THE ALLEGED CONTRIBUTIONS OF PEDRO E. PAULET TO LIQUID-PROPELLANT ROCKETRY[+]

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Not infrequently, the name Pedro E. Paulet appears in chronologies, articles, and books dealing with the specific subject of liquid-propellant rockets and the larger areas of rocketry and astronautics. Paulet (Figure 1), a Peruvian, is recognized largely because of a letter he wrote from Rome in 1927 to a Lima newspaper. In that letter he claimed to have engaged in liquid-propellant-rocket experiments while a student in Paris three decades earlier. Paulet's letter subsequently came to the attention of a Russian rocket and space flight popularizer who quoted extracts in a book published in German in 1929. The purpose of this paper is to review the background and examine the available evidence concerning the only known claim to liquid propellant rocket engine experiments in the nineteenth century.

References to the alleged work of Paulet are fairly widespread. Albert Hausenstein, for example, wrote in 1940:[1] "We should not fail to mention Pedro Paulet who carried out, in 1895, experiments with a liquid propellant rocket characterized by a surprizing performance. During the period 1900-1918, no successful progress was made in the field of liquid propellant rockets based on Paulet's discoveries." After World War II, George P. Sutton described the Peruvian's work in these terms:[2]

> It is not yet certain when the first liquid propellant rocket motor was invented. The first practical working rocket motor is claimed by Pedro E. Paulet, a South American engineer from Peru (1895). He operated a conical motor, 10 centimeters in diameter, using nitrogen peroxide and gasoline as propellants and measuring thrust up to 90 kilograms. He apparently used spark ignition and intermittent propellant injection. The test device which he used contained elements of later test stands, such as a spring thrust-measuring device. He did not publish his work until twenty-five years later.

[+]Presented at the Third History Symposium of the International Academy of Astronautics, Mar del Plata, Argentina, October 1969.

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Fig. 1
Pedro E. Paulet c 1905

Sutton published in both editions of his Rocket Propulsion Elements a diagram (Figure 2) of the motor based on Paulet's written description. In the first (1949) edition, no direct reference is noted, but in the second edition he assigned Ref. No. 2.111: "P.E. Paulet, Liquid Propellant Rocket, El Commercio, Lima, Peru, 1920" [sic: 1927].

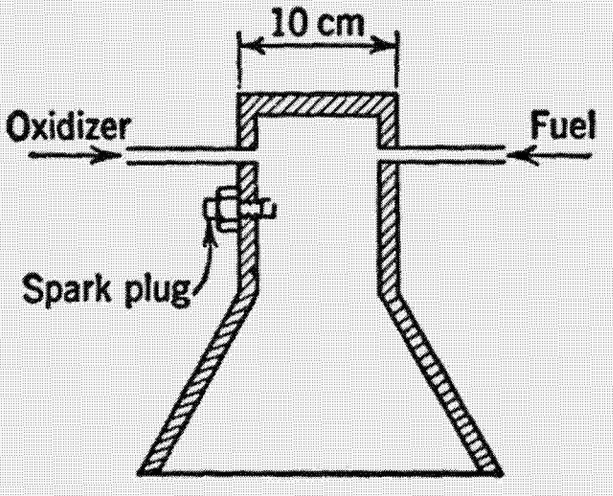


Fig. 2
George Sutton's Representation of Paulet
Thrust Chamber

In December 1946, a few years before Sutton's book appeared, the liquid-propellant rocket engineer, James H. Wyld, presented a survey paper, "The Liquid-Propellant Rocket Motor," to the Oil and Gas Power Division of the American Society of Mechanical Engineers in New York.[3] Wyld touched on Paulet's claim, and offered a schematic diagram

not only of the thrust chamber but of the thrust-measuring spring dynamometer, timer, and propellant tanks (Figure 3). Sutton, who cited Wyld in his book apparently took no steps to check the authenticity of Paulet's claim.

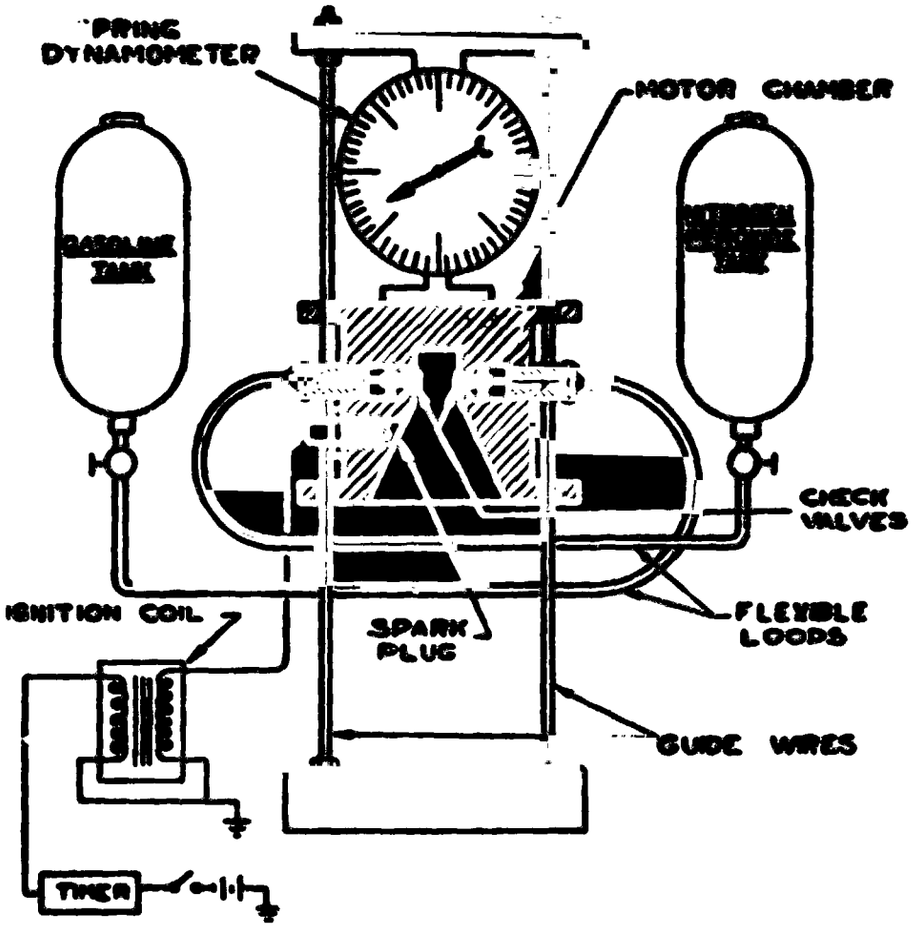


Fig. 3
James E. Wyld's Representation of Paulet's Liquid-Propellant Rocket

Nor did Wyld. But more cautiously, he asserted that the original source of the liquid-propellant rocket concept remained "quite uncertain," although "there is some evidence that the earliest practical working motor of this type was constructed in 1895 by Pedro E. Paulet, a young engineer of Peru, South America." Noting that Paulet did not publish an account of his work until 1927 in the Lima newspaper El Commercio (whose spelling, incidentally, is El Comercio), Wyld reiterated that "the validity of his claim may be rather doubtful."

