BLUEBIRD NEWS

P.R.O. for Land Speed Record Attempt
Mr. R. Bryan Cooper
NATional 1200, EXT 484

BLUEBIRD CAR TESTED AT GOODWOOD

Following five years of design and building, the new Bluebird car, with which Mr. Donald Campbell will make an attempt on the world's land speed record in September this year, has now been completed and is being tested by Mr. Campbell at the Goodwood Motor Circuit, Sussex, from July 18th - 22nd.

During these preliminary tests, the car will be driven at speeds up to 80 m.p.h. One of the main purposes of the tests is to devise and practise the pit procedure for fuelling and tyre changing, etc., which will be used on the Bonneville Salt Flats, Utah, where the record attempt is being made. Mr. Leo Villa, who for 40 years has been chief engineer first to Sir Malcolm Campbell and now Donald Campbell and who has supervised the construction of the new Bluebird, will be in charge of the pit crew. Time will be an important factor when the attempt is made because a return run over the measured mile must be made within one hour in order for a record to qualify under the official F.I.A. regulations.

One item of interest that will be checked during the trials is the accelerometer, which will be reflected onto the armoured glass windscreen in such a way that the figures will appear to be projected onto the track surface 100 yards in front of the car. In this way, Campbell will be able to read his speed without taking his eyes off the track. The instrument will show two indices, one denoting the speed in miles per hour and the other showing the rate of acceleration. This is the first time that such an instrument has ever been used on a land vehicle.

Bluebird was transported from Coventry, where it was built, to Goodwood on a special road trailer which has been provided by Graham Adams Ltd. of New Malden. This trailer will also be used to transport the car across the United States to the Utah Salt Flats after it has been shipped to New York. During the journey across the United States the trailer will be driven by two drivers chosen by the American Trucking Association as having the best record of accident-free driving.

The trailer, which is a flat platform, 35 feet long, was built by Seddon Diesel Vehicles Ltd. The engine for the tractor which will tow it is 178 b.h.p.

and was supplied by Cummins Diesel Sales and Service Ltd., whose American associates are also providing the drivers in America.

On Friday, when the public will be admitted to the Goodwood Motor Circuit to watch the trials, there will also be on show three cars which previously held the world's land speed record; the Sunbeam 350, Sunbeam 1,000, and Golden Arrow, all lent by the Montagu Motor Museum. Donald Campbell will demonstrate one of these cars, the Sunbeam 350, by driving it round the Circuit. It was with this car that his father, Sir Malcolm Campbell, held the land speed record in 1924 and 1925, with speeds of 146.16 m.p.h. and 150.87 m.p.h. respectively.

Construction of Bluebird

Construction of the car began in October 1959 at the Coventry works of Motor Panels (Coventry) Ltd., a member of the Owen Organisation. The Company's Development Department undertook the manufacture of the complete body structure and the installation of the engine, transmission and brake units, and all the other components supplied by the various companies taking part in the project.

At the outset, a manufacturing programme was drawn up by Motor Panels to ensure that assemblies and parts coming in from the over 80 companies co-operating in the project could be built into the assembly at the right time in a planned sequence. This was necessary particularly because of the limited space available within the structure, together with the fact that the whole body forms one stressed unit.

A primary requirement in the construction of Bluebird was for the lightest possible structure, which still provided the necessary strength. The decision to use a midships mounted gas turbine, which had to be enclosed in a slightly pressurized chamber, led to the incorporation of the chamber walls into the vehicle structure. From these considerations developed the choice of a predominantly sheet metal structure, using aluminium alloy sheet as the basic material. In selecting a suitable alloy, operating conditions and fabricating facilities had to be considered in addition to simple mechanical properties. The Development Department of The British Aluminium Company, which provided the material, recommended the use of an alloy with 3½% Magnesium content. This medium strength alloy has proved its resistance to corrosion in numerous marine applications, and is resistant to heavy saline atmosphere such as that encountered on the Utah Salt Flats.

The method of construction was similar in many respects to that employed for aircraft. The whole body is built as an integral unit, thus eliminating the necessary of a separate chassis.

