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## Chapter 7

# New Observations on Reaction-Propelled Manned Aircraft Concepts, ca. 1670–1900: Part II (1870–1900)*

**Frank H. Winter† and Philippe Cosyn‡**

### Abstract

This chapter concludes our historical survey of concepts of reaction-propelled manned aircraft from 1670 to 1900. Part I, covering 1670–1869, was a paper presented at the 47th History Symposium of the International Academy of Astronautics (IAA) as part of the 64th International Astronautical Federation (IAF) Congress held in Beijing, China during 23–27 September 2013 (IAC-13-E4.2.2.).[1] The current chapter covers the period 1870 to 1900, and covers later pioneers including Thomas Griffiths, Russell Thayer, Sumter B. Battey, Edmund Pynchon, et al. As with the previous presentation, the present chapter helps fill gaps in the history of the earliest known concepts of manned, rocket-propelled flying craft. However, this survey does not cover reaction aircraft utilizing air-breathing concepts (precursors to jet planes), excluding de Louvrie's 1865 concept covered in Part I, nor the earliest reaction-propelled spacecraft concepts, nor fictional concepts. Rather, the emphasis is upon rocket or near rocket-propelled designs.

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# I. Introduction

As mentioned in the Introduction of Part I, Konstantin E. Tsiolkovsky and Robert H. Goddard stand out in the history of astronautics since they developed, from the late 19th to early 20th centuries, the earliest known concepts of rocket-propelled unmanned and manned spacecraft. It was also stated that the earlier history of the potential use of the rocket, or reaction propulsion, is not so well documented in the literature and we are therefore continuing the remainder of our survey. It is reiterated that this survey is not definitive but includes the most significant pioneers and others who are of unique interest, and offers new perspectives overall.

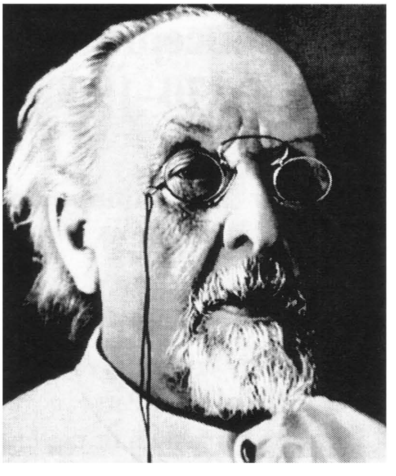


**Figure 7–1:** K. E. Tsiolkovsky. (Frank H. Winter collection).

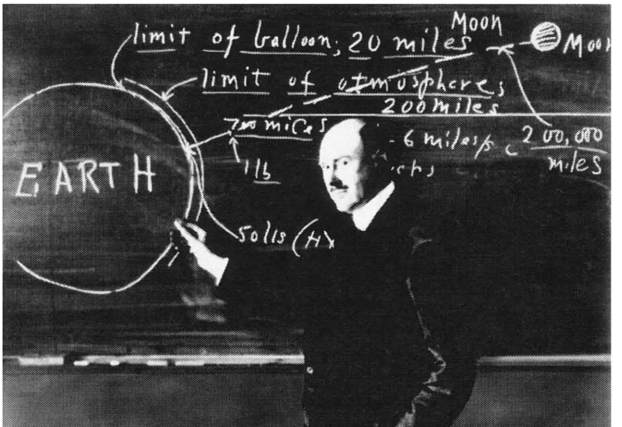



**Figure 7–2:** R. H. Goddard. (NASA photo).

## II. Unsubstantiated Early Attempt at Rocket Propulsion (1871)

Interestingly, Part I began with "Unsubstantiated Early Attempts at Rocket Propulsion." This part of our survey similarly begins with such an attempt. This is found in a curious item in the British journal, *The Graphic* (London) for 9 September 1871 under the heading "Transatlantic Clippings." "A parachute is no new invention," the piece begins,

> "but an old Delaware philosopher, ambitious of aeronautic fame, recently lost his life in attempting to utilize [*sic*] this contrivance in a somewhat novel manner. He erected in his garden a huge sky rocket [a gunpowder-propelled pyrotechnic rocket], to the head of which he attached a parachute in such a way that...while the sky rocket soared upwards, it would remain closed, but would open like an umbrella on his descent and thus break his fall to the ground. He accordingly attached himself to the lower end of the stick, with the fuse [i.e., fuse] turned from him, so that the fire would not injure him, applied a light [ignited the fuse], and went whizzing through the air at an enormous speed. But alas! [*sic*] for the philosopher and his science...for the rocket and its parachute were seen to turn sharply in mid-air and fall, while the rash aeronaut was found close to his laboratory fearfully burnt and mangled."[2]

Unfortunately, in this case, we have too few clues to go on to even verify that this alleged event did take place in the state of Delaware in the United States, much less try to identify the alleged "philosopher." If anything, it is clear that in that period the rocket was little more than a crude weapon or firework, or for carrying signals or rope for lifesaving (as a lifesaving rocket) and similar low-power applications. Hence, it was ludicrous to even think of the rocket itself as a means of transport for man and in any case, the largest "sky rockets," or pyrotechnic rockets of the period were generally limited to a few grams or ounces in weight, or a handful of pounds or kilograms at most.[3]

## III. Ridely (1874), Buchanan (1876), Pennington (1877), Abate (1877), Rogers (1877), and Forlanini (1879)

On 3 March 1874, the Englishman Joseph Douglas Ridley of Islington, London, was granted a "Letters Patent" (No. 777) for "Propelling and Steering" in which an "aërial machine" (a now quaint and antiquated term for a flying machine) "is provided with wings operated by pistons working in cylinders by the explosion of gunpowder or other explosive material." In effect, then, this was an ornithopter concept and was not propelled directly by reaction propulsion; rather, the gunpowder, that was to be ignited electrically, provided indirect propulsion upon the pistons. In any event, more details are wanting and this patent was declared "void for want of final specifications." If anything, Ridley's (as well as Werner Siemens' similar idea of 1847, covered in Part I, is illustrative, or helps define, how a gunpowder (or other explosive) engine for propelling a flying machine is *not* necessarily true reaction propulsion. A more bona fide example of *direct* reaction propulsion is found in the British patent of John Buchanan (No. 327) of 27 January 1876, also titled "Propelling and Steering."

The craft was a balloon "or other body in the air" and was to be propelled by "the reaction of the air or gas in escaping into the atmosphere" through one or more discharge valves, the air or gas forced into a drum by an onboard boiler then compressed by an air compressor. The basic idea, however, was hardly unique and throughout the 19th century there were countless similar schemes for "aerial propulsion." In fact, Buchanan's idea may be classed as "very typical" of reaction-propelled flying machines of the period. However, the concepts in 1877 of James J. Pennington, Charles B. Mansfield, and Stanislao Abate are by more noteworthy.[4]

James Jackson Pennington (1819–1885) was a farmer and merchant of tiny Henryville, in northern Lawrence County, Tennessee, United States. He was also inventive and in 1872 devised and built a prototype of his "Aerial Bird" flying machine that used a fan and clock-spring mechanism. Whether the prototype was merely a model or full-sized machine is unknown but it allegedly did fly very briefly. Apparently encouraged by his progress, he continued to improve upon his designs and on 4 September 1877 was granted U.S. Patent No. 194,841 for an "Improvement in Flying Machines" although the patent text consists of merely a single page with the sparest details.