Wyld, unlike Sutton, cited S.B. Scherschevsky's 1929 book Die Rakete für Fahrt un Flug as the source of information on Paulet's claim. Wyld simply translated from German into English Scherschevsky's own translation into German of extracts from the Spanish language letter in El Comercio. In a section entitled "First Practical Experiments," Scherschevsky stated categorically that liquid-propellant rocket motors were first tested by Paulet between 1895 and 1897. Notwithstanding the interval of three decades between the time of the alleged work and the time he got around to writing about it, Scherschevsky declared:

> At that time one could have experimented with rocket motors operating on liquid propellants. And one could have worked with imperfect propellants and materials. This must be said to the doubters and skeptics.

Doubters and skeptics there have been ever since. One of the first, Willy Ley, expressed strong reservations in his 1932 booklet, Grundriss einer Geschichte der Rakete.[5] He allotted Paulet's claim slightly over four lines, concluding: "The doubts are obviously correct." Ley never thought much of Scherschevsky, either. In the first edition of Rockets,[6] whose title was to expand over the years,[7] Ley complained:

> There are many legends connected with that early period which unfortunately acquired some permanence because a German-writing Russian by the name of Aleksander Borissovitch Sherschevsky (sic) uncritically put hearsay into some of his articles, and into his one and only book.

Scherschevsky, it appears, had gone to Germany to study gliders. But he overstayed his time and dared not return to his homeland. "Lazy by nature (and very proud of it), he earned just enough money for room and board by writing for professional journals," wrote Ley. "He could have done better if he had written about Russia but he didn't; he felt that what could be said at that time would not be considered too favorable by the Western mind, and he was genuinely in favor of the Soviet government. He was a refugee by accident." Between 1944 and his death 1969, y would not change his opinion about Scherschevsky, nor give further credence to Paulet's claims of experimenting with liquid-propellant rocket engines.

One who did believe in Paulet was the German, Max Valier. In 1930 he wrote that a liquid-propellant rocket motor of "astonishing power" had been developed by the Peruvian.[8] Valier seemed most pleased that "the 19th century did not close without a promising beginning to the technical development of rocket motors." He also felt that "the work of the Peruvian Paulet is most important for present projects leading to rocket ships, for it proved for the first time—in contrast to powder rockets burning only a few seconds—that by using liquid propellants, the construction of a rocket motor functioning for periods of hours would be feasible."

Paulet's claim has continued to arise intermittently. Following Ley's precedent, however, neither Pendray,[9] Ananoff[10] nor Williams and Epstein[11] credit the Peruvian in their books, although all refer to Scherschevsky in one context or another and certainly

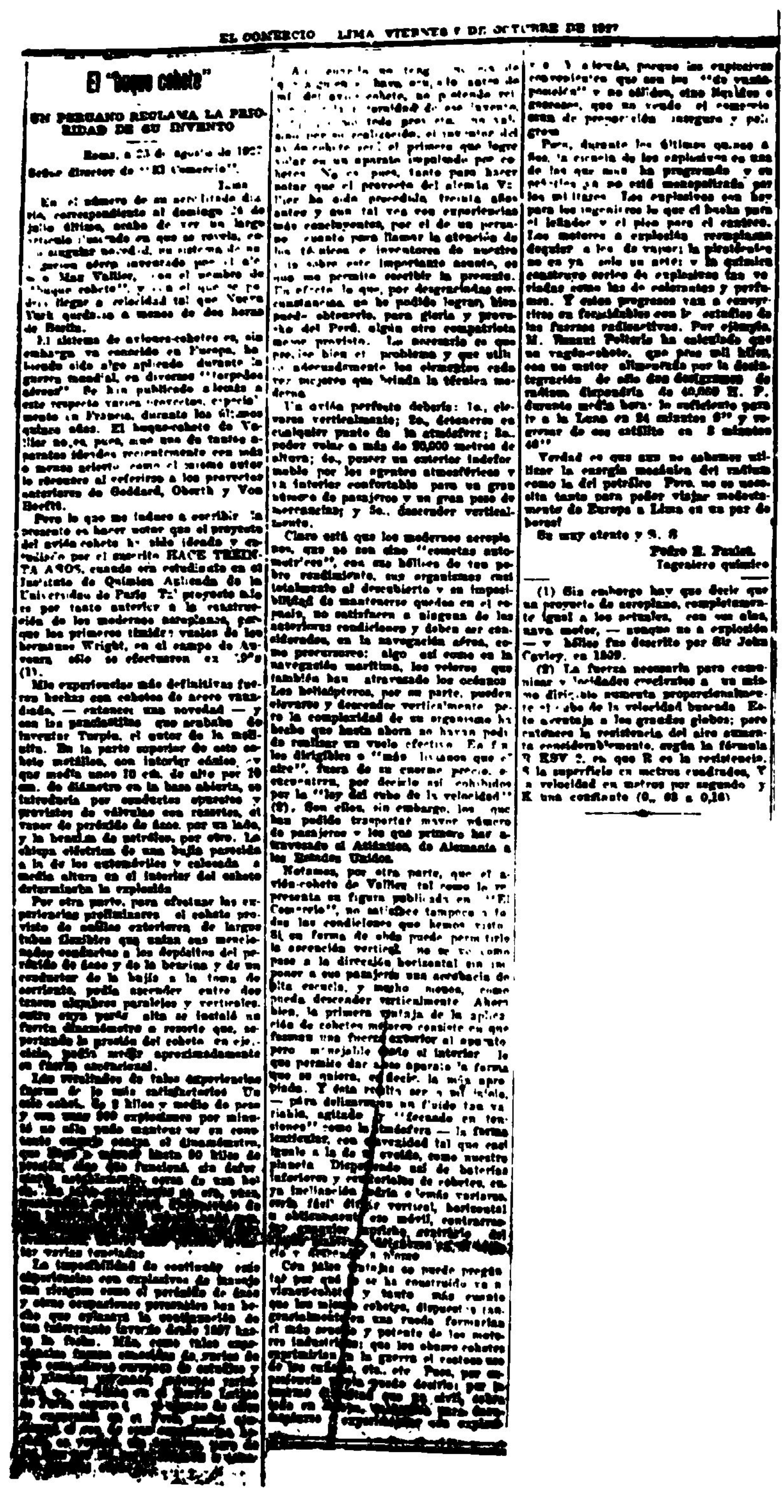
knew of his writing.[4] Ordway and Wakeford, in their International Missile and Spacecraft Guide,[12] simply state that Paulet "reportedly" tested a liquid-propellant rocket motor; Ordway and his coauthors ignored him completely in their two-volume survey of astronautics, as did Shirley Thomas in her eight-volume Men of Space,[14] and Eugene Emme in his History of Space Flight.[15] Bragg in Rocket Engines [16] and Glasstone in his NASA-sponsored Sourcebook of the Space Sciences [17] only mention the claim. Fritz, however, in Start in Die Dritte Dimension[18] accepts the claim at face value. Prior to Goddard, he wrote, the liquid-propellant rocket motor was tested only once:

> Between 1895 and 1897, Pedro E. Paulet, an engineer, constructed in Lima an apparatus whose combustion was not uniform, but rather consisted in a series of 300 explosions per minute. Pressure oscillated in accordance with this rhythm, which caused the motor's performance to diminish appreciably. Notwithstanding this difficulty, a thrust of 90 kilograms was produced.

