Evaluating Lincoln’s Patented Invention

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Despite the plenitude of Lincoln studies, significant aspects of his character have received short shrift. In fact, even some acclaimed biographies completely omit one aspect of Lincoln that would make him unique among American presidents even without his great accomplishments—he is the only president who held a patent for an invention. This singularity is not mere trivia. His political genius proves that he had a great mind, but his inventive and mechanical skills prove his mind was also exceptionally versatile.

Lincoln’s invention was a device for saving steamboats or similar vessels run aground in shallow water. He applied for a patent on March 10, 1849. The patent, numbered 6469 and titled “Buoying Vessels over Shoals,” was issued on May 22.1 This was a remarkable achievement because Lincoln’s schooling was, after all, very limited, making him essentially an autodidact. We know he did not have any formal training in science or engineering at any time in his life, nor did he ever work as an engineer. In contrast, the one U.S. president who had scientific training and had worked as an engineer—Herbert Hoover—never held a patent. Hoover had a degree in geology and worked as a mining engineer before entering politics.2

When Lincoln applied for the patent, he submitted a model of his invention. In 1860, when his election to the presidency fostered intense public curiosity, his patent model became a subject of interest. At that time the model was at the Patent Office, where the staff of the Scientific American magazine inspected it. (Founded in 1845, the magazine continues today as the oldest continuously published periodical in the U.S.) The verdict by the Scientific American was anything but scientific: “The merits of this invention we are not disposed to discuss; but we

1. The patent is viewable at the U.S. Patent and Trademark Office’s website, www.uspto.gov. The document contains three pages, two of text and one of drawings. Part of the analysis in this article derives from the drawings.

hope the author of it will have better success in presiding as Chief Magistrate over the people of the entire Union than he has had as an inventor in introducing his invention upon the western waters, for which it was specially designed.”

William Herndon, whose inimitable personal knowledge of Lincoln sets him apart from all other biographers and whom we would expect to be at least somewhat sympathetic to Lincoln’s idiosyncrasies, expressed an even more definitive opinion of Lincoln’s patent: “This invention was a perfect failure; the apparatus has never been put on any boat so far as known.” Given such annihilation, it is no wonder that Lincoln’s invention has been relegated to the marginalia of Lincoln scholarship. Besides, Lincoln himself apparently did not make much of an effort to popularize his invention, essentially consigning it to oblivion.

But was Lincoln’s invention such a fiasco? Was it completely devoid of scientific and engineering merit? And why did he abandon it?

Because such questions require scientific or engineering analysis and I am an engineer, this article will resemble the format of an engineering discussion. Therefore, it will comprise three sections: background (description and history of the problem—i.e., that of boats running aground), analysis (discussion of solution—i.e., Lincoln’s invention), and conclusions. Nevertheless, since it is written primarily for Lincoln enthusiasts who may lack a technical background, no previous scientific training is required of the reader. As a result, some explanations are long. The longest section is the analysis, and thus it has been divided into seven subsections with descriptive headings to help the reader navigate through the article.

**Background**

*Factors that led to Lincoln’s invention*

The first steamboat on the western rivers—the waters of the trans-Appalachian region—appeared in 1811 on the Ohio River. 6 Soon

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5. Perhaps the only exception is Jason Emerson, *Lincoln the Inventor* (Carbondale: Southern Illinois University Press, 2009). Though a worthwhile read, it is short, with only a general discussion of Lincoln’s patented invention and half the book dealing with Lincoln’s lecture on mankind’s discoveries and inventions (which he delivered in the 1850s). Emerson does not engage in a scientific and engineering evaluation of Lincoln’s invention, which is understandable given he is a historian and not an engineer.
thereafter, steamboats became increasingly popular on the western waters, since they obviated the arduous land journey across the Appalachian Mountains. A problem that soon became apparent was the shallow waters, or shoals, of those rivers. Even a river as big as the Ohio was not navigable along its entire length throughout the year; the navigable length varied with the seasons. Needless to say, smaller rivers had even shallower water, making them even less navigable. The success of steamboats depended on sufficient depth of water, and in times of drought such operations simply shut down.

In the 1840s, the decade of Lincoln’s invention, steamboats required a depth of water of four to eight feet, depending on the size of the vessel. This depth is known as the vessel’s draft; thus a vessel that draws eight feet of water has the bottom of its hull eight feet below the water surface. In dry seasons, even the Ohio fell below a depth of three feet in many areas, creating shallow conditions. Foolhardy operators who chanced their boats on shallow waters often found themselves—and their passengers and cargo—stuck in a sandbar and humiliated by having to unload the passengers and thousands of pounds of cargo onto smaller boats.7

After all, steamboats were not small vehicles. By the mid 1840s, a medium-sized steamboat was about 25 feet wide and 165 feet long, and the larger boats measured well over two hundred feet in length and could carry five hundred tons (one million pounds) of cargo.8

Even in sufficiently deep water, sandbars with surfaces just below water level were invisible to boatmen until it was too late. There were other menaces as well. Trees that grew along the riverbank fell into the river, drifting down until coming to rest at the river bottom—thus becoming treacherous snags that could inflict fatal gashes on the hulls of boats. Sometimes the sunken trees signaled their presence with a protruding bough, but even this indication was not always a talisman


7. Louis C. Hunter, Steamboats on the Western Rivers: An Economic and Technological History (Cambridge: Harvard University Press, 1949), 74, 219–25. Comprising almost seven hundred pages, this work is a highly authoritative and comprehensive study of steamboats. My interest in steamboats dates back at least twenty-five years, and I am not aware of a more thorough study of them than that by Hunter. For readers who prefer a shorter treatise, see Adam I. Kane, The Western River Steamboat (College Station: Texas A&M University Press, 2004).

for avoiding danger, because as the pilot steered to go around such snags, the steamboat could end up in a shallow part of the river and run aground.

Consequently, running aground was a ubiquitous risk for steamboats, especially during dry seasons, and an efficient method of extricating boats caught in such a predicament was patently needed, especially one that eliminated the specter of having to unload cargo before extricating the boat.

Enter Lincoln and his invention. Having been a boatman himself, he doubtless understood the risks of river travel. As a young man, he had at least twice taken flatboats all the way to New Orleans, first when living in Indiana and second when in Illinois. Later, as a state legislator, he advocated for so-called internal improvements—what we today call infrastructure projects—among which the advancement of river navigation figured prominently.9

The Sangamon River, which Lincoln came to know so well in his New Salem years, was notoriously shallow and essentially unsuitable for steamboats, though one small steamer—appropriately named Talisman—did traverse it in 1832, with Lincoln helping navigate through the narrow and shallow stream.10 Even the Illinois River (of which the Sangamon was a tributary) was only moderately amenable to steamboats due to its insubstantial depth; nevertheless, they had been in service on the Illinois since 1828.11 Thus, it is probable he either witnessed or at least heard about steamboats running aground on the Illinois.

