. x 2 ins. x 15-1/2 ins.

SUSPENSION:

Front	-	Two skis 11.75 ins. x 45 ins. (ground contact), pivotted on rocker arms which are supported by compression springs suspended from a tubular cross member running behind dashboard of vehicle. Skis are composite wood and steel.
Rear	-	Bogie wheels mounted on opposed oscillating crank arms with interconnected compression coil springs.
Bogies	-	Four on each side. Wheels drop-center, double disc type with 4.50 x 16 4-ply tires at 30# pressure.

TRACK ADJUSTMENT:

Movable wheel spindle with screw adjustment on each suspension rear crank arm.
2-3 ins. slack measured over front intermediate bogie wheel.

ELECTRICAL:

System	-	6-volt.
Battery	-	one 17 plate acid type - negative ground 100 ampere hours
Generator	-	3rd brush adjusting 19 amps. maximum
Starter	-	Ford type with Bendix drive. Starter circuit closed by solenoid switch operated by button on dash.
Lighting	-	Std. Blackout to Spec. O.A. 62. 1 Headlamp 2 Tail lamps 2 Side lamps 1 Stop lamp 1 Instrument Panel Lamp
Circuit Breakers	-	In lighting circuit.

MAJOR MODIFICATIONS INTRODUCED DURING PRODUCTION

Improved Bogie Spring Unit attaching chain and retaining lug. (Sil/Gen.-40) Material supplied rectroactively for all early vehicles.

Body heater pipes re-routed to ensure positive drainage. (Sil/Gen.41) Material supplied rectroactively for all early vehicles.

REFERENCES:

Maintenance Manual, January 1943. SNOW-B2

Spare Parts List, August 1942

Log Book, Militia No. 96A

D.M.S., D.A.D. Specification No. O.A. 98 Rev.4

D.M.S. File 73-V-16

D.M.S. Photo File No. G-2

A.E.D.B. - E.E. Reports E-113, E-122, E-161; Snow Traversing Trials, Ottawa 1942-43.

D.M.S. Schedule #S300800

PRODUCTION ORDERS:

CDLV/1681	File 20LV/7/707	23 LHD
MSX/246	File 134-246	1 LHD
AID/USSR-1	File 198/1	3 LHD
TP/1063	File 18-16A-519	1 LHD
MSX/11	File 134-11	1 LHD
SPLY/MECH 2561	File BSB/1621	100 RHD

Approximate price per vehicle:- $2200.00

Coincidental with the receipt of the British Ministry of Supply order in the spring of 1942 for half track Bombardier Military Snowmobiles, Army Engineering Design Branch at the request of the above mentioned British authority initiated with General Motors the development of a half tracked snowmobile, of greater load carrying capacity, which was to be designed from the ground up using the basic principles of the Bombardier vehicle which had proven successful. It was realized that such a programme would require extensive engineering design details to provide a vehicle suitable for mass production manufacturing methods. Thus as at the spring of 1942 the programme was a long term one.

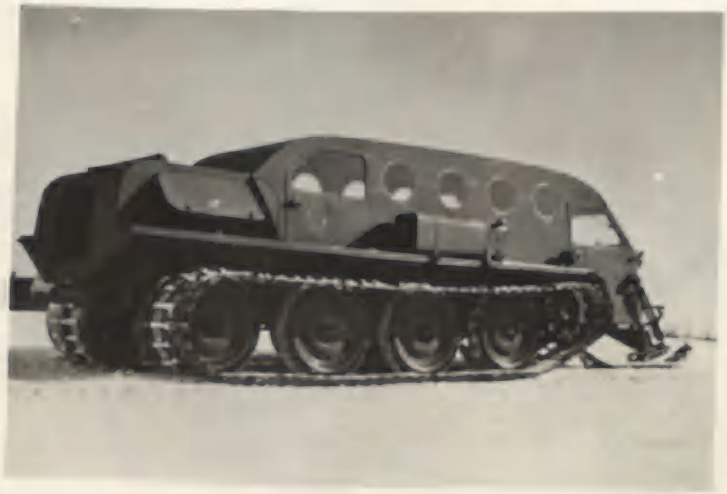
It was planned that the basic chassis should be used in three roles, namely,

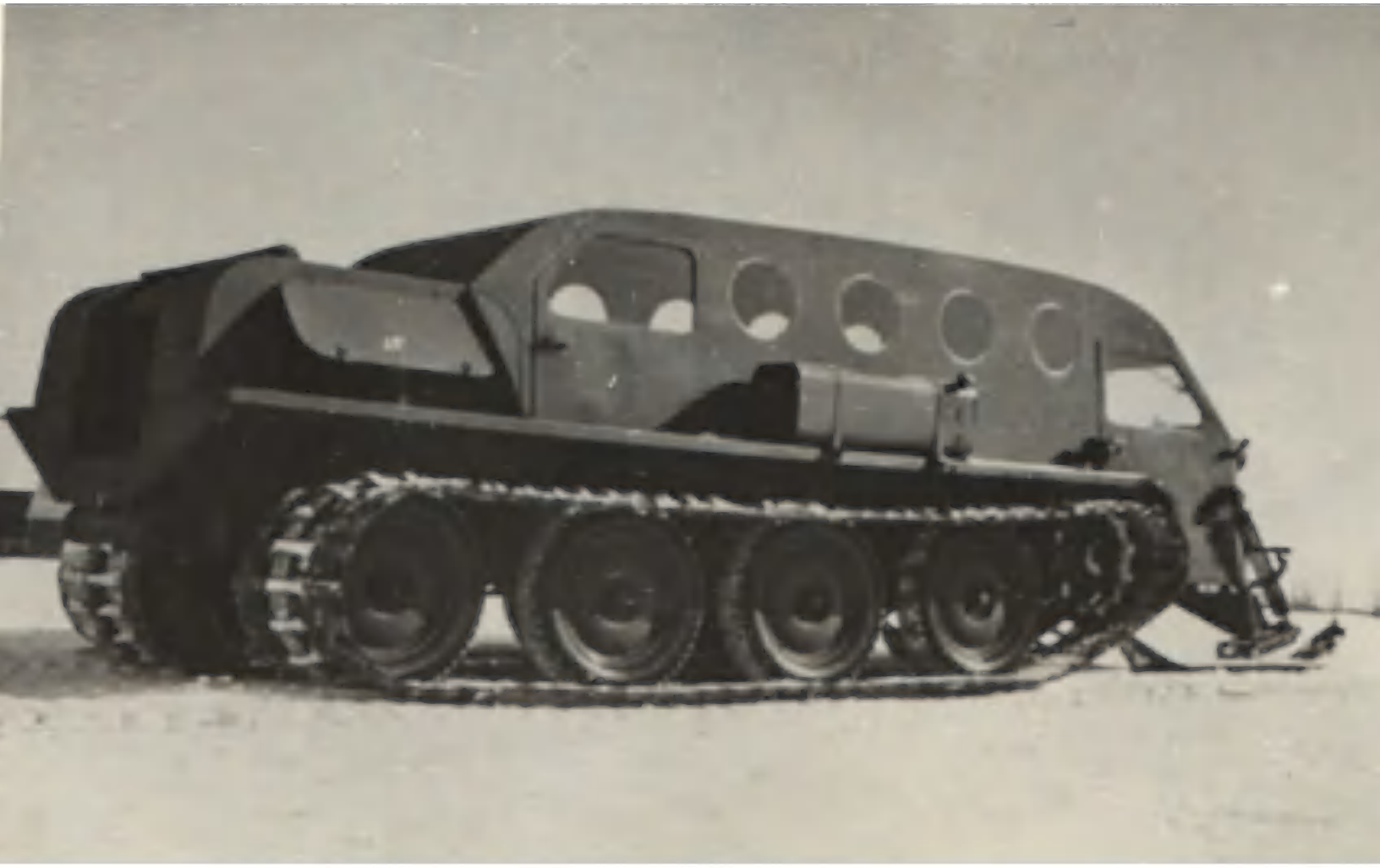
(a) personnel carrier

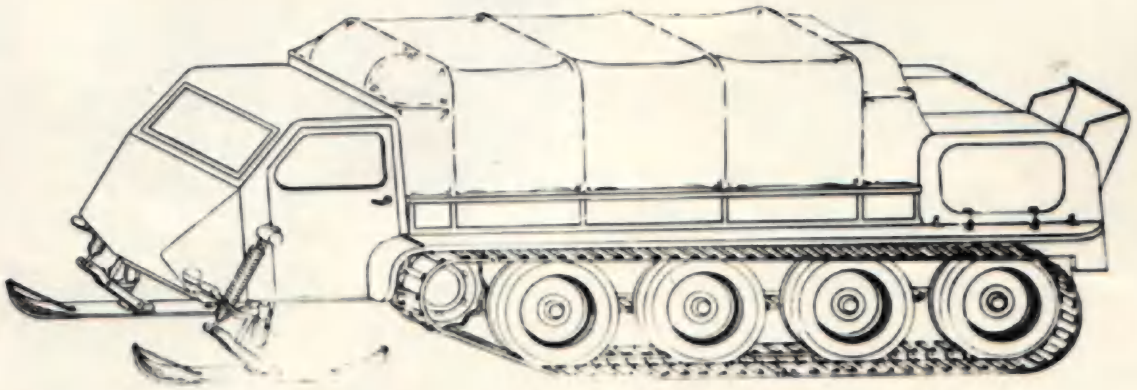
(b) load carrier

(c) mobile gun mount

The basic vehicle width dimension was set by frame width required for the Cadillac Power Plant, plus the width of two tracks and the necessary clearances between the running gear and frame. The basic length was controlled by the tire and wheel size plus the required number of tires and wheels along with reasonable distribution of uniform load onto the track. The tire size decided on was 600-20 - 6 ply, as having the approximate capacity and due to its ready availability at that time.



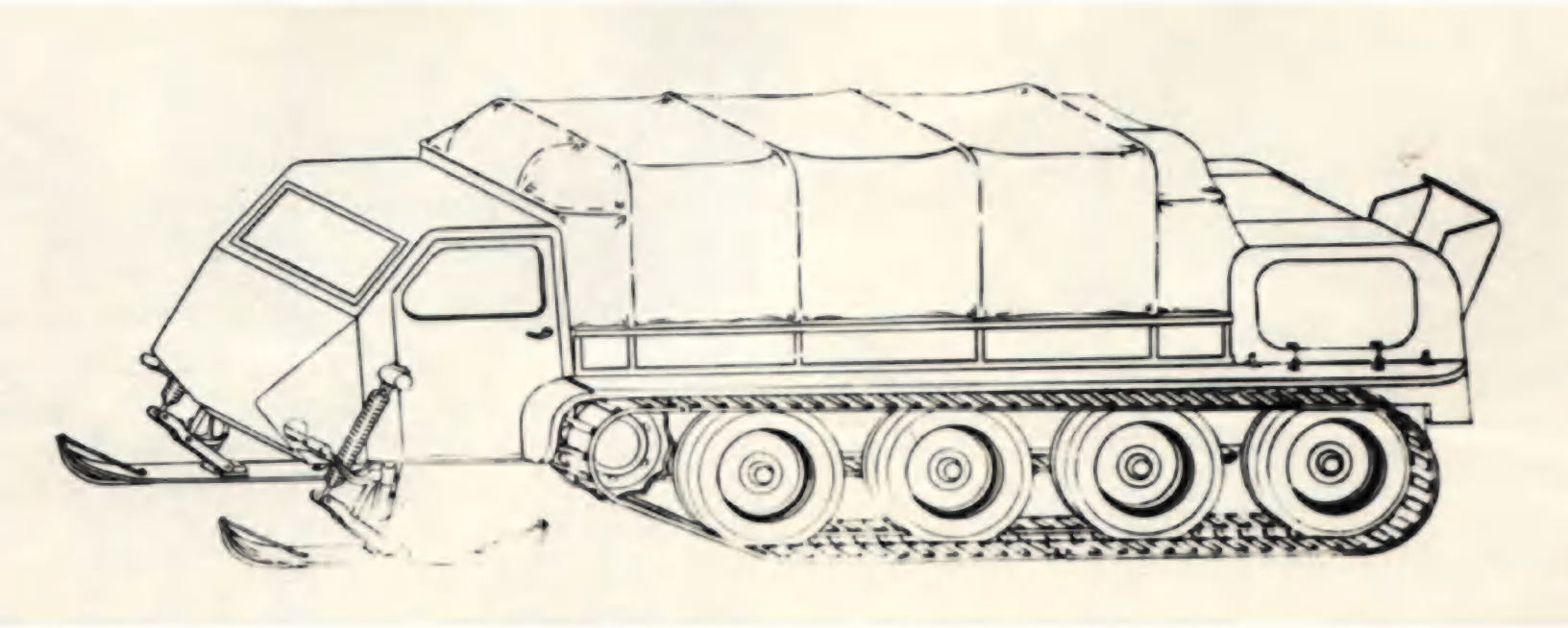


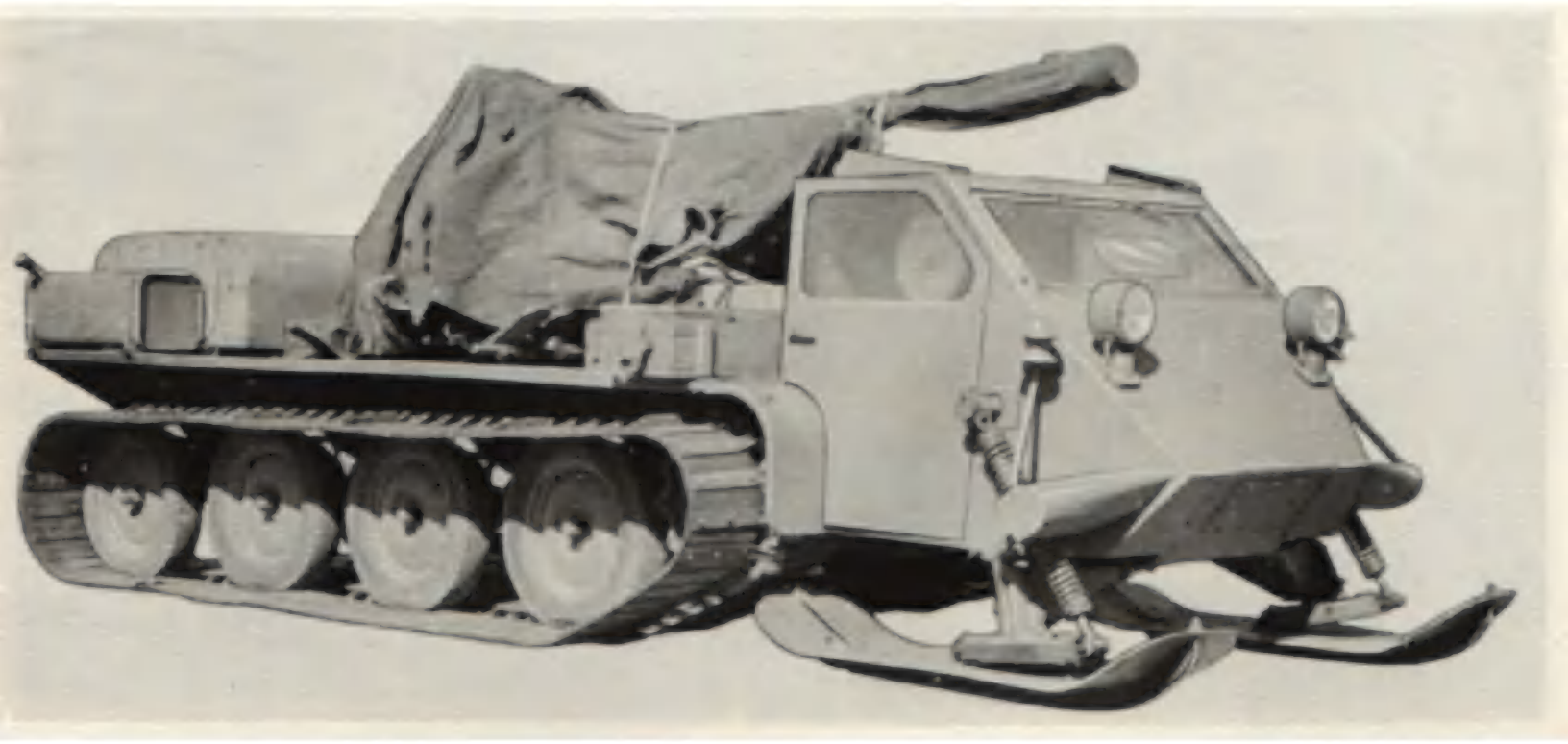


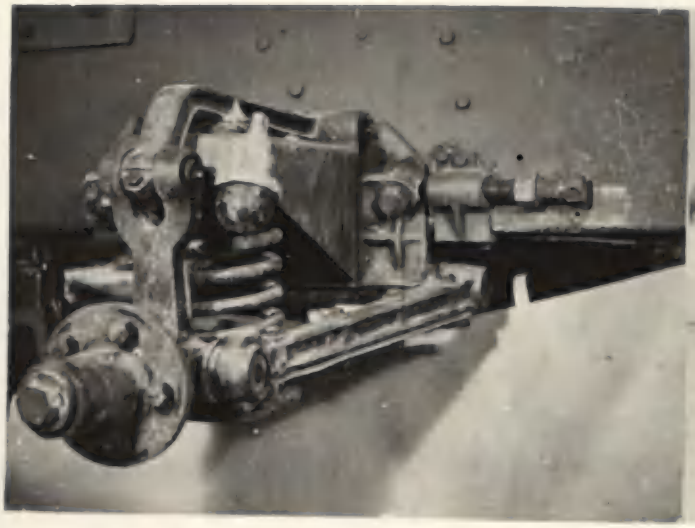
The components used in building the chassis were designed for a payload capacity of 3,000 lbs. in the load carrier role. A target gross vehicle weight of 9,000 lbs. was visualized.

The reader is referred to the following sheets for the detailed specifications of the pilot vehicle. For general information, the vehicle was powered by a rear mount Cadillac V-8, 143 H.P. engine with a hydramatic transmission and a driving member of conventional axle design to which were fitted front driving sprockets. Two ladder type rubber belt tracks 31.5 ins. wide by 14 ft. out to out were provided, running around four in line 6.00/6.50 x 20 6-ply pneumatic tires. The wheels of the bogie were each independently suspended by a knee action unit bolted to a steel ladder type frame. The forward end of the vehicle was supported by two steering skis approximately 68 ins. long by 12 ins. wide. Steering was accomplished using skis which were controlled through a conventional steering gear and tie rods, and the steering of the vehicle was assisted by braking effort applied to either driving hub.

As soon as the first pilot, a personnel carrier, became available, it was put to extensive tests. The results showed that this vehicle, with 1600 pounds payload, was comparible in performance to the Military Bombardier Half Track Snowmobile with 1200 pounds payload.



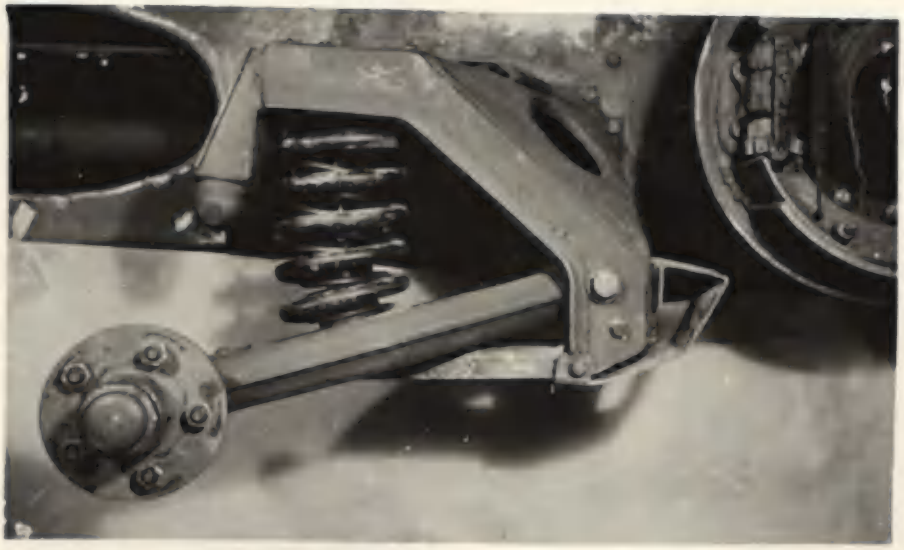




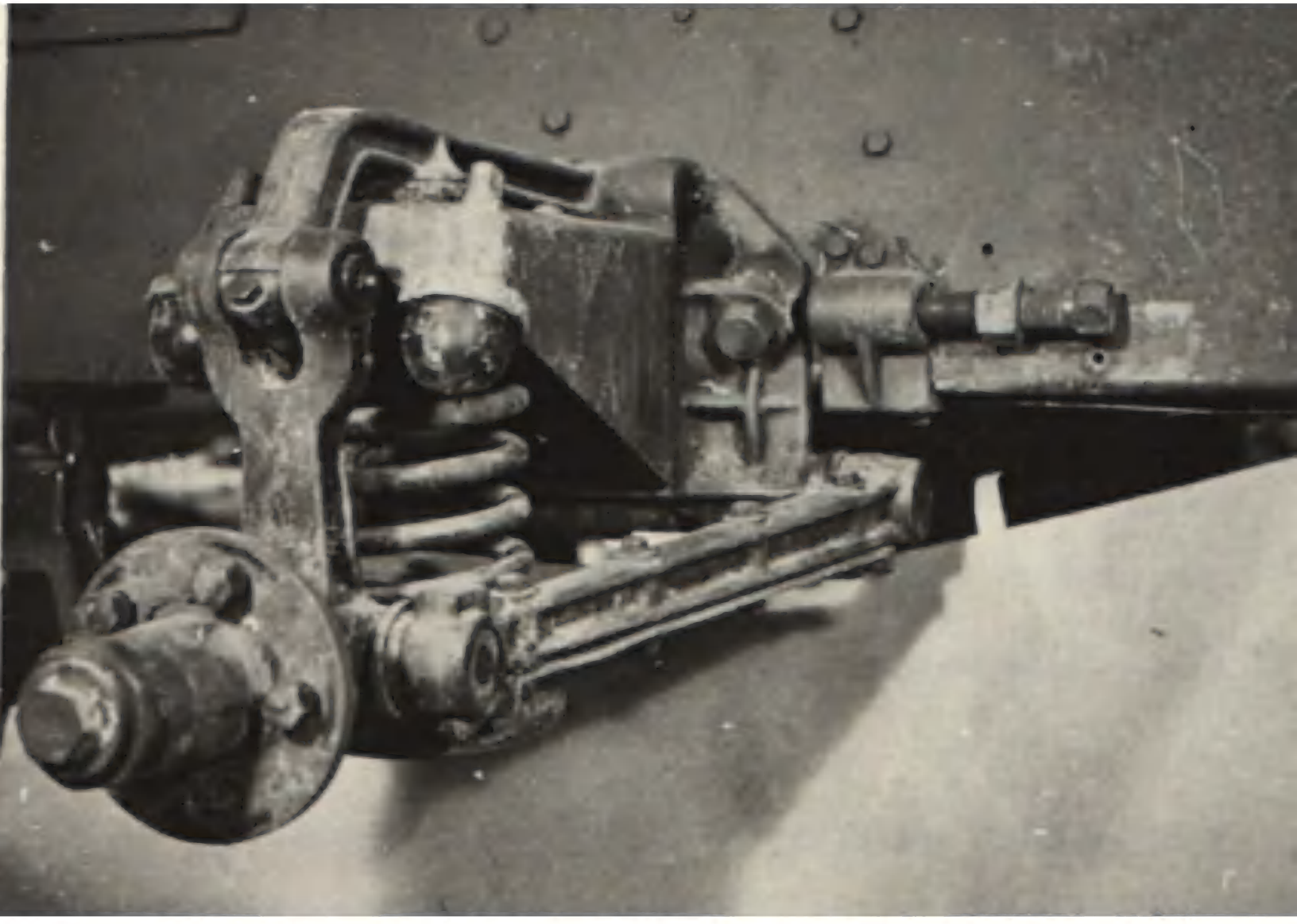
REAR BOGIE, ADJUSTABLE

SKI SUSPENSION

ELEVATION - SPROCKET AND IDLER BOGIES



FRONT BOGIE

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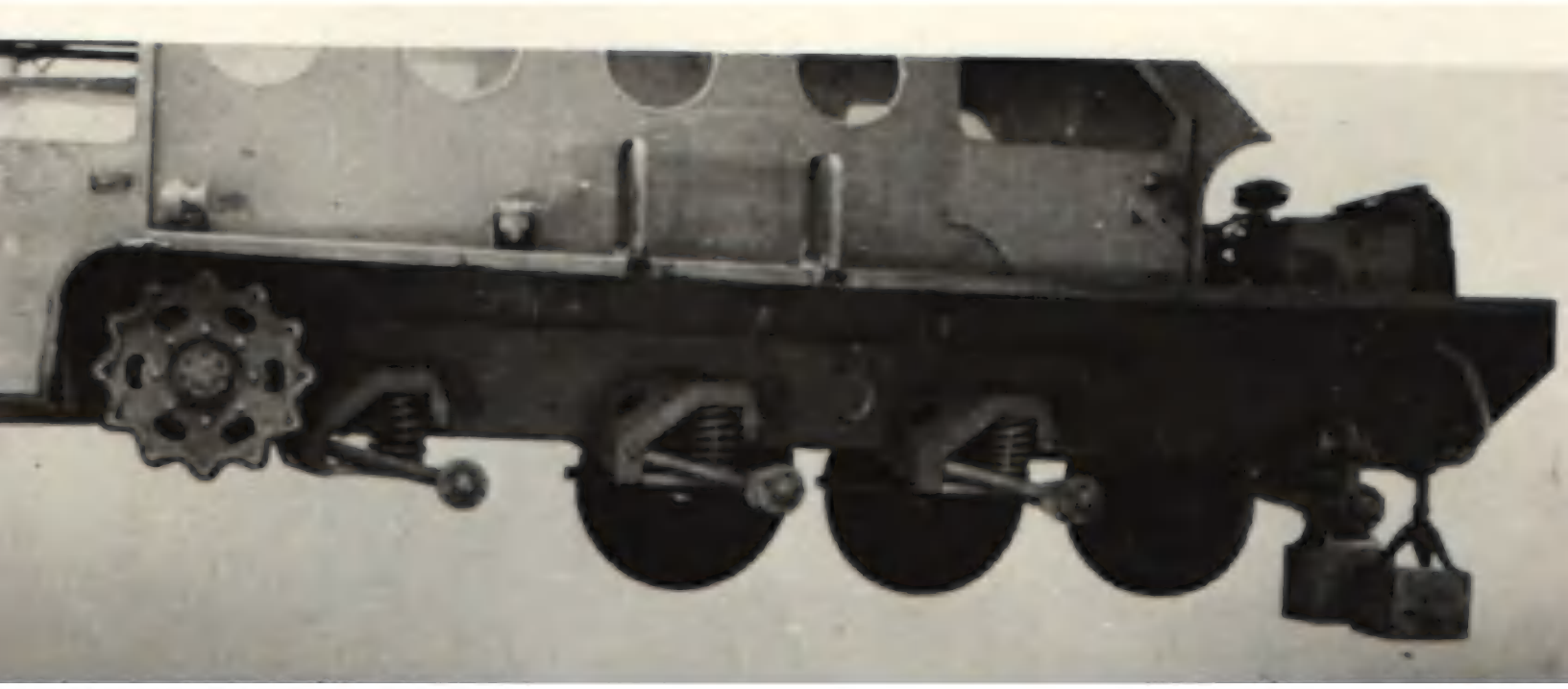
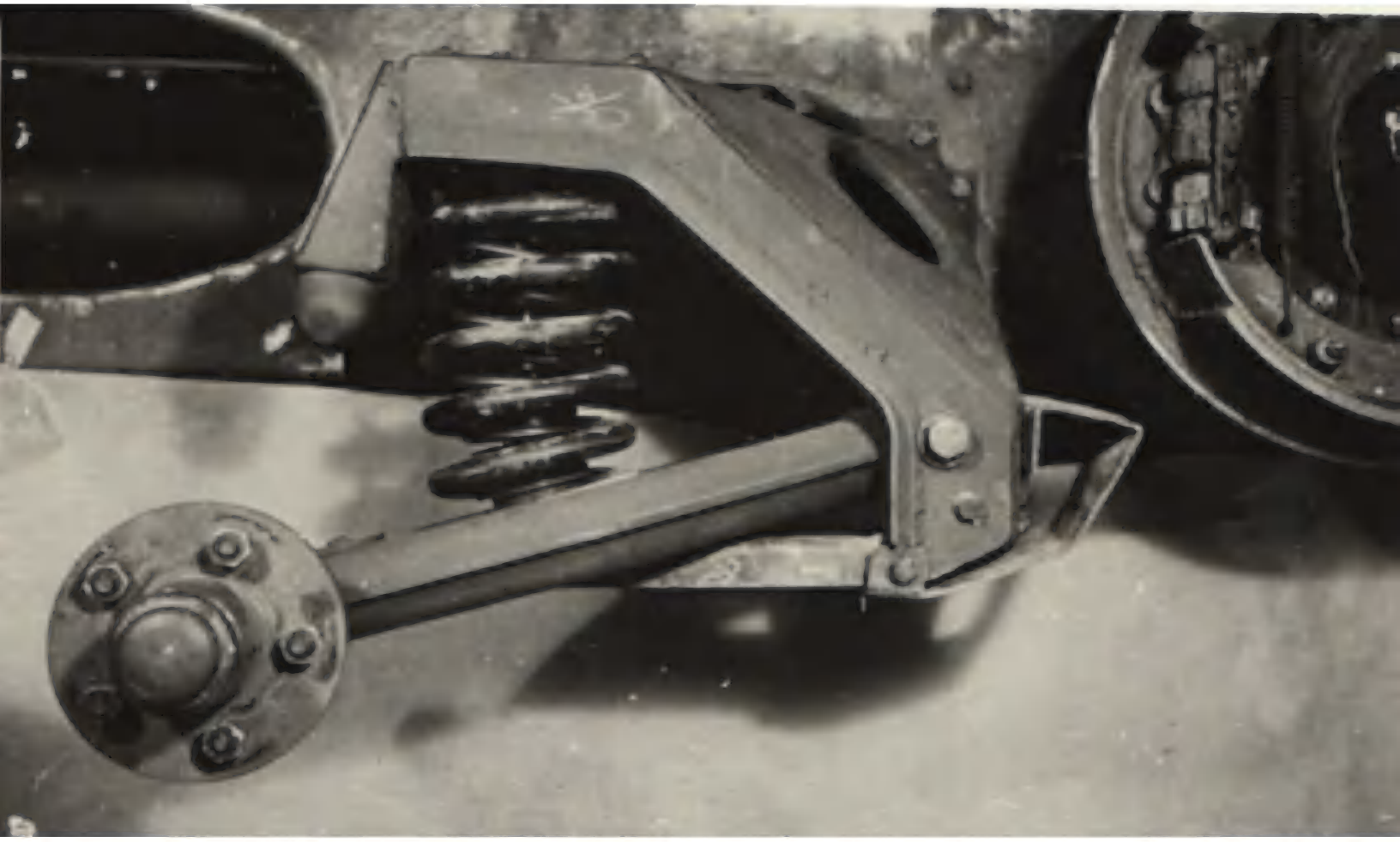




During the trials in an effort to improve the gradeability and handling, the skis were removed. It was possible to operate the G.M. Snowmobile without skis on operations excepting down hill, due to the location of the centre of gravity longitudinally. The results thus obtained were so encouraging that a decision was made to build a purely experimental light full track vehicle, covered in more detail on subsequent pages headed "Experimental Full Track Vehicle."

The basic faults found in G.M. design may be briefly stated as follows:

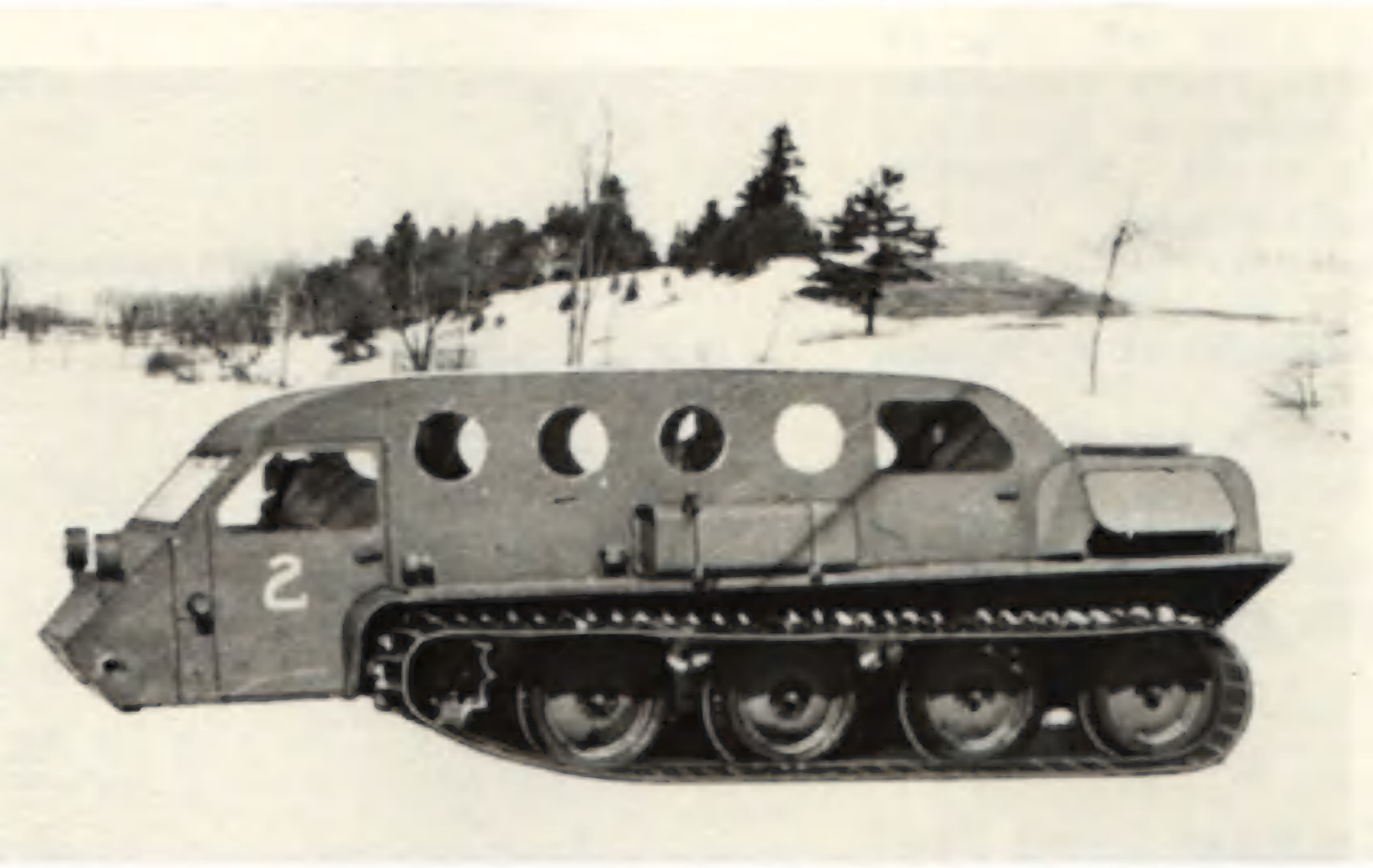
(a) The curb weight of the vehicle was much greater than anticipated.

(b) Considerable redesigning of the ski support and limiting springs was necessary as a high incidence of failure occurred during the tests.

(c) The design of the track cross links was found inadequate due to its length and support at one point. Material and dimensional changes were made but satisfactory track life had not been reached.

(d) Snow entered the engine compartment which resulted in ignition trouble and icing on the carburetor air cleaner.

In July of 1943 The Ministry of Supply advised that the interest in this vehicle was lost due to tactical conditions then under consideration. They suggested the development should be discontinued. As a result of this information further work on the project was stopped.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GENERAL MOTORS HALF TRACK SNOWMOBILE

MECHANICAL DATA

LADEN WEIGHT:

11,140 lbs. (Payload 1600)

OVERALL DIMENSIONS:

Height: 19.25 ins.
Length: 259.6 ins.
Width: 97.0 ins.

ENGINE:

Location	-	Rear Mounted
Make	-	Cadillac
Model	-	Modified Tank
Type	-	V-8 - 90° L Head
Displacement	-	346 cu. ins.
Peak Gross BHP	-	143 at 3600 R.P.M.
Torque	-	243 at 1400 R.P.M.

COOLING SYSTEM:

Liquid Pressure type with relief valve opening at 9 lbs. per sq. in.
Radiator - Tube and Fin Type.

FUEL SYSTEM:

2 - 20 Gal. Tanks interconnected with three-way valve.

CLUTCH:

Hydraulic Fluid Coupling.

TRANSMISSION:

Hydramatic with in-line drive.
Gear Ratios:

First	-	3.67 to 1
Second	-	2.53 to 1
Third	-	1.45 to 1
Fourth	-	1 to 1
Reverse	-	4.31 to 1

DRIVING MEMBER:

Full Floating Spiral Bevel forward mounted ratio 7.17 to 1.

STEERING BRAKES:

Hand Levers through master cylinders to sprocket brake cylinders.

SPROCKETS:

Location	-	Bolted to driving axle hub.
Type	-	Malleable iron with rubber facing on teeth.
Number	-	One on each side.
No. of Teeth	-	12.
Pitch Dia.	-	19.1 ins.
Rolling Circum.	-	60 ins. (pitch of cross-links x No. of teeth).

TRACK:

Type	-	Two rubber belts bolted together in parallel by crosslinks at a pitch of 5 ins. with reinforcement plates under bolt heads.
Width of Track	-	31.5 ins.
Length of Track	-	31.5 ins.
Tread Width (Overall)	-	97 ins.
Center to Center	-	85.5 ins.
Grousers	-	Nil.
Construction		
Belts	-	Goodyear Specification No. 21218 Rubber 0.75 ins. thick x 12 ins. wide.
Crosslinks	-	G.M. No. 9260 Steel, 0.25 x 2.25 x 30.5 ins.

SUSPENSION:

Front: Two skis 12 ins. x 40 ins. (ground contact) steel, pivotted on threaded metal bushings in suspension arms which are supported at their upper end by coil spring units. Suspension arms are pivotted at their midsection on threaded metal bushings and fastened to knuckle supports which are anchored to brackets attached to the frame.

Rear: Bogie Wheels mounted on independently suspended modified Buick spindles.

Bogies: Four on each side. Wheels 20 x 3.62 ins. steel disc type with 6.00/6.50 x 20 tires.

TRACK ADJUSTMENT:

Rear wheel suspension unit adjustable 2.5 ins. fore and aft.

ELECTRICAL:

System	-	12 volt radio suppressed.
Battery	-	Two 15 plate 90 Ampere Hours in insulated case.
Lighting	-	2 Headlamps, 2 tail lamps and 1 stop lamp.

REFERENCES:

D.M.&S. File 73-V-16

D.M.&S. A.E.D.B. Experimental Report entitled Snow Traversing Trials Ottawa 1942-43.

D.M.&S. A.E.D.B. Photo File No. G-2.

M.O.S. T.T.2 File 257/Veh/2475/KMP/CC
" " " 257/Veh/3197-TT2-Tech.

FULL TRACK SNOW VEHICLES

EXPERIMENTAL FULL TRACK VEHICLE

Encouraged by the results of tests on G.M. Snowmobile without skis and following A.E.D.B. opinions that a controlled differential driving member would assist in steering, it was decided to produce an experimental model light type full tracked vehicle in the fall of 1942.

This vehicle included the following basic components:

1. Full Track
2. The Engine was mounted at the front.
3. The Driving member was mounted at the rear.
4. The Driving member incorporated a controlled differential.
5. The Track was suspended as on the Military Bombardier Half Track Snowmobile with slight modifications.

The unit was produced in a minimum of time, and was not intended to be a complete military vehicle but rather as a prototype to prove or disprove the full track principal for Snow Traversing Vehicles.

Tests were run during the winter of 1942-43. These were successful to such a degree as to confirm that a full track suspension vehicle when fitted with the ladder type rubber tracks would perform beyond the ability of other snow traversing units available at that time. Comparative trials were made with the U.S. Weasel as then produced; Military Bombardier Half Track and G.M. Half Track Snowmobile.

As a result of demonstrations made before representatives of the Ministry of Supply, Canadian Army and other interested personnel it was decided the full Track Vehicle would be adopted for any further orders of Snow Traversing vehicles.

THREE QUARTER FRONT

OPERATING IN SLUSH

PRODUCED BY:

Bombardier Snowmobile Limited.

UNLADEN WEIGHT:

4200 lbs. approximately.

OVERALL DIMENSIONS:

Height: 72 ins.
Length: 150 ins.
Width: 92 ins.

ENGINE:

Chrysler 250 cu. in. displacement.

TRANSMISSION:

3 Speed Chrysler Synchro-mesh Passenger Car.

DRIVING AXLE:

Model H Cleveland Tractor Company axle assembly with controlled differential steering assembled into a special housing. Drive Gear Ratio 5.2 to 1.

TRACK:

Width	31.5	ins.
Length out to out	127	ins.
Crosslink Pitch	4	ins.
Tread	58	ins.

SUSPENSION:

4 Wheels in line each side with 4.50 x 16 Tires. (Military Bombardier 1/2 Track Suspension modified).

TURNING CIRCLE:

Approximately 20 ft. Diameter.

GRADEABILITY:

In excess of 50%.

REFERENCES:

D.M.S. File 73-V-16

D.M.S. A.E.D.B. Photo File G-2

D.M.S. A.E.D.B. Motion Pictures.


THREE QUARTER FRONT


OPERATING IN SLUSH

SNOWMOBILE, ARMOURED, CANADIAN, MARK I

As a result of the performance demonstrated by the experimental full track vehicle, Army Engineering Design Branch, in the spring of 1943, contemplated building a full track unarmoured personnel and cargo carrying snowmobile. A Cadillac Engine with Hydramatic Transmission, and a Ford T-16 Universal Carrier Axle with controlled differential which was then available, were purchased.

Building of such a vehicle did not commence for at that time the British Ministry of Supply verbally laid down a specification for an armoured two man reconnaissance snowmobile to meet their immediate requirements.

A prototype full track armoured snowmobile was manufactured in a minimum time from sketches and by the "cut and try" method. This vehicle was put through severe tests where it was found that many components required redesign in order that production snowmobiles would have satisfactory reliability, but the major automotive units involved were considered satisfactory.

The production vehicle became known as the "Snowmobile, Armoured, Canadian Mk.I".

Its basic tactical features included:-

(a) Armoured hull for protection of driver and observer gunner.

(b) Tandem seating arrangement.

(c) Communication facilities through provision of a #19 Wireless Set.

(d) Provision of light armament, consisting of Bren Gun, Sten Gun and Service Rifle.

(e) Protectoscope to give driver horizontal protection with the adjustable seat at low position; observer-gunner's seat positioned to provide shoulder protection.

(f) Wide track (35 ins.) distributed load over large area and thus enabled vehicle to negotiate soft surfaces.

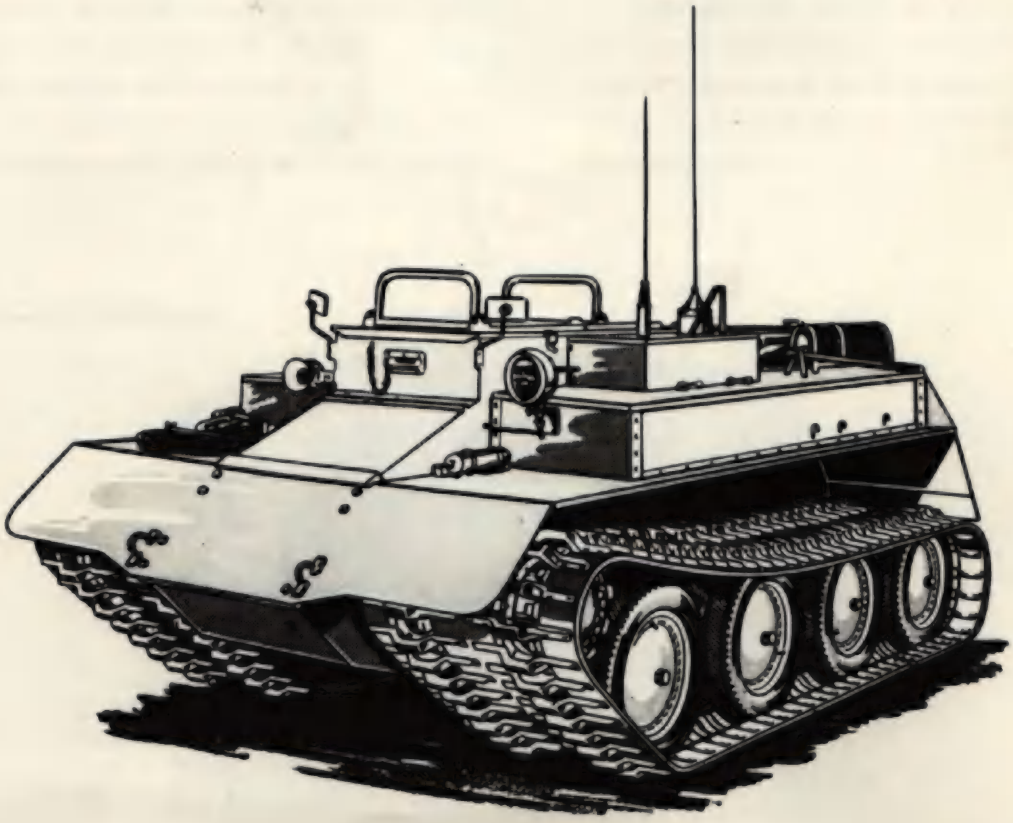
(g) Top speed of 28-30 M.P.H. under favourable conditions at engine governed speed.

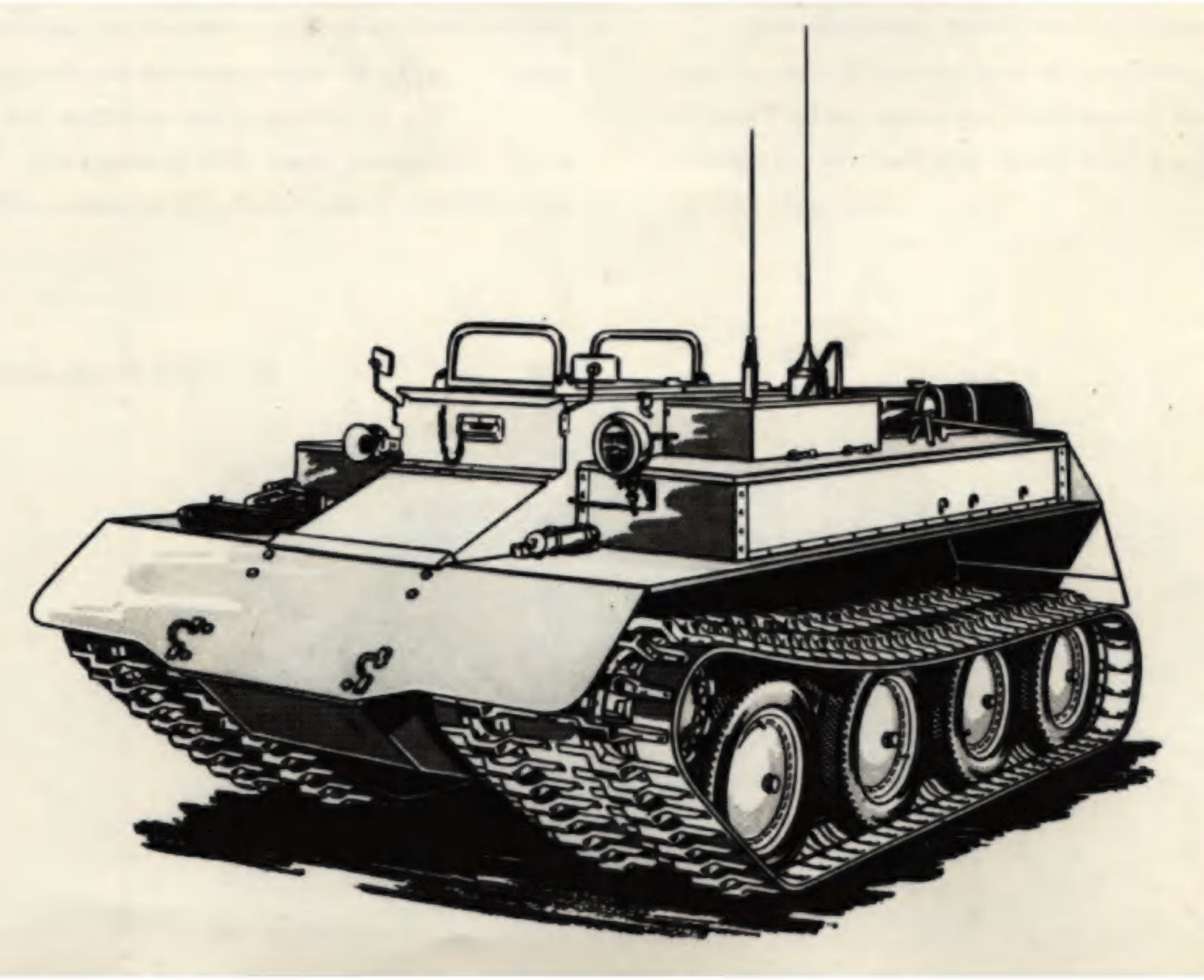
(h) Cruising range of approximately 225 miles without refueling under favourable conditions.