Whether mentioned or ignored, no serious efforts were made to try to establish the validity of Paulet's claim, or even to search out primary documentation, until the mid 1960s. In 1966, von Braun and Ordway published some preliminary comments[19] after locating Paulet's 1927 article—which turned out to be a 2 1/2-column letter written in Rome and published in the October 7 issue of El Comercio (Figure 4). After drawing attention to the plans he was reading about in Europe for airplanes and spaceships, Paulet wrote that he, himself, had conceived of these ideas "THIRTY YEARS AGO [sic] when [I] was a student at the Institute of Applied Chemistry at the University of Paris." He also expressed the fear that his claims would not be believed, and called upon his former student friends in the Latin Quarter to tell the world of his experiments, which were, nevertheless, "made, truly, without witnesses."[20] In 1968, von Braun and Ordway published additional information on Paulet in their Histoire Mondiale de l'Astronautique.[22] They included a picture of Paulet and a schematic (Figure 5) he had allegedly drawn of a rocket-powered airplane, though it was not published until 1965,[23] long after his death. Another drawing, made in 1902 with captions in English, appears in Figures 6 and 7.

Correspondence and personal discussions with Peruvian scientific and cultural officials in Washington and London, with a member of Paulet's family in Peru, and with the editor of El Comercio, have since yielded further information about Pedro Eleodoro Paulet Mostajo's life and activities. He was born on July 4, 1875 in Arequipa, Peru. His father died three years later, and, under the care of his mother, he attended school in Arequipa (Figure 8) and later graduated from the local university. In 1895, the youthful Paulet left for Europe, entered the Institute of Applied Chemistry at the Sorbonne (University of Paris) in 1898, and received an industrial engineering degree in 1901.[+] The next year he

[+]If he did not start experimenting with rockets until after he entered the university, the 1895-1897 dates given earlier are incorrect. However, Paulet does mention, in other notes and letters, carrying out independent work beginning in 1895.



EL COMERCIO LIMA VIERNES 7 DE OCTUBRE DE 1927

El "buque cohete"

UN PERUANO RECLAMA LA PRIORIDAD DE SU INVENTO

Roma, a 23 de agosto de 1927

Señor director de "El Comercio".

Lima

En el número de su acreditado diario, correspondiente al domingo 24 de julio último, acabo de ver un largo artículo ilustrado en que se revela, como singular novedad, un sistema de un [illegible] aéreo inventado por el a[illegible] Max Valier, con el nombre de "buque cohete", y con el que se podría llegar a velocidad tal que Nueva York quedaría a menos de dos horas de Berlín.

El sistema de aviones-cohetes es, sin embargo, ya conocido en Europa, ha [illegible] sido algo aplicado durante la guerra mundial, en diversos "torpedos aéreos". Se han publicado a lo largo a este respecto varios proyectos, especialmente en Francia, durante los últimos quince años. El buque-cohete de Valier no es, pues, sino uno de tantos aparatos ideados recientemente con más o menos acierto, como el mismo autor lo reconoce al referirse a los proyectos anteriores de Goddard, Oberth y Von Hoefft.

Pero lo que me induce a escribir la presente es hacer notar que el proyecto del avión-cohete ha sido ideado y ensayado por el suscrito HACE TREINTA AÑOS, cuando era estudiante en el Instituto de Química Aplicada de la Universidad de París. Tal proyecto sería por tanto anterior a la construcción de los modernos aeroplanos, porque los primeros tímidos vuelos de los hermanos Wright, en el campo de Auvours, sólo se efectuaron en 1908 (1).

Mis experiencias más definitivas fueron hechas con cohetes de acero vanadiado, — entonces una novedad — y con las [illegible] que acababa de inventar Turpin, el autor de la melinita. En la parte superior de este cohete metálico, con interior cónico, y que medía unos 10 cm. de alto por 10 cm. de diámetro en la base abierta, se introducía por conductos apuestos y provistos de válvulas con resortes, el vapor de peróxido de ázoe, por un lado, y la bencina de petróleo, por otro. La chispa eléctrica de una bujía parecida a la de los automóviles y colocada a media altura en el interior del cohete determinaba la explosión.

Por otra parte, para efectuar las experiencias preliminares el cohete provisto de anillos exteriores, de largos tubos flexibles que unían sus mencionados conductos a los depósitos del peróxido de ázoe y de la bencina y de un conductor de la bujía a la toma de corriente, podía ascender entre dos tensos alambres paralelos y verticales, entre cuya parte alta se instaló un fuerte dinamómetro a resorte que, soportando la presión del cohete en ejercicio, podía medir aproximadamente su fuerza ascensional.

Los resultados de tales experiencias fueron de lo más satisfactorios. Un solo cohete de 2 kilos y medio de peso y con unas 300 explosiones por minuto no sólo pudo mantenerse en constante empuje contra el dinamómetro, que llegó a marcar hasta 90 kilos de presión, sino que funcionó sin deterioro [illegible] cerca de una hora [illegible]

[illegible] tar varias tentativas.

La imposibilidad de continuar estas experiencias con explosivos de manejo tan riesgoso como el peróxido de ázoe y otras ocupaciones perentorias han hecho que aplazara la continuación de un [illegible] invento desde 1897 hasta la fecha. Más, como tales experiencias fueron conocidas de varios de mis compañeros [illegible] de estudios y [illegible]

[illegible]

Así, cuando no tengo [illegible] de [illegible] hace algo acerca del avión-cohete, no pretendo reivindicar la paternidad de ese invento, [illegible] todo proyecto [illegible] por su realización, el inventor del avión-cohete será el primero que logre volar en un aparato impulsado por cohetes. No es pues, tanto para hacer notar que el proyecto del alemán Valier ha sido precedido treinta años antes y aun tal vez con experiencias más concluyentes, por el de un peruano, cuanto para llamar la atención de los técnicos e inventores de nuestro [illegible] sobre este importante asunto, es que me permito escribir la presente. En efecto lo que, por desgraciadas circunstancias, no he podido lograr, bien puede obtenerlo, para gloria y provecho del Perú, algún otro compatriota mejor provisto. Lo necesario es que precise bien el problema y que utilice adecuadamente los elementos cada vez mejores que brinda la técnica moderna.

