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**Contents**

# Two of the many Blue Plaques seen in London

Pictures & Text By Mike Frost



16 Pennywern Rd, near Earl's Court, was Norman Lockyer's address in London, not far from the South Kensington site where his solar observatory was located. The plaque to Rugby's most famous astronomer (so far) was put up a couple of years ago. The address is now an annexe for the Oxford Hotel.

Isaac Newton has a plaque in Jermyn St, not far from where the BAA meet (Burlington House, Piccadilly). The address is now used by Hacketts, a gentlemen's retailer.

# The Six Bangs

By Ivor Clarke

*Space travel has always been a keen interest of mine since I was about 11 years old and read Willy Ley and Chesley Bonestell's 1952 book* The Conquest of Space. *Since then I've (like a lot of other folk), dreamt of travelling to the Moon and beyond even if the technology did not exist. . . But there was soon born a project back then to take men to the planets that didn't get off the drawing board.*

*This is its story. . .*

Those of us old enough to remember the heady days of the sixties space race to the Moon, will wonder what has happened to all that drive and determination we once had to fly into space? What happened to the plans for a Moon base? And Mars by 1976? Designs for a massive expansion of effort to build on the work of the Apollo missions with reusable spacecraft instead of throw-a-way bits, was the order of the day. By now it would all be so different, holidays in space at the big wheel of a orbiting space station as in the film 2001, and for the rich, on the Moon! Apollo would only have been the start, the first steps on the ladder to the planets and moons of our solar system. Mankind would then quickly build on the technology used in the Moon landings and build a large international lunar base. Also a large space station to assembly the Mars fleet, mine the asteroids for metals and rare minerals and head out to the moons of Jupiter and Saturn. But today all of these dreams, sadly, have all but disappeared, well nearly all.

**Chemical Rockets Rule**

Even today, 40 years after it was first designed, the Saturn V rocket used by the Apollo missions is still one of the biggest rockets ever built. It stood 365 feet high and weighed 6,000,000 lbs when loaded with fuel at lift-off. After the fight only the top 10 feet of the vehicle was left with the crew sitting in a neat row. All the rest of this vehicle was thrown away one bit at a time. It was an amazing achievement at the time; *"I'm sitting on top of 2 million parts, all built by the firms with the lowest quote"* was the thought of one of the astronauts during blast-off. It was overwhelming to most folk who watched Apollo 11 lift off on that sunny Wednesday morning in July 1969...

All of us think of rockets which are like the Saturn V, V2 or the Shuttle. In which a great deal of the craft is made up of tanks to hold the fuel, either liquid or solid. Indeed most of the mass of the launch vehicle is propellant to lift the craft into Earth orbit or outward away from the Earth's gravity well into the solar system. For every 1Kg of payload into orbit, it takes about 16Kg of propellant to put it there. Also each rocket has to be made as light as possible so as not to waste fuel lifting unnecessary weight. The Saturn V first stage was fuelled by kerosene and liquid oxygen, the second and third stages burnt liquid oxygen/liquid hydrogen, solid fuel boosters such as used on the space shuttle were not developed until later.

The method of comparing rocket thrust is called the specific impulse (ISP), this is the amount of thrust in lbs produced per second by a given amount of propellent. The best that can be achieved at the moment is a cryogenic hydrogen-oxygen engine with a ISP of about 450 seconds. The Space Shuttles main motors use this mix and the burn produces super heated steam, $H_2O$. One of the major problems is keeping the rocket motor chamber cooler then the melting point of the materials it's made from, about 3000ºK with current materials. In the Saturn V motors the fuel was pumped around the sides of the rocket motor to cool it before being injected into the chamber.

The hotter the exhaust gasses, the faster the molecules move, about 3km/sec (6,000 mph) constantly colliding with each other and pressing on the sides of the rocket engine. Also for a given temperature the lighter the molecule the faster it will move. The oxygen atom is 16 times heavier than its partner the hydrogen atom, so water has 18 times the weight of an hydrogen atom, so oxygen slows down the exhaust speed by having a greater kinetic energy. If the exhaust was only $H_2$ (and not $H_2O$), then the speed of the gas would be 3 times faster, giving higher speeds for a given temperature to the rocket. But no chemical burn process can produce a pure hydrogen exhaust.

A project called NERVA *(Nuclear Engine for Rocket Vehicle Application)* was started in the early 1960's, it used an experimental nuclear reactor to heat liquid hydrogen in a rocket motor to create thrust. It was stopped in late 1972 as the engineering problems and risk of a core melt down with the subsequent environmental contamination was far too high and dangerous to use in a launch.

America had suffered a demoralising shock on October 4th 1957 when the USSR launched Sputnik 1 weighing 184 lbs into a 90 minute low earth orbit. Then the next month on November 3rd, launched Sputnik 2 with the dog Laika aboard. It was not until the following January 31st, that the USA got a small satellite into orbit. Weighing in at only 31 lbs and called Explorer 1, it was launched by a modified ICBM, a Jupiter-C rocket. It was however more than just a test launch and carried a couple of science instruments which discovered the Van Alan radiation belts around Earth.