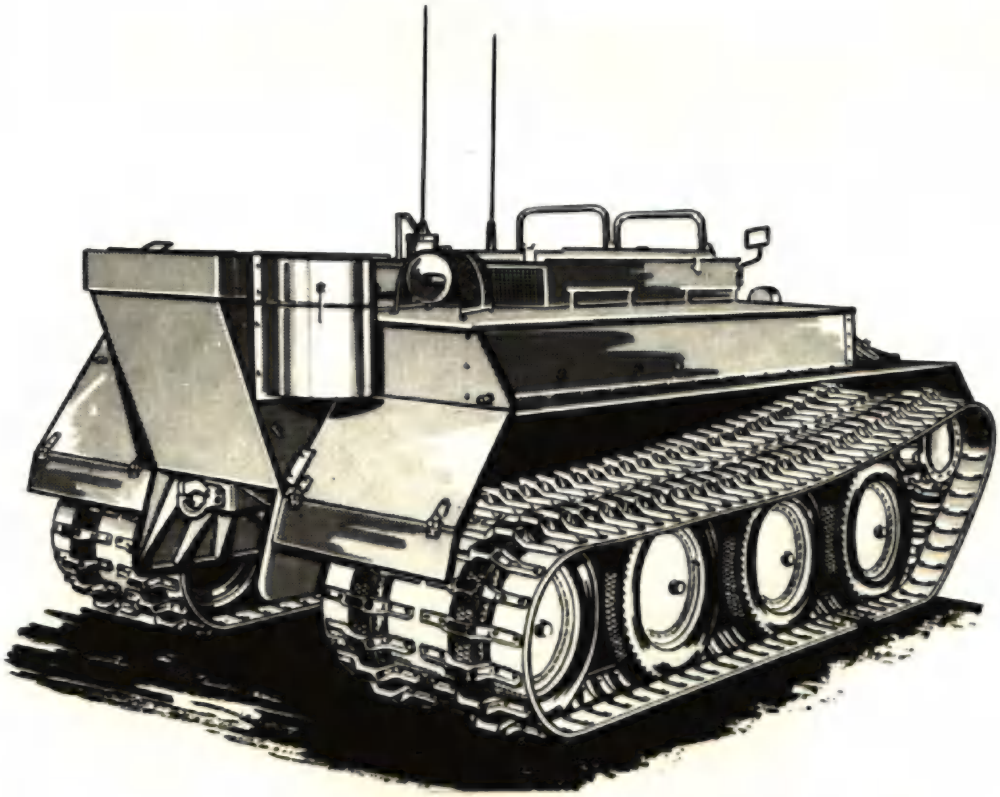
(i) 12 ins. ground clearance combined with good obstacle climbing ability facilitated cross-country travel with reasonable maneouvreability.

(j) Draw-Bar pull was sufficient to use vehicle as a Tractor.

Its basic mechanical features included a rear mounted liquid cooled 90° - V8 Cadillac engine and 4-speed hydra-matic transmission with fluid coupling clutch driving through a modified Ford T-16 Axle, with controlled differential steering brakes, to track drive sprockets. The tracks, each consisting of 1 wide and 2 narrow rubber belts fastened together by cross links, were carried on two front and two rear bogie suspension units having a total







of sixteen (4 per unit) bogie wheels fitted with 4.50 x 16 run-flat tires. Section of light armour plate welded into a single unit formed the sides and ends of an open top hull and wide 3/4 inch plywood running boards covered the tracks and provided accommodation for stowage boxes, etc.

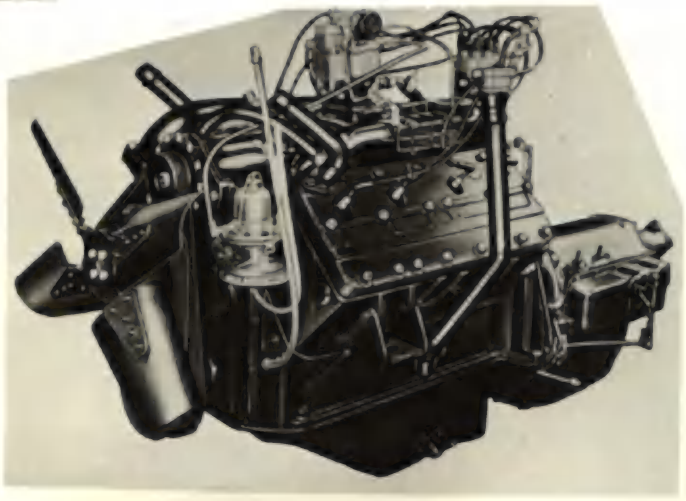
Production of the Canadian Mk. I Armoured Snowmobile commenced at Farand & Delorme Ltd., Montreal, in the early spring of 1944 and was completed in the late winter of 1945. A total of 410 vehicles was produced.

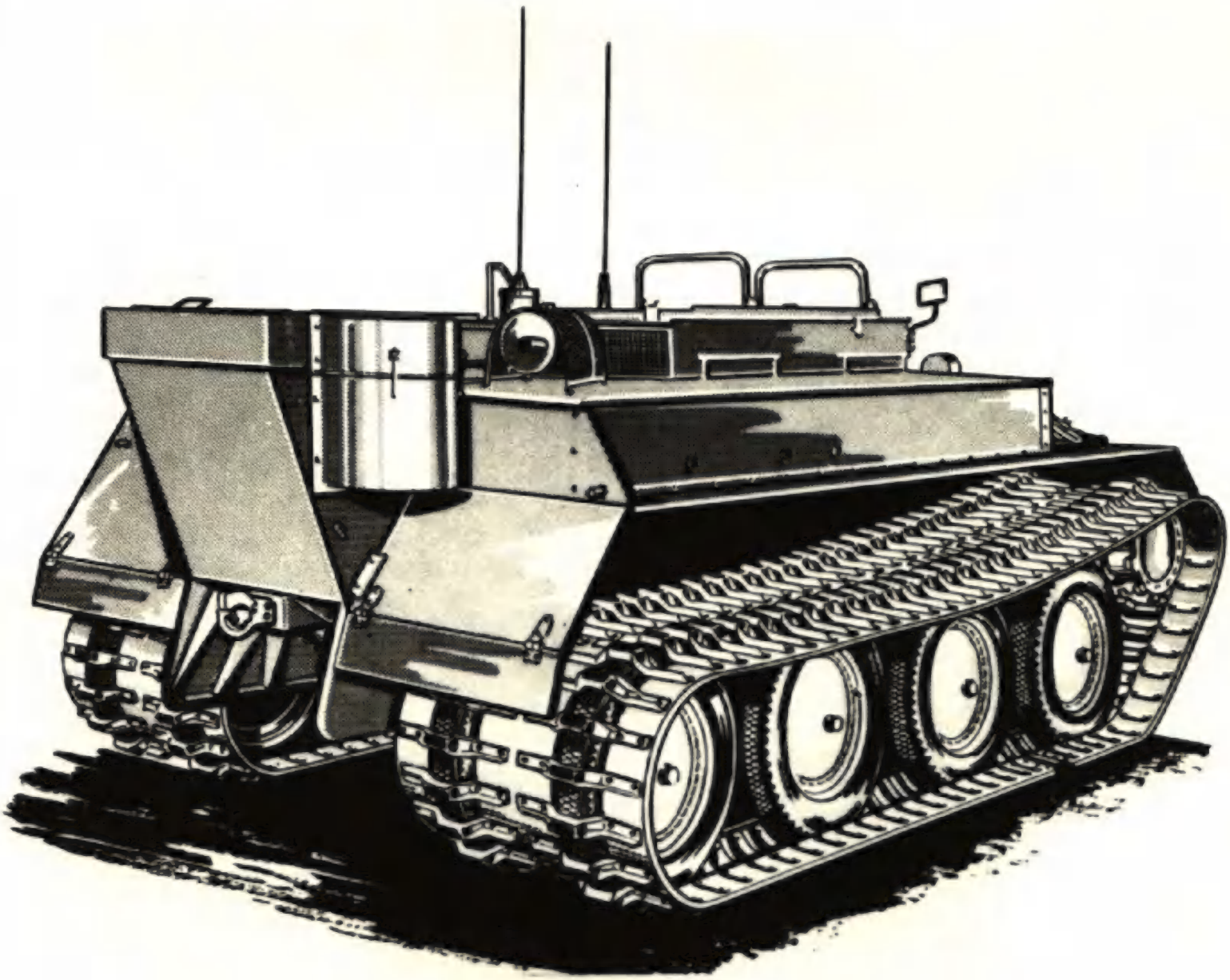
The Armoured full-track Snowmobile, built to requirements laid down by the British Ministry of Supply, was completely new in design in most respects, and similarity to its predecessors was confined to the track.

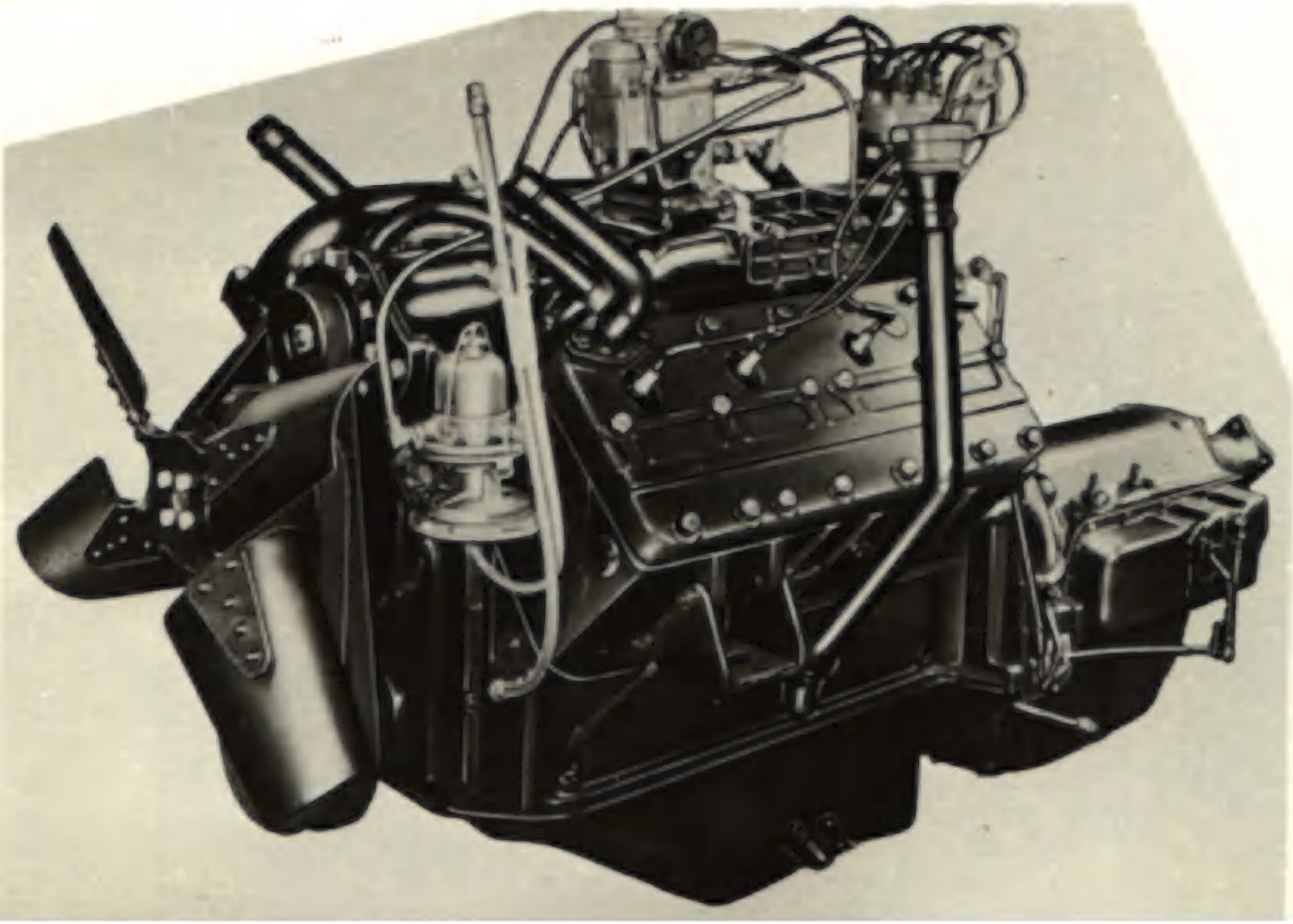
From test experience gained with the Bombardier military pattern vehicles, and the experimental half track (General Motors) and full-track (Bombardier) vehicles, a cubic foot per ton mile performance requirement figure had been established as a guiding factor in the development of the Armoured Snowmobile.

Investigation, design and development of the various components were carried out as indicated below, the prime requirement for each being its availability since time was of the utmost importance.

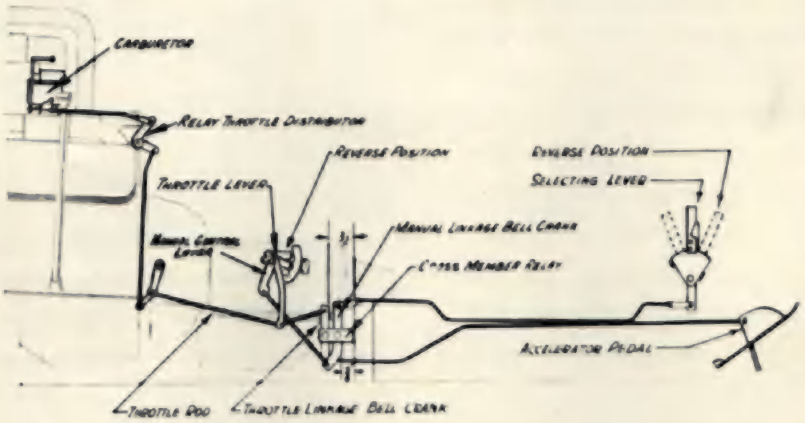
ENGINE AND TRANSMISSION







The Cadillac M-5 Tank Engine with Hydra-Matic Transmission was decided as the power plant capable of providing the cubic foot per ton mile requirement figure and at the same time was readily available on the market. The worth of this engine had been indicated during tests with the General Motors Half Track Experimental Snowmobile; also it was realized that the Hydra-Matic Transmission, when coupled directly to the engine by a fluid type clutch or flywheel, would have an advantage over the conventional hand operated transmission due to its automatic selection and instantaneous gear change features without appreciable interruption of engine torque to the driving axle, or loss of vehicle speed during gear change and would reduce the shock loads on driven components. In addition, the reduction gears in the Hydra-Matic Transmission had a greater life expectancy.



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Application of the M-5 Tank Cadillac Engine with Hydra-Matic Transmission in the Snowmobile necessitated using the following materials:

(a) Passenger car engine fan support and intake manifold, due to a vertical instead of tilted mounting.

(b) Passenger car water pump assembly, due to the Snowmobile radiator being mounted vertically at the rear of the vehicle instead of horizontally over the engine, as in the M-5 tank.

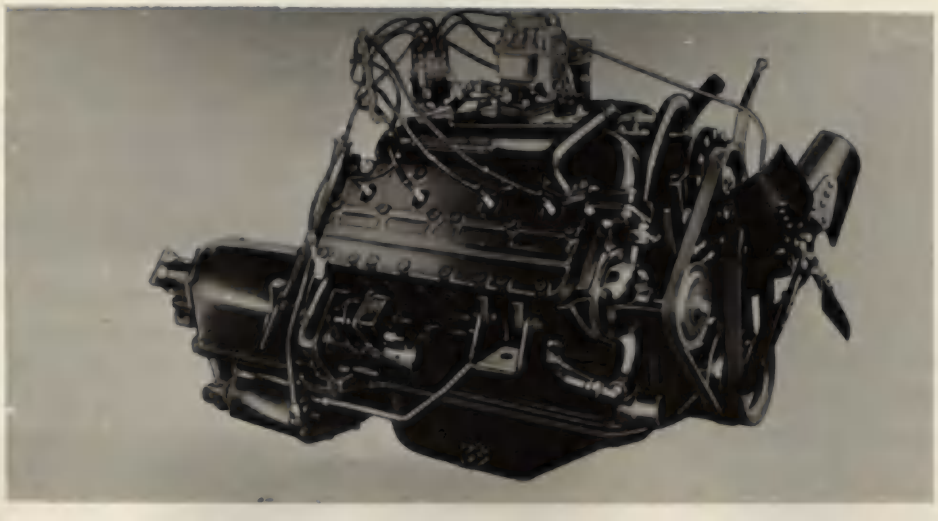
(c) Special water outlet pipes from the cylinder heads, due to different radiator location.

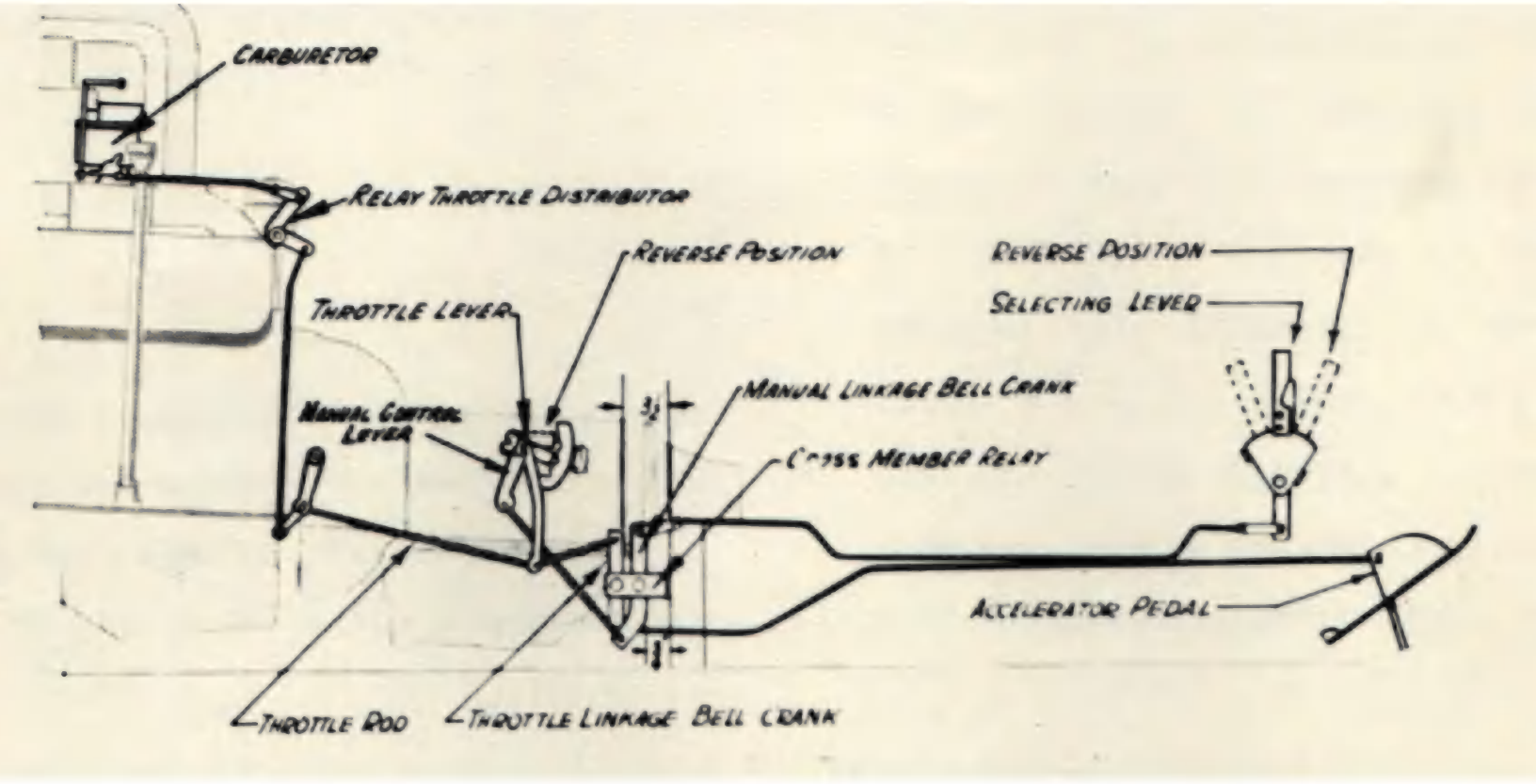
(d) Special crankcase oil filler pipe (Dipstick & Oil Filler Tube Assy.), due to inaccessibility of M-5 engine design.

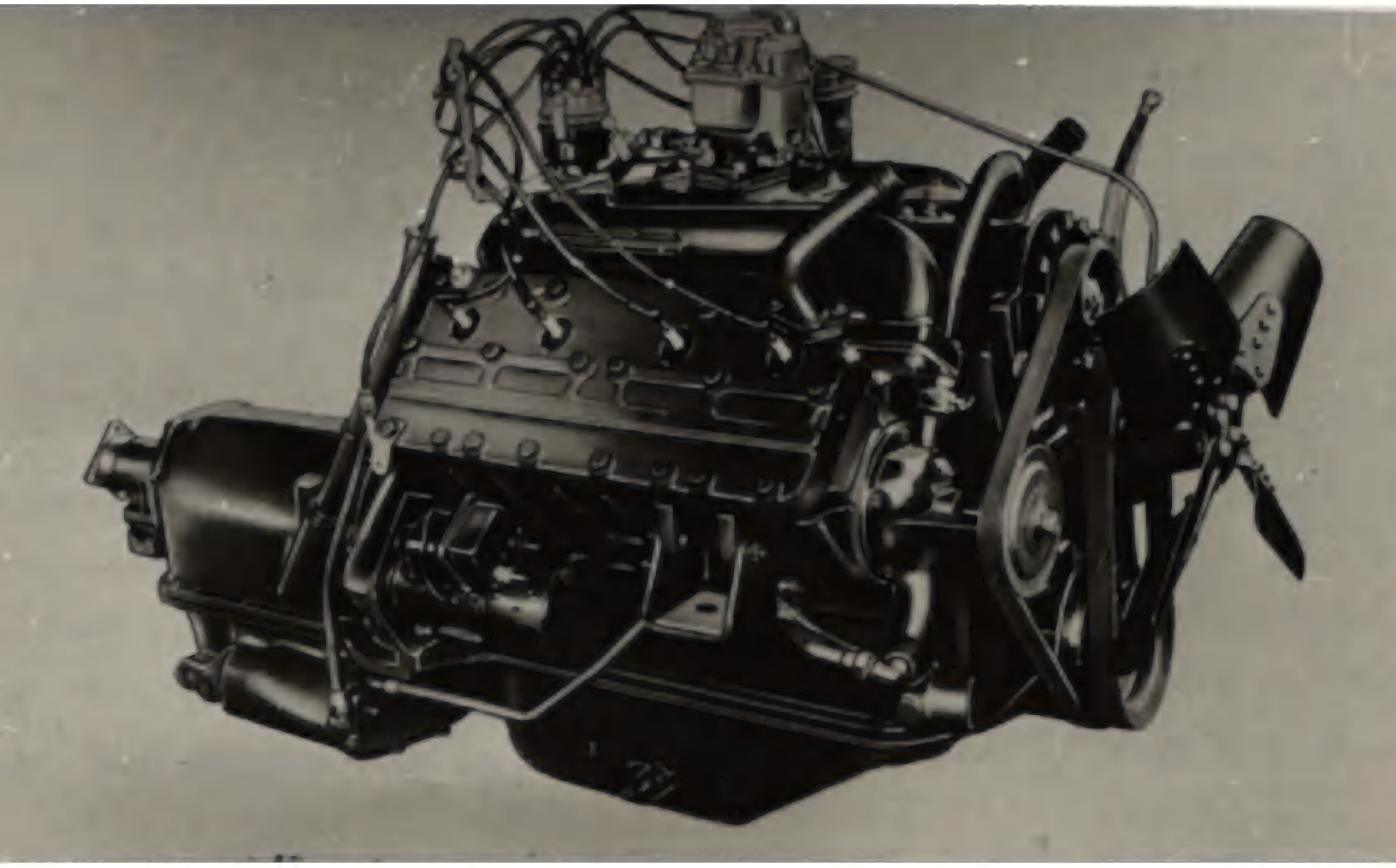
(e) Canadian radio suppression units, with exception of the generator filter, in place of the American material in order to meet Canadian and British suppression standards.

(f) Fly-ball type governor to limit engine speed to 4000-4200 r.p.m. which was considered the maximum speed this engine should operate in high gear for satisfactory life in the Snowmobile. (In M-5 tank application, the engine was governed at 4500-5000 r.p.m. but it was not possible to reach this speed in high gear.)

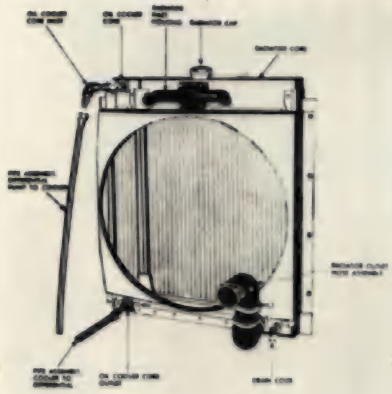
(g) Special fluid flywheel drain plug wrench, to permit draining this unit through the floor plate.




CARBURETOR
RELAY THROTTLE DISTRIBUTOR
REVERSE POSITION
REVERSE POSITION
SELECTING LEVER
THROTTLE LEVER
MANUAL LINKAGE BELL CRANK
MANUAL CONTROL LEVER
CROSS MEMBER RELAY
ACCELERATOR PEDAL
THROTTLE ROD
THROTTLE LINKAGE BELL CRANK



COOLING SYSTEM

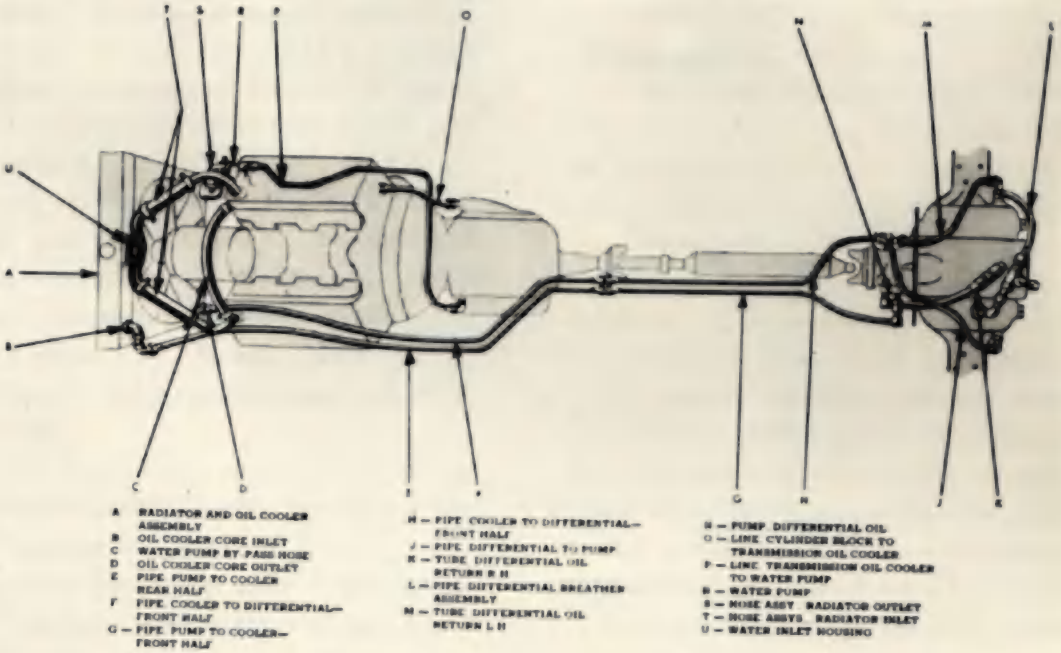


The engine coolant was circulated by pump through a four inch tube and fin radiator core. This coolant was as well circulated through an intercooler of the hydra-matic transmission, to control the oil temperature of the Transmission. The system was pressurized to 9 pounds and had a capacity of 25 imperial quarts.

The oil of driving axle unit was cooled by being circulated through a tubular core set adjacent to the engine coolant core.

Air circulation through each of the cores was maintained by a four bladed fan drawing the air from the outside of the vehicle.

Test experience indicated insufficient cooling system capacity at temperatures above 70°F. Also the single belt driven fan appeared barely capable of carrying the load, even though it was run at maximum tension to avoid belt slippage. However, as the vehicle was designed for operation in temperate zones (range - 20°F to + 70°F. Specification O.A. 225) the above described cooling system was retained, rather than delay production by further design-development work.



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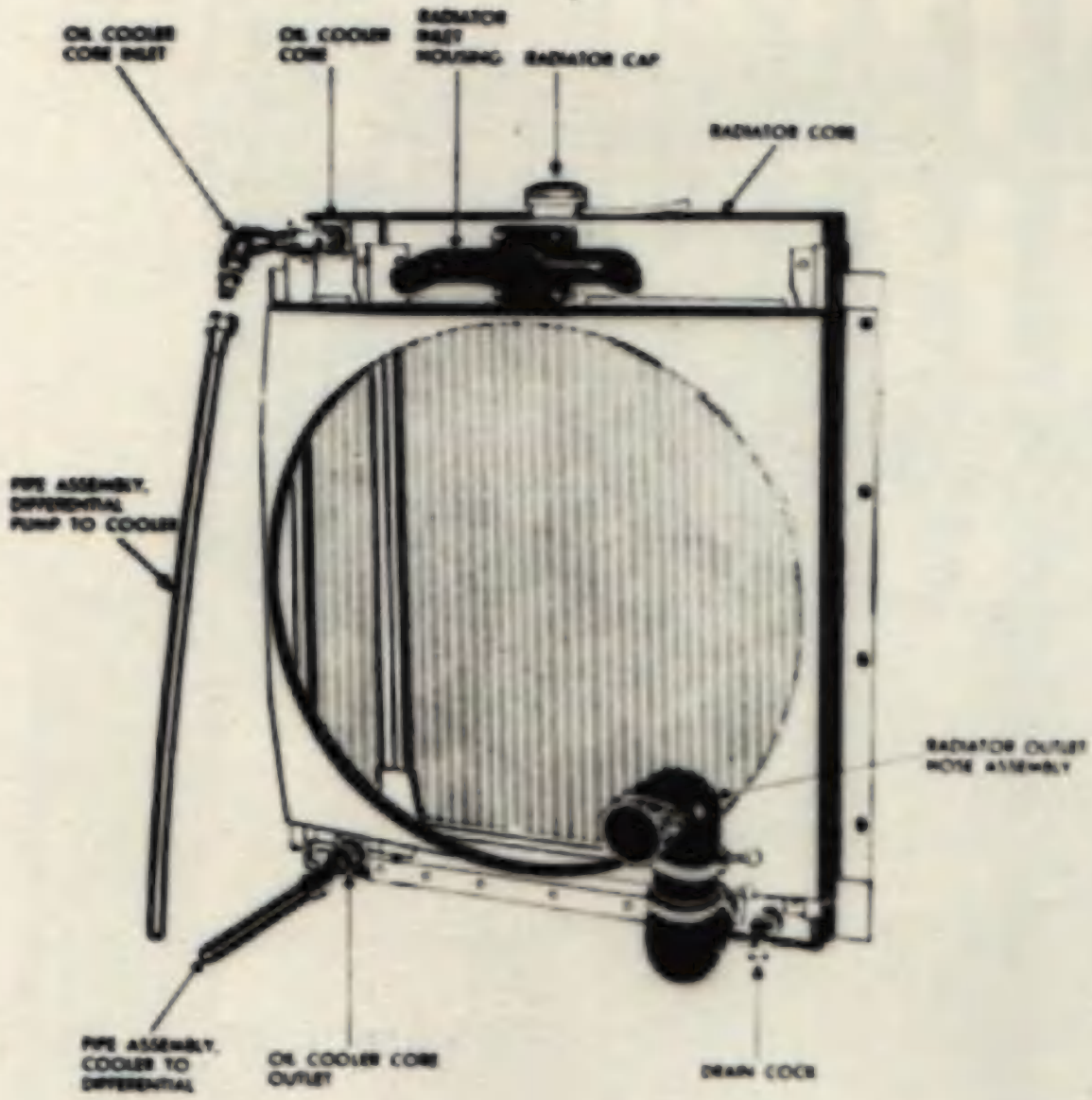
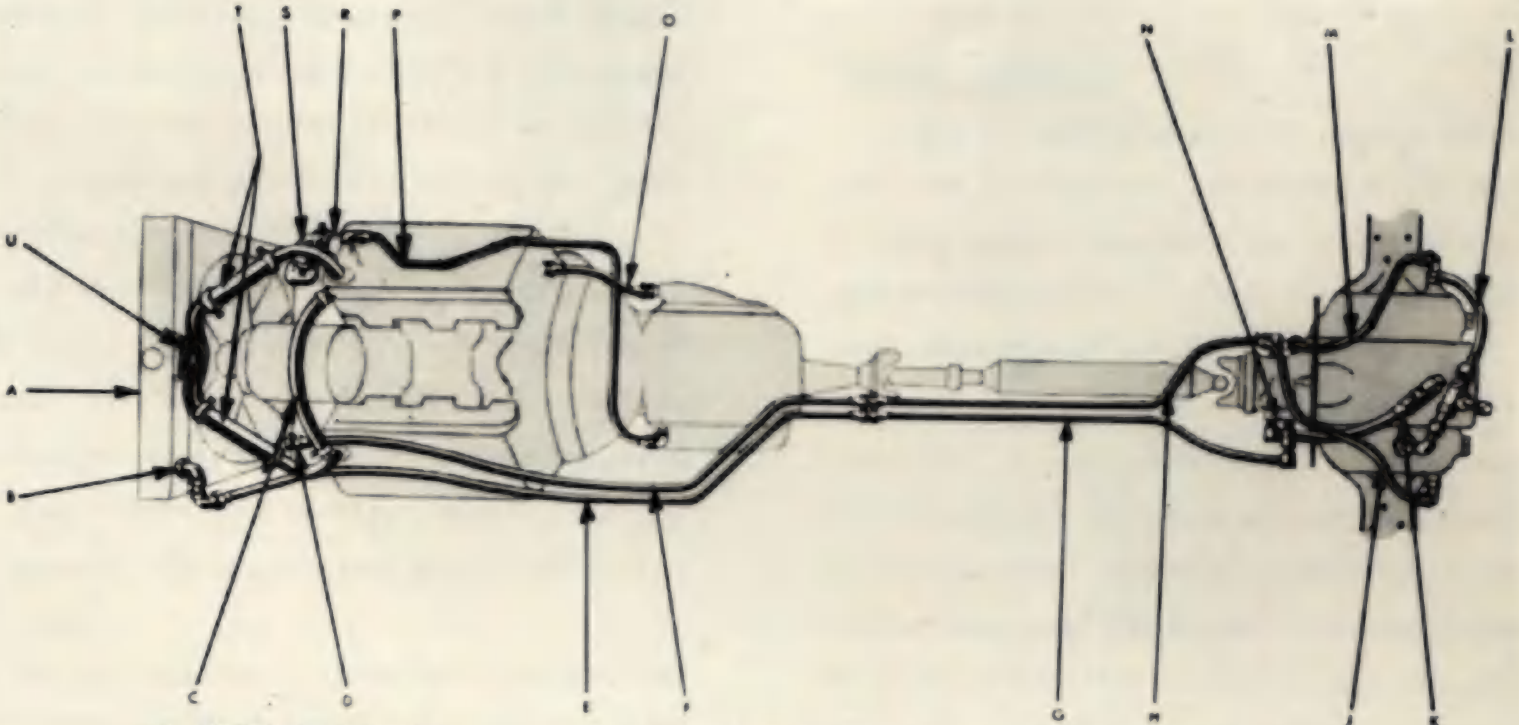
FINAL DRIVE

It was decided that a controlled differential type driving axle with internal steering brakes would give an efficient driving mechanism. Investigation revealed that the Ford (U.S.) T-16 Axle, then being made for the British Universal Carrier, was the only suitable unit on the market, based on medium light weight vehicle requirements, suitable torque capacity and availability. This driving axle was therefore selected but as no control could be exercised over the design of the assembly as available from Ford, the Snowmobile hull width was designed to suit the axle unit dimensions.

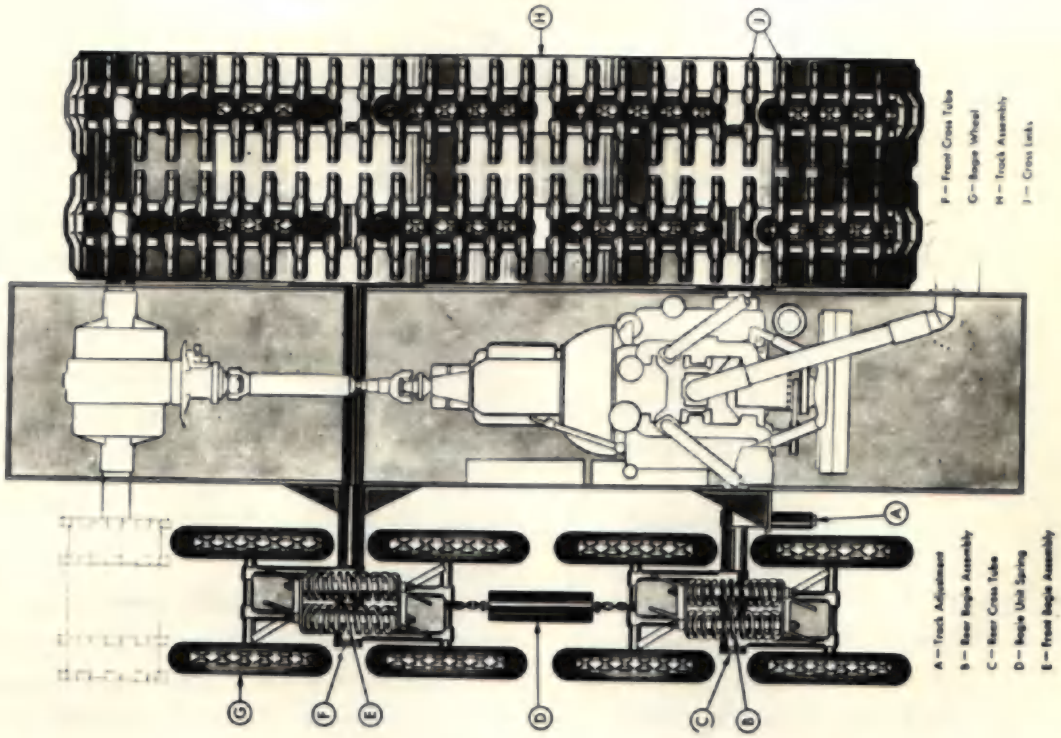
In order to ensure the two-man crew having adequate seating space and a maximum field of vision, and to provide reasonable accessibility to the engine and axle assemblies without concentration of weight at any one part, it was decided that the driving axle should be located in the front and the power plant at the rear of the vehicle. This arrangement was known

COOLING SYSTEM





A — RADIATOR AND OIL COOLER ASSEMBLY
B — OIL COOLER CORE INLET
C — WATER PUMP BY-PASS HOSE
D — OIL COOLER CORE OUTLET
E — PIPE, PUMP TO COOLER REAR HALF
F — PIPE, COOLER TO DIFFERENTIAL—FRONT HALF
G — PIPE, PUMP TO COOLER—FRONT HALF
H — PIPE, COOLER TO DIFFERENTIAL—FRONT HALF
J — PIPE, DIFFERENTIAL TO PUMP
K — TUBE, DIFFERENTIAL OIL RETURN R H
L — PIPE, DIFFERENTIAL BREATHER ASSEMBLY
M — TUBE, DIFFERENTIAL OIL RETURN L H
N — PUMP, DIFFERENTIAL OIL
O — LINE, CYLINDER BLOCK TO TRANSMISSION OIL COOLER
P — LINE, TRANSMISSION OIL COOLER TO WATER PUMP
R — WATER PUMP
S — HOSE ASSY., RADIATOR OUTLET
T — HOSE ASSYS., RADIATOR INLET
U — WATER INLET HOUSING



to give satisfactory performance in full-track vehicles and, in addition, provided sprocket protection on steep up-grades (with weight transfer to the rear). Obstructions that might lodge on the track were likely to be thrown clear on front drive vehicles before they could be carried into the sprockets.

The decision to locate the drive at the front of the vehicle necessitated inversion of the axle unit in order to obtain the correct sprocket rotation. This action further required

(a) a new lubricant venting system.

(b) sealing the circulating pump internal intake.

(c) the addition of a check-valve to the re-routed external intake to help the pump maintain its "prime".

(d) relocation of the brake levers to suit the upside-down position of the axle.

Other changes to the driving axle - but not related to the inverting of the unit - consisted of

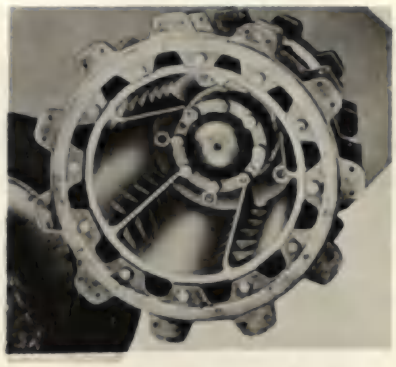
(a) the addition of a temperature tell-tale signalling unit to the housing to warn the driver when the axle lubricant reached a temperature of 245°F.

(b) the attachment of mud shields to the brake backing plate flanges to prevent the entry of mud into axle outer bearings.

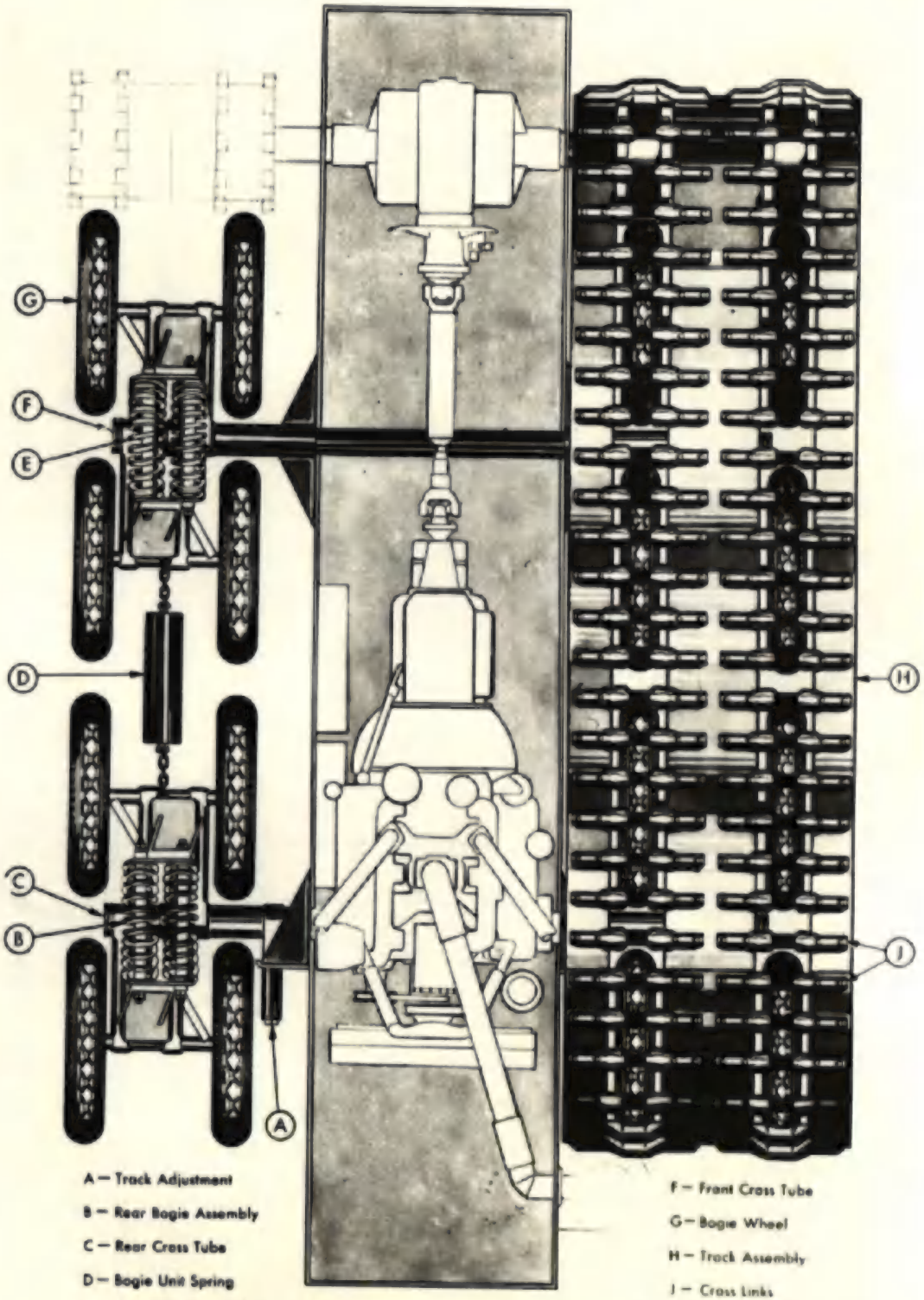
(c) the welding of a mild steel flange to the alloy steel pinion shaft coupling to permit attachment of the drive line universal joint. The welding of this unit was covered by a special welding and heat treat procedure to prevent cracks in welding.

DRIVING SPROCKETS

The British Ministry of Supply specified that the Armoured Snowmobile was to be capable of bare ground operation up to 25% of its normal travel. Test experience with the Bombardier type rubber faced sprockets had shown that this requirement could not be met without sprocket redesign. A concerted effort was made therefore to improve sprocket life by modifications to the original sprocket arrangement such as: (a) crowned resilient rubber facings agreeing with the cross link contour, (b) bonded (instead of bolted) resilient rubber facings, (c) corded facings made of rubber-canvas belting, (d) sprockets with theoretically correct tooth contour covered with crowned rubber facings vulcanized in place.



None of the foregoing designs proved entirely successful and eventually a narrow faced sprocket was developed on which metal



A — Track Adjustment

B — Rear Bogie Assembly

C — Rear Cross Tube

D — Bogie Unit Spring

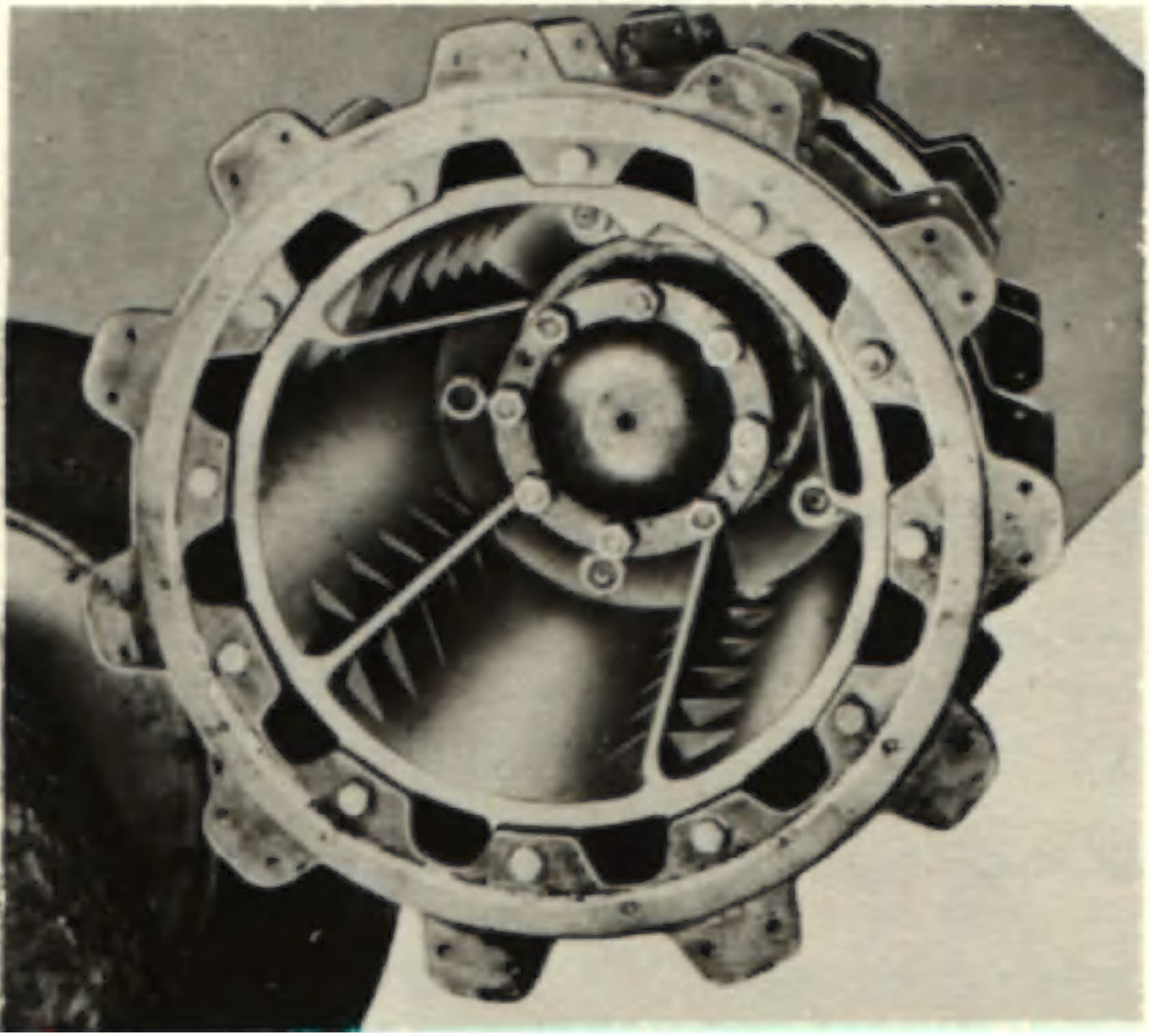
E — Front Bogie Assembly

F — Front Cross Tube

G — Bogie Wheel

H — Track Assembly

J — Cross Links



teeth contacted the cross links. It incorporated guide rings to centralize the tracks. Two sprockets at each cross link were provided in place of a single wide faced sprocket, or a total of four sprockets per side. With this design, the sprocket-track contact point more nearly coincided with the neutral axis of the belt as it bent around the sprocket, so the cross link pitch lead varied only slightly from the normal 4 in. dimension. The narrow tooth face (3/8 inch) permitted sufficient pressure to be exerted to prevent ice from building up at the tooth root. Development of the new sprockets required entirely new cross links and new sprocket drums. Subsequently the sprocket drums were re-designed, of rolled plate and tubing instead of cast steel, effecting a considerable reduction in weight.

The new sprocket arrangement proved satisfactory - increasing the bare ground life from 50 - 500 miles up to 2500 miles. Due to the relatively narrow face of the steel sprocket, "feet" were rivetted to the teeth to minimize the possibility of their cutting the track belt.

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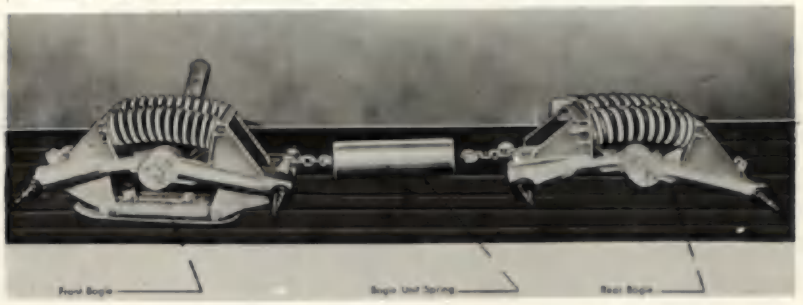
SUSPENSION

The Armoured Snowmobile Suspension was completely new in design. Each side of the vehicle was supported on eight wheels, grouped into two, four wheel trucks. Each truck consisted of a spindle fitted with arms, compression coil springs and rebound control chains. The forward trucks were fitted with tension coil springs to accept the greater front end shocks. The articulation of one truck to the other was limited by a spring loaded connecting chain.