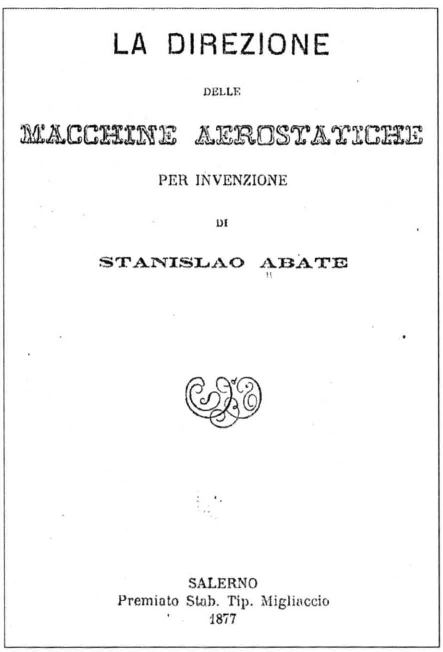
His craft was also a balloon but used a wholly different mode of propulsion that consisted of a fan at the front which "takes in air and forces it out of the rear" through a narrow aperture he called an "air blast tube" for movement. The latter is also termed a "discharge nozzle."

"The fan," says the patent "may be driven by any convenient motor which is sufficiently compact, light, and powerful." Pennington's balloon was therefore a reaction-propelled machine." He is also said to have patented a "working model." (In those years, up to 1885, it was necessary for patentees to produce a working model and a model was displayed at the Southern Exposition held in Louisville, Kentucky, that opened on 2 August 1883, one of the most successful regional American fairs in national history. But the later fate of the model is unknown, although it appears to have disappeared.

Also, according to Frank Meredith, one of Pennington's descendants; the inventor could not find the funds to build a full-sized version of the machine during his lifetime. Later, it is alleged, his widow Martha Ellen Pennington sold the patent to the Wright brothers for $500, although this dubious claim is not verified in the two volumes, *The Papers of Wilbur and Orville Wright* (1950) by Marvin McFarland. In any case, the airport at the county seat at Lawrenceburg, Tennessee, is named "Pennington Field" in his honor and there is a Tennessee historical marker on U.S. Highway 64 (Pulaski Highway), likewise honoring him.

But overall, Pennington's concept was crude and not well worked out insofar as actual power requirements, besides the control of the contraption. Yet, he is included here simply because of the considerable posthumous local acclaim afforded to him. Swint and Mohler add that he was the earliest in the predominately agricultural state of Tennessee to have taken out an aeronautical patent but that it is was an "obviously impractical device..."[5]

In the same year as Pennington's patent there appeared the seven-page leaflet, *La Direzione delle Macchine Aerostatiche per Invenzione de Stanislao Abate* (*The Direction of the Aerostatic Machine by the Invention of Stanislao Abate*), privately published in Salerno, Sicily, Italy, and includes interesting depictions of his craft.


LA DIREZIONE

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DI

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**Figure 7–3**: The cover of the booklet by Stanislao Abate, 1877.
(Copy in the Library of Congress, Washington, D.C.)

"Anyone...studying the great problem of the direction of aerostatic machines," Abate begins, "cannot ignore that the whole difficulty...is to apply them a drive power serving to overcome their air resistance." Gunpowder, he felt, was the best solution to "meet the dual requirement of a great power and relatively low weight." Thus, he arrived at his concept of the "motor unit" consisting of a large wheel fitted with multiple gunpowder rockets (we count 99); the wheel was attached by a rod to the gondola, or car, of the "aerostatic balloon" and faced in at a right angle and position to the balloon and gondola.

Also seen in one of his pictures, though not shown here, is, not only an Italian flag attached to the "rear" of the gondola, but one of the rockets discharging in the same direction as the waving flag. That is to say, it is clear the way the balloon is headed and that the rockets, fired individually, (or potentially also in sets, if required) moved the balloon forward. Also in one of his figures is a circle, representing the front side of the rocket ring with the rockets packed tightly in it, one next to another. Abate calls it a "cylindrical case," or "wheel" that was made of metal.

It is fairly easy to see what Abate had in mind. In his very brief summary he explained that it offered a "powerful driving force" that could be "successively increased or decreased at will, according to the need..." and that the "mechanism" was indeed, "simple and of relatively little weight..." Yet, he said almost nothing about the rocket units themselves, only that they would not be the same "as those [as] used in war [i.e., war rockets], impaired by the heavy weight of their iron pipes [iron bodies]..." Therefore, presumably they were more like pasteboard firework type rockets.

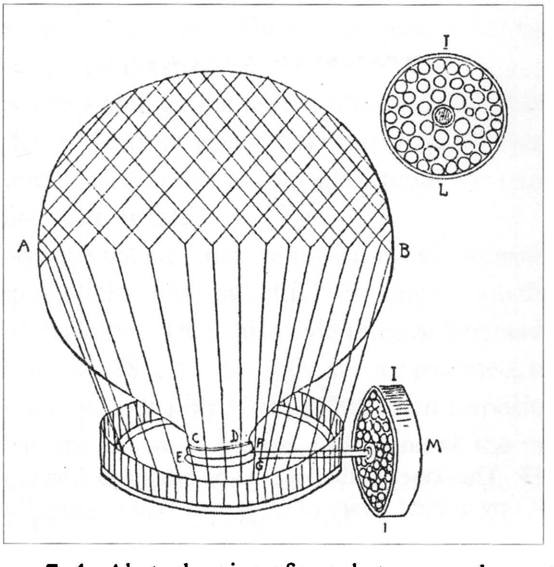


**Figure 7–4**: Abate drawing of a rocket-powered aerostat.
(From Stanislao Abate, *La Direzione*; see Figure 7–3).

But in those years, neither "thrusts" nor "burning times" of rockets were taken; in fact, the terms themselves were unknown until the 20th century. Nonetheless, this did not stop Abate from calculating that assuming each rocket was loaded with charge of a kilogram (2.2 lb) of gunpowder, this would be sufficient to "push the aerostatic car...for the distance of at least a kilometer" (0.6 mi); therefore, all the rockets would be capable of "no less than a hundred kilometers" (62 mi). (One had to also consider the weight of luggage carried in the gondolas.)

Abate therefore took far too much for granted, let alone that this many of these essentially hand-fabricated rockets would have really been safe, powerful—and predictable—enough as multiple propulsion units for *controlled* manned flight. If anything, Abate's rocket-propelled aerostatic balloon is an ideal example of the extremely rudimentary level of rocket technology of the period as well as lack of understanding of fundamentals of rocket propulsion itself during this period.

It is thus not surprising that Abate concluded his brief description with a highly optimistic, although altogether naïve summation of the possibilities of his "invention." "And who does not see," he asked, "that it will reap immense benefits to humanity...as well as [for] the science of war...for strategic discoveries of the enemy camp...and battlefield and transmit the appropriate orders...with the speed of the rocket?" He even envisioned an "air race" with the rocket balloon "between Naples and Sorrento...and vice versa" and that this "air locomotive" was "free to run in any direction [through]...immense atmospheric spaces...and was destined to mark an epoch in the annals of human invention."