The space race had begun.

It was the German rocket pioneer, Wernher von Braun, working at the Marshall Space Flight Center who pushed the cause of the chemical fuelled rocket to the exclusion of all else. In doing so he got America to the Moon in 1969, inside Kennedy's decade deadline. During von Braun's reign about 60 people got into space and 12 got to stand on the Moon.

Von Braun worked with what he know and understood, but there was another rocket design being worked on at the same time, in secret, which visualised putting 150 scientists on the Moon in one go in one rocket! At the same cost as the Apollo program and then going on to Mars and Saturn in the same time frame!

**The Nuclear Rocket**

Way back in the 1950's, after the initial frantic WWII work on the Manhattan Project, America's (and the worlds) first atomic bomb had slowed and released some of the designers and builders of this weapon. These scientists set about looking for peaceful commercial uses for their work, rather than just blowing up cities and killing people. Turning the power of these weapons into something useful for mankind was a challenge, the spears into ploughshares concept. One early suggestion was to use atomic bombs to build canals by planting several in a row and blasting out a channel. Build the Panama Canal in 20 seconds. Peaceful projects maybe, but still controlled by the military.

A team was assembled to look at peaceful applications in 1958 in San Diego, at General Atomics, a division of General Dynamics, by a former Manhattan project leader/physicist, Frederic de Hoffman. Rapidly a team of around 50 was formed including one of the foremost bomb designers of the day, Theodore "Ted" Taylor who was the project leader. This team became Project Orion and developed the concept during its short seven year life.

With the governments Advanced Research Project Agency and the Air Force serving as overlord, soon Taylor's team had designed a spaceship of between 4,000 and 10,000 tons propelled by atomic bombs! This would carry a crew of up to several hundred in comfort, not at all like the spartan conditions endured by the chemical fuel rocket crew.

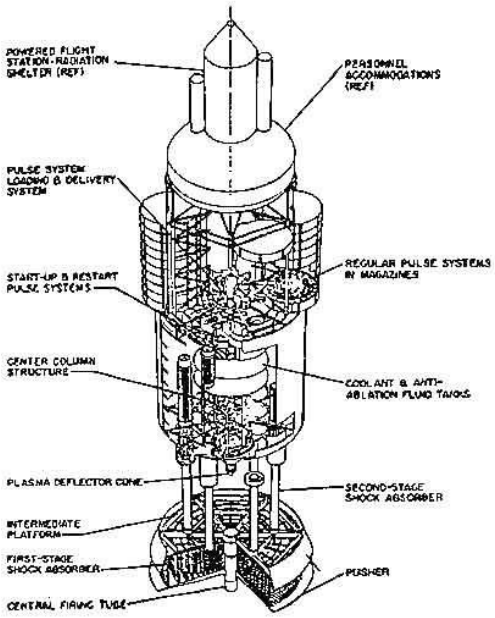
The first ideas for an atomic drive were developed by Stanislaw Ulam and Frederic de Hoffman while working on the Manhattan Project in 1944. While everyone was working out how to deliver a bomb by rocket, Ulam was thinking how to deliver a rocket by bombs! Taylor's team refined the initial ideas into a working spacecraft.

At first glance this all sounds daft. To expect a series of explosions to give a smooth ride is wrong. Yet this is how we have been travelling now for over a hundred years, propelled by an engine which has an explosive heart. That is how a car's petrol or diesel engine works, a series of timed controlled explosions in each cylinder in turn transmits the energy into the turning motion of the crankshaft which in turn drives the wheels. It doesn't feel jerky because the power of each pulse is small in relation to the mass and speed of the car and each pulse is smoothed out by the gasses expanding down the cylinder as the piston is pushed down. With a 6 cylinder engine there is almost a continues force acting on the crankshaft. Even a single cylinder motor scooter runs smoothly, OK there may be a bit of vibration at tickover but once running over that speed it's fine. A rocket motor is just one long controlled explosion pushing on the top surface of the rocket chamber as the gasses try to escape as fast as possible out the other end.

But it would be crazy, no, suicidal to sit on top of an exploding atom bomb. Even a "small" one. Two "small" atomic bombs flattened two Japanese cities, Hiroshima and Nagasaki in 1945. One early design was for a nuclear pulse rocket with a chamber 130 feet in diameter with a small 0.1 kiloton bomb going off every second (a kiloton is 1,000 tons of TNT), with water being injected as propellent.

One of the early members of the team at General Atomics was the mathematician Freeman Dyson, then at the Institute for Advanced Study in Princeton, New Jersey, (this is the same Freeman Dyson who advised astronomers to look for a very dull infer-red glow from a star. Which is all you would see, he suggested, of a sufficiently advanced civilisation that had enclosed their star in a shell to gather all of its energy, a Dyson Sphere). *"It will work, and it will open the skies to us"*, Dyson stated in 1958. *"The problem of course is to convince oneself one can sit on top of a bomb and not be fried."*

It was after one of the first atomic blasts in the New Mexico desert that one of the team went looking for the remains of the 60 foot tower the device was set off on. Most assumed it had been vaporised by the bombs fireball, but he found it in bits scattered around on the desert floor, blackened, bent and twisted by the blast, but not melted has had been predicted. The heat of the 80 kiloton bomb was too fleeting to melt the metal completely. With this observation the team realised they could tame the bomb.