No later than in the opening sentence of the patent itself, Lincoln made clear that his invention was intended not only to facilitate steamboat travel in shallow water but also to prevent the burden of unburdening the boat:

Be it known that I, Abraham Lincoln, of Springfield, in the County of Sangamon, in the State of Illinois, have invented a new and improved manner of combining adjustable buoyant air chambers with a steamboat or other vessel for the purpose of enabling their draught of water to be readily lessened to enable them to pass over bars, or through shallow water, without discharging their cargoes (emphasis added).12

11. Hunter, Steamboats on the Western Rivers, 46.
An accident in 1848, during Lincoln’s return from Washington to Springfield while he was a congressman, inspired him to devise his invention. He and his family took the scenic route via the Great Lakes by steamboat, from Lake Erie into the Detroit River, through Detroit to Lake Huron, then to Lake Michigan and to Chicago. According to Herndon, “the boat on which Mr. Lincoln, wife, and child were passengers stranded on some sand bar.” The crew “collected all the loose planks, empty barrels, boxes and the like which could be had. These planks, barrels, and boxes were used as a kind of buoy; they were shoved by force under the hull of the boat and they, being light and disposed to float by their own small gravity and lifting power, lifted the boat above the surface of the sand bank.”

That was the Eureka! moment. “It was at this time that Mr. Lincoln formed . . . the idea of the means to make the stranded boats float. The idea of Mr. Lincoln was to make a kind of bellows, a great sack that would run around the boat and which could be folded up at pleasure and opened at pleasure, probably by machinery.”

There has been some debate over whether this stranding befell Lincoln’s steamboat or another steamboat that he watched. Nevertheless, from an engineering standpoint, what matters is what he did here. He saw a problem firsthand—and he wanted to solve it. Solving real-world problems is what engineering is all about. The first test of an engineer is the ability to recognize a problem. Lincoln passed this test.

Thomas Edison, widely considered the greatest inventor of all time, is credited with the famous aphorism that genius is 1 percent inspiration and 99 percent perspiration. In Lincoln’s case, this incident was the 1 percent inspiration; the 99 percent perspiration would be actually working out the details of the invention, building a model that exhibits those details and demonstrates his idea, and applying for a patent to protect his idea so he could potentially collect royalties to reward his perspiration.

14. Ibid.
15. Historian Wayne C. Temple argues Lincoln was on another boat, watching the stranded boat. See Temple, Lincoln’s Connections with the Illinois & Michigan Canal, His Return from Congress in ‘48, and His Invention (Springfield: Illinois Bell, 1986), 35–36. According to Temple, the other steamboat ran aground at Fighting Island, in the Detroit River. In addition, whereas Herndon said it was “Mr. Lincoln, wife, and child” who were on board, Temple asserts the Lincolns were traveling with both of their sons at the time, Robert and Eddy.
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Analysis

Part I—The patent model

The model Lincoln submitted with his patent application is currently at the Smithsonian Institution. This analysis derives from my first-hand inspection of it. There are several reasons a thorough analysis of Lincoln’s invention would not be possible without inspecting this model. Lincoln did not expatiate on his invention other than what was described in the patent itself, and the patent does not contain specific technical information (recommended dimensions, physical properties, etc.) that would lead one to think that Lincoln had conducted trials and thereby arrived at a design with proven feasibility and operability (this was not a requisite for patent applicants, whose primary obligation was to prove originality, not feasibility or operability). Even after the patent was issued, his invention was never installed on a steamboat, and thus there was no full-scale demonstration of his concept. This model, therefore, is the reification of his method for relieving a boat run aground. Finally, and perhaps even more important, it is the only extant physical object whereby we could assess his mechanical ability.

For an object that is 170 years old, the model is in fairly good condition, though time has taken a mild toll on some of its parts. Lincoln, being a mechanically oriented man, paid close attention in building this model in the fall of 1848 with the assistance of a local mechanic. Herndon recounted:

I well remember when Lincoln was at work on his patent. He was very much taken up with the project and, for a time, would slip away from the office and hurry down to the shop of Walter Davis, a Springfield mechanic, where, with the aid of the latter and the use of his tools, he gradually constructed the model. . . . I often saw him tinkering in Davis’s shop and, on one or two occasions, owing to his absence from the office, I had to go down there and confer with him regarding matters of business.

16. This inspection was conducted on March 6, 2017, and lasted about an hour. I thank Harry Rubenstein, chair of the Division of Political History, Smithsonian Institution, for granting access to this prized artifact. The Smithsonian displays a replica of the model, and access to the original is restricted to serious researchers. Though I conceived and conducted this research project independently, I am most appreciative of the unstinted encouragement offered by James Cornelius, curator of the Lincoln Collection, Abraham Lincoln Presidential Library and Museum.

17. Apparently a second model made by Lincoln was found in his Springfield home after his death, but its whereabouts are not known. See Emerson, Lincoln the Inventor, 33.

Lincoln did not expect a scenario where he would become president and future generations would study every one of his actions, including the construction of this model. Obviously, his goal for the model was to convince the Patent Office of the originality of his idea. Given this finite goal, it is indeed a testament to his workmanship that this model—composed primarily of wood, with secondary use of cloth, strings, and glue—has survived this long with only minor disintegration (figures 1 and 2).

Figure 1. The patent model (the bow is on the left). © Ian de Silva

Figure 2. The patent model, bow-and-starboard view. The horizontal rod just below the top deck is the central shaft (The degradation of the bellows of the forward chamber on the starboard side is clearly visible). © Ian de Silva
Details will follow, but in short the model can be described as a miniature boat with four exterior bellows—two per side—and a system of poles and ropes that would extend and contract the bellows (or chambers). If one is willing to overlook the tentacular appearance of the upright poles, the rest of the model exhibits a mechanical harmony peculiar to machines and perhaps only perceptible to mechanically oriented observers.

Though Lincoln intended his apparatus for use on steamboats, the model does not exhibit a steam engine or related equipment such as a boiler or a chimney. Nor does it exhibit cabins, a paddlewheel, or other prominent features of a steamboat. This is perfectly understandable, since his purpose was to show the apparatus he invented, and adding the aforementioned items or representations thereof would needlessly complicate the model. He doubtless understood that a complicated model would not help him elucidate his idea to the Patent Office, let alone to prospective investors.

From bow to stern, the length of the model is approximately 60 centimeters (hereafter, cm), or about 24 inches. The width of the hull is approximately 6 cm, or about 2.5 inches. The overall height—from the bottom of the hull to the top of the upright poles—is approximately 19 cm (7.5 inches). The model sits on a cradle, which was excluded from measurements.