We can only add that while Abate's project is covered in various Italian aeronautical histories, nothing is known of the "inventor" himself. We may also point out that Abate's concept was hardly new and is almost identical to the anonymously produced idea of 1831 by one of his fellow countrymen, as covered in Part I of this paper.[6]

Yet there were certainly other pioneers in this aspect in the history of the development of aeronautics who were far more systematic and scientific. One was the Englishman Charles Blachford Mansfield (1819–1851) whose work of more than 500 pages, *Aerial Navigation,* also appeared in 1877. Mansfield thoroughly investigated all phases of attempts at flight, and possibilities of flight and Chapter XIV is devoted to "propulsion" in which he included combustible or "liquid fuels," including naphtha, the combustion gases of which could be arranged to "escape" through apertures for propulsion and he was also looking at other "chemical means." He may therefore have been on the track toward arriving at a liquid-propellant rocket motor for a flying machine. However, Mansfield died in 1851 before his studies and manuscript could be fully completed and the manuscript was therefore edited years later by his brother Robert and finally published, as mentioned, in 1877. Technically speaking, therefore, we cannot include him in this section and his work was unknown to us in undertaking Part I of this paper.[7]

Finally, also in 1877, we encounter the British patent of 15 October of that year by Charles Ogle Rogers for a "Military Machine" in which he proposed "One or more balloons connected by a line or lines" in which the balloons carry explosive bombs that were to be discharged from aloft against an enemy and the balloons also "propelled by the explosives, or by firing rockets..."[8]

We should also mention that in the same year, the Russian Vice-Admiral Nikolai Mikhailovich Sokovnin (1811–1894), whose earlier (1866) reaction-propulsion flying machine propulsion was covered in Part I of this paper, further presented his ideas in the December 1877 issue of the French journal, *L'Aeronaute.* This was not rocket-powered, but a dirigible propelled by compressed air, although still a reaction-propulsion concept.[9]

It is not until two years later, in 1879, that we find another early pioneer of who conceived the idea of rocket-propelled flying machines. This was the gifted and well-known Italian engineer Enrico Forlanini (1848–1930) who, in fact, went so far as construct and experiment with such a machine using true rockets, but also of the gunpowder type. The model, however, was merely to test the principle. Back in 1877, Forlanini successfully built and flew a steam-driven helicopter that according to aviation historian Gibbs-Smith, was the second such successful machine after the Englishman William Henry Phillips' reaction-propelled helicopter demonstrated in 1842, covered in Part I of this paper.

However, Forlanini's helicopter was not reaction-propelled since the steam operated a very light, compact, and powerful steam engine that drove at least one of the propellers. But he continued his experiments and designed another helicopter that *was* propelled by jets of steam escaping from the ends of the blades, and was therefore comparable with Philips' 1842 model. Forlanini is better known for considerable contributions in the design and construction of powered airships as well as hydrofoils. But perhaps his most ambitious project was the airship *Omnia Dir* (*All Directions*), first flown in 1931 after his death and that used blasts of compressed air for directional control—a form of jet or reaction propulsion. But this project does not fit the scope of this chapter that only covers such developments up to 1900.[10]

## IV. Kibalchich (1881), Van Kerkhove and Snyerrs (1881), Delaurier (1883), Griffiths (1883, 1885), Nezhdanovsky (1888s–90s), Griffiths and Beddoes (1890), Thayer (1884–1885), Ciurcu and Buisson (1886–1887), Eval'd (1886), Geshvend (1887), and Edselle (1889)

Undoubtedly one of the most unusual—and historic—appearances of a reaction-propelled flying machine originated as a result of the assassination of the Russian Tsar Alexander II on 13 March 1881. Within a very short time, the perpetrators of the crime, members of the revolutionary party, *Narodnaya Volna* (*Will of the People*) were caught and led to a sensational trial during that 7–9 April in St. Petersburg. Nikolai Ivanovich Kibalchich (1853–1881), the maker of the bomb used in the crime, was one of those arrested. Besides being a political activist, he was a former student of the St. Petersburg Institute of Communications Engineers. He hardly spoke at the trial and the authorities noted that his mind was completely preoccupied with other things. In fact, when in his cell he requested from his attorney some paper so he could write down mathematical calculations and pleaded that his paper be turned over to scientists before his execution that had already been decided. However, his wishes were not totally heeded. He was executed on 3 April along with his co-conspirators and his paper was simply filed away with the trial documents in an archive. It was only in 1918 that the Secret Police released Kibalchich's paper that was turned over to Prof. Nikolai A. Rynin, the eminent authority on aeronautics who subsequently published his findings in the Russian journal *Byloje* (*The Past*) in the October–November 1918 issue. This story is well covered in the literature and we need not go into much further detail on it.

Basically, Kibalchich had designed a reaction-propelled flying machine that Ley, in his 1938 article mislabeled "the world's first rocket aeroplane [*sic*]," while much later, Gibbs-Smith similarly refers to it as "a rocket aeroplane." As we have amply seen in Part I of this paper and above, that it certainly did not qualify this characterization, especially since it was not aerodynamically shaped. Rather, the device was rather simple and not configured like an airplane, with horizontal stabilizers for lift, for example. Basically, it was a platform with a hole in the middle but mounted above this hole was a cylindrical explosion chamber. "Candles" or cylinders of compressed gunpowder (or rather, slower-burning gunpowder) were to be fed into the chamber. Probably the most interesting aspects of it were that the craft was to rise vertically and the chamber tilted for horizontal flight. Thus, in effect, this was one of the earliest (but not the first) proposals that encompassed a type of swiveling rocket engine chamber. (See the concept of the Italian Onofrio Abruzzo of 1868, covered in Part I of this paper for an earlier example of rocket motor swiveling.) The speed of the Kibalchich apparatus was regulated both by the size of the "candles" (i.e., for a controlled burning rate) and the numbers used.

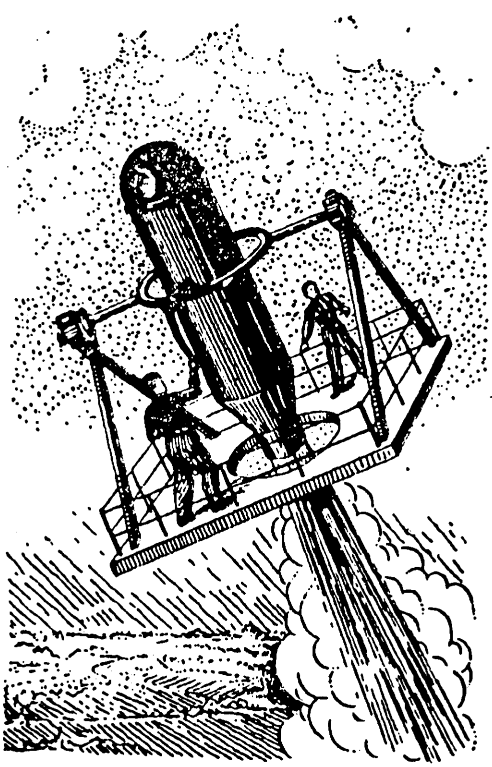

**Figure 7–5**: Modern artist's rendering of Kibaltchich's concept. (From the Frank H. Winter collection).

However, although the design was far from extraordinary, in 1970 the International Astronomical Union saw fit to honor Kibalchich by naming a crater on the far side of the Moon in his honor (3.0° N 146.5° W). Perhaps this was because Y. I. Perelman, the Russian writer on spaceflight, incorrectly referred to it as a "spaceship" although it was only intended for atmospheric flight. Furthermore, in 2006 Lee B. Croft published a 163-page book titled *Nikolai Ivanovich Kibalchich: Terrorist Rocket Pioneer*, although Ron Miller, cited above, more correctly termed his device as only a "rocket-powered man-carrying platform."[11]

In actuality, the design in the same year of 1881, by the two Belgians, Auguste Henry van de Kerkhove and Theodore Snyerrs Jr. of Brussels, is technically far more interesting than that of Kibalchich. This appears in their British joint patent No. 3561 of 1 August 1881 as "Propulsion of Motors or Engines." In this case, their "reaction engine" was intended to operate on a "liquid or gas" for propulsion of land, water, and air. The apparatus was quite complex and consisted of four parts: (1), the gas generator in which water was dissociated into oxygen and hydrogen by means of an electric current supplied by batteries; (2), the gas-production regulator that increased or reduced the production of gas; (3), the mixture (detonating) gas supply regulator; and (4), the "Explosion chamber with nozzle."

