THE POLAR RECORD

NUMBER 12:

JULY 1986

PRINTED IN GREAT BRITAIN FOR
THE SCOTT POLAR RESEARCH INSTITUTE
CAMBRIDGE: AT THE
UNIVERSITY
PRESS

1986

Price Two Shillings

TRACTOR OPERATIONS ON THE SECOND BYRD ANTARCTIC EXPEDITION

For the following article we are indebted to Admiral Byrd, and also to Mr Demas, his chief transport engineer, by whom it was written. It is printed almost exactly as received, but the Editor would like to remind readers, that, though the manufacturers of the machines described are to be congratulated on their design. Their successful operation in severe conditions was almost entirely due to the skill and endurance of Mr Demas and his assistants, as can be realised fully only after reading Admiral Byrd's narrative.

On the Byrd Antarctic Expedition II a third mode of transportation was added to the existing means of dogs and aircraft-the use of tractors. Previous attempts bad been made to use motor transport, first on Shackleton's Expedition in 1908, Scott's in 1910, and on the Byrd Antarctic Expedition in 1928-30. Shackleton had taken a regular motor car, which was of use on the bard bay ice, for handling supplies, but it proved inadequate for the softer surface of the barrier. Scott used special tractors, but they were not a success.

On the Byrd Expedition of 1928-30, a Ford, equipped with two idler wheels on a horizontal movable axle and a metal tread running over the idler and rear wheels for traction, was used. The tread was designed for hard packed snow with a solid foundation under it. The " Fordmobile", however, did demonstrate that tractors would also be practical on the softer barrier surface. A trip of 72 nautical miles was made by this machine, but ultimately the differential gave out, due to the sudden gripping of the treads, after the machine had dug itself in. and it had to be abandoned. This machine was found in 1933, buried under 8 ft. of snow. In 1934 it was dug out and towed back to Little America; but at the last minute it bad to be left behind, with three others, at the edge of the barrier, owing to the breaking up of the ice at the docking place. Admiral Byrd was convinced of the importance of mechanical surface transportation, so he equipped his second expedition with the following machines:

1 30-40 Cletrac,
2 Fordmobiles with Arps Motor Co. Tread attachments,
1 Citroën·Kegresse Snow Cars.

Performance of the Cletrac.

The Cletrac travelled approximately 200 nautical miles in the unloading between the ships and Little America, hauling as much as 8 tons to a load. It also made a 200-mile trail journey to the Bolling Advance Weather Base, a journey which was interrupted, and then resumed, as will be later explained. For this journey the machine was equipped with 24-inch plates on its 8-ft. tread, to decrease the bearing load. A 50-gallon tank for fuel was installed, giving it a total capacity of 75 gallons. The metal top on the cab was replaced by a fabric one to afford an extra means of exit in case the machine fell into a crevasse, and it also protected the personnel against injury in case they were thrown against the top. The hood was lined with asbestos cloth to decrease heat losses by radiation.

A remote control system was devised to meet the exigencies of this journey. A line was attached to each guiding lever of the tractor and brought out to the

rear sled. A wooden lever operated by a line running through a pulley attached to the dash-board and then brought back to the rear sled was used to operate the clutch. The Cletrac was put into gear while the clutch was being held out, and the driver got out and then released the clutch by releasing the line, and thus operated the Cletrac from the rear sled. The tractor was stopped by throwing out the clutch by pulling on the line from the driver's position in the rear sled. The remote control system was used in traversing crevassed areas.

After the first stage of this 200-mile journey-at 67 miles from Little America-the Cletrac had to be abandoned until the next year. The crank-pin on the shaft was sheared off by the crank. The throw-out spring was weak. The crank was frozen to the bearing by condensed moisture. It was repaired, but the temperature had dropped to 60° below and we could not supply enough heat to the motor to loosen the oil so that it could be cranked.

In January, 1935, after being buried for ten months, the Cletrac was dug out of the drift, started, and completed its interrupted journey to the Advance Base. The house which Admiral Byrd had occupied 'there and its equipment were loaded on the sleds, and the Cletrac hauled them back to Little America along with the Fordmobile of the first expedition, which was picked up on the way home at a distance of 72 miles from Little America.

At 53 miles from Little America, on the way back, the condenser on the magneto burned out. The radio battery was then used with a Citroen coil and condenser, and, utilising the magneto as a distributor, the magneto ignition system was converted into a battery system, with which the Cletrac completed the trip and continued service until the last moment when it had to be abandoned.

Cletrac troubles. The only troubles experienced with the Cletrac were those mentioned above; there was, however, occasional clogging of the gas-line by dirt or ice from condensation. Condensation ice caused similar trouble with the air-filter.