At first glance, an informed researcher would notice one feature of the model that is puzzling, even problematic. The model has a very pronounced keel (figure 3). The reason this is puzzling is that steamboat builders began eliminating the keel in the 1830s, and its elimination was almost complete by the time Lincoln built the model in 1848 (figure 4).

Structurally, the keel is the backbone of a ship. As can be seen on dry-docked ships even today, the keel projects downward from the bottom of the hull and runs the length of the ship. For ocean-going

19. Due to the delicate nature of the model, great care was exercised in taking measurements so that actual physical contact was avoided. The measurements were taken with a soft flexible fiberglass tape (instead of metallic) to prevent scratches to the model in case of inadvertent contact. The tape was held about an inch from the model. While this type of noncontact measurement lacks the high accuracy of contact measurement, it is amply sufficient for the current analysis. Most measurements were made in centimeters, whose graduations are smaller and therefore offer better accuracy than inches. Nevertheless, all measurements of the model are approximate. This caveat applies throughout this article.

20. By 1850 the keel had almost vanished. Hunter, *Steamboats on the Western Rivers*, 78. Moreover, steamboat archaeology—excavation of sunken steamboats—has confirmed the keel elimination. Kane, *Western River Steamboat*, 98.
Figure 3. Bow view of the model, showing the pronounced keel. This keel runs the length of the hull. (The scalloped shape in the foreground is part of the cradle on which the model rests.) © Ian de Silva

Figure 4. Bow view of the steamboat *Buckeye State*, built in 1850. This is a dry-dock view, i.e., how the boat would look if it were taken out of the water. Notice the hull’s rectangular shape and the absence of a pronounced keel. This is believed to be the earliest extant technical drawing of a steamboat; it appeared in Thomas Tredgold, *Machinery Used in Steam Navigation* (London: John Weale, 1851), although the nomenclature has been added for this article.
sailing vessels throughout history, the projecting portion of the keel added stability by resisting unnecessary motion (acting like a long baffle) caused by the wind on the sails, especially when the ship’s intended direction was at an angle to the wind direction. In contrast, inland steamboats did not depend on the wind for propulsion and therefore had no sails, and thus such motion was not an issue. In fact, due to the shallow waters of western rivers, projecting keels on steamboats were a liability, since they could contact the river bottom or an underwater snag. Therefore, dispensing with the keel amounted to giving the boat a smaller draft—a desirable asset in western rivers.\textsuperscript{21}

The model’s keel projects approximately 1 cm from the bottom of the hull. If such a dimension were extrapolated to a midsized steamboat, the keel would project 2 feet—an extremely undesirable feature.\textsuperscript{22}

We cannot dismiss the pronounced keel as a mere peccadillo, for Lincoln included a pronounced keel in the patent drawings as well.\textsuperscript{23} Since Lincoln was a deliberate man, it is hard to believe he would depict the keel in both the model and the patent without a reason. Evidently, neither Lincoln nor Davis knew keels were being eliminated. This is understandable, for that was rather esoteric knowledge limited mainly to shipwrights and steamboat captains, and Springfield was, after all, far from the major shipbuilding cities on the Ohio.\textsuperscript{24}

In fact, another vexing feature is even more conspicuous than the keel: the concave shape of the model’s hull itself. When Lincoln set out to build the model, steamboat hulls had already assumed a rather rectangular shape (resembling a bathtub), with the bottom being nearly flat (see figure 4).\textsuperscript{25} A rectangular hull not only decreased the draft but also reduced the probability of the steamboat’s listing and rolling.

\textsuperscript{21}There are additional technical reasons for the keel elimination, but they are beyond the scope of this discussion. The structural integrity lost by the keel elimination was sufficiently regained by other techniques, which are also beyond the scope of this discussion. For the role of the keel in ships in general, see Hunter, \textit{Steamboats on the Western Rivers}, 78.

\textsuperscript{22}The extrapolation is based on the depth of the model’s hull (3 cm) exclusive of the keel. The hull depth for a midsized steamboat is conservatively assumed to be 6 feet.

\textsuperscript{23}It is possible that Lincoln or Davis cannibalized the hull from a toy boat and built the rest of the model, but that scenario still leaves one to wonder why Lincoln depicted the pronounced keel in the patent drawings. Keelboats and flatboats were common at the time; keelboats of course had a keel, but flatboats did not. Keelboats were designed for both downriver and upriver travel and often had sails; the keel improved stability and directional control. In contrast, flatboats were designed only for downriver travel.

\textsuperscript{24}Pittsburgh, Cincinnati, and Louisville were the major shipbuilding centers. Hunter, \textit{Steamboats on the Western Rivers}, 105.

\textsuperscript{25}Hunter, \textit{Steamboats on the Western Rivers}, 76–78.
Consequently, the entire hull (which includes the keel) of Lincoln’s model was atavistic even in the mid-nineteenth century. Perhaps we can excuse this deficit if we acknowledge a distinction. After all, he did not invent a boat—rather, he invented an apparatus for boats. Let us, therefore, now turn to the question of whether his apparatus has scientific and engineering merit.

Part II—The scientific principle behind Lincoln’s invention

The pièce de résistance of Lincoln’s invention was inflatable chambers. To explain their function, we must begin with the scientific principle behind them. It is Archimedes’ principle. It states that when an object is submerged in a liquid, the object will encounter an upward force equal to the weight of the liquid displaced by the object. This upward force is known as the buoyant force, or buoyancy. When this force is smaller than the object’s weight (which is a downward force due to gravity), the object sinks. When this force is greater than the object’s weight, the object rises. And when this force is equal to the object’s weight, the object floats.

Thus, a brick sinks because the upward force exerted on it by water is smaller than the downward force of its weight. In contrast, consider a block of wood with the same size and shape as the brick. The block will easily float on water. (Assume the block is painted to be waterproof, to prevent its absorbing water and becoming heavier.) Looking carefully, one will see that a portion of the block is underwater; that is, the block has sunk to the point where it has displaced an amount of water equal to the block’s weight. In other words, the buoyant force is now equal to the block’s weight—and the block floats. If one pushes down on the floating block, the block’s tendency is to rise, because the buoyant force exerted on it by water is greater than the block’s weight.

The same logic is applicable to an air-filled container. If forcibly submerged and released, it will always rise to the surface due to the dominance of the buoyant force. Hence the rationale for Lincoln’s inflatable chambers. When the chambers were inflated and inserted into water, the buoyant force would compel the chambers to rise, and since the chambers were attached to the boat, this upward force would be transmitted to the boat, making it rise too.