Un avión perfecto debería: 1o., elevarse verticalmente; 2o., detenerse en cualquier punto de la atmósfera; 3o., poder volar a más de 20,000 metros de altura; 4o., poseer un exterior indeformable por los agentes atmosféricos y un interior confortable para un gran número de pasajeros y un gran peso de mercancías; y 5o., descender verticalmente.

Claro está que los modernos aeroplanos, que no son sino "cometas automotrices", con sus hélices de tan pobre rendimiento, sus organismos casi totalmente al descubierto y su imposibilidad de mantenerse quietos en el espacio, no satisfacen a ninguna de las anteriores condiciones y deben ser considerados, en la navegación aérea, como precursores: algo así como en la navegación marítima, los veleros que también han atravesado los océanos. Los helicópteros, por su parte, pueden elevarse y descender verticalmente pero la complejidad de su organismo ha hecho que hasta ahora no hayan podido realizar un vuelo efectivo. En fin los dirigibles o "más livianos que el aire", fuera de su enorme precio, se encuentran, por decirlo así, cohibidos por la "ley del cubo de la velocidad" (2). Son ellos, sin embargo, los que han podido trasportar mayor número de pasajeros y los que primero han atravesado el Atlántico, de Alemania a los Estados Unidos.

Notamos, por otra parte, que el avión-cohete de Valier tal como lo representa su figura publicada en "El Comercio", no satisface tampoco a todas las condiciones que hemos visto. Si su forma de obús puede permitirle la ascención vertical, no se ve cómo pase a la dirección horizontal sin imponer a sus pasajeros una acrobacia de alta escuela, y mucho menos, cómo pueda descender verticalmente. Ahora bien, la primera ventaja de la aplicación de cohetes motores consiste en que forman una fuerza exterior al aparato pero manejable desde el interior lo que permite dar a ese aparato la forma que se quiera, es decir, la más apropiada. Y ésta resulta ser a mi juicio, — para deslizarse en un fluido tan variable, agitado y "fecundo en tensiones" como la atmósfera — la forma lenticular, con convexidad tal que casi iguale a la de un ovoide, como nuestro planeta. Disponiendo así de baterías inferiores y [illegible] de cohetes, cuya inclinación podría a voluntad variarse, sería fácil dirigir vertical, horizontal u oblicuamente ese móvil, contrarrestar [illegible] [illegible] [illegible] y descender a [illegible]

Con tales ventajas se puede preguntar por qué no se ha construido ya un [illegible]-cohete y tanto más cuanto que los mismos cohetes, dispuestos tangencialmente en una rueda formarían el más [illegible] y potente de los motores industriales; que los obuses cohetes [illegible] en la guerra el costoso uso de los cañones, etc., etc. Pues, por [illegible] puede decirlo; por [illegible] [illegible]

[illegible] y también, porque los explosivos convenientes que son los "de vasta potencia" y no sólidos, sino líquidos o gaseosos, que no vendo el comercio, son de preparación insegura y peligrosa.

Pero, durante los últimos quince años, la ciencia de los explosivos es una de las que más ha progresado y su práctica ya no está monopolizada por los militares. Los explosivos son hoy para los ingenieros lo que el hacha para el leñador y el pico para el cantero. Los motores a explosión reemplazan doquier a los de vapor; la pirotécnica no es ya sólo un arte; y la química construye series de explosivos tan variadas como las de colorantes y perfumes. Y estos progresos van a convertirse en formidables con los estudios de las fuerzas radioactivas. Por ejemplo, M. Esnault Pelterie ha calculado que un vagón-cohete, que pese mil kilos, con un motor alimentado por la desintegración de sólo dos decigramos de radium dispondría de 40,000 H. P. durante media hora: lo suficiente para ir a la Luna en 24 minutos 8" y regresar de ese satélite en 8 minutos 40"

Verdad es que aun no sabemos utilizar la energía mecánica del radium como la del petróleo. Pero, no se necesita tanto para poder viajar modestamente de Europa a Lima en un par de horas!

Su muy atento y S. S.

Pedro E. Paulet.
Ingeniero químico

(1) Sin embargo hay que decir que un proyecto de aeroplano, completamente igual a los actuales, con sus alas, nave, motor, — aunque no a explosión — y hélice fue descrito por Sir John Cayley, en 1809.

(2) La fuerza necesaria para comunicar velocidades crecientes a un mismo dirigible aumenta proporcionalmente al cubo de la velocidad buscada. Esto aventaja a los grandes globos; pero entonces la resistencia del aire aumenta considerablemente, según la fórmula R KSV 2, en que R es la resistencia, S la superficie en metros cuadrados, V la velocidad en metros por segundo y K una constante (0,08 a 0,10)

Fig. 4

Un ingeniero peruano es el precursor mundial de los aviones a retropropulsión

Pedro E. Paulet diseñó en 1902 el primer avión impulsado por cohetes

El ingeniero peruano Pedro E. Paulet que fuera fundador y Director de la Escuela Nacional de Artes y Oficios de Lima en 1904 y 1910, inventó en 1902 el avión sin hélices y está considerado como el precursor de la moderna navegación.

Desde niño, en su ciudad natal (Arequipa), antes de 1895 tuvo la idea de aplicar la propulsión por cohetes a la aerostación. Al viajar a Europa lo hizo con la idea de desarrollar su teoría, realizando en París diversas experiencias.

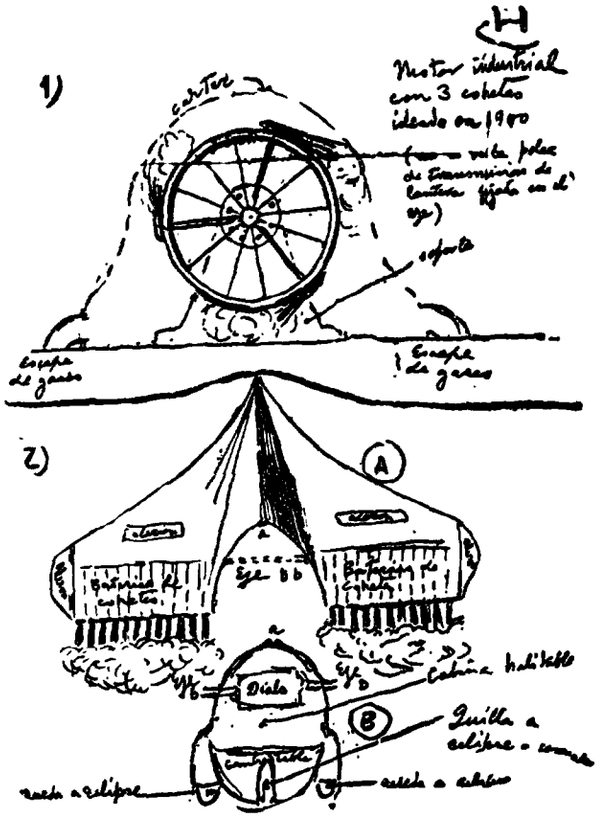
En 1902, en Bélgica, adoptó la forma de una nueva clase de aviones, que reproducimos en el grabado que acompaña a esta información y que nos ha sido proporcionada por el Presidente de la Comisión Encargada de Estudiar la creación de la Comisión Nacional del Espacio, doctor Manuel del Castillo, gracias a la gentileza de la familia del ingeniero Paulet.