Cutaway View of the 10-m Mode III Engine (U)

CONFIDENTIAL

*An early design for the Orion spaceship. These are the best drawings I can find of the early designs.*

**The Orion Project**

This idea of an atomic bomb fuelled spaceship takes a bit of getting use to. This would have been a really, seriously **BIG** spaceship, as big as a warship and built like one. Up to 10,000 tons or more in weight and propelled by small atomic bombs going off once or twice a second. The first Orion ship would have been around 20 stories tall and be about 135 feet in diameter at the base. This was the size of the two stories high circular technical library at a facility in down town San Jolla were General Atomic moved to in 1958. This is the total size of the space ship, it is not a "staged" ship like the Saturn V vehicle, the fuel is only a small amount of the total weight. So the complete ship stays together and no parts of it are thrown away after take off.

The base, a slightly concave smooth armoured surface weighing 1,000+ tons is called the pusher plate, this is were the blasts from the bombs would be converted into energy to push the ship forward through a system of shock absorbers and hydraulic dampers so as to give the craft and crew a smoother ride.

For the first launches Taylor thought that the US nuclear test site at Jackass Flats, Nevada would be ideal. The sight of Orion at launch can only be imagined, even small nuclear bombs going off every half a second under a 20 story high silver space ship is the stuff of science fiction. Surely no-one could watch as the flash from the explosions would burn the eyes from miles away and the noise would break windows. . .? The launch from Earth would

take about 200 bombs going off every half-second with a yield of around 100,000 tons of TNT. This would lift the ship to 125,000 feet with each blast adding 20 mph to its velocity. 600 more bombs with increased power up to 5 kilotons would get the ship into a 300 mile low Earth orbit. The G forces on the vehicle would be quite low during a vertical take-off of 50 or so miles until it had cleared the atmosphere before banking over to go into orbit so as to minimise radioactive fallout and contamination.

It should be remembered that this staggering concept was developed at a time when the USA was struggling to put a man in orbit; and Taylor and Dyson were designing pulsed nuclear space ships to explore the solar system, *"Our motto was 'Mars by 1965, Saturn by 1970'"* remembers Dyson.

Some of the early cost estimates were surely overly optimistic, Dyson gave a cost at $100 million a year for a 12 year program, this could not have been realistic, as the thousands of items needed to be designed and built, from spacesuits to scientific instruments would have soon doubled this amount. Even if Orion had piggybacked on top of military programs it would have cost a lot more. But even if Dyson was out by a factor of 20 the cost would have been roughly the same as the final Apollo accepted cost at $24 billion.

The whole ship would be built more like a submarine than a space ship, with thick steel for sides and bulkheads instead of thin aircraft aluminium as in todays space craft. With a payload of a thousand tons and with a crew of 150, this was a space liner. This thickness of metal would be a huge help in shielding the crew in the nose section from cosmic and solar radiation as well as the atomic blasts from the rear. The pusher plate would be several feet thick with the bomb ejector mechanisms just behind it.

The bomb ejector mechanism took a great deal of design effort, the designers looked at the handling processes involved in a Coke Cola bottling plant as well as the Gatling machine gun firing system. The ejector mechanism would have to be able to pick up different sizes and types of bombs and fire them out of an aperture in the pusher plate at least several a second steadily for several minutes at a time and not fail. This machine would have to fire out a bomb perhaps every quarter of a second at take off, increasing that to once every second with larger bombs after it had gained height and left the atmosphere behind.

Each blast would be exploded less than 100 feet behind the pusher plate, the heat pulse would be quick and not able to melt such thick material even through it would abrade a layer each time a bomb exploded. Even in car engines the peak temperature reached in the cylinder on each combustion cycle far exceeds the melting point of the metals but it is far too brief a part of the combustion cycle to damage the engine.

Up to 5 billion hp would be produced by each atomic device and an ISP from 10,000 to a million seconds is available as thrust, hundreds of times more power than is available with chemical fuel. No wonder a BIG rocket was a possibility. Each blast would give the ship a large kick, so the idea of the pusher plate was that it was separated from the main body of the rocket by a system of hydraulic rams which would smooth out the ride as the suspension on a car smoothes out a rough track full of potholes and ruts.

The atomic devices were not pure atomic bombs, but would be coated with a thick coating of hydrogen-rich plastic which is instantly converted to gas when the bomb goes off giving the push to the ship. In a chemical rocket, the fuel is heated by combustion which pushes the propellent away from the ship, but Orion pushes the ship away from the propellent.