Archimedes’ principle was well known to scientists and engineers for centuries before Lincoln’s time. However, whether Lincoln knew it in its scientific meaning—that the buoyant force was equal to the weight of the displaced water—is something we may never know. It is clear he had a general understanding of buoyancy, but that is different from a scientific understanding of the principle, for it is the
scientific understanding that would allow one to make calculations about floating objects.26

Nevertheless, it would be imprudent to assume that Lincoln had not at least heard of Archimedes’ principle. After all, unlike the keel and hull issues discussed above, Archimedes’ principle was not esoteric knowledge and was therefore knowable to anyone who had access to physics books. (Though such books were not common in his day, he often borrowed books from various sources, as every Lincoln scholar knows.27) In fact, there is a noteworthy hint in the text of his patent that suggests Lincoln had at least a basic understanding of Archimedes’ discovery: “The buoyant chambers will be forced downwards into the water and at the same time expanded and filled with air for buoys ing up the vessel by the displacement of water” (emphasis added).28 It is difficult to fathom that someone who had never heard of that principle would use a phrase—“displacement of water”—that was inherent to the enunciation of that principle.

As mentioned earlier, the model exhibits four inflatable chambers, two per side. Notably, the forward chambers on both sides are longer than the rearward chambers.29 This is a detail that merits attention, because it reveals Lincoln’s river sense in general and his mechanical sense in particular. When moving in shallow water, a steamboat—or any boat, for that matter—would obviously run aground at the bow first (since the bow would be the first part of the boat to hit an obstacle). Therefore, it is the forward part of the boat that would need the most relief. Thus, the forward chambers, by being longer, provide

26. For instance, given the dimensions of a floating object and knowing the depth of its submerged portion, one can calculate the volume of the underwater portion of the object, and that gives the volume of the water that was displaced, which reveals the weight of the displaced water, which in turn gives the weight of the entire object. Similarly, when an object is forcibly submerged, the volume of the portion submerged enables one to calculate the buoyant force. In the case of Lincoln’s inflatable chambers, such calculations enable one to estimate the lift imparted to the steamboat by the chambers.

27. In Robert Bray, “What Abraham Lincoln Read,” Journal of the Abraham Lincoln Association 28, no. 2 (2007): 28–81, one finds a substantial list of books accessible to Lincoln along with a grading scale indicating the historical likelihood of his having read them. However, when the list is filtered by two criteria—i.e., physics or related science books published before Lincoln filed his patent, and the likelihood of his having read them—only two books emerge: A New Philosophy of Matter by George Brewster (1843) and On the Correlation of Physical Forces by William Grove (1846). Both books mention Archimedes as an early scientist but there is no discussion of his principle.


29. The forward chambers are approximately 25 cm (10 inches) and the rearward are 17.5 cm (7 inches) in length, thus making the former about 40 percent longer than the latter.
greater buoyancy when inflated. That this feature was intentional and not just an aberration for the model is corroborated by the patent drawings, where the forward chambers are depicted longer as well.

Part III—The inner workings of Lincoln’s apparatus

Now that the scientific principle behind Lincoln’s invention has been explained, the next question is, How were the buoyant chambers activated? To properly answer this question, one must consider the composition of the chambers.

Each chamber is basically an accordion-like bellows with three internal, horizontal plates; one at the top, one at the middle, and one at the bottom. A number of upright poles pass through orifices in the top and middle plates and are attached to the bottom plate. The bellows surround the plates, being fastened to the perimeter of each plate. Lincoln says the bellows “are composed of india-rubber cloth, or other suitable water-proof fabric.” When contracted, each chamber is in a box attached to the guards. (The guards are those portions of the lower deck that overhang the hull. See figure 4.) The box is optional, so each chamber can be directly attached by fixing the top plate to the underside of the guards.

Figure 5 is a simplified view of the internal composition of each chamber. Thus it does not show the bellows, which would be attached around the perimeter of the plates shown. (For simplicity, only two upright poles are shown; the model has four upright poles for each forward chamber and three for each rearward.) The reason for the top and bottom plates is fairly obvious since they form the rectangular shape of the chamber, but the reason for the middle plate is to help retain the shape when the chamber is extended and inflated. The top plate is fixed, as noted above. Therefore, when the upright poles move downward, they move the bottom plate downward, since the poles are attached to the bottom plate. The bottom plate’s perimeter is fastened to the bellows, so the bottom plate pulls down on the bellows. This pull-down extends to the upper portion of the bellows, eventually producing a rather rectangular chamber. (Imagine the bellows of an accordion and these three plates inside it. When you pull on one of the end plates, it eventually pulls on the entire bellows.) Preinstalled check ropes between plates would help control the maximum distance between plates and prevent the pull-down forces from overstretching the bellows.

30. This article uses the terms inflatable and buoyant interchangeably since their meaning is the same in the context of Lincoln’s invention.
As the upright poles push down and unfold the bellows, the air holes on the upper and middle plates admit air into the chamber, inflating it. Outside air will enter through the air hole on the top plate first, and as the bellows is extended, that air will travel through the air hole on the middle plate and fill the bottom portion of the chamber. After the chamber is thus inflated, the air hole on the upper plate must be plugged to prevent any escape of air due to the external pressure the chamber will undergo once it is immersed into the water. (Plugging the air hole on the middle plate is unnecessary, since it is internal.) The whole process is reversed when the upright poles are pulled up, an action that contracts the chamber into its folded condition.

Now let us turn to the question of how the upright poles were to be operated. The poles are driven by a rope wound around a central shaft—essentially a long thick rod that is mounted horizontally, runs almost the entire length of the boat, and drives all four chambers. The rope is wound in such a manner that, when the shaft is rotated clockwise, the rope will move one way, and when the shaft is rotated counterclockwise, the rope will move the opposite way (Figure 6 illustrates the clockwise motion).

Next, imagine this rope to be a loop—Lincoln called it an “endless” rope—that is linked to an upright pole, and pulleys guiding the rope (figure 7). Consequently, the pole can be made to move up or down depending on which way the rope moves, which of course
Figure 6. A simplified view of the operation of the central shaft. Here, a rope has been wound around a wooden rod that simulates the central shaft. When the rod is turned clockwise as shown, the rope moves as indicated by the arrows. If the rod is turned counterclockwise, the rope will move in the direction opposite to what is shown. © Ian de Silva

Figure 7. A simplified view of the interaction between the central shaft and an individual pole. The rope forms a loop that runs over pulleys and imparts an up/down motion to the pole, depending on which way the shaft turns. Here, the shaft turns clockwise, making the pole move down. Rope-to-pole fastenings transmit the rope movement to the pole. © Ian de Silva
is controlled by the central shaft. Finally, imagine the bottom of the pole is attached to the bottom plate of a chamber, as discussed above; that enables the up or down motion of the bottom plate. Collectively, this is how the upright poles extend or contract the chambers. Each pole would have its own “endless” rope, but all the ropes would be wound around the central shaft at various spots along its length.

