Contents

Chapter One

A Kind of Aladdin's Cave

UNDER BROADWAY RECEPTION.

To State Officers, Members of the Legislature, City Officials and Members of the Press:

You are respectfully invited to be present on Saturday, February 26th, 1870, from two to six o'clock P.M., at the office of the Beach Pneumatic Transit Company, 260 Broadway, corner of Warren street.

A.E. BEACH, President.

JOSEPH DIXON, Sec.[1]

The engraved invitations began arriving at the homes and offices of New York City's most prominent citizens earlier that week. The recipients were undoubtedly familiar with the address to which they were invited; for weeks the doings at 260 Broadway—or, more precisely, underneath it—had been the subject of much rumor and conjecture. The previous autumn passersby had begun noticing strange paraphernalia being delivered into the basement of the building: iron rails, an enormous fan, wagonloads of bricks, a piano—unusual because the five-story building housed a large clothing store called Devlin's, a business not typically requiring such equipage.

Then, at night, large wooden boxes filled with dirt and sand, presumably excavated from beneath the building, were observed being hauled away on large flatbed wagons, the wheels of which, some claimed, were wrapped in blankets to muffle the noise.

Ostensibly, the Beach Pneumatic Transit Company was merely installing an experimental pneumatic tube under Broadway "for the expeditious delivery of goods and parcels."[2] But many New Yorkers were convinced something else was going on beneath Devlin's, something much more interesting and perhaps more important than, as one paper put it, "a new way of 'puffing' merchandise."[3]

"For some time past there has been a great deal of speculation as to the character of the work going on beneath Broadway," the *New York Times* reported in December 1869. "Numerous attempts were made by the curious and members of the Press to obtain admission to Devlin's basement," the paper added. "But to all the doors were closed, and the most profound secrecy on the matter was preserved by all engaged in the matter."[4] A *New York Sun* reporter dispatched to the scene had no more luck than his *Times* counterpart. "No one save those employed therein is admitted into the mystic depths of the Broadway bore," the *Sun* explained, "and none of those employed there will utter a word."[5]

Finally, on Saturday, February 26, the secrets underneath the Devlin building would be revealed—to those fortunate enough to receive an invitation, at least.

The guests began arriving at two o'clock sharp, the men donning long dark coats and tall silk hats, the women in long, flowing skirts in striking shades of red, green, and blue, wrapped in jackets of velvet or brocade. The women wore hats too, extravagant wide-brimmed affairs trimmed with flowers and ribbons. Martin Kalbfleisch, the mayor of Brooklyn (an independent city at the time), was there, as were Common Pleas Court judge Charles P. Daly and a host of other luminaries. Entering through a door on Broadway, the guests descended a few steps into the space beneath Devlin's, and, passing through another door, this one airtight, they entered what one visitor called "a kind of Aladdin's cave,"[6] a long, wide room with colorful pictures of rail carriages hanging on walls of polished oak and black walnut. Natural

light streamed through circular glass blocks installed in the sidewalk above. Zirconia lamps, the kind used as limelights, added more illumination—electric lighting was still a decade in the future. In the middle of the room was a water fountain stocked with goldfish, and in one corner sat the piano. Scattered about were plush settees. There was even a special area reserved for ladies. "Such as expected to find a dismal, cavernous retreat under Broadway, opened their eyes at the elegant reception room," the *Times* reported.[7]

The guests were greeted by a slight, dapper man with a painter's brush mustache. Alfred Ely Beach was the publisher of *Scientific American* magazine, a tireless promoter of American inventors, and an inventor himself. He had organized the soiree.

This room, Beach announced, was the waiting room.

But what was meant to be waited for?

The answer to that question was a few more steps down where, astride a small platform, the guests encountered something so startling, so unexpected, that some must have gasped in amazement: a sleek cylindrical passenger railcar that sat on tracks at the entrance of a brightly lit tunnel. It was an underground railway—a subway—America's first.

But no engine was attached to the car. Beach explained to his bemused guests that this railcar would not be powered by a lumbering, rumbling, soot-spewing locomotive, but by a "blower"—a huge stationary fan, powered by a steam engine, that would blow the carriage into the tunnel and suck it back out. Stepping inside the car, the visitors found it richly appointed with twenty-two upholstered seats. Like the waiting room, the interior of the car and the tunnel were lighted with zirconia lamps. Flanking the entrance to the tunnel were bronze statues of Mercury, the Roman god of travelers (and commerce). Encircling the portal were gas lights covered with alternating globes of red, white, and blue.

Alfred Beach had built a pneumatic subway, covertly, in the shadow of City Hall.

While his guests marveled at his creation, Beach was busy "making his visitors explanations and entertaining them like princes."[8]

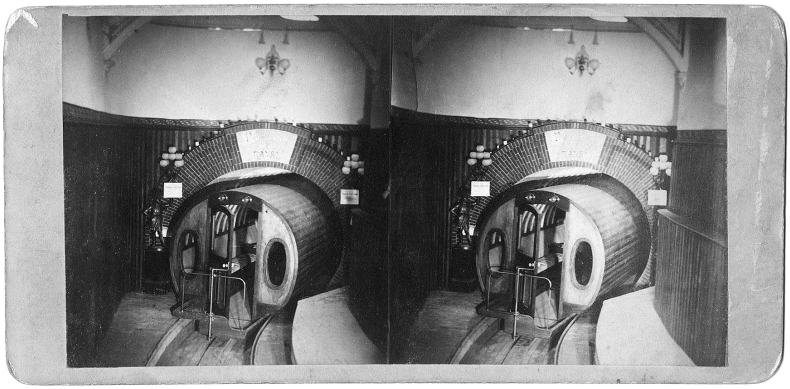
In a promotional brochure, Beach explained how his subway worked:

> The method of communication known as the Pneumatic Dispatch consists of a railroad track inclosed in a tube, the cars being driven by atmospheric pressure. The car, in effect, is a piston, moving within the tube.
>
> The velocity of the car is in proportion to the degree of atmospheric pressure, which is produced by means of a fan or blower, operated by a stationary steam-engine.
>
> The mechanism for operating the Pneumatic Dispatch is of the simplest description. A tube, a car, a revolving fan! Little more is required. The ponderous locomotive, with its various appurtenances, is dispensed with, and the light aerial fluid that we breathe is the substituted motor.[9]

Pneumatic power, Beach wrote, worked "with the celerity of Aeolus, with the silence of Somnus."[10]

Beach's subway was just a block long; the tunnel went south only as far as Murray Street. It was intended merely to demonstrate the viability of his scheme—a proof of concept. But Beach hoped to eventually extend the tunnel the length of Manhattan, from the Battery to Harlem. A stationary fan at each station would blow the carriage down the tube to the next station. Or a fan at every other station could suck the car from the preceding station, reverse itself, and blow it to the next one.