A front support consisted of a fixed tube. The rear support was adjustable but since it carried both right and left track, the adjustment meant skewing the tracks slightly, which in extreme cases of adjustment affected the tracking of the vehicle.

The bogie wheels, consisting of two formed discs welded together, were the drop centre type with a detachable side rim to accommodate 4.50 x 16 "run-flat" pneumatic tires. The tires were specially designed including bead spacer with a wire core.

The entire suspension arrangement was of medium weight, comparatively simple in construction and, with good bogie articulation, gave an excellent ride.



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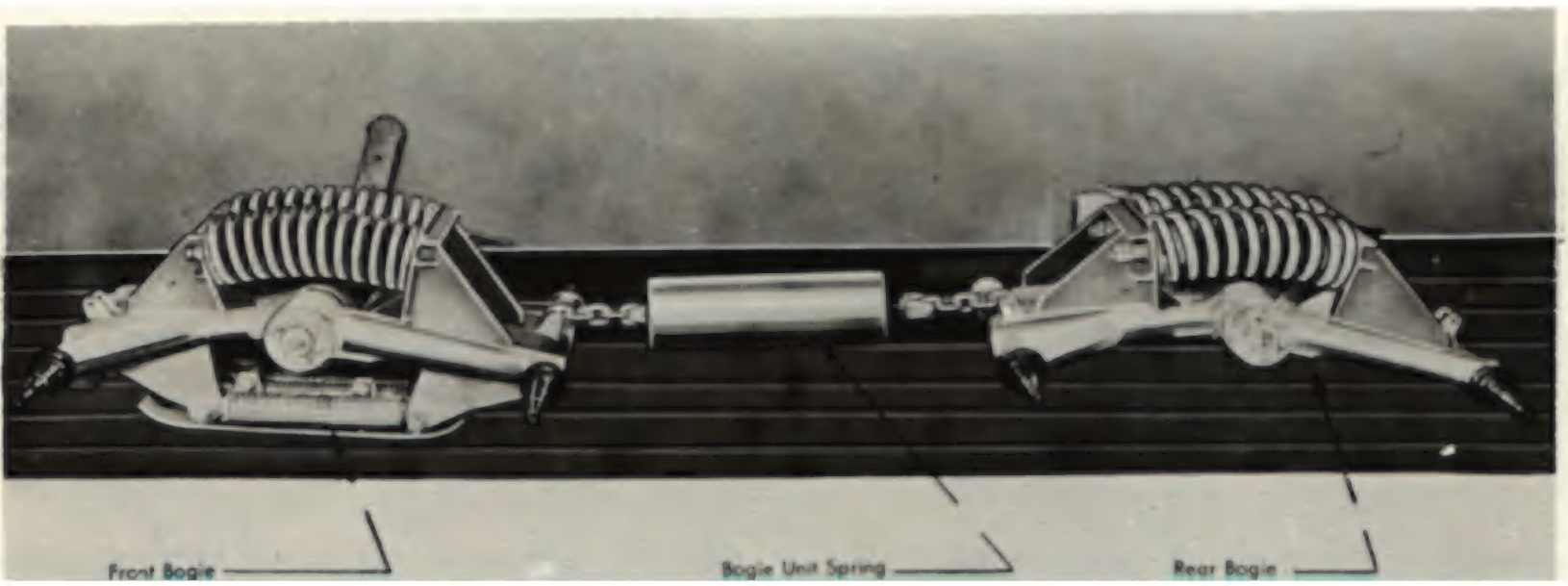
TRACKS

An early appraisal of the armoured Snowmobile indicated that its laden weight would be in the neighbourhood of 10,000 lbs. As test experience with prior types of snow traversing vehicles had shown that the ground pressure figure should be from 1.5 to 2.0 lbs. per sq. inch for reasonable flotation and performance, it was evident that the track used on this vehicle should provide a total ground contact area of 5000 to 6600 sq. inches.

Two 17-1/2 ins. commercial Bombardier tracks coupled in parallel on each side of the vehicle provided a ground pressure within these limits. Coupling these tracks was investigated; first by connecting two tracks together by short lengths of link chain, and, secondly by the use of rubber blocks, both the chains and the rubber blocks being attached to the tracks by bolts and spaced at approximately every tenth cross link. It was found during tests, however, that the inner and outer tracks coupled by chains could move independently of each other with resultant interference at the sprocket and/or damage to the sprocket rubber facing. In the case of tracks coupled together by rubber blocks, considerable bolt breakage was experienced. In order to eliminate the difficulties experienced with coupled tracks, a new


Front Bogie
Bogie Unit Spring
Rear Bogie

track, having two outer belts (6 ins.) and a 12 in. centre belt was adopted for production. This track had the overall width - 35 ins. of two Bombardier commercial tracks.

At about the time that this type track (two narrow -one wide) was introduced, a change in belt construction was made wherein a layer of heavy longitudinal cotton cords was added to the core of the previous five-ply with breaker strip construction belts. The overall dimensions of the belts remained much the same, the external rubber coating being made somewhat thinner to compensate for the increased core thickness. This change was made to reduce belt stretch and was successful to the point that in some cases shrinkage actually was experienced. Track belts with both crude and synthetic rubber were used during production.

TRAVERSING DEEP SNOW'

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TRACK CROSS LINKS

The cross links served several purposes:

(a) To hold the track belts in parallel.

(b) To stabilize the track in its running position on the wheels.

(c) To keep the belt surface from ground contact.

(d) To drive the belts.

(e) To act as grousers for the track.

Coincident with the use of four narrow faced sprockets a new type cross link was designed with the tooth contact point of the narrow faced sprockets just inside the track belts. This reduced the bending moments on the link. The outer belts were reduced in width from 6 ins. to 5-3/8 ins. and the centre belt was reduced in width from 12 ins. to 10-5/8 ins. The edges of the track belts were bevelled in order to minimize drag at the time of sprocket engagement.

The cross link ground contact area was increased, as was the thickness of the section, to provide greater transverse strength and the contour was changed to better accommodate the tire. Rubber blocks were vulcanized in the ground contact surface to increase its bare ground life. Vertical legs were added at the attaching flange to provide a grouser.

Special attention was given to the sprocket tooth contact point, making it a correct contact surface. As a result, much of the pitch variation and sprocket-track interference was eliminated.

After the incorporation of considerable metallurgical refinements, including a change from S.A.E. 1095 steel to S.A.E. 4340 steel, the new cross link proved relatively satisfactory.

CROSS LINK TO TRACK BELT BOLTS

Considerable trouble was experienced with breakage of the cross link to track belt attaching bolts. In order to minimize this condition the standard carriage bolts were changed, first to S.A.E. 1020 steel, and subsequently to S.A.E. 1035 heat treated bolts having rolled threads. Steel bushings were installed in the belt bolt holes to provide a solid column against which to tighten the nut on the bolt.

TRACK CONNECTING COUPLING PINS AND LINKS

In order to increase the life of the track connecting arrangement, the coupling hinge pins were increased in diameter and considerably better material was specified for both the coupling hinge links and pins. Chrome plating of the wearing surfaces was tried but never adopted due to relatively high cost and indifferent bonding of the chrome to the mother metal.

HULL

While weight was a prime consideration, the hull was fabricated of armour plate to provide the specified protection. The front vertical plate was 14 m/m, the balance 7 m/m. The hull bottom was unarmoured 1/8 mild steel. With the use of this gauge material, caution had to be exercised during fabrication to avoid concentration of heat resulting in distortion. Consideration was given to the method of placing mounting plates and brackets, and to the welding sequence.

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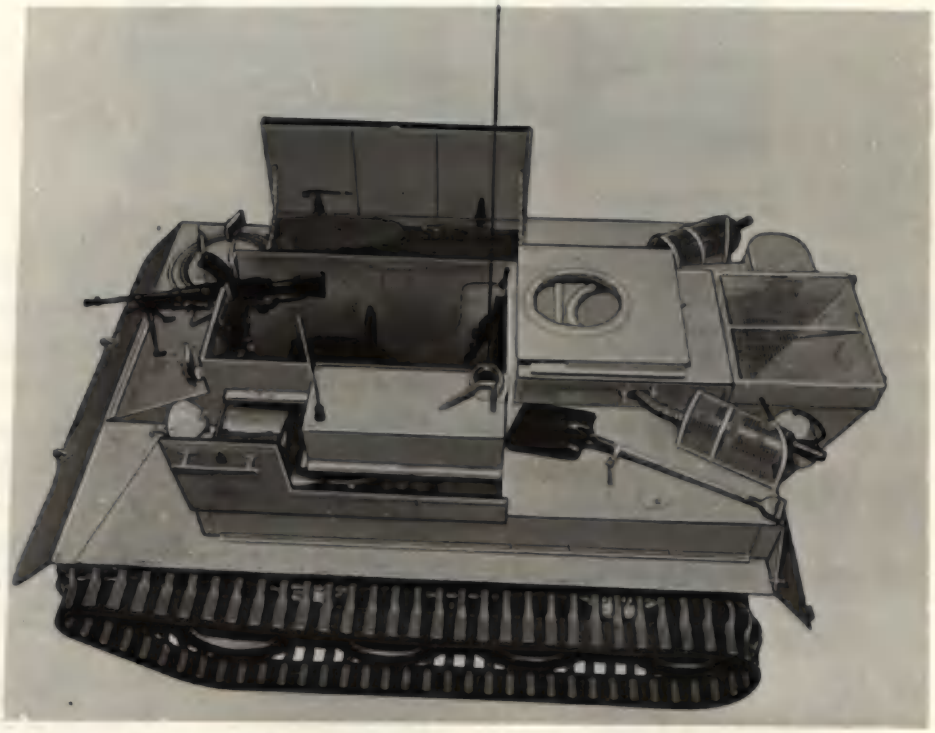


COMMUNICATION

A No. 19 Wireless Set was installed to provide communication facilities. Two regular mounts were added on the centre line of the carriage. These mounts relieved the load on the carriage so that the radio performance life proved satisfactory.

STOWAGE AND SPECIAL TOOLS

Two stowage compartments were provided, one on each running board attached to the hull and to the fuel tank compartment front plate. All stowage items are illustrated in Section "L" of the Maintenance Manual. Likewise, all special tools are listed in Section "M" of the Maintenance Manual.

WINTERIZATION

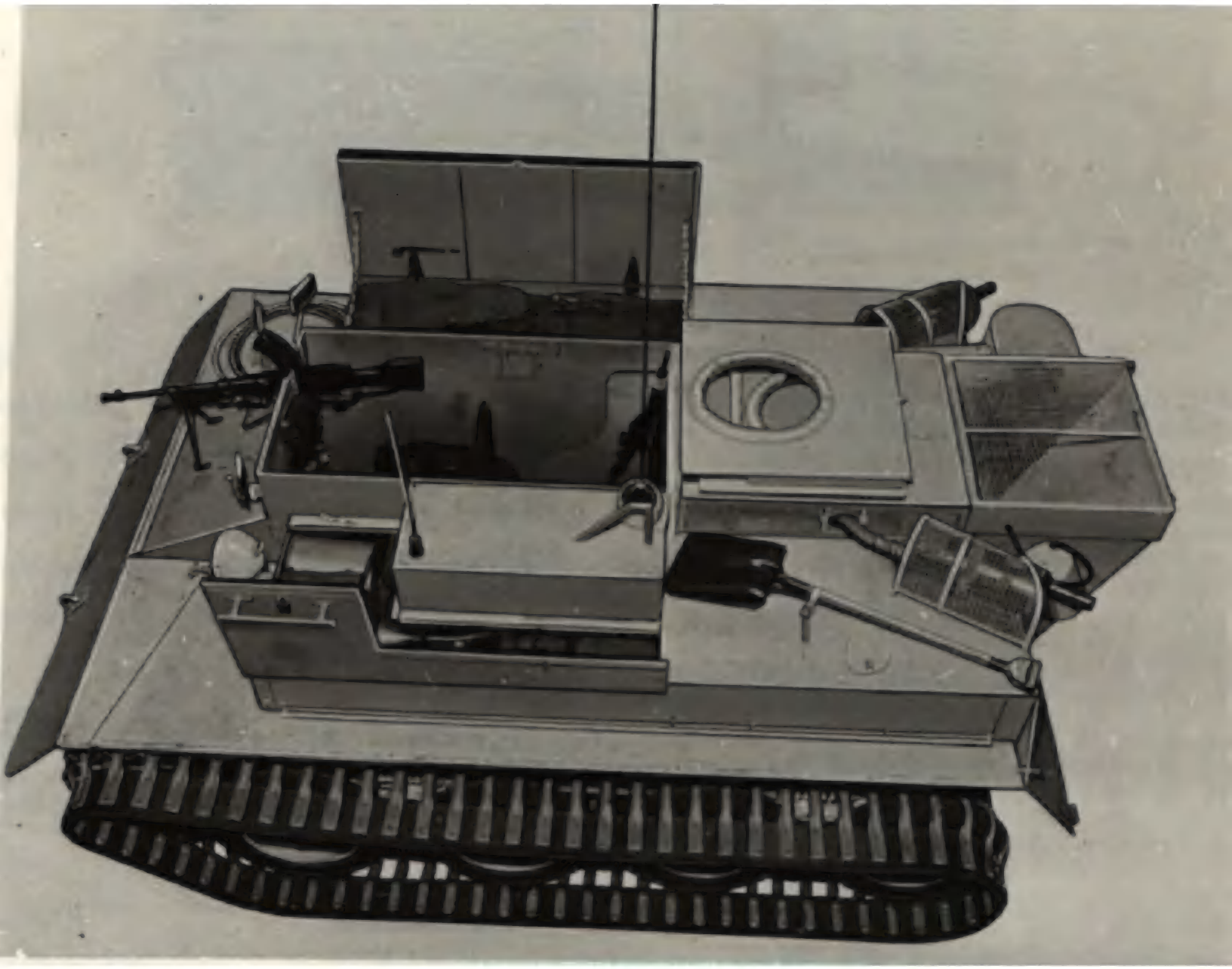
The winterization equipment provided on the armoured snowmobile was a prediluter system installed as a precautionary measure only. Test indicated that the vehicle could readily be started at temperature of minus 20°F. without auxiliary equipment, providing the battery, etc. was in good condition. With the aid of the prediluter system, starting at temperatures lower than this was possible.

TIRE PERFORMANCE

The tires were protected from cuts and bruises at the sides by the rubber belts and at the ground contact point by the cross links. Both crude and synthetic rubber tires were used during production and gave satisfactory life performance.

CREW PROTECTION FROM ELEMENTS

To minimize crew exposure, due to the open top hull, two man-hole type flat plywood covers were installed over the driver's and observer's seats. The front cover was hinged to the body of the vehicle so that they could be folded out of the way when not in use. Although of simple construction and easy to operate, it was found that the crew's movements were somewhat hampered when the covers were in the closed position.



PERFORMANCE

The following excerpts from various Operational and Army Reports give an indication of the performance of the Armoured Snowmobile. It is recommended that reference be made to the reports themselves for more complete data.

1. From CAORG, Report #25 - Exercise "Lemming".

"The Canadian Armoured Snowmobile functioned efficiently but to be a desirable barren ground vehicle it needs the following modifications.

(a) Much improved petrol consumption.

(b) Capacity to seat 3 or 4 men with sufficient cargo space on the vehicle for carrying personnel equipment.

(c) A snow-proof cover for the interior of the vehicle allowing all-round vision for the Commander.

(d) Slight reduction in ground pressure".

2. From fifth Canadian Armoured Brigade Report dated 25 January 45 by I.L. Davies, Major.

"Comparison Armoured Snowmobile versus American Weasel.

	Snowmobile	Weasel
Ground pressure and soft country traverse	good	good
Armour protection	fair	nil
Load carrying space	poor	fair
Mechanical reliability	good	not sufficient time to report. Understand track life extremely short.
General construction	generally rugged	all components appear very light for use under service conditions.
General ride	good	considerable pitching across country.
Wading	good up to 45 ins.	appears good.
Amphibious properties	no, not above 45 ins.	"Understood to be amphibious".

3. From REME 6th Army (British Report on Trials conducted 4/3/45. (Words in brackets added for continuity).

"The cross-country performance of the Snowmobile and tracked trailer was excellent (although) margin between the running temperature and blow-off was very small (for the engine cooling system)".

4. From Report on visit to Italy and U.K. by Lt. Col. M.M. Evans, A.E.D.M., D.M.&S.

"All personnel were enthusiastic on the general performance and soft and rough ground crossing ability of the vehicle. Road performance and reliability was much better than experience with any other tracked vehicle".

5. From Report on Exercise Polar Bear by C.D. Morris, Captain, D.V.S.A. (Canadian Army) Observer.

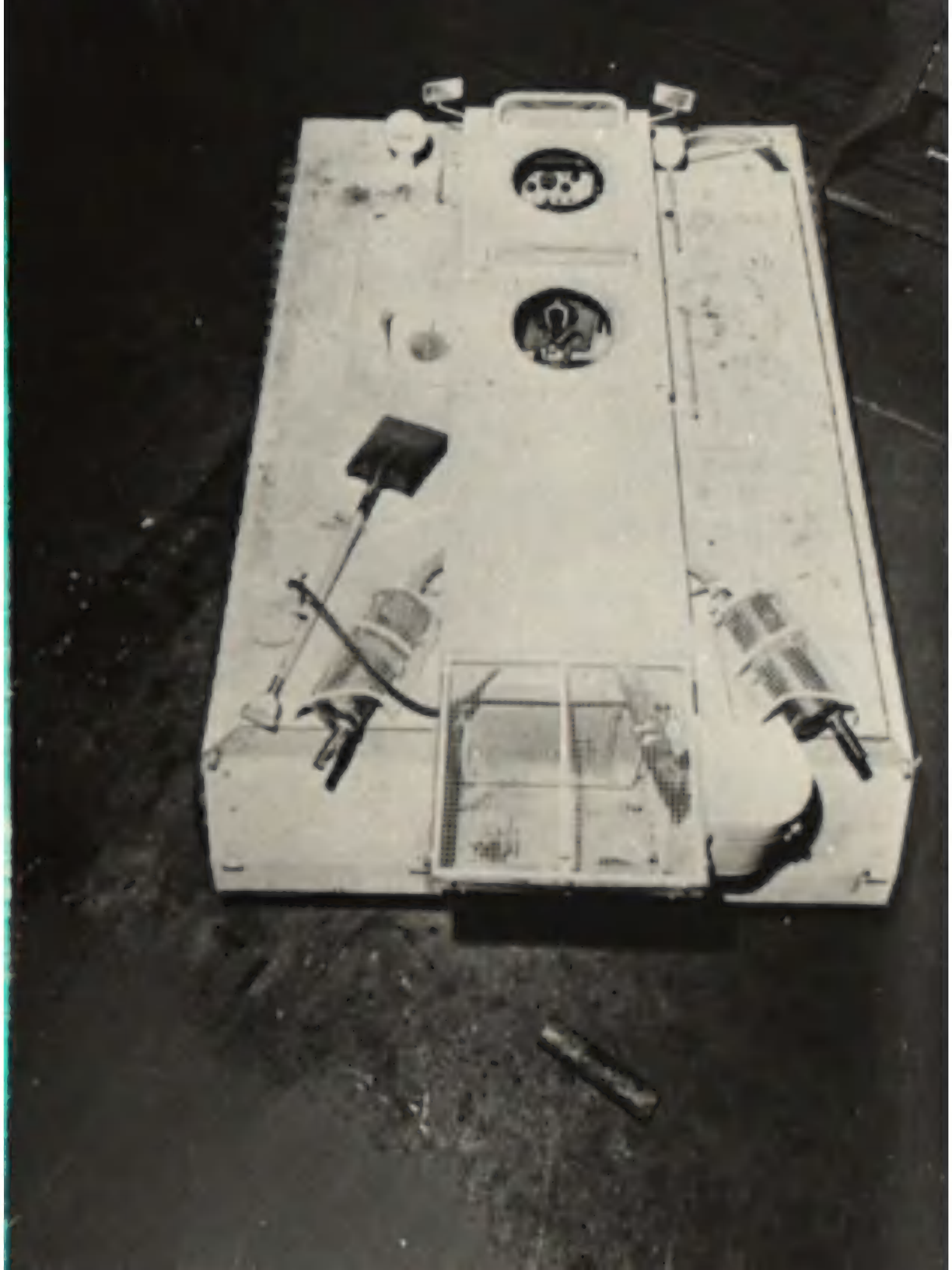
"This vehicle is an excellent vehicle for operations in snow of all types and over rough terrain".

6. From British Army Staff Report on D.T.D. Trials of Mud Committee.

"The vehicles used were the Snowmobile, Weasel, Loyd, Australian Tracked Truck and T16 - all used at battle weight and towing 6 Pdrs. - and the order of success is understood to be more or less as above. The Snowmobile was apparently an easy first, and the Australian Vehicle and T16 an equal last, both failing in a few yards".

DISTRIBUTION

Production orders totalled 415 Mark I Snowmobiles. 400 were ordered by the British, 3 by U.S.S.R. and 10 by the Department of National Defence. Also, 2 Mark I vehicles were produced for the Army Engineering Design Branch. Due, however, to orders being placed for 5 Mark II Snowmobiles after some of the major components (final drive and engine) were already out of production it was necessary to make a cutback of 4 vehicles on the British order and 1 vehicle on the D.N.D. order, thus bringing the total Mark I Snowmobiles produced to 410 vehicles.



SNOWMOBILE, ARMOURED, CANADIAN, MARK I

TECHNICAL DATA

PRODUCED BY:

Farand & Delorme Ltd.

PRODUCTION:

Commenced: 1944
Finished: 1945

NO. VEHICLES PRODUCED:

415 Total (410, Mk.I; 5, Mk.II)

SERIES:

Mk. I Vehicle Code B-FT2-Snow-A-1
Mk. II Vehicle Code B-FT2-Snow-A-2

TYPE:

Full Tracked. Driver centrally located in front of vehicle.

BRIDGE CLASSIFICATION: 5.

CREW:

2 - Driver and Observer seated in tandem.

ARMOUR:

Hull
Front and Rear - Vertical Plates 14 m/m
Sloping plates 7 m/m
(equivalent to vertical plate protection)
Sides - 7 m/m
Bottom - Unarmoured (1/8 mild steel)
Radio Comp't & Fuel Tanks - 7 m/m (sides and ends only)

GUN MOUNTS:

Three Bren gun Pivot Mounting Brackets - 1 at front - 1 ea. side.

ARMAMENT:

1 Bren .303 Cal. Gun with Mounting Attachment - 22 amm. clips of 30 rounds ea.
1 Sten. 9 m/m (carried, not mounted) 11 clips of 32 rds. ea.
1 Service Rifle No. 4 Mk.I .303 Cal. with 1 bandolier of 50 rounds.

SIGHTING: Nil.

PROTECTED VISION:

Protectoscope, driver's (for use when seat is in lowered position)

COMMUNICATION:

No. 19 Wireless Set in compartment at left of rear seat.

COMPASS:

Small magnetic type (similar to standard commercial compass for automobiles) to assist crew in following a general direction.

LIGHTING:

One Spot Lamp; Two Tail Lamps, Two Inst. Panel Lamps.

PERFORMANCE DATA

POWER/WEIGHT:

29.0 B.H.P. per short ton (laden weight into gross B.H.P.)

GROUND PRESSURE:

1.62 lbs. per sq. in. at approx. 2 ins. ground penetration.

GROUND CLEARANCE: 12 ins.

GRADEABILITY: Theoretical 105%.

MINIMUM TURNING RADIUS: 38 ft. 6 ins.

SPEED, MAXIMUM: 28-30 M.P.H.

TRENCH CROSSING ABILITY: 4 ft. 8 ins.

VERTICAL OBSTACLE CLIMBING: 26 ins.

FORDING DEPTHS: 45 ins.

CRUISING RANGE: Optimum - 225 miles.

FUEL CONSUMPTION: Optimum - 4.5 m.p.g.

OIL CONSUMPTION: 400 m.p.g.

MECHANICAL DATA

LADEN WEIGHT:

9850 lbs. (vehicle completely stowed and with crew).

OVERALL DIMENSIONS:

Height - 68 ins,
Length - 154 ins.
Width - 101 ins. (approximately)

WHEEL BASE:

87 ins. (c to c front and rear bogie wheels at curb weight)

CENTRE OF GRAVITY:

24-3/4 ins. behind centre line of front cross tube.

ENGINE:

Location	-	Rear
Make	-	Cadillac
Model	-	Modified M-5 tank
Type	-	90° - V8
Compression Ratio	-	7.06 to 1
Displacement	-	346 cu. in.
Peak Gross BHP	-	143 @ 3600 r.p.m.
Torque	-	243 ft. lbs. @ 1400 r.p.m.
Weight of Engine with accessories	-	1300 lbs.

LUBRICATION:

Engine - Pressure and forced circulation system, except valves which are splash type. Capacity crankcase 7 Imp. quarts. Relief valve opens at 30 lbs. minimum.

COOLING SYSTEM:

Liquid circulating under pressure from a generator-belt driven centrifugal pump through the cylinder block and head and fin and 4 tube deep type radiator core. A pipe from the right cylinder block to the hydra-matic transmission and returning to the water pump cools the oil in the transmission. The oil in the differential is cooled by forced circulation through an oil cooler built into the radiator core. Total capacity (water or anti-freeze) of cooling system - 25 Imp. qts.

FUEL SYSTEM:

Dual barrel down-draft carburetor, reciprocating diaphragm fuel pump, laminated disc type fuel filter, heavy duty oil bath air cleaner and two "terne-plated" rectangular fuel tanks of 25 Imp. gallons each.

CLUTCH:

Fluid coupling type (part of Hydra-Matic Transmission).

TRANSMISSION:

Hydra-Matic (including fluid coupling type clutch) 4 speeds forward - 1 reverse.
Gear Ratio:

1st speed	-	3.26 to 1
2nd speed	-	2.26 to 1
3rd speed	-	1.44 to 1
4th speed	-	1 to 1
Reverse	-	3.77 to 1

DRIVING MEMBER:

Modified Ford T-16 controlled differential with full floating axle shafts and 1-1/2 g.p.m. gear type oil pump. Drive gear ratio 5.83 to 1.

STEERING BRAKES:

Contracting shoe type controlled by steering levers.

SPROCKETS:

Location	-	Front
Number	-	4 each side.
No. of Teeth	-	11
Effective Pitch Dia.	-	12-3/4 ins. (First Type) 14 ins.(Second Type)

TRACKS:

Type	-	Three rubber belts (2 narrow, 1 wide) fastened together in parallel by cross links at a pitch of 4 ins. with reinforcement cleats under bolt-heads.
No. per Veh.	-	2
No. of Cross Links per track	-	138 (2 used each pitch lead)
No. of Reinforcement Cleats per track	-	268 (no cleats used either side of track connecting pins.)
Width Tracks	-	35 ins.
Length Track	-	23 ft.
Tread Width	-	65 ins. (c to c track)
Grousers	-	Intergral with cross links.

SUSPENSION:

Two front bogie suspension units mounted on a rigidly supported cross tube and two rear bogie suspension units mounted on a cross tube which is movable in its brackets for the purpose of track adjustment. Each bogie suspension unit has two main compression springs mounted on collars between opposed front and rear bogie arms. The front bogie units also have four supplementary tension springs installed on underside of the opposed bogie arms to compensate for additional stress imposed on front bogies. Compression springs sealed in cylindrical containers are attached between front and rear suspension assemblies by chains to control articulation.

BOGIE WHEELS:

Eight each side. Wheels are double disc drop centre type with removable side to accommodate 4.50 x 16 Run-Flat tires carrying 25 lbs. pressure.

TRACK ADJUSTMENT:

Rear cross tube movable in support bracket guides by adjusting bolt on each side of vehicle. Tighten adjusting bolt until bottom of track cross link is 2 ins. above the 2nd bogie wheel.

ELECTRICAL:

System	-	12 volts
Batteries	-	Two 6-volt 19-plate acid type connected in series - negative ground - 120 ampere hours
Starter	-	Delco-Remy 4-brush, 4-pole. Over-running clutch engages pinion with fly-wheel ring gear by means of solenoid operated shifting mechanism.
Generator	-	Delco-Remy 2-brush, 2-pole, 24 to 26 amps. max.
Regulator	-	Delco-Remy, including cut-out relay, voltage regulator and current regulator.
Coil	-	Delco-Remy, 1-1/2 amperage draw at idling speed.
Condenser	-	Delco-Remy, capacity 0.18-0.23 microfarad.
Spark Plugs	-	A.C. type 104 10 m/m gap .028 ins.-.033 ins.
Distributor	-	Delco-Remy type #1110609 22° automatic advance.
Horn	-	Sparks-Withington Vibrator type.
Lighting	-	One Trippe S.C. 12-16V, 60 watt spotlight; 2 Tail Lamps; 2 Instr. Panel Lamps.
Circuit Breaker	-	In lighting circuit.

REFERENCES:

Maintenance Manual, November 1944.

Illustrated Parts List B-Snow-03 Jan. 1945.

D.A.D. Specification No. O.A. 225 - Rev. 4.

D.M.&S. File 73-V-16.

D.M.&S. Photo Files No. G-2.

D.M.&S. Drawing Schedule S-38405.

D.M.&S. Motion Picture.

D.N.D. File HQS-3352-75.

T.T.2 - M.O.S. File 257/VEH/3197 TT2 (Tech)
257/VEH/3493 TT2 (Tech)
257/VEH/3530 TT2 (Tech)

ADDITIONAL REPORTS

"Exercise Lemming" Report No. 25 Canadian Army Operational Research Group.

D.M.&S. Report by Lt. Col. M.M. Evans covering visit to Italy and United Kingdom (includes 5th Canadian Armoured Brigade Report and R.E.M.E. 8th Army (British) Report).

"Exercise Polar Bear" by D.V.S.A. (Canadian Army) Observer.

PRODUCTION ORDERS:

Contract No.	Requisition No.	File No.	Qty.
UN 3110	AID/GB - 1	BSB-2827 (PC2621)	400
UN 11	AID/USSR - 2	P-187 - 2	3
MP 5458	MSX/292	PE-134-292	2
MP 5459	CD/LV - 2535	20/LV7-85 Army	10

Approximate price per vehicle: $8000.00.

PERFORMANCE

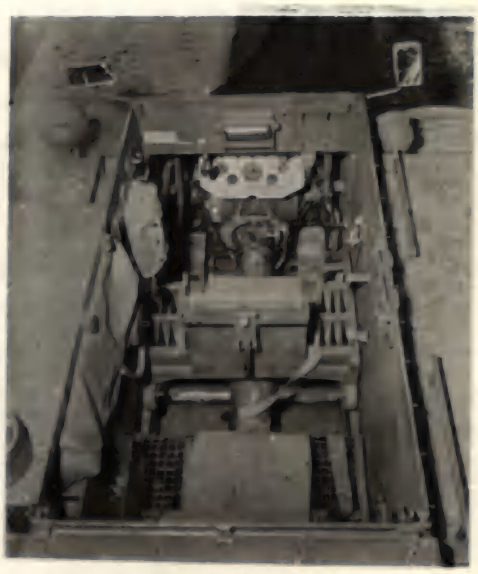
Based on results of limited testing, the overall performance of the Mk.II Armoured Snowmobile was considered to be good. The improved steering mechanism added greatly to its manoeuvrability and while the new cooling system did not give the expected results - due principally to the air being drawn around the warm engine before being passed through the radiator - some improvement over the Mark I vehicle cooling was obtained.

EQUIPMENT

The equipment items supplied with the Mark II Snowmobile were the same as that furnished with the Mark I vehicle, except for cold weather necessities, e.g. sleeping bags, blankets, etc. Also, the prediluter system for cold weather starting was eliminated. One Spare Wheel and Tire Assembly was carried instead of two.

PRODUCTION AND DISTRIBUTION

Five Mark II Armoured Snowmobiles were produced by Farand & Delorme Ltd., Montreal, in the summer of 1945. Four of the vehicles were supplied to the British on Contract No. UN4718, File P200-497, and one vehicle was supplied to Canada under Contract No. MP 10027, File P134.



REFERENCE INFORMATION

D.A.D. Specification No. O.A. 265(Mk.II)

D.M.&S. File 73-V-16

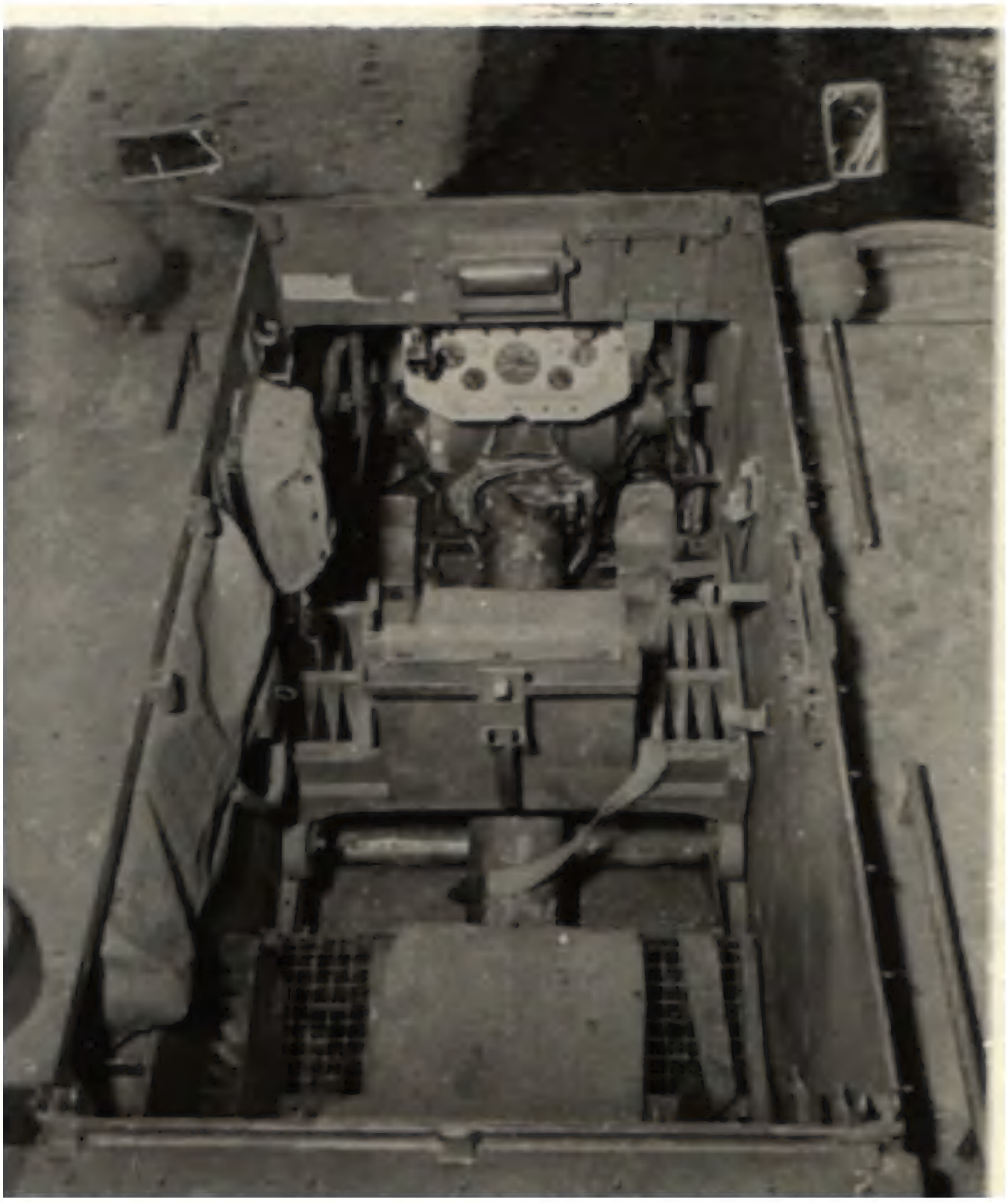
D.M.&S. Photo File #G-2

D.N.D. File H.Q.S. 3352-75-1

VEHICLE VARIATIONS

With the exception of the changes referred to in the foregoing, all other information given in the Mark I Armoured Snowmobile write-up apply to the Mark II Armoured Snowmobile, including the specifications and technical data.

As already noted the Armoured Snowmobile Mark II was an interim vehicle only. Early interest in an amphibious vehicle forestalled extensive research to improve the cooling characteristics of the Snowmobile Armoured Mark II, due to lack of personnel. The reader is referred to Cooling - of Mudcat (Pilots) in this volume for details of the successful cooling of a similar vehicle for ambient temperatures of 120°F.

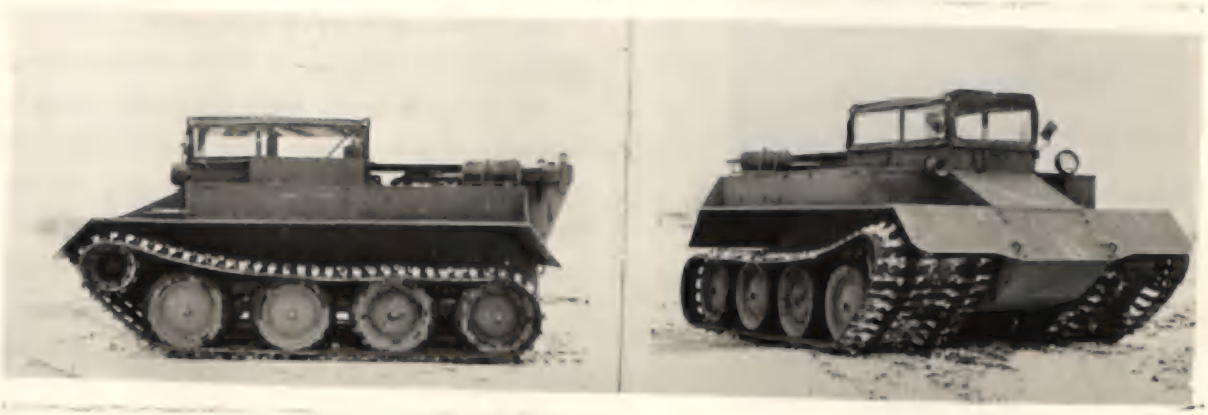


SNOWMOBILE, ARMOURED, CANADIAN, MARK II

As in the case of the Mark I Snowmobile, this vehicle was a two-man, full tracked, front drive, rear engine mounted, armoured vehicle, but designed specifically for 100% bare ground operation in torrid zones at temperatures up to 120°F. The term "bare ground operation" included hard packed ground corresponding to the best snow conditions, and swamp or bog corresponding to the worst snow conditions.

In addition to the basic tactical features shown for the Mark I Armoured Snowmobile, the Mark II vehicle was supplied with a fitted tarpaulin cover supported on three tubular "hoops". Side panels with plastic windows - combined with the front and rear plastic windshield, - provided ample light and were removable for ventilation. The purpose of the tarpaulin cover was to provide protection from the heat of the sun and other adverse weather conditions. When not required, the front two supporting hoops could be removed from their sockets and the tarpaulin folded and stowed on the engine compartment cover. The rear hoop folded backwards, thus permitting complete freedom of movement of personnel.

The mechanical modifications incorporated in the Mark II Snowmobile consisted chiefly of (a) improved cooling by reversing the air flow through the radiator and engine compartment, (b) improved steering control, and (c) improved battery location.



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COOLING

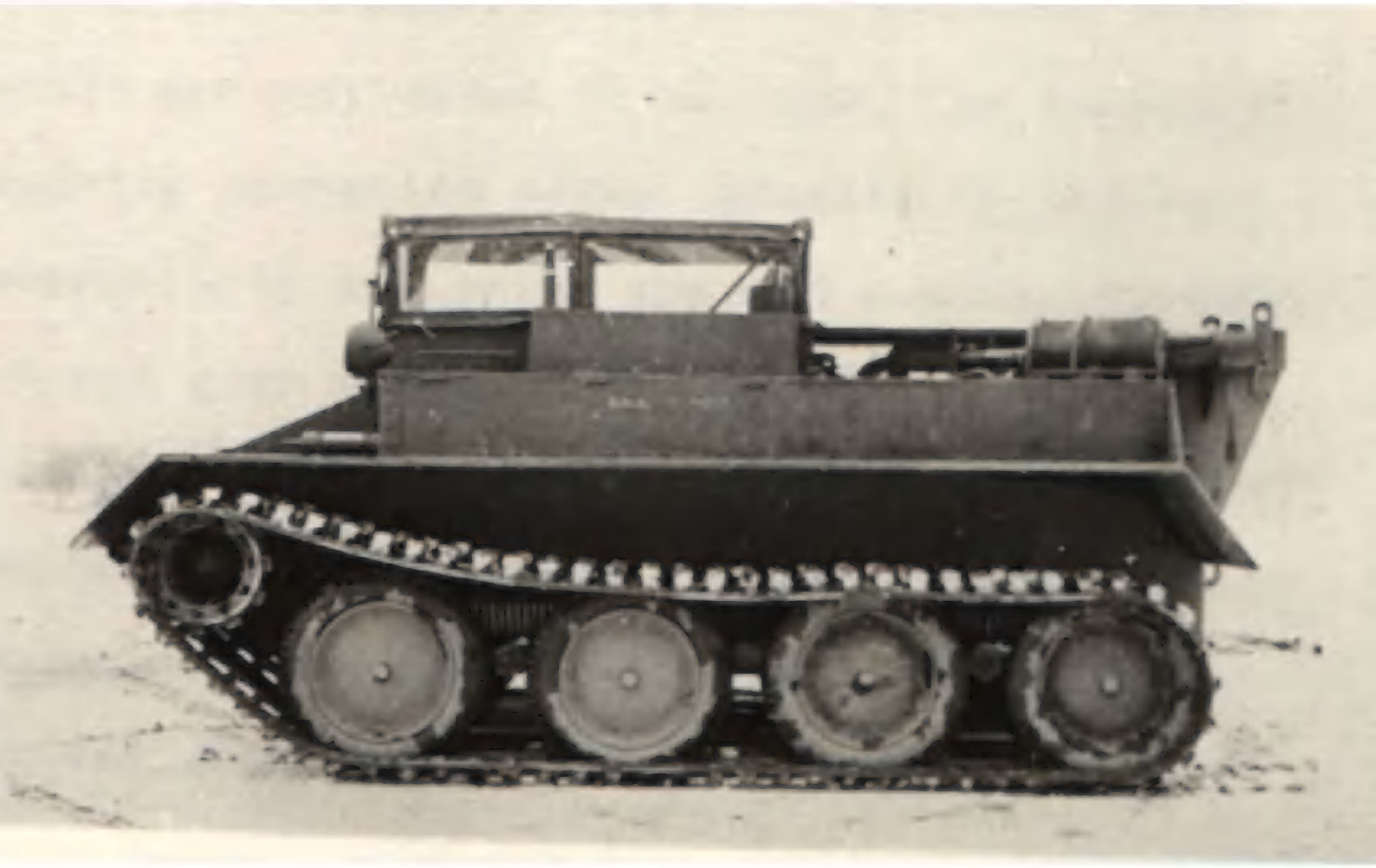
The improved cooling arrangement, to meet the tropical operating requirements included the use of (a) six-blade "pusher" type fan instead of a four-blade "puller" type fan, (b) dual fan belts driving on larger diameter pulleys instead of a single fan belt, (c) 6 ins. thick radiator water section instead of 4 inch thick section, and (d) screened openings added underneath and to each side of the observer's seat to increase air intake openings. The air was drawn in through the driver's compartment and discharged at the rear of the top of the vehicle, thus contrary to the Mark I.

STEERING

Improved steering was achieved by installing considerable more rugged hand levers and a new toggle type linkage, resulting in greatly increased leverage on the steering brakes.

BATTERY POSITION

Increased battery accessibility was obtained by placing a battery on each side of the transmission, thus facilitating battery service. In the Mark I vehicle, the batteries were located in tandem, with the result that the rear battery was partially covered by the engine cylinder block.



SECTION IV

FULL TRACK MUD AND SNOW VEHICLES

M U D C A T (Pilots)

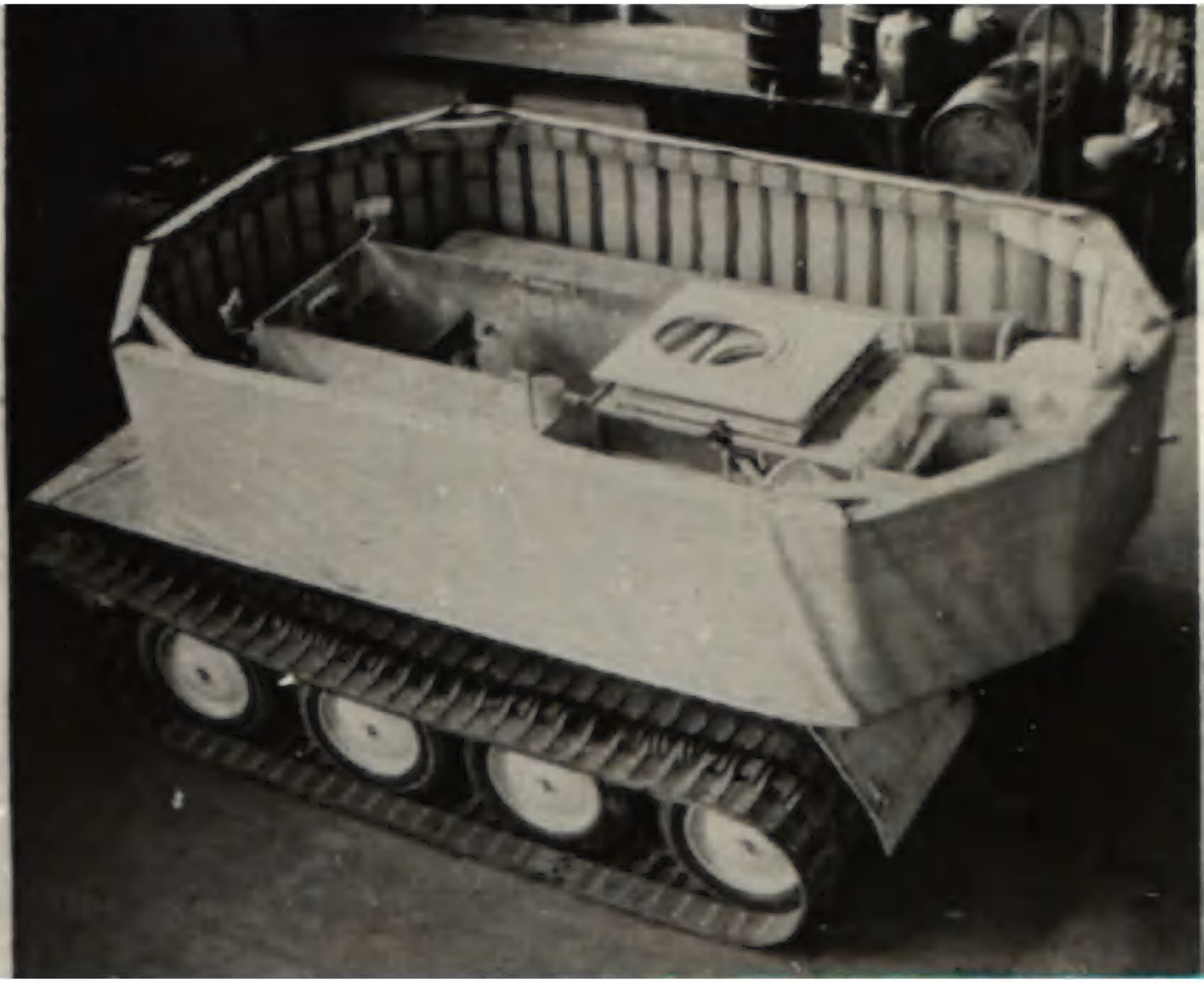
During the early spring 1944 reliability tests, the Snowmobile Armoured Mark I was waded through water, slush, and mud in a depth that it became apparent the vehicle could be made to be buoyant without too great an increase in volume. Trials were therefore made to float the vehicle by adding empty drums front and rear; these were successful but the vehicle moved through the water, using tracks as motive means, very slowly.

On the basis of this success, the users, M.O.S., were advised and asked if they would be interested in an amphibious version of the Armoured Snowmobile Mk.I. An affirmative reply was received, combined with a delivery date on four vehicles which was impossible to meet. As an interim vehicle without the amphibious feature but with tropical cooling, the Snowmobile Armoured Mark II was offered. (The reader is referred to the preceding section for data on this vehicle.

Later, confirmation was received from M.O.S. to proceed with the development of a fully amphibious tracked armoured vehicle and the programme was commenced early in the spring of 1944. The first move was to determine the displacement and trim of the Snowmobile Mark I, when afloat.

The general requirement as laid down was that it be basically the Snowmobile Armoured Mk.I modified to carry a crew of 4, be amphibious, have some protection against land mines, and operate in ambient temperatures up to 120°F.

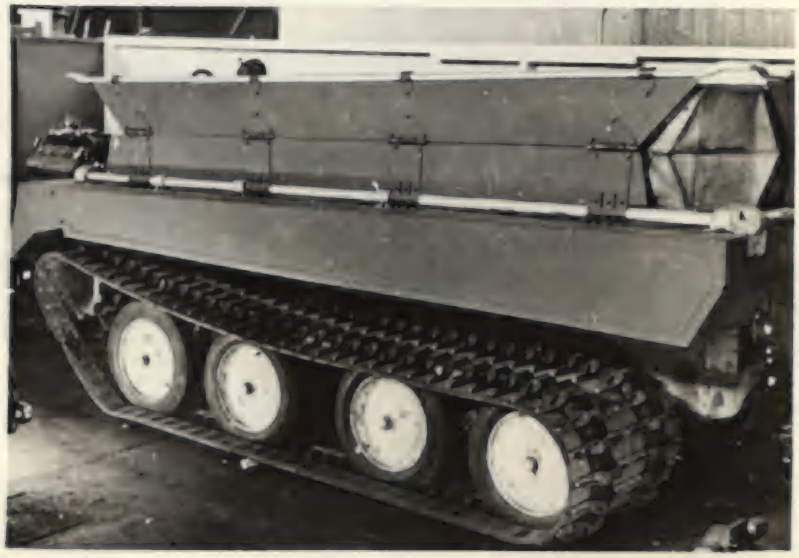
The first development was therefore basically the Snowmobile Armoured Mk.I, to which had been added a device with power driven collapsible water tight structure around the top of the vehicle. Two propellers, one over each track, were mounted at the rear and driven through individual shafts connected to a rever-



sing transmission which in turn was driven by the timing gear end of the Engine Crankshaft. Steering in waterborne role was through side pivotted rudders at the rear. The collapsible device was raised and lowered mechanically by an electric motor.