Optionally, as Lincoln points out in the patent, there could be two central shafts, one for operating the forward chambers and the other the rearward chambers, thus providing flexibility by enabling a particular pair of buoyant chambers to be utilized depending on the situation.

**Part IV—Testing Lincoln’s idea**

We have now come to a crucial question: Does Lincoln’s idea actually work?

The ideal way to answer that question is to build a full-scale model and test it, but constraints on time and resources demand more practical options. Fortunately, Lincoln’s invention is amenable to basic tests that can empirically confirm the validity of his concept. Recognizing this, I devised an experiment requiring only household tools and materials available at most hardware stores. In science and engineering, one can often arrive at the gist of an issue by using the philosophical rubric known as Occam’s razor, that is, the simplest explanation is often the correct one. Thus, a simple experiment often provides a clearer result than a complicated experiment does.

The primary component was a plastic receptacle that strongly resembled the rectangular hull of a steamboat in miniature. This makeshift boat was filled with sand to simulate cargo and passengers. After carefully placing it into a tank of water and letting it settle down, the draft at the bow was recorded. This was the first phase of the test.

Subsequently, two small plastic bottles filled with nothing but air (and tightly sealed) were attached to this test boat, one bottle on each side. The draft at the bow was recorded again. This was the second phase.

Figure 8 illustrates the experiment. The air bottles substituted for Lincoln’s inflatable chambers or bellows. Conceptually, when the...
issue is buoyancy, there is no difference between a plastic container filled with air and a bellows filled with air. Before the air bottles were attached, the draft at the bow was 2.1 cm. After the air bottles were attached, the draft was 1.7 cm. The buoyant force exerted on the air bottles by the water lifted the air bottles, and since they were attached to the test boat, the test boat also underwent a lift, causing the decrease in draft. This lift occurred despite the additional weight of the gantry and bottles—a testament to the power of buoyancy.

Such a change in draft, from 2.1 cm to 1.7 cm, represents a 19 percent decrease. For a steamboat that would normally have a draft of, say, eight feet, a reduction of 19 or 20 percent means that it would now

plastic mesh, and then the gantry and bottles were attached to the test boat via straps. These straps were attached to the inside bottom of the hull before filling the hull with sand; this was done to prevent the disturbance and shifting of sand that would have occurred if the straps were attached after the first phase, as such shifting would have altered the load distribution of the boat, rendering useless the baseline draft recorded in the first phase.

33. The reason for recording the draft at the bow instead of elsewhere was that the air bottles were attached close to the bow and therefore the greatest effect would be seen at the bow. As pointed out earlier, it was the bow of a steamboat that was most likely to run aground first.

34. The plastic gantry carrying the air bottles was fairly rigid but not inflexible. Thus some of the lifting force imparted by the bottles was probably lost in flexing the gantry. In other words, not all of the lifting force was transmitted to the test boat. Therefore, the draft decrease would be even greater if the gantry were ideally constructed to be completely inflexible. Furthermore, the straps holding the gantry may have allowed some play between them and the gantry, which also probably decreased the lift transmitted to the test boat.

35. The gantry and bottles were light but nevertheless amounted to a 12 percent increase in the weight of the test boat.
need only about six and a half feet of water. In other words, it amounts to lifting the boat a foot and a half. For a steamboat that ran aground at the bow, a lift of a foot and a half would most probably set it free. It must be emphatically pointed out, however, that this does not mean Lincoln’s apparatus would have produced a 20 percent decrease in draft or a foot and a half of lift. Those results are due to the particular shape of the test boat and the size of the air bottles compared to that of the test boat.

Nevertheless, Archimedes’ principle and a basic experiment such as this clearly demonstrate that Lincoln’s concept is irrefragable—buoyant chambers produce a lift. But the magnitude of the lift is a question that would depend on several factors. Of these, two are paramount: the size of the hull and the size of the buoyant chambers. In other words, given a fixed hull size, a larger buoyant chamber would provide a greater lift than a smaller chamber.

Part V—How effective was Lincoln’s invention?

We can now attempt to determine how effective Lincoln’s apparatus would have been in actuality. Perhaps the most logical way of addressing this question is to estimate the lift provided by his apparatus. Such an estimate requires an extrapolation of his model’s dimensions so that we can visualize his model being an actual full-scale boat.

For this extrapolation, the size of the full-scale boat needs to be realistic. As explained previously, the problem of shallow water existed even on big rivers. Therefore, in dry seasons, small steamboats, instead of large ones, were preferred. Given this preference, they were more likely to venture into even shallower areas as ambitious captains sought ways to increase operational profit by reaching destinations others would not approach, thereby making even small boats vulnerable to running aground. Above all, a steamboat owner who wanted to try Lincoln’s apparatus would have first tried it on a small boat for obvious reasons—a comparatively small investment and therefore a comparatively small loss if it failed. For these reasons, it is realistic to extrapolate Lincoln’s model to a full-scale steamboat of comparatively small size.

In the 1840s, a small steamboat was about 140 feet in length. The reader will recall that the model measures 60 cm, or 24 inches, long, which is 2 feet. Therefore, the ratio between the two objects is 70. The model is 1/70th the size of a small steamboat. Thus, the first step of

36. Hunter, Steamboats on the Western Rivers, 74. This measurement refers to the length of the hull. The hull width was approximately 23 feet.
the extrapolation is simply multiplying the dimensions of the model by 70. The result gives a full-scale, albeit theoretical model the size of a small steamboat.

When the appropriate calculations are performed, it appears that for a small steamboat whose length is 140 feet, Lincoln’s apparatus would produce a lift of about 15 inches, but it must be emphasized that this is a theoretical number. Even 10 inches of lift, however, would have made the difference between passage and no passage. In fact, strictly speaking, the minimal condition necessary for passage was to keep the bottom of the hull just above the river bottom. By that standard, 10 inches of clearance would have been a welcome relief.

A natural question that may occur to many readers is whether Lincoln’s apparatus itself would weigh down the steamboat to the point where it could render the boat more vulnerable to running aground, thus defeating its intended purpose. This is a commonsensical question and one that, in the minds of nonengineers, would militate against the apparatus. In fact, at least one eminent Lincoln scholar has postulated that the weight of the apparatus was the patent’s undoing. Nevertheless, this is a case where common sense is intrinsically insufficient and one must defer to the laws of science.