But there was a catch: Beach had no legal authority to build a passenger-carrying subway. The charter the state had granted him permitted only "the transmission of letters, packages, and merchandise"—not people.[11] That's why he'd been so secretive. Even this short stretch between Warren and Murray was technically unlawful. Beach knew that powerful interests were opposed to a subway underneath Broadway. William M. Tweed, the notorious boss of Tammany Hall, sat on the board of one of the horse-drawn streetcar companies and did not take kindly to competitors underground or anywhere else. And the department store magnate Alexander T. Stewart, who owned many properties along Broadway, feared a subway would be bad for business by taking customers off the street, potentially undermining his real

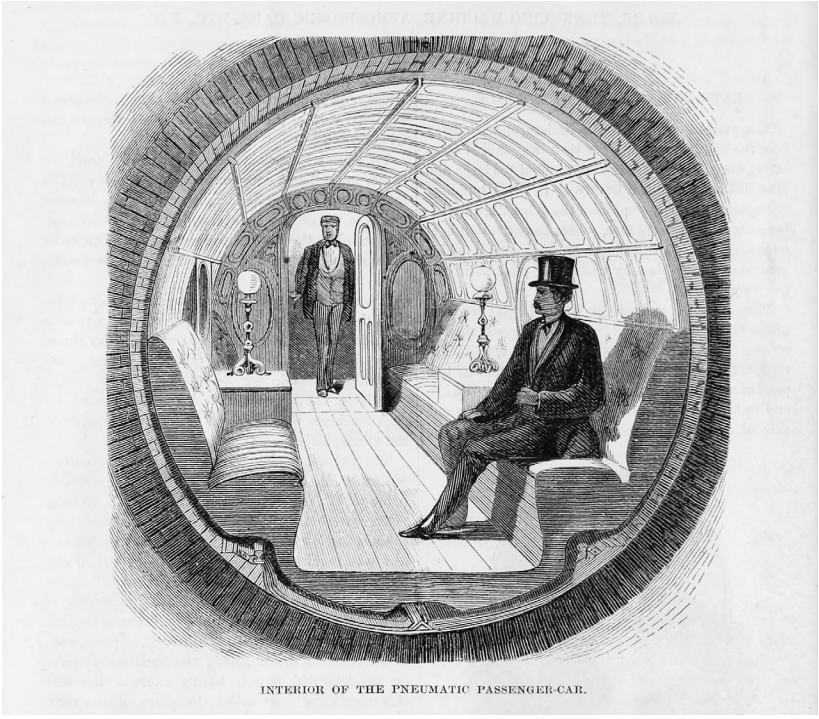


A stereoscopic photograph of the Beach Pneumatic Railway.
(New York: Rockwood & Co., ca. 1870. Stereograph File, PR 065, Box 29, PR 065-0292-002. New-York Historical Society, 101680d. Credit: Photography © New-York Historical Society)

estate empire, literally and figuratively. Stewart was unalterably opposed to any attempt to improve public transportation on Broadway.

Beach had built this surreptitious subterranean system right under Tweed and Stewart's noses. But he wasn't worried. He was convinced that once New Yorkers saw it in action, the force of public opinion would compel the authorities to give him permission to extend the line. Passenger cars would be shot up and down the island quickly, cleanly, quietly, and safely. The people would love it, and New York would finally have a mass transportation system worthy of its status as the nation's most important city.

The Under Broadway Reception did not go off without a hitch. There was a "slight accident with the engine"[12] that powered the blower. Reports conflict, but it's possible nobody even got to ride the Beach Pneumatic Railway that day.[13] But the guests enjoyed themselves immensely nonetheless, promenading in the clean, lucent tunnel, twenty feet underground, where the temperature was about sixty degrees and always would be, year-round, even on the hottest summer days. The muffled sounds of hoof falls and wagon wheels were dimly audible above them. It was certainly more pleasant than ambulating

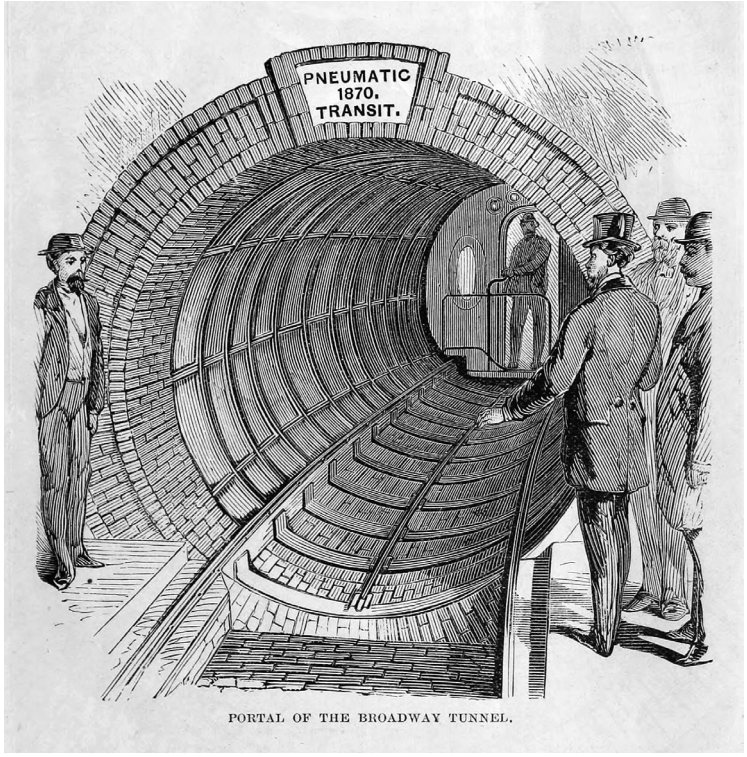


The interior of the passenger car.
(Credit: Public domain from *Illustrated Description of the Broadway Pneumatic Underground Railway*, 1870)