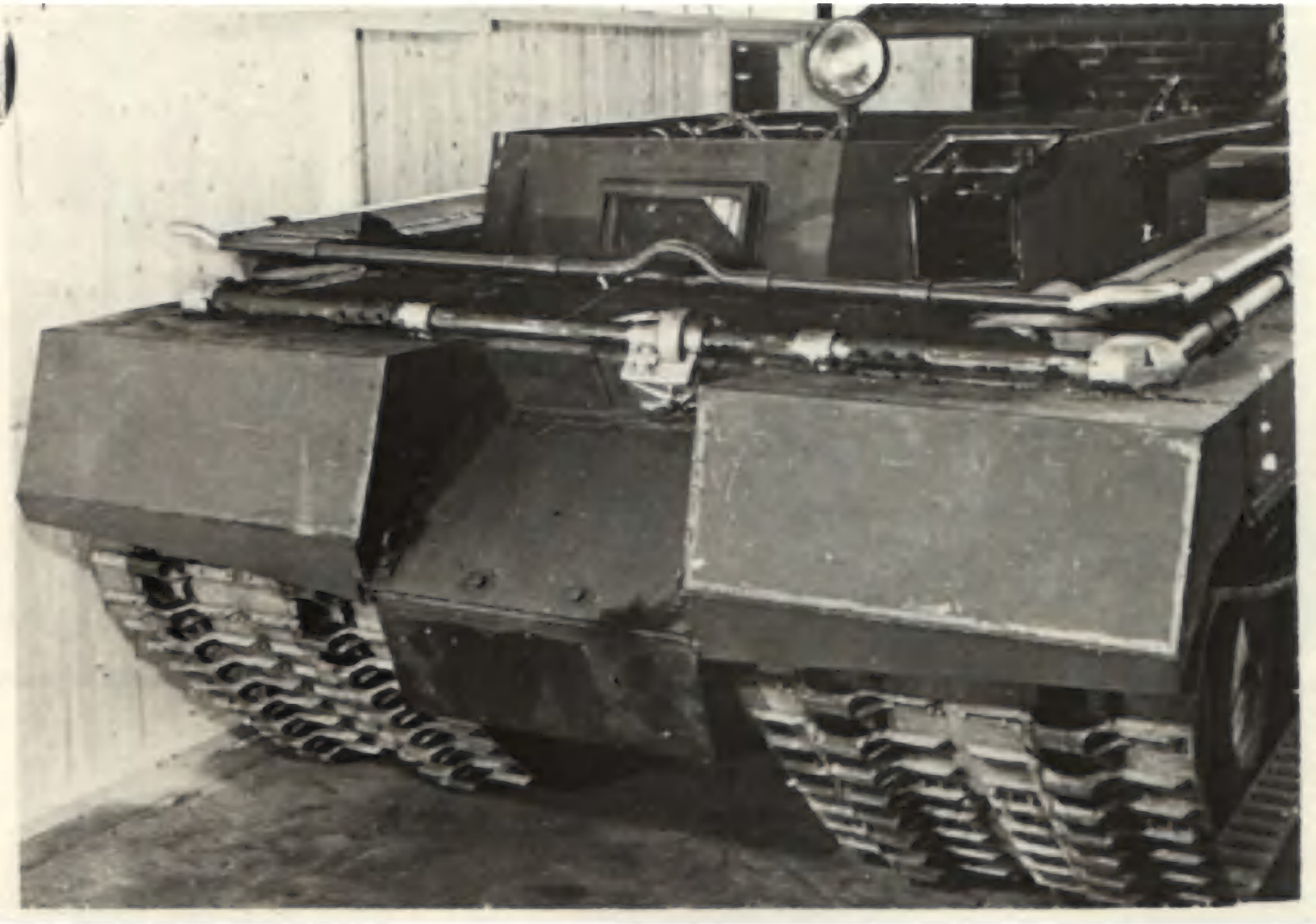
The above prototype required considerable modifications to the basic engine, and in addition excessive battery and generator capacity to provide current for the electric motor. Due to the above and the high gross weight, relatively poor waterborne steering, indifferent water speed, poor driver visibility on land; its development was discontinued.

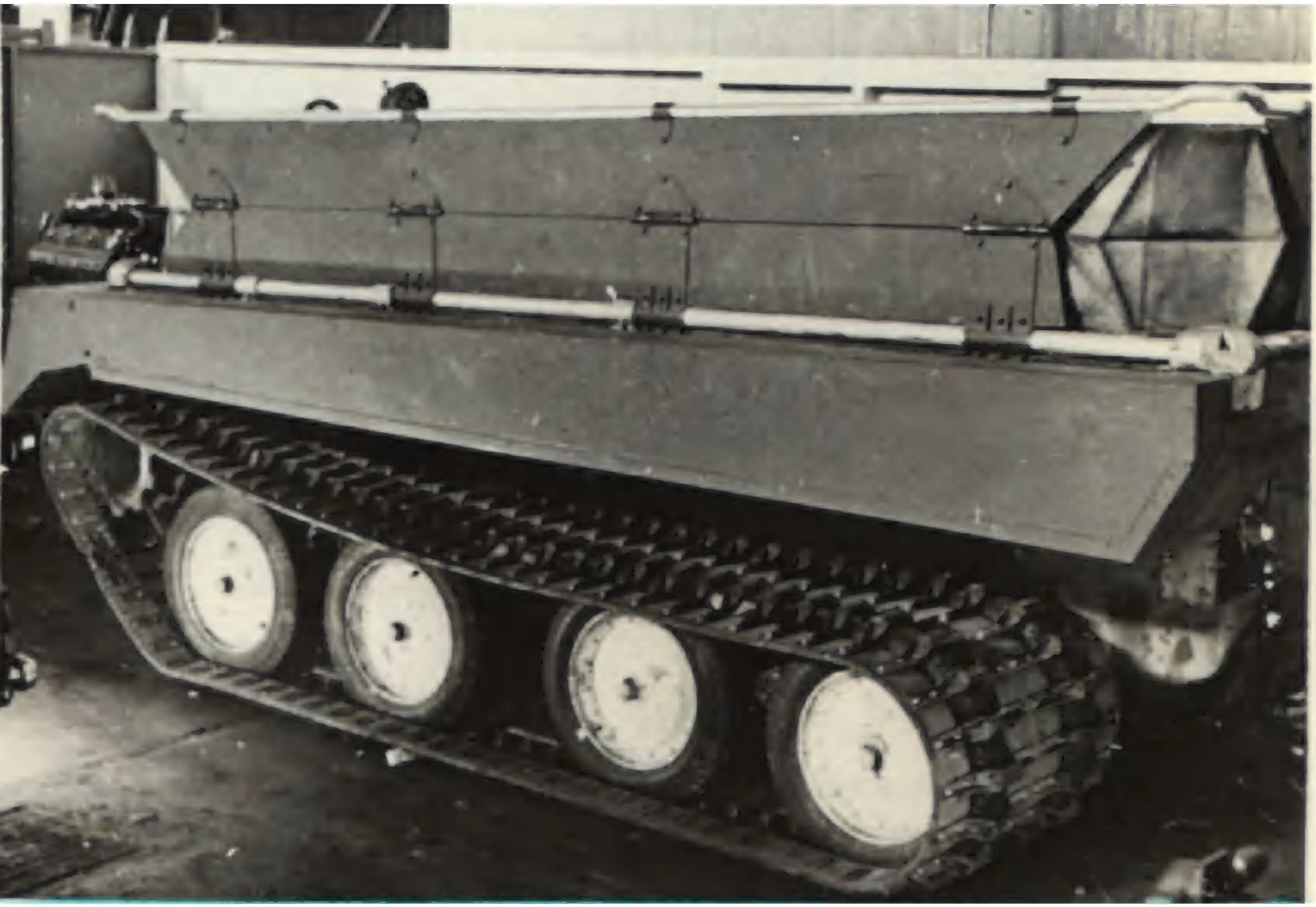
SIDES COLLAPSED



SIDES EXTENDED

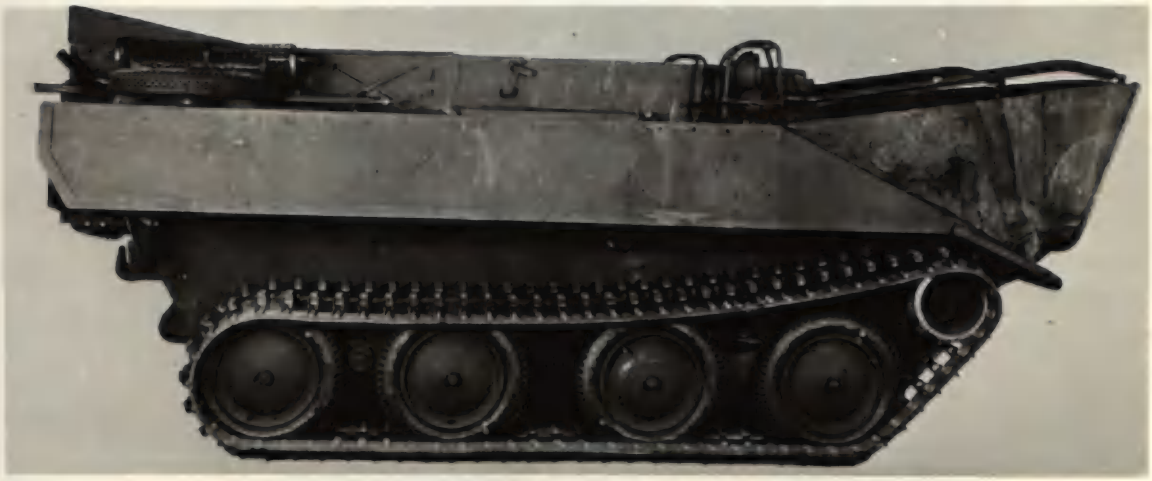
Several possibilities for increasing the displacement without greatly adding to the weight over that of the Armoured Snowmobile Mk.I were explored. The major one involved increased width of the lower portion of the hull. This required that, if the driving axle, as used in Snowmobile Armoured Mk.I, were used the hub bearings were eccentrically loaded when the standard 35 ins. wide tracks were fitted; or alternatively if the axle bearing loads remained normal, then the track required narrowing. To maintain reasonable ground pressure in the latter case, the narrowed track required lengthening and resulted in a longer overall vehicle with additional bogie wheels. The wider lower hull did however give additional crew foot room and ease the accessibility to the engine, driving linkages and assemblies.



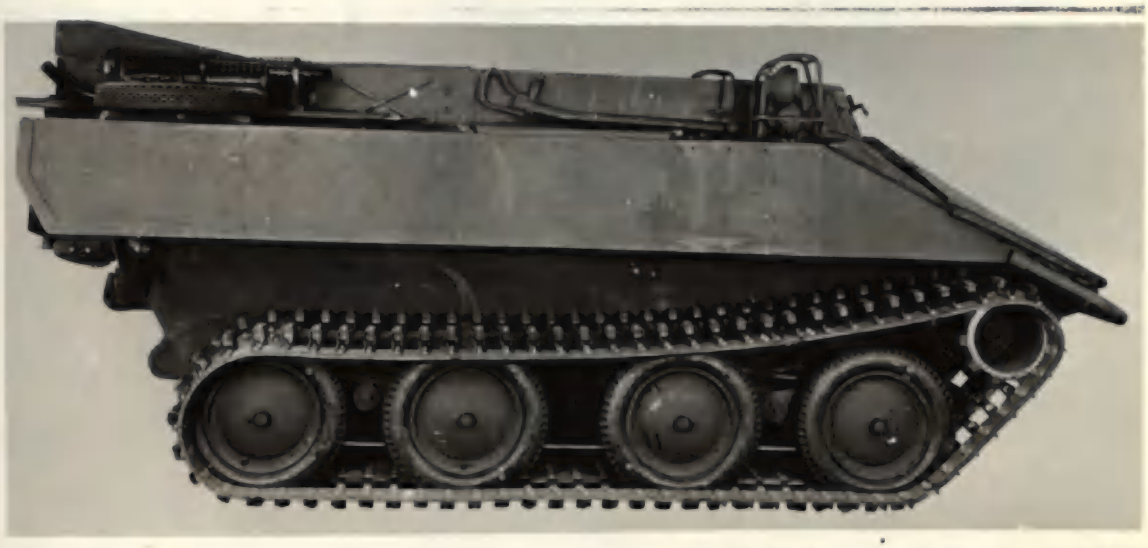


It was felt the prospective disadvantages outweighed the advantages and the investigation along this line was dropped.

The decision was made to retain the lower hull width and track width of the Snowmobile Armoured Mk.I but to redesign completely the hull flotation gear, propeller drive, rudders, and cooling system of the first Mudcat development referred to above.



FRONT FLOTATION CELL UP



FRONT FLOTATION CELL DOWN

The basic tactical features of the redesigned Mudcat included:-

(a) Armoured crew compartment.

(b) Four passengers with 2 in tandem facing forward and 2 lateral facing in.

(c) Communication facilities through provision of one No. 19 wireless set.

(d) Provision of light armament consisting of 2 Bren Guns.

(e) Driver's protected vision by means of a prism.

(f) Contact track area with ground varying from 5000 to 6600 sq. ins.

(g) Top speed performance of 30 M.P.H. on land.

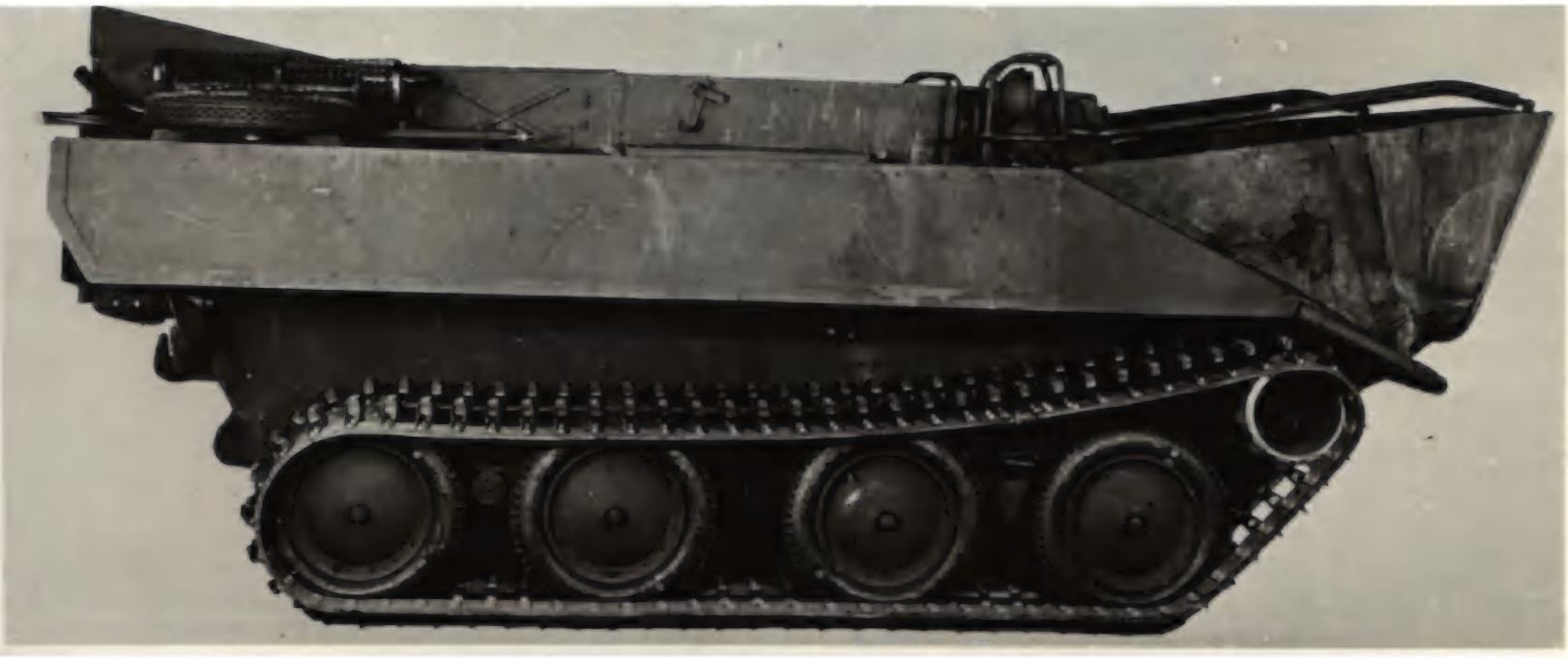
(h) Cruising range of approximately 225 miles without refueling.

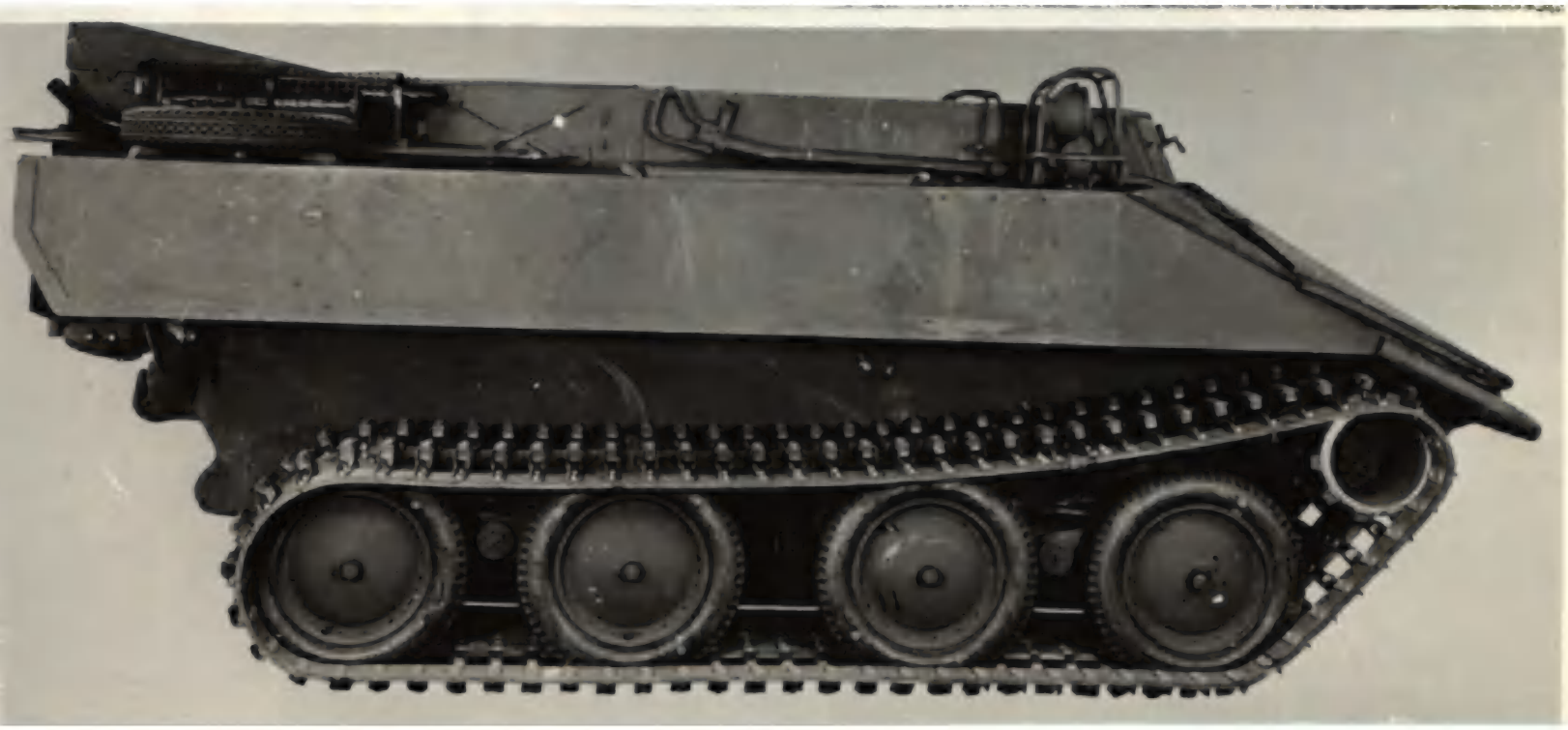
(i) 12-1/2 ins. ground clearance with good obstacle climbing ability.

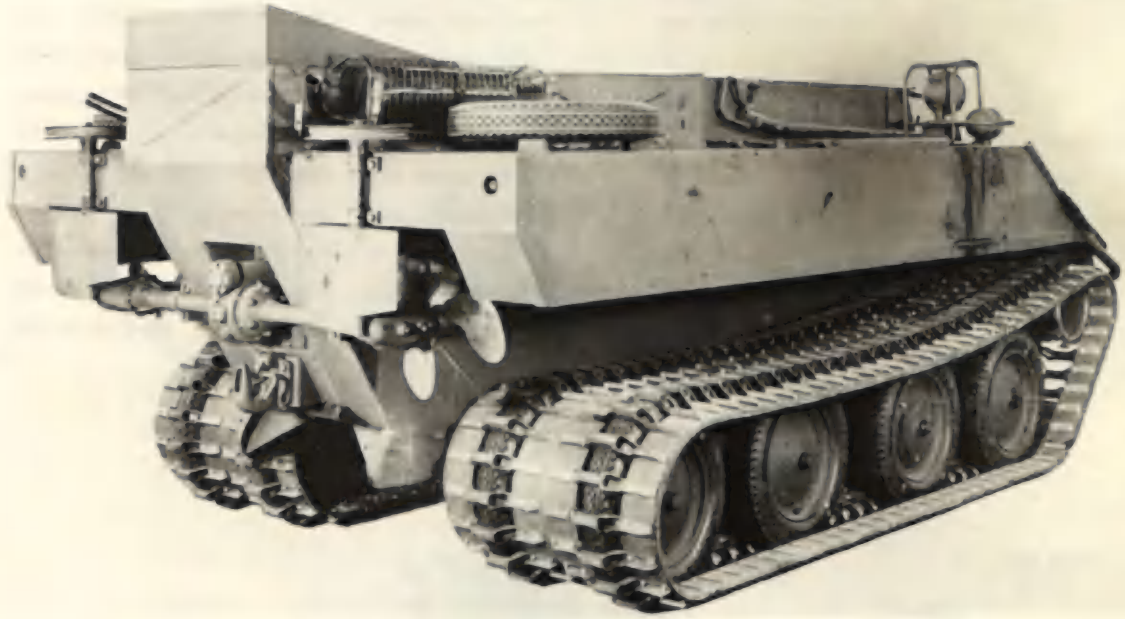
(j) Amphibious, with a still water speed of 3.5 land miles per hour approximately.

(k) Capable of operation in ambient temperatures up to 120°F.

(l) Relatively high performance on soft terrain as well as on hard surfaces.



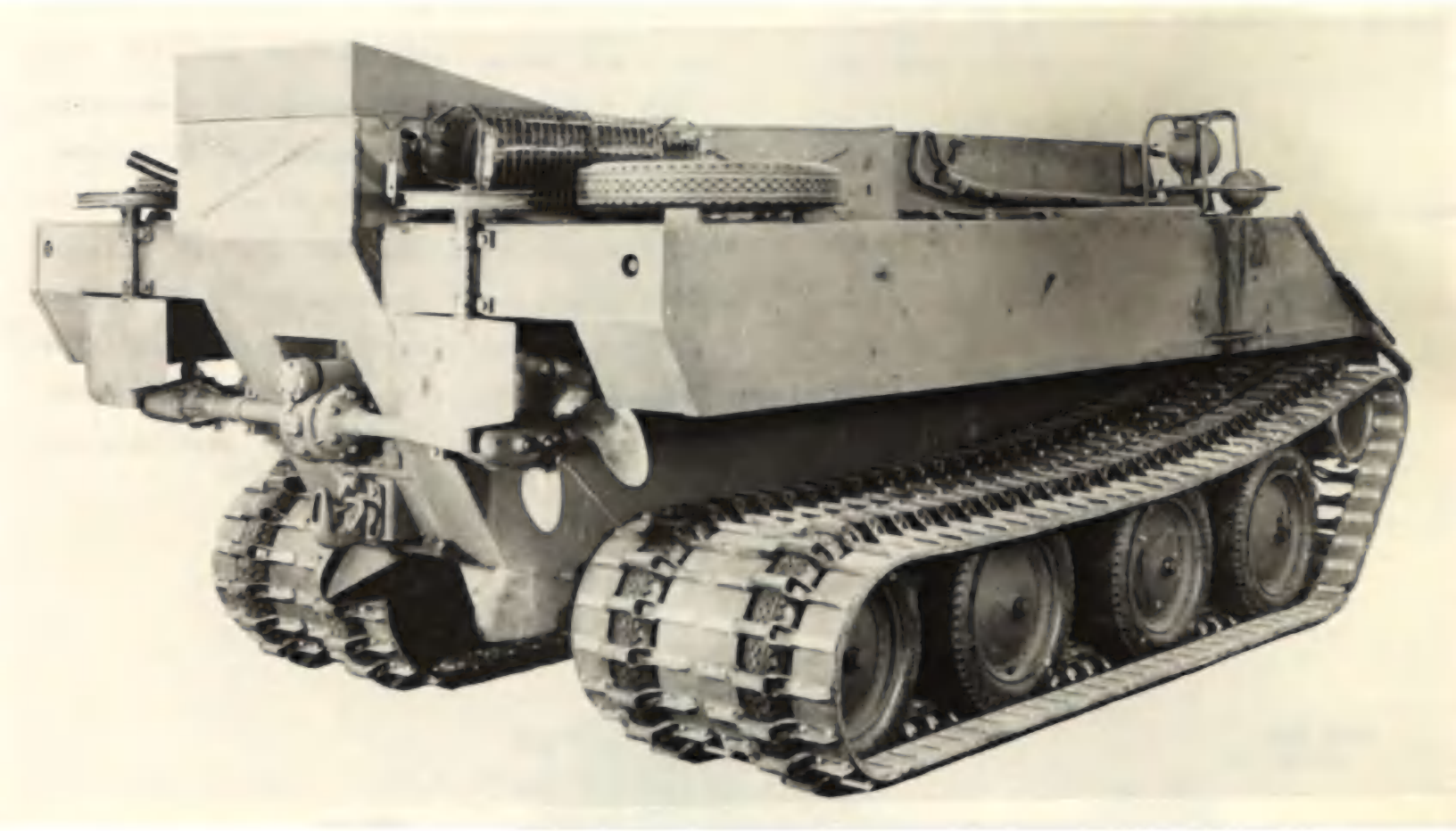




Its basic mechanical features were a rear mounted liquid cooled 90° - V8 Cadillac engine and four speed hydramatic transmission with fluid coupling clutch driving through a modified Ford T-16 controlled differential axle, to track drive sprockets. The tracks, each consisting of one wide and two narrow rubber belts, fastened together with cross links were carried on two front and two rear bogie suspension units having a total of 16 (4 per unit) bogie wheels fitted with 4.50 x 16 R.F. tires. Compression springs retained by hooked rods and chains were slung between front and rear suspension assemblies to control the articulation. Marine propulsion was provided through two propellers at the rear which were driven by a worm and gear attached to a counter shaft driven by V-belts from an extension shaft of the engine crankshaft. Steering in waterborne role was accomplished through two synchronized rudders 180 degree, controlled remotely by cables. Sections of steel plate assembled into a single unit formed the sides and ends of an open top hull with fixed flotation cells at either side and a collapsible cell at the forward end.

Four Mudcats of similar design were produced in 1945.

The land operation mechanical components of the Mudcat were based on the Snowmobile Armoured Mk.I, but with the requirements of operation in high ambient temperatures and operation in water, the Snowmobile mechanical components were necessarily extensively modified. Herewith is listed a detail description of these modifications and the reader is referred to the section of this Volume describing the Snowmobile Armoured Mk.I for a clearer description of the assemblies affected.

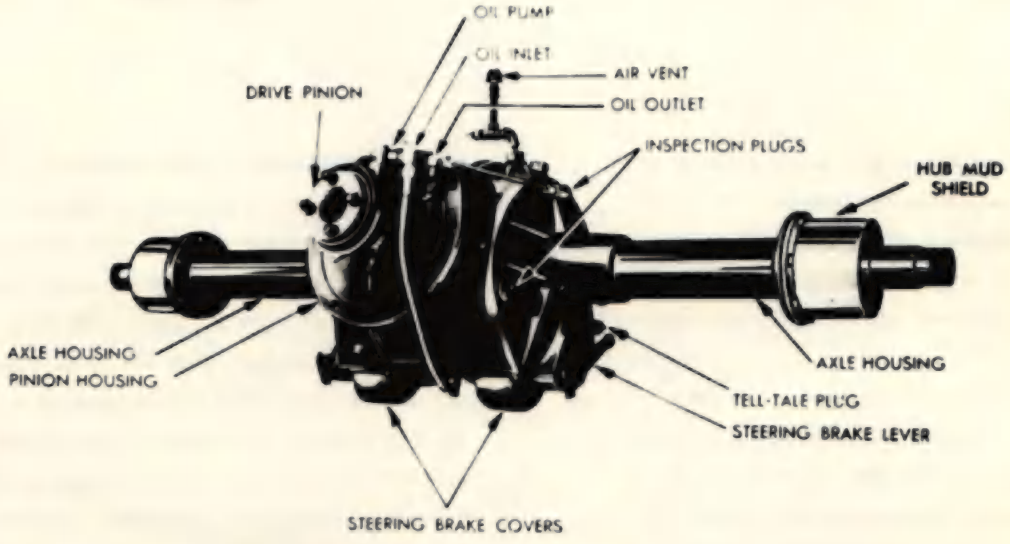


A. ENGINE AND TRANSMISSION

There was practically no change from the Snowmobile except for the addition of sealed and shielded high tension leads and a re-arrangement and re-design of the piping, etc., leading to the exhaust mufflers and the air cleaner. Also a relocation of the crankcase breather assembly was made which involved the design of a new bracket. The transmission valve body assembly differed from that of the Snowmobile and was identical with that used on the M-24 Tank. The major difference was the detent arrangement which was made much stiffer so that the "feel" of the shifting mechanism was more pronounced.

B. AXLE

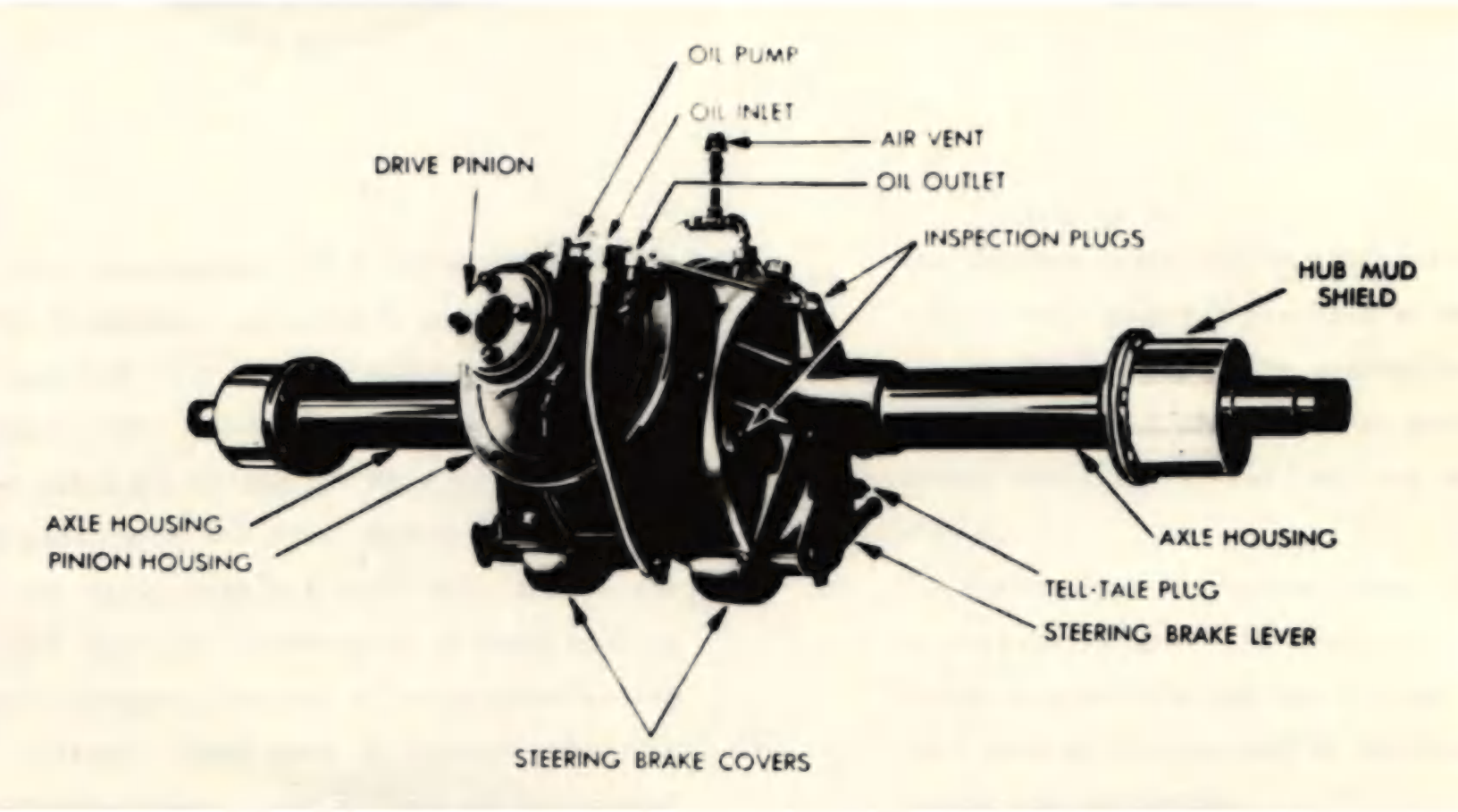
The axle was identical with that used on the Snowmobile. The oil piping leading to it was, of course, different due to the difference in the two hulls, but the schematic piping arrangement was identical.



C. TRACK AND SPROCKETS

Snowmobile and Mudcat tracks were similar, but not identical, the difference being:

1. The belting on the Mudcat was 1/16 ins. narrower for the narrow belts and 1/8 ins. narrower for the wide belts. This was necessary to accommodate the 1/2 in. plate sprockets which were used in place of the 3/8 in. plate sprockets on the Snowmobile.
2. The sprocket drums differed from those on the Snowmobile mainly in the position of the attaching flanges for the sprockets which were shifted to accommodate the different sprocket thickness and to maintain the same centre of applied pressure - i.e., the same track centres.
3. The sprocket width increase, from 3/8 in. to 1/2 in., was done in an endeavour to improve the sprocket life as continuing reports of rapid wear of Snowmobile sprockets under certain weather and terrain conditions were received. 10 tooth sprockets were used instead of 11 to com-

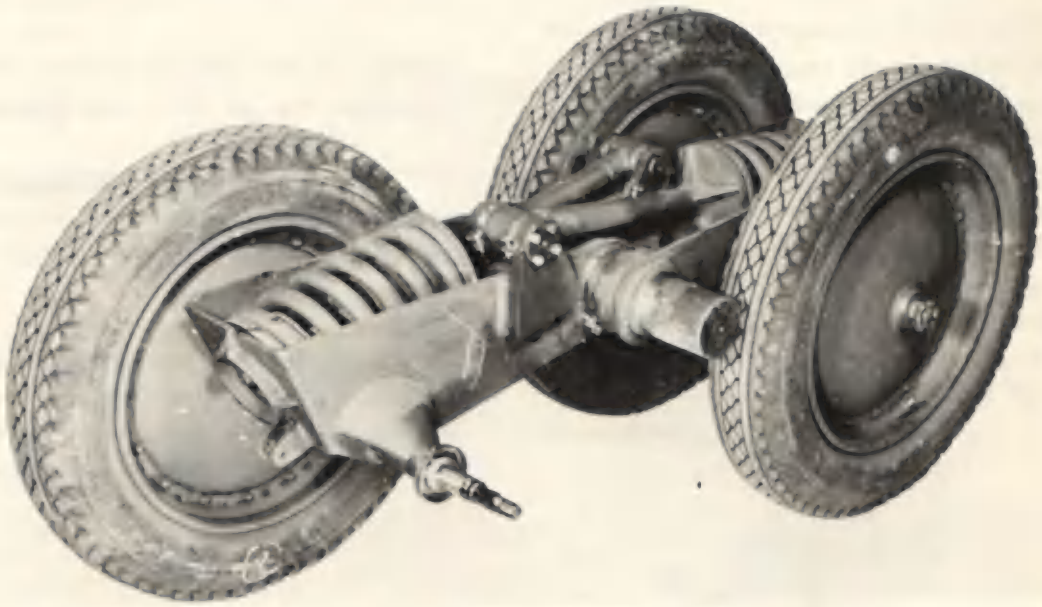

OIL PUMP
OIL INLET
AIR VENT
DRIVE PINION
OIL OUTLET
INSPECTION PLUGS
HUB MUD SHIELD
AXLE HOUSING
PINION HOUSING
AXLE HOUSING
TELL-TALE PLUG
STEERING BRAKE LEVER
STEERING BRAKE COVERS

pensate for the greater weight of Mudcat.

4. The tracks were 8 ins. longer to accommodate the increased distance between front and rear suspension. This increased distance was partially compensated for by the slightly altered relative positions of the sprockets and bogies.

5. Crosslink material improved and gauge changed from 5/32 ins. to 3/16 ins. Bolt and nut material was alloy steel heat-treated to produce 125000# tensile.

D. SUSPENSIONS



The suspensions were fundamentally similar to the Snowmobile suspension in that each unit consisted of four wheels mounted in pairs of two bogie arms which in turn were pivotted on cross tubes projecting out from the side of the lower portion of the hull. However, experience with the Snowmobile had indicated a need for stronger springs, elimination of lower springs on forward bogie, removal of track interference with springs, some more efficient method of limiting re-bound, and a means of individual track adjustment without skewing the rear axle as was done on the Snowmobile.

The re-design then resulted in the following features:-

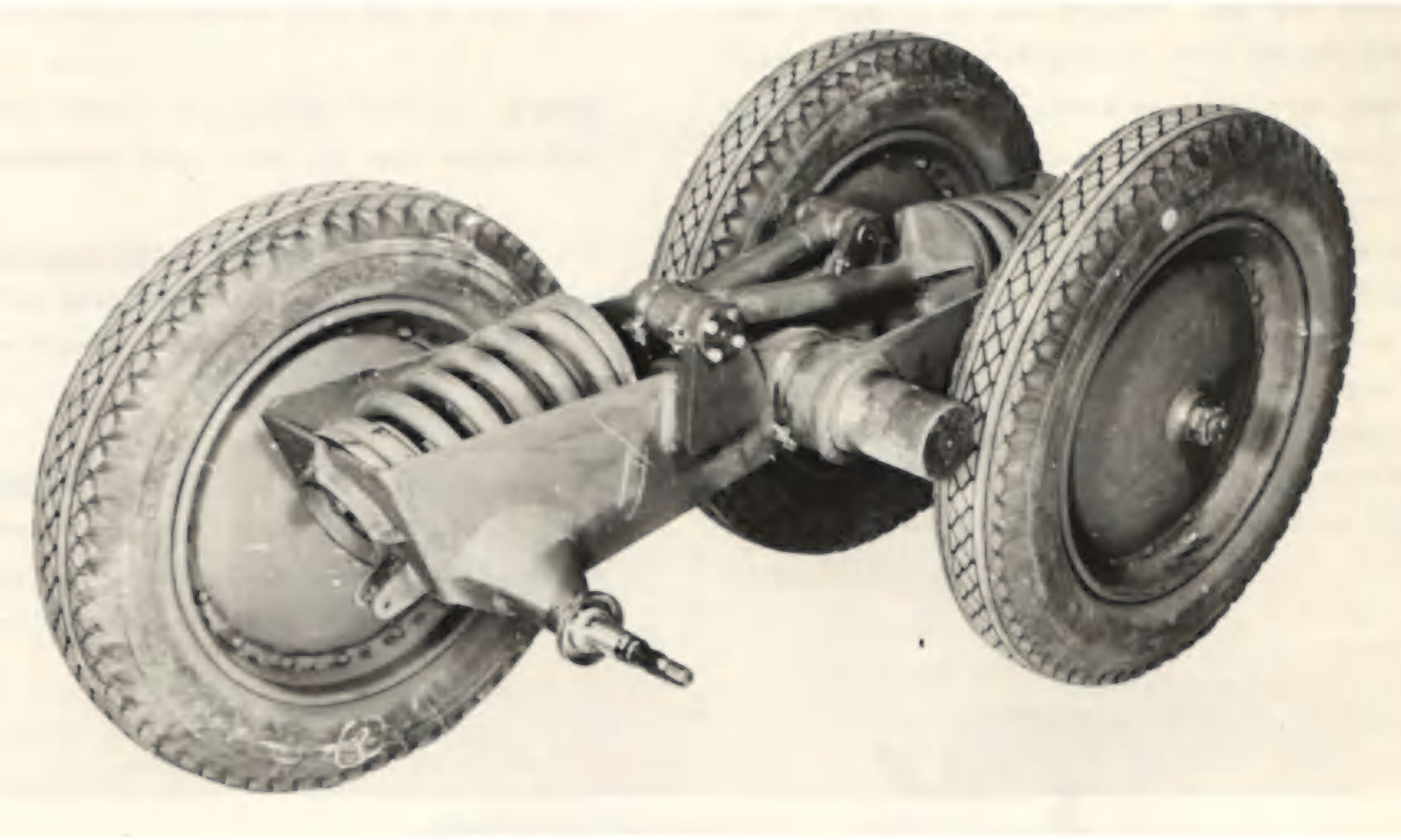
1. The tires, tubes, wheels, wheel bearings and wheel spindles, as well as the front cross tube of the Snowmobile were retained.

2. Re-bound springs were replaced by a push-rod running through the centre of each coil spring with a ball and adjusting nut on one end sitting in a cup attached to the opposed bogie arm to limit re-bound. One of these rods was pivotted on each of the two bogie arms of the suspension unit and the other end of the rod as mentioned above, carried the ball and nut seating anchor.

3. The spring capacity was increased to compensate for the greater anticipated wheel loads, to eliminate the need for the auxiliary tension springs, and to endeavour to reduce the bottoming.

4. Heavy rubber washers, installed on the push rod, acted as a cushion to prevent spring bottoming and to take the bottoming shock.

5. The rear bogies were bracketed individually from the hull instead of being mounted on a through cross tube. Each bracket was capable of being adjusted fore and aft in slides provided by means of an adjusting screw and were locked in place by tightening up on the wedge type slides. Access to all lubrication fittings was made more convenient.



The geometry of the suspension arms and push rods was such that the "ride" was improved over that of the Snowmobile due to a different spring "rate" and the greater articulation. Positive re-bound limits it was thought improved the ride due to a reduction in the inertia effects which result from the over-travel of wheels improperly limited on re-bound.

The replacement of re-bound springs by re-bound rods assisted in assembly as the rods formed a rigid assembly member capable of easy adjustment once the springs were in place.

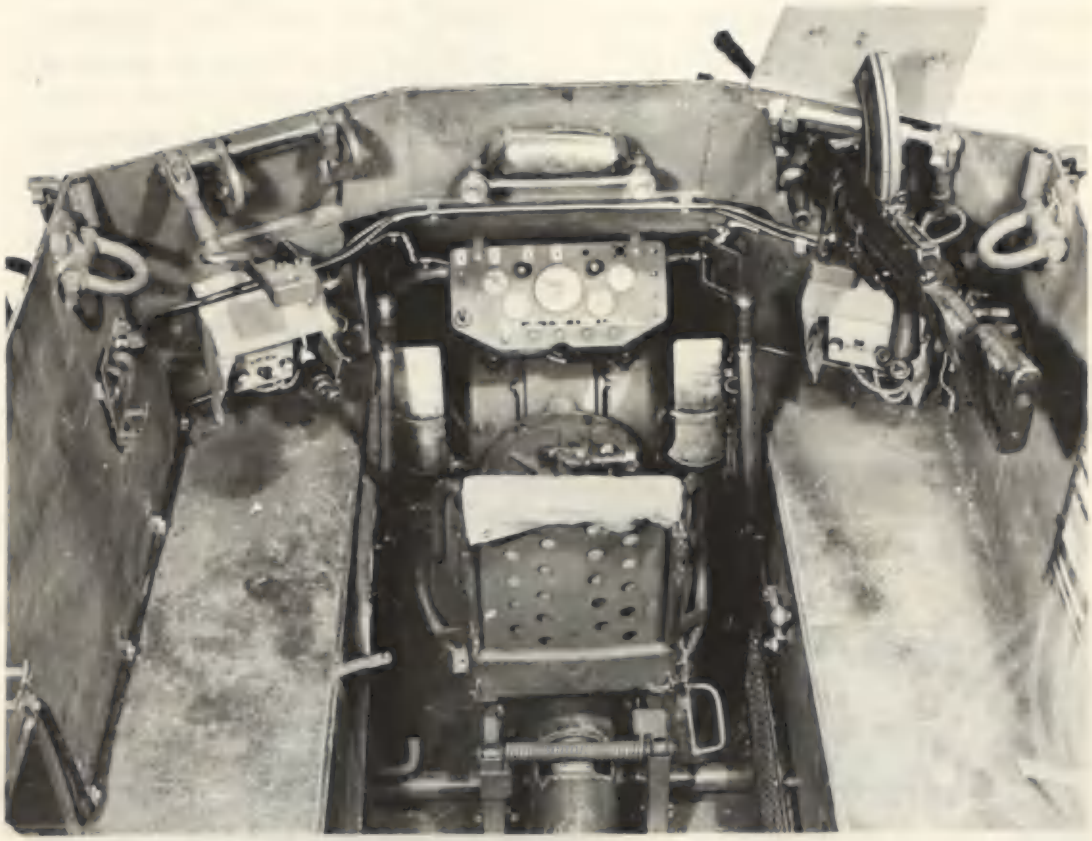
6. The front suspension had 20% greater capacity than those of rear suspension.

E. PROPELLER SHAFT (Engine to Axle)

The main shaft was the same as that used on the Snowmobile except that it was slightly longer.

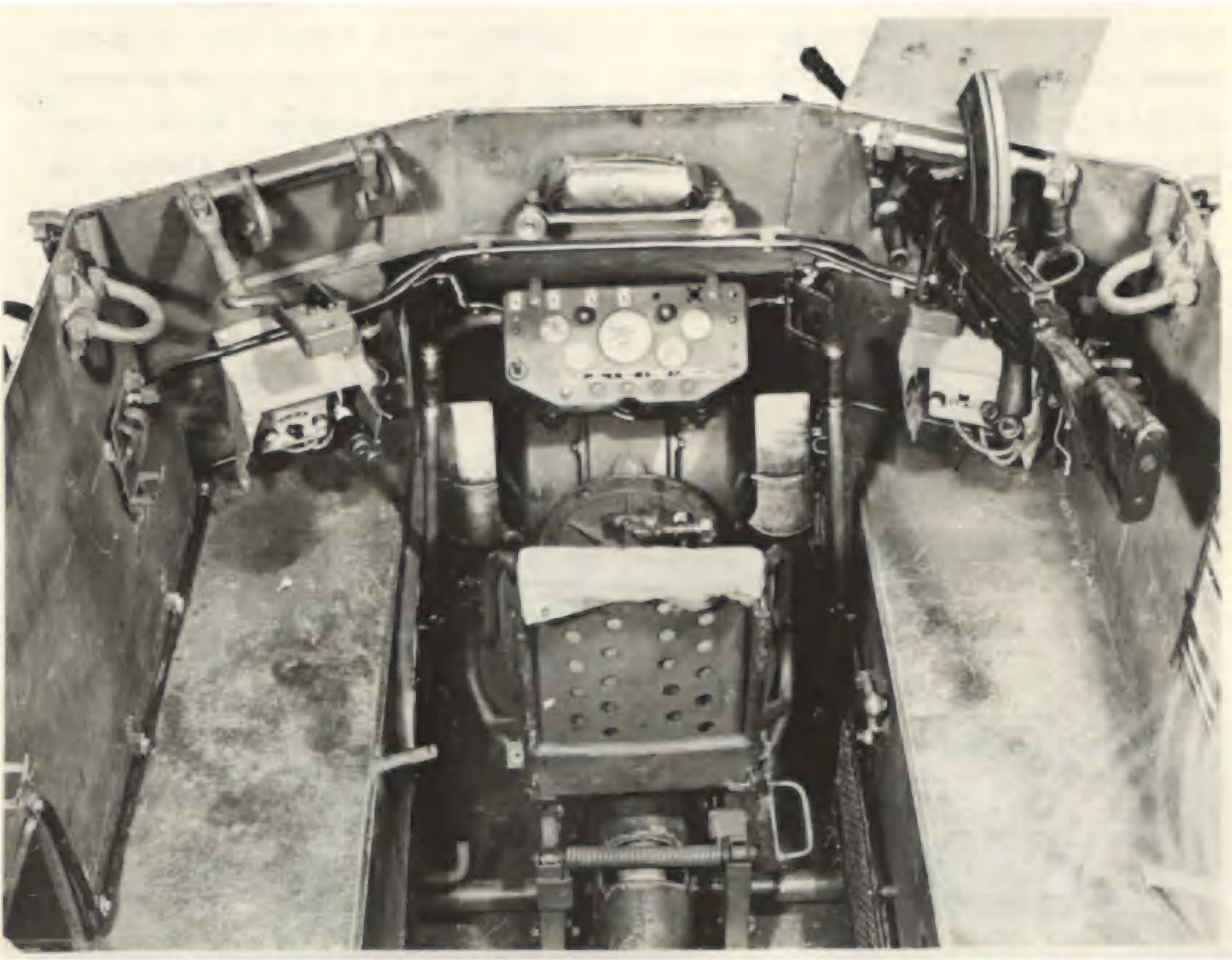
F. STEERING CONTROLS

Reports of difficult steering of Snowmobile being very frequent, and well-founded, it was decided to increase the mechanical advantage up to the limit of the safe capacity of the axle internal brake mechanism. This was calculated to be a ratio of approximately 50 to 1 considering travel of the grip of the steering lever vs. the travel of the end pins of the brake band. The levers and linkage were, therefore, designed on this basis and test drivers' reports indicated that the steering was considerably improved over that of the Snowmobile. A test vehicle had one brake adjustment at approximately 200 miles and did not require any subsequent adjustments up to 2000 miles. It was thought that the main reason for the improvement was that the greater mechanical advantage gave a more positive grab of the brake bands during casual driving which resulted in less glazing of the bands. It was generally admitted that the glazing of the bands was a major contributor to difficult steering of the Snowmobile. Of course, the increased mechanical advantage was of great help in performing sharp turns, where the drum was locked. The basic detail design of the steering lever mechanism was the same as that used on the Snowmobile.



G. THROTTLE CONTROLS

Owing to the shape of the hull and the requirements of water driving, the details of the throttle linkages were entirely different from those used on the Snowmobile.



