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VENUSIAN VIGNETTE
by R. R. S. Cox

Although Venus approaches the earth more closely than any other planet, our knowledge of physical conditions on its surface is meagre. Slipher terms it "this very difficult planet." And no wonder! For Venus, when nearest to us, lies between us and the sun, and is thus very unfavourably placed for observation. Moreover, the planet's surface shows hardly any identifiable markings, albeit under favourable conditions certain faint markings or shadings can be seen. So indefinite are they, however, that no conclusions can be drawn from them regarding the planet's period of rotation. Attempts to determine this period have so far failed. Spectrograms taken with the object of revealing—by means of the Doppler effect—the velocities of approach and recession of opposite limbs of the presumably rotating planet yield negative results. From this it may be concluded that the rotation, if any, must be slow, with a period exceeding ten days. It has even been suggested that Venus, like Mercury, turns one face always to the sun, merely rotating on its axis in the same time that it takes to revolve round the sun, *i.e.* 225 days. Radiometric observations of temperature, however, do not support this suggestion. The temperature of the dark side is probably about minus 25 degrees Centigrade, while that of the bright side is about 50 degrees Centigrade. And if the two hemispheres of the planet were permanently turned to and away from the sun, the difference in temperature would undoubtedly be very much greater. A surface in permanent darkness would endure a temperature well below minus 150 degrees Centigrade. Probably the rotative period lies somewhere between 2 and 16 weeks.

A series of photographs of the planet, taken at Mount Wilson in 1927 and 1928 in violet and ultra-violet light, showed markings which were much more definite than

those normally evident. The origin of these markings, which appear to suffer a rapid change, is unknown, but their impermanence suggests cloud. And it is, indeed, well established that the surface of Venus is completely cloud-covered. Strong evidence of this is its very high reflecting power—60 per cent., as against Mars' 15 per cent., and the moon's 7 per cent. Above the visible surface of cloud is a transparent atmosphere which reveals itself in the ring of light which surrounds Venus when the planet encroaches on the sun's disc at times of transit. Sunlight, reflected by the atmosphere, produces a twilight actually observable in the prolongation of the horns of the crescent Venus, beyond the geometrical limit ascrible to an airless sphere. Measurements of this effect indicate that the height of the atmosphere producing it is about 4,000 feet.

Spectroscopic study, conducted with the object of determining the chemical constitution of the atmosphere, is much hampered by the difficulty of disentangling the spectrum lines of our own atmosphere from those of Venus. Certain results. however, seem to be clear. There is no evidence of oxygen or water vapour; if these exist at all above the level of the cloudy surface, the quantity must be minute. Spectra taken at Mount Wilson show certain dark bands, the origin of which was at one time unknown. The bands have now been identified with carbon dioxide, and their intensity indicates that the gas must be present in considerable quantity. Hence the suggested production of a "greenhouse effect" of some magnitude. Which is to say, the gas, though transparent to incoming solar energy, prevents the escape of reflected heat rays. and thus warms the surface by entrapping heat. It is possible that the surface temperature may be as high as 100 degrees Centigrade.

If the constitution of the atmosphere is as spectroscopic evidence suggests, the existence of life on Venus seems very unlikely. The absence of water vapour and oxygen, and the presence of carbon dioxide in large quantities, seem to indicate an absence of both animal and vegetable life. On the other hand, it has been suggested that much, if not all, of the free oxygen in the earth's atmosphere was produced by the action of vegetation on carbon dioxide. Hence, the lack of oxygen on Venus may be a consequence, rather than the cause, of an absence of life on the planet.

HYMN TO PROGRESS

By P. E. Cleator

Prologue

The original propounder of the idea of making a journey through space is unknown, and the probability is that his name is forever lost. But so venturesome a specimen of the animal that thinks, we may be sure, was promptly rewarded for his mental pains in the immemorial manner—decapitation by forty-five blows of a stone axe if it happened that he graced this ball during the Neolithic Age, and burning alive at the stake if, perchance, he shared the benefits of our now perfected Christian civilisation. But though he justly died the death for his unbounded temerity of thought, the impiety he uttered lived unaccountably on, and even came to be recorded on the tablets of the race . . .

Before Interplanetary Travel

57 B.I.T.

May 3rd: A rocket-propelled stratosphere plane, flown under the auspices of the International Rocket Society, achieves a height of 25 miles, and attains a speed in excess of 13,000 miles an hour. The Governments of the world pronounce the vessel to be "of no practical use."