El avión se componía esencialmente de un compartimento cerrado, en forma de huevo, de cuyo interior se manejaba una armazón externa que sostenía la proa del sistema, las dos alas y los timones posteriores. El compartimento era herméticamente cerrado y en su interior se podía viajar hasta la estratósfera o en la profundidad del mar.

Lo más original de su invento es el sistema de cohete que inventó y el explosivo utilizado en dicho cohete, que realizaba en ese entonces, la proeza de comprimir la mezcla explosiva y producir en seguida una explosión en campo abierto. En cuanto a la mezcla, utilizaba como base la gasolina o el agua.

El diario "El Comercio" publicó en el Suplemento Especial del 1º de enero de 1958 una información sobre el particular, destacando su labor de precursor mundial de la aviación, lo cual ha sido ampliamente reconocido en todo el mundo.

Como una primicia ofrecemos a nuestros lectores el grabado que acompaña a esta nota, en el cual, de puño del ingeniero Paulet, se aprecia el diseño de *su invento*.



Esquema del primer avión-cohete inventado en el mundo, en 1902 por un peruano, el ingeniero Pedro E. Paulet. Por ello está considerado como el precursor de la navegación aérea a reacción, adelantándose a los inventores rusos y americanos

Fig. 5

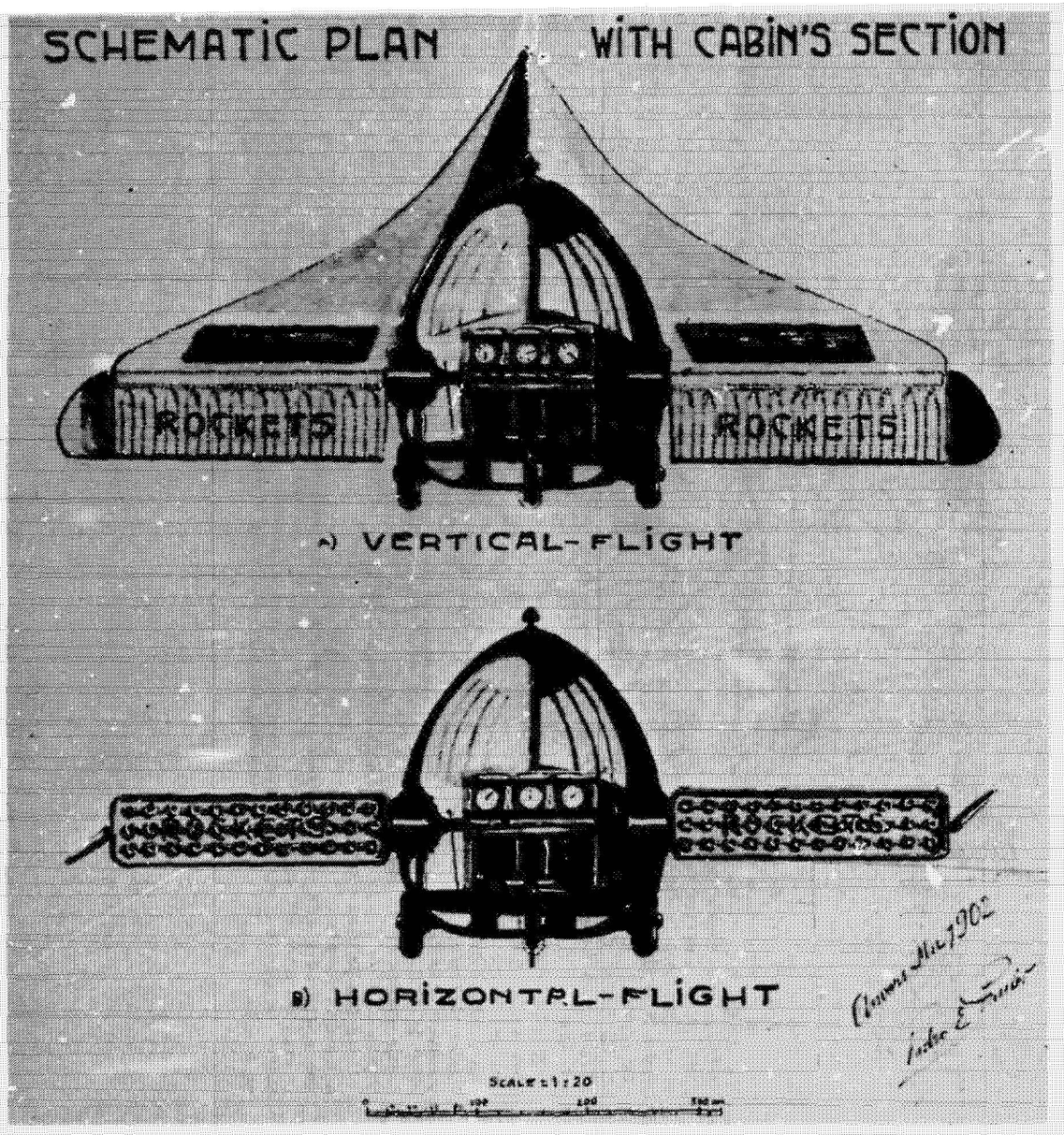


Fig. 6
Avion-Torpedo System Paulet (1902)

was named Peruvian Counsel in Antwerp, where he remained for a few years. Returning to Peru in 1905, he served as the first director of the Escuela Nacional de Artes y Oficios in Lima, and became active in a construction enterprise. In 1910 he returned to Europe, married Louise Wilquet of Brussels, and started a publishing firm. Later, he served in Peruvian consular posts in Norway, Holland, Japan, and Argentina. He died on January 30, 1945. Whatever experimental rocket work Paulet accomplished, therefore, had to have been undertaken during his early 20s.