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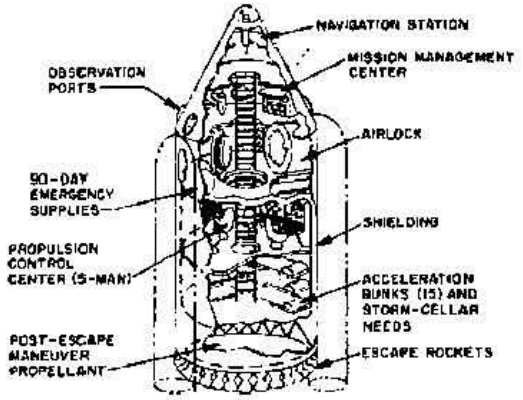



Fig. 3.5--Powered flight station-escape vehicle for 20-man exploration missions with 20-in configurations

*20 man Orion spaceship emergency escape vehicle showing layout.*

Ted Taylor was a specialist at making small atomic bombs when the drive was on to build ever larger ones and he was aware of techniques for shaping the explosions to force debris in a particular direction. Any type of material can be used, including ice and even shipboard waste between the ejected bomb and the pusher plate. The bomb vaporises any material into a jet of plasma which hits the pusher plate, this will be moving a hundred times faster than the speed of a rocket exhaust. An ISP up to a million could be produced with larger bombs! The wave of plasma hits the pusher plate, bouncing off the rear of Orion at temperatures no rocket motor would withstand. The blast of gas is at about 120,000ºK but only lasts for about one three-thousands of a second. This is too short a time for the heat to melt or penetrate the plate, so it is able to survive and cool before the next blast. Even after several thousands of explosions needed for a long voyage the total plasma push time will be less than a second.

The idea of the flat pusher plate to do away with the combustion chamber completely was first thought of by Stanislaw Ulam and Cornelius Everett in a classified 1955 paper. Instead bombs and propellent material would be ejected from the ship and rely on the plasma pulse to push the ship forward. Ulam was also the person who made the first practical design for an H-bomb.

Over seven years and at a cost of about 10 million dollars several designs for a bomb fuelled space ship were made and many models built. Much of the design work was on the detail of the types of atomic devices necessary to power the vessel. Many successful models were built and launched with small chemical explosives to test out ideas and designs for the pusher plate and the dampers. The specifications and designs for the small atomic bombs needed for Orion remains classified to this day. Think how many terrorists would like to have plans for small atomic bombs!

No technical problem seemed to be a stumbling block, not the melting of the pusher plate or the radiation hazard for the crew. With such a large ship thick lead for shielding was no problem. One design was for a ship of 40 million tons, powered by 10,000,000 bombs!

Think Big. At the beginning of 1958 a design of a 4,000 ton vehicle powered by 2,600 bombs capable of orbiting 1,600 tons was proposed, with such a large vessel costing up to $500 million. By 1964 a tour of our solar system would be possible including a two year stop on Mars and Saturn's moons by 1970!

When Arthur C. Clarke and Stanley Kubrick started to work on the film *2001, A Space Odyssey*, in the mid 60's, Clarke wanted the spaceship Discovery to be powered by the Orion type of engine, but Kubrick didn't want anything to do with it as his previous film had been *Dr. Strangelove.* Which ended with the end of civilisation by atomic warfare, and he had had enough of atomic bombs. *Footfall* by Larry Niven and Jerry Pournelle, published in 1985 was the story of an Earth invasion by small elephant like aliens, who were only beaten when the US built a large Orion space ship covered in ice to attack their mother ship. I don't know of any other SF works which feature this method of propulsion.

But the world was changing in the early 60's. Up to that time, thousands of nuclear weapons with millions of kilotons of explosive power had been tested around the globe and fallout radiation was building in everyone on the planet. Suddenly pollution was the worry, with Strontium 90 getting into everyone's food and then into their bodies. Everyone on the planet was infected with fallout, there was no escape. Hundreds of air burst atomic bombs going off at three a second suddenly didn't seen to be such a good idea, so in 1963 Orion was cancelled. The Nuclear Test Ban Treaty had stopped the project dead.

**Will Orion ever be built?**

But it was not quite the end, a proposal to use the bottom half's of the Saturn V to lift the Orion ship into Low Earth Orbit was suggested. Several Saturn V strapped together to lift parts to be assembled in LEO before setting out for the Moon and planets was a none starter for NASA who by then had all the designs done for the lunar landers. All of the design work on Orion was classified and all mention of the project silenced. Work was stopped and the team disbanded. Even today many details of the project are secret.

But what has been invented, sometimes years before time, will maybe, someday, many years later, need brushing off and re-examining for todays needs. If the USA are serious about going to Mars, Orion may be the best (the only way?) to get there with todays technology. A ship could be assembled in lunar orbit from material mined on the Moon and shot into orbit. It need not look pretty but with thick walls it would keep the crew safe from dangerous solar flares and cosmic radiation over the journey. With such a large vessel it may be possible to spin it so as to create artificial gravity on the journey.

Orion ships are big and would not land on Mars or anywhere else for that matter. So small landing craft would be taken along and left either on Mars or on one of the moons for future use. The radiation from the nuclear bombs would not be a problem in space as the speed of the plasma is well in access of the solar systems escape velocity. The small amount not ejected would be swept up by the solar wind and pushed out of the system with the rest of the radiation from the sun.

