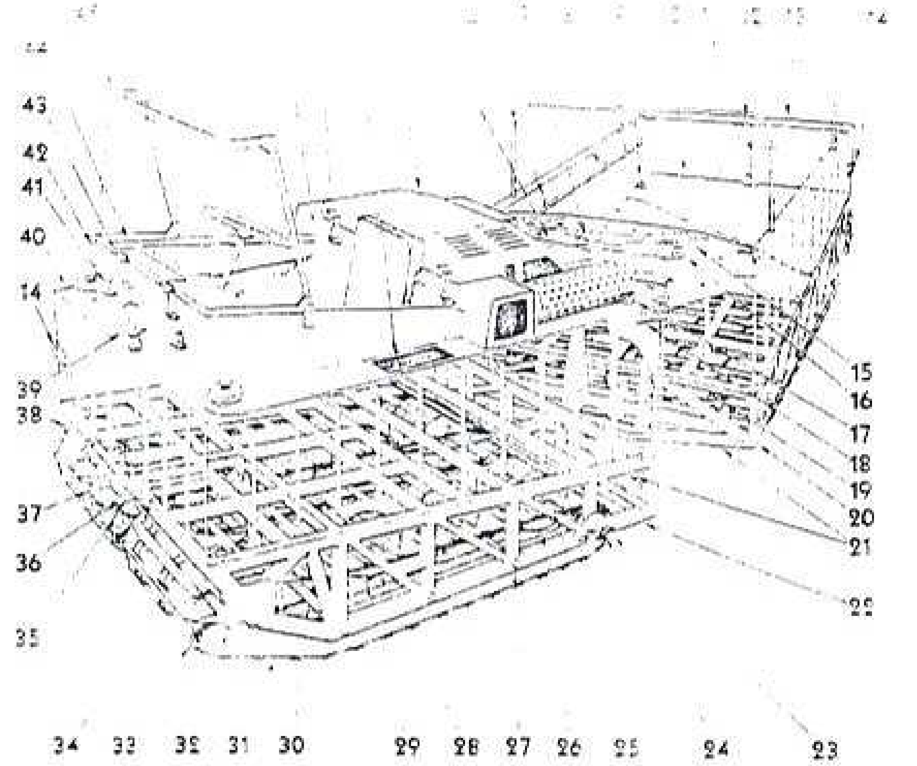

Fig. — Chassis of each unit consists of two side frames joined together by a horizontal grid work on the upper edge, and four tubular grids forming the lower members

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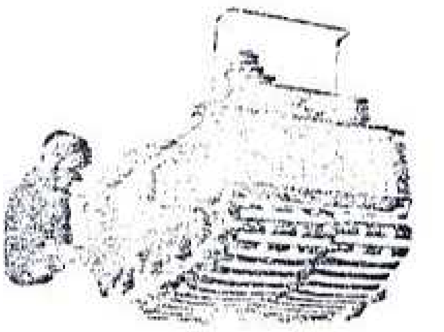


Designed for airborne delivery and use in extreme

Canadian Army's

L. J. Stypinski

THE RAT, Canadian Army's recently developed light, tracked vehicle, is designed to carry a load and to tow infantry sleds and toboggans over snow and ice and barren wastes. It can cross rivers and medium-sized lakes and is suitable for amphibious landings.

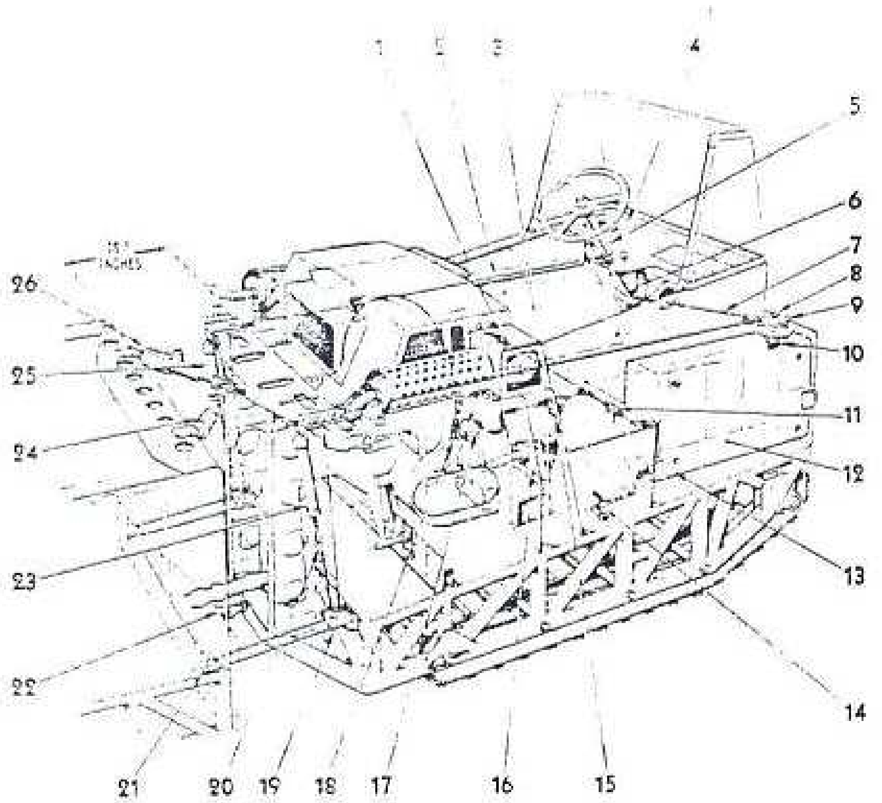
Design parameters for the RAT's structure were greatly influenced by the requirements of air dropping techniques. Its maximum size, for example, was dictated with air transportation and air delivery in mind.