up on Broadway itself, covered as it always was with stinking piles of garbage that mixed with mud and animal excrement to create a foul bouillabaisse that residents called "Corporation Pudding."[14]

It also helped that a "first-class subterranean lunch" was served.[15] When the function was over, the *Times* reported, every visitor "came away surprised and gratified."[16]

"Virtually," the *New York Herald* reported the next morning, "yesterday's reception was the opening day of the first underground railway in America."[17] And it was just the beginning. Beach envisioned not just a city but a whole country crisscrossed with a vast network of pneumatic tubes, below ground and above, underneath wide rivers and over (or through) tall mountains, whisking passengers from city to



The entrance to the tunnel.

(Credit: Public domain from *Illustrated Description of the Broadway Pneumatic Underground Railway*, 1870)

city at speeds approaching one hundred miles per hour. The tyranny of the loud, obnoxious, and dangerous locomotive, he wrote, would end: "No screeching whistles or jangling bells disturb the community, no turnpikes require to be guarded; there is no running down of the helpless, no mangling of passengers, no burnings from sparks; no fearful dangers of any kind attend the use of the Pneumatic Dispatch."[18]

In an age when it seemed every problem could be solved by a machine, Alfred Beach was determined to build one that would end New York's congestion nightmare. It was a solution he believed in so deeply that he was willing to risk his reputation and his fortune—even incarceration—to achieve it.

Chapter Two

For Society He Had No Taste

Alfred Ely Beach was born on September 1, 1826, in a two-story brick house at 51 Court Street in Springfield, Massachusetts. His parents, Moses Yale Beach and Nancy Day, were both descended from Puritans who settled New England in the seventeenth century. Alfred was their fourth child and third son. He was named for his mother's uncle, the Rev. Alfred Ely, a Congregationalist minister. Altogether the couple would have eight children, six of whom survived into adulthood. Moses Yale Beach made a good living as a furniture maker, but he aspired to more. In 1835, the family moved to New York City, where Moses went to work for his brother-in-law, Nancy's brother, Benjamin Henry Day, the publisher of the *New York Sun*.

Benjamin Day owned a small printing shop at 222 William Street, not far from where the approach ramp to the Brooklyn Bridge now looms. In the summer of 1832, a cholera outbreak caused business to plummet. Rather than keep his hand-operated press idle, Day started up a newspaper—and upended the applecart of American journalism. At the time, the only other papers in the city cost six cents and were "of, by, and for the mercantile and political elite."[1] They published little more than commercial and political news. Day's *Sun*, however,

published crime reports, human interest stories, and serialized versions of popular novels like *The Pickwick Papers*. The paper was illustrated with woodcuts. And it was priced at just one cent. It was a medium for the working class, an increasingly literate segment of the population that the sixpenny papers ignored.

The first edition of the *Sun* was published on Tuesday, September 3, 1833. Perhaps a thousand copies were printed. From that humble start, circulation grew at an astonishing rate. By November 1834, it topped ten thousand. In early 1835, Day could afford to buy a modern Napier press, capable of simultaneously printing on both sides of a broadsheet.

By the autumn of 1835, the *Sun*'s circulation was nineteen thousand, making it the highest-circulated daily newspaper in the United States, and Day had moved the operation to a large building at 156 Nassau Street, near Park Row, the heart of what was then the city's newspaper district. The business had grown so large that Day needed a full-time bookkeeper and all-around man Friday, and it was this role for which he hired his sister's husband, Moses Yale Beach. Although he had never worked in the newspaper business, Beach was a fast learner, and he soon mastered every aspect of the operation, from writing ad copy to maintaining the newfangled printing press.

On June 28, 1838, Benjamin Day, at just twenty-eight years old, sold the *Sun* to Moses Beach for $40,000. Circulation was now thirty thousand, but expenses were mounting. Day refused to raise the price above a penny, and the paper was barely breaking even. But Moses Beach was convinced he could turn the *Sun* into a hugely profitable enterprise. And he did. He published romantic fiction to attract women readers and "Help Wanted" ads for the unemployed.[2] He commissioned special express trains and steamboats to be the first to get the news from Albany and Washington (long-distance telegraph lines would not reach New York until 1846). At the same time, the development of paper made from pulp rather than cotton made newsprint cheaper, increasing Beach's profits.

New papers arose to challenge the *Sun*, chiefly James Gordon Bennett's *New York Herald* and Horace Greeley's *New-York Tribune*. But Beach held fast to the penny price and raised revenue by increasing the size of the paper (in both dimensions and pages) to make room for

more ads. And when the competition got too expensive, he cut a deal with his rivals. In 1846, he convinced the *Herald*, the *Tribune*, and three other papers to join the *Sun* in a cooperative to share expenses covering the Mexican-American War, thus creating the Associated Press.

Alfred Beach was nine when his father went to work for the *Sun* and not quite twelve when he bought the paper. He grew up in a cosmopolitan milieu. His father's famous friends, among them Edgar Allan Poe and Walt Whitman, would stop by the family's townhouse on Chambers Street for meals or just to chat. At the same time, Alfred came of age in an era of great public works projects. The Erie Canal was completed the year before his birth, and when he was eleven, work began on the massive Croton Aqueduct, which carried fresh water forty-one miles from the Croton River in Westchester County to a massive, 180-million-gallon reservoir in Manhattan that covered the area now occupied by the New York Public Library, its forty-foot walls towering over the city like a fortress.