Fordmobiles. The Fordmobiles were 1932 Model A Ford motors and chassis. The bearing surface of the treads was 4 1/2 feet, 14 inches wide. Skis were used in front instead of wheels. A set of skis were made of hickory on the way to the Antarctic on board the Jacob Ruppert, as the steel skis furnished with the machines had proved inadequate for Antarctic use on the first expedition.

The exhaust from the engines on the Fordmobiles was led through a jacket around the transmission and rear end to warm these sections while idling the cars in the extreme temperatures.

The reduction gears on the rear wheels of these Fordmobiles were found to be weak and were unable to stand up under the torque developed when the tread, which had a tendency to dig in, suddenly gripped. The gears were part of the tread arrangement installed by the Arps Company. An attempt was made to soften the gears by reheating and tempering them, but they still proved inadequate.

It is the writer's opinion that the fault was entirely with the design of the tread. It is his belief that a flat tread plate with half-inch angle rib incorporated will perform well in the Antarctic, or any place with similar snow conditions.

One of these Fordmobiles was repaired with the remaining spare parts during the winter months and did considerable useful work around the camp. Extreme care had to be used, however, in driving it. It performed well if the snow was hard-packed but on soft snow it was likely to get stuck.

(Here follow specifications of the Citroën-Kegresse Snow Cars in the original article.]

General. For six weeks during the unloading period, the three Citroën Snow Cars and the Cletrac ran continuously twenty-four hours of the day. They were stopped only for minor repairs and periodic fuelling, inspection, lubrication, and greasing.

In the low temperatures it was necessary to heat the grease gun and the bearings to be greased. It would be advisable for future cold weather operations that larger grease passages be incorporated on the bearings to facilitate the greasing operations.

The Citroëns were operated in third and second gear. Due to snow conditions, no load could be pulled in the fourth gear.

Lubricants used:

At 0°F.	Tydol A.A.E. 40
At sub 0° F.	Tydol A.A.E. 10 and 20
Grease	Tydol 600 W (for transmission and rear end)
Water pump	Tydol water pump grease
Bearing grease	Tydol 600 W with 25 per cent. kerosene

Gasoline:

Tydol Triple X

Gas consumption: Tests made at 36° F.

Citroën: 3rd gear, 7000 lb. load, 1·7 nautical miles/gal.
2nd gear, 7000 lb. load, 1·2 nautical miles/gal.
3rd gear, 8·ton load, ·9 nautical mile/gal.

Considerable discomfort was experienced in making these tests. A one U.S. gallon can with a rubber stopper with two holes for air and fuel delivery pipes was used. A rubber hose was used to make the connection from the can to the carburettor.

Distance covered by cars in nautical miles:

Citroën	Unloading and loading Nautical miles	Trail Nautical miles	Total Nautical miles
Car 1	3500	1319	4819
Car 2	2800	970	3770
Car 8	2000	1111	3111
		Total	11,700

Method used for starting in sub-zero weather. Above zero it was

necessary only to turn over the engine several times by hand to loosen the stiff oil so that the motor could be spun for starting.

Below zero temperatures, the cooling solution and oil were drained and preheated for starting. However, this consumed too much time so that it was not used more than three or four times. The method which proved quicker and less troublesome was as follows:

A Van Prag vertical blow-torch was placed under the crank case of the cars and the oil was heated in the motor. Then some of the heat got to the cylinder walls to loosen the oil. Care bad to be exercised so as not to get the oil too hot. Also a constant watch was kept to prevent fire. The crank was constantly being tried, and just as soon as it moved the motor was turned over by hand to help the loosening of the oil. As soon as the motor could be spun, the torch was removed, the carburettor flooded, the ignition turned on, and the car was started.

To minimise beat losses the entire front part of the car was covered during the beating with a canvas cover made for that purpose.

The time required for starting a car varied with the temperature and wind. At 20 below, with a ten-mile wind, 45 to 60 minutes were consumed. If the car faced the wind it took 45 minutes, if not, it took an hour. At lower temperatures as much as three hours were spent in getting the machine started. Below 50° F. we found it advisable to heat the transmission and rear ends of the cars after the motor was started and previous to getting under way.

At low temperatures it required fifteen to twenty minutes on second gear before the third gear could be used. This was due to the cold bearings on the other moving parts of the machine.

Changes made on the machines for trail operations. The following is quoted from a report to Admiral Byrd by the writer:

Little America, October 20, 1934.

Subject: Safety precautions and improvements on the Tractors for Antarctic operations.

1. An oil tank has been installed under the hood of the dash-board of each machine. There is a line from the tank to the oil-filler neck with a pet-cock on it for adding oil to the engine when necessary. This tank holds ten gallons of oil which will be sufficient for a long journey. The tank, being under the hood, permits the heat from the engine, when running, to heat the oil and save fuel, which would have been used otherwise, and, preventing waste by spilling, saves an enormous amount of time. I t also saves the men a good deal of cold work.