In the latter, the so-called "detonating gas" entered into the huge, horizontally placed teardrop-shaped chamber where it exploded then out of the adjoining conical nozzle with a very wide exit, thus creating a "force of reaction" that drove the whole apparatus forward in the opposite direction of the exploding gases. In essence, they had invented a huge gaseous rocket motor—and one using gaseous oxygen and hydrogen at that. Surely, it must have been the first such patented rocket application of oxygen and hydrogen. Moreover, their "gas generator" presaged the modern "fuel cell" as used in space in Project Apollo, although the very first, albeit crude, fuel cell was conceived in 1838 by the Welsh physicist and barrister and later, a judge, William Grove (1811–1896) and appearing in the December 1838 edition of *The London and Edinburgh Philosophical Magazine and Journal of Science*. Nonetheless, the problem with the apparatus of van de Kerchove and Snyerrs, Jr. is that it was *too complex*, not to mention far too heavy since the whole (at least for land use) was mounted on a base made of bricks! Needless to say, their apparatus was never built.[12]

As covered in more detail in an earlier IAF paper by V. N. Sokolsky, the Russian Sergei Sergeevich Nezhdanovsky (1850–1940), who had actually begun his researches on reaction-propelled flying machines from 1880 and continued his work until 1895, was one of the first to realize that a funnel-type nozzle would increase the "efficiency" of the machine and produce "an economy of fuel and increase the time of flight." (His first chosen mode of propulsion was the use of gases by the burning of gunpowder "equal to 150 and 200 atmospheres.") By 1882, according to Sokolsky, Nezhdanovsky was also more concerned with the dynamics, or physics, behind such a machine. "As a result of his calculations," says Sokolsky," Nezhdanovsky concluded that "The work needed to support a body [the reaction-propelled flying machine] is directly proportional to the speed of the air flowing from the engine, and inversely proportional to the square root of the wing surface or to the square root of the section of the opening from which reaction gas exhausts."

In another publication, Sokolsky shows that Nezhdanovsky even attempted to calculate the exhaust velocity of the reaction of gunpowder gases, at 928 m/sec

(3,045 ft/sec) based upon the weight of a rocket charge of 65 kg (143 lb) for a duration of flight of 300 sec, although this velocity is excessively high; burning duration is not given and obviously the inventor was theorizing and his calculations were not based upon actual experiments.

Nonetheless. Nezhdanovsky "differed from most inventors who tried to solve the problem of jet [reaction-propelled] before him," Sokolsky adds, in that he spent much of his time to also "finding the best fuel" and "thought of such problems as fuel feeding into the combustion chamber by...pumps, and the use of one of the fuel components for cooling the walls of the combustion chamber [regenerative cooling]." Indeed, in his 1882–1884 manuscript he even thought of two liquids—a fuel and oxidizer—based upon a patent of 1880 (presumably, Russian patent, No. 154 to A. Gelgoff, G. Grusson, and I. A. Halbmeier for producing a new kind of explosive with combinations of liquids).

One example of fuel (or propellant) combination conceived by Nezhdanovsky in the 1882–1884 period was based on nitrous acid. Therefore, quite rightly, Sokolsky says Nezhdanovsky was describing "liquid-propellant rocket engines" and their propellants, although he "was little concerned with the design of the aircraft [itself...]." Mainly, he focused upon "the aerodynamic and rocket-dynamic principle of creating the lifting power." By the late 1880s, he concentrated more on the design of such aircraft with wings, while in the 1890s he turned his attentions on reaction-powered helicopters, of one-and two-rotor design. It was during 1894–1895 that he specifically covered regenerative cooling that predated this proposition made by his compatriot Tsiolkovsky in 1903. However, Sokolsky judges Nezhdanovsky's paper to be "working notes" and was never "a finished study" despite his "very original progressive ideas."[13]

On 3 September 1883, John Henry Johnson, in a communication from Emile Joseph DeLaurier of Paris (the original inventor), took out British Patent No. 4245 for an "aerial machine" propelled by steam but in his case he also suggested pivoting the "discharge nozzle" (another gimbaling idea). In the same year, the Welsh-born sea captain, Captain Thomas Griffiths (d. 1894), delivered a talk before the Royal Aeronautical Society of Great Britain on his concept for "A Light and Economical Motor for Propulsion in Air." This was a remarkable presentation in several respects. Here, as his title implies, he concentrated upon his ideas for a motor for a potential flying machine, not upon the aircraft itself, but such a motor could be "equally applicable to all kinds of apparatus...whether balloons or wings."

He proposed "to use gas on the jet [reaction propulsion] system, thereby getting rid of all weight except that of the reservoirs for the gas, the gas itself and the nozzles for delivering it." He concentrated on the nozzle. This was fixed to a very light cylinder, 10 in. (25 cm) long and 2 in. (5 cm) in diameter that constituted the "reservoir." The end of the nozzle was not a de Laval type, but actually "tapered like the neck of a champagne bottle," as he colorfully described it, with a hole on the top and an adjusting crew or valve down it length. In other words, it was an adjustable nozzle, comparable to a modern welder's torch.

Griffiths went on to explain that ordinary water is composed of parts of oxygen and hydrogen and that the oxygen could be "take away from the water...for the expansion of the hydrogen..." He did not state how this was done but it could have been accomplished by dissociation, as suggested in 1881 by van de Kerchove and Snyerrs, Jr., mentioned above. In any case, he was thinking of compressed hydrogen. But Captain Griffiths proposed that "various" hydrocarbon gases also be considered, like ethylene gas. His point was that such gases could take up a small volume and weight yet potentially was able to exert more horsepower "for work" than ordinary steam.

Next, he explained Newton's third law of motion that, in his words, "action and reaction are equal in opposite directions." Hence, Griffiths was a rare early proponent of a reaction-propelled manned flying machine who unequivocally recognized the true principle of reaction motion adapted for such propulsion. He additionally recognized that the screw, or propeller, for aerial propulsion had the drawback of "requiring weighty machinery," whereas the "jet or expulsion of gas method did not. "That a jet of gas," he added, "can propel is proved...by the action of a rocket..." Griffiths thus clearly understood that Newton's law also applied to the rocket.*

He also chose the term "continuous thrust" in further describing a reaction-propelled steam-driven vessel. "It is evident," the captain concluded, "that a jet may be worked without machinery [i.e., hydraulic and pumps, for a flying machine]." The chairman of the meeting made his concluding remark that, "...the paper was in the direction in which the Society wanted experiment," although it is not known if the Society pursed this. There is no indication it did.[14]

* It is further interesting that he referred to "water-jet" [reaction-propelled] ships like the British vessel *Waterwitch* [launched in 1866] and the Thorneycroft torpedo boat by the same manner, and thus operating under Newton's law. In other words, Griffith backed up his proposals by citing examples of already many years of *proven* and well-established technology of the "jet propulsion" or "hydraulic propulsion" as it was also called, of ships, but the earliest history of this complex technology is beyond the scope of this chapter.