56 B.I.T.

February 10th : The International Rocket Society announces that the construction has begun of a rocket vessel capable of reaching the moon.

February 11th : The Churches of the world temporarily unite solemnly to proclaim that had it been intended that man should engage in interplanetary exploration, he would have been fashioned with a rocket, instead of a tail, between his legs.

February 12th : A group of eminent professors demonstrate, to the entire satisfaction of themselves and the world, that an extra-terrestial voyage is physically, chemically, and biologically impossible.

54 B.I.T.

March 25th : The International Rocket Society announces that an attempt to reach the moon will be made within a week.

March 27th : A frantic, semi-Christian mob, ten thousand strong, wrecks the completed space-ship.

April 5th : The building of a second ship is begun.

44 B.I.T.

March 25th : The second ship, shot secretly moonwards, backfires at a height of 53 miles, and crashes in flames on the British House of Lords, causing the untimely demise of five bishops, eight peers of the realm, and a charlady.

March 27th : Rocket research, by international agreement, is prohibited throughout the world.

March 28th : All books on space travel are placed on the *Index Librorum Expurgandorum*.

April 1st : The Archbishop of Canterbury, after due prayer, denounces the interplanetary idea as impious and against God.

43 B.I.T.

January 1st : The construction of a third rocket vessel is secretly begun.

35 B. I .T.

June 10th : The third space-ship, after a secret launch. falls into the Atlantic. with the loss of all hands.

June 11th : All known members of the International Rocket Society are imprisoned without trial.

June 12th : By international law, the conducting of rocket research is made a capital offence.

June 13th : A group of eminent professors demonstrate, to the entire satisfaction of themselves and the world, that an extra-terrestrial voyage is physically, chemically, and biologically impossible.

25 B.I.T.

December 25th : Forty-five rocket experimenters escape from jail.

10 B.I.T.

May 4th : The construction of a fourth rocket-ship is secretly begun.

1 B.I.T.

December 31st : Man reaches moon

After Interplanetary Travel

A.I.T. 1.

January 5th : A group of eminent professors demonstrate, to the entire satisfaction of themselves and the

world, that an extra-terrestrial voyage is physically, chemically, and biologically impossible.

A.I.T. 2.

May 7th : The Governments of the world, suddenly aroused by the thought of planetary colonisation, release all imprisoned rocket experimenters.

June 15th : Unlimited funds are placed at the disposal of the International Rocket Society for the purpose of constructing a space-ship capable of reaching Mars.

June 16th : The Pope denounces the enterprise as an attempt to defeat the plain intent of God, and calls upon the nations to forsake "this wicked project, this new Babel."

A.I.T. 8.

November 12th : The space-ship departs for Mars.

November 13th : The Archbishop of Canterbury, after due prayer, predicts the end of the world within forty-eight hours.

November 14th : A member of the Church of England is excommunicated for publicly quoting Newton's Third Law of Motion.

A.I.T. 9.

February 27th : The Martian expedition effects a landing, and radios the discovery of intelligent beings.

October 3rd : The adventurers return to earth, bringing two Martians with them.

November 2nd : An obscure monk, delving into Holy Writ in his gloomy cell, discovers that mention of space travel is actually made therein, and quotes 2 Kings, ii, 9-14.

November 3rd : The Archbishop of Canterbury, after due prayer, declares that he knew it all along.

December 25th : The Poet Laureate composes a new hymn, entitled *Rocket of Ages*.

December 26th : From the Vatican comes the glad tidings that a Herald Angel, swooping low over the City, has let it be known that interplanetary travel is no longer an abomination in the sight of the Lord.

December 27th : A Fundamentalist is lynched during a Thanksgiving Service for declaring that had it been intended that man should engage in interplanetary exploration, he would have been fashioned with it rocket, instead of a tail, between his legs.

A.I.T. 10.

January 19th : The whole of Christendom is profoundly shocked to learn from the Martian visitors, who boast three legs, five eyes, seven noses, one ear, and two tails apiece, that they are made in the image of God.

January 23rd : Plans are made to organise a united missionary expedition for the benefit of the poor, unfortunate heathen Martians.

December 13th : The good ship *Hallelujah* sets off for Mars, overloaded with representatives of the ninety-nine One and Only True Cults, three dozen Y.M.C.A. secretaries, the entire Salvation Army, Navy, and Air Force, 5,000 repeating rifles, 350 machine-guns, 3 tanks, a submarine, 10 hand grenades, 300 gallons of poison gas, 10,000,000 rounds of ammunition, and two dozen copies of the Bible, translated into Martian.