These and other considerations resulted in the RAT's being an articulated, fully tracked, amphibious vehicle capable of operating under extreme winter and summer conditions. The method of steering by articulation and the very low ground bearing pressure eliminated the inherent instability common to some other types of track-laying vehicle. Absence of suspension in the standard model restricts the RAT to operations on a predominantly soft surface, and caution must be exercised when high-speed driving is attempted on bumpy ground.

The RAT's ground pressure of ½ psi is the lowest ever achieved in any power driven unit. It is equivalent to the pressure of a man on a pair of snow skis, so it is true to say that wherever a skier can go, so can the RAT.

This low ground pressure was achieved by careful design and extensive use of aluminum alloys where possible.

The tracks are designed to cover full width of the vehicle, which makes it bellyless and adds greatly to its mobility. The tracks themselves follow the principle of the space-link track design, which takes advantage of the arching effect of soil or snow in supporting spaced track in the same way as if it had a continuous surface. The added advantage of this



1 [illegible]
2 [illegible]
3 FUEL TANK – LH
4 COLD START PROCEDURE CHART
5 STEERING COLUMN
6 SPIRAL DRUM
7 STEERING CABLE – RH
8 FUEL FILLER CAP ADJUSTABLE VENT (TWO)
9 FUEL FILLER CAP (TWO)
10 FUEL TANK SCREEN (TWO)
11 FUEL SELECTOR COCK – RH
12 FUEL TANK – RH
13 WATER TRAP (TWO)
14 FUEL TANK DRAIN COCK (TWO)
15 FUEL LINE FILTER
16 COLD START MECHANISM
17 ENGINE FUEL PUMP
18 COLD START INDUCTION ADAPTER – RH
19 STEERING PULLEY SWIVEL MOUNT – FORWARD
20 STEERING CABLE TURNBUCKLE (TWO)
21 STEERING PULLEY SWIVEL MOUNT – REAR
22 LOWER ARTICULATION COUPLING
23 STEERING CABLE [illegible] – RH
24 SHOCK ABSORBER – RH
25 STEERING CABLE [illegible] – LH
26 SHOCK ABSORBER – LH

Fig. 2 — Steering is effected by controlling the angle of articulation between the front and rear units. This is accomplished by a cable and pulley arrangement.

SAE Montreal Section Paper

winter and summer conditions is the

new RAT

design is that the spaces tend to increase traction.

Design of the track and steering results also in greatly increased drawbar pull, a factor that has not been improved in orthodox vehicles for many years. In sand, for instance, the drawbar pull of the RAT is equivalent to about 110% of the vehicle's weight, while a well-designed single-unit vehicle can only pull an equivalent of approximately 70% of its own weight. With the differential steering on a single unit vehicle, there is a practical limit to the area of the tracks in contact with the ground.

The length of such a vehicle is limited by its ability to steer. And to increase its width is also impractical, since increasing frontal resistance will soon offset any advantage. It is true of any medium, be it air, water, or snow, that it is better to increase the length rather than the width of an object moving at subsonic speeds. Few ski races would be won using water skis.

The articulated principle imposes practically no limit to the length of the tracks; hence the large

AIR DELIVERY and air transportation were much in the minds of designers of the RAT, because this recent Canadian Army vehicle is primarily for carrying loads and towing infantry sleds and toboggans over the snow-covered, barren terrain of the North.

So, many of the same design considerations were involved as in the BAT and the ABC, newest projected members of the U. S. Army's airborne family. The story of these two U. S. Army vehicles was told in SAE Journal's November, 1958, issue, starting on p. 52.