The strength of the structure is derived from four main beams which run the length of the vehicle. These consist of ¾ inch thick aluminium foil honeycomb, bonded between 18 gauge alloy sheets. Solid machined aluminium reinforcements are inserted at points of high stress, such as engine mountings and suspension. This form of construction, which is very strong, is also used for the engine compartment and plenum chamber bulkheads. The beams are reinforced with diaphragms and stiffeners and the whole body covered with a skin of stressed 18 gauge aluminium alloy.

Manufacturing tolerances were expressed in thousandths of an inch, creating considerable problems in a completely hand made structure measuring 30 feet long, 8 feet wide and 4 feet 9 inches high. Accuracy was maintained by building the car over heavy steel base plates mounted on concrete. Four jacking points, just inboard of the wheels, carried the body during building and assembly, and formed the main assembly rig.

In order to maintain close limits and uniformity on individual panels, accurate wooden formers were made. The alloy sheets were hand formed, using these formers for shaping and flanging. Where panels had to be shaped to match the outer contour of the car, wooden "egg box" jigs were used. The wheel fairings and air intake are good examples of the complexity of shape involved.

The assembly is mainly of a rivetted construction with specially made high tensile bolts taking the shear load. High duty alloy castings are used for engine mountings.

Skinning was accomplished by hand forming the outer panels to the already assembled diaphragms and stiffeners. After fitting, the individual skins were rivetted into position. Special attention was given to the smoothness of the surface in an endeavour to avoid as far as possible any unnecessary air turbulance while the car is travelling at high speeds.

Built into the main body structure are the air intake and exhaust outlet ducts. From a nose intake the air for the turbine is split into two parallel ducts, one on each side of the cockpit, leading to the central engine chamber. The shape of the nose intake and the streamlining of the ducts has been developed to give efficient airflow at speed. The four outlet ducts accommodate the actual turbine exhaust pipes with encompassing blankets of aluminium foil insulation to protect the main structure. The top and bottom covers of the engine chamber are again made of aluminium honeycomb sheeting. Similar panels cover the gearboxes, and all are held in position by aircraft pattern quick release fasteners.

July 18th 1960

BLUEBIRD NEWS

FACTS AND FIGURES ON "BLUEBIRD"

Length Overall:	30 ft.
Breadth Overall:	8 ft.
Height Overall:	4 ft. 9 in.
Wheel Base:	13 ft. 6 in.
Track:	5 ft. 6 in.
All Up Weight:	4 tons
Ground Clearance:	4 in.
Designed by:	Norris Brothers Ltd.
Built by:	Motor Panels (Coventry) Ltd.

Frame: The main frame of the Bluebird is formed from an aluminium honeycomb type cell structure sandwiched between two aluminium plates. The advantages of this structure are its extreme rigidity and its strength to weight ratio.

Power Unit: Single Bristol-Siddeley Proteus 705 developing 4,250 b.h.p., which has been modified by the addition of a drive shaft at the rear, which with the front drive shaft enables power to be transmitted to all four wheels - giving four wheel drive.

Transmission: In transmitting the power from the Turbine Shafts to the wheels a system similar to the back axle in a racing car is used with sliding joints inside the spiral bevel gear boxes, necessitated because of the difference in length of the wishbones and half-shafts. A free wheel system is incorporated in the forward re-distribution of the car's weight, which takes place at decceleration and has the effect of decreasing the radius of the front wheels so that they rotate faster than the rear wheels and damage the front half-shafts.

Suspension: A fully independent suspension system is used, which consists of oleo-pneumatic leg suspension units of the aircraft type. They are used in a conventional wishbone arrangement, being identical on all four wheels.

The oleo system gives the lightest practical form of suspension - the medium used being dry nitrogen.

Damper and spring medium are combined in the one unit which weighs only 12 lbs and supports 2,500 lbs, a quarter of the weight of the car.