A.I.T. 12.

January 3rd : The good ship *Hallelujah* returns to earth with a cargo of Martian missionaries, itching to convert. the poor, deluded, pagan peoples of this ball.

January 4th : The visiting missionaries solemnly proclaim Bunkum-Bunkum to be the One True God.

January 5th : Earth declares Holy War on Mars.

January 6th : Escaping in the good ship *Hallelujah*, the ambassadors of Bunkum-Bunkum proceed systematically to exterminate the barbarian peoples of earth with the aid of a lethal ray.

Janary 12th : Satisfied that the delousing is complete, the triumphant Martians depart for home. Behind them, the earth burns merrily for forty days and forty nights . . .

Epilogue

To a lusty bawling of "Noah, Noah, a thousand times Noah!" the space-ark glided earthwards, alighted elumsily on a mountain top, and disgorged its psalm-singing occupants—a Sunday School Superintendent, his neighbour's wife, their three sons, a couple of blondes, and a brunette. Then emerged specimens of every living thing—two elephants, a couple of tetanus bacilli, a brave of pheasants, a pair of kippers —everything, in brief, from two tapeworms to a double dose of chicken-pox. And so it came to pass that life on this sterile ball began anew . . .

(Back to *Prologue*, and repeat *ad libitum, ad infinitum*, for ever and ever, Amen.)

TEMPERATURE IN SPACE

by Dr. Otto Steinitz

Temperature is a quality of matter ; only where matter exists can temperature be spoken of in the ordinary sense. But despite the fact that empty space does not possess this quality, we often encounter literary discussions on the temperature of space, and even find it erroneously stated to be minus 273 degrees Centigrade. Such a statement is absurd, assuming that space is devoid of any material substance.

The temperature of a body at a given point in space depends upon several circumstances. Neglecting, for the moment, all circumstances except solar and other radiation, let us assume that the body is very small, its radiant surface of uniform quality, and that it has already reached the equilibrium of radiation, i.e. the temperature is constant, there being no absorption or radiation of heat. This temperature is referred to in the following as *the temperature in space at that point*, or, in short, the *space-temperature*.

Elsewhere, I have shown that the *space-temperature* has a certain value at every point, and have mathematically developed formulae to calculate this value. By calculation, I have found that the *space-temperature* at a point which is a similar distance from the sun as the earth, is 281.8 degrees Centigrade Absolute or 8.8 degrees Centigrade above freezing point. The corresponding values for other planets at their mean distances from the sun, are:

Planet.	Mean distance from Sun. (in millions of miles)	°C. Absolute	°C. above F.P.
Venus	67	331	58
Mars	141	228	–45
Jupiter	483	124	–149
Neptune	2,783	51	–222

It can he seen that the *space-temperature* is considerably higher than absolute zero (minus 273 degrees Centigrade), even at the distance of Neptune from the sun.

In the immediate neighbourhood of a reflecting celestial body, the intensity of radiation is increased by its reflection, thereby increasing the *space-temperature*. The increase depends upon the nature of the reflecting surface, but it is, at most, 19 per cent. of the absolute *space-temperature* which exists without the reflecting influence.

In the space between the earth and moon, the influence

of the radiation reflected from these two bodies varies according to their position relative to the sun. Midway between earth and its satellite, that influence is very small ; at that point the *space-temperature* is about 282 degrees Centigrade Absolute. Near the moon's surface it is about 330 degrees Centigrade Absolute, and in the immediate neighbourhood of the earth's atmosphere, a little less. So that the temperature of a body going between earth and moon is between 9 and 50 degrees Centigrade above freezing point, provided it is not in the shadow, where its temperature would be in much lower. However, a direct line between the illuminated hemispheres of earth and moon is only entirely in shadow during the new moon or an eclipse of the moon by the earth's shadow; at all other times this line is within the sphere of sunlight.

THE STORY OF THE ROCKET AEROPLANE

by Willy Ley

On March 22nd, 1918, Professor Nikolai Alekseyevitch Rynin, of the Technical High School in Leningrad, received a letter from Professor Pyotr Ssergeyevitch Shtegoloff, editor-in-chief of the monthly *Builoye* (*The Past*). It stated that Comrade Shtegoloff would be glad to receive Comrade Rynin's criticism of a manuscript, which was enclosed, and which had been found among certain documents of the Secret Police of the late Czar. Professor Rynin opened the document and began to read. And he was amazed to discover that this manuscript, dug out from a pile of documents concerning cases of high treason during the Czarist epoch, contained a description of the world's first rocket aeroplane!