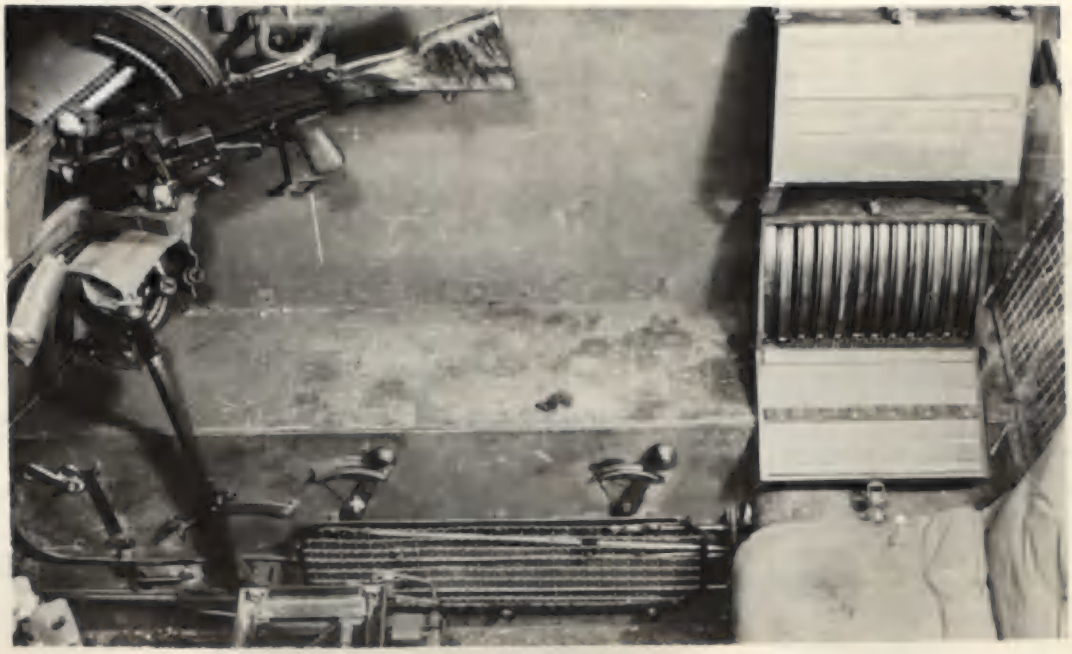
1. Foot Linkage. A large sized accelerator pedal pivotted about the instep of the right foot with a correspondingly shaped fixed foot-rest for the left foot provided more comfortable and secure driving positions than the Snowmobile arrangement. The foot pedal actuated an intermediate swivel connected to the long throttle rod which ran alongside the hull to a bracket and lever, mounted on the side plate near the transmission; from there a short rod extended to the throttle lever pivot on the transmission from where the linkage formed part of the engine assembly and was identical with the Snowmobile.
2. Hand Throttle. A cam and lever type hand throttle was located on the right side plate convenient to the driver. Its purpose was to allow the setting of the engine at any idling or running speed and for starting the engine.
3. Hand Throttle for Water Use. An additional over-riding hand throttle was mounted on the bulkhead at the rear of the fighting compartment for the use of the member of the crew who operated the rudder steering mechanism. The Mudcat rudder steering mechanism was mounted out of reach of the vehicle driver and necessitated an additional hand throttle assembly. This hand throttle was also of the eccentric and push-rod type and held in its various positions by friction surfaces.

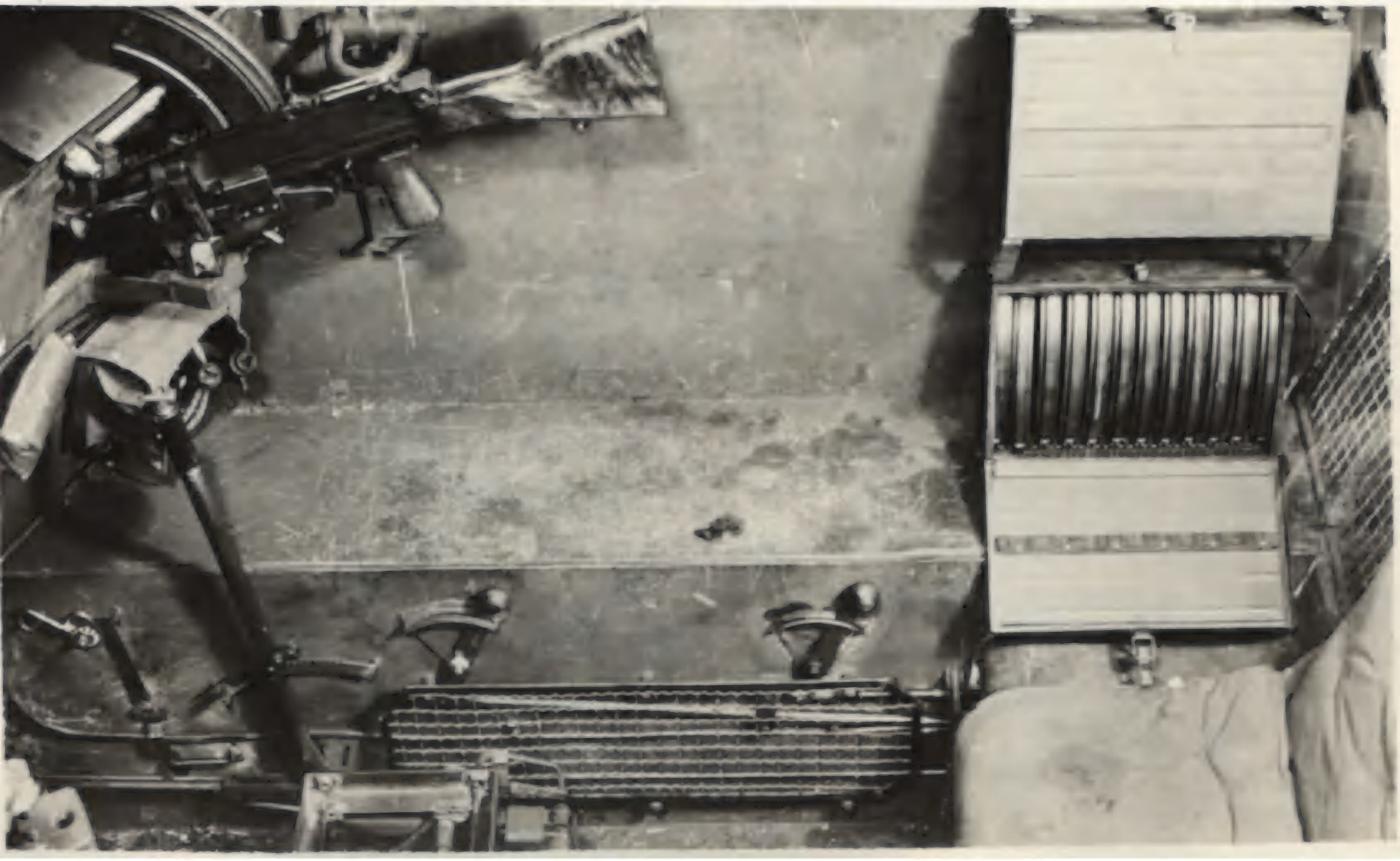
H. GEAR SHIFT CONTROLS

The gear shift controls differed but slightly from those of the Snowmobile except in location of the pivots and the lengths of the rods. However, introduction of the M-24 Tank valve body and detent assembly was made at such time in the design and production of the pilot models that the resultant excessive heaviness of the shifter mechanism could not be rectified on all pilot models. One Experimental Assembly, using greater hand leverage and an up-and-down hand lever motion, was bolted and installed on No.1 Pilot. This linkage was a considerable improvement over the standard and a recommendation that any future developments should use this linkage in preference to that used on the other three pilots has been recorded.

I. PROPELLER CLUTCH SHIFTER CONTROLS

These, of course, were new to the Mudcat, there being no such device required in the Snowmobile. In general, the linkage consisted of a 2-position lever and arc of the same basic design as used for the transmission shifter mechanism. From this lever a long compression rod ran back paralleling the right side plate through the engine shroud to a lever and cross shaft extending from the hull side plate to the pulley and clutch support bracket. From this cross shaft a shifter yoke extended upward to connect with the shifter collar which formed part of the jaw clutch. The push rod was guided by clips attached to the side plate and was of sufficient diameter to prevent buckling or "springy" action.





J. RUDDER CONTROLS

The rudder controls consisted essentially of a hand wheel and gear and sprocket assembly driving a light roller chain which in turn connected to a flexible steel cable running through guides and over suitably placed pulleys to two sheaves fastened rigidly to the vertical rudder shafts at the rear of the vehicle. (See photo Engine and Transmission) The overall gear reduction was approximately 8 to 1; i.e. 4 turns of the hand wheel moved the rudder shaft through approximately 180°.

A device incorporated in the hand wheel and gear assembly permitted the mechanism to be locked in any given position by releasing a detent pin and drawing the hand wheel partly off the shaft. The detent then retained the hand wheel in its partly off position. The main use for this device was to insure the rudders remaining in the crosswise position where they were less liable to damage during land travel.

The hand wheel was quickly removable from the assembly for stowage during land travel when considered desirable.

The hand wheel and gear assembly was mounted on the bulkhead at the rear of the fighting compartment with a hand throttle arrangement close by. Some member of the crew other than the vehicle driver operated the Mudcat when in the water.

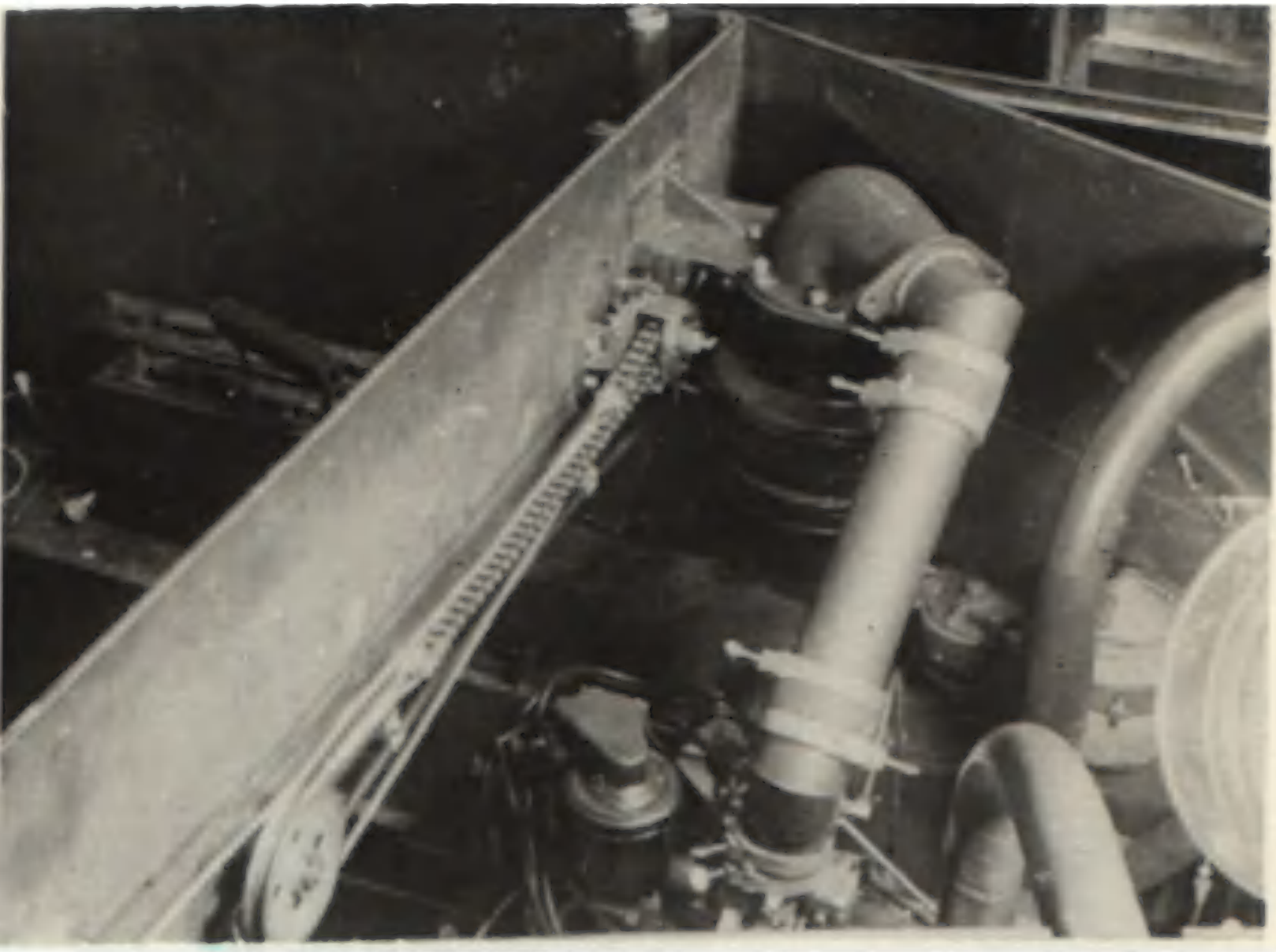
The adjustment of cable tension was accomplished by means of two turn-buckle assemblies in the flexible cable run. These turnbuckle assemblies were housed in tubes to support their weight and slid back and forth in the tubes as the mechanism was operated.

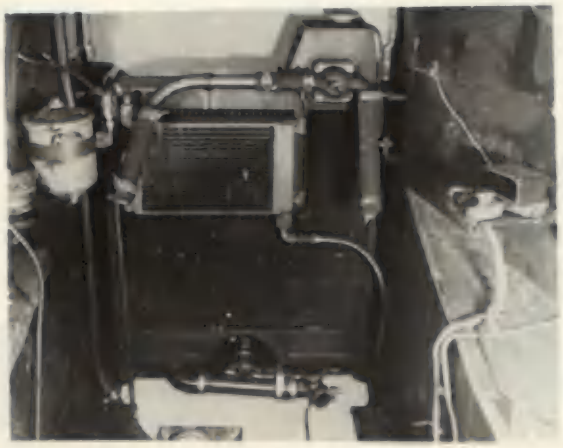
The light loads imposed on the flexible cable and the expected infrequency of the operation of the rudder controls indicated that adjustment of the cable tension would not be required except at rare intervals. The fact that the cable was anchored to the sheave by means of a bolted clip, made it unnecessary to have any considerable tension on the cable since no frictional forces were involved.

K. ENGINE AND AXLE COOLING SYSTEMS

One of the most serious defects of the Snowmobile was its inability to operate under heavy loads in moderate to high ambient temperatures. The Mudcat being essentially a mud vehicle and having as a user requirement a demand for satisfactory operation in ambient temperatures up to 120°F. required a drastically improved cooling system, particularly for the engine.

The details requiring new design were fan capacity and heat radiation surfaces. The Snowmobile radiator was inadequate for high ambient temperatures due to the fact that the axle oil cooling and engine water cooling units were both incorporated in one radiator. For the Mudcat, therefore, a decision was made to use a larger frontal area, 504 sq. inches, pressurized radiator for the engine coolant. This radiator was a 6-tube thick core compared with a 4-tube thick core on the Snowmobile Mk.I and was mounted where the cooling air passed over the engine before entering the radiator, thus contrary to the Snowmobile arrangement and did not have the axle oil cooling surfaces included in it.





ENGINE AND DIFFERENTIAL RADIATORS

The axle oil cooling was accomplished by means of a separate small radiator with a frontal area of 96 sq. ins. mounted in front of, and close to, the engine radiator and therefore in the air stream of the engine fan.

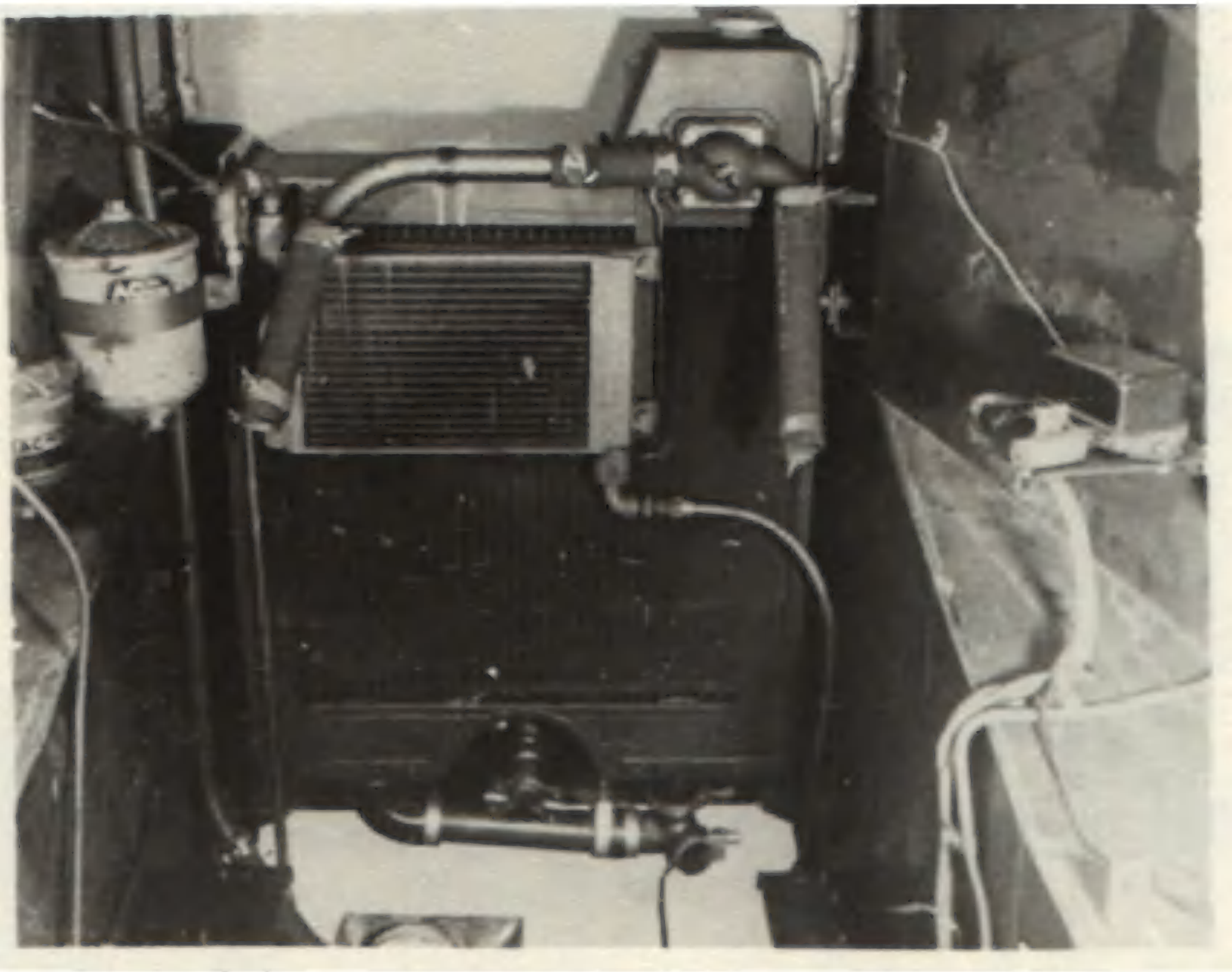
The fan was mounted to the rear of the radiator so as to suck the air through and deliver it toward the rear. By this means, the normal motion of the vehicle assisted the air circulation. The fan itself was a considerably greater capacity than that of the Snowmobile and being mounted close to the radiator and parallel to it, could be adequately shrouded for best efficiency. It was driven at engine speed from a pulley on the water propeller counter shaft.

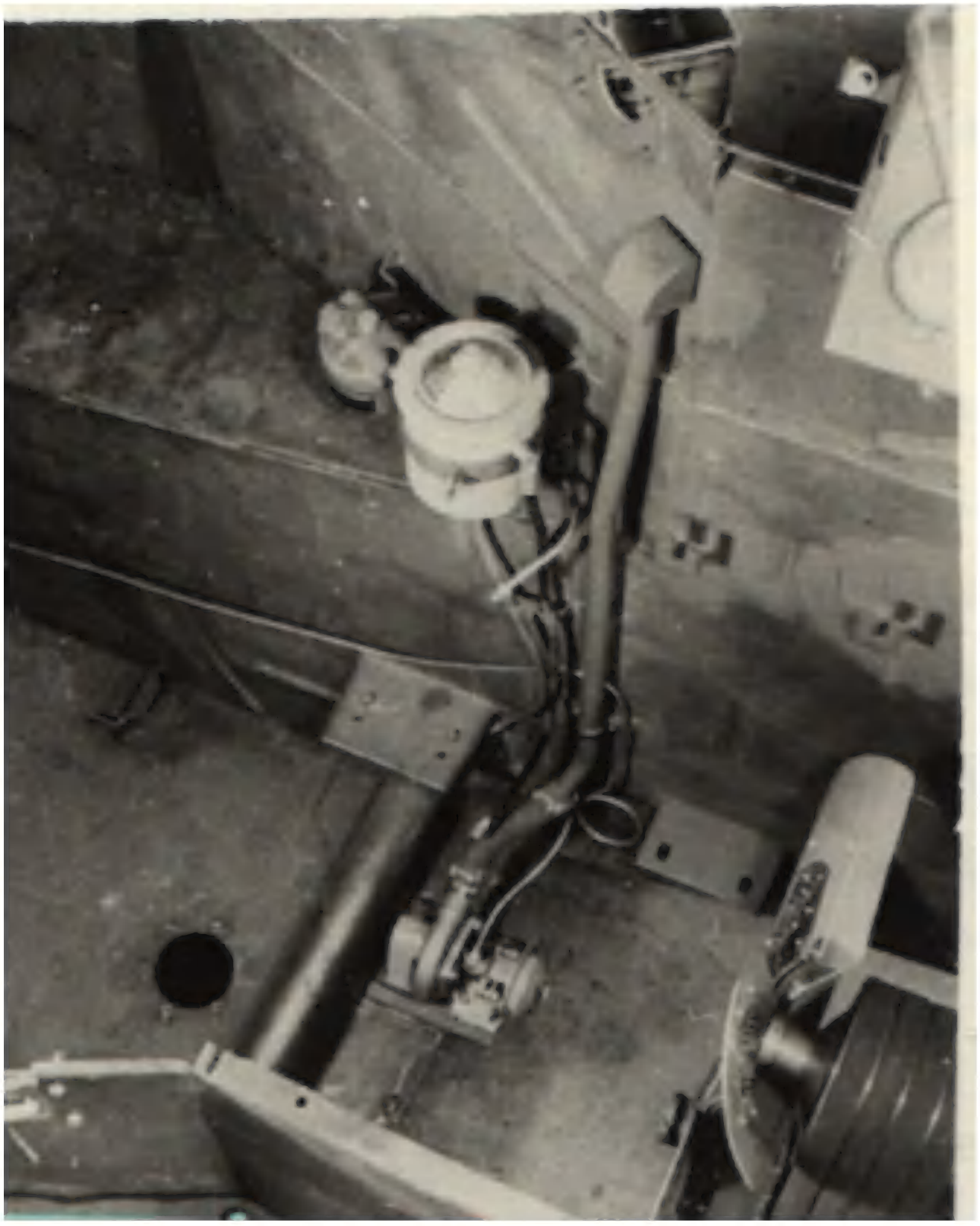
Severe tests of both these cooling systems at ambient temperature varying from 75°F to 90°F when, corrected to an ambient 100°F., did not exceed 210°F. Therefore, at 120°F ambient the radiator temperatures would not exceed 240°F. under the most severe load conditions. With 15-pound pressure in the radiator it blew off at approximately 240°F, leaving an apparent adequate amount of safety. For normal operations, and without the pressure cap on the radiator, no boiling was expected at normal altitudes.

L. WATER PROPELLER DRIVE

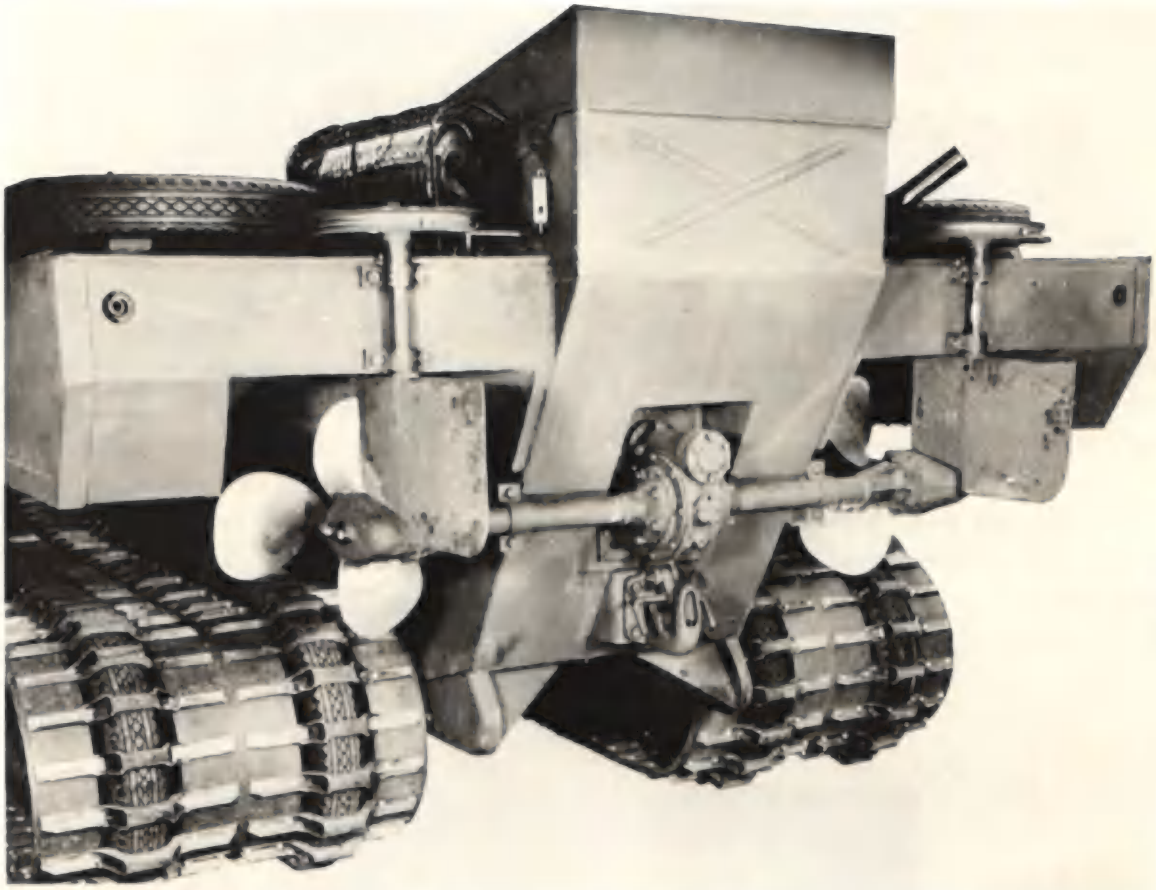
V BELT DRIVE

BILGE PUMP





The train of power to the propellers was from the engine crankshaft through a universal jointed drive shaft upward through a V-belt drive to a jaw clutch and thence through worm and worm gear to cross shafts enclosed in a housing outside the rear of the hull; from cross shafts through spiral bevel gears to two propellers 20 ins. in diameter, left and right screw, operating in opposite senses.



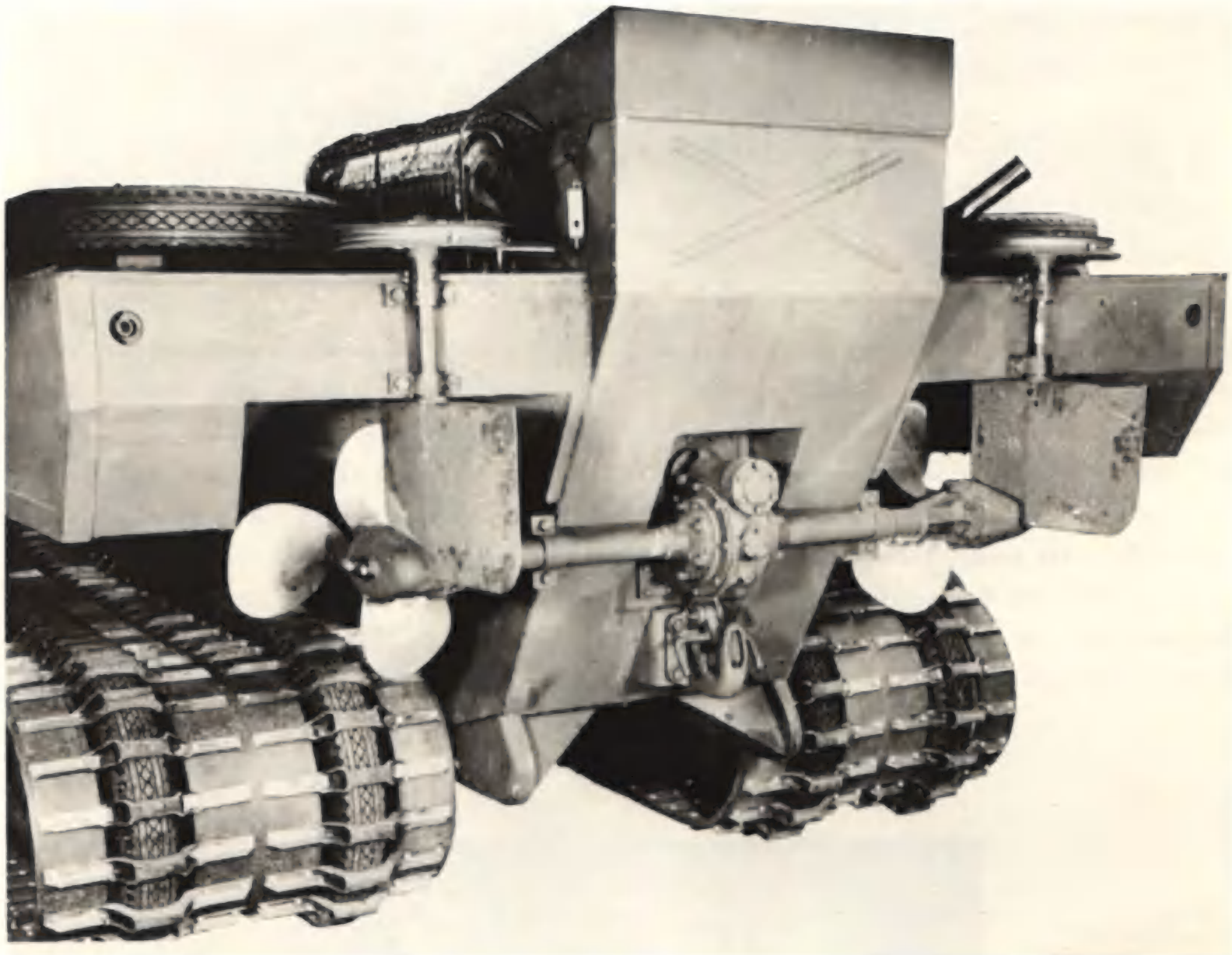
M. BILGE PUMP

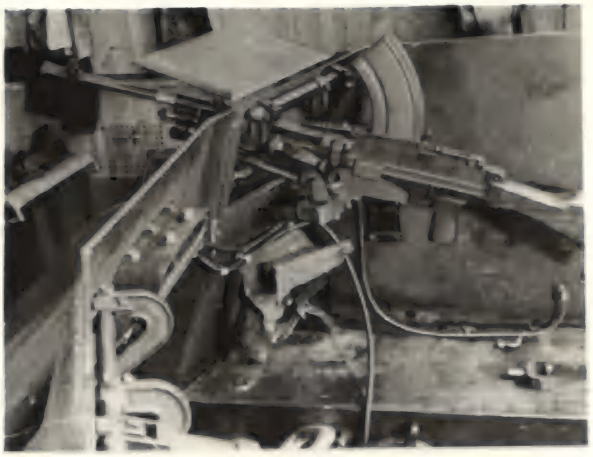
A bilge pump was provided mounted on the floor of the hull under the rear end of the engine. It was of the centrifugal type having a capacity of 50 gallons per minute at 4000 R.P.M. and was driven by belt from the generator drive pulley, operating continuously with the motor. The pump became operative at a water depth of 2-3/4 inches or greater and continued until the depth was 1/2 inch. The delivery tube discharged overboard at deck level. The pump itself was set in a sheet metal container which was placed there for the purpose of keeping the bilge water away from the belt pulley. Without this housing the water was thrown up drenching the propeller drive mechanism and wetting the crew if the wind was unfavourable. The pump was lubricated by means of a tube leading up to a grease fitting accessible for daily lubrication.

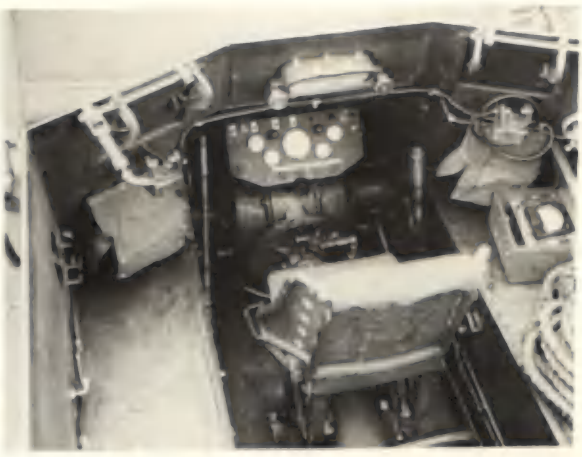
N. HULL

The Mudcat Hull was similar to that of the Snowmobile in that the crew compartment was armoured to withstand .303 ball ammunition on the sides and the rear and to withstand .303 A.P. on the front. The crew compartment widened out above the sponson plate and was longer than that of the Snowmobile, thus providing sufficient room for a 4-man crew, two sitting in tandem (driver and radio operator) and two sitting on the sponson plates (Bren gunners). As on the Snowmobile, the deck around the fighting compartment was made of plywood with steel frame. Stowage space was provided between the deck and the sponson plate.

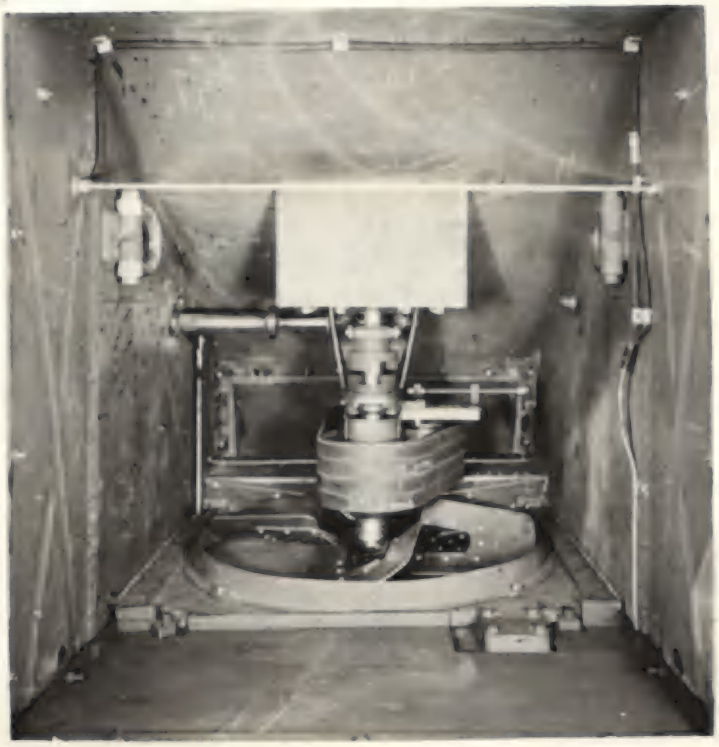
As in the Snowmobile, the driver had protected vision but in this case it consisted of a thick prism as used in the commander's cupula of the M-24 tank. This device provided excellent ground vision owing to its wide field of







view. Two gun ports were provided in the front slope of the hull and behind each a swivel mounting was fitted for a Bren gun. A special gun adapter was needed in order to utilize these mountings. The guns and magazines were stowed when not in use in brackets provided on the hull wall. (See Illustration below Propeller Clutch Shifter controls). Behind the fighting compartment, a hinged cover was provided over the engine for accessibility in servicing. Adjacent to this cover and extending to the rear was a hinged screen through which the cooling air exhausted. This screen was readily opened for access to the propeller V-belts and propeller clutch. The floor under the crew compartment was double and consists of a 3/16 in. mild steel skin plate with a false bottom made of 1/8 in. mild steel spaced 4 ins. above the skin plate. This arrangement was intended to minimize the damage from exploding mines.



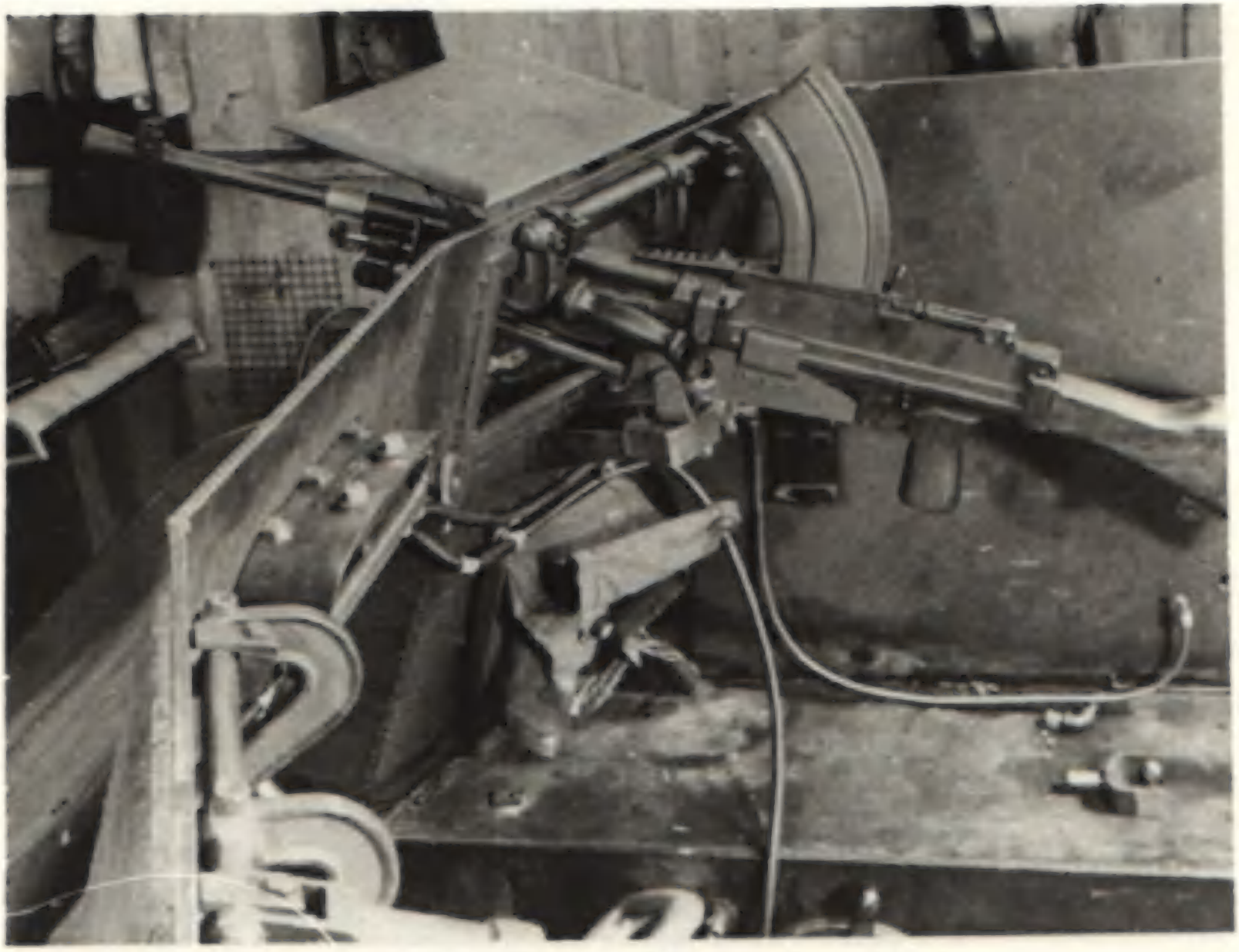
FAN - PROPELLER V BELTS AND CLUTCH

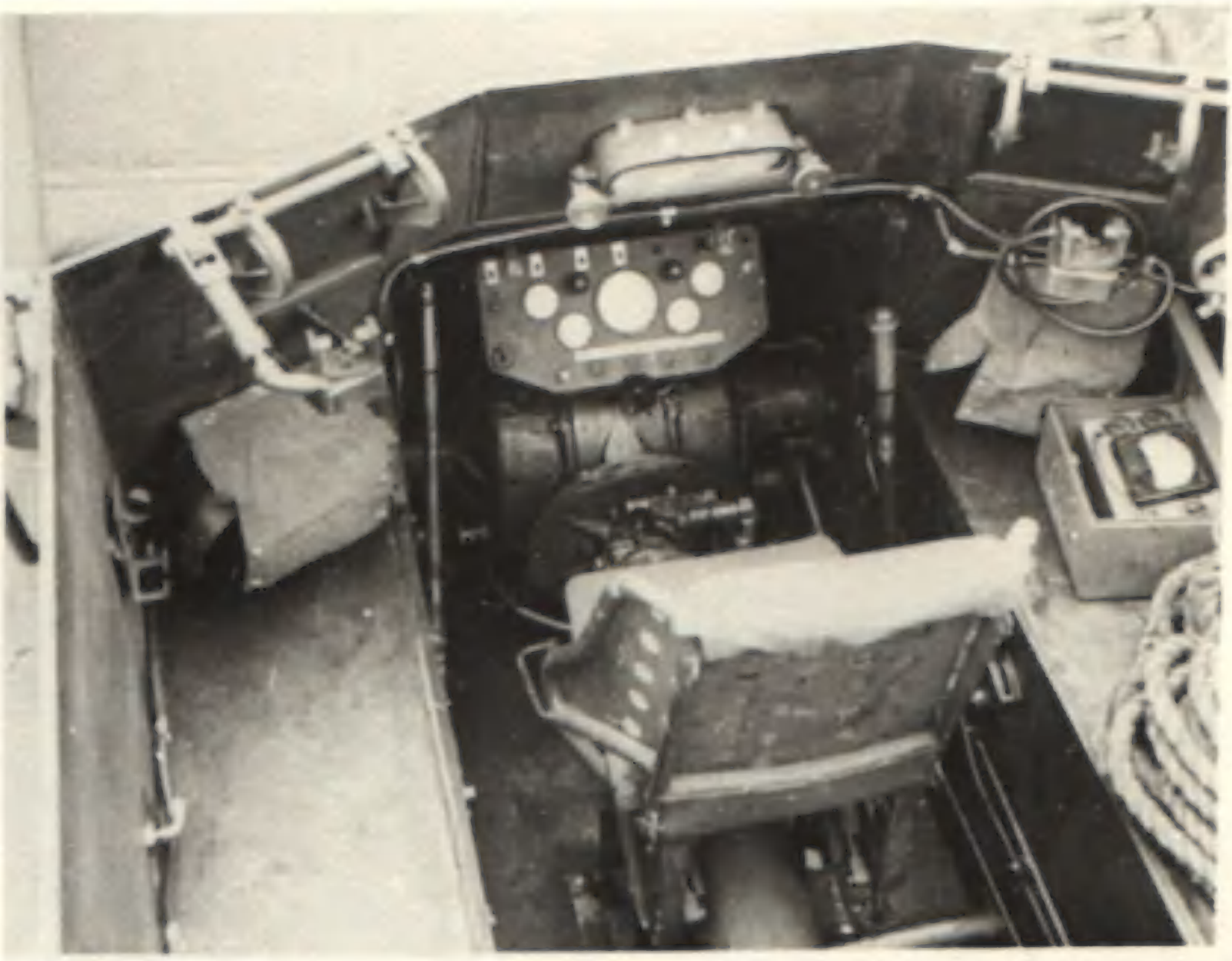
O. EXHAUST SYSTEM

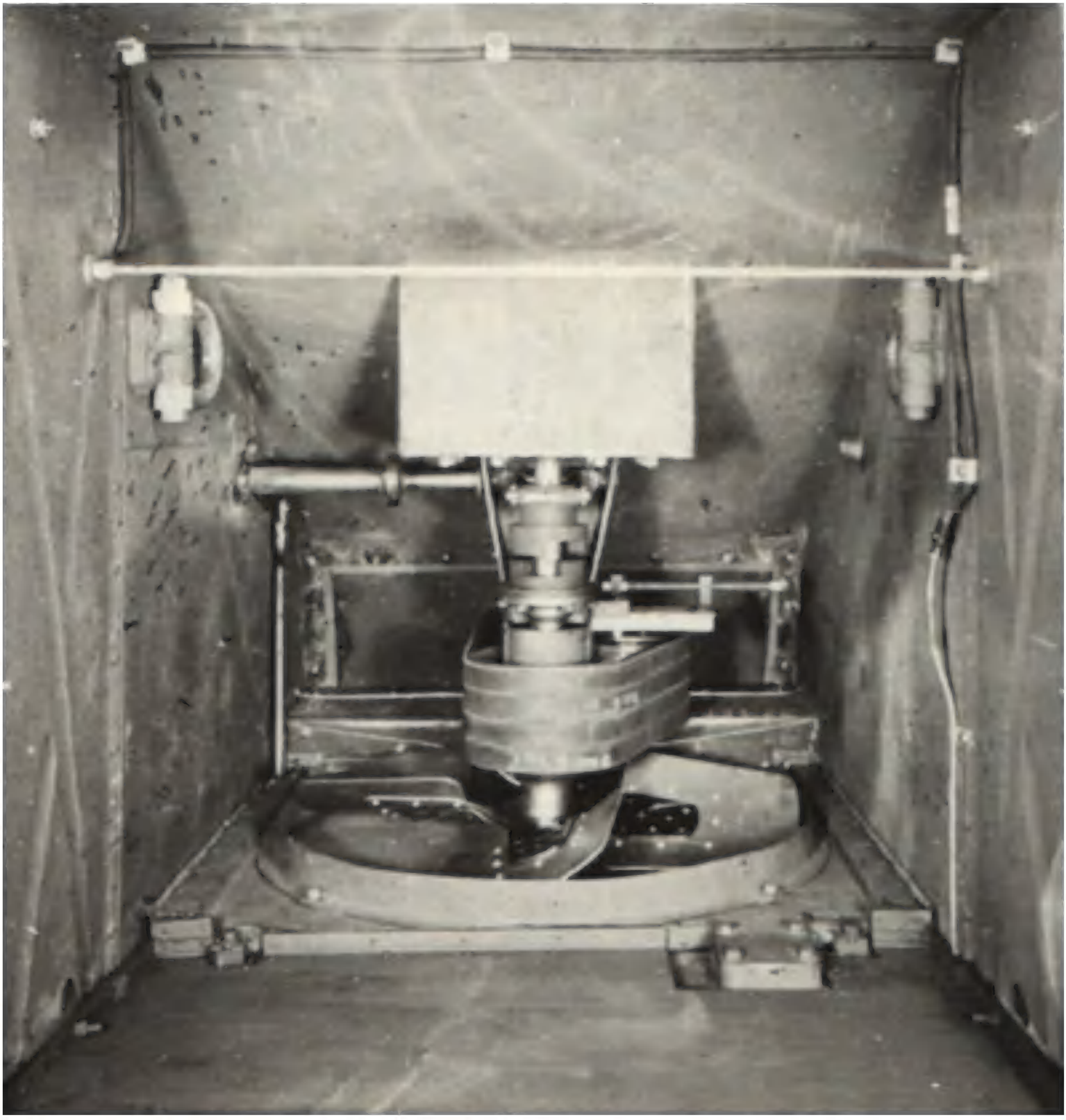
Separate pipes from each bank of cylinders led to a pair of Ford mufflers mounted on the deck beside the raised portion of the rear end of the hull. (See Illustration in Tactical Features and Radio Installation.)

P. AIR CLEANERS

The air cleaner used was identical with that used on the Snowmobile but its location and the piping leading from it differed. (See Illustration in Radio Installation.)