In the autumn of 1835, when Alfred was nine, his parents sent him to Monson Academy, a boarding school in Monson, Massachusetts. The boy's namesake great uncle, the Rev. Alfred Ely, was the school's president, and Alfred was "placed under his guardianship."[3] Founded in 1806, the academy occupied a large Federalist-style building in the center of the town, and its student body numbered around 175. Most students stayed in boardinghouses, though Alfred lived with his great uncle. Tuition was $4.50 annually for the Classical curriculum in Latin, Greek, and French and $3.50 for the English curriculum.[4] Students in the former were promised "all the preparatory studies required for admission to any of the New England colleges," whereas students in the latter would be prepared for "mechanical or commercial employments."[5] Alfred enrolled in the English curriculum but later switched to the Classical. His course work included classes in algebra, astronomy, bookkeeping, botany, chemistry, geography, history, and surveying, and he was required to deliver a public oration every two weeks. Progressive for its time, Monson admitted girls.

At Monson, Alfred Beach met the two people who would shape the course of his life: his future wife, Harriet Holbrook, and his future business partner, Orson Munn.

Harriet was two years younger than Alfred. Her father, John Fiske Holbrook, was, as Alfred's had once been, a furniture maker. When Harriet was five, her mother died of "nervous insanity."[6] When she was eleven, her father married for a second time, to a woman named Mary Cheeseman, and Harriet was sent to Monson. Alfred's older sister, Drusilla, also attended the school at the time and may have introduced her brother to Harriet. After one year at Monson, Harriet transferred to another school but stayed in touch with Alfred, and, as they matured, so did their relationship.

Orson Munn, Alfred's future business partner, was two years older than Alfred. Orson was a townie: his father, Rice Munn, was a farmer in Monson who "never aspired to great worldly wealth."[7] Orson and Alfred were classmates in the English curriculum, and, despite the differences in their ages and economic strata, they became close friends.

Alfred attended Monson for seven years, graduating in the spring of 1842, when he was not yet sixteen. That summer, his father sent him on a tour of South America. Upon his return, Alfred briefly attended Williston Seminary in Easthampton, Massachusetts, but by 1845 he was back in New York, working for his father at the *Sun*, where he "received the thorough training in the publishing business which left him so well equipped for what was to be his life work."[8]

On October 22, 1845, Moses Yale Beach made Alfred and his older brother Moses Sperry Beach his partners in the *Sun*. At nineteen, Alfred was part owner of the most popular newspaper in the country. Four years later, in 1849, the elder Moses sold the *Sun* to his sons outright for $100,000. The timing was noteworthy. At the time, the father was having an affair with his housekeeper, Julia Kelly, and his wife, Nancy, was talking about suing him for divorce. When he sold the paper to his sons, Moses Yale Beach had Nancy sign a document "releasing her dower," that is, her claim to her husband's property, including the *Sun*. Nancy would later insist she was coerced into signing the document. In any event, the couple eventually reached a settlement and divorced in 1852.

In early 1846, just months after becoming part owner of the *Sun*, Alfred heard about another publication that was for sale, a new magazine called *Scientific American*. The price was $800. Alfred thought it

sounded like a "good opening for business," and he wrote to his old school chum, Orson Munn, asking him if he was interested in becoming his partner in the venture.[9] Orson "started at once for New York city."[10]

Scientific American was founded by a great American eccentric named Rufus Porter, "a strange, many sided genius" whose attention span was inversely proportionate to his many talents.[11] Born in Massachusetts in 1792, Porter worked as an itinerant artist in the 1820s and 1830s, painting landscape murals that covered the walls of New England mansions (a dozen of these works survive). But he truly made his mark as an inventor. Over the course of his long life (he would live to ninety-two), Porter, who left school at thirteen, devised an astounding array of gadgets, machines, and apparatuses: early versions of washing machines, fire alarms, clocks, and cameras; a life preserver, a cheese press, a level-and-plumb indicator, and a cane that could be turned into a chair; and railway signals, windmills, waterwheel turbines, prefabricated houses, and "sundry contrivances for abolishing as far as possible agricultural labor."[12] With his wife, the former Eunice Twombly, he also produced ten children. When Eunice died, he married again, to Emma Tallman Edgar, and fathered six more.

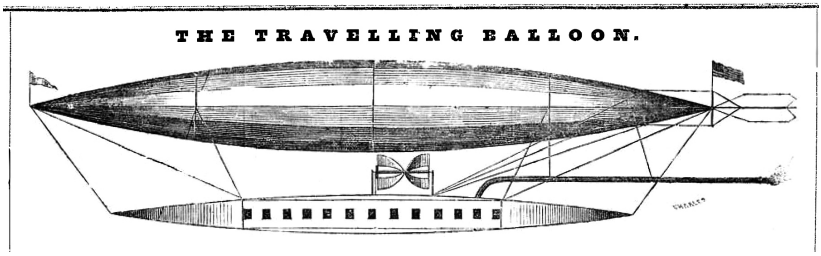
Porter never bothered to patent many of his inventions; when he finished one, his attention immediately turned to the next, with little regard for the commercial possibilities of any. Besides, obtaining a patent was largely pointless. Under the Patent Act of 1793, the patent office was loosely organized, and patent applications were routinely approved without any formal review. Disputes were to be hashed out in the courts, and it's estimated patentees lost as many as 75 percent of litigated cases.[13] By making them easy to get, patents were rendered worthless. From 1820 through 1829, just 270 were granted each year on average.[14] Congress tried to address the problem when it passed a new patent law in 1836, but it overcorrected. Two examiners were appointed, not nearly enough to speedily adjudicate applications, and in any event, the examiners routinely rejected from half to two-thirds of them.[15] So, when Porter invented a revolving rifle, instead of applying for a patent he just sold the rights to Samuel Colt for $100. As a result, Porter secured neither wealth nor fame from his inventions.