37. The calculations can be explained as follows. In the model, each of the forward chambers is 25 cm long and 2 cm wide. The depth of each chamber was estimated by scaling Lincoln’s patent drawings (see note 1). Therein both the forward and rearward chambers are shown in the extended position. Their bottoms are at a point approximately half the hull depth. The hull depth is 4 cm; thus, the chambers are estimated to be 2 cm in depth. Therefore, each forward chamber, when extended, has these dimensions—25 cm long, 2 cm wide, and 2 cm deep. Applying the ratio of 70 gives the extrapolated dimensions—57.4 feet long, 4.6 feet wide, and 4.6 feet deep. The same goes for rearward chambers, except their length is 17.5 cm instead of 25 cm. Hence the extrapolated dimensions are 40.2 feet long, 4.6 feet wide, and 4.6 feet deep.

Per these extrapolated dimensions, the volume of each forward chamber is 1,215 cubic feet; thus both forward chambers have a combined volume of 2,430 cubic feet. Similar logic for rearward chambers gives 850 cubic feet for each, 1,700 for both. Thus all four chambers have a total volume of 4,130 cubic feet. Therefore, when all four chambers are deployed, they will displace 4,130 cubic feet of water.

Due to the buoyancy of the chambers, the boat must rise so that the difference between the hull’s former underwater volume and the current underwater volume is 4,130 cubic feet. Since the hull was assumed to be rectangular and measuring 140 feet long and 23 feet wide (see note 36), we can simply treat it as a box. Thus, we can determine how much this box has to rise to offset 4,130 cubic feet in volume. Using basic geometry and algebra, the rise is 1.28 feet, or about 15 inches.

38. “He received Patent No. 6469 but never realized anything from his device—probably because the weight of the apparatus could cause the problem he was trying to solve.” Mark E. Neely, The Abraham Lincoln Encyclopedia (New York: McGraw-Hill, 1982), 162.
To answer that question, we must first estimate the weight of his apparatus. Thus, let us recall the main components of Lincoln’s invention: inflatable chambers (whose interiors contained three plates each), upright poles, central shaft, upright supports for the central shaft (see figure 2), ropes, and pulleys. Per the original model, the most numerous component is the upright pole, of which there are fourteen; seven per side. If we adduce the extrapolated 140-foot-long model mentioned above and use that as the basis for the dimensions of components, we can arrive at an estimate of the weight of Lincoln’s apparatus—about 16,000 pounds.\(^{39}\)

At first glance, such a number might appear to make Lincoln’s apparatus sink the boat to the river bottom, which would sink any discussion of the scientific merits of his invention. But that is hardly the case. To begin with, per Archimedes’ principle, 16,000 pounds would displace only 256 cubic feet of water.\(^{40}\) This means Lincoln’s apparatus would make the steamboat drop only about one more inch.\(^{41}\) A mere one inch! Thus even doubling the weight of his apparatus—to a massive 32,000 pounds—would cause the boat to drop only a total of two inches. So the issue of weight is, to invoke an aquatic creature

39. This estimate is based on the following calculations. The interior plates in the chambers were estimated using dimensions mentioned in note 37 and a thickness of 1 inch. The upright poles are assumed to be 3 inches in diameter and 20 feet long, the central shaft 6 inches in diameter and 140 feet long, shaft supports 1 foot wide, 3 inches thick, and 9 feet high each. Once their volume is calculated, the weight can be determined via the density of wood. White oak was a common wood in steamboat construction, and its density is about 50 pounds per cubic foot. Hence the following weight itemization, rounded to the nearest 10 pounds:

<table>
<thead>
<tr>
<th>Component</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upright poles (fourteen in all)</td>
<td>690</td>
</tr>
<tr>
<td>Central shaft</td>
<td>1,370</td>
</tr>
<tr>
<td>Shaft supports (five in all)</td>
<td>560</td>
</tr>
<tr>
<td>Forward chamber plates (two chambers, thus six plates)</td>
<td>6,600</td>
</tr>
<tr>
<td>Rearward chamber plates (two chambers, thus six plates)</td>
<td>4,620</td>
</tr>
<tr>
<td>Ropes and pulleys</td>
<td>300</td>
</tr>
<tr>
<td>Waterproof bellows (all four chambers)</td>
<td>600</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td><strong>14,740 lbs.</strong></td>
</tr>
</tbody>
</table>

Add a generous miscellaneous allowance (reinforcing bars for chamber plates, additional bracing, etc.) so as to round out the estimate:

| Miscellaneous allowance                                      | 1,260 lbs. |

**Total**                                                   **16,000 lbs.**

40. A cubic foot of water weighs 62.4 pounds, so 16,000 pounds is 256 cubic feet.

41. The scientific rationale here is similar to that given in the third paragraph in note 37. Theoretically, the drop is 0.95 inch.
since we are discussing water, nothing but a red herring. *Quod erat demonstrandum.*

It is this phenomenon of weight vis-à-vis displacement that explains why ships can carry a tremendous amount of cargo. As previously mentioned, there were steamboats that could carry one million pounds. (Though the steamboat era is gone, anyone who visits a busy port today and watches arriving ships can see firsthand the incredible loads disgorged by vessels.) Even a small steamboat of the aforementioned size could carry 300,000 pounds. The 16,000 pounds due to Lincoln’s apparatus would hardly be a remora, to invoke another aquatic creature.

*Part VI—Where Lincoln’s invention runs into trouble*

Indeed, the weight of the apparatus is far outweighed in importance by other factors that would make the actual lift smaller, probably considerably smaller, than the theoretically estimated 15 inches mentioned above. This is where Lincoln’s invention really begins to run aground in the world of engineering.

Once the chambers are underwater, they are subjected to increased pressure due to the surrounding water. In this case, let us assume the apparatus is optimally situated and therefore the chambers are fully immersed. The top of each chamber, being at the waterline, is at normal atmospheric pressure, but the bottom is at a greater pressure since it is below the waterline. The extrapolated depth of each chamber is 4.6 feet (see note 37 above). Thus the bottom of the chamber is 4.6 feet below the waterline. This results in the bottom of the chamber undergoing a pressure that is approximately 14 percent greater than at the top, which would cause the bellows to be compressed inward at the bottom. And this compression increases the pressure of the air inside the chamber, turning even the smallest orifice into an air outlet.

In fact, Lincoln’s design would make it very difficult—using nineteenth-century technology—to prevent air leaks from the chambers. For instance, figure 5 illustrates two pass-through holes on the top plate of the chamber, the holes through which the upright poles

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42. The pressure at the top is atmospheric pressure, that is, 14.7 pounds per square inch (psi). The pressure at the bottom is 16.7 psi. Hence the difference is 13.6 percent, or about 14 percent.