Tyres:	Dunlop interwoven web 4 ply; 52 in. diameter; 8.52 in. section.
Brakes:	Consist of two sets; namely air brakes (flaps) and disc brakes. To deccelerate from top speed down to 400 m.p.h. the air flaps are opened by an air hydraulic system from each side of the rear of the vehicle. The disc brakes, produced by Girlings, are a development from aircraft design and are actuated by compressed air at 350 lbs per sq. in. These brakes bring the car from 400 m.p.h. to halt in 70 secs. The energy dissipated in halting the vehicle is 75,000,000 ft. lb.
Fuel:	B.P. Avtur, 25 galls. capacity.
Shape:	The overall elliptical shape of the C.N.7. "Bluebird" is in effect the minimum envelope which will incorporate the engine, being set as close to the ground as possible. Tests were carried out in the wind tunnel at Imperial College. One of the impressions of the shape is the size of the wheels (52"), which were developed as the most efficient size for the vehicle. These move up and down in a plane whilst rotating and have a stabilising gyroscopic effect at high speeds.
Development:	Design of the Bluebird began in January 1956, and building commenced in October 1959.

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BLUEBIRD WORLD LAND SPEED RECORD ATTEMPT

UTAH, 1960.

FIVE LAND-ROVERS TO PROVIDE SERVICING FOR BLUEBIRD AND TRANSPORT FOR THE CREWS.

Donald Campbell will be using five Land-Rovers to assist his land speed record attempt at Utah this year. Two Land-Rovers will be used for servicing the Bluebird during the attempt, and in particular, to assist the "turn round" at the end of each run. There will also be a Regular Land-Rover, which has been equipped with Pyrene Fire Equipment. This vehicle will be acting as course patrol, crash and fire tender. In addition to these, there will be two Long Land-Rover Station Wagons in attendance to transport personnel attending the Bluebird, from hotel headquarters on to Salt Flats. Service engineers from The Rover Motor Company of North America Limited, will be in attendance to look after these vehicles.

The two Land-Rover Service vehicles, in Bluebird blue, are each identical in their specification and their equipment includes Hydraulic Winches, Long Range Fuel Tanks, Tropical Roofs, Air Compressors, Generators, Alternators, Hydro-Electric Power Packs and Intercom Radios. Both vehicles have special overhead awnings, which come out from the side and rear of the vehicle to give the crews protection from the sun, as well as tropical roofs on the Truck Cab and engine oil coolers.

During the speed attempts, which must not take more than one hour, it is necessary for the Bluebird to turn round and be jacked up for its wheels to be changed, brakes cooled, and restarted. These jobs will all be done by the Land-Rover Service vehicles, which will be placed at each end of the run.

Continued.........

The Long Land-Rovers each have a centre power take-off, to which is fixed a six groove pulley, and driven from this pulley is a Dunlop Air Compressor, which delivers 4,000 p.s.i. to charge compressed air reservoirs on the Bluebird. The compressed air is used for operating the disc brakes and air brakes. The reservoirs have to be replenished at the end of each run as quickly as possible. A C.A.V. 9 k.v.a. Generator is also driven off this pulley, and is designed to charge the ten Lucas G.T. 9A 12 volt batteries, located on each Land-Rover. The batteries are used for the electric starting of the Bristol Siddeley Proteus Turbine Engine in the Bluebird. The batteries also energise the Dowty Hydro-Electric Power Pack, which is used to operate the hydraulic jack system built into the Bluebird. Yet another item of equipment driven by the pulley is the Brush Alternator, which supplies current to operate the four fans. When the Bluebird comes to rest after braking from high speed, the fans are placed over the brake compartments of the Bluebird, in order to blow cooling air on to the extremely hot disc brakes, so as to reduce their temperature before the car starts on another run.

The third Land-Rover will be equipped with Pyrene Fire Equipment, which consists of a variety of extinguishing agents, and will be patrolling the circuit. The three Land-Rovers, the Bluebird and the Control Towers are all in communication by means of Pye radio telephones.