Rufus Porter's one abiding ambition was to build an airship, or, as he called it, an "aeroport," or "Aerial Steamer."[16] He toyed with the idea for years, even publishing an early design in a British magazine in 1834—perhaps the first practical proposal for a self-powered airship ever published. The design was remarkably similar to the great dirigibles of the Zeppelin era: a giant, hydrogen-filled balloon supported a large compartment accommodating passengers, crew, a steam engine that powered a large propellor, and charcoal to fuel the engine. Horizontal and vertical rudders controlled direction and altitude. Porter predicted the machine would transport one hundred passengers from New York to San Francisco in three days, at speeds approaching one hundred miles per hour—this at a time when the trip typically took five months, either overland or by sea. All he needed to get this thing off the ground was cash. In the summer of 1845, he "propose[d] to raise the necessary funds by publishing a weekly paper to be called the Scientific American, at $2 a year."[17] Each subscriber would be a stockholder in the venture.

The first issue of the weekly, subtitled "The Advocate of Industry and Enterprise, and Journal of Mechanical and Other Improvements," was dated August 28, 1845. It included not just science news, but discourses on art, music, and religion as well. There was even a little poetry:

> You throw a stone up in the air,
> And down it comes—ker-whack!
> The centrifugal casts it up—
> The centripetal—back.[18]

But, as with most of his other projects, Porter soon tired of *Scientific American*. It wasn't providing the money needed to build his airship. In ten months he'd secured just two hundred subscribers. The work bored him and took too much of his time. So, in July 1846, less than a year after founding the periodical, Porter sold it to Alfred Beach and Orson Munn, though he agreed to stay on as editor for a time. Porter never raised enough money to build a fully operational, passenger-carrying, charcoal-burning aeroport. It was the only project that he never



Rufus Porter's proposed airship.
(Credit: Internet Archive from *Scientific American*, September 18, 1845)

abandoned—and one of the very few he never realized. But the magazine he founded has survived to report on machines traveling to distant corners of the solar system in the twenty-first century.

When they bought *Scientific American* in June 1846, Beach and Munn—who were nineteen and twenty-two years old, respectively—formed a copartnership, each holding a half stake in the business, which they decided to call Munn and Company. Beach would handle the editorial side of things, while Munn took care of the business.[19] Why Beach's name was omitted from the letterhead is unknown, though the controversy and notoriety his father had brought the family's name as the owner of the *Sun* may have been a factor. Munn and Co. would become one of the most important players in America's age of invention, and the two friends would collaborate amicably, productively, and profitably for half a century, until Beach's death. If a cross word was ever exchanged between them, there is no record of it.

Working out of an office in the *Sun* building that Beach's father made available to them, Beach and Munn published the first issue of *Scientific American* under their purview on July 23, 1846. Beach had a clear editorial vision for the magazine: to encourage and promote American inventors and innovation. Poetry was banished (but would return as a regular feature in 2020). *Scientific American* became a clearinghouse for patent information, with weekly listings of patents applied for and patents granted. The Patent Office itself would not begin officially publishing this information until 1872. The magazine also became a forum for exchanging information, like an online message

board or subreddit today. This free exchange of information was especially helpful at a time when opportunities for professional training in technical fields like engineering were limited. In a letters column, readers could ask and answer questions, comment on new inventions, review new products, and dispense advice, as shown in one exchange: "'E. B. of Mass.':—Your Soda Fountain will operate well. It is upon the well known principles of Hydrostatics. The cistern is extraneous, as the water discharged depends upon the pressure entirely. A stream can be forced through a pipe to the height of the fountain head. The size of pipe &c. is immaterial."[20]

When Beach and Munn took over *Scientific American*, only three schools in the United States offered degrees in engineering: the US Military Academy at West Point; Rensselaer Institute in Troy, New York; and the American Literary, Scientific and Military Academy (now Norwich University) in Vermont. The magazine filled a void, and circulation skyrocketed from ten thousand in 1848 to thirty thousand in 1853. The readers weren't just aspiring and established inventors; they were also farmers, financiers, artisans, craftsmen, industrialists, mechanics (as all manual laborers were called)—anyone interested in keeping up with the latest technologies. "Thoughtful men"[21] was how the magazine described its subscribers, though many women read it too. "Our experience teaches us that women have as much natural inventive talent as men," the magazine explained, "and that the circumstances under which most of them pass their lives only prevent an equal manifestation of this talent on their part."[22] A young Thomas Edison walked three miles every week to fetch the latest issue, and when he moved to New York in 1869, one of his first stops was the offices of *Scientific American*, where he introduced himself to the publishers. The magazine's democratic appeal reflected Alfred Beach's belief that anyone could be an inventor—credentials, academic or professional, were not required, nor was it necessary to come from wealth, as had previously been the case for centuries.

As *Scientific American*'s circulation grew, the magazine began receiving inquiries from inventors seeking advice on securing patents. Seizing on the opportunity, Munn and Co. spun off a patent agency. Readers were invited to submit models or drawings and descriptions

of their inventions to the Munn and Co. offices for "advice as to their patentability, without charge."[23] For five dollars, the company would conduct a patent search. Further than that, prices were negotiable. At the time, patent agencies were largely unknown.

Soon Beach was traveling from New York to the patent office in Washington, DC, every two weeks to attend personally to his clients' applications, and the superintendent and the examiners came to know him well.[24] Munn and Co. eventually established a branch office in Washington, with a staff that grew to twenty, including attorneys specializing in patent law and a former patent commissioner, though Beach remained firmly in charge. "His fondness for new inventions always rendered him courteous to inventors," one account said of Beach, "and however busy he might be, he never was reluctant to lay aside his work to greet an inventor and listen to his description of his invention, exhibiting that degree of interest which was marvelous."[25]

Without patent laws, Beach wrote, "The inventor would starve, and the pirate would grow rich."[26] But the US patent system, he believed, was broken, and *Scientific American* lobbied Congress to liberalize the process. By 1851, the backlog of patent applications numbered more than seventeen thousand, and there were but four examiners (with one assistant each). In *Scientific American*, Beach complained that he was still waiting for a ruling on a patent application he'd filed more than a year earlier. "Such delays are not unfrequent, and we hope another instance of the kind will not occur" he wrote. "Inventors cannot afford to stand such delays and the Commissioner should see to it that this evil is remedied."[27] And when they finally did rule on the applications, Beach thought the examiners were often unnecessarily stringent, rejecting applications for picayune technical reasons.