43. Recall the explanation, presented earlier in this analysis, about how each chamber is inflated, that is, by atmospheric air and thus to atmospheric pressure only. Consequently, once it is underwater, the surrounding water will make the pressure inside the chamber greater than that of the atmosphere, a condition that increases the probability of leaks.
Evaluating Lincoln’s Patented Invention

pass to reach the bottom plate. Air would easily leak from the annular gap at each hole unless an airtight bushing or grommet is used, which would then require a proper lubricant to facilitate the pole’s up-and-down motion through the bushing or grommet while also preventing air leaks. Lincoln does not mention the concern of air leakage. It goes without saying that the cloth that constitutes the bellows would have to be not only waterproof (which he mentions) but also abrasion-resistant to withstand scrapes against sandbars and so forth (which he does not mention). Due to underwater pressure, even a small tear on the bellows would release the air contained within, thus nullifying the benefits of buoyancy.

There are other concerns as well. For instance, the central shaft, due to its rotary nature, would be plagued by friction (and resultant problems) if it rested directly on upright supports, as is exhibited by the patent model. The shaft would need to be on bearings or a friction-reducing surface. At a minimum, the shaft’s contact areas would need to be lubricated—and kept lubricated.

Those are some of the problems intrinsic to Lincoln’s apparatus. Then there are extrinsic problems. Let us begin with the issue of supplying power, which would come from the steamboat’s engine. The issue is not that the engine would be unequal to the task. After all, by the 1850s, steamboat engines with power rated at several hundred horsepower were not unusual, and some boats boasted 1,000 or more horsepower. Most steamboats of the antebellum period were side-wheelers—having two paddle wheels, one on each side—and were powered by two engines on board, which of course meant more horsepower than single-engine steamboats of early years. Rather, the issue would be connecting the engine (or engines) to Lincoln’s apparatus. Addressing this problem requires a brief excursion into steamboat architecture.

44. The word annular means ring-shaped, and annular gap is the empty space between the pole’s circumference and the hole’s circumference. The annular gap in the pass-through holes on the middle plate is not a concern since the middle plate is not exposed to the outside.

45. Hunter, Steamboats on the Western Rivers, 142–44.

46. But such a multiengine power supply was not essential to Lincoln’s invention. The chambers would not be thrust into the water with a quick downward stroke; instead, it would be a gradual and fairly slow process taking several minutes, which requires less power than a quick downward thrust. In any case, the power of steamboat engines can be understood by realizing that they turned huge paddle wheels against the water, and paddle wheels were often 10 feet wide and 25 feet in diameter (the height of a modern two-story home). Therefore, though the chambers would encounter considerable resistance against the water during insertion, even a 100-horsepower steam
One of the main reasons that steamboat designers preferred two engines was that the shaft connecting a single engine to both paddle wheels caused all sorts of complications. Since the paddle wheels were on the sides, this shaft ran across the main deck, not only depriving the boat of otherwise usable cargo space but also causing alignment problems and safety hazards. In contrast, each engine of a two-engine system was right next to a paddle wheel, leaving the main deck free of the dangerous rotating shaft as well as allowing more room for cargo and movement by deckhands.

Consequently, incorporating Lincoln’s apparatus would mean inserting a connection mechanism between one or both engines and Lincoln’s central shaft. This connection mechanism, no matter how simple, would ineluctably be an interference—thus defeating a main advantage of the two-engine layout.

In fact, the connection could not be simple. Lincoln does not elaborate here, but it is implicitly understood that the connection to the engine would require a coupling-decoupling mechanism; otherwise the central shaft would turn every time the engine ran and deploy the chambers regardless of need. The buoyant chambers were intended for deployment when the boat accidentally ran aground, whereas moving with them deployed would actually slow down the boat due to the additional resistance induced by the chambers against the water. In fact, there is nothing in the patent that suggests Lincoln intended his apparatus for full-time operation. Quite the contrary, as evident from this sentence in the patent: “The buoyant chambers . . . can be expanded so as to hold a large volume of air when required for use, and can be contracted, into a very small space and safely secured as soon as their services can be dispensed with” (emphasis added). But for short distances in shallow water and at slower speeds, there is no reason the boat could not travel with the chambers deployed.

Nevertheless, Lincoln would have run into a catch-22 with the coupling-decoupling mechanism. Without it, his apparatus would engine could perform the task, if given enough time. Even if the engine inserted only one chamber at a time and all four chambers took, say, one hour in total, it would still be only a very minor delay by nineteenth-century travel standards.

Besides, his apparatus was primarily intended for use when the boat ran aground, at which point most of the power would be diverted to operating the chambers, as one or both of the paddle wheels would be temporarily irrelevant, since the lift would be more important than the propulsion supplied by the paddle wheels. Therefore the question of whether the engines could simultaneously power the chambers and paddle wheels is somewhat moot.

47. Patent #6469, “Buoying Vessels over Shoals.”
really be a hindrance. With it, it would be just the type of additional connection that steamboat engineers resented, making them reluctant to install it in the first place.

Worse yet, the problems posed by the connection mechanism would be dwarfed by those of the upright poles and ropes. Perhaps the best way to understand this issue is to refer to figure 9, which shows the typical appearance of a steamboat about the time Lincoln designed his apparatus. The wide openings between support posts on the main deck facilitated the loading and unloading of cargo. Firewood—the fuel that heated the water in the boiler that produced the steam that pushed the piston in the engine that drove the paddle wheel—was stowed on the main deck as well. To maximize profit, captains used more of the deck space for cargo and less for wood, which sometimes meant frequent stops along the way to replenish the fuel supply. Thus easy access to deck space was critical to quick loading of wood, and Lincoln’s system of poles and ropes would have been an invidious interference.

The upper deck holds passenger cabins, surrounded by a promenade edged with a rail. Imagine the complications of incorporating
Lincoln’s upright poles into this picture. They not only would crowd the main deck, restricting cargo movement and wood replenishment, but also would complicate the promenade area where passengers walked about. The photograph clearly shows some passengers so comfortable at the promenade that they dangle their feet over the rail. But complications of the poles would pale in comparison with the intrusions of Lincoln’s rope connections between the central shaft and those poles. If we assume the central shaft would be mounted just below the upper deck (as Lincoln did in his model), his rope system would essentially turn the main deck from a spacious platform for profitable cargo into a cranny with a cobweb of ropes. This interference would have rendered his apparatus incompatible even with steamboats that had no passenger promenade and carried only cargo.

As we can imagine, steamboat captains and engineers were a pragmatic breed. They instinctively rejected the complex in favor of the simplex. Their goal was to deliver the most cargo and passengers for the most profit.\textsuperscript{48} Anything that interfered with that goal was viewed with skepticism at best and disdain at worst. The steamboat industry was not dissimilar to today’s airline industry in its minimalist operating philosophy—anything that did not produce a profit was jettisoned.