The document concerned the sensational trial of the 7th, 8th and 9th of April, 1881, in which six members of the revolutionary party, *Narodnaya Volna* (*Will of the People*), were charged with the "major crime"—notably A. Shyelyabov, N. Ryssakoff, and Nikolai Kibaltchitch.

The "major crime" was the assassination of Czar Alexander II. Shyelabov had been the leader; he talked propaganda throughout the trial. Ryssakoff had thrown the bombs; he was ready to tell everything. Kibaltchitch had manufactured the bombs; he hardly spoke at all, because his mind was working on other things. Only twice did he speak, for the first time when the chemical and

technical experts were summoned ; he argued about technical details, and asked many questions about explosives which even the experts could not readily answer. The second time he asked for paper, pen and ink, and for permission to write in his cell. He wished to record the preliminary design of an invention before the death sentence he expected was executed. Kibaltchitch was promised that his manuscript would he submitted to a committee of technical experts immediately. Actually. it was simply attached to the documents among which it was found, it being considered that the matter would merely arouse "undesirable public interest."

Professor Rynin found it necessary to report that the invention of Comrade Kabaltchitch did not provide a satisfactory solution of the problems concerned. Nevertheless. interest was aroused. Nor was the question any longer "undesirable," for books on rocket theory had already been published in Russia as well as in other countries.

When asked if the rocket can he used as a means of propulsion for aeroplanes, engineers, especially those engaged in experimental work, usually answer in the negative, and if questioned further, explain that the rocket motor burns only for a very brief period—a matter of seconds, maybe minutes. And that is sufficient for their particular purpose, for vertical rocket shots, involving steady accelerations of two, three, or even four gravities. do not require long burning times to reach high altitudes. But, if questioned further, they admit that rocket motors may be made to burn for longer periods; that Dr. Sänger had one going full blast (with a thrust of 25 kilograms or 55 lbs.) for no less than 25 minutes. But they will add that the efficiency of the rocket blast depends upon the speed of the rocket (or rocket vehicle), and that a high efficiency can only be reached if exhaust speed and rocket speed are about equal. And a good rocket blast has an exhaust speed ranging from 6,000 to 10,000 feet per second—a speed which it is difficult to imagine any vehicle, except a rocket, approaching.

Inventors, insist, however, that there must be a way. And the problem is admittedly fascinating. The rocket motor can function in the absence of air, and those who have investigated the matter mathematically assert that the thrust of the rocket motor would actually increase in *vacuo* because the exhaust velocity would increase. One

of the investigators, Dr. Robert H. Goddard, demonstrated this fact experimentally. Rocket aeroplanes, therefore, could operate at altitudes inaccessible to ordinary aircraft.

Rocket engineers perforce admit that there is some logic in this argument, but remain doubtful. They remember the tests made with ordinary, and even with specially constructed, aircraft that were propelled by rocket motors. The German *Rhön-Rossitten Gesellschaft* tested small models (type *Stork*). The rockets (powder) shot the models vertically into the air, and, when burned out, the machines emulated the "falling leaf" and were smashed. The same Society had one pilot. Friedrich Stamer, fly a full-sized glider of the type *Duck* in June, 1928, from one of the Rhön mountains. The flight, performed with the aid of two powerful powder rockets, proved fairly successful, but the last spark set the 'plane aflame. Wilhelm Kolltmorgen's rocket 'plane models crashed because their landing speed was higher than they could stand. A large all-aluminium model tried at Greenwood Lake, U.S.A.. in February, 1936, lost its wings in flight. The wings had been well designed, but ill-constructed, and the rocket motor exerted ten pounds more thrust than the maximum allowed. Air resistance bent the wings and tried to tear them off as the rocket motor hurled the 110-pound fuselage through the air like a projectile.

Before these tests were made, a French engineer, Henri F. Melot, had already found a very surprising solution of the problem. Aware that the efficiency of a rocket 'plane suffers from the discrepancy between exhaust velocity and actual flying speed, he devised a method of avoiding high exhaust speeds without sacrificing power or simplicity of design. His ideas were published for the first time in *La Science et la Vie* in March, 1921. The "Melot propulsor" consisted of two parts—the "blast generator" and the "thrust augmentor." To-day, a normal rocket motor would serve as a blast generator, but such a device did not exist in 1918. Melot solved the problem by using a horizontal double-cylinder instead, with a freely moving piston shuttling back and forth inside. This piston was not connected to rods and crankshaft, but merely took care of the compression. The exhaust gases were expelled through a common nozzle, thus producing a fairly steady stream. Around the exhaust nozzle, Melot arranged a series of so-called venturi nozzles, designed to suck in air and add it to the blast. When the blast entered the first

venturi nozzle it was of small mass and high speed; when it left the last, it was of large mass and slow speed.