As *Scientific American*'s circulation rose, so did Munn and Co.'s influence. "When they spoke," the patent historian Kenneth W. Dobyns wrote, "the government frequently listened."[28] That can be seen in the patent office's annual reports. In 1854, a record 1,902 patents were granted. In 1861, more than 3,000 were granted. By then, the number of examiners had grown to twelve (and twelve assistants), each specializing in a particular field.[29] At the same time, the Commissioner of Patents, Joseph Holt, ordered examiners to rule more favorably on

applications. He established a board of appeals for inventors whose applications were rejected, and he fired examiners who attempted to "subvert his policies of liberality."[30] After the Civil War, the pent-up demand for patents exploded. From 1865 to 1867, the number of patents issued doubled from 6,099 to 12,301. Never again would fewer than 10,000 patents be granted in a single year.

Munn and Co.'s roster of clients came to comprise the leading lights of American invention: Alexander Graham Bell, Thomas Edison, John Ericsson, Richard Gatling, Elias Howe, Samuel F. B. Morse, and many others. When Edison perfected the phonograph in 1877, the first person he demonstrated it for was Beach. Wrote Edison:

> I worked at it all night and we fixed it up to get the best results. That morning I took it over to New York and walked into the office of the Scientific American, walked up to Mr. Beach's desk and said I had something new to show him. He asked what it was. I told him I had a machine that would record and reproduce the human voice. I opened the package, set up the machine, and recited Mary [Had a Little Lamb], then I reproduced it so it could be heard all over the room. They kept me at it until the crowds got so great that Mr. Beach was afraid the floor would collapse and we were compelled to stop.[31]

Munn and Co. became the most successful patent agency in US history.[32] In the early 1860s, about one-third of all US patents issued annually were granted to its clients. In all, the firm successfully prosecuted some two hundred thousand patents before Munn and Co. was sold in 1948—about 8 percent of the total issued to that point. By March 2024, the United States had issued some twelve million patents in total. About 80 percent of those had been issued since Munn and Co. went out of business—yet the company still accounted for 1.6 percent of the total amount issued.[33]

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On October 27, 1846, less than four months after purchasing *Scientific American* and the month after his twentieth birthday, Alfred Beach

wrote a letter to Harriet Holbrook's father, John Holbrook. "The attentions paid to your daughter Harriet by myself for a long time have been of too marked a nature not to have attracted the notice of and be fully understood by you," he wrote. "Having as you well know pretty thoroughly tested our mutual attachment, I feel it as a duty due to Harriet, as well as myself, that our connection by ties dearer than life itself should be more openly avowed."[34] Beach asked John Holbrook for permission to marry his daughter, and Holbrook consented.

Accordingly, on Wednesday, June 30, 1847, Alfred Beach and Harriet Holbrook were married in Boston, where the bride's father was now managing a dry goods store.

Harriet was a reluctant bride. Many years later, after Alfred had died, she would confide in a letter to a friend that "the one injury" Harriet's father had done her was "consenting [to] my marriage with Alfred at 19 yrs. under the influence of a woman[:] my *step mother*."[35] Alfred and Harriet's marriage would produce two children—Frederick in 1848 and Jenny in 1850—and much heartache. The greatest source of friction was Harriet's belief in spiritualism. In 1848, two sisters in upstate New York, Maggie and Kate Fox, began to hear rapping sounds they said came from beyond the veil, and soon the whole country was swept up in the mania for spiritualism. The movement was largely shaped and led by women, which may have made it especially attractive to Harriet, who once referred to herself sarcastically as Alfred's "mascot."[36]

But Alfred had no time for talk of communicating with the dead. "Spiritual rappers," he said, "lead silly-minded persons astray."[37] Cornelia Robinson, a friend of the family, said she knew "that there were occasional family jars between Alfred C. Beach [*sic*] and his wife, occasioned by his severe criticism in regard to her belief in spiritualism."[38] It could also be that Harriet's beliefs threatened Alfred's stature in the scientific community. The fraught marriage may have been a factor in Alfred's almost pathological devotion to his work.

After they married—I could find no mention of a honeymoon—Alfred and Harriet moved into a house on Pineapple Street in Columbia Heights, a fashionable neighborhood in Brooklyn. As no bridge yet connected Brooklyn and New York (as Manhattan was referred to at the time), Alfred rode a ferry across the East River to and from work

Alfred Beach, circa 1860.
(Credit: Photographed by George L. Partridge, Bridgeport, Connecticut. Courtesy of the Stratford Historical Society, Stratford, Connecticut.)

each day. In other words, he was an early version of that urban species so common today: the daily commuter.