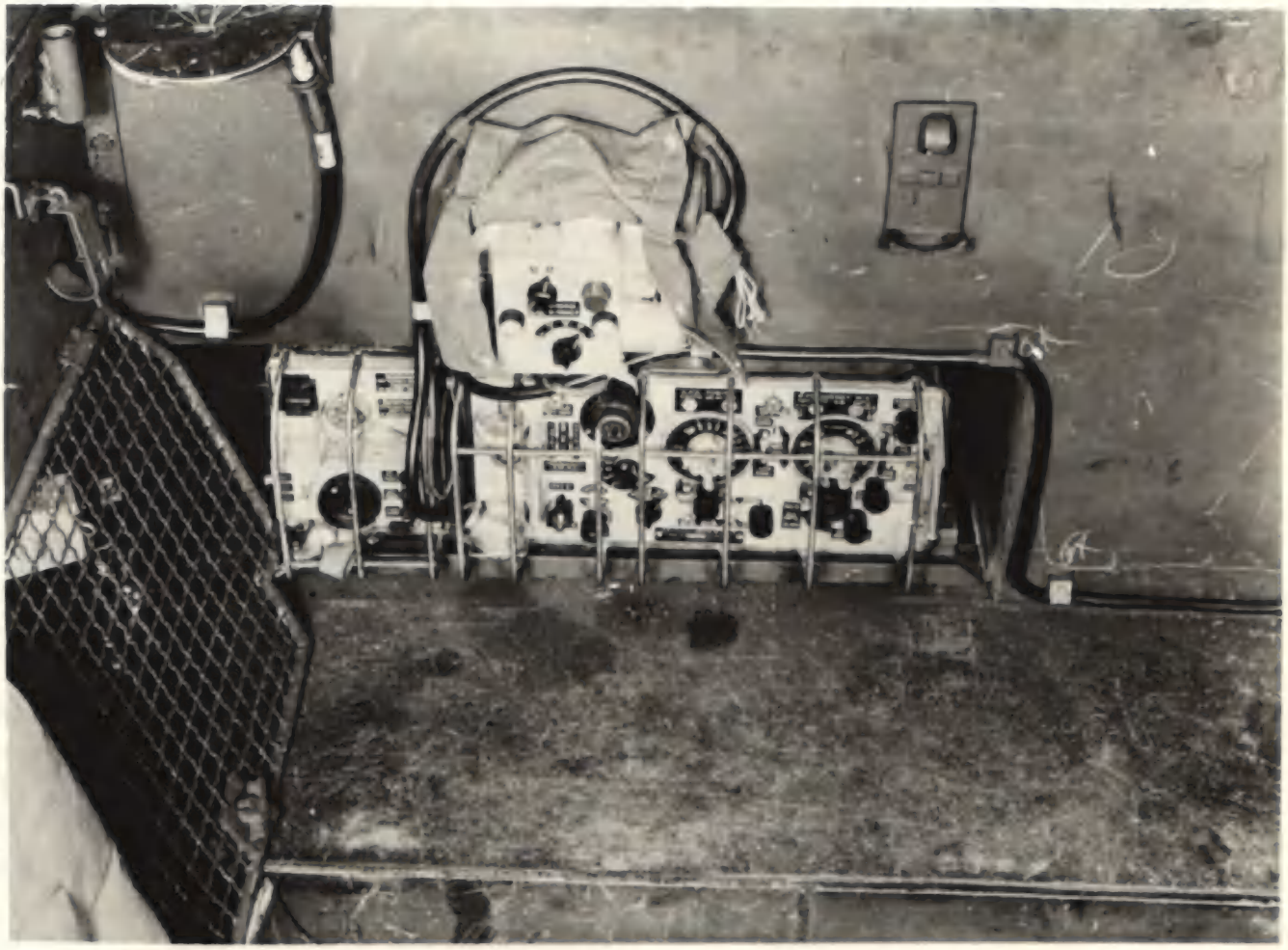


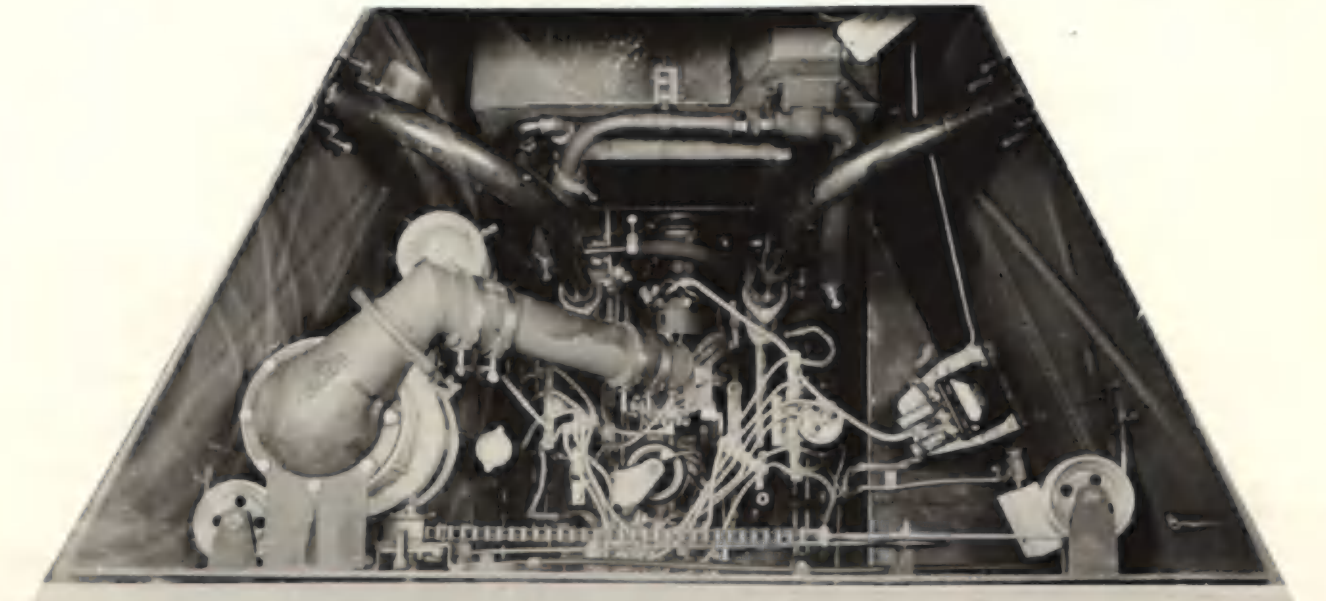




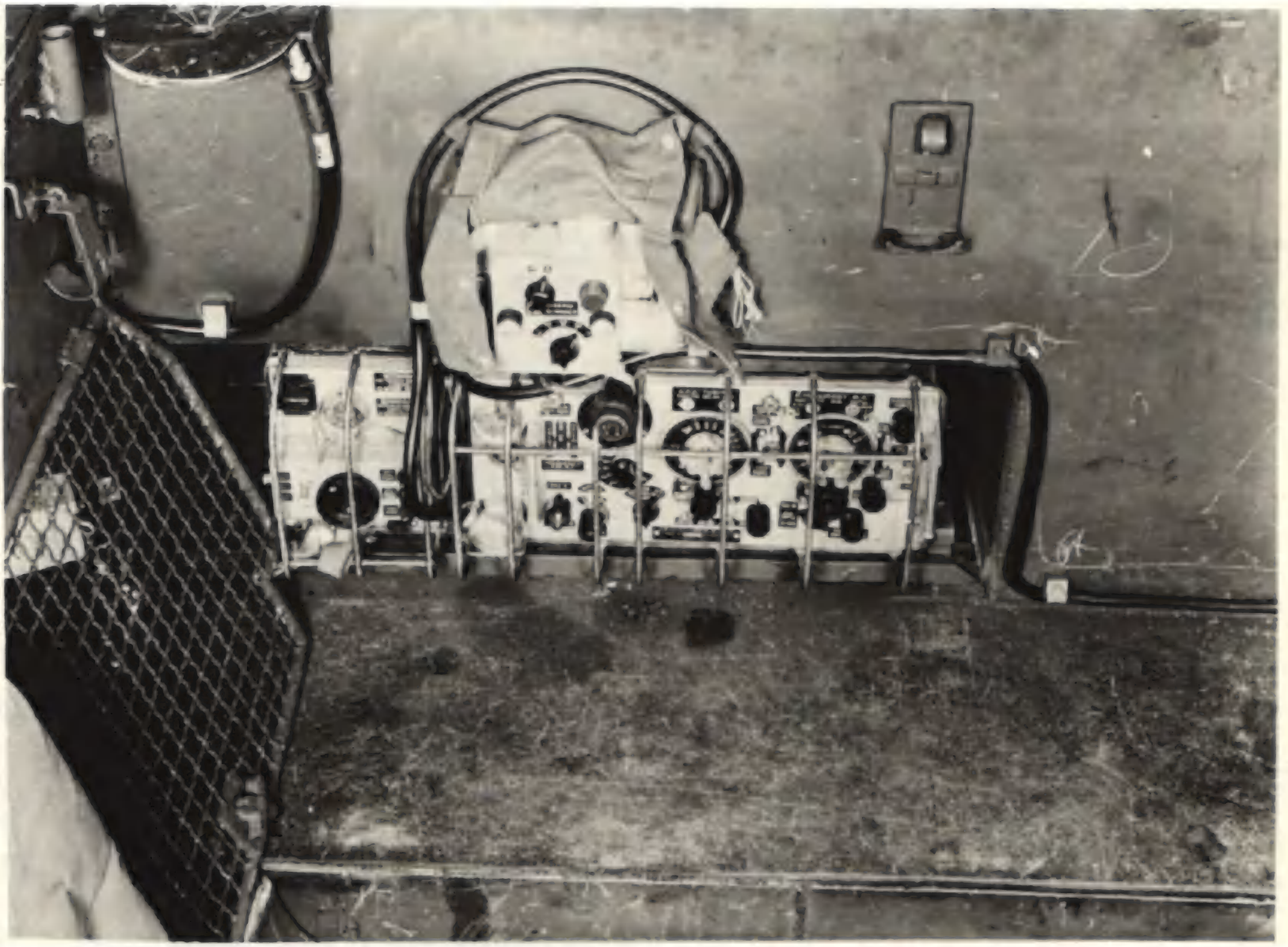
Q. RADIO INSTALLATION

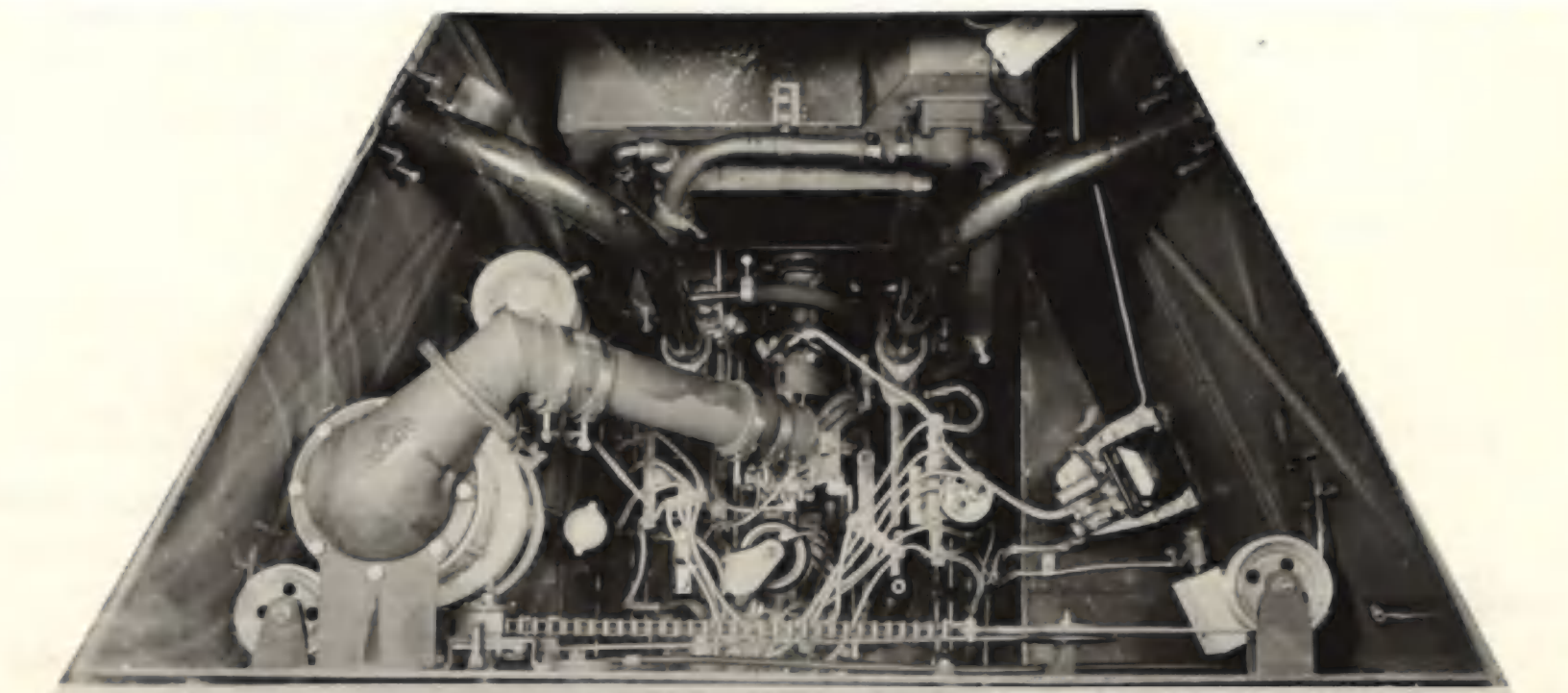
A No. 19 Wireless Set was provided in an armoured compartment to the left of the Radio Operator above sponson level.





ENGINE COMPARTMENT - Note Shielded Wiring





ENGINE COMPARTMENT - Note Shielded Wiring

MUDCAT, ARMOURED, AMPHIBIOUS, PILOT MODELS

TECHNICAL DATA

PRODUCED BY:

Farand & Delorme Ltd.

PRODUCTION:

Commenced: 1945
Finished: 1945

NO. VEHICLES PRODUCED: 4.

TYPE:

Full tracked. Driver centrally located in front of vehicle.

BRIDGE CLASSIFICATION: 5.

CREW:

4 - Driver and Radio Operator seated in tandem. 2 - Gunner-Observors seated one on each sponson plate facing each other.

ARMOUR:

Hull
Front - Sloping Plates 3/8 ins.
Sides and rear - 7 m/m
Belly Armour - Unarmoured (3/16 ins. mild steel with additional false bottom 1/8 inch mild steel in crew compartment.)

GUN MOUNTS:

Two Bren gun Pivot Mounting Brackets behind gun ports in frontal plate.

ARMAMENT:

2 Bren .303 Cal. Guns with Mounting Attachment - 24 clips of 30 rounds ea. in chests.

SIGHTING: Nil.

PROTECTED VISION:

Prism, driver's (for use when seat is in lowered position).

COMMUNICATION:

No. 19 Wireless Set in compartment at left of rear seat.

COMPASS: Nil.

LIGHTING:

Two Spot Lamps; Two Tail Lamps; Two Inst. Panel Lamps.

PERFORMANCE DATA

POWER/WEIGHT:

24 B.H.P. per short ton (laden weight into gross B.H.P.)
27.2 B.H.P. per short ton (unladen weight into gross B.H.P.)

GROUND PRESSURE:

1.80 lbs. per sq. in. at approx. 2 ins. ground penetration.

GROUND CLEARANCE: 12.5 ins.

GRADEABILITY:

Theoretical 97% (laden).

MINIMUM TURNING RADIUS: 38 ft. 6 ins.

SPEED, MAXIMUM:

30 M.P.H. on land; 3.5 M.P.H. in water approx.

TRENCH CROSSING ABILITY: 5 ft.

VERTICAL OBSTACLE CLIMBING: 26 ins.

FORDING DEPTHS: Amphibious.

CRUISING RANGE: Optimum - 225 miles.

FUEL CONSUMPTION: Optimum - 4.5 m.p.g.

OIL CONSUMPTION: 400 m.p.g.

MECHANICAL DATA

LADEN WEIGHT:

11,870 lbs. (vehicle completely stowed and with crew).
10,500 lbs. (vehicle completely stowed but less crew and their equipment).

OVERALL DIMENSIONS:

Height - 82.5 ins. Windshield and tarpaulin in place.
74 ins. Windshield and tarpaulin stowed.
Length - 176 ins. Flotation cell closed.
201 ins. Flotation cell opened.
Width - 102 ins. (approximately).

WHEEL BASE:

95 ins. (c to c front and rear bogie wheels at curb weight).

CENTRE OF GRAVITY:

30 ins. behind centre line of front cross-tube.

ENGINE:

Location	-	Rear
Make	-	Cadillac
Model	-	Modified M-5 tank
Type	-	90° - V8
Compression Ratio	-	7.06 to 1
Displacement	-	346 cu. in.
Peak Gross BHP	-	143 @ 3600 r.p.m.
Torque Net	-	243 ft. lbs. @ 1400 r.p.m.
Weight of Engine with Accessories	-	1300 lbs.

LUBRICATION:

Engine - Pressure and forced circulation system, except valves which are splash type. Capacity crankcase 7 Imp. quarts. Relief valve opens at 30 lbs. minimum.

COOLING SYSTEM:

Liquid, circulating under pressure from generator-belt driven centrifugal pump through the cylinder block and head, and fin and

tube type radiator core. A pipe from the right cylinder block to the hydramatic transmission and returning to the water pump cools the oil in the transmission. The oil in the differential is cooled by forced circulation through a separate oil cooler. Total capacity (water or anti-freeze) of cooling system - 28 Imp. qts.

FUEL SYSTEM:

Two gasoline tanks, trapezoidal in shape, of self-sealing rubber compound - Capacity 24.5 gals. each. Other normal units plus electric fuel pump and primer.

BILGE PUMP:

Centrifugal type; V-belt drive from direct take-off at rear of engine. Capacity 50 g.p.m. at 4000 R.P.M.

CLUTCH:

Fluid coupling type (part of Hydra-Matic Transmission).

TRANSMISSION:

Hydra-Matic (including fluid coupling type clutch) 4 speeds forward - 1 reverse.

Gear Ratio:		
	1st speed	- 3.26 to 1
	2nd speed	- 2.26 to 1
	3rd speed	- 1.44 to 1
	4th speed	- 1 to 1
	Reverse	- 3.77 to 1

DRIVING MEMBERS:

Tracks: Modified Ford T-16 controlled differential with full floating axle shafts and 1-1/2 g.p.m. gear type oil pump. Drive gear ratio 5.83 to 1.

Propellers: V-Belt drive from Special drive shaft connected to rear of engine crankshaft to jaw clutch behind fan and thence through worm and worm gear to cross-shafts enclosed in housing outside rear of hull. From cross-shafts through spiral bevel gears to two propellers 20 ins. diameter, left and right screw, operating in opposite senses. Total reduction: 4 to 1 in worm gear.

STEERING BRAKES:

Contracting shoe type controlled by steering levers.

STEERING RUDDERS:

Two rudders located at rear of vehicles in propeller slip-stream. Partially balanced with about 1/3 leading and 2/3 trailing area.

SPROCKETS:

Location	-	Front
Number	-	4 each side
No. of Teeth	-	10
Effective Pitch Dia.	-	12-3/4 ins.

TRACK:

Type	-	Three rubber belts (2 narrow, 1 wide fastened together in parallel by cross links at a pitch of 4 ins. with reinforcement cleats under boltheads.
No. per Veh.	-	2
No. of Cross Links per track	-	142 (2 used each pitch lead)
No. of Reinforcement Cleats per track	-	276 (no cleats used either side of track connecting pins).
Width Track	-	35 ins.
Length Track	-	23 ft. 8 ins.
Tread	-	65 ins. (c to c track)
Grousers	-	Integral with cross links

SUSPENSION:

Two front bogie suspension units mounted on a rigidly supported cross tube and two rear bogie suspension units mounted on individual brackets which are movable in their guides for the purpose of track adjustment. Each bogie suspension unit has two main compression springs mounted on pushrods between opposed front and rear bogie arms. The front bogie units have heavier springs installed to compensate for additional loads imposed on front bogies. Inter bogie spring units control the articulation.

BOGIE WHEELS:

Eight each side. Wheels are double disc drop centre type with removable ring to accommodate 4.50 x 16 Run-Flat tires carrying 26 lbs. pressure.

TRACK ADJUSTMENT:

Rear suspension brackets movable individually in support guides by adjusting bolt on each side of vehicle. Tighten adjusting bolt until bottom of track cross link is 2 ins. above the 2nd bogie wheel.

ELECTRICAL:

System	-	12 volts.
Batteries	-	Two 6-volt 19-plate acid type connected in series - negative ground - 120 ampere hours.
Starter	-	Delco-Remy 4-Brush, 4-pole. Over-running clutch engages pinion with flywheel ring gear by means of solenoid operated mechanism.
Generator	-	Delco-Remy 2-brush, 2-pole, 24 to 26 amps. max.
Regulator	-	Delco-Remy, including cut-out relay, voltage regulator and current regulator.
Coil	-	Delco-Remy, 1-1/2 amperage draw at idling speed.
Condenser	-	Delco-Remy, capacity 0.18-0.23 microfarad.
Spark Plugs	-	A.C. type W104 10 m/m; gap .028 ins. - 0.33 ins.
Distributor	-	Delco-Remy type #1110609 22° automatic advance. Sealed and shielded H.T. leads.
Horn	-	Sparks-Withington Vibrator type.
Lighting	-	Two Trippe S.C. 12-16V, 60 watt spotlights; 2 Tail Lamps; 2 Instr. Panel Lamps.
Circuit Breaker	-	In lighting circuit.

REFERENCES:

D.M.&S. File	73-V-16.
D.M.&S. Photo File	G-2.
D.M.&S. Drawing Schedule	S-2222-CSK.

ORDER NUMBERS:

MSX-478	1 Vehicle.
AID/GB/497	2 Vehicles.
CDLV 3540	1 Vehicle.

SUGGESTED IMPROVEMENTS TO MUDCAT

As manufacture and testing of the 4 Pilot Mudcats proceeded, it became evident that certain design improvements could be affected if time had permitted. Listed herewith are those design improvements which appeared to be worth considering for any future manufacture:-

1. Greater buoyancy required at rear end as compared with front end. This could be affected either by increasing the displacement of the hull at the rear, or reducing the weight of the hull at the front, or both.
2. The propeller diameter could be increased to get improved water speed. The hull, as designed, will accommodate a propeller 2 ins. greater in diameter than those used, and one such set (22 in. dia.) has been made and tested and is being turned over to the Canadian Army along with other vehicle spares. The 22 inch propeller, together with the standard 20 inch propellers, was manufactured by Wm. Kennedy & Sons Ltd., Owen Sound, Ont.
3. Worthy of consideration would be the development of reversing gears for the propeller drive and the use of automotive type clutch with a chain or gear drive to replace the multiple V-belt drive. The V-belts tended to slip when wet or normally slack. Failing the development of friction clutch and positive drive, it would be possible to use the present jaw clutch with a positive drive provided some shear pins or slip joints were introduced in the system. The present V-belts could be improved by the use of the newly developed wire cable insert type of V-belt which is reported to eliminate stretch, but of course would not eliminate slip due to wetting.
4. Track belts with steel cable inserts to reduce uneven stretch or shrinkage which was sometimes experienced should be investigated. One pair of belts made thus to drawing A-5275-CSK was delivered to Canadian Army with other spares, without test.
5. A general examination of the design should be made to improve the tropicproofing.
6. The coupling links and pins of the tracks could be chrome-plated on the wearing surfaces to improve life, but a new design coupling would appear desirable.
7. The bolts joining the wheel rims to the wheel discs should be increased from 1/4 ins. to 5/16 ins. The 1/4 inch bolts had a high incidence of failure when the terrain was rough.
8. Some means of clearing mud from the suspensions as vehicle operated would be desirable. Adequate guards or more open construction would alleviate the situation.
9. The radiator filler cap gaskets should be made more resilient than the type used which tended to harden and lose their sealing properties quickly.
10. Present design of rear suspension bracket was a welded assembly. One of these failed on test at 1500 miles. Improvements in this welded design were made on the brackets supplied on the last three Muskrats and all spares for both vehicles. These improvements were not tested beyond the 50-miles break-in run for each vehicle. It is recommended that for quantity production, these brackets should be made from steel casting with a minimum ultimate tensile of 85,000 pounds per square inch, with adequate ductility.
11. Greater free-board is needed on the vehicle, particularly at the rear, to take care of even moderate surf, such as encountered on rivers and lakes up to 1/2 mile.
12. After test, it was found that a screen over the bilge pump inlet was desirable to prevent the cumulation of leaves, etc., from blocking the pump. Vehicles, except No. 1 Mudcat (A.E.D.B.) and No. 2 Mudcat (U.K.) had the screen incorporated during production. It is recommended that before any extensive use of these vehicles is made, that personnel either fit a screen or make sure that there is no debric in the bottom of the hull which could block the pump.
13. After all the parts of the propeller drive mechanism had been manufactured, it was found that the pilot bearing at the forward end of the worm shaft burned out due to misalignment of the worm shaft with the pulley. Since there were already two main bearings supporting the worm shaft, it was decided to delete the pilot bearing (New Departure #88584) as

it was not considered essential. Details were not otherwise changed so that the bearing may be put in again if extensive testing proved the need, and if the flexibility of the pulley bracket will permit satisfactory alignment.

14. The front end of the vehicle rides too low when travelling on road, and this tends to cause hammering of the hull on the ground during rough cross-country runs. This should be corrected by increasing front spring capacity to a point where the suspension geometry under load is approximately the same as the geometry of the rear suspension. Note:- the springs of the front suspension were designed 20% stronger than the springs of the rear suspension.

15. To improve water speed slightly, the flotation cell at the front of the vehicle should be tapered toward the front to reduce resistance while in the water. To do this, it would also be necessary to taper the hull accordingly. Refer to the shape of the Muskrat hull and flotation cell for a more satisfactory design.

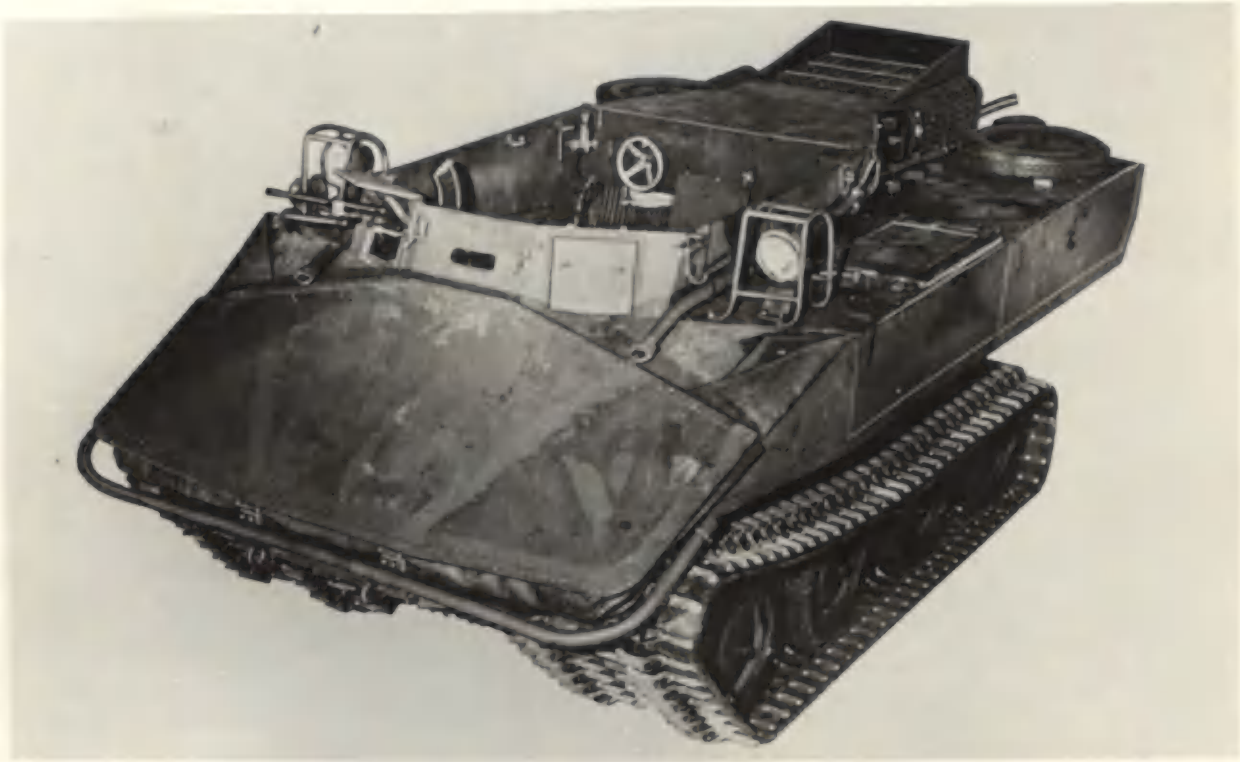
16. The seat carrier should be strengthened as the present design does not seem rigid enough and requires considerable fitting when being installed to provide satisfactory operation of the various adjustments. Heavier material at crucial points would likely result in the necessary improvement.

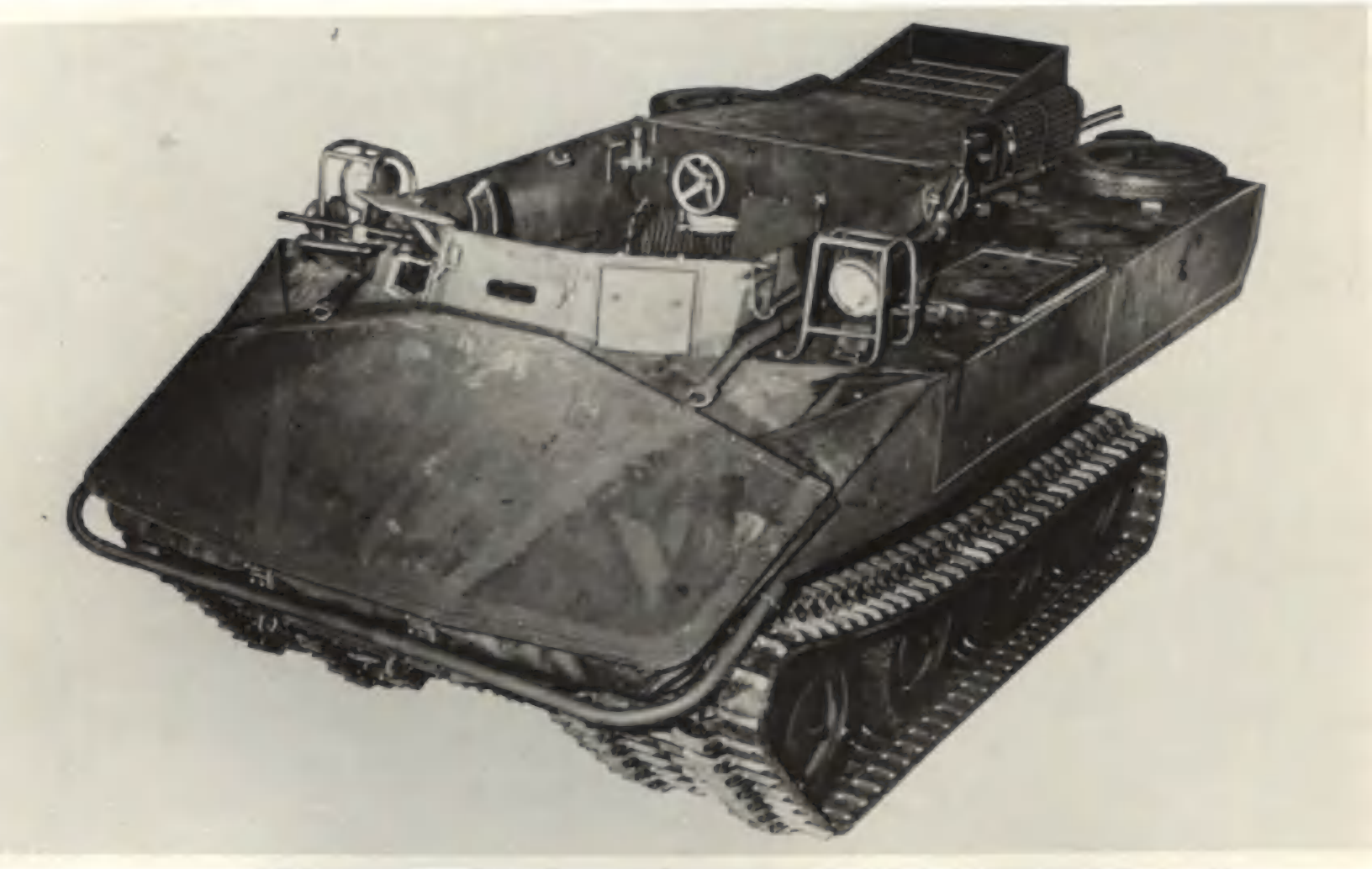
17. An improved lamp bracket and guard have been designed, but were not incorporated in any of the pilot vehicles. The revised components - are shown on B-5613-CSK, E-5620-1-CSK and F-5610-11-CSK.

18. A small inspection plate should be added to the hull floor under the radiator to eliminate the necessity of removing main plate to drain the radiator.

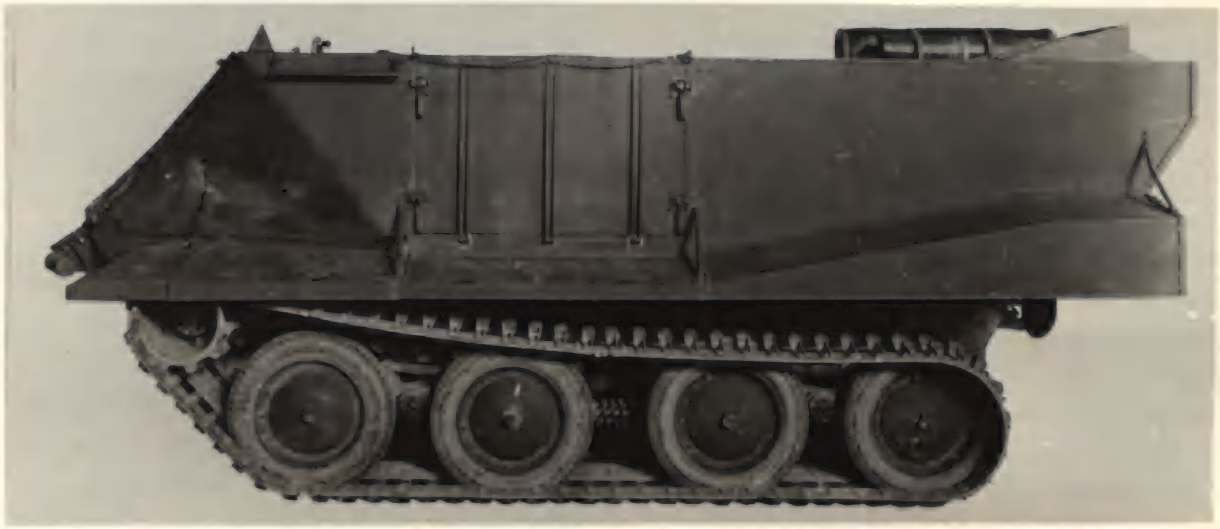
19. An improved linkage for gear shifting was tried successfully on No. 1 Pilot. This linkage overcame the difficulty of "heavy" operation of the later type valve and detent assembly as supplied with Cadillac M-24 Tank Engine. (This detent was redesigned by U.S. Ordnance to provide more "feel" of the shift lever). The improved design is recorded on D-5450-CSK, C-5441-CSK, B-5443-CSK, B-5437-CSK, and A-2723-CSK.

20. Continued effort to lighten all existing components should be explored and any further fittings required by new demands should be weighed against the penalty of reduced performance due to the increased gross weight.





MUSKRATS (PILOTS)



After the Mudcat had developed to some degree the Canadian Military Authorities began to show interest in an unarmoured load carrier on the basic Mudcat chassis. This led to a new vehicle to be known as the Muskrat.

The tactical features of the Muskrat were:

(a) Unarmoured.

(b) Crew of one, the Driver.

(c) Payload 3000 pounds on an accessible deck.

(d) Ground contact-track area 5000-6600 sq. ins.

(e) Top speed performance 28-30 M.P.H. on land.

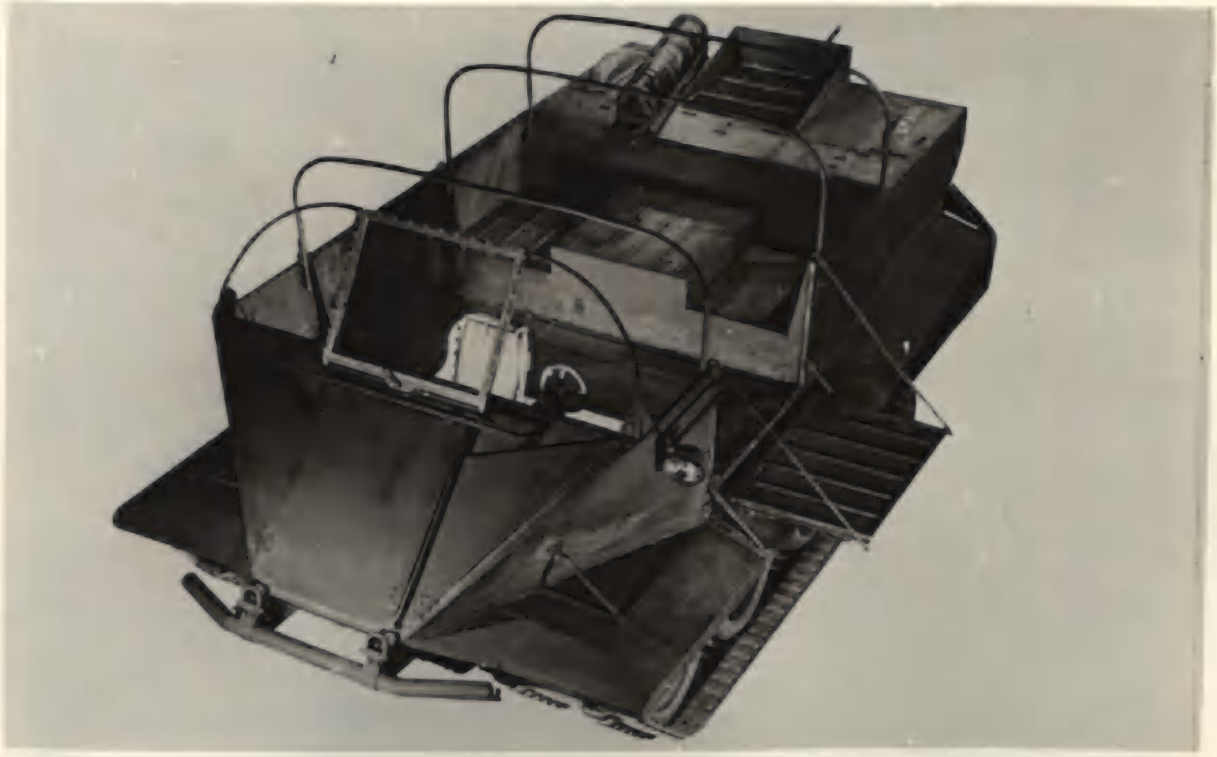
(f) Amphibious with a still water speed performance of approximately 3.5 M.P.H.

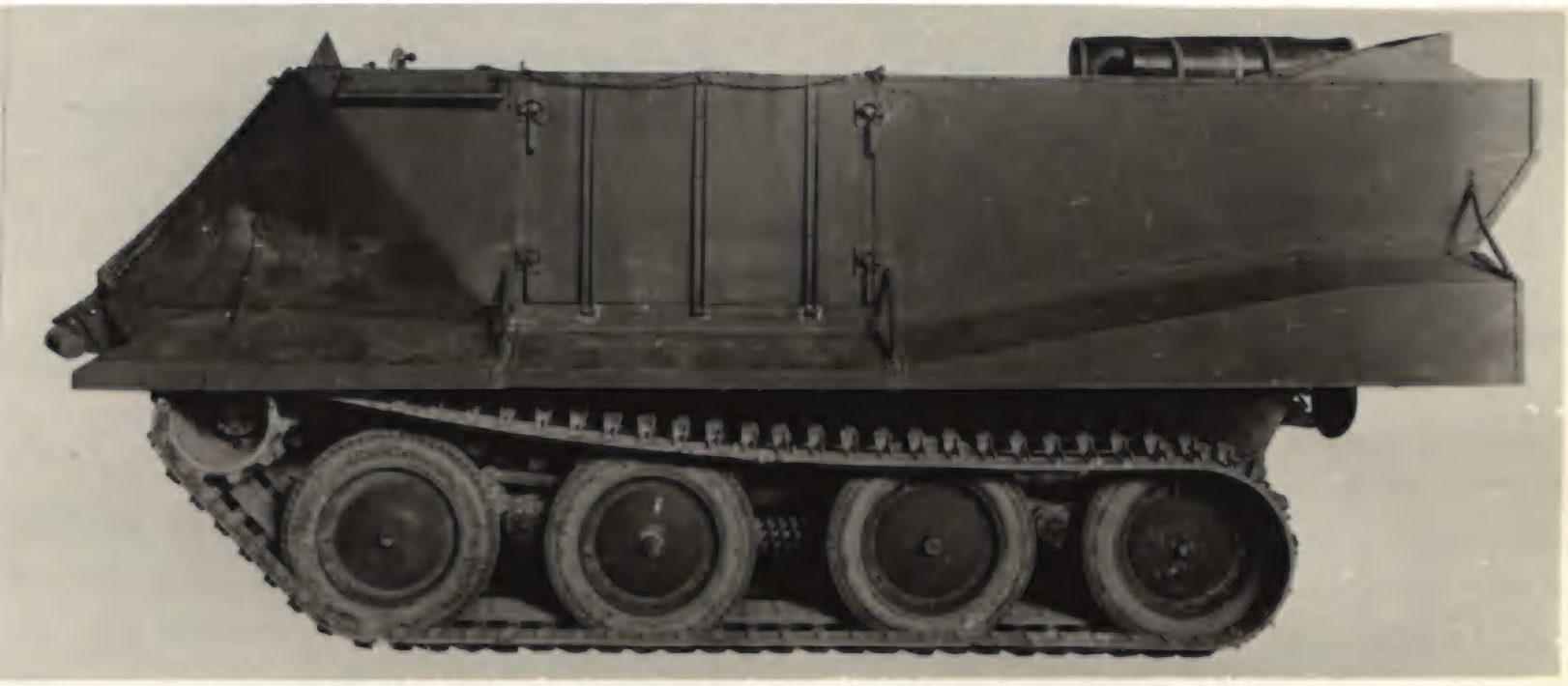
(g) Cruising range 225 miles approx. without refueling.

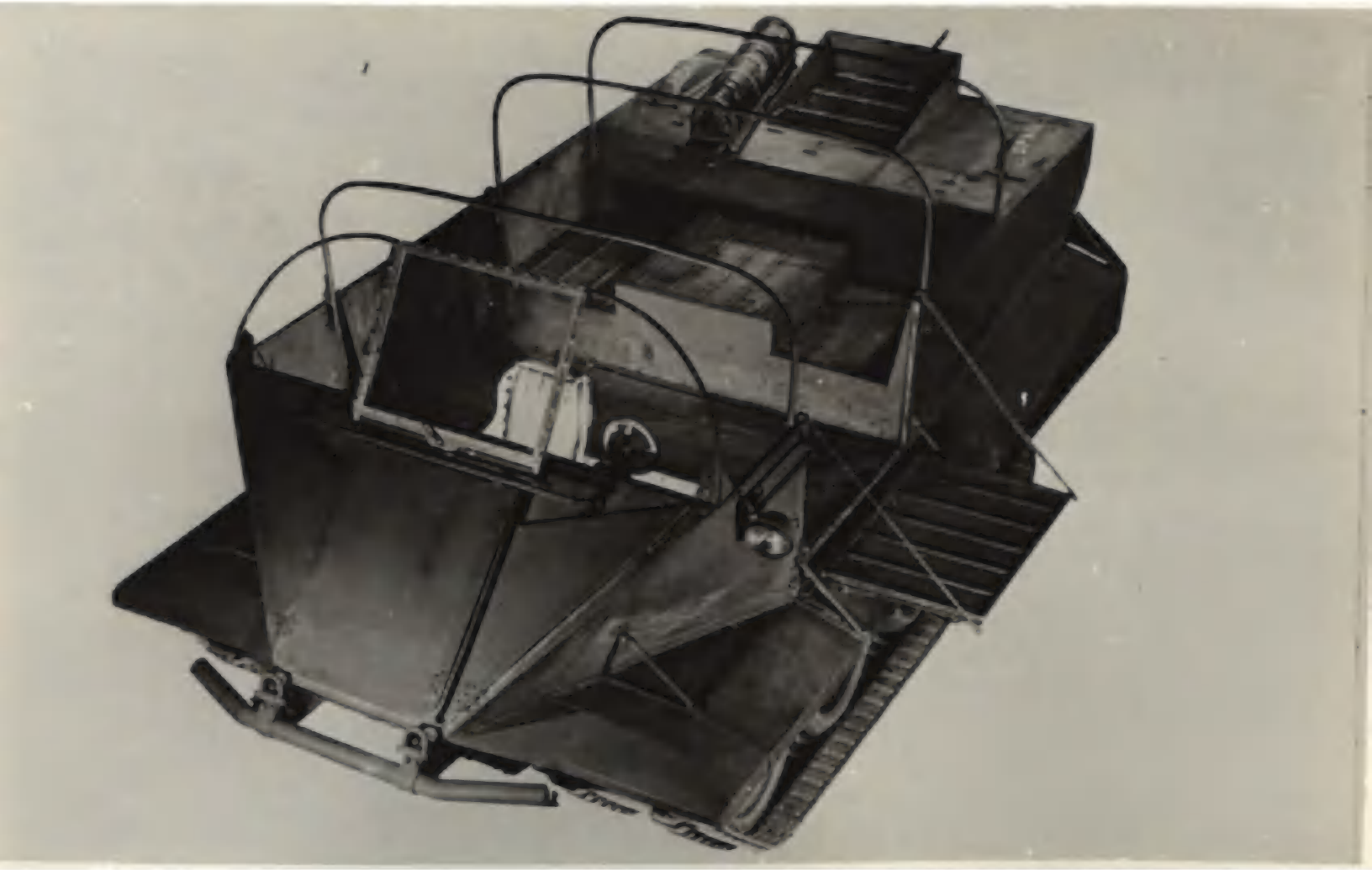
(h) Ground clearance 12 inches with good obstacle climbing characteristics.

(i) Capable of operation in ambient temperatures of 120°F.

(j) Relatively high performance on soft terrain as well as on hard surface.







Its basic mechanical features were to all intents and purposes duplicates of those of the Mudcat with such modifications as were imposed by the difference in the roles of the vehicles.

Four Muskrats of similar design were produced during the fall and winter of 1945.

The mechanical means of both land and water operations were duplicates of the Mudcat, described in this volume, except for such items as are listed hereafter. These are minor except for the hull assembly, and the paragraphs are indexed to agree with the corresponding paragraphs in the Mudcat description.

G. THROTTLE CONTROL.

One only hand throttle was provided adjacent the driver's seat.

H. GEAR SHIFT CONTROLS.

The improved vertical motion linkage for the transmission gear shift lever as developed for the Mudcat during their production was incorporated on the Muskrat vehicles.

I. PROPELLER CLUTCH SHIFTER CONTROLS.

Minor detail differences occured on the marine clutch shifting mechanism, the main of which was that the control rod was located on the left side of the hull rather than the right side.

J. RUDDER CONTROLS.

The control wheel for rudder operation was located at the front of the vehicle to the left of the driver. The routing of the cable caused it to cross over the lower hull and a pulley tightener located in the bottom R.H. Stowage box replaced the turnbuckles used on Mudcats.

N. HULL.

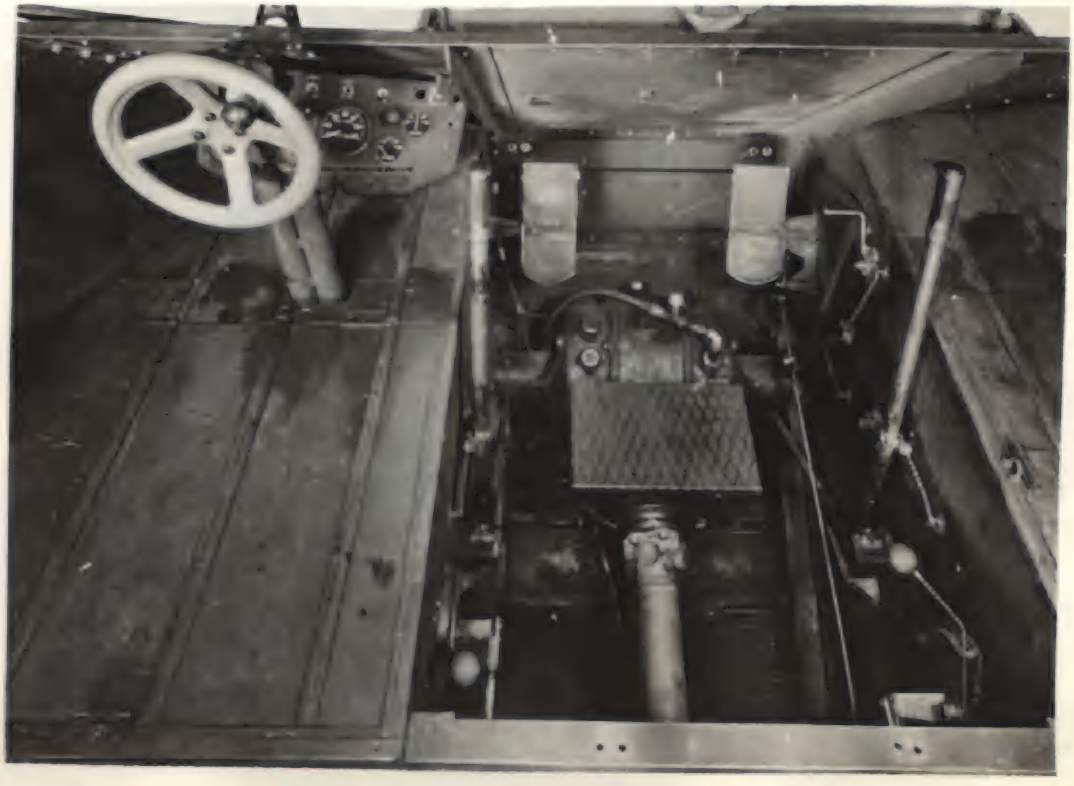
Since the Muskrat was a load carrier, the hull design was controlled by three features:

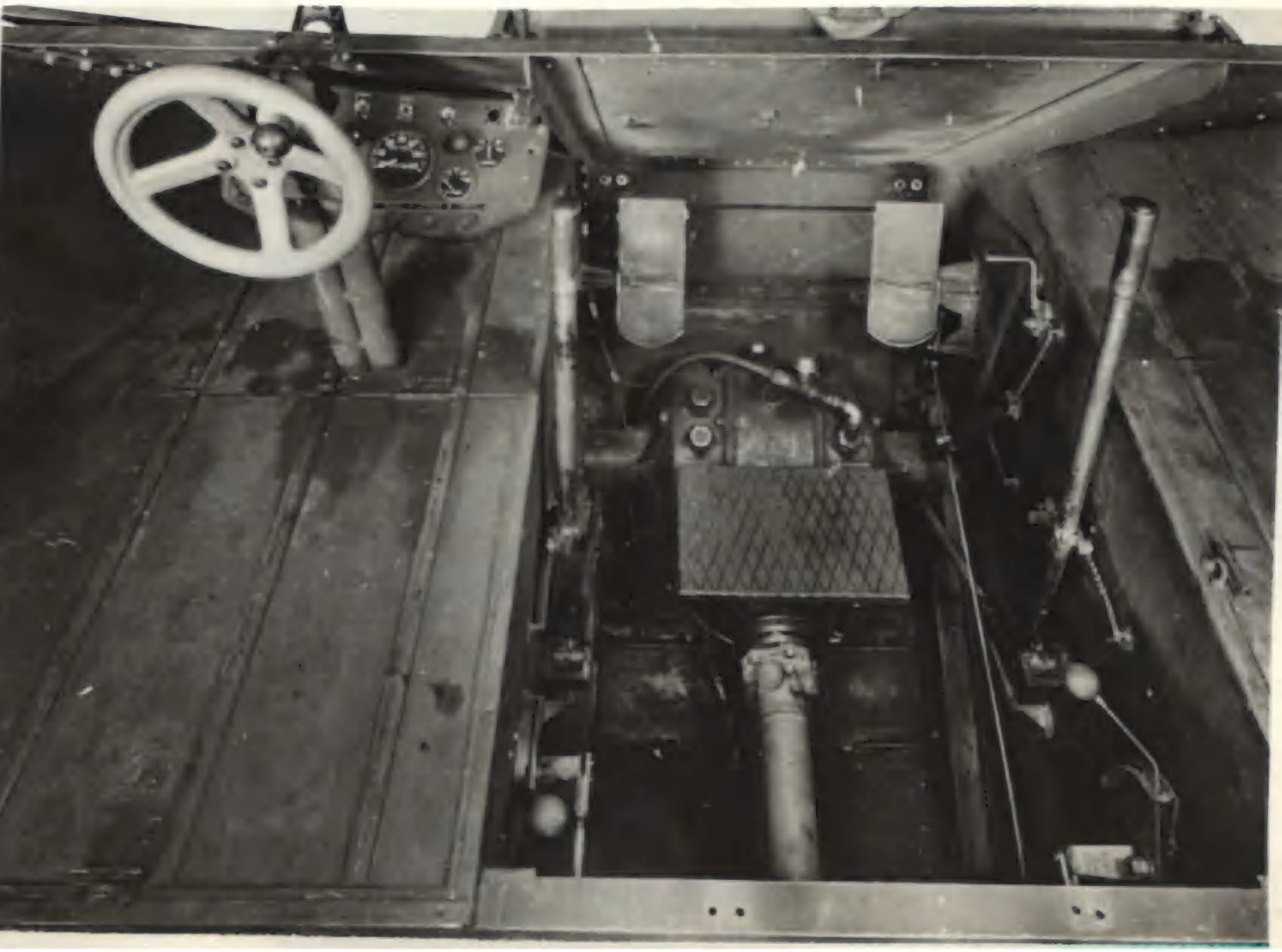
1. It was to accommodate the Mudcat Power Train and Suspension.
2. It was to be as light as feasible.
3. The cargo space was to be as large as possible and designed for convenient loading of a 3000 pound payload.