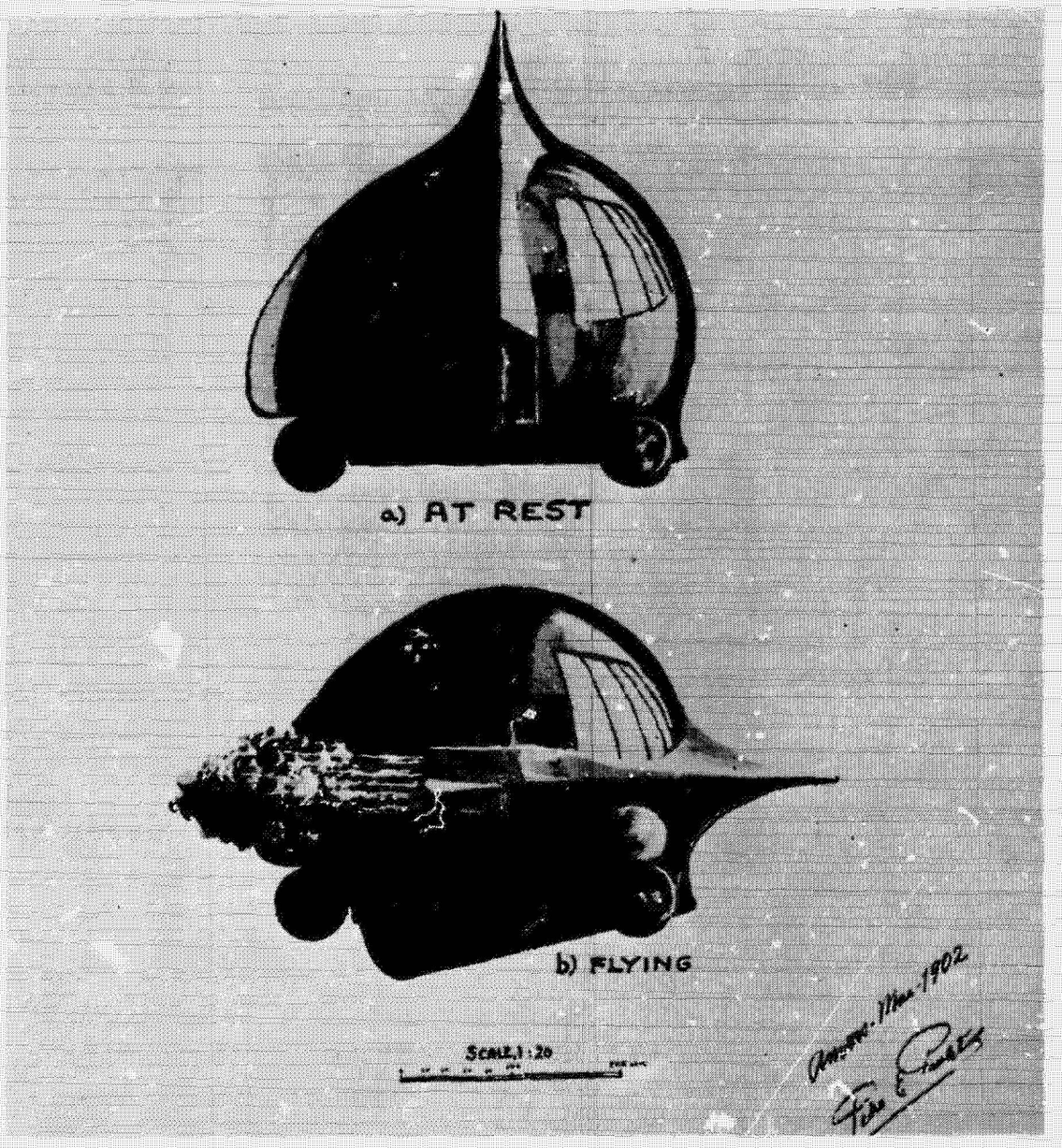


Fig. 7
Avion-Torpedo System Paulet (1902)

On March 10, 1965, possibly as a result of the inquiries in connection with the writing of references 19 and 21, *El Comercio* published an article, "A Peruvian Engineer is the World Forerunner of Jet Propulsion Aircraft,"[22] that included the design of the "first rocket-airplane," already referred to. The article stated that Paulet worked out the theory of rocket propulsion and conducted some early experiments in Paris, adopting the final design of his craft in 1902--when he had moved to Belgium. According to the

Fig. 8
Pedro Eleodoro Paulet Mostajo
b. Arequipa, Peru, 1874
Picture Made in Arequipa, 1883

description, the Paulet vehicle was to travel with equal ease out to the stratosphere or down into the depths of the sea. The batteries of rocket motors are clearly marked ("baterías de cohetes," Figure 5).

Next day, on March 11, El Comercio published[23] what it considered proof of the authenticity of the airplane, reproducing several artist's interpretations of the invention. The article first explained that many foreigners had written to El Comercio requesting details of Paulet's ideas and experiments, then summarized an interview given by the Peruvian in Buenos Aires in 1944 in which he had explained that his rocket airplane would fly at 600 miles per hour in the rarefied outer atmosphere; or, at much lower speeds, "travel like a submarine" under the ocean. He also related that:

> In my native city, Arequipa, built over lava from a neighboring volcano, we have no fear of fire. For this reason, rockets are the obliged entertainment in our celebrations. During my childhood, I learned how to make them, occasionally tieing to their "tails" nets with objects attached to them.

> Later, in Europe, while studying in the Institute of Applied Chemistry at the Sorbonne in Paris, I was seduced by the work of the great chemist Marcelin Berthelot on the power of explosive materials.
>
> Early in this century, there was great interest in the question of mechanical motors.
>
> At the Institute, we were taught that steam motors with performance less than 10 percent and which stood little chance of significant improvement, were impotent in the face of progress. The electric motor was not transportable except by generating power from heavy batteries. And the new internal combustion engine used in automobiles was relatively heavy and complicated for the new field of aviation, which was then such a novelty. It seemed to me then, as it does now, that the problem would be solved by utilizing explosive forces not in enclosed cylinders pushing a piston . . . but rather by rockets with constant injection of the explosive material and of simple design.

Unfortunately, neither of these references shed light on the supposed 1895 liquid-propellant rocket engine tests, the principal item of interest and the pedestal on which Paulet's fame rests. It is one thing to sketch a concept without supporting technical details and quite another to develop workable hardware. Efforts to obtain documentation on this from Paulet's son proved unsuccessful.

On December 12, 1965, another article[24] (Figure 9) in El Comercio stated that an American document proved Paulet to have been the world forerunner of astronautics. The evidence given to the newspaper by Dr. Manuel del Castillo, President of the Organismo Nacional de Investigacions Espaciales, consisted primarily of James H. Wyld's June 1947 article. But all Wyld had done, El Comercio had to admit, was to report what Scherschevsky had said. El Comercio did not quote or reproduce Paulet's 1927 letter from which Scherschevsky derived his information about Paulet.

It is perhaps ironical that the El Comercio article attached a "certified copy" of a short note appearing in an unidentified issue of the Journal of the American Rocket Society which says, "Paulet did not publish an account of his work until 1927, in an obscure news article in Lima, Peru, 'El Commercio' [sic], so that the validity of his claim may be rather doubtful, but it is interesting nevertheless to quote Paulet's description of his motor, as abstracted in A.B. Scherschevsky's book The Rocket for Transport Flight (see encircled upper left portion of Figure 7).