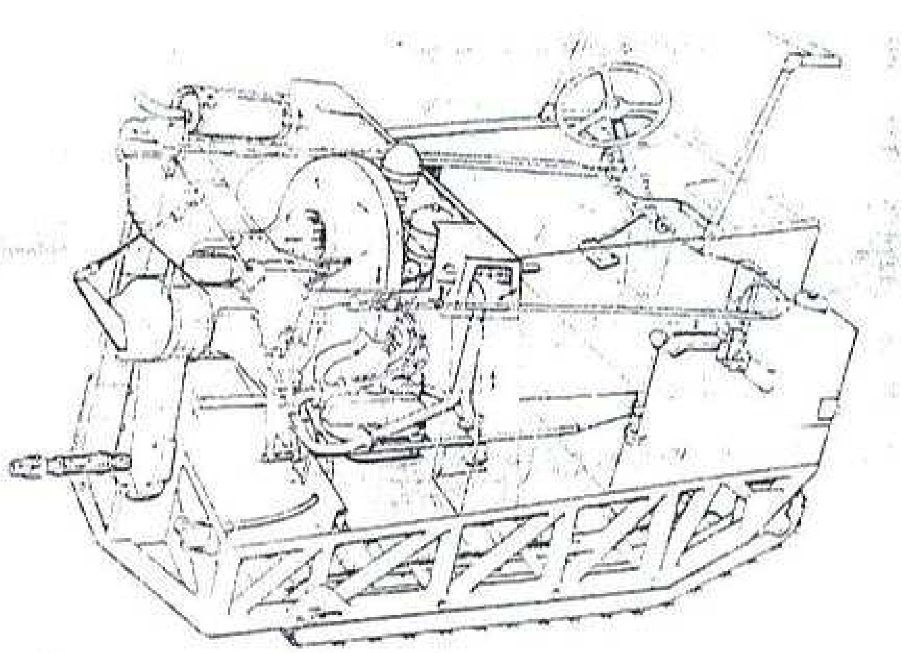


Fig. 3 — The engine is a standard unit, developing 35 hp but has been modified slightly to operate successfully in the RAT.

Canadian Army's new RAT

. . . continued

contact area with the ground, which increases the traction and reduces the unit pressure.

With the articulated steering principle, all tracks move at the same speed at all times, so that bogging down, so common with other vehicles, does not occur when turning is attempted in snow, mud, or muskeg. Due to lack of relative slip between the tracks, the articulated vehicle is extremely stable no matter how rough the terrain over which it travels. This is particularly noticeable in entering or leaving water obstacles, and during other maneuvers when the vehicle may be momentarily supported on part of the track only — such as when traversing boulders, tree trunks, or steep snow banks.

General Arrangement

The RAT consists of two driven units in tandem configuration, joined together, but having freedom to articulate within designed tolerances.

The first unit accommodates driver, engine, main transmission, and the fuel tanks.

The rear unit is left clear for cargo carrying. The dimensions of the floor space on the rear unit are 4 ft by $5\frac{1}{2}$ ft.

The two units are connected by a ball joint located on the centerline below the floor level, and between the two units.

The amount of relative angular displacement between the two units is restricted in the three principal planes to a designed degree by the hydraulic dampers and the articulation beams located at top of the structure. These limit the movement to 80 deg included angle in the horizontal plane and to 5 deg in sag, 16 deg in hog, and 7 deg in relative roll. This arrangement allows the vehicle to mold itself into terrain for maximum traction and also to cross small ditches and other hazards by bridging them.

Steering of the vehicle is effected by displacement of one unit in relation to the other about the point of articulation.

The rolling resistance of the vehicle is such that no foot brake is necessary and the hand brake is intended for parking and emergency use only.

Chassis

The chassis of each unit (Fig. 1) consists of two side frames joined together by a horizontal grid work on the upper edge and four tubular axles joining the lower members. The axles form an integral part of the chassis. The lower members are also joined at one end by a triangular-shaped articulation beam.

Chassis and the engine mount are designed to 12g limit loads. Individual components, such as wheels, axles, and articulation beams, are designed in general to an acceleration factor of 3g and an ultimate factor of 2. The two chassis of a complete vehicle are joined "back to back" by the ball joint, which is located at the apex of articulation beams.

The body and chassis form an integral structural member and they share the loads imposed on them by the movement of the units.

Steering System

Steering of the vehicle (Fig. 2) is effected by controlling the angle of articulation between the front [illegible] side of the vehicle and pays it out to the other, thus pulling a rear unit about the point of articulation. The drum is designed in the shape of a lemon so that the geometrical gain and loss in lengths of the cable during articulation is compensated for.

The Engine

Several engines were considered in the initial stages and various arrangements for the layout of the front unit were drawn. The Volkswagen engine satisfied the specifications, and, in addition, is easily available in 90% of all civilized countries throughout the world.

The engine (Fig. 3) is a standard unit developing 35 hp, but it has been modified slightly to operate successfully in the specific application of the RAT.