⊖

Manhattan is an island about two miles wide and thirteen miles long. When the first Dutch settlers landed in 1608, they found the indigenous inhabitants had carved a path through the woods running the length of the island. Known as the Wickquasgeck Trail, it facilitated communication, hunting, and trade among the area's Lenape clans. The Dutch erected their first settlement along this path, which they christened the *Heerewegh*—the Lord's Road.[39] When the Dutch finally surrendered control of the island to the British in 1674, the unusually wide road was renamed the Broad Way. The settlement, which the Dutch had called *Nieuw Amsterdam* (New Amsterdam), was also given a new name: New York, in honor of the Duke of York, the future King James II. The artery through which much of American history has flowed, Broadway has been the site of George Washington's headquarters during the American Revolution and his home as the first president, Civil War recruitment drives and draft riots, Lincoln's funeral cortege, and ticker tape parades for Charles Lindbergh and the *Apollo 11* astronauts. By the end of the eighteenth century, it was already the center of the nation's cultural and economic life. When the capital moved to Philadelphia in 1790, a disappointed Abigail Adams lamented to her daughter that "when all is done, it will not be Broadway."[40]

In the first half of the nineteenth century, the growth of New York County—Manhattan and the small islands that surround it—was phenomenal. In 1800, the population was only about 60,000 (London's population at the time was more than a million). But its port was perfectly located, ideally suited to servicing the tall ships that plied the bustling Atlantic and Caribbean trade routes, and by 1820, the county's population had more than doubled to 123,000. When the Erie Canal connected the port to the Great Lakes, the rate of growth accelerated, and development on Manhattan, originally concentrated on the southern tip, began to push farther north. Still, when Alfred Beach was a boy, the land above today's Canal Street (about two and a half miles north

of the Battery, Manhattan's southernmost point) was largely undeveloped—the country. You could walk practically anywhere in the populated area of the island in thirty or forty minutes. By 1830, the northern boundary was around Houston Street (about three miles north) and the city's population was 202,000. "Overturn, overturn, overturn! is the maxim of New York," the city's former mayor Philip Hone wrote in 1845. "The very bones of our ancestors are not permitted to lie quiet a quarter of a century, and one generation of men seem studious to remove all relics of those which preceded them."[41] By 1850, the northern boundary was approaching 42nd Street and the population was 515,000.

The growth was not well planned. The city didn't begin installing a sewer system until 1850, after several cholera outbreaks. But no issue confounded New Yorkers more than transportation. Technology limited development horizontally, so the city expanded vertically. It began to sprawl.

In 1827, a stagecoach operator named Abraham (or Abram) Brower began running one of his carriages, called *Accommodation*, up and down Broadway between the Battery and Bleecker Street. Passengers could embark and disembark as they pleased. The fare was one shilling—about twelve cents, a sum that exceeded the means of most working people. Still, the line was so successful that Brower ordered more carriages from John Stephenson, a New York coach builder, who designed a new vehicle specially for urban mass transit: a long carriage with a rear door and longitudinal benches that left plenty of standing room in the middle. Pulled by teams of two or four overworked horses, these vehicles, which came to be known as omnibuses, seated a dozen passengers but in reality carried many more—as many as could fit. Passengers requested a stop by pulling on a leather strap attached to the driver's ankle.

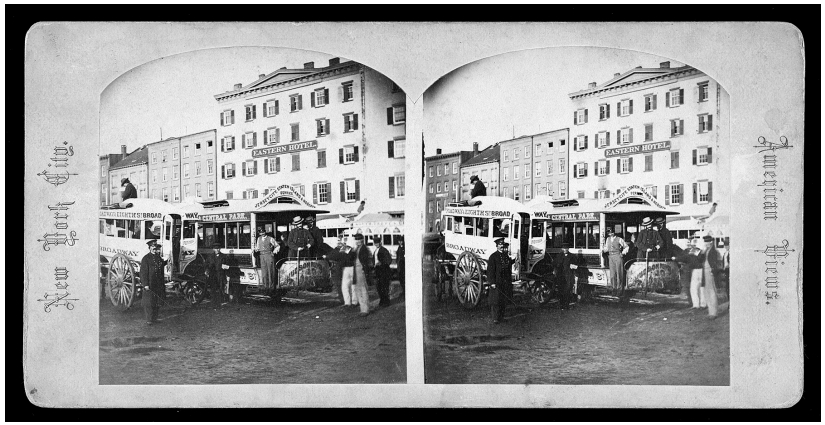
Brower's business took off, and competitors sprouted like weeds, bringing down fares and turning Broadway into a river of carriages. "The white tops of the omnibuses resemble the waves of the ocean," one visitor noted, "and it looks as if we might walk from one end of Broadway to the other upon them, without the slightest difficulty."[42] To attract attention, operators painted their omnibuses in garish colors

and adorned them with landscape scenes or portraits of celebrities, like the brightly painted minibuses popular in West African countries today. By 1835, more than a hundred omnibuses were operating in the city, most on Broadway. Omnibus drivers competed furiously for business, racing to be the first to reach a beckoning customer. Fistfights and whip fights between drivers were not uncommon, adding to the general mayhem that the omnibuses wrought on the streets. Before it was the Big Apple, New York was the City of Omnibuses.[43]

The success of the omnibuses spawned a competing mode: the horse-drawn streetcar, or horsecar. When pulling a carriage running on rails embedded in the roadway, horses could haul much heavier loads (and many more passengers) than omnibuses, and at faster speeds (eight miles per hour compared to five miles per hour for the omnibus). The ride was more comfortable too. "You glide along very smoothly and very swiftly," one visitor from London reported.[44]

In 1831, the New York and Harlem Railroad was granted a charter to lay rails on Bowery between Prince and 14th Streets on the East Side. Horsecar service commenced the following year and slowly expanded northward up Fourth (now Park) Avenue, reaching Harlem in 1837. Also in 1837, the horses were replaced with steam engines, but only above 23rd Street, as locomotives were banned in the more densely populated areas of lower Manhattan due to fears they would frighten horses or their cinders might cause fires. This railroad eventually extended as far north as Albany and is now the Metro-North Railroad's Harlem Line (terminating at Wassaic). But in Manhattan, the New York and Harlem made only three stops north of City Hall (at 26th Street, 42nd Street, and 125th Street), so did little to alleviate congestion downtown, in the most populated part of the city. Another horsecar line opened on Greenwich Street on the West Side, but on Broadway, the city's central and most congested thoroughfare, this mode of transportation was banned. In 1844, there were two proposals to lay rails on Broadway, but both were defeated by a coalition of omnibus operators and property owners spearheaded by Alexander T. Stewart, the retail mogul.