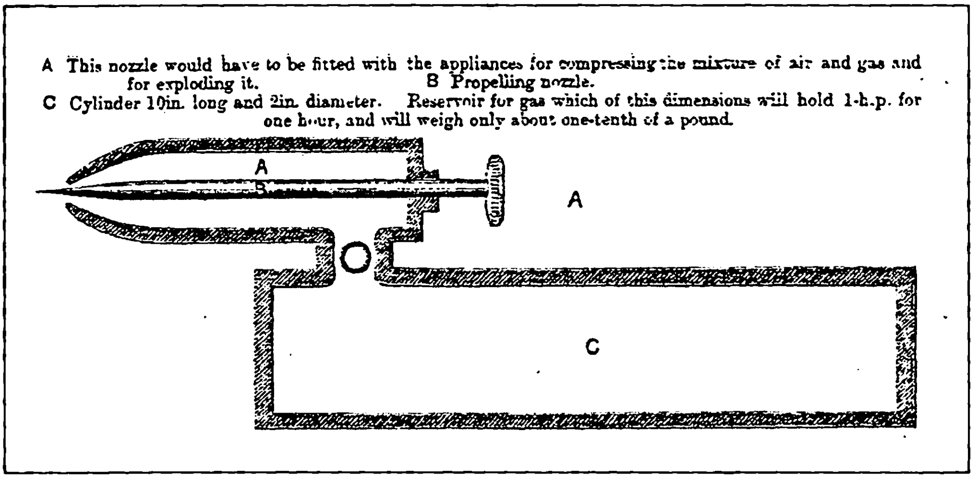


**Figure 7–6**: Griffiths' nozzle, 1883. (From Royal Aeronautical Society, *Eighteenth Annual Report of the Aeronautical Society of Great Britain* [Henry Richardson: Greenwich, 1883, p. 69]).

Yet, the case of Captain Griffiths does not end here. On 25 August 1885 he took out British Patent No. 10,068 for "Improvement in Jet Propulsion [*sic*]." This is most interesting by itself since it was an early (certainly one of the earliest) uses of the term "jet propulsion" specifically applied to flying machines. However, the patent covers much the same *technical* features and applications as he had presented in his talk before the Society—but with an extremely significant alteration in the wording. "The jet or jets of combined steam and air and gases," it reads, "is or are delivered from a bottle-shaped nozzle into the atmosphere..."

Hence, he was not discarding steam although was also including the possibility of *combined* gases. Then, he adds, "My method is specially adapted for the use of liquid-fuel..." But, curiously, combustion is still left out, or at least direct combustion, since he mentions a "boiler furnace" for producing the steam or gases.

Five years later, there was yet another patent, this one taken out with a partner, Thomas Henry Willoughby Beddoes (apparently a fellow mariner, a Royal Navy commander, by this same name, 1846–1914), on 7 August 1890 as Patent No. 12,349 for "Propulsion of Aeronautical Apparatus and the Like..." But this time they add the words "...by direct reaction due to the pressure of gases caused by the explosion of combustible gas, vapour, or comminuted hydrocarbon liquid [reduced to minute particles, or mixed] and air..." The patent then says that the explosive mixture should be compressed by means of a pump before ignition. In short, Griffiths and Beddoes co-patented a type of liquid-propellant rocket motor in 1890 for potential used in propelling a manned flying machine. But neither were known to have produced any hardware; moreover, Griffiths died in 1894.[15]

On 9 December 1884 the American Russell Thayer (1852–1933) of Philadelphia took out Patent No. 309,009 for a "Motor" to serve as the propulsion for "aerial ships, land vehicles, and marine vessels" in which compressed air could be discharged intermittently "in the direction opposite to that from which the spent energy is released." His second patent, No. 309,008, went into more detail on the airship. The first patent therefore seemed to be like many other reaction-powered concepts of the time.

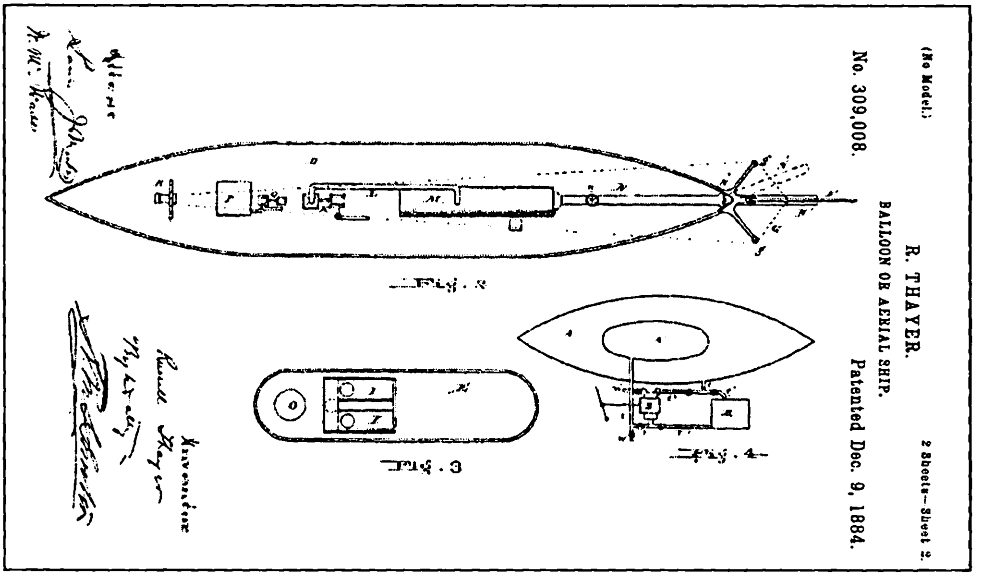


**Figure 7–7:** Thayer's patent drawing of 1884.
(U.S. Patent 309,008).

But Thayer was a distinguished military officer—a brigadier-general. He was also a gifted engineer and inventor and his second patent and subsequent writings thus considerably expanded his ideas and converted his reaction-propelled balloon into an aerial warship. In fact, he constructed a working model, which the *Scientific American* for 22 October of that year reported was "under serious consideration at the British War Office." His "dirigible balloon" was designed to carry a cannon and was propelled by compressed "carbonic acid gas" (carbon dioxide) forced from a reservoir by a high-speed air compressor underneath the platform or deck of the dirigible.

Still another motor design by General Thayer that year consisted of a powerful turbine that could generate "the continuous discharge of a large volume of air through a nozzle pointed stern-ward. This develops a powerful propelling force." A variation was the addition of a hollow, concentric, truncated cone placed over the nozzle, thereby drawing in outside air and increasing "the velocity of the discharge." The general also thought of "several such conical tubes, one outside the other...[that] considerably increases the efficiency of the motor." In other words, he had conceived of thrust augmenters.

He had tried experiments with water and the addition of five cones that "gave an increase [of thrust] of fifty per cent." Moreover, in his overall design the discharge nozzle was "fitted on a ball and socket joint, which permits it to be moved in any direction at pleasure," and thus was another mode of gimbling. It is further reported that Thayer had "carefully constructed models" of both balloon types.[16]

Thayer's dirigible was thus well thought-out and seemed so promising at the time that it generated a great deal of publicity both in the United States and England. The nationally circulated *Harper's Weekly* of New York, for example, ran a long article on it and dubbed it "The Dynamite Balloon" while *The Graphic* of London simply hailed it as "A new American navigable balloon."

More than this, on 7 January 1885 Thayer had written a proposal for it to the then Secretary of War, Robert T. Lincoln, the son of the former president. Consequently, the story goes, U.S. Army's Ordnance Board recommended that a full-sized version of the 185 ft (56 m) long, boat-shaped "monster air-ship," as it was also called, be constructed and would be suitable for dropping heavy bombs. (*The Graphic* gave different dimensions of 66 ft, or 20 m, in length, and a diameter of 60 ft, or 18.3 m, and a cost of nearly $10,000.) The U.S. Congress, the story continues, even approved of an appropriation of $60,000 but the money was never forthcoming and that is as far as the project went.