The Power Transmission

The power from the engine is transmitted through a single dry plate clutch to a four-speed forward and one reverse manually operated gearbox, and from there by chain drive to a system of prop shafts. A spiral bevel gearbox transmits the power in the final stage to the sprocket axles on both the front and rear units. Two rubber covered sprockets are mounted on sprocket axles on each side of the final gear box. These sprockets drive the tracks by engaging with the track cross links, which are called grousers.

The power transmission was designed for operation at maximum input of 35 bhp at 3400 rpm and maximum torque of 56 ft-lb at 2200 rpm. The nominal design life of the transmission is 1000 hr calculated on the basis of continuous operation under maximum torque conditions. A shock load factor of two was introduced to take care of sudden clutch engagement, jerky starts with a heavy load, and beaching operations, which may cause an abrupt reduction of the track speed. This factor was applied to stressing gears, splined shafts, and the chain [illegible] were again factored. The main gearbox was designed for maximum life of 300 hr in each of the first and reverse gears and for 600 hr in each of the remaining gears.

Main Gearbox

Of necessity, the main gearbox is a very compact design since it had to be mounted at the back of the engine inside a relatively short engine compartment. The design is more or less conventional, and the four forward and one reverse gears are manually selected.

The final gearbox transfers a torque of approximately 1000 ft-lb through a spiral bevel crown gear and pinion giving 2.5:1 reduction ratio.

Tracks on both units are identical in design and they are fully interchangeable. Each track is constructed from three rubber conveyor-type belts joined by the grousers. In the fore and aft direction the tracks stretch between the sprockets (Fig. 4) and the idling wheels.

Air Dropping Technique

To permit a parachute aerial delivery of the RAT to the scene of operation required a specially designed energy absorption platform capable of arresting the total kinetic energy of the impact, which at 35 fps drop velocity amounts to some 30,000 ft-lb. After extensive investigations of several possible schemes and many laboratory and field tests, an air dropping platform was designed consisting of several fruit juice cans sandwiched between plywood boards. This platform arrested successfully the kinetic energy of the RAT during several parachute drops at the Rivers proving grounds at Manitoba. The deceleration on impact never exceeds 12*g*, which is the designed static load for structural yield governed by the strength of the engine beam.

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. . . on which this article is based, turn to page 6.

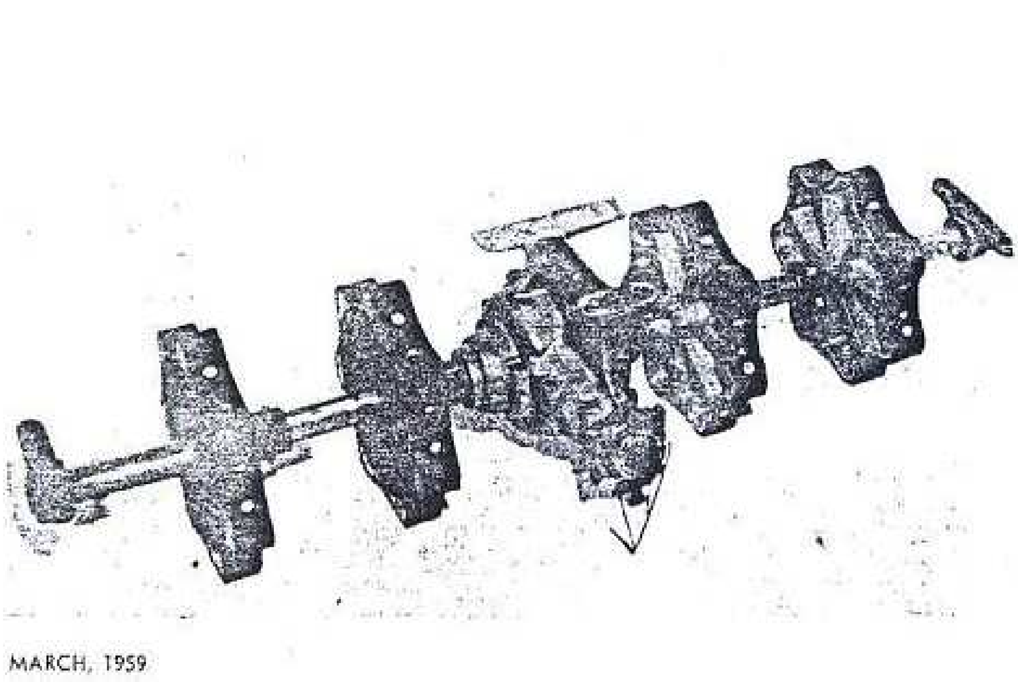

Fig. 4 — Tracks on both units are identical. In the fore and aft directions the tracks stretch between the sprockets and the idling wheels.