Wherever they ran, on Broadway or off, the omnibuses and horsecars were overcrowded and malodorous, steaming in summer and freezing in winter, and "infested with rowdies, drunken men, and



A New York omnibus and horsecar, circa 1865.
(Credit: Library of Congress)

other objectionable characters."[45] Women and girls were frequently harassed, and pickpockets operated with impunity, despite signs in the cars warning riders to beware of them.

In 1860, New York's population surpassed 800,000, and the city's public transportation network consisted of twenty-nine omnibus routes and fourteen horsecar lines—not nearly enough to meet demand.[46] "Under present arrangements it is utterly impossible to get down town in the morning, or up-town at night, with any comfort, either by [horse] railroad or by omnibus," the *New York Times* lamented.

> All attempts to limit any of these vehicles to the number of passengers they will hold, have been abandoned. Omnibuses already full are regularly stopped for fresh accessions, and those who have seats are compelled to give them up, or have stout men and women treading on their toes or tumbling into their laps during the whole journey. Any remonstrance on the part of passengers provokes insolence from the driver, and sour looks from the new comers.…
>
> In the [horse]cars at starting there is a general rush and scramble for admission. Women and children stand no chance whatever in the *mêlée*, and may think themselves fortunate if they are not run over. Passengers who get seats keep them under the agreeable vigilance of

> two or three persons standing, eagerly watching the moment of his exit, in order to seize his place. The conductor does his best to force everybody to the forward part of the car, in order to accommodate the new comers, and is profoundly unhappy if a square foot of standing room is left unoccupied, either in the car or on the platform. The whole journey is a perfect *crush* from one end of the route to the other,—and to get out from a car thus loaded, one is compelled to force himself, by main strength, through a dense mass of persons, and may think himself well off if he alights on his feet, with sound limbs and untorn garments.[47]

Maddeningly, omnibus and horsecar companies did not allow free transfers between different lines. A transfer required a passenger to pay a full fare twice. But, as the *Times* noted, the companies had little incentive to improve service:

> The companies are determined *to give as little as possible* for the money they receive for fares. They will not provide seats so long as the people who ride with them will consent to stand. They will not provide two cars so long as their customers will consent to be crammed into one. It is the old contest between avarice and the public convenience,—and as things are managed here, avarice is pretty sure to carry the day.[48]

Since horses could only work four or five hours a day, companies stabled five or more for each vehicle. At their peak, the omnibus and horsecar companies employed more than ten thousand horses, each of which could produce more than thirty pounds of feces and four gallons of urine every day. That added up to three hundred thousand pounds of poop and forty thousand gallons of pee daily, much of which was deposited directly on the streets. And that was just the horses used for public conveyances. Thousands more pulling private vehicles such as carriages and delivery wagons deposited their own excreta. The smell, especially in summer, was overpowering. The equine waste was also a superb vector for diseases, including cholera and tetanus. A New Yorker today could easily go months, even years, without encountering equine effluence, but in the nineteenth century, every denizen, young or old, rich or poor, was well acquainted with the aroma of horse shit.

And this is to say nothing of the rotting carcasses. The lives of working horses in New York City were brutal and brief; often worked to death, they lived, on average, just two or three years (a horse well cared for can live thirty or more). About a dozen horses dropped dead in the street every day. Many were left to rot.

New Yorkers who wanted to avoid the indignities and discomforts of the omnibuses and horsecars could always hire a private hackney carriage, the precursor of the modern taxi, but that was expensive and no quicker than public transportation. Walking was the other option, though it was neither faster nor more pleasant than the alternatives. The average person can walk a mile in about twenty minutes, but the rigors of navigating Broadway made that pace unachievable. The boardwalk sidewalks were teeming with hucksters selling "roots and herbs they had dug up, clams collected from beaches, muffins purchased cheap at the end of the previous day's market, or berries and apples bought from country women at the edge of town."[49] Then there were the oyster and catfish vendors, the organ grinders, and the Black girls hawking grilled corn on the cob with a cry that rang familiar to generations of New Yorkers: "Hot corn all hot, just come out of the boiling pot."[50] Walt Whitman called it "one continued, ceaseless, devilish provoking, delicious, glorious jam!"[51] Glorious, perhaps, but crossing Broadway was downright dangerous. Traffic was so heavy that it was nearly impossible to traverse safely during peak traffic hours.

The chaos on Broadway was compounded by a complete lack of traffic-control devices. There were no traffic lights, not even stop signs, and no marked crosswalks. Even club-wielding police were helpless in the face of this "solid mass of braying, animal-powered vehicles."[52] The noise, too, was maddening. The clatter of iron horseshoes and iron-rimmed wagon wheels on the Belgian-blocked streets, mixed with the hoarse cries of the innumerable vendors and newsboys, created a cacophony that made casual conversation practically impossible.

Newcomers never failed to be amazed by the spectacle that was Broadway. "Faces and coats of all patterns, bright eyes, whiskers, spectacles, hats, bonnets, caps, all hurrying along in the most apparently inextricable confusion," marveled Charles Loring Brace, who arrived in 1846 to study at the Union Theological Seminary and later founded

The dangers of crossing Broadway, circa 1870.
(Credit: Library of Congress)

the Children's Aid Society. "One would think it a grand gala-day. And it's rather overpowering to think of that rush and whirl being their regular every-day life."[53] Broadway may have been, as another visitor put it, "one grand kaleidoscope in perpetual motion,"[54] but to Alfred Ely Beach, taking in the opalescent scene from his office high in the *Sun* building, it was a disorderly, inefficient mess, and he could not abide it. His rational mind, his craving for order, and his "inborn taste for mechanics" fixed in him a need to find a solution to the congestion crisis.[55] There had to be a way to improve the movement of vehicles, people, and goods, and in the November 3, 1849, issue of *Scientific American*, he proposed one: "An Under-ground Railway in Broadway."

> "What is it?" some will ask. Nothing less than a railway underneath, instead of one above—railway life down stairs, instead of railway life up stairs….

(continued...)

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