However, a closer examination of this account shows that the latter part of this story is not true. Rather, through Lincoln's recommendation, Thayer was invited to appear before the Ordnance Board at the New York Arsenal on Governors Island, New York, and he *did* appear and explain his invention. The Ordnance Board subsequently *did* recommend that "a machine of about seven tons ascending force [i.e., thrust, or 14,000 lb or 62,275 N] be made and tried, the cost not to exceed $5000."

Thayer had to repeatedly inquire with the Board of Ordnance on the status of the recommendation although he got nowhere. In sum, the matter became mired down in the bureaucracy and never left the recommendation stage yet this is probably as close as anybody came in the 19th century, at least within the

United States, to seeing the initiation of the development of a large-scale operable reaction-propelled aircraft.[17]

On 12 October 1886, Alexandre Ciurcu (aka Alexandru Churcu) (1854–1922) of the Kingdom of Romania, received French Patent No. 179,001 for a "Propulseur à Réaction" ("Reaction Propulser"). In this invention, he had been assisted by a Frenchman, Just Buisson. Both deemed the invention so important that it was also patented in Germany on 19 October 1886 (Patent No. 39,964), in England on 7 June 1887 (No. 8,182), in Belgium on 8 June 1887 (No. 110. 77,754), in Italy on 17 June 1887 (No. 21,863), in Austria-Hungary on 21 August 1887 (No, 41,129), and in the United States on 23 July 1889 (No. 407,394). "This invention," reads the opening of the patent,

> "relates to an improved apparatus for propelling vehicles, boats, balloons, aerial machines, and like purposes by the reaction of gas under pressure escaping from a contracted orifice. The gas may be advantageously generated by the combustion of a compound consisting of, say, about seventy-eight per cent of nitrate of ammonia intimately mixed with about twenty-two per cent of petroleum. To this mixture is added about seven per cent of wood-charcoal previously broken into small fragments and soaked in a concentrated solution of nitrate of ammonia."

This mode of propulsion was thus clearly a rocket, or reaction-propulsion, utilizing heated gases. Ciurcu was a journalist in his native land but he attacked the government and had been forced to flee to Paris. Here he met an old friend, Just Buisson, also a journalist and both also shared the same passion for invention.[18]

In Paris, Ciurcu and Buisson were able to confer with authorities on aeronautics, such as Gaston Tissandier and to "read passionately [on the subject]," according to Zăgănescu et al., but never had the chance to more fully work toward applying their propulser to a flying machine; in fact, Tissandier was rightly appalled by the explosive mixtures they were proposing and judged their machine to be too dangerous to consider.

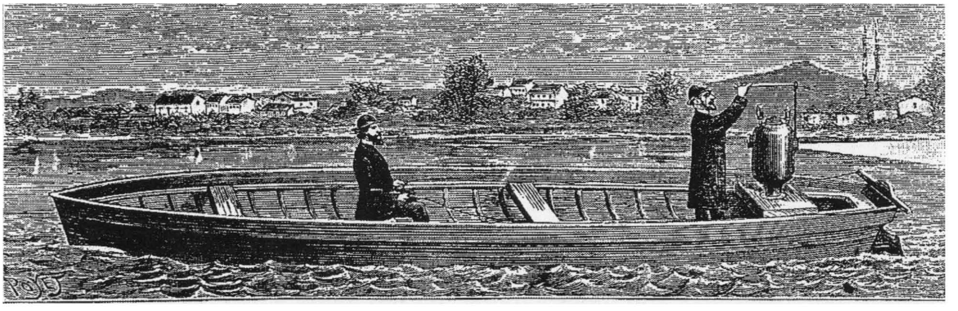

**Figure 7–8**: Original Model of Ciurcu's reaction-propelled boat on Seine River, Paris, successfully tested on 3 August 1886. (From *La Nature* [Paris], 15 Année, 2 July 1887, p. 72).

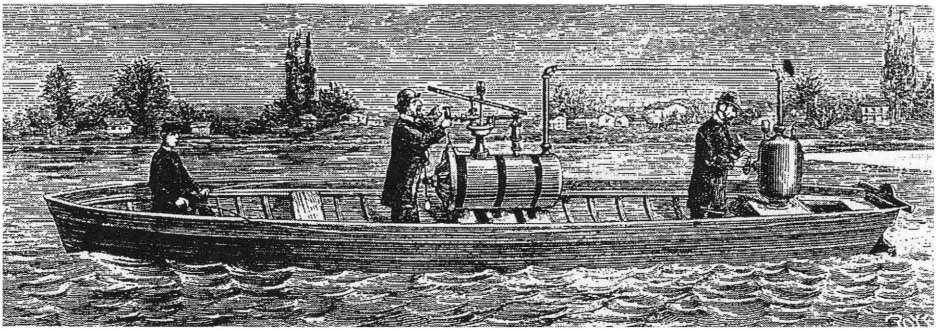

**Figure 7–9**: Second version of Ciurcu's reaction-propelled boat on Seine River, Paris, 1886. (From *La Nature* [Paris], 15 Année, 2 July 1887, p. 72).

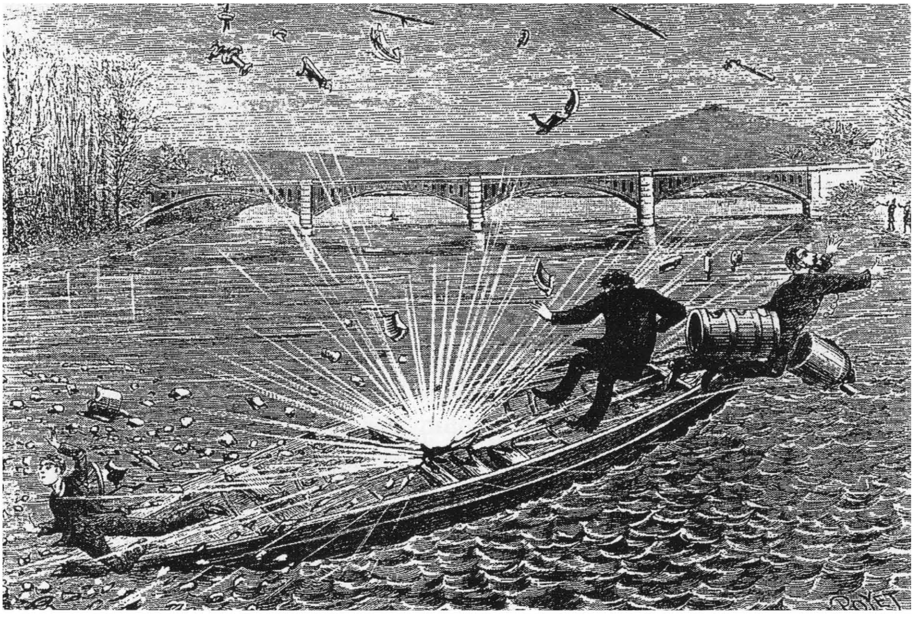

**Figure 7–10**: Explosion of second model of Ciurcu's reaction-propelled boat on Seine River, Paris, 16 December 1886. (From *La Nature* [Paris], 15 Année, 2 July 1887, p. 73).