Living in Europe in the 1920s, Paulet certainly had an opportunity to become acquainted with the work and writings of German and French rocket and astronautical innovators. Just how many of his ideas were original and how many derived from these sources it is impossible to determine. Based on information available in October 1969, his claim of having experimented with liquid-propellant rocket motors in Paris in the late 1890s cannot be proved. To date, no actual witnesses have been located, nor any solid evidence uncovered as to the possible existence of the rocket motor.

...constructed about 1885 by Pedro E. Paulet, a young engineer of Peru, South America. (See Fig. 1) Paulet did not publish an account of his work until 1927, in an obscure news article in the Lima, Peru, "El Commercio", so that the validity of his claim may be rather doubtful, but it is interesting nevertheless, to quote Paulet's description of his motor, as abstracted in A. B. Schesnchevsky's book "The Rocket for Transport and Flight":

Reproducción de la copia certificada que obtuvo el doctor Manuel del Castillo de los funcionarios de la NASA en Washington, y por la cual se aprecia el artículo escrito por Wild en el "Journal of the American Rocket Society". Se nota, encerrado dentro de la marca, las expresiones del norteamericano sobre la prueba de que Paulet fue el primero en realizar las experiencias sobre motores a chorro. También se ve claramente que tomó los datos de "El Comercio" en 1927.

de la colectividad en general

Al Señor de los Señores y Paladín de la Democracia.

muy respetuosamente:

Ricardo Espinoza Bono.
"Odracure" Ex-Redactor
Hijero de "El Comercio".

SEMINARIO NACIONAL DE ECONOMIA

Lima, 10 de diciembre de 1965.

Señor doctor Luis Miró Quesada.
Director de "El Comercio".
Ciudad.

De nuestra especial consideración:

El Seminario Nacional de Economía, se satisface al expresar a Ud. su especial felicitación por haber cumplido el 69º aniversario de su natalicio y medio siglo de actividades en la noble profesión del periodismo. Y le hacemos llegar, al mismo tiempo, nuestro agradecimiento por su permanente inquietud en el estudio de los problemas y defensa de sus soluciones técnicas de la economía nacional.

Hacemos propicia esta oportunidad para reiterar a Ud., señor doctor Luis Miró Quesada los sentimientos de nuestra más alta y distinguida consideración.

De Ud., muy atentamente.
por el Seminario Nacional de Economía.

Dr. Arturo Burga Freitas, Presidente. — Leonidas Becerra Zúñiga, Secretario General Coordinador.

El Secretario General de la Asociación Peruana Pro Naciones Unidas, saluda muy atentamente a su distinguido amigo el Sr. Dr. Don Luis Miró Quesada de la Guerra y se complace en hacerle llegar en su nombre propio y en el de la Institución, su sincera felicitación con motivo de haber cumplido 88 años de edad, dedicado la mayor parte de ellos en servicio de nuestra querida Patria.

César Gálvez Pintado, aprovecha la oportunidad para renovarle los sentimientos de su consideración más distinguida.

Lima, 9 de diciembre de 1965.

TARJETAS RECIBIDAS

De Miguel Dommert Muelle, Guillermo Byrne, Irma Byrne, L. Carbone, Alejandro Bueno de la Fuente, Claudio Bueno de la Fuente, Napoleón M. Burga, Germán Stagnich Gazzani, Miguel Angel Ramírez Z.O., Aniceto Castillo y Méndez, Guillermo Ehni y señora, Aurelio C. Dávila R., J. Estimio Pinto Li., Oswaldo Jimeno Aguilar, Juan de Dios Alcedo, Carlos Dávalos Aneja, Octavio Tudela del Campo, Alejandro Bertello y señora, Víctor del Valle E., F. Romero Elguera, Gino Bianchini, Juan A. Bendezú Pacheco y señora, Eduardo Orbegoso P., Alberto Trelles R., Elio Piaggio Bueno y señora, Enrique Monge y señora, Agustín Tovar de Albertis y señora, Alfredo Ortiz de Villate y señora, Carlos Salas Perales y señora, Luis Dommert Muelle.

Artículo de "El Comercio" fue la base

Peruano Paulet fue el 1er. precursor de astronáutica, prueba documento en E.U.

Existe una publicación, en la Biblioteca de Washington, en los Estados Unidos de Norteamérica, que confirma que los estudios teóricos y prácticos del ingeniero peruano Pedro E. Paulet, en 1885, fueron anteriores a los de Zoulkowsky, Oberth y Goddard, considerados hasta entonces, como los precursores de los estudios que han hecho posibles los viajes espaciales.

El doctor Manuel del Castillo, Presidente del Organismo Nacional de Investigación Espacial, ha conseguido la importante copia certificada de dicha publicación, que es la revista "Journal of the American Rocket Society", al visitar las organizaciones de la NASA. El doctor del Castillo es miembro del Comité Interamericano de Investigaciones del Espacio, que patrocinará estudios del ingeniero Paulet y ha acordado considerarlo precursor de la astronáutica en América.

De la copia tomada por nuestro compatriota, de funcionarios de la NASA en Washington, se desprende que el autor del artículo, James H. Wild, se refiere a un resumen tomado del libro del autor ruso, A.B. Schershchewsky (colaborador de Hermen Oberth), "The Rocket for Transport and Flight", quien a su vez lo tomó de un artículo aparecido en nuestro Diario en el año 1927.

Lo escrito por Wild en el "Journal of the American Rocket Society" de junio de 1947, dice textualmente en uno de sus párrafos: "hay evidencia, que el primer trabajo práctico, sobre motores a reacción fue construido en 1885 por Pedro Paulet, joven ingeniero peruano, quien publicó en 1927 un artículo en "El Comercio" de Lima...", es interesante, contiene el artículo, "acerca la descripción del motor de Paulet, tal como aparece en el libro "El Cohete para Transporte y Vuelo" del científico ruso A. B. Schershevsky".

Fig. 9

APPENDIX

Translation by the author of Paulet's letter written from Rome on 23 August 1927 and published in the Lima, Peru, newspaper El Comercio on 7 October 1927.

To the Director of "El Comercio"

In the issue of last 24 July of your esteemed newspaper, I have just seen a long, illustrated article which reveals an aerial navigation system invented by Max Vallier (sic), a German. He calls it the "rocket ship" and said that it would be able to reach a velocity such that New York would be less than two hours away from Berlin.

The rocket airplane system is already known in Europe, having been used in various "aerial torpedos" during the World War. A number of projects have been published in this regard—especially in France—during the last fifteen years. The rocket ship is, therefore, only one of many conceptions recently advanced—some accurate, some not so accurate. The author himself recognizes this by referring to the early pioneers Goddard, Oberth, and von Hoefft.