2. Drain pet-cocks have been installed on the engine block and radiators with copper tubing leading out to an accessible position for facilitating the draining of these parts of the machine if the temperature is lower than the solution can stand without freezing, or in case the solution is lost and water has to be used.

3. A small line with a T connection and a pet-cock was added to the gasoline line before it reaches the fuel-pump in order to blow the line clear in case it plugs up. This has been one of our chief troubles during our operations so far. Before, we had to take the lines apart to blow them clear, which caused

connections to leak, thus increasing our troubles by permitting air to be pumped; so that there would not be sufficient gas supplied to the carburettor by t he pump. By means of these pet-cocks we will be able to blow t he line clear in a very short time instead of after hours of cold, miserable work with cold gasoline dripping and soaking us, and freezing our fingers.

4. We have built racks under the hood for the oil cans and grease guns so that they would be handy with warm grease and oil for greasing and oiling while on the trail.

5. We have added a pan under the entire engine to keep all possible heat under the hood and prevent the cold air from striking the crank case pan and cooling the oil.

6. A toggle switch was installed in the ignition system for quick switching in case of an accident by falling into a crevasse and a gas line breaking, thus minimising the fire hazard.

7. A switch was installed between the generator and battery lead, so that when the generator cut-out sticks, the switch could be opened and thus prevent the burning of the cut-out and generator at low speeds of the engine.

8. Pieces of raw hide were tied to the door latches and the forward end of the door to allow the occupants an easy and quick way of operating the doors in case of an emergency.

9. New bodies were built on the rear out of angle iron frame work, with wooden floors and sides up to three feet; and the rest of canvas, due to lack of lumber.

10. Under the floor, a 145-gallon airplane gas tank was installed connecting with the regular tank of the car, giving a total capacity of 172 gallons.

11. In the rear two folding-bunks were installed which folded up against the sides. The bodies are five feet high, six and one-half feet long and eight feet wide. The centre and sides under the bunks were used for cargo space. In the forward part was a box for the cooker and cooking utensils and another box for a week's rations for two men. This arrangement saves a great deal of time while travelling the trail and will also permit twenty-four hour operation while on the trail if desired.

The following is a summary of the function of the various parts of the machines.

Cooling solution. Everready Prestone anti-freeze was used in the cooling system. It gave excellent results. The cars were operated as low as 71° F. below zero with a 60 per cent. solution. It was found necessary to mix the solution before putting it in the cars. The hydrometers supplied were found to be unreliable due to dirt sticking to the sides of the tube of the hydrometer. Care must be exercised that the solution does not reach above 62 per cent. Prestone, as the solution is reversible and at percentages greater than 62 per cent. will freeze at 10° F. above zero. However, in one of the cars (Cletrac) the 60 per cent. solution remained in the car throughout the Antarctic winter, and stood temperatures of 78° F. below zero without any damage to radiator or cooling system. A 40 per cent. solution was frozen in a can as an experiment and no noticeable expansion of the solution resulted.

Fan belts. Rubber V -shaped belts were used to drive the fan and generator. It was found that at lower temperatures than 50° F. below zero the rubber became brittle and the belts flew apart. The belt should be warmed up before starting the engine. Then while running sufficient heat is created by the friction to keep the rubber elastic. Spare fan belts were made of leather, and notched leather pieces riveted to the circumference.

Generators. The generator cut-outs stuck frequently and burned out. They were rewound and a switch was put in the circuit to break contact, and thus save the cut-out and the generator. The brushes showed undue wear in low temperatures. A General Electric engineer advised soaking them in kerosene and oil and this remedied the trouble. Spare brushes were made of the positive poles of dry cells on one of the mid-winter journeys.

Starters. The starters were very seldom used so that the battery current might be conserved.

Batteries. The cars were equipped with cadmium-nickel-alkali batteries which gave excellent service. Lead batteries were also used with equal success. However, care had to be exercised to keep them well charged to prevent freezing.

Ignition system. The ignition system was of 12 volts and gave excellent service. No trouble was experienced with the coil, condenser, points, or distributor. Mica spark plugs were used, due to extreme changes of operation temperatures. Porcelain plugs tended to crack under these conditions.

Fuel pump. The fuel pump was of the diaphragm type, operated from the cam shaft. It gave excellent service. The cork gaskets on the strainer bowls, however, were a constant trouble owing to leaking air. These were replaced by rubber ones which had to be changed frequently. Rubber was the only available material for this purpose. The bowls had to be cleaned frequently due to ice condensation.

Gas-line system. The tanks were lead-coated and painted with some black paint which flaked off, clogging the gas-lines. A T fitting, with a short piece of pipe with a pet-cock was installed at the fuel strainer so that the lines could be blown clear without taking them apart. A tirepump was used for this purpose.