Undiscouraged, they set about first testing the apparatus on water, in a reaction-propelled boat on 3 August 1886, which was a brief but successful run, followed by another successful run, as a reaction-propelled rail car. Yet when they tried the boat again but with a larger, more powerful combustion chamber with two propellant tanks and more valving, on the Seine River on 16 December 1886, the test turned into a catastrophe and the apparatus exploded, resulting in the death of Buisson and another assistant. But we need not go into the technical and details since these are very well covered in the IAF paper by Zăgănescu, Burlaca, and Stefan, as well as in the French journal *La Nature* (Paris) of 2 July 1887, the lengthy and illustrated description written by Ciurcu himself, besides other sources.[19]

We should also briefly mention the Russian engineer Fyodor Romanovich Geshvend (1841–1890) who was also active during this period with his own ideas and experiments toward the same goal of reaction propulsion of flying machines that was similar, in certain respects, to those of Ciurcu and Buisson. Geshvend's work actually goes back to 1866 with the publication of his brochure, as translated into English, *General Basis of the Project of Application of Jet Work of Steam in Railway Locomotives* (Kiev, 1866). That is, he originally thought of "jet propulsion" for land vehicles—trains—then quickly adapted the principle to "aerial navigation" and four months later produced his second brochure, *General Basis for the Construction of Aeronautical Steamer*, and considered using kerosene for fuel, although mainly opted for steam. In May 1887, he published his third brochure, about the engine itself, *Obshchee osovanie cstroistva vozdckhoplavatel'nogo parokhoda* (*General Fundamentals of the Design of an Aeronautical Steam-Driven Vehicle* [*Steam Plane*]. He is also said to have conducted experiments by this time on a farmstead at Rybnoie, near Kiev, although budgetary restrictions rather than a disaster halted his work.

The most interesting features of his craft included its biplane design and nozzle of seven concentric cones, like those of Thayer (whom he may not have known about), for maximum efficiency of his steam jets. His compatriot, A. V. Eval'd, from 1886, had actually conducted a number of experiments on the grounds of the riding school of the Horse Guards in St. Petersburg with a small model aircraft fitted with solid-propellant (gunpowder) rockets. But he similarly ran out of funds although much later did later produce his results, as *Letatel'nye mashiny—Opyti I nablycdenia* (*Flying Machines—Experiments and Observations*), St. Petersburg, 1897.[20]

In April 1889, there appeared another—unfortunately unsubstantiated—claim for a manned rocket flight. (This was originally found as an undated newspaper clipping in a scrapbook on aeronautical items compiled by William H. "Kidd" Hanner, a prominent early balloonist of Cincinnati, Ohio. But now, through the medium of Google, we can for the first time more precisely date this claim.) Starting on 17 April of that year, there was published in *The Evening Bulletin* (Maysville, Kentucky) and other newspapers (with the exact same wording, although with different titles), the following account:

> "Manager Robertson of the International Exposition [perhaps the International Exposition held in Paris in that year] has secured a novel attraction—

> a human sky rocket, the handicraft of Mr. Edselle of Callao, Peru, [and] formerly of the United States Navy...Signor Camarara made the initial trip. The apparatus consists of a combination of rockets of immense power with a parachute attached... Four tubes form the framework and contain the explosives [*sic*]...the explosive is secret and is called Dynoascenemite... A small volume of the solid makes an immense volume of vapor and lifts the machine with lightening rapidity... The test took place near Callao, in December [presumably in 1888]. The charge, touched by electricity, sent the machine over 15,545 ft [4,738 m], and the descent by parachute was perfect. Sig. Camarara landed [safely] five miles [8 km] from the starting point... Fifteen thousand people were present and watched with telescopes... Mr. Edselle will start for Buffalo [NY] within a few days."

However, we never hear of further progress of Mr. Edselle's astounding apparatus; nor can we identify "dynoascenemite." Nor is there any known account of 15,000 people witnessing such an event. Lastly, it is highly problematic that the then, incredible altitude of 15,545 ft would have been obtained and recorded of an extremely fast rockets ascent. Therefore, the story of Mr. Edselle of Callao was very likely apocryphal—a hoax.[21]

## V. Harris (1890), Nobel (1891), Petersen (1892), Battey (1892), Pynchon (1893), and McEwen (1896)

Not surprisingly, in the 1890s, considering the explosion of inventions then, including the first successful internal combustion engine and an even greater activity toward the development of controllable flying machines, that there was also a flurry of inventions of reaction-propelled motors adaptable to flying machines. On 7 June 1890, for instance, Henry Marmaduke Harris obtained a British patent (No. 8816) for "Aërial [*sic*] Machines with Aerostats" in which the "car...in the form of a boat" was attached to a balloon and was "propelled by the reaction of gases discharged through the nozzle...the direction of which is controlled by lines...for steering."

In the following year, no less than Alfred Nobel (1833–1896), the great Swedish engineer and inventor of dynamite came out with his own patent, No. 11,212 of 1 July 1891, in England, for "Propelling," while the same patent was granted in the United States as Patent No. 515,500 on 27 February 1894 for a "Means of Generating Gases Under Pressure for Obtaining Motive Power." This motive power was for "propelling torpedoes and other explosive missiles, for controlling the course of balloons" and the machinery for producing the power was to be "extremely light."

"Hitherto," he continues, "compressed air, liquid carbonic acid, and electric...batteries...applied for such purposes...have proved comparatively inadequate..." He therefore simply substituted them for the energy (gases) produced by the "chemical reaction [decomposition] of metallic sodium or potassium or alloys of those two metals...thus...developing a...gas...the explosion of which is capable of producing motive power." This concept, however, was more complicated than it seemed and was not developed further.[22]

On 17 June 1892, Nicholay (or Nikolai) Petersen, living in Mexico (Rynin says Guadalajara), was granted a German patent (Group 37/03) for a unique "rocket-powered airship," in which the rocket bodies, or cylinders, were automatically fed into a large "revolver cylinder" and fired successively by an electric igniter, then removed for the next rocket. The gases escaped from a "truncated cone," or nozzle, at the stern of the ship.

Many years later, Rynin judged the invention "hardly suitable in practice" since the impulses would have endangered the structure of the ship; the replacement of the rockets was "manual and...unreliable," and Petersen provided "no computation of the quantity and power of the rockets." Besides all this, there was no safety device "against explosions."[23]

Nonetheless, the concept of Sumter B. Battey (1861–1934) generated far more public interest throughout the United States and overseas. Battey, who was actually a distinguished physician who practiced medicine in New York City, was also inventive and on 6 September 1892 was granted British Patent No. 15,977 for his "Aerial Machine." The same patent also later granted in the United States as No. 502,168 of 25 July 1893; patents were also taken out in other countries. Dr. Battey's concept was featured in the *Scientific American* and many newspapers and even briefly described in a later issue of the fashionable British magazine *Badminton Magazine of Sports and Pastimes* as follows: "Mr. Battey's idea consisted of a cigar-shaped balloon of thin aluminum, assisted by wings for upward and downwards movement; the whole thing to be propelled by a series of explosions...at the rate of six a minute, and the ship was to be propelled by the shocks." In actuality, like Peterson's idea, Battey's airship (also described as "like a gigantic fish") reaction propulsion was by small spherical pellets of nitroglycerin fed automatically in a "cap" and fired electrically.[24]

A far more grandiose reaction-powered airship was conceived by another inventive American physician, Dr. Edwin Pynchon of Chicago (1853–1914) in his U.S. Patent No. 508,753 of 14 November 1893 for an "Air-Ship." Like Peterson and Battey, Pynchon's vessel was to be propelled by the successive detonation of explosives—although these were to be high explosives "now being built by [Hiram] Maxim [inventor of a machine gun after his name]..." They were in the form of dynamite cartridges discharged under a detonating plate. For auxiliary propulsion, air could be sucked in by an electric fan and blown out a rear opening.