The requirements of the power train and suspension governed the width of the lower portion of the hull as well as its length. The shape, size and materials of the upper portion of the hull were governed by the requirements for loading space, freeboard, driver accommodation, and service accessibility of the various components. Armour plate was not used in the Muskrat hull. All steel used was mild steel. The lower portion was made of 16-gauge side plates and 10-gauge bottom with angle frame stiffeners forming an open top box section. The open top was stiffened with both fixed and removable diagonal horizontal angle braces.

The sponson plates were 16-gauge with angle stiffeners. The forward third of the side walls, the sloping portion of the hull and the rear of the hull were of 16-gauge.

The deck and the rear two thirds of the side walls were of birch plywood, the floor 3/4 inch, the balance 1/2 inch thick. A removable panel was provided over the engine compartment. Side loading accessibility to the load floor was provided by two bottom hinged sealed steel doors. A stowage compartment to the right





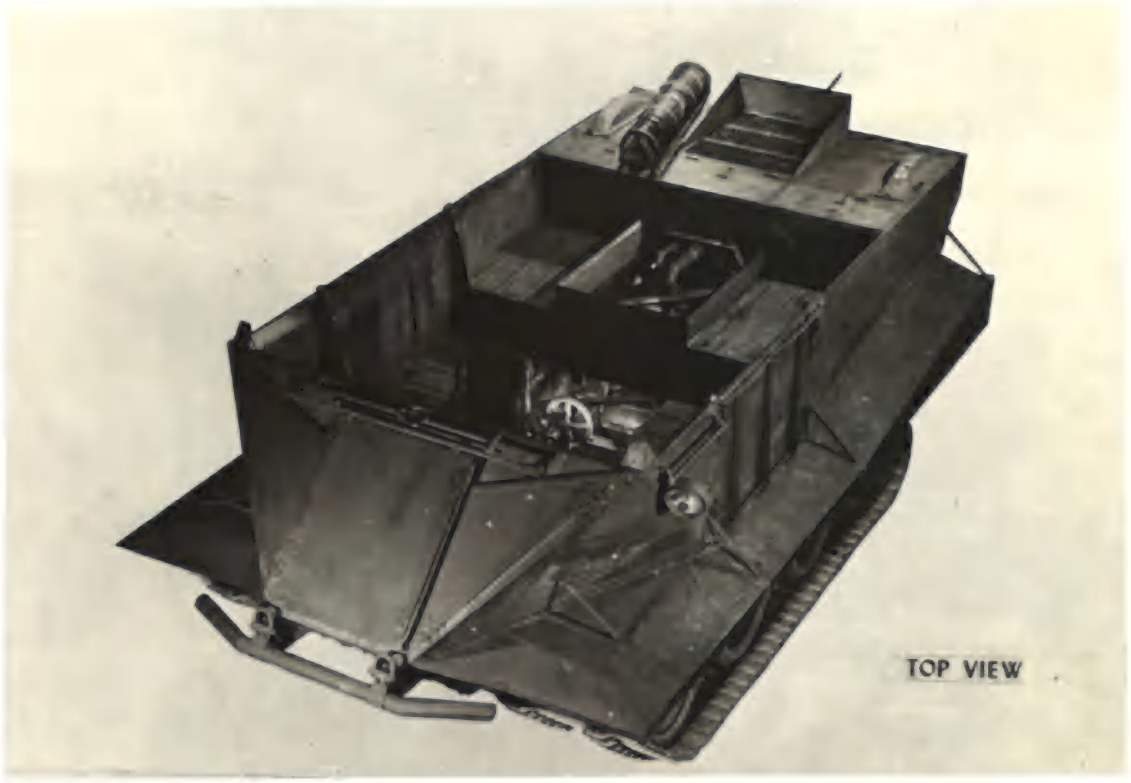
and left of the driver ahead of the loading doors was provided. The two steel Truncated fuel tanks mounted either side of the engine were filled through small hatches in the deck. Two spare tires and wheels were stowed in cells longitudinally on either side at the rear of the vehicle.

O. EXHAUST SYSTEM.

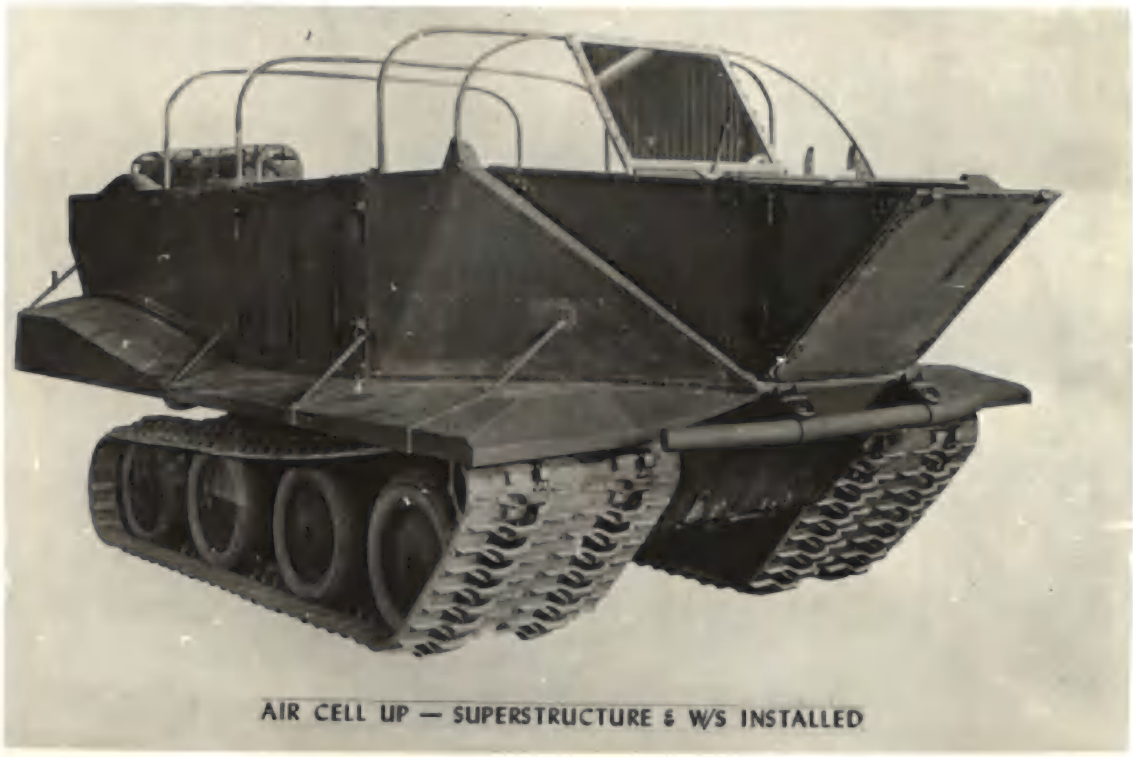
The exhaust was discharged through a single muffler on the right rear deck. To use this a crossover manifold was provided with the engine to combine the exhaust from each bank. Space limitation made the above changes necessary.

P. ENGINE AIR CLEANER.

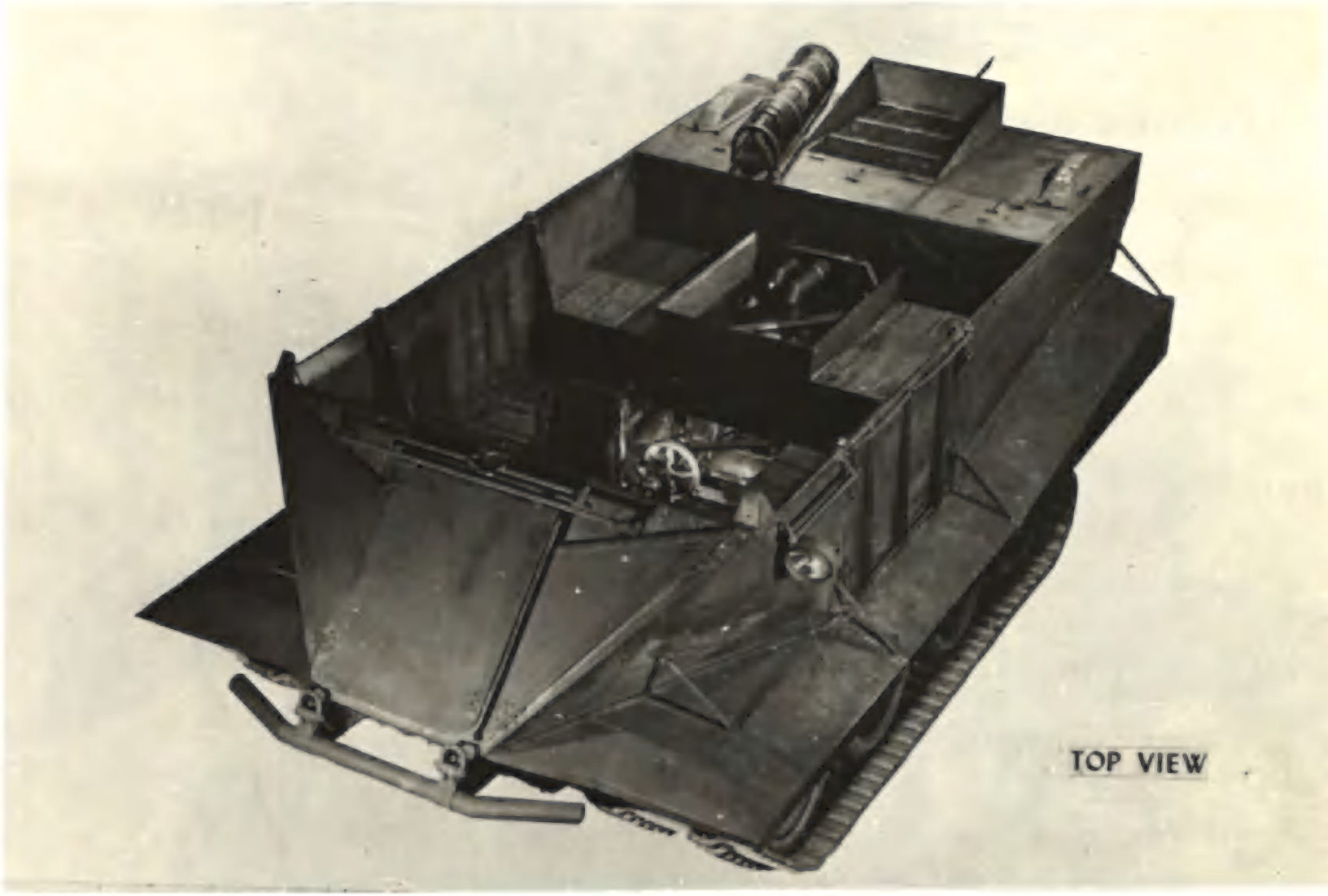
The air ducts from the cleaner were at variance with the Mudcat ducts due to the change in hull design and the necessity to mount the cleaner in a slightly different location.



TOP VIEW



AIR CELL UP — SUPERSTRUCTURE & W/S INSTALLED



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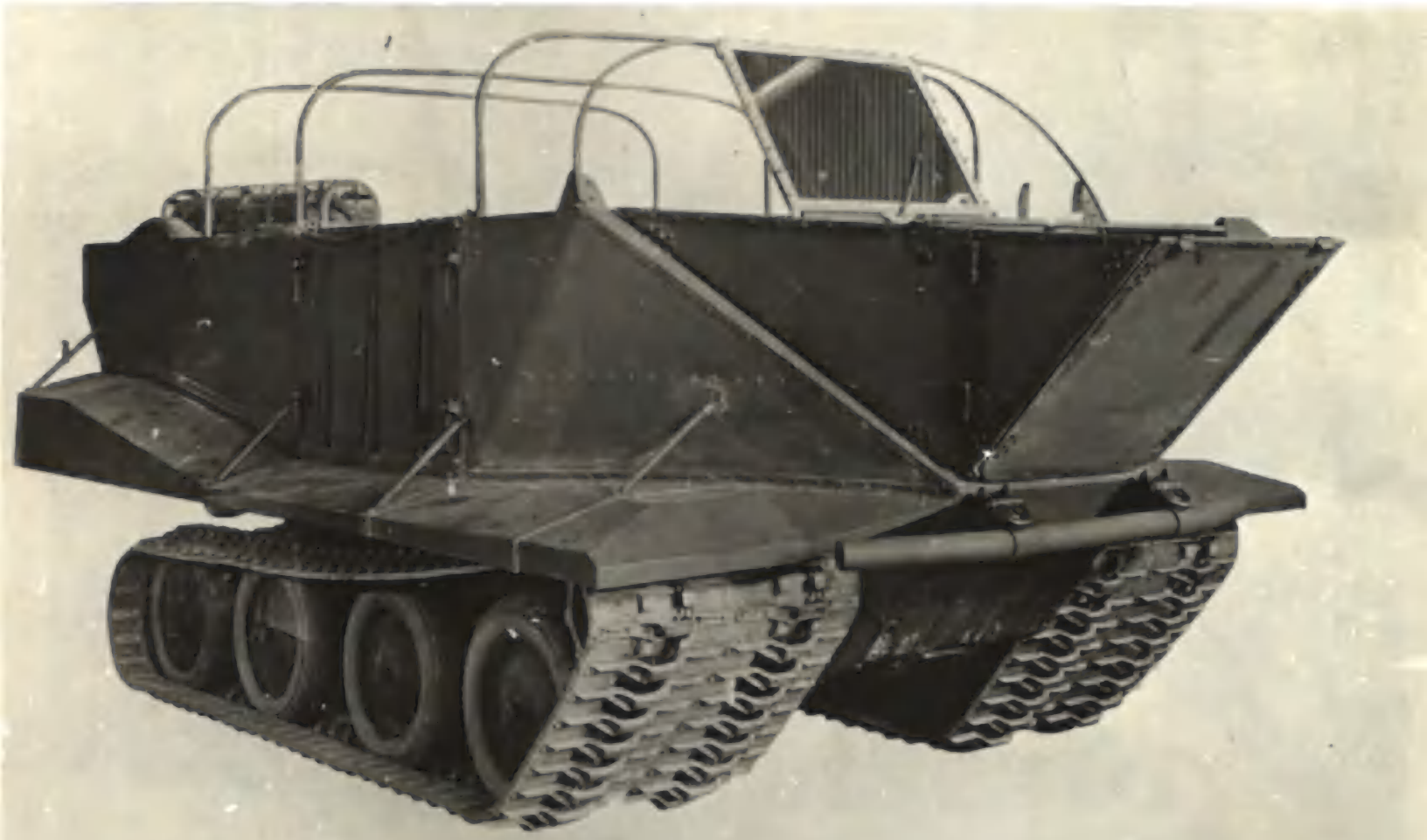
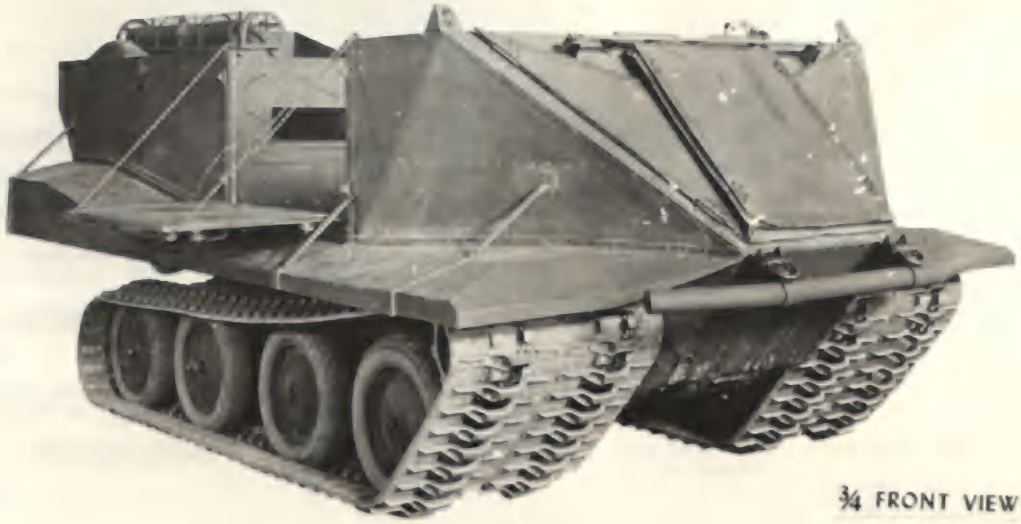
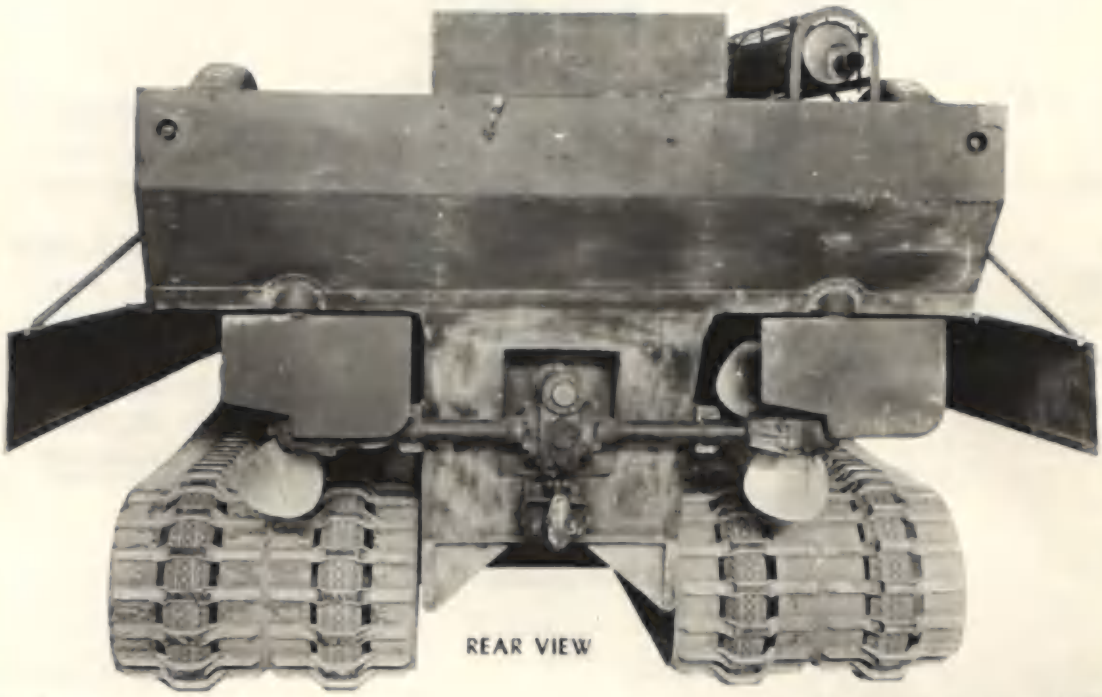


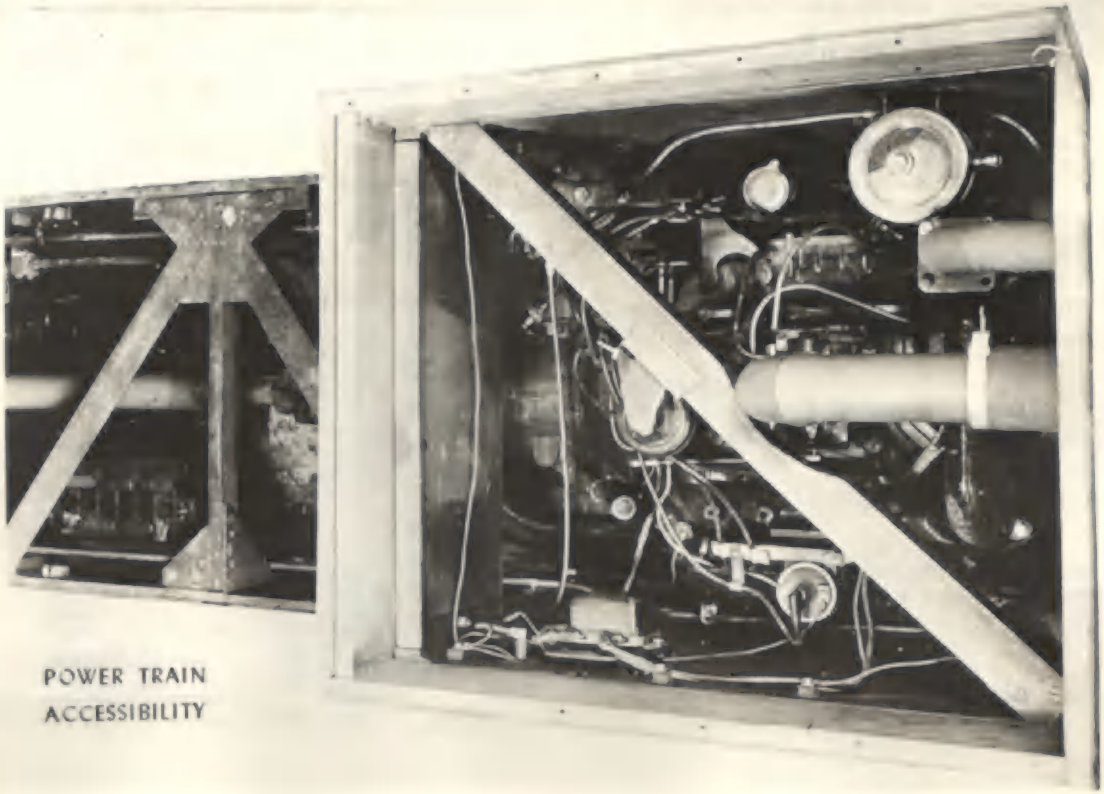
AIR CELL UP — SUPERSTRUCTURE & W/S INSTALLED



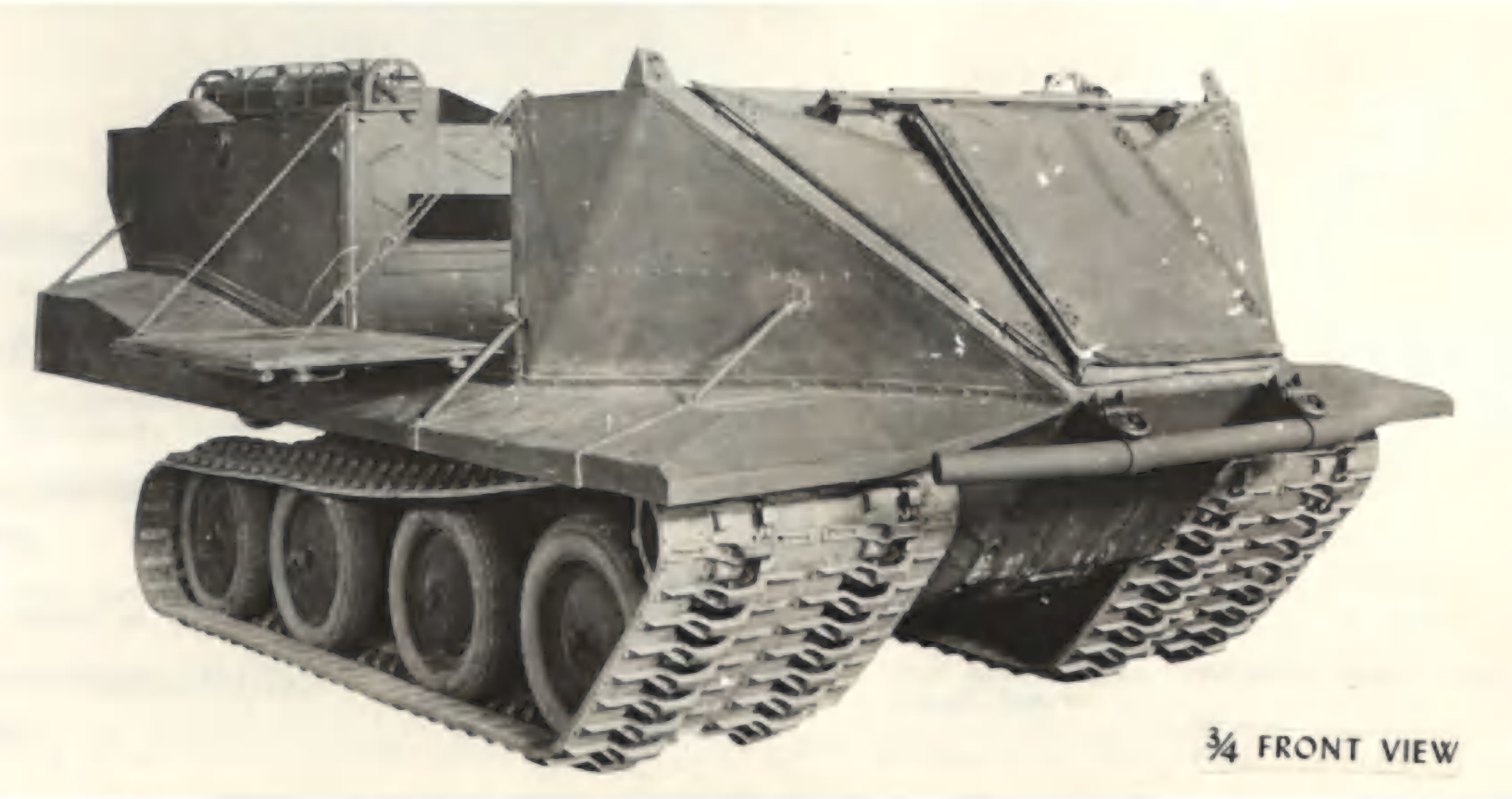
¾ FRONT VIEW



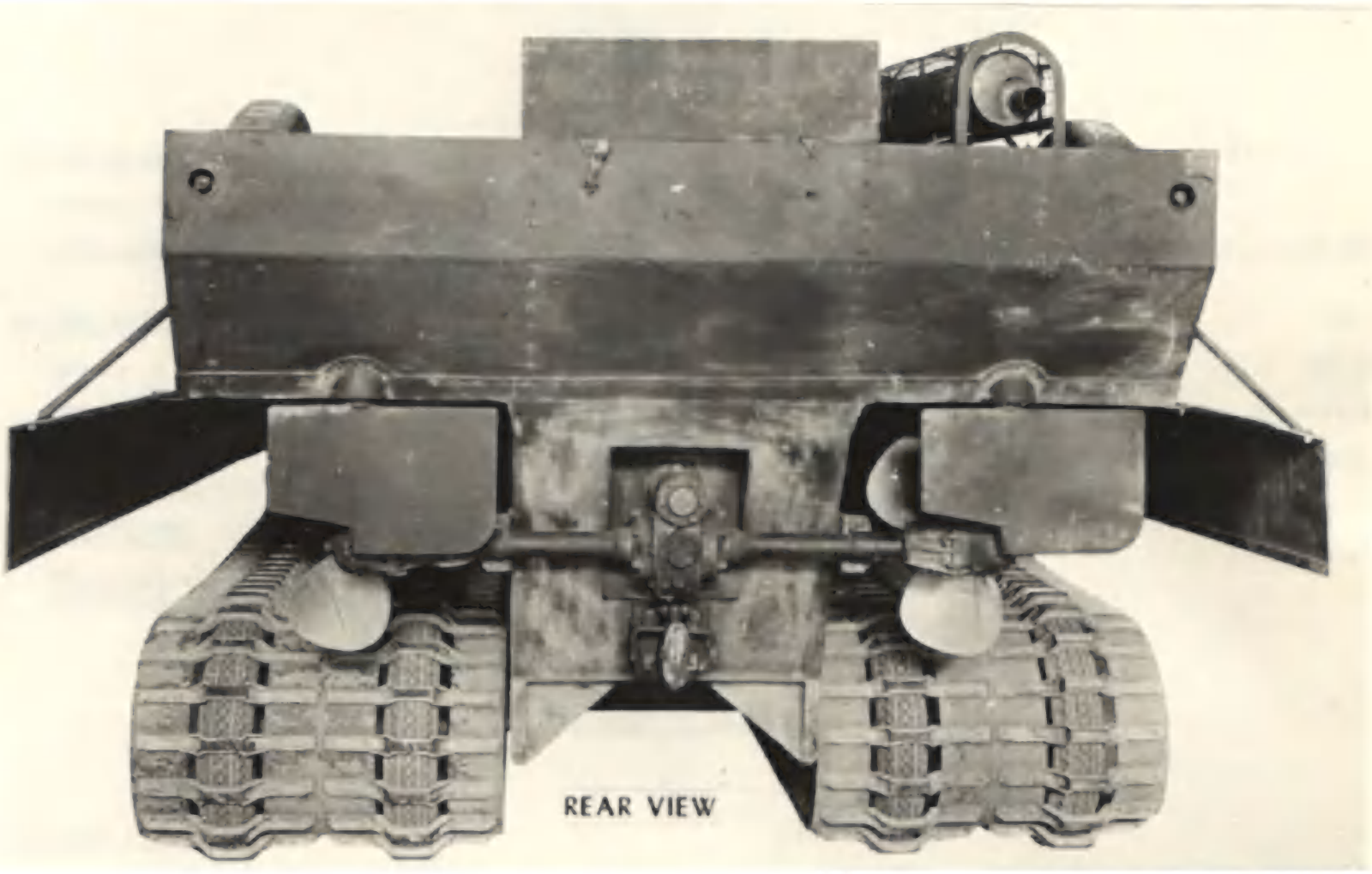
REAR VIEW



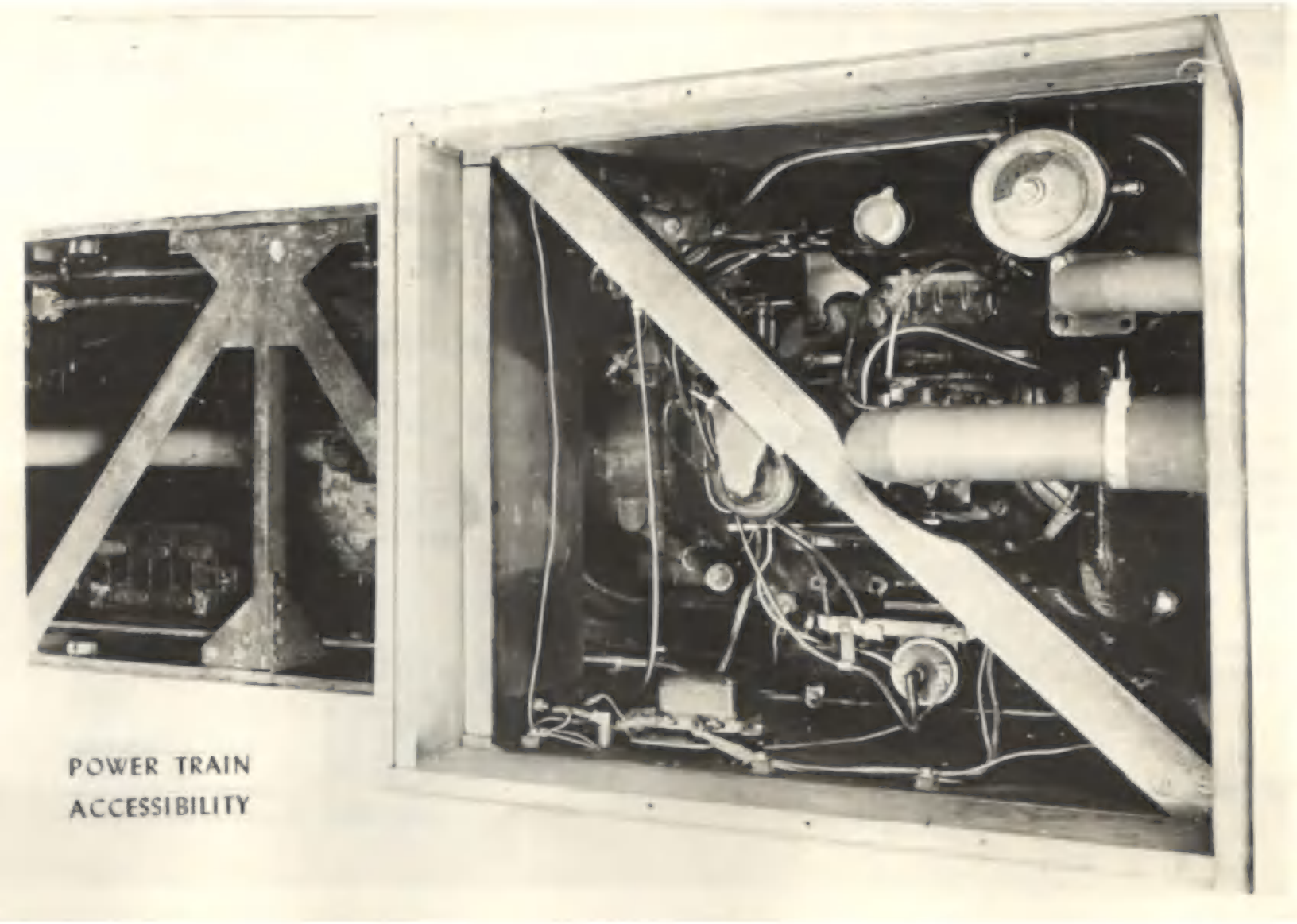
POWER TRAIN
ACCESSIBILITY



¾ FRONT VIEW



REAR VIEW



POWER TRAIN
ACCESSIBILITY

MUSKRAT, LOAD CARRIER, AMPHIBIOUS, PILOT MODELS

TECHNICAL DATA

PRODUCED BY:

Farand & Delorme Ltd.

PRODUCTION:

Commenced: 1945
Finished: 1946

NO. VEHICLES PRODUCED: 4.

TYPE:

Full tracked. Driver centrally located in front of vehicle.

BRIDGE CLASSIFICATION: 5.

CREW: 1 - Driver only.

ARMOUR: Nil.

GUN MOUNTS: Nil.

ARMAMENT: Nil.

SIGHTING: Nil.

PROTECTED VISION: Nil.

COMMUNICATION: Nil.

COMPASS: Nil.

LIGHTING:

Two Spot Lamps; Two Tail Lamps; Two Inst. Panel Lamps.

PERFORMANCE DATA

POWER/WEIGHT:

Laden : 21.4 B.H.P. per short ton (laden weight into gross B.H.P.)
Unladen: 27.6 B.H.P. per short ton (unladen weight into gross B.H.P.)

GROUND PRESSURE:

Laden : 2.02 lbs. per sq. in. at approx. 2 ins. ground penetration.
Unladen: 1.57 lbs. per sq. in. at approx. 2 ins. ground penetration.

GROUND CLEARANCE: 12 ins.

GRADEABILITY:

Theoretical 86% (Laden)
Theoretical 111% (Unladen)

MINIMUM TURNING RADIUS: 38 ft. 6 ins.

SPEED, MAXIMUM:

30 M.P.H. on land; 3.5 M.P.H. in water approx.

TRENCH CROSSING ABILITY: 5 ft.

VERTICAL OBSTACLE CLIMBING: 26 ins.

FORDING DEPTHS: Amphibious.

CRUISING RANGE: Optimum - 225 miles.

FUEL CONSUMPTION: Optimum - 4.5 m.p.g.

OIL CONSUMPTION: 400 m.p.g.

MECHANICAL DATA

UNLADEN WEIGHT:

10,350 lbs. (Driver and normal equipment).

LADEN WEIGHT:

13,350 lbs. (Unladen weight plus 3000 lbs. payload.)

OVERALL DIMENSIONS:

Height -	Windshield and Tarpaulin in place	93 ins.
	Windshield and Tarpaulin stowed	79 ins.
Length -	Flotation Cell out	207 ins.
	Flotation Cell in	189 ins.
Width -	Out to out dust guards	111 ins.

WHEEL BASE:

93 ins. (c to c front and rear bogie wheels at curb weight).

CENTRE OF GRAVITY:

Midway between front and rear suspension pivots.

ENGINE:

Location	-	Rear
Make	-	Cadillac
Model	-	Modified M-5 or M-24 tank
Type	-	90° - V8
Compression Ratio	-	7.06 to 1
Displacement	-	346 cu. in.
Peak Gross BHP	-	143 @ 3600 r.p.m.
Torque Net	-	243 ft. lbs. @ 1400 r.p.m.
Weight of Engine with Accessories	-	1300 lbs.

LUBRICATION:

Engine - Pressure and forced circulation system, except valves which are splash type. Capacity crankcase 7 Imp. quarts. Relief valve opens at 30 lbs. minimum.

COOLING SYSTEM:

Liquid circulating under pressure from a generator belt driven centrifugal pump through the cylinder block and head and fin and tube type radiator core. A pipe from the right cylinder block to the hydra-matic transmission and returning to the water pump cools the oil in the transmission. The oil in the differential is cooled by forced circulation through a separate oil cooler. Total capacity (water or anti-freeze) of cooling system - 28 Imp. qts.

FUEL SYSTEM:

Two sheet steel gasoline tanks, truncated wedge shape, capacity 25 gals. each. Other normal units plus electric fuel pump and primer.

BILGE PUMP:

Centrifugal type; V-Belt drive from direct take-off at rear of engine. Capacity 50 g.p.m. at 4000 R.P.M.

CLUTCH:

Fluid coupling type (part of Hydra-Matic Transmission).

TRANSMISSION:

Hydra-Matic (including fluid coupling type clutch) 4 speeds forward - 1 reverse.
Gear Ratio: 1st speed - 3.26 to 1
(Where M-24 Tank engine is used ratio is 3.92 to 1.)
2nd speed - 2.26 to 1
3rd speed - 1.44 to 1
4th speed - 1 to 1
Reverse - 3.77 to 1

DRIVING MEMBERS:

Tracks: Modified Ford T-16 controlled differential with full floating axle shafts and 1-1/2 g.p.m. gear type oil pump. Drive gear ratio 5.83 to 1.

Propellers: Special V-Belt drive from drive shaft connected to rear of engine crankshaft to jaw clutch behind fan and thence through worm and worm gear to cross-shafts enclosed in housing outside rear of hull. From cross-shafts through spiral bevel gears to two propellers 20 ins. diameter, left and right screw, operating in opposite senses. Total reduction: 4 to 1 in worm gear.

STEERING BRAKES:

Contracting shoe type controlled by steering levers.

STEERING RUDDERS:

Two rudders located at rear of vehicles in propeller slip-stream. Partially balanced with about 1/3 leading and 2/3 trailing area.

SPROCKETS:

Location	-	Front
Number	-	4 each side
No. of Teeth	-	10
Effective Pitch Dia.	-	12-3/4 ins.

TRACK:

Type	-	Three rubber belts (2 narrow, each 5-3/8 ins. in width; 1 wide - 10-5/8 ins. in width) fastened together in parallel by cross links at a pitch of 4 ins. with reinforcement cleats under bolt-heads.
No. per Veh.	-	2
No. of Cross Links per track	-	142 (2 used each pitch lead)
No. of Reinforcement Cleats per track	-	276 (no cleats used either side of track connecting pins).
Width Track	-	35 ins.
Length Track	-	23 ft. 8 ins.
Tread	-	65 ins. (c to c track)
Grousers	-	Integral with cross links.

SUSPENSION:

Two front bogie suspension units mounted on a rigidly supported cross tube and two rear bogie suspension units mounted on individual brackets which are movable in their guides for the purpose of track adjustment. Each bogie suspension unit has two main compression springs mounted on pushrods between opposed front and rear bogie arms. The front bogie units have heavier springs installed to compensate for additional loads imposed on front bogies. Compression springs, retained by hooked rods are slung between front and rear suspension assemblies by chains to control articulation.

BOGIE WHEELS:

Eight each side. Wheels are double disc drop centre type with removable side to accommodate 4.50 x 16 Heavy Duty tires. (4.50 x 16 Run-Flat tires may be used alternatively.)

TRACK ADJUSTMENT:

Rear suspension brackets movable individually in support guides by adjusting bolt on each side of vehicle. Tighten adjusting bolt until bottom of track cross link is 2 ins. above the 2nd bogie wheel.

ELECTRICAL:

System	-	12 volts
Batteries	-	One 12-volt 9-plate acid type connected with negative ground - 60 ampere hours at 20 hr. rate.
Starter	-	Delco-Remy 4-brush, 4-pole. Over-running clutch engages pinion with flywheel ring gear by means of solenoid operated shifting mechanism.
Generator	-	Delco-Remy 2-brush, 2-pole, 24 to 25 amps. max.
Regulator	-	Delco-Remy, including cut-out relay, voltage regulator and current regulator.
Coil	-	Delco-Remy, 1-1/2 amperage draw at idling speed.
Condenser	-	Delco-Remy, capacity 0.18-0.23 microfarad.
Spark Plugs	-	A.C. type W104 10 m/m gap .028"-.033".
Distributor	-	Delco-Remy type #1110609 22° automatic advance. Sealed and shielded H.T. leads.
Horn	-	Sparks-Withington Vibrator type.
Lighting	-	Two Trippe S.C. 12-16V, 60 watt spotlights; 2 Tail Lamps; 2 Instr. Panel Lamps.
Circuit Breaker	-	In lighting circuit.

REFERENCES:

D.M.&S. File 73-V-16.

D.M.&S. Photo File G-2.

D.M.&S. Drawing Schedule S-4500-CSK.

ORDER NUMBERS:

MSX-594	1 Vehicle.
AID/GB/2048	2 Vehicles.
CDLV 3540	1 Vehicle.

SUGGESTED IMPROVEMENTS TO MUSKRAT

As manufacture and testing of the 4 Pilot Muskrats proceeded, it became evident that certain design improvements could be effected if time had permitted. Listed herewith are those design improvements which appeared to be worth considering for any future manufacture:-

1. Greater buoyancy required at rear end as compared with front end. This could be effected either by increasing the displacement of the hull at the rear, or reducing the weight of the hull at the front, or both.
2. The propeller diameter could be increased to obtain improved water speed. The hull, as designed, accommodated a propeller 2 ins. greater in diameter than those used, and one such set (22 in. dia.) was made and tested and is to be turned over to Canadian Army along with other vehicle spares. The 22 in. propeller, together with the standard 20 in. propellers, was manufactured by Wm. Kennedy & Sons Ltd., Owen Sound, Ont.
3. Worthy of consideration would be the development of reversing gears for the propeller drive and the use of automotive type clutch with a chain or gear drive to replace the multiple V-belt drive. The V-belts tended to slip when wet or normally slack. Failing the development of friction clutch and positive drive, it would be possible to use the present jaw clutch with a positive drive provided some shear pins or slip joints were introduced in the system. The present V-belts could be improved by the use of the newly developed wire cable insert type of V-belt which is reported to eliminate stretch, but of course, would not eliminate slip due to wetting.
4. Use steel cable inserts in all track belts to reduce uneven stretch or shrinkage which was sometimes experienced. One pair of belts made thus to drawing A-527b-CSK is to be delivered to Canadian Army with other spares, without test.
5. A general examination of the design should be made to improve the tropicproofing.
6. Wiring harness terminal at engine and instrument panel should be made plug-type to facilitate servicing.
7. The coupling links and pins of the tracks should be chrome-plated on the wearing surfaces to improve life.
8. The bolts joining the wheel rims to the wheel discs should be increased from 1/4 ins. to 5/16 ins. The 1/4 inch bolts had a high incidence of failure when the terrain was rough.
9. Some means of clearing mud from the suspensions as vehicle operated would be desirable. Adequate guards or more open construction would alleviate the situation.
10. The radiator filler cap gaskets should be made more resilient as the present type tended to harden and lose their sealing properties quickly.
11. Present design of rear suspension bracket was a welded assembly. One of these failed on test at 1500 miles. Improvements in this welded design were made on the brackets supplied on the last three Muskrats and all spares. These improvements were not tested beyond the 50-mile break-in run for each vehicle. It is recommended that for quantity production, these brackets should be made from steel casting with a minimum ultimate tensile of 85,000 pounds per square inch, with adequate ductility.
12. Greater free-board is needed on both vehicles, particularly at the rear, to take care of even moderate surf, such as encountered on rivers and lakes up to 1/2 mile in extent.
13. After test, it was found that a screen over the bilge pump inlet was desirable to prevent the cumulation of leaves, etc., from blocking the pump. All vehicles, except No. 1 Muskrat (A.E.D.E.) had the screen incorporated during production. It is recommended that before any extensive use of the above vehicle is made, that personnel either fit a screen or make sure that there is no debris in the bottom of the hull which could block the pump.
14. After all the parts of the propeller drive mechanism had been manufactured, it was found that the pilot bearing at the forward end of the worm shaft burned out due to misalignment of the worm shaft with the pulley. Since there were already two main

bearings supporting the worm shaft, it was decided to delete the pilot bearing (New Departure #88584) as it was not considered essential. Details were not otherwise changed so that the bearing may be put in again if extensive testing proves the need, and if the flexibility of the pulley bracket will permit satisfactory alignment.

15. The boards of the flotation cell should extend approximately 6 ins. higher at the front end to take care of the plunge when entering the water.

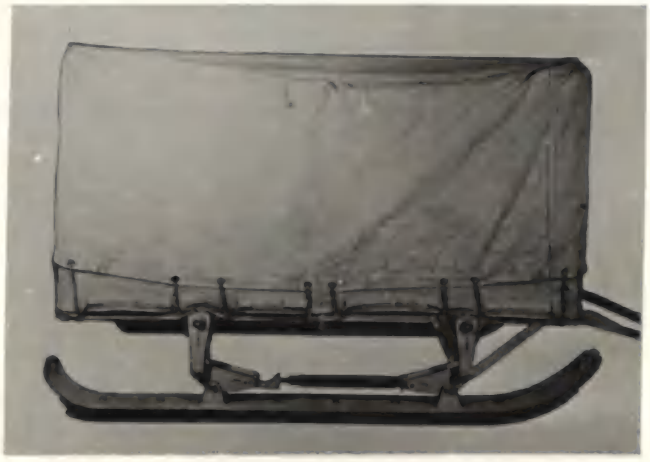
16. The canvas sealing pieces for the flotation cell were made in two pieces which were lapped and bolted together at the center of the cell. This lapped joint should have been stitched or the two pieces should have been made as one.

17. Heavier chains and hardware for supporting the open loading doors should be provided. This would ensure against failure in the event of heavy concentrated loads being dropped on the open door.

18. The Rudder Control Mechanism needs some means of indicating rudder position. The present method of centering the rudders "blind" is to rotate the hand wheel through the full travel of the control cables (about 4 turns) and then turning back about halfway (2 turns). A simple gear and indicator hand attached to the forward end of the handwheel shaft is suggested.

TRAILED SNOW VEHICLES

TRAILER SLED



The Ministry of Supply in 1943 had a requirement for a considerable number of light weight sleds to be used with snow traversing units such as the U.S. Weasel and the Armoured Snowmobile. Army Engineering Design Branch were asked to develop a suitable design as light as possible and suitable for transporting 1200 pound payload. The length of the body was to be 6'-0".

Two experimental units were built each of which weighed slightly more than 500 pounds. Two skis were used on each and were supported on the one unit by Semielliptic Springs while on the other coil springs were used.

The Ministry of Supply were advised of the weights and the results of tests. They felt that the unit was much too heavy and set a target weight of 350 to 400 pounds, a weight considered to be the maximum two or three men could manhandle in snow.

Accordingly a third unit was built with lighter components and of less length, using the coil spring suspension. It weighed approximately 380 pounds.

All three pilots were tested during a season without snow, payloads of 1500 to 2000 pounds, on hard roads, swamps, boulders etc. The light vehicle failed in its components; the laminated spring vehicle did not give as good a ride as the coil spring unit. The User's insisted that the deck length of 6'-0" was necessary.

An order was placed for 2200 units which were fitted with a 6'-0" x 3'-0" deck, 2-coil springs - supported skis, laminated plywood platform, pipe rail side walls, Tarpaulin Superstructure and Valance.

SKIS

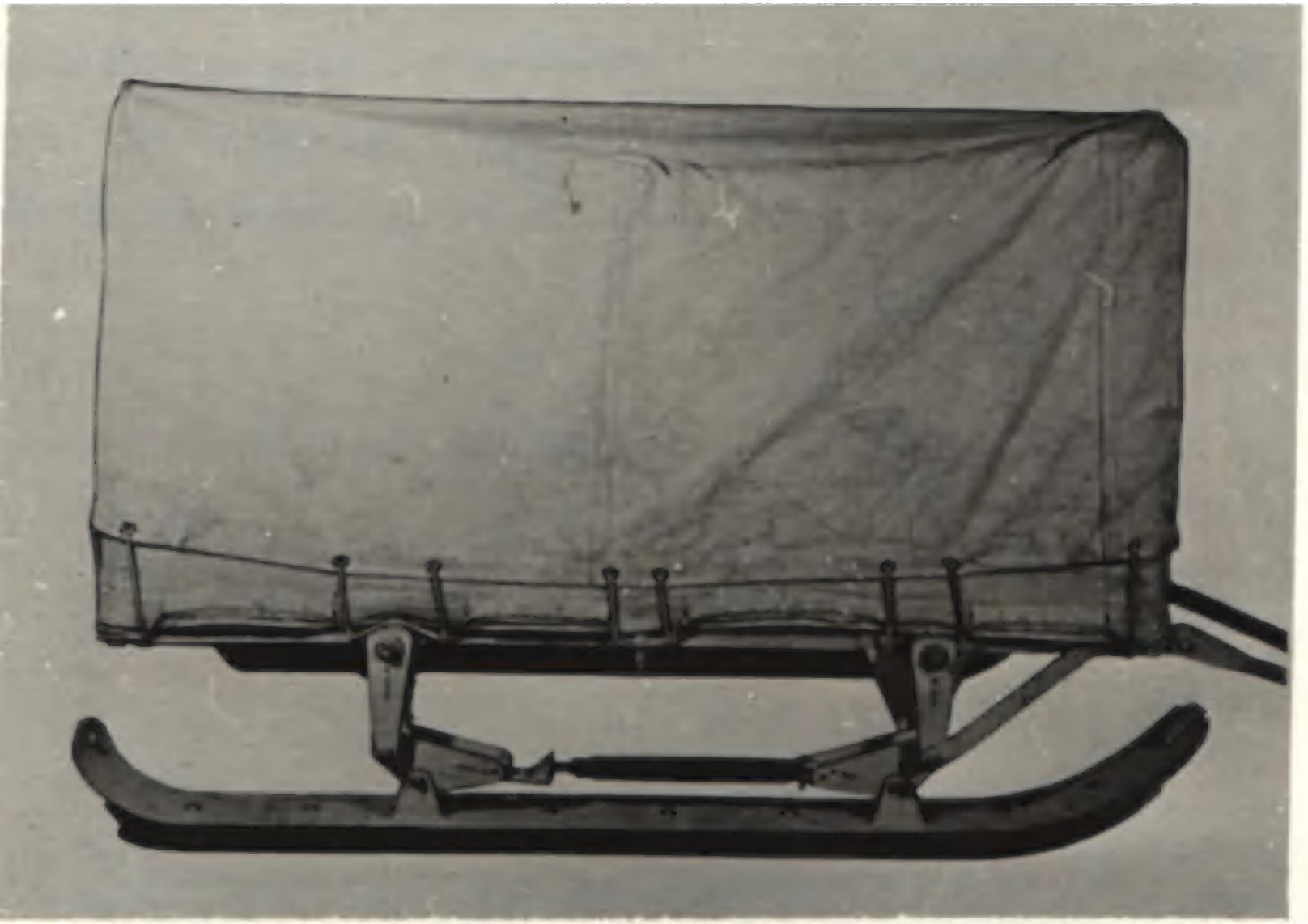
Two skis were provided, one on either side outboard mounted, the design of which was based on the Bombardier Half Track Snowmobile Skis, with the necessary modifications for application to the Trailer Sled. Round guide rods were not provided at the lower face of the ski.