On one occasion the gas-line was rubbing against the drive shaft and a hole appeared. Finally, the hole became so large that the car stopped, five miles from Little America. A blizzard started, something had to be done in a hurry to get the car going before it became cold. There were no heating torches available to warm it up. Rubber and friction tape would not hold in the cold temperature. After hunting through the car a. package of chewing gum was found; all five sticks were chewed and collected. The gum was applied to the hole and a rag wrapped around it and the car was started and driven in to Little America. Thus a package of gum saved a probable disaster for the party of five men. It was extremely dangerous to travel on foot in this crevassed area.

Carburettion. The carburettor was of the "Vertical Solex'' "startertype". It is of simple design and operation. The jets clogged frequently from condensation. Small particles of ice would clog the metering jet which necessitated taking the lower part of the carburettor apart to clean the jet.

Wing bolts were installed so that the lower part could be dropped quickly for this purpose.

Clutch. The· clutch was of the Citroen two-ton type and gave excellent service. One did burn out at a. most inappropriate time, but that was due to the heavy load and to previous use.

Steering gear. The steering gear was of the worm-gear type and handled surprisingly easy on the snow with wheels and skis.

Speedometer. The speedometer was connected to the transmission and calibrated in knots (nautical miles). The drive-coil spring gave out, due to solidification of the grease in the cold temperature. The mileages given in the earlier part of this report are a conservative estimate.

Transmission. Considering the fact that the cars were operated in second and third gears instead of fourth, and with 50 to 100 per cent. overload most of the time, the transmission is a credit to the manufacturer. In fact the entire car is a credit to the late Monsieur Citroen.

Drive shaft and universals. The drive shaft was of the slide steel tubing type. The universal joint housing packed with a felt washer threw the grease out due to centrifugal force and two drive shafts were ruined in the latter part of operation of the cars.

Rear end. The rear end gave excellent service. One of the cars which had fallen in a crevasse, losing its grease from the vent, ran 25 miles without grease, and 50 miles with S.E.A. 40. When inspected, the only harm indicated was slight chipping of the edge of the teeth. It was cleaned and put together and continued to give excellent service.

The rubber-coated canvas belt. The belt was 2 inches wide and had a theoretical length of 18 feet 6 inches and was fitted with:

1. On the extreme face with 68 duraluminium shoe-plates, each supporting a wearing pad of rubber with canvas base.
2. On the internal face: (a) At the centre-68 centre guides of fibre attached to the belt by bolts which also held the shoes and rubber pads. (b) On the sides- 186 driving teeth (68 on each side) fixed by bolts to the belt and shoes.

The belts gave excellent service. In low temperatures, the rubber became brittle and cracked; the canvas, however, held the belt together. In all of our operations only one patch was necessary to replace one bad split on one of the belts.

Recommendations for future expeditions. Although the Cletrac and the Citroens performed successfully in the Antarctic as low as 71° F. below zero, there is plenty of room for improvement for future low temperature operations.

A tractor for the Antarctic should be 80-40 feet long, with front and rear drive, built of light material with the weight equally distributed. It should have a wide tread with a maximum bearing load of one pound per square inch of surface. The motors should be inside the body and easily accessible. The load should be carried within the body. Air-cooled engines would be preferable. The fuel should be heated separately for starting, and the exhaust used for heating the fuel while operating.

The length is needed for bridging crevasses which proved such a hindrance to the recent operations on certain sections of the continent.

Low temperature operations would be greatly simplified if a lubricant could

be developed that would retain its lubricating qualities at the temperature of the engine and at the same time remain a liquid at 75° F. below zero. There is urgent need for such a lubricant at present in Canada, Alaska and Russia, where airplanes and tractors operate at low temperatures.

Certain refinements could be made in the gasoline engine to improve its performance under extreme conditions. The fuel should be preheated before entering the carburettor by a fuel coil around the exhaust, or immersed in the cooling solution. The air should also be pre-heated before entering the carburettor. This would prevent clogging the jets by condensation, assist in complete vaporisation of the fuel, and improve the fuel consumption .

A magneto ignition system should be used instead of the battery. The generator and fan should be gear-driven. The generator should be used for lighting, and for operating the radio.

In conclusion, Admiral Byrd and the members of his recent expedition are grateful to the Cleveland Tractor Company, the Ford Motor Company, the Tydol Company, and the late Monsieur Citroen for their generosity in donating the cars and supplies to the Expedition.

Their operation was an experiment in exploring a most desolate continent which has defied conquest and claimed the lives of many daring men.

It was with deepest regret that we sailed, leaving three of these machines sitting on the edge of the barrier to be claimed by the Antarctic. The Antarctic was cheated out of one car, which was brought back and is now in storage in Boston.

E. J. DEMAS
In Charge of Tractors
Byrd Antarctic Expedition II