A launch from lunar orbit would look amazing from earth, with a pinprick of light winking on and off twice a second near the first quarter Moon low in the western evening sky. At first the flashes would seem not to be moving, but soon they would be seen to be becoming further apart as the Orion ship picked up speed. After a few hundred pulses the ship would be going faster then the escape velocity of the Earth and Moon and they would be on their way at a far higher speed than is possible with chemical fuelled rockets so cutting months off the journey. A trip to Mars in Orion would only take a month or so there, after a little more

than a year on the planet the Earth would have swung close enough to return to by the shorter route. The crew could be back much sooner than by using chemical fuel rockets and using a long six month transfer orbit to reach Mars. Then the long wait for the two planets to re-aline for the (6 month) voyage back. Some estimates put this as a minimum 2½ year trip.

What is true is that this spaceship idea may be the best and fastest way we have yet got if we are ever threatened by a large NEO or a comet. It is not feasible to expect it to ever be launched from the ground as the fallout is totally unacceptable today (unless a planet wide disaster was in store). But out in space, in high orbit around the Earth or Moon it would be a possible to use any number of devices to drive the ship. And the further from Earth the less of a problem, it may be our only way to the outer planets and the stars until we invent warp drive.

And the six bangs of the title?

Many small models of Orion where made and tested using small amounts of explosive to test the theory, and many were destroyed. But much work was done on the design of the pusher plate and in November 1959 a test was made with a model which fired six small timed controlled explosions behind the model onto the pusher plate, this sent the model over 100 feet into the air. Impulsive fight could be made to work and was stable. To date this is the longest fight yet made by the project Orion!

**Sources / Further Reading**

*"Death of a Project"* by Freeman Dyson, Science, vol. 149, p. 141-4, 9 July 1965.

*"Interstellar Transport"* by Freeman Dyson, p. 41 Physics Today, October 1968. A design for an Orion spaceship can be found in the same issue.

# A Penguin Called Venus

By Mike Frost

The island of Kerguelen, in the stormy waters of the southern Indian Ocean, is one of the most remote parts of the world. Although it is quite a large island, approximately 80 miles long by 60 miles wide, most of Kerguelen is covered by glaciers, and it has never been inhabited on a permanent basis. The only people to stop there regularly before the modern era were whalers and sealers. Yet, for a period of five months in 1874 and 1875, Kerguelen was the destination of three major scientific expeditions. Why? Because (of course) of the 1874 transit of Venus.

Transits of Venus across the face of the Sun, you may recall, occur in the current epoch in pairs, 8 years apart, separated by intervals of more than a century. When the previous pair of transits to 1874 occurred, in 1761 and 1769, expeditions were dispatched all over the world. This was because astronomers, led by Edmond Halley, had figured out that precise measurements of the path of Venus across the Sun, as measured from a number of different locations, would enable the size of the solar system to be determined with accuracy for the first time. The single most important measurements were the time of ingress and egress; that is to say, the second contact, the exact time when Venus moved completely on to the

solar disk, and the third contact, the last moment before the planet began to move off the solar disk. The first contact, when Venus first touched the solar disk, and the fourth contact, when the final part of the planet slipped off the disk, were more difficult to judge exactly.

Unfortunately the results from the eighteenth century expeditions were disappointing. Quite apart from all the misfortunes that befell many of the participants, it turned out to be surprisingly difficult to estimate the exact ingress and egress times. As Venus came fully onto the solar disk, most observers reported a tiny "black drop" which appeared to connect Venus to the edge of the Sun, distorting the image of Venus from circular to pear-shaped and making the exact time of ingress difficult to discern. This effect is still not fully understood; even now, different authors suggest effects in the atmosphere of Venus, and effects in the Earth's atmosphere. However, a recent article in Sky and Telescope makes a convincing case for the black drop effect resulting from seeing in the Earth's atmosphere.

By 1874, other methods of estimating the size of the solar system were available; in particular measurements involving asteroids, which were first discovered in 1801. By 1874 dozens of asteroids were known, some of which approached the Earth more closely than Venus. Accurate measurements of asteroid positions gave a good estimate of the distance from the Earth to the Sun, the Astronomical Unit or A.U. We can now measure solar system distances directly, by means of radar, and the A.U. is known to be ninety three million miles. However, in 1874 an independent estimate of the size of the A.U. was still desirable, and so, as the next transit approached teams were once again dispatched around the world.

Kerguelen was judged to be the most accessible land able to see the transit in the far southern hemisphere and expeditions from Britain, Germany and America were sent there. The official report of the British Kerguelen expedition was published by the Royal Astronomical Society in 1882. I haven't read it. I have however read excerpts from a journal kept by one of the members of the expedition, Lieutenant Cyril Corbet, a fellow of the Royal Astronomical Society. The excerpts appeared in a paper in the BAA Journal in 1954. They give a fascinating insight of what it was like to be a part of a Victorian scientific expedition.