But the most astounding feature was the vessel's size. Grandly known as the *Albatross*, it was to carry 25 passengers accommodated on different decks with state rooms, a chandelier, multiple windows, and staircases and meant for travel over the ocean at 200 mph (322 km/hr). Needless to say, *Albatross* never materialized. Dr. Pynchon was more successful with his electric tonsillectomy procedure and other medical advances.[25]

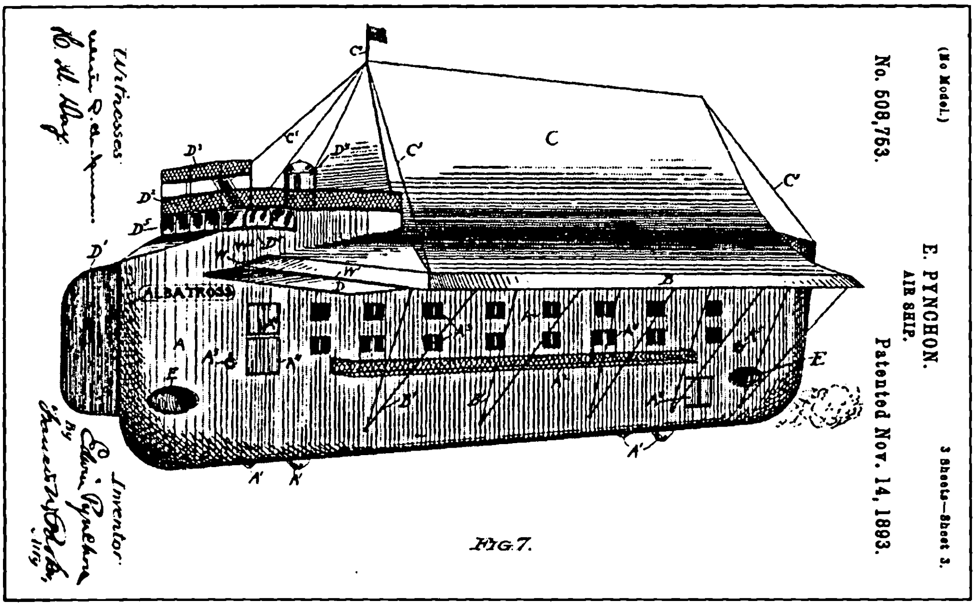


**Figure 7–11:** Pynchon's reaction-propelled airship, *Albatross*, 1893. (U.S. Patent No. 508,753).

Yet, almost at the turn of the century there was a far grander plan than that of Dr. Pynchon. It was proposed by the so-called "Professor" William W. McEwen (or William Wallace McEwen), a daring aeronaut of Jackson, Michigan, United States. His idea was to make a "rapid transit experiment" on a 60 ft (18.3 m) long aluminum skyrocket "and take up excursion parties later on." This was at the rate of 100 miles/min (161 km/min), or 6,000 mph (9,656 km/hr). So claimed the front page headline of the *New York Journal* for 26 January 1896.

McEwen, also given as M'Ewen, based his confidence on his career of 18 years as a "balloonist and parachutist" and reported that he had been working out the detail of a rocket ascent for several years. The paper also indicated he had already undertaken preliminary experiments "one model after another." However, the front-page article focused more on the evolution of his parachute, rather than rockets.


Pages 17 to 32. NEW YORK JOURNAL Pages 17 to 32.

SUNDAY, JULY 26, 1896.

# TO TRAVEL A HUNDRED MILES A MINUTE.

## PROF. M'EWEN, OF MICHIGAN, WILL MAKE A RAPID TRANSIT EXPERIMENT ON A SIXTY-FOOT ALUMINUM SKYROCKET AND TAKE UP EXCURSION PARTIES LATER ON.

## New York 100 Years Hence.

### Notable People Prophesy as to the Changes That Another Century Will Bring.

### WAR AND THE LOCUST

**Figure 7–12:** Newspaper article on manned skyrocket of William W. McEwen, 1896. (Front page of the *New York Journal* of 26 July 1896).

Moreover, it is clear enough McEwen was neither a scientist nor an engineer but a professional showman. All he could say about rockets is that Congreve's war rockets, developed earlier in the century, carried "charges" (he may have meant their full weight) up to 30 lb (13.6 kg) and that "there was no radical obstacle [for] . . . a rocket large enough to carry the weight of a man." He therefore reasoned it could ascend to 7,000–8,000 ft (2,134–2,438 m), with a safe recovery by parachute.

The "professor" did realize that the greatest difficulty would be the shock of sudden acceleration, but he believed that the ascent could be made gradual, or "regulated," with experiments with its (gunpowder) composition. It is also mentioned that he had already made experiments with rockets and that their flights began at "only 20 miles an hour" (32 km/hr) but that their speed "materially increased." McEwen's largest rocket was 7 ft, 10 in. (2 m, 25 cm.) in length. Also, the newer model was "now being constructed in Chicago and is made of aluminum with phosphor-bronze reinforcements..."

His ultimate projected full-scale, *multi-manned* rocket was to be far larger, about 25 ft (7.6 m) wide, 100 ft (30 m) long, "and [with] accommodations for about fifty people" and would be equipped with telescopes and "other necessary optical instruments." All was to be under the control on one "engineer." Yet, little was heard of McEwen's progress after this. A small *Washington Post* article of 19 July 1896 did say that, "At last a model [rocket] has been produced [in Chicago] which has made three highly successful ascensions" and that he had started on the 60 ft (18.3 m) version.

There was also almost a repeat, in the *Chicago Tribune of* 2 August 1896, of the original, sensationalistic *New York Journal* front-page article. But other than these "news" items, nothing more is heard of Professor McEwen. We only know that listings of him in issues of the *Jackson City Directory* show him being called an "aeronaut" up to 1901 and then as an "electrician," although he had also worked as the manager of different theaters in various states up to 1915. Therefore, McEwen never made his flight, nor built his big rocket, and in all probability remained a showman.[26]

## VI. Conclusion

Neither Rynin, Duhem, nor Miller in their comprehensive works, cite any other pioneers in reaction propulsion concepts from 1897 to 1900. Thus "Professor McEwen" was perhaps the last of such pioneers in the 19th century. Overall, then, with some exceptions, the history of reaction propulsion concepts and possible experiments before 1900 was, as already stated in Part I, one of naïveté about the true nature of "reaction propulsion"—or even lack of basic knowledge of Newton's third law of motion that explains reaction propulsion.

In addition, the state-of-the-art in requisite engineering and chemical technologies was wanting; rocketry itself was still primitive and was largely locked in the "gunpowder" era. Inadequate means of steering flying machines, as well as ignorance of the dynamics of flight (especially rocket flight) were also common endemic deficiencies. Moreover, the 19th century was especially marked with examples of showmanship rather than technically oriented pioneers in this unique and highly specialized area of aeronautics and, as also mentioned, national patent systems were not rigorous in their standards as they are today.

In short, for many reasons, the vast majority of these ideas were impracticable. But at the same time, we can see the *inevitability* of these pioneers seriously considering reaction propulsion during this period when so many diverse modes of propulsion were then proposed and explored in order to achieve man's first powered flying machines, especially during the Industrial Revolution that witnessed the first successful steam, electrical, and internal combustion engines, besides many other technological advances in materials and their manufacture.

Indeed, this brief two-part survey further shows that there were a few outstanding although hitherto little known pioneers in this field of reaction-propelled flying craft, notably the team of Butler and Edwards with their farsighted concepts of the late 1860s described in Part I, and Nezhdanovsky and Griffiths and their own very progressive ideas of the 1880s–1890s, presented in Part II.

Lastly, it is interesting to observe the amazing diversity of these reaction-propelled concepts as part of the background of the far more advanced interplanetary reaction-powered (rocket) concepts of other pioneers in the late to early 20th-century timeframe, notably the pioneers Tsiolkovsky and Goddard. We thereby gain new perspectives and a "bigger picture" of the overall history of reaction-propulsion for manned flying craft that included numerous concepts for Earth-bound flying machines, or rather, terrestrial applications.

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