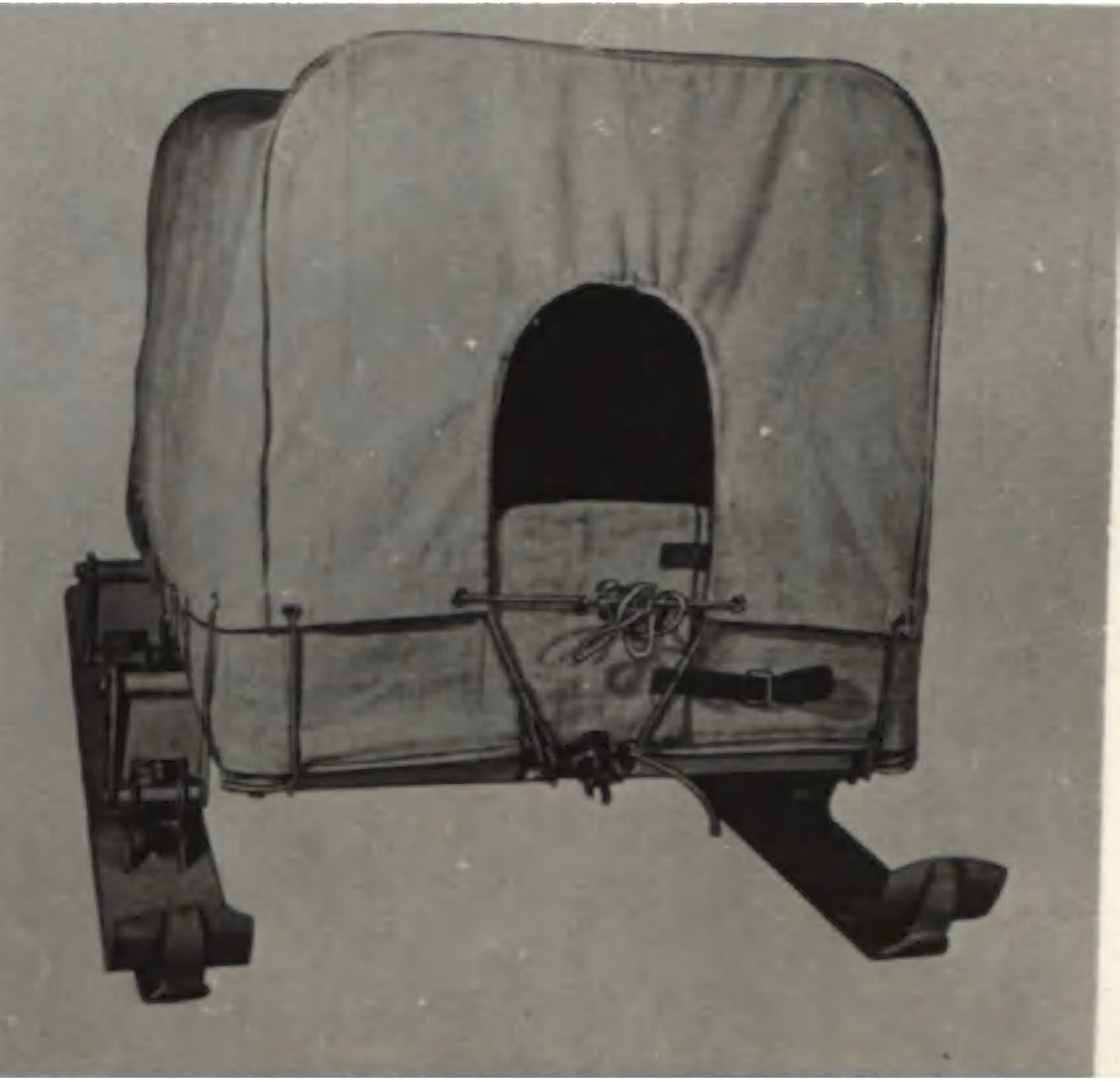
PLATFORM

The platform deck was flat with a curved forward edge for rising over obstructions. It consisted of a steel frame with a laminated wood top and a light gauge steel bottom. The intermediate cross sills were timber.

SUPERSTRUCTURE

A light steel tubular railing and bows formed a superstructure. These were made removable for compact shipment. One ridge pole was centrally located to support the tarpaulin.





TARPAULIN AND VALANCE

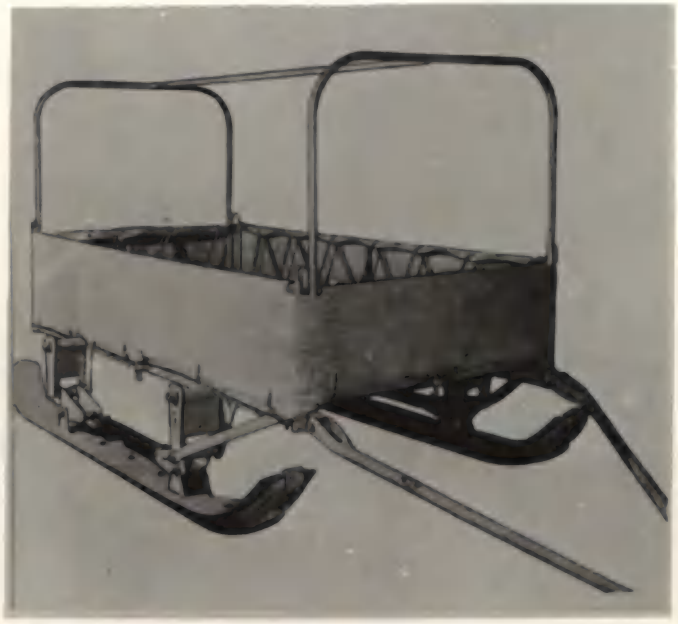
The lower railing was fitted with a duck Valance and a complete Tarpaulin was provided to cover both valance and superstructure. An opening was provided at the rear for entrance when the Tarpaulin was in place. Suitable lashing ropes and hooks completed the assembly.

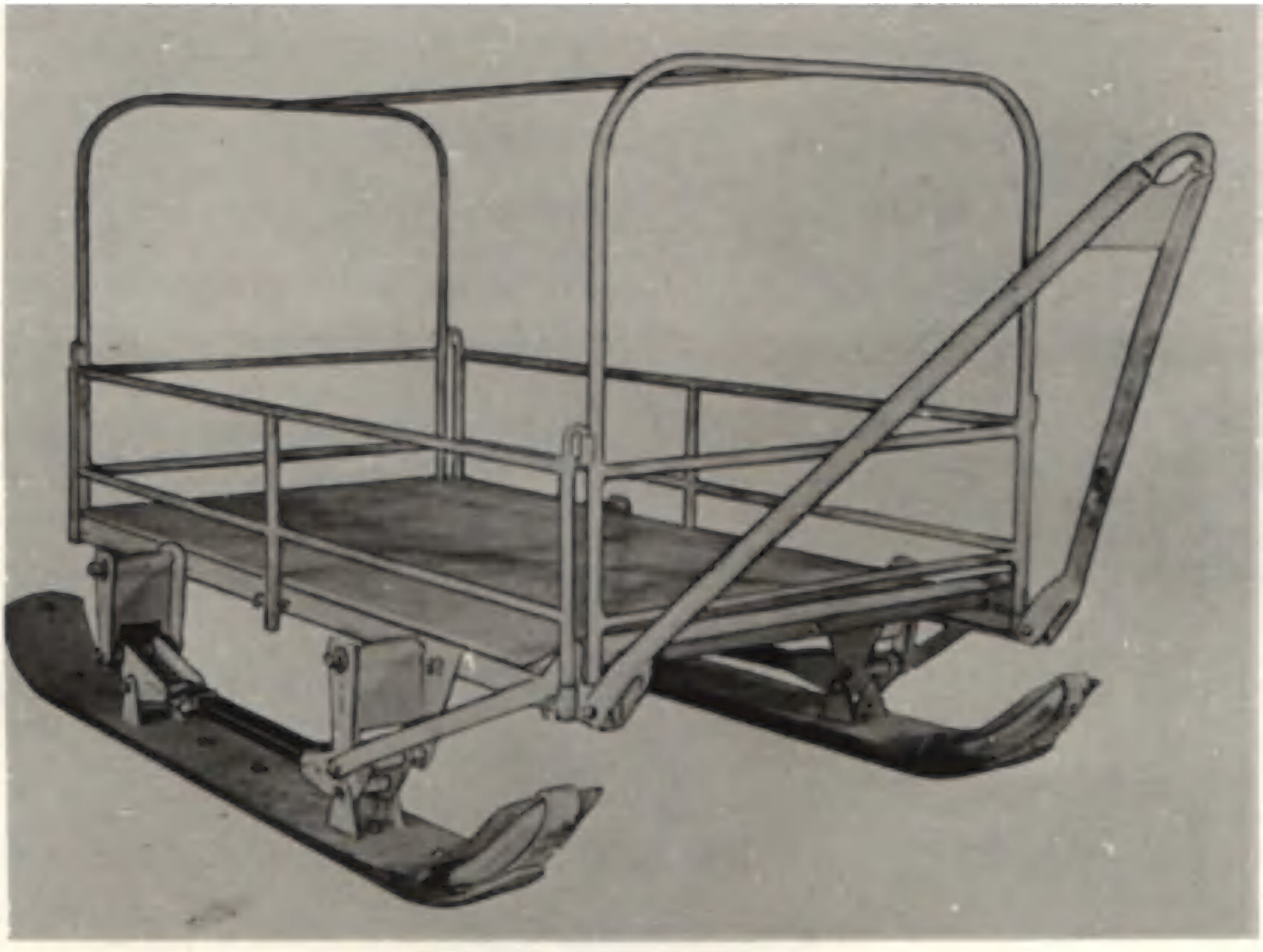
TOW BAR

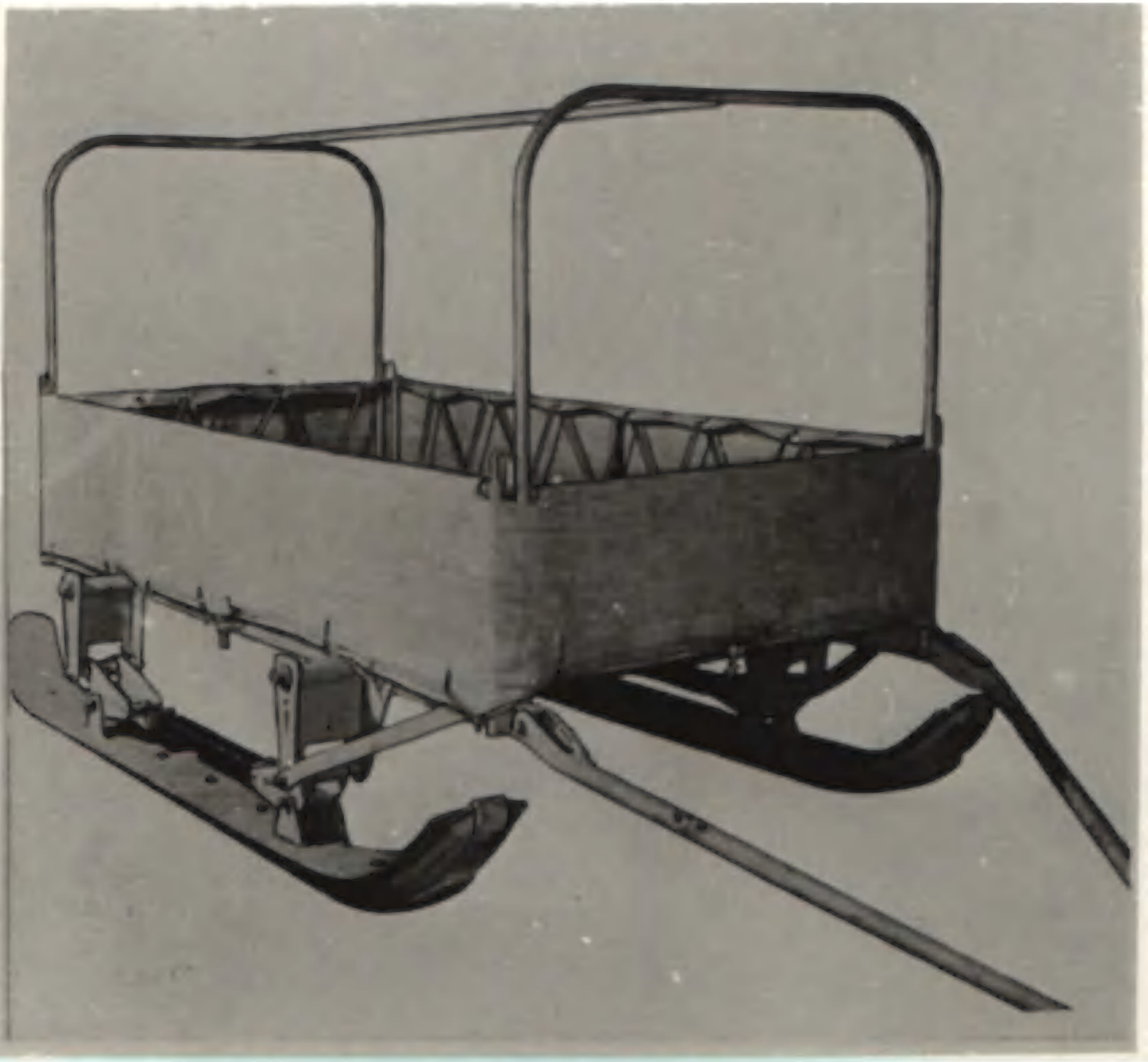
A steel tubular 'V' tow bar was hinged to the front of the deck. The bar was fitted with a fixed lunette eye, suitable for attaching to the Weasel tow hook. Early tests indicated the hinge point should be as low as possible to "lift" the front end up rather than "dig in".

TOW HOOK

To facilitate operation "in train" each trailer sled was fitted with a rear tow hook.







TECHNICAL DATA

PRODUCED BY:

Frost & Wood, Smith Falls, Ont.
Dominion Bridge Co., Toronto, Ont.

PRODUCTION:

Commenced: 1944
Finished: 1944

NO. VEHICLES PRODUCED: 1500.

SERIES: 1C-F-SLED-1.

TYPE:

General Purpose, flat platform with removable open-frame sides and ends. Carried on two full length skis. Removable fitted tarpaulins completely enclosed sled for adverse weather conditions.

MAJOR CHANGES INTRODUCED DURING PRODUCTION:

1. The method of attaching sled valance (lower tarpaulin) to platform to eliminate a padded section used to make the lower edge around the end of the sled platform weathertight, in favor of a double flap arrangement fastened to the same edge. Difficulties in production manufacture of first design made change highly desirable.

2. Suspension members exclusive of spring, considerably strengthened for longer life.

MECHANICAL DATA

UNLADEN WEIGHT: 500 pounds.

LADEN WEIGHT: 1700 pounds.

DECK DIMENSION: 6'-0" x 3'-0".

OVERALL DIMENSIONS:

Length, to tip of Tow Bar	:	118.25" (approx.)
Without Tow Bar	:	80.5 " (approx.)
Width,	:	49.5 " (approx.)
Height,	:	51.5 " (approx.)

SKIS:

Composite construction, consisting of a steel "snow shoe" plate, wooden key-strip and steel shoe.

Length, overall	:	75.5"
Grd. Contact:		54 "
Width	:	7 "

SUSPENSION:

Two coil springs, - one on each side of the sled, - working between opposed rocker arms which pivot in brackets attached to the skis are shackled to the sled body. The front shackles are rigidly held in a vertical position and the rear shackles are hinged to provide articulation.

PERFORMANCE DATA

GROUND PRESSURE:

Laden	:	2.25 lbs. per sq. in. @ 2" penetration.
Unladen	:	.66 lbs. per sq. in. @ 2" penetration.

GROUND CLEARANCE: 13 ins.

VERTICAL OBSTACLE NEGOTIATED: 7 ins.

REFERENCES:

D.M.&S. File 73-V-16

D.M.&S. Drawing Schedule S-39160

D.M.&S. Photo File G-2

Order Nos. Sply Mech 6133 & CD.LV 3584.

TRACKED TRAILER

From the behaviour of the trailer sleds when pulled behind Snowmobiles, it was apparent that a tracked trailer, possibly amphibious, would be more suitable for cross country freighting on snow covered terrain as well as on muddy terrain and bare ground. In August 1944 the Canadian Army asked Army Engineering Design Branch to design a full tracked amphibious trailer to be capable of carrying about 1500 pounds of general cargo, to be suitable for towing behind the Armoured Snowmobile or the related amphibious vehicles, Mudcat and Muskrat, which were being projected at the time.

The original Tracked Trailer design utilized a single two-wheel tandem bogie track on each side of the hull pivotted on a central tubular support. The bogie was designed to swing through a complete 360° arc. The track was similar to the Snowmobile track and standard Snowmobile tires and tubes were used. It was intended that the tracks be removed and the trailer run on its wheels alone, when a large amount of travel on highways was anticipated. The tracks were to be carried in the trailer or on the towing vehicle, as convenient. A tow bar, fitted with a swivelling eye, was rigidly fastened to the front of the hull. With this arrangement, the tower supported some of the trailer load. When the trailer was detached from the tower, a stanchion arrangement supported the front end.

The performance of the pilot model of this design, however, was unsatisfactory for several reasons:-

(a) In marine operation, the rigid tow bar caused serious fore-and-aft tilting due to the unequal buoyancy of trailer and tower. This was a most serious defect.

(b) The uncontrolled articulation of the two wheeled bogie truck produced an extremely rough ride and made retention of cargo difficult.

(c) The loading door made water-sealing most difficult.

(d) The suspensions were complicated and too heavy in the amphibious role.

(e) The body lacked roominess and was heavy for its displacement.

In May 1945, a revised design was developed incorporating:-

(a) Same wheels and track as original design.

(b) Each of the four wheels was independently sprung.

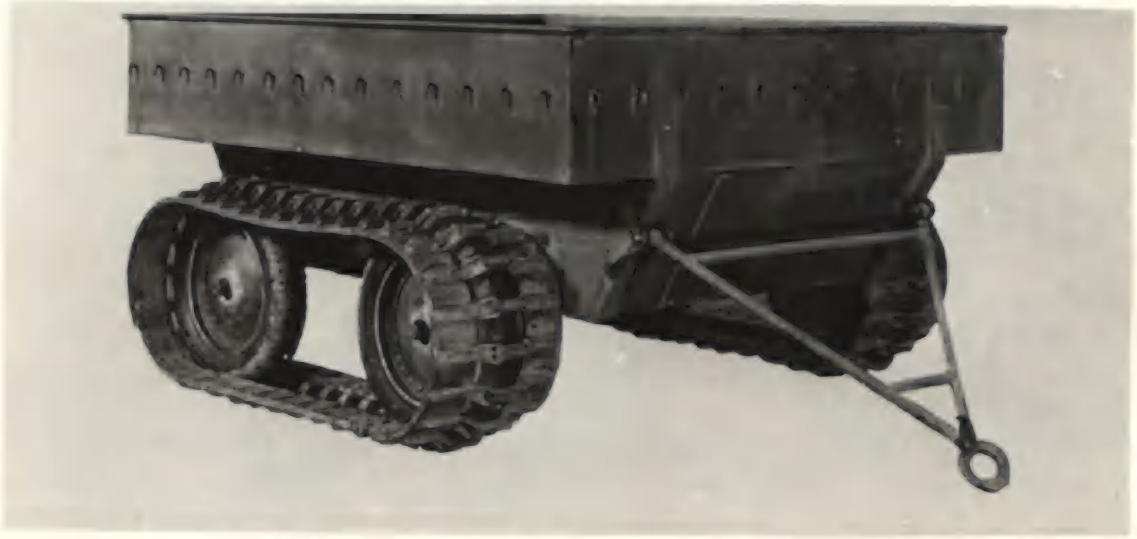
(c) A pivotted tow bar.

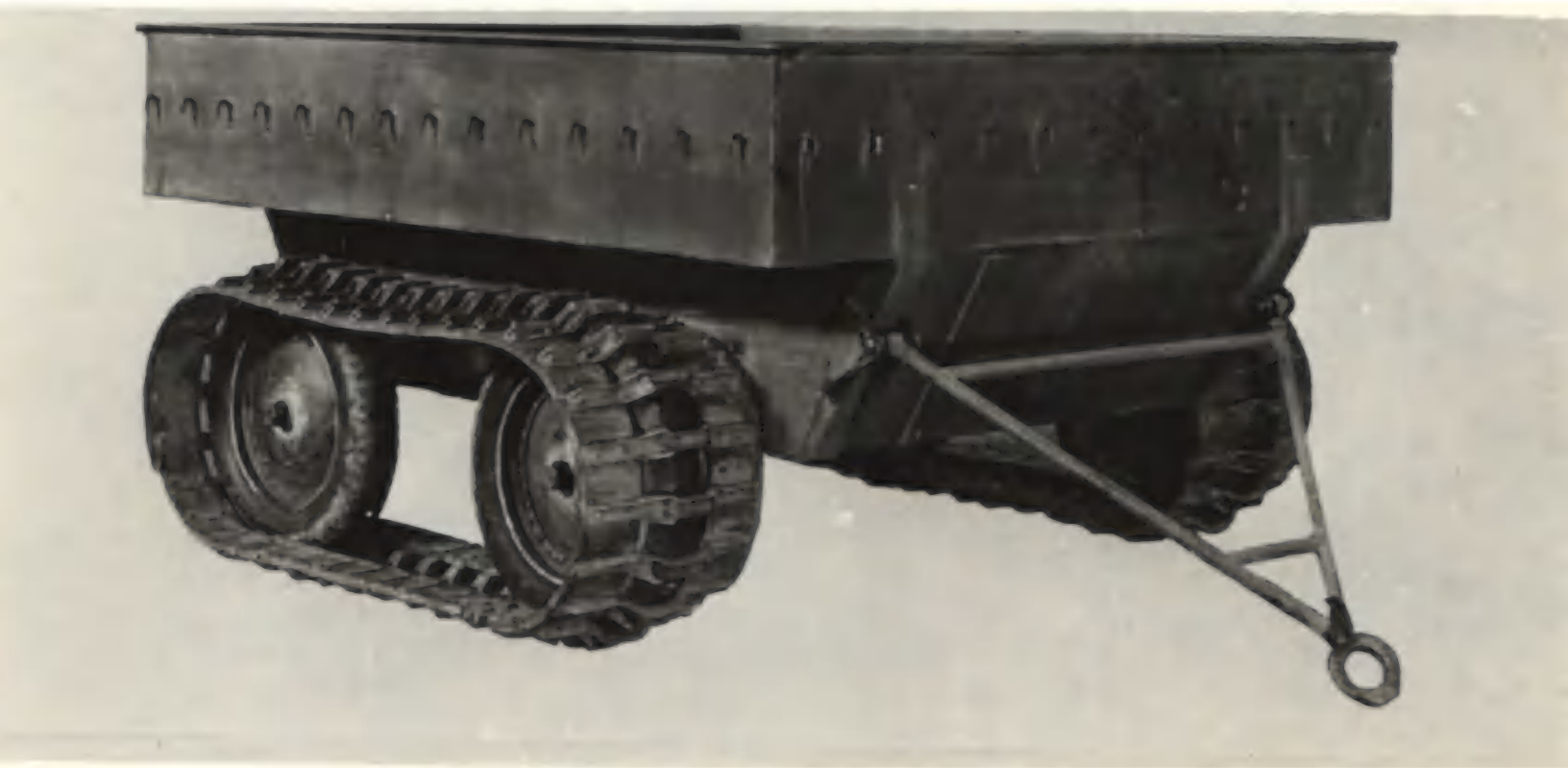
(d) Greater body capacity obtained by extending sponson plates out over the track.

(e) Buoyancy versus weight ratio improved.

The pilot model made from this second design proved satisfactory from an operational standpoint but mechanical defects showed up in (a) Tow Bar, which was too short and caused fouling of tower on sharp turns; (b) The two main suspension links and the suspension cage (frame) showed structural weakness, and (c) the tarpaulin required more overlap with body to ensure surf-proofness.

The final design as released for production included revisions to eliminate these defects but proving of the revised components had not been done at the time of writing.





Details of the production design were as follows:

1. Suspensions:- Torsion bar suspensions were first considered but it was soon realized that considerably more time than was available woule be required to develop and manufacture, a satisfactory torsion bar. Consequently, the scheme was dropped in favor of a transverse parallelogram type of suspension similar to that used on the Bofors Light-pattern Gun Trailer.

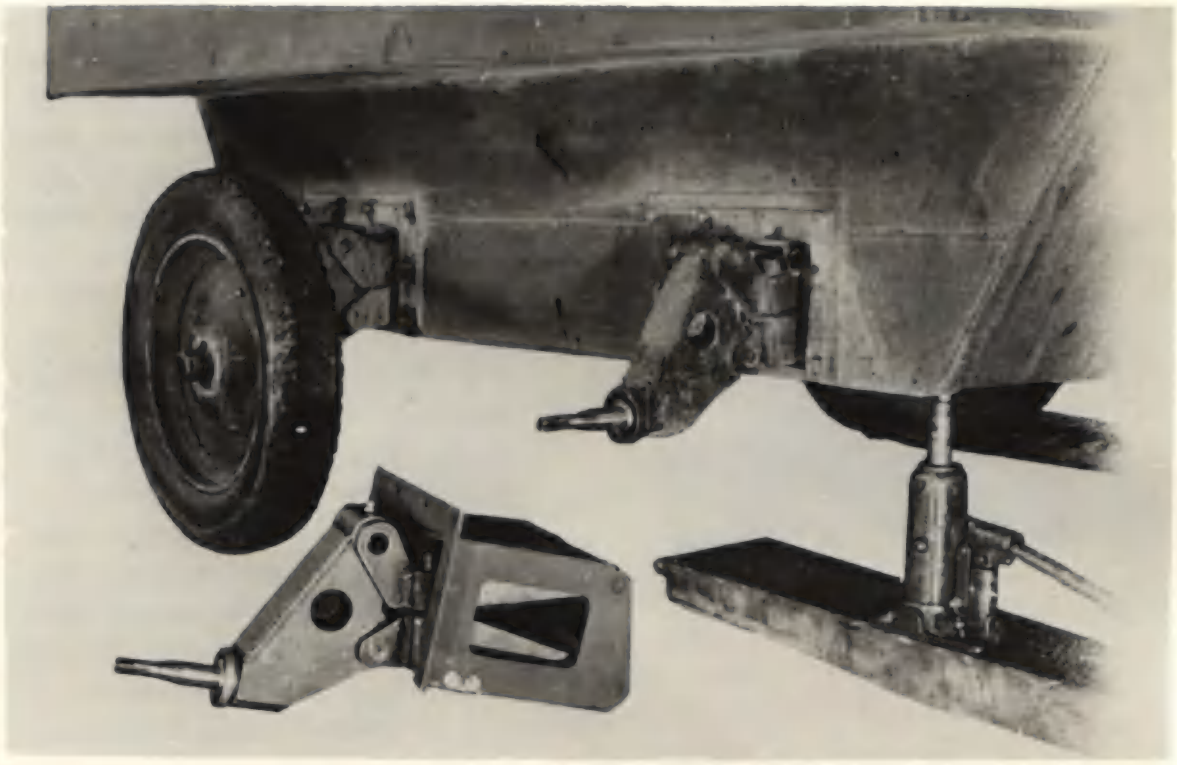
   This design, consisted of two horizontal arms working in a "cage" pivoted at the inside end of it, with a compression spring retained between the lower arm and the top of the cage. The outer ends of these arms supported the carrier for the bogie wheel spindle to which they were pinned to form the outer end of the parallelogram. This arrangement permitted the bogie wheel under load to move vertically approximately 2 ins. against the spring, and provided only enough articulation to protect the components against undue road shocks. Four suspensions were provided, one at each corner of the vehicle; bolted individually to the hull, with no provision being made for track adjustment. The complete suspension was attached to the hull by bolting through a flange on the "cage".

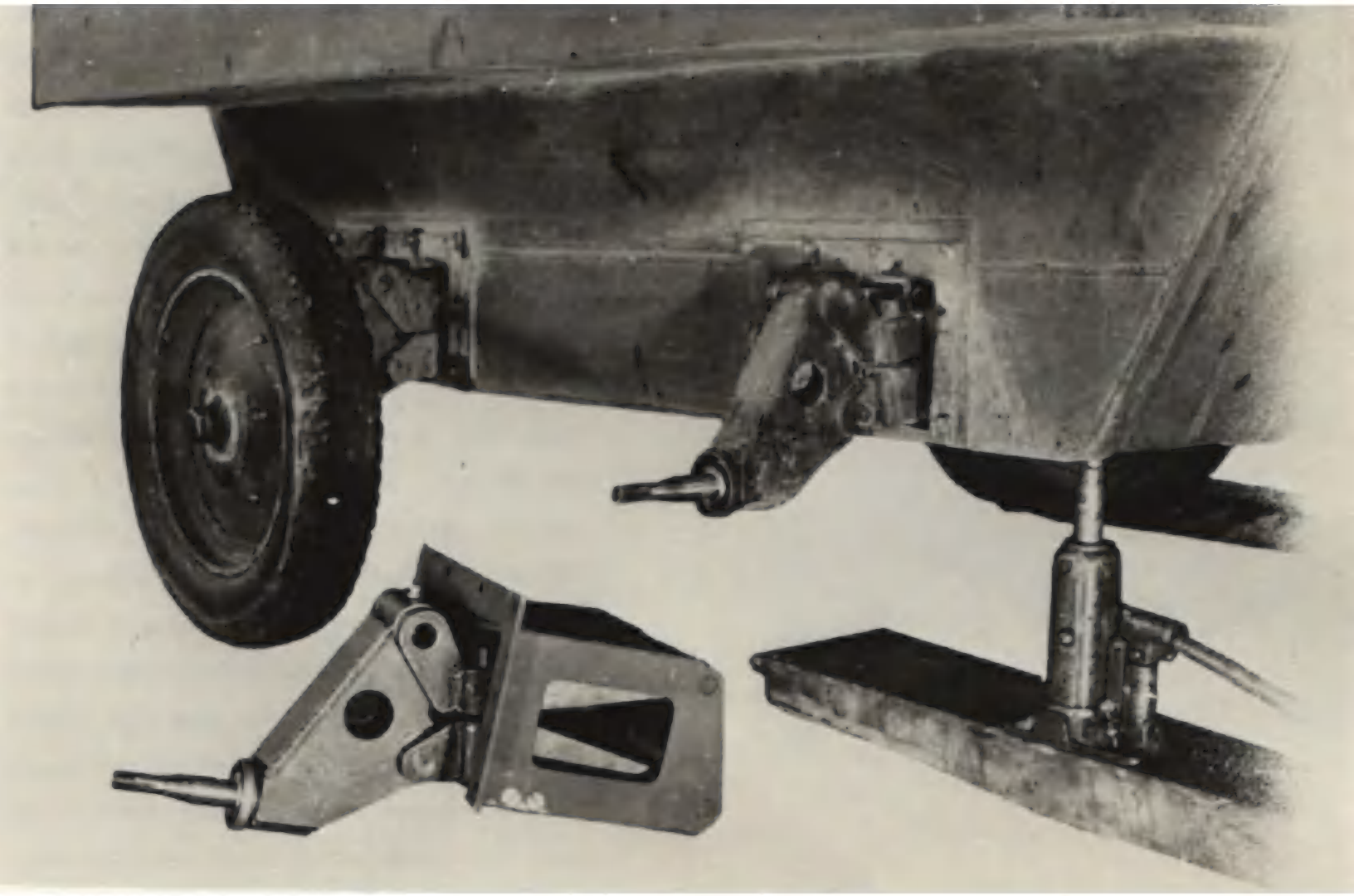
   On cross-country test, some twisting of the arms was encountered, particularly on the front suspensions, possibly due to impact of the wheels against the edges of pot-holes too deep for the wheels to climb over. To overcome this trouble, the design of the arms and cage was revised before being released for production.

   The bogie wheel and tire assemblies were 4.50 x 16 as on the Armoured Snowmobile and Mudcat. Self-locking nuts were used on the rim bolts. The tapered roller bearings supporting the wheels were the same as the Snowmobile and Mudcat pattern.

   Run Flat tires was specified. The run-flat tire with its stiff side walls maintained its shape so that there was little danger of losing the track should the tires become deflated. Rubbing strips were attached to the suspension cages to prevent track edges from being scuffed by the bolt heads of the suspension attaching stock.

2. Tracks:- In the track design, interchangeability with the Snowmobile, Mudcat and Muskrat track components was considered. The two rubber belts in each track conformed both in construction and dimensions, except length, with the narrow belt of the Snowmobile track. The cross links, belt bushings, reinforcement cleats, track





couplings, and track bolts were the Snow-mobile design. Inasmuch as the track on the trailer did not have to transmit any torque, but acted only in a "snow-shoe" capacity, reasonable life expectancy would result. Tests conducted so far gave every indication that this will be the case. In spite of any slewing of the trailer behind the tower, the track had no tendency to throw.

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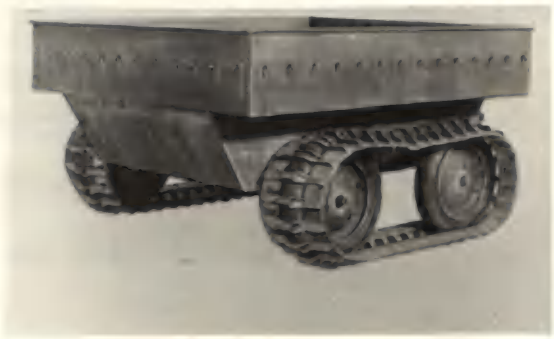
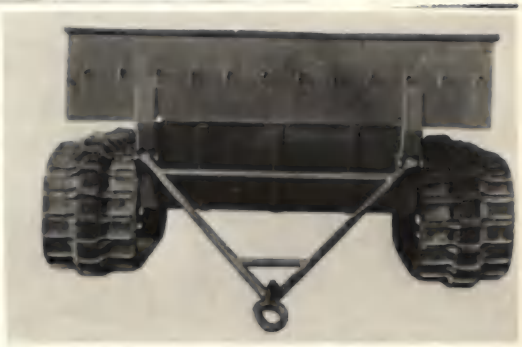


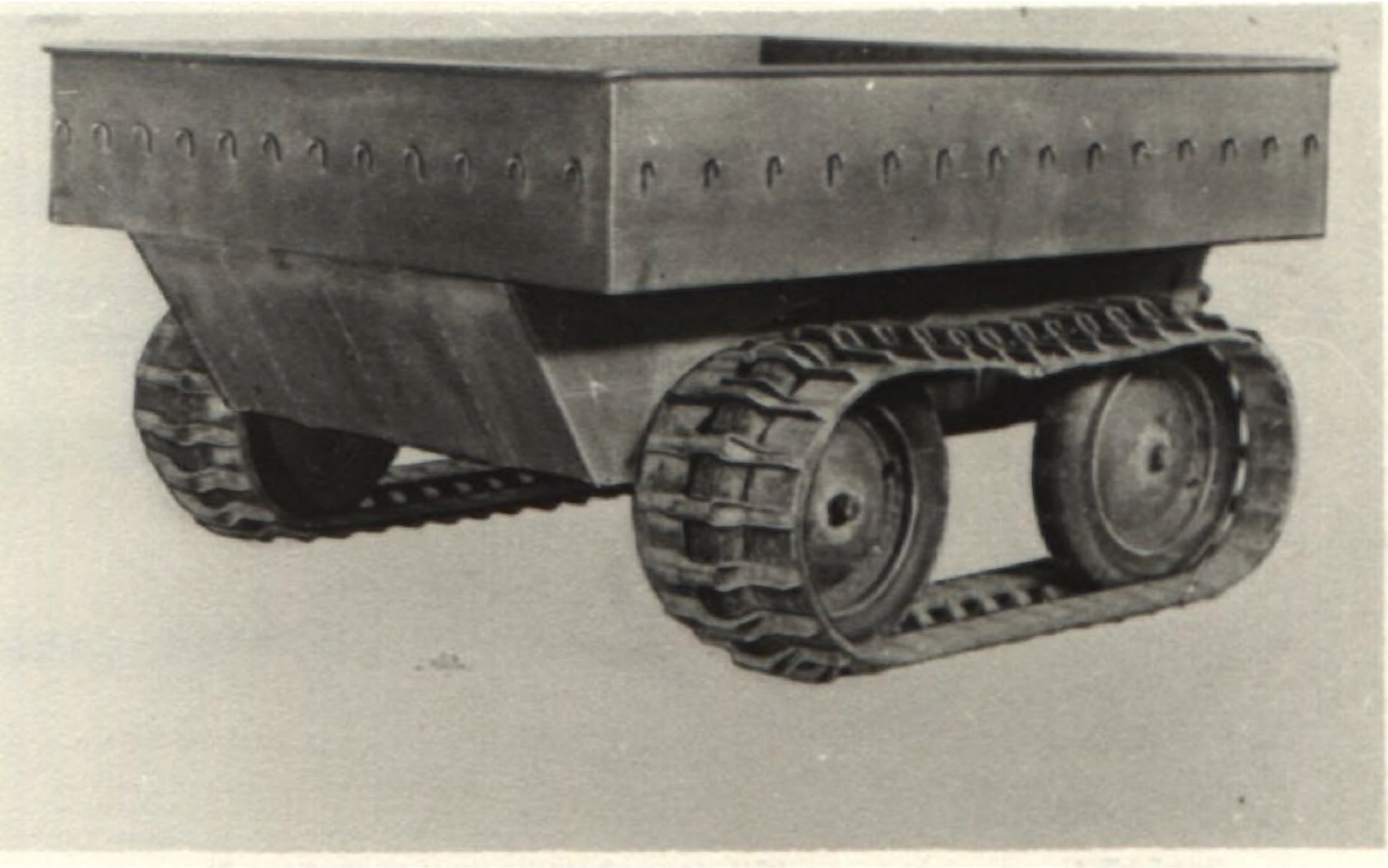


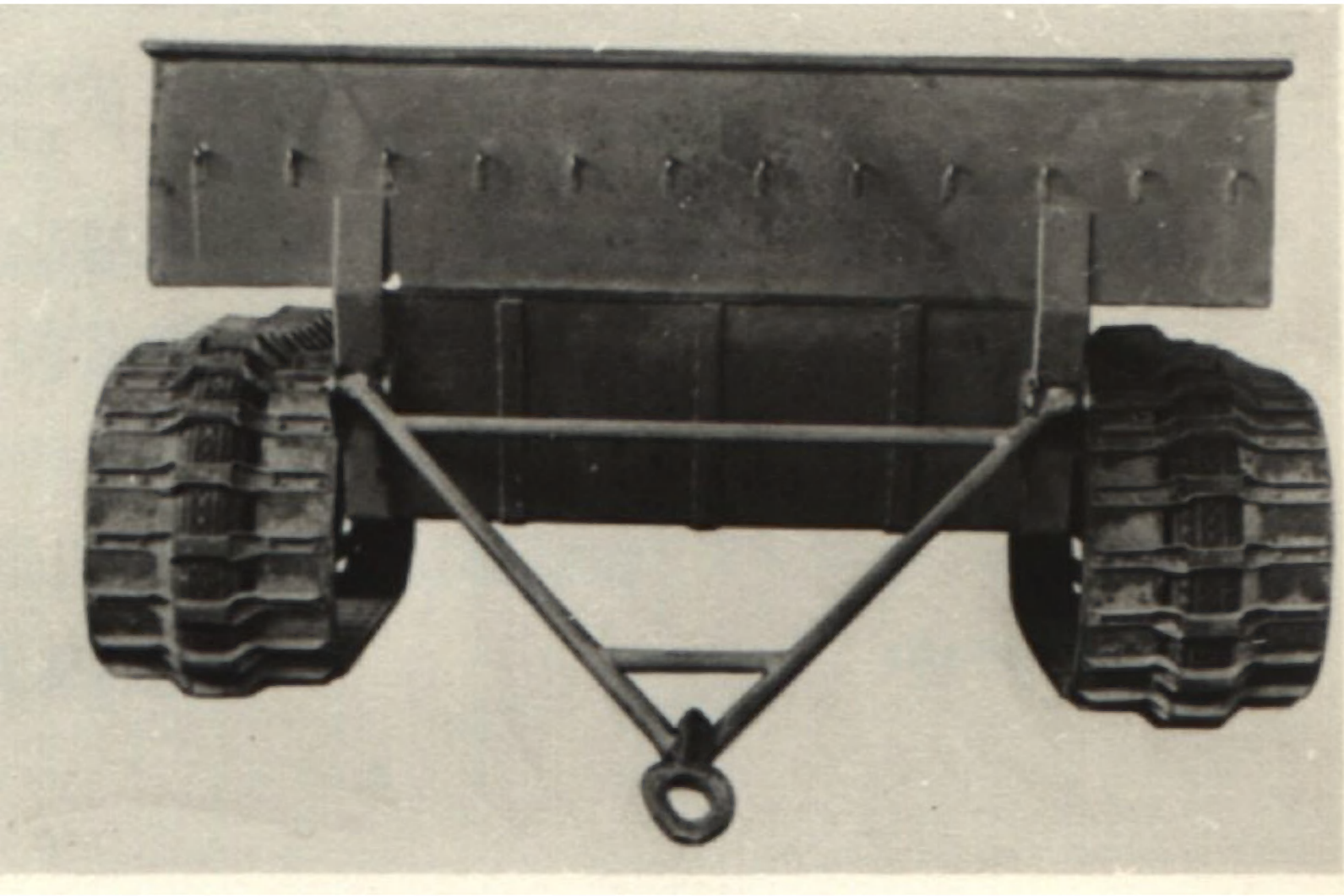
3. Body:- The body consisted of, a rectangular metal box of 10 and 12 gauge mild steel plate with 'U' shaped base and with an overhang above the bogie assemblies on each side. The front and rear lower faces were inclined outward. For simplicity of design and weight-saving, no loading door was provided; the loading being done over the top edge of any of all sides. The hull had a double floor. The space between floors was sealed off as a buoyancy chamber and also formed a box girder to resist distortion. Drain Plugs were provided in the rear of this chamber and in the rear of the load compartment, so that water seepage could be drained off.

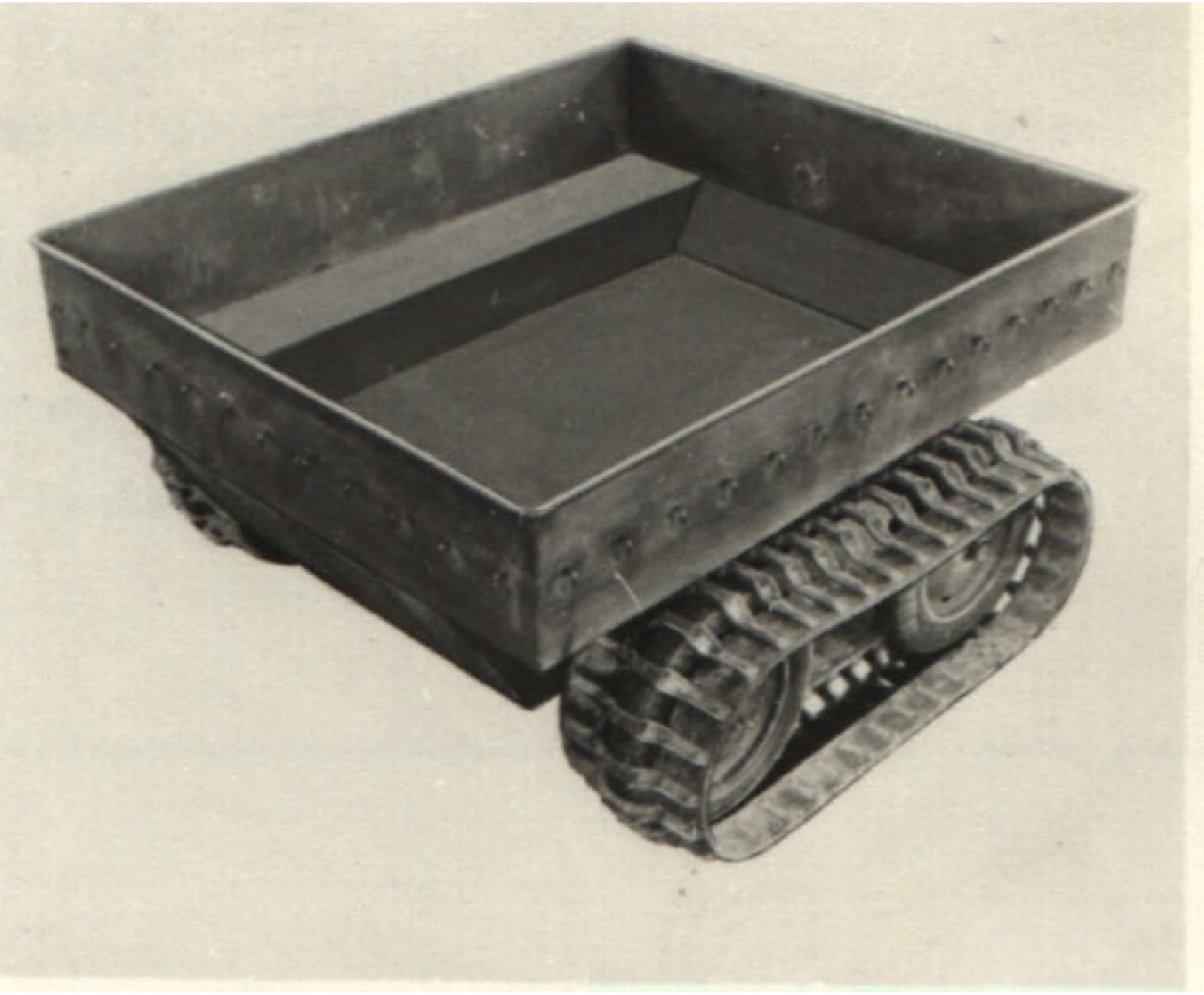
4. Tow Bar:- Since the trailer had four separately sprung wheels it was possible to pivot an A-frame tow bar to the trailer and thus allow trailer and tower to each find its own level in the water without tilting the trailer. The Tow Bar was a welded assembly of steel tubing with two transverse bushings at the trailer end and a single longitudinal bushing at the tower end. Careful attention was given to the connection details to eliminate, as far as possible, eccentric loading at the welded joints. A substantial swivel lunette eye was provided for connecting the towing vehicle. Tests of the first pilot model to this design indicated: (a) a need for a longer tow bar to allow short radius turns without fouling the tower, to allow travel through deep pot-holes without fouling the tower, and to increase the distance between tower and trailer to minimize the reaction and slewing effect of propeller back-wash; (b) heavier walls on steel tubing. Each of these modifications were incorporated in the design as released for production.

5. Towing Hook:- A standard D.N.D. tow hook was mounted on the rear of the trailer to allow use of trailers in Train.

6. Tarpaulin:- A rectangular tarpaulin of No. 12 treated duck was provided with each vehicle. This tarpaulin had fitted corners and more than the usual number of lashing eyes and lashing ropes, to ensure extra snug coverage of the body and to forestall swamping when being towed in water.







TRACKED TRAILER

SPECIFIC TECHNICAL DATA

PRODUCED BY:

Cusson Freres Ltd., Montreal.

PRODUCTION:

Commenced: November 1945.
Finished: December 1945.

NO. VEHICLES PRODUCED: 15.

TYPE:

General Service.

PERFORMANCE DATA

GROUND PRESSURE:

Unladen: 1.23 lbs. per sq. in.
Laden : 2.38 lbs. per sq. in.

GROUND CLEARANCE: 14.5 ins.

TRENCH CROSSING ABILITY:

18 ins. (with uniform loading).

VERTICAL OBSTACLE CLIMBING: 12 ins. (approx.)

FORDING DEPTH: Amphibious.

MECHANICAL DATA

WEIGHT:

Unladen: 1590 lbs.
Laden : 3090 lbs.

OVERALL DIMENSIONS:

Length	-	138.5 ins. overall 86.5 ins. without Tow Bar & Tow Hook.
Wheel Base	-	38 ins.
Height	-	46 ins.
Width	-	84 ins., overall tracks
Tread	-	66.5 ins. centre to centre of tracks.

TRACK:

Type	-	Two flat rubber belts in parallel held together by pressed steel cross links. (Construction similar to track of Snow-mobile, Armoured, Mk.I)
No. of Cross Links per Track	-	36
Width of Track	-	17.5 ins.
Length of Track	-	12 ft. including track joint.

SUSPENSIONS:

Type	-	Transverse parallelogram typw with single compression spring and one bogie wheel per suspension; two suspensions per side.
Bogie Wheels	-	4, with 4.50 x 16 "Run Flat" tires.

REFERENCES:

D.M.&S. File 73-V-16 Series.

D.M.&S. Drawing Schedule S-4000-CSK.

ORDER NUMBER:

CDLV 4529 - 15 Jobs.

PHOTOGRAPHS & MOTION PICTURES

A large quantity of photographs of mud-snow vehicles has been taken, covering development, test and certain exercises. The majority of these may be found in Photo File No. G-2. This file includes a binder of positives and an envelope of negatives.

Motion pictures of development tests also exist.

In addition, many photos and motion pictures were made during D.N.D. exercises "Lemming", "Eskimo" and "Polar Bear" of 1945.