Equipment on the Land-Rovers is specified and designed by the Bluebird team of designers and engineers, with the assistance of the Rover Company technicians. All the equipment was fitted on the Land-Rovers by the Tooley Electro Mechanical Company Limited of Earl Shilton, Leicestershire. Equipment has been supplied by the Aviation Division of Dunlop, Lucas, C.A.V., Brush Electrical Engineering Company Limited, Dowty Hydraulic Units Limited, Durnford Brothers Limited of Newcastle-on-Tyne, Chesterfield Tube Company Limited and Pyrene Limited.

Mr. Donald Campbell will be using a Rover 3-Litre as personal transport during the period of the attempt.

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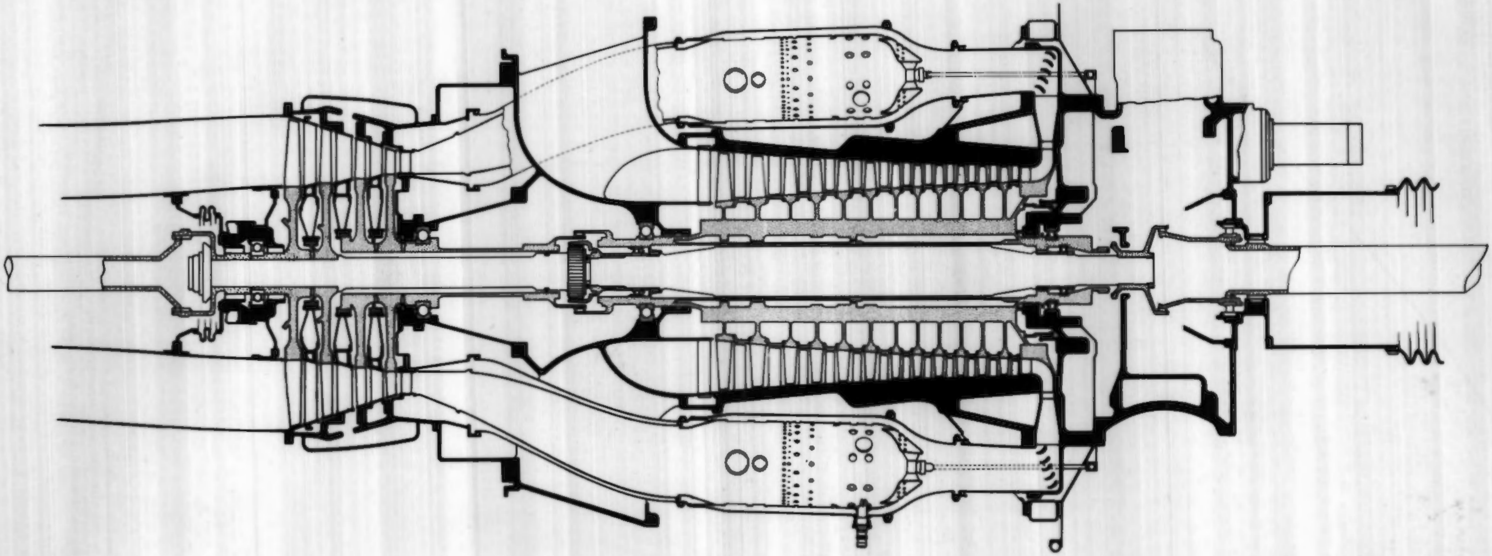

BRISTOL SIDDELEY **PHOTONEWS**

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This diagram shows how the Proteus engine for Bluebird has been modified. At the front the reduction gear has been replaced by a housing for a forward extension of the power turbine shaft. At the rear the exhaust pipe has been re-arranged to allow for a similar rearward extension. The extension shafts are coupled directly to the front and rear bevel gears. The free power turbine arrangement of the Proteus provides the equivalent of a fluid torque converter so that no clutch or gearbox is needed.

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18th July 1960

POWER FOR THE CAMPBELL RECORD CAR

Details of Bristol Siddeley Proteus gas turbine for attempts on World's Land Speed Record

The Proteus engine for Donald Campbell's Land Speed Record car was recently delivered by Bristol Siddeley to the works of Messrs Motor Panels Limited of Coventry, who are building the car to the design prepared by Messrs Norris Brothers.