Melot reported that his system, which was only tried on the proving stand, worked very satisfactorily after the motor had warmed up.

A German inventor, Wilhelm Godau, in Duisburg, found another solution, which may find wide application. While Melot first created a small blast of high speed, which was afterwards changed into a low speed blast of greater weight, Goldau produces such a blast at once. He uses a series of extremely large combustion chambers working through a common exhaust nozzle. In contrast to the pressure in the combustion chamber of an ordinary rocket motor. which is in the region 300 lb. per square inch, Goldau uses only 30 to 45 lb. per square inch pressure. The fuels used are benzol and similar compounds, which are sprayed into the chamber in a vaporised state, whereas they are fed into the chamber of ordinary rocket motors in liquid form. The working of the whole assembly is as follows : While the exhaust valve of one chamber is closed, a quantity of fuel is sprayed into it and the intake valve for the atmospheric air closed simultaneously. The fuel-vapour-air mixture is ignited, combustion takes place, and the exhaust valve opens. Since at least two chambers work on a common nozzle, the exhaust of one must result in the sucking of fresh air into the other chamber. Then the exhaust valve of the second chamber closes and fuel vapour is sprayed into it.

Both designs can probably be developed sufficiently to do what their inventors claim, but the use of both types of rocket-driven aircraft would be restricted to the lower atmosphere, because both need atmospheric air. Melot needs it to increase his blast ; Goldau needs it to ensure combustion. But rocket aeroplanes are supposed to travel in altitudes inaccessible to other aircraft, where the speed of travel can be greatly increased due to lack of air-resistance ; and while it is true that Melot's and Goldau's designs will exceed the speed of propeller-driven craft, the gain will not be very great.

Professor Hermann Oberth,. who is outstanding as a theorist of rocket propulsion, first hinted how it could he done. It was necessary, he explained. to start the flight vertically, thus avoiding as much air-resistance as possible. At an altitude of twelve or fifteen miles, the ship would have attained a very high speed, and, turning into a horizontal position, would aim in the direction of its

destination. The ship would have gathered sufficient momentum on its upward flight to carry it, without further expenditure of fuel, across the distance to be flown, there being very little air-resistance. The small amount of air-resistance encountered would retard the ship gradually as it approached the Tropopause—the transitional layer between Stratosphere and Troposphere. The ship would enter this layer, continuously decreasing its speed until it finally reached the Troposphere near its destination, with a speed about equal to that of ordinary fast aircraft. The landing would be made in the fashion of aeroplanes, assisted by the expenditure of a small amount of fuel saved for this purpose.

This hint of Professor Oberth's—it cannot be termed a theory because Oberth merely wished to show what forces were involved in the problem of the rocket 'plane, and how they differ from those applied in aviation—caused further investigation by various authors. The most complete work has been done by Dr. Eugen Sänger, of the University of Vienna, who has advanced a theory of rocket. aeroplanes very similar in its major aspects to that of Oberth. The performance of a flight (or should it be called the trajectory?) differs from Oberth's suggestion mainly in the ascent. While Oberth thought it advisable to ascend vertically, Dr. Sänger wants to ascend at an angle of 30 degrees. In this case the thrust needs to be equal to about 65 per cent. of the weight of the ship, whereas a vertical ascent requires a thrust approximately two and a half times the weight of the ship.

It is true that Dr. Sänger's method requires more time for a. given altitude to be attained, but there must be taken into consideration that at the same time distance is covered. When the stratosphere is reached, and supersonic speeds are attained, the rocket motors will be shut off. The remainder of the flight closely resembles the performance as outlined by Professor Oberth. Dr. Sänger has worked out many of the minor problems, too ; his work fills a book of 220 pages that are not very easy to read. Whether everything he suggests will be the final solution may be justly doubted, but his work shows that a solution is possible.

It is more than fifty years since Kibaltchitch made the first attempt to tackle the problem. We can hope, however, that it will take less than that time for present-day theory to develop into a practice which, later still, will be regarded as one of the great achievements in the development of transportation.