Corbet set sail from England on May 28th 1874, over six months before the transit date of December 9th. After the full expedition assembled in South Africa, two boats, the Volage and the Supply left Simonstown on September 27th and reached Kerguelen on October 8th and 11th respectively. The first view of the island emphasized the desolation and remoteness, *". . .snow to the water's edge, high mountains in the background. . . the straits of Magellan seem to me to be a sort of paradise comparatively."*

The intention was to establish several observing stations around the island, to maximize the chances of clear observation in case of bad weather. Indeed, the original intention was for Corbet and his colleague Lieutenant Coke to observe the transit from Heard Island, four degrees to the south. Heard Island, however, is even more remote and inaccessible than Kerguelen and even the masters of the sealing vessels counseled against trying to land there.

Eventually, three stations were established on Kerguelen, and Lieutenant Corbet took charge of one of them, Supply Bay. The main base was at Observatory Bay and was commanded by the eminent Jesuit astronomer Father Joseph Perry. [One day I will tell you about Father Perry's fascinating and tragic life story]. Lieutenant Goodridge commanded the third station at Thumb Peak.

Corbet and Coke and three others, (Young, Baynes and Dorrien) landed at Supply Bay on November 5th. It took two days to build a dwelling hut, named "black-drop hut", an observatory and a flagpole. The weather was so bad that they were unable to open food cases

systematically and had to make do with the first two cases they came across — so their first few meals consisted solely of jam and sardines!

Fortunately, the weather improved, and the two lieutenants were able to able to locate the rest of their food stores, and begin assembling the observing equipment for the big day ' barometers and thermometers, altazimuth and transit telescopes, and most important of all, the clocks which would enable them to make the all-important timings of the ingress and egress of Venus on the solar disk. Day after day, they practiced taking timings, collimating their observing instruments, and checking the rate of the clocks. There was time for relaxation — bathing, exploring the surrounding terrain, and attempts to tame one of the native animals, a penguin they named "Venus".

Transit day approached. On December 7th, Corbet wrote *"...Trying to keep calm and collected for the day after tomorrow. The barometer is falling fast though, and the weather apparently getting worse"*. On the next day *"...weather still bad and the barometer very low and falling, but I shall keep hoping, hoping, hoping for tomorrow. Oh! To think it is so close — I felt funnier today than ever I have felt in my life, and I suppose really tomorrow morning will be about the most unpleasant time of my life up till about 11 o'clock, when one will know one's fate..."*

On the evening of December 8th, Lieutenant Corbet suggested that his fellow team members went to sleep; Corbet himself observed stars until 1AM, before retiring to lie on his bed. *"I did not go to sleep of course, and at 4:30 I was up without any waking from Young [Corbet's servant]; the heavens were cloudy, yet hopeful ... Hot cocoa and then to fix my telescope firmly outside the Observatory door, compare clocks and chronometers, and get perfectly ready, although at 6 a.m. it looked dubious, very. I then roused the others, got their fat heads shaken out of them, and we all sat down at our posts patiently to wait..."*

Corbet and his team had luck on their side. There was no wind, and as the start of the transit approached the sun was still visible. The following journal entries were written up directly after second contact: Corbet's timings were noted by sub-lieutenant Baynes as Corbet called *"NOW!"*

11:49:43.5 [U.T. — 6:49 local time I think] - *"First appearance of Venus on the Sun's disk ... it was so steady, and in just the place I was intently watching for it."*

12:01:25 - *"Venus half-way on"*

12:14:14.8 - *"Venus more than three-quarters of the way on at this time: I saw its last limb outside the Sun, a very faint light ring distinctly marking it out: the sun was evidently illuminating that side."*

12:19:26.8 — *"This I believe to have been the moment of true contact: the cusps were just beginning to shake and get blunt, and I could just distinctly see Venus' second limb, with its faint light streak in perfect contact with the Sun's limb. I sang out 'Star' immediately after the 'NOW' to sub-Lieutenant Baynes, that I might make no mistake in the different times when writing at each time afterwards."*

12:19:51.0 — *"At this moment the black-drop, if any, for there was very little, was at its biggest or greatest stretch, and about to break; but I could all along, since the last time taken, distinctly see Venus' limb inside the Sun's, and only a slight shaky black shade between the two."*

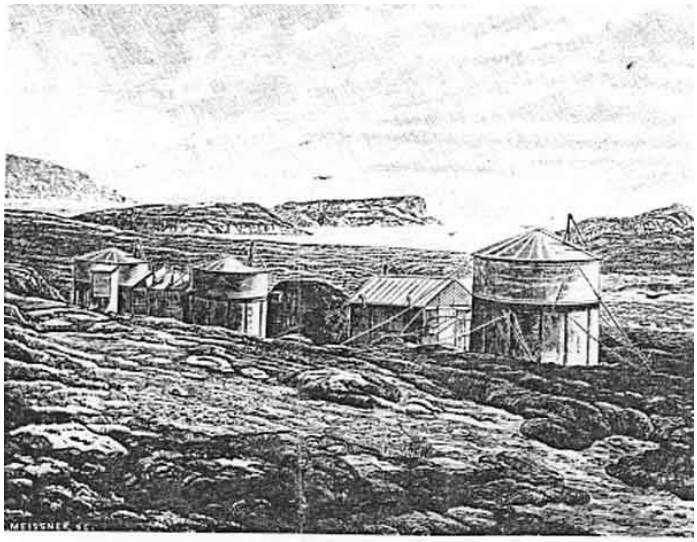
12:20:8.0 — *"At this moment there was no more shade between the two limbs, it had disappeared. . . Venus never assumed a pear-shape as observed by me, and her loss of roundness was very little at all."*

Interestingly, despite the very accurate timings taken by Corbet and Coke, their estimates of the time of ingress differed by 14 seconds. This illustrates the difficulty in estimating the exact times of contacts; easily the most important source of errors in the observations.