The Proteus, which has built up a fine reputation as the powerplant of the Britannia airliner, is also used for electrical power generation and to propel the Royal Navy's Brave class Fast Patrol Boats, the fastest warships in the world. Its use in Donald Campbell's record car is a further example of the adaptability of gas turbines of this type.

All gas turbines have the advantage of delivering high power for a small bulk and weight. The Proteus, 8 ft ¾ in long and 40 in in diameter, produces 4,250 hp for a weight of about 3,000 lb. No piston engine or combination of piston engines could compete with these figures and, moreover, the Proteus requires no cooling system, no clutch because it incorporates the equivalent of a fluid torque converter, and no gearbox because it can produce its power over a wide range of rpm. The output shaft is simply coupled directly and permanently to bevel gears in the front and rear axles.

The engine for the Campbell car is in no way a tuned unit, as were the piston engines in earlier record breakers. The normal power output of the Proteus is sufficient for the purpose and it is designed to run for long periods at full speed with complete reliability. There is nothing temperamental about it and it does not even require to be warmed up - full power is available immediately and the shut down can be equally quick.

The Proteus is a free turbine engine; that is to say the power turbine is mechanically separate from the compressor and its turbine. The speed of the output shaft can thus be varied over a wide range of rpm while the compressor system continues to run at its optimum speed. It is this arrangement, working in much the same manner as a fluid torque converter, which gives the engine its great flexibility and makes the gearbox and clutch unnecessary. Power is regulated by the amount of fuel admitted to the combustion chambers.

Air enters radially through passages in a light alloy casing just to the rear of the mid-length of the engine. It then passes forward through the compressor, which has twelve axial stages and a final centrifugal stage. On leaving the compressor the air is turned rearward into the eight tubular combustion chambers which are compactly arranged round the compressor casing.

Behind the combustion chambers there are two two-stage turbines. The first drives the compressor through a hollow shaft, the second drives the output shaft which runs forward through the tubular compressor shaft and normally terminates in a reduction gear at the front of the engine.

In the Campbell car there is no reduction gear. The output shaft is continued forward to the bevel gears which drive the front wheels. At the rear the engine has been modified to allow the output shaft to be extended backward to the bevel gears for the rear wheels. The main change entailed is the division of the exhaust pipe into four branches which are carried round the rear bevel casing. The jet thrust provided by the exhaust will be negligible at maximum speed.

At the beginning of each run the car will be held on the brakes while the compressor system is run up to a predetermined rpm. The brakes will then be released and the car will accelerate as the power turbine gathers speed. To avoid excessive wheelspin the throttle will be opened gradually as speed is gained.

In some respects the engine will be operating under conditions not previously experienced. During acceleration it will be exerting greater torque than ever before, but trials on the test bed have shown that it is well able to withstand the increased loads. In the Britannia airliner the Proteus does not exceed a sea level speed of 350 mph. The Campbell car is designed for a maximum speed approaching 500 mph, at which the intake pressure would naturally be considerably higher at sea level. However, Bonneville Salt Lake is at an altitude of 4,300 ft and this is sufficient largely to offset the increase in intake pressure due to increased speed.

At low speeds the Proteus will offer no overrun braking effect similar to that provided by the compression and internal friction of a piston engine - the propellers of a Britannia can easily be rotated by one finger! At speeds around 400 mph it would provide about 500 hp for braking if the throttle were cut completely, but it is not likely that it will, in fact, be cut completely at such a speed.

An overrun braking effort of 500 hp is comparable with that which would be exerted by the two Napier Lion piston engines, of half the Proteus' total power, fitted to the late John Cobb's Railton car which set up the present record in 1947. This is a relatively small contribution to the effort needed to stop the car from maximum speed.

The fuel consumption of this 3½ ton, 4,250 hp car is not as heavy as might be expected - probably about 1½ mpg at maximum speed.

It cannot be said that the Campbell car will provide lessons which can be applied directly to the development of a gas turbine driven family saloon, but its success could add impetus to this idea and its design, which dispenses with gearbox, clutch and cooling system, illustrates the remarkable adaptability of the free turbine engine.