Such was the business climate for Lincoln’s apparatus. Moreover, steamboats were expensive business ventures. Even a small steamboat cost about $12,000 at that time—the approximate equivalent of $350,000 today.\textsuperscript{49} Larger boats cost the equivalent of $1.2 million or more today.\textsuperscript{50} Ergo, they were not small investments, and it is readily conceivable that a steamboat owner who was dubious about Lincoln’s apparatus—what with all those poles and ropes—could think that installing it would amount to a mutilation of an expensive investment, one without any guarantee of recompense, at that.

In the patent, Lincoln states that his apparatus could also be operated by man power. This option still does not absolve his invention of intruding into profitable space on a steamboat. He also says that his apparatus could be used on other vessels besides steamboats. This lemma ends up being a dilemma as well. The other main types

\textsuperscript{48} Generally the exception was the steamboats specifically advertised for their comfortable accommodations, where the emphasis was on quality instead of quantity.

\textsuperscript{49} The historical price is based on an estimate of $100 per measured ton for a 120-ton steamboat; see Hunter, \textit{Steamboats on the Western Rivers}, 307. The current equivalent is from an inflation calculator available at the website of the Federal Reserve Bank of Minneapolis (minneapolisfed.org), according to which $1 in 1850 is worth $29 in 2017.

\textsuperscript{50} Based on an estimate of $40,000 or more; see Hunter, \textit{Steamboats on the Western Rivers}, 308.
of vessel used on western rivers at that time were keelboats and flatboats—whose onboard real estate was no less valuable to their operators. These boats, being smaller than steamboats and manually propelled, already had sufficient labor on board to extricate the vessels from a stranding, and therefore were the least likely to need complicated recovery apparatus. In fact, because they were smaller—and therefore more maneuverable—their probability of running aground was small in the first place.

Part VII—Abandoned brainchild

So we come to the last of the three main questions posed at the beginning of this article. Why did Lincoln abandon his invention?

It would be naive to think that he, after returning from Congress, became preoccupied with resuming his law practice and tending to his family, and consequently had little time for anything else; that someone of Lincoln’s intellect, ambition, and persistence was too busy to pursue something in which he invested so much time and to protect which he even took the extraordinary step of securing a patent. That notion is particularly naive given his advocacy for internal improvements, which his invention would have helped promote. Furthermore, Lincoln’s oratorical and legal skills would have made him a uniquely formidable promoter of his own patent because he himself could have defended it against infringements better than other lawyers.51

The foregoing analysis of his invention points to a different answer. It can be given in a word that is very apropos here—resipiscence, a rare literary word that basically means the recognition of one’s errors. What most probably happened was, once the excitement of building the model and acquiring the patent receded, Lincoln realized the defects of his invention. This is not unusual for inventors; many have had second thoughts after their patents were secured. Since it is a public document with technical details, a patent puts an invention into public knowledge, enabling knowledgeable observers to point out its problems. After all, throughout American history the number of patents issued has always exceeded the number of patented inventions adopted by society.

Though no piece of correspondence from someone pointing out to Lincoln the shortcomings of his invention is known today, he probably encountered people who conveyed their skepticism in person. Even without such intimations, it is not improbable that he realized

51. It is possible Lincoln promoted his invention, though evidence of that has not come to light.
his errors on his own deliberation. After all, we know he was a deeply reflective man.

Some skeptics of his invention may have lived no farther away than his hometown. According to an eyewitness account, albeit recollected several decades after the event, Lincoln demonstrated a four-foot-long model boat—which we may presume was a larger version of his patent model—on a water trough in Springfield.\(^5\) The witness recalled that Lincoln used bricks to load down the model boat until it dropped down to water level at the first deck. At that point he extended the chambers, “and in a few moments it slowly rose above the water about six inches, Lincoln remarking that each inch represented a foot, on a good sized steam boat. . . . The crowd listened to Lincoln’s defence of his invention, gave three cheers and dispersed, much impressed *but not fully convinced*” (emphasis added).\(^53\)

Moreover, the historical record indirectly suggests that Lincoln’s abandonment of his invention was intentional and permanent, instead of unwitting and temporary. As any scholar of his presidential years knows, Lincoln was a hands-on commander in chief, often involving himself in the types of weapons bought by the federal government.\(^54\) During the Civil War, steamboats were a critical link in the movement of men and materiel, and, as we can imagine, running aground has dire consequences during a war. Therefore, if he still thought his invention was a worthy endeavor, it is reasonable to suppose he would have directed someone to at least try it once. But there is no evidence he gave such direction—even though he found time to refer other inventors to various officers of the War Department.

**Conclusions**

Though Lincoln’s invention was never adopted, it would be rather remiss to conclude that it was a fiasco. On the contrary, it was a prescient concept and one that was scientifically tenable. Where Lincoln erred was in the execution, specifically his complicated system of poles

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52. He had apparently built two models, the smaller one going to the Patent Office. See note 17.
53. Gaius Paddock, “Is the Sangamon River Navigable?," *Journal of the Illinois State Historical Society*, April 1920, 49–50. By the way, if Lincoln made that remark about six inches representing six feet, then he grossly overestimated the capability of his apparatus. A rise of six feet would have raised the entire hull of a midsized steamboat out of the water!
54. Perhaps the preeminent authority on Lincoln’s involvement in weapons acquisition decisions during the Civil War is Robert V. Bruce, *Lincoln and the Tools of War* (Indianapolis: Bobbs-Merrill, 1956).
and ropes that made it an invidious contraption. Had he devised a simpler and less intrusive means of inflating his bellows, the Great Emancipator might have also been remembered for an emancipation of a different sort—freeing boats captured by river sand.

Today, the principle of buoyancy is used in an aquatic application far more demanding than even Lincoln intended. Flexible buoyant containers called lift bags—made from modern fabrics—are now a standard way of raising sunken vessels from the sea floor; divers attach these to the sunken vessel, which then rises due to the buoyancy of the air inside the bags.55

We must remind ourselves that Lincoln conceived his invention without any scientific training—a remarkable achievement by any definition. That fact alone should make his invention a timeless reminder of the inimitably versatile mind he possessed.

55. However, Lincoln did not pioneer the idea of using buoyancy to control underwater vessels. Otherwise reputable biographers have suggested that Lincoln’s invention enabled the submarine (e.g., Temple, Connections, 70). On the contrary, the submarine existed long before Lincoln was even born—dating to the 1620s in Europe. The first American sub was used in 1776 during the Revolution, three decades before Lincoln was born.