Corbet's delight in successfully observing the start of the transit is evident from the entry he made in his journal later in the day. *"Oh! The happy moment when from 6 a.m. to 6:30 I had been watching intently the bottom of the Sun for an impression, and I saw it — really and truly the happiest moment of my life. . . Between ingress and egress we hoisted all our flags to the ensign staff and dwelling-hut, had our breakfast of Oxford sausages and champagne, and were very happy."*

They were perhaps less happy, when twenty minutes later, the sky clouded over. Corbet noted that the black disk of Venus was the last detail to be visible on the Sun, presumably because it presented the greatest contrast. The Sun did not reappear and so the team was unable to time the egress of Venus from the disk of the Sun. This must have been a disappointment, but it was not a disaster. Provided that the timings were accurate, each observation of ingress or egress was valuable in itself.

After the conclusion of the transit, the party's thoughts naturally turned to wondering how the other parties and expeditions had fared. It was three days before they found out. Fathers Perry and Sidgreaves at Observatory Bay had seen the egress of Venus at the end of the transit; Lieutenant Goodridge at Thumb Peak had seen the ingress just like Corbet's party; the American expedition also saw the ingress. The German party, at Betsy Cove on the north side of Kerguelen, fared best, seeing both ingress and egress.



The German expedition to Kerguelen Island, as sketched by L. Weinek. From left to right, the conical shelters protected a visual refractor, a heliometer (device for measuring small angles), and a photographic refractor. The shed adjacent to the latter contained a camera obscura. From A. v. Schweiger-Lerchenfeld's *Atlas der Himmelskünde*, 1898.

The British expedition remained on Kerguelen for nearly three more months, continuing to make stellar observations and reducing the data from the transit (the final derivation of the Astronomical Unit, from the combined worldwide observations, would take another six years). On February 27th 1875, the expedition departed from Kerguelen.

Lieutenant Corbet, who had run up his spare coat on the flagpole at Supply Bay, as a gift to visiting whalers, wrote *". . .we watched the dreary desolate island for ever so long till all the low land had sunk into the sea and we could see the snowy mountains only. . . We were well clear of the land by night, and all with light hearts and full of happiness at getting away from Kerguelen at last after five months of it, which sometimes seems an age, and at other times nothing but a mad whirling gap in one's existence."*

After a successful expedition, carried out professionally and conscientiously in adverse conditions, Lieutenant Corbet was surely looking ahead to a brilliant naval career. Alas, like Jeremiah Horrocks before him, the potential was to remain unfulfilled. Cyril Corbet fell ill and died of "African Coast Fever" just over a year after observing the transit. He was still in his mid-twenties. Lieutenant Corbet was buried, with full military honours, on St Helena — another desolate island in the southern oceans.

**Sources / Further Reading**

*"The Transit of Venus, 1874"*, H.E.Ruddy, BAA Journal, July 1954

*"Transit — When Planets Cross the Sun"*, Michael Maunder and Patrick Moore (Springer-Verlag, 2000)

*"June 8th 2004 — Venus in Transit",* Eli Maor (Princeton University Press, 2000)

*"Transits of Venus"*, William Sheehan, Sky and Telescope, Feb 2004 (& succeeding months)

*"The Astronomical Scrapbook — Skywatchers, Pioneers and Seekers in Astronomy"*, pp. 226-227, Joseph Ashbrook (Cambridge and Sky Publishing, 1984). [This extract, showing

a sketch of a camera obscura used by the German expedition, was sent to me by Mike Feist of the Foredown Tower Camera Obscura, Portslade, Sussex]

# Letters (& E-mails) to the Editor

Hi Ivor,

I was reading your article in MIRA about Lagrangian points and I noticed that you say that the Sun's and Earth's gravitational pulls cancel out at L1. Can I be allowed to correct you on this point?

A satellite at L1 still experiences a net pull towards the Sun, in fact the Sun's and Earth's pulls cancel out at point inside the Moon's orbit! If the SOHO Satellite were at this point, because it would experience no gravity, it would fly out straight into the orbit of the Earth. What actually happens is that a satellite on a circular orbit inside the Earth's orbit would orbit the Sun more rapidly than the Earth, but the gravity of the Earth (so long as the sat is directly between the Earth and the Sun) in effect reduces the mass of the Sun so that the natural orbital time of a circular orbit lengthens to equal a year again.

The opposite effect happens at L2.