I have been prompted to write the present letter to bring to your attention the fact that the rocket airplane project was conceived and studied by the undersigned THIRTY YEARS AGO when he was a student at the Institute of Applied Chemistry at the University of Paris. This project, therefore, antidates the construction of modern airplanes because the first timid flight of the Wright Brothers at the Auvours Field only took place in 1908.[1]

My most definitive experiments were conducted with rockets made of vanadium steel, then a novelty, and with panklastite that had just been invented by Turpin, discoverer of melinite. The interior of the metallic rocket was conical and measured 10 centimeters high by 10 centimeters at the open base (mouth). The propellants were introduced through the upper part of the chamber through opposing ducts provided with spring loaded valves. The nitrogen peroxide entered through one side and the benzine through the other. Ignition was effected by an electric spark from a spark plug, similar to those used in automobiles, which was placed halfway up the rocket chamber.

On the other hand, in order to undertake the preliminary experiments the rocket was provided with outside rings made of long flexible tubes which connected the above mentioned ducts to the nitrogen peroxide and benzine tanks and to a lead from the spark plug to the electric mains. The rocket would ascend between the two taut parallel and vertical wires, between whose upper part was installed a strong, spring thrust measuring device supporting the pressure of the firing rocket. The dynamometer could give an approximate measurement of the lifting forces.

The results of these experiments were very satisfactory. The 2-1/2 kilo rocket motor underwent 300 explosions each minute and was not only able to maintain its thrust

against this thrust measuring device but was able to develop 90 kilograms of thrust. Moreover, it functioned without any noticeable deformations of its structure for nearly an hour. Under such conditions, it was possible to venture to foresee a craft provided with two batteries of 1,000 rockets each (one battery would rest while the other functioned) lifting several tons.

The impossibility of continuing these experiments with explosives, such as the nitrogen peroxide, whose handling was so risky, and other personal activities, have made it necessary for me to postpone my work on this interesting invention from 1897 to the present time. Moreover, because these experiments were known by several of my European student compatriots and by the few Peruvians (who at the time were very rare in Paris) living in the Latin Quarter, I hope that if one of them is now in Peru he will confirm the echo of these experiments which were made, truly, without witnesses but about which I talked to anyone who would listen to me.

Even though I do not have news of anyone who had concerned himself before me with rocket airplanes, I don't pretend to regain possession of my fathership of this invention because, as in all projects, it is not valid except as a consequence of its realization. The inventor of the rocket airplane will be the first one to fly in an apparatus powered by rockets. Therefore, it is not enough to say that the project of the German Vallier has been preceded thirty years earlier, and even perhaps by the more conclusive experiments performed by the Peruvian, who would like to call to the attention of the technicians and inventors of our country this important matter which has led me to write the present article. In effect that which, but for unhappy circumstances, I have not been able to achieve can be accomplished (for the advantage and good of Peru) by some other compatriot who is better prepared than I. It is necessary that he lay out carefully the problem and that he adequately use the elements offered by a continually improving modern technology.

A perfect airplane should: (1) rise up vertically; (2) maintain itself at any point in the atmosphere; (3) fly at an altitude of more than 20,000 meters; (4) possess an exterior which would not be deformed by atmospheric agents and whose interior would be suitable for a large number of passengers and a heavy load of merchandise; and (5) could descend vertically.

It is clear that modern airplanes are no more than "automotive comets" whose propellers give low performance, whose parts are almost completely uncovered, and which it is impossible to maintain motionless in space. These do not satisfy any of the earlier mentioned conditions and should be considered in aerial navigation as forerunners—somewhat as, in maritime navigation, sailing ships earlier crossed the oceans. Helicopters, for their part, can go up and down vertically but, because of their complexity, have up to now not been able to undertake effective flights. Finally, the dirigibles or "lighter than air craft," outside of their enormous cost, are also restricted because of the "law of the

cube of the velocity."[2] They are nevertheless the craft that have been used to carry the greatest number of passengers and are the first to have crossed the Atlantic between Germany and the United States.

We noted, on the other hand, that Vallier's rocket airplane, like the one represented in the figure published in "El Comercio," satisfies neither of the conditions we have seen above. If its projectile form permits it to go straight up, one does not see how it changes to the horizontal direction without subjecting its passengers to acrobatic maneuvers. Even less do we see how it can go down vertically. Well, the first advantage of the application of rocket motors consists in that they form an outside force to the apparatus that is manageable from the inside, which permits it to have whatever form may be desired, i.e. that which is the most appropriate. This becomes in my judgement——in order to slide through a variable, stirred up, and "fecund in stress" fluid as the atmosphere——the lenticular form with convexity such that it is almost equal to that of an ovoid, such as our planet incorporating, thus, lower and horizontal batteries of rockets whose angle of firing could be varied. It would be possible to direct oneself vertically, longitudinally, and obliquely, resisting any contrary forces that the ambient fluid might produce, remain in space, and then descend to the ground.

With such advantages, one can ask why rocket airplanes have not been made, even more, why rockets have not been placed tangentially on a wheel which would form the most simple and most potent of industrial forces; and why rocket projectiles haven't eliminated the costly use of cannons in war, etc.,etc. Well, as a result of my own experience, I can reveal why: it is because of the great difficulty that a civilian has, especially in Europe, to obtain information on, and experiment with, explosives. Moreover, because the convenient explosives are of "juxtaposition" type and not solid, but rather liquid or gaseous, they are not sold commercially due to their uncertain and dangerous composition.

But, during the last fifteen years, the science of explosives has progressed from a practical point of view, and explosives are not now monopolized by the military. Explosives today are now to the engineers what the ax was to the woodcutter, the pick was to the miner. Internal combustion motors are replacing steam engines; pyrotechnics is no longer an art; and chemistry manufactures a series of explosives as varied as coloring compounds and perfumes. And this progress is going to advance into formidable studies of radioactive forces. For example, M. Esnaut (sic) Pelterie has calculated that a rocket ship, weighing 1,000 kilograms with a motor fed by the disintegration products of 2 decigrams of radium, would produce a force of 40,000 hp over a period of 1/2 hour, sufficient to be able to go to the Moon in 24 minutes, 9 seconds and return from this satellite in 3 minutes, 46 seconds.

It is true that even now we do not know how to utilize the mechanical energy of radium as we do that of petroleum. But, we don't need so much to travel modestly from Europe to Lima in a couple of hours.

Your humble and obedient servant,
Pedro E. Paulet
Chemical Engineer

(1) Nevertheless, it must be said that an airplane project, completely like those actually existing with its wings, body, and airship motors—even though it did not involve any explosions and propellers, was described by Sir John Cayley in 1809.

(2) The necessary force to transmit increasing velocities to a dirigible would proportionally increase as the cube of the velocity desired. This offers an advantage to the large globes; but, then air resistance goes up considerably, in accordance with the formula R KSV, where R is the resistance, S the surface in square meters, V the velocity in meters per second, and K a constant (0.08 to 0.16).

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