I haven't explained it very well - a diagram would help!

Regards, Mark Edwards

**To: undisclosed-recipients**

**Subject: Martian Air Force Denies UFO Crash**

Gusev Crater (MPI) - A spokesthing for Mars Air Force denounced as false rumours that an alien space craft crashed in the desert, outside of Ares Vallis on Saturday. Appearing at a press conference today, General Rgrmrmy The Lesser stated that "the object was, in fact, a harmless high-altitude weather balloon, not an alien spacecraft."

The story broke late Saturday night when a major stationed at nearby Ares Vallis Air Force Base contacted the Gusev Crater Daily Record with a story about a strange, balloon-shaped object which allegedly came down in the nearby desert, "bouncing" several times before coming to a stop, and "deflating in a sudden explosion of alien gases." Minutes later, General Rgrmrmy The Lesser contacted the Daily Record telepathically to contradict the earlier report.

General Rgrmrmy The Lesser stated that hysterical stories of a detachable vehicle roaming across the Martian desert were blatant fiction, provoked by incidences involving swamp gas. But the general public has been slow to accept the Air Force's explanation of recent events, preferring to speculate on the "other-worldly" nature of the crash debris. Conspiracy theorists have condemned Rgrmrmy's statements as evidence of "an obvious government cover-up", pointing out that Mars has no swamps. They point to the release of secret government memos

detailing attempts to discredit reports of the landings by alien space craft. The memos discuss strategies to avoid troubles similar to those caused by the War of the Worlds radio program of years ago. The program, which featured a sensational story of gigantic oxygen breathing two-eyed invaders from Earth, sparked planet wide panic.

Local residents like Driv Rhodo, who lives in the area of the alleged landings, are even more sceptical. "I seen it with my own 5 eyes" claimed Rhodo last week. "I've lived here over 300 years, most of my adult life-form. Them things used to be few and far between but lately they come in every few years or so. The government wants to bury the truth but I can tell you what's real. The Earthlings are going to invade and the government is spending our hard earned tax dollars on press releases and denials instead of preparing for the battle to come." A spokesthing denied any government involvement in the disappearance of Rhodo, who has not been seen since shortly after the interview, claiming "Any sentient being knows that a planet with the concentrations of water and oxygen found on Earth is a deadly and inhospitable environment for the formation of life, much less intelligent life. The fear and consternation caused by the unfounded and wild speculations of citizens like Rhodo are a traitorous disservice to the citizens of Mars."

Clive Rogers

16th December 2003

Rugby

Warwickshire

**Campaign for Dark Skies in Warwickshire**

Dear Mr Blair,

I am writing to you to ask for your support in implementing the recommendations of the Parliamentary Select Committee for Science and Technology, which reported on October 6th this year on the important subject of astronomy and light pollution. The committee found that light pollution is getting worse, and that the government is failing to take the issue seriously.

We can certainly vouch for this in Warwickshire. I am chairman of Coventry and Warwickshire Astronomy Society: we have noticed a steady deterioration of the quality of the night sky over the years. We used to have an observatory in central Coventry, but it is now impossible to observe all bar the brightest objects from the city, in part due to unnecessary and intrusive lighting schemes. Even in rural Warwickshire, the growth of (usually badly installed) security lighting means that truly dark skies are now impossible to find from our county.

However, it need not be like this. The Select Committee made a series of excellent recommendations, which could go a long way towards restoring the night skies for the enjoyment of the people of Warwickshire. Unfortunately no government department seems to be willing to take responsibility for implementing these recommendations. I would therefore ask you to take the lead in ensuring that the following recommendations are acted on:

Obtrusive lighting should be made a statutory nuisance. Local authorities should consider the polluting effects of lighting when assessing planning applications. The government's guidance "Lighting in the Countryside" should be updated. British Standard codes of practice and guidance on lighting design and power should be updated. Dark rural areas should be protected from intrusive lighting through local authority planning policies. The relation between lighting and crime prevention should be further investigated (I attended a seminar earlier this year in Winchester where the statistical deficiencies in recent research were made clear).

You may have been made aware of many of these recommendations in other correspondence from members of the Campaign for Dark Skies (CFDS). Coventry and Warwickshire AS is affiliated to this organisation, and we strongly support its goals. Dark Skies legislation has recently been enacted in the Czech Republic, in Lombardy, and is planned by our own Scottish Assembly.

However, I am led to believe that when Tom Harris MP of the Select Committee asked a question in the house about light pollution on Oct 22 2003, the matter was treated less than seriously by many present. I find this attitude disappointing, and I hope that you do not share it. The night skies are for everybody to enjoy; unfortunately we are in danger of losing them. The Select Committee report offers a golden opportunity for a strong and wise government to restore the beauty of the night skies to the people of Warwickshire and to the rest of the country.

I would be delighted to hear that you are willing to take the lead in implementing the recommendations of the Select Committee report.

Yours sincerely,

Michael Frost, M.A., M.Sc (Astronomy), M.I.E.E., C.Eng

Chairman, Coventry and Warwickshire Astronomy Society,

Member, British Astronomical Association