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Bursting Boilers and the Federal Power

JOHN G. BURKE

I

When the United States Food and Drug Administration removes thousands of tins of tuna from supermarket shelves to prevent possible food poisoning, when the Civil Aeronautics Board restricts the speed of certain jets until modifications are completed, or when the Interstate Commerce Commission institutes safety checks of interstate motor carriers, the federal government is expressing its power to regulate dangerous processes or products in interstate commerce. Although particular interests may take issue with a regulatory agency about restrictions placed upon certain products or seek to alleviate what they consider to be unjust directives, few citizens would argue that government regulation of this type constitutes a serious invasion of private property rights.¹

Though federal regulatory agencies may contribute to the general welfare, they are not expressly sanctioned by any provisions of the U.S. Constitution. In fact, their genesis was due to a marked change in the attitude of many early nineteenth-century Americans who insisted that the federal government exercise its power in a positive way in an area that was non-existent when the Constitution was enacted. At the time, commercial, manufacturing, and business interests were willing to seek the aid of government in such matters as patent rights, land grants, or protective tariffs, but they opposed any action that might smack of governmental interference or control of their internal affairs. The government might act benevolently but never restrictively.

The innovation responsible for the changed attitude toward government regulation was the steam engine. The introduction of steam power

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¹ See, e.g., *Report on Practices and Procedures of Governmental Control*, Sept. 18, 1944 (House of Representatives document 678, ser. 10873 [Washington: 78th Congress, 2d session]), p. 3, where it is stated: "Regulation, seen through modern eyes is not a violent departure from the ways of business to which the nation is both habituated and strongly attached . . . regulation . . . enjoys, as a system, in large measure the confidence and approval of the parties concerned."

was transforming American culture, and while Thoreau despised the belching locomotives that fouled his nest at Walden, the majority of Americans were delighted with the improved modes of transportation and the other benefits accompanying the expanding use of steam. However, while Americans rejoiced over this awesome power that was harnessed in the service of man, tragic events that were apparently concomitant to its use alarmed them—the growing frequency of disastrous boiler explosions, primarily in marine service. At the time, there was not even a governmental agency that could institute a proper investigation of the accidents. Legal definitions of the responsibility or negligence of manufacturers or owners of potentially dangerous equipment were in an embryonic state. The belief existed that the enlightened self-interest of an entrepreneur sufficed to guarantee the public safety. This theory militated against the enactment of any legislation restricting the actions of the manufacturers or users of steam equipment.

Although the Constitution empowered Congress to regulate interstate commerce, there was still some disagreement about the extent of this power even after the decision in *Gibbons v. Ogden*, which ruled that the only limitations on this power were those prescribed in the Constitution. In the early years of the republic, Congress passed legislation under the commerce clause designating ports of entry for customs collections, requiring sailing licenses, and specifying procedures for filing cargo manifests. The intent of additional legislation in this area, other than to provide for these normal concomitants of trade, was to promote commerce by building roads, dredging canals, erecting lighthouses, and improving harbors. Congress limited its power under the commerce clause until the toll of death and destruction wrought by bursting steamboat boilers mounted, and some positive regulations concerning the application of steam power seemed necessary. Thomas Jefferson's recommendation that we should have "a wise and frugal Government, which shall restrain men from injuring one another, shall leave them otherwise free to regulate their own pursuits of industry and improvement" took on a new meaning.²

Although several historians have noted the steamboat explosions and the resulting federal regulations, the wider significance of the explosions as an important factor in altering the premises concerning the role of government vis à vis private enterprise has been slighted.³ Further, there has been no analysis of the role of the informed public in this matter.

² Thomas Jefferson, "Inaugural Address," *Journal of the Executive Proceedings of the U.S. Senate*, I (Washington, 1828), 393.

³ The most authoritative work is Louis C. Hunter, *Steamboats on the Western Rivers* (Cambridge, Mass., 1949), pp. 122–33, 271–304, 520–46.

The scientific and technically knowledgeable members of society were—in the absence of a vested interest—from the outset firmly committed to the necessity of federal intervention and regulation. They conducted investigations of the accidents; they proposed detailed legislation which they believed would prevent the disasters. For more than a generation, however, successive Congresses hesitated to take forceful action, weighing the admitted danger to the public safety against the unwanted alternative, the regulation of private enterprise.

The regulatory power of the federal government, then, was not expanded in any authoritarian manner. Rather, it evolved in response to novel conditions emanating from the new machine age, which was clearly seen by that community whose educations or careers encompassed the new technology. In eventually reacting to this danger, Congress passed the first positive regulatory legislation and created the first agency empowered to supervise and direct the internal affairs of a sector of private enterprise in detail. Further, certain congressmen used this precedent later in efforts to protect the public in other areas, notably in proposing legislation that in time created the Interstate Commerce Commission. Marine boiler explosions, then, provoked a crisis in the safe application of steam power, which led to a marked change in American political attitudes. The change, however, was not abrupt but evolved between 1816 and 1852.

II

Throughout most of the eighteenth century, steam engines worked on the atmospheric principle. Steam was piped to the engine cylinder at atmospheric pressure, and a jet of cold water introduced into the cylinder at the top of the stroke created a partial vacuum in the cylinder. The atmospheric pressure on the exterior of the piston caused the power stroke. The central problem in boiler construction, then, was to prevent leakage. Consequently, most eighteenth-century boilers were little more than large wood, copper, or cast-iron containers placed over a hearth and encased with firebrick. In the late eighteenth century, Watt's utilization of the expansive force of steam compelled more careful boiler design. Using a separate condenser in conjunction with steam pressure, Watt operated his engines at about 7 p.s.i. above that of the atmosphere. Riveted wrought-iron boilers were introduced, and safety valves were employed to discharge steam if the boiler pressure exceeded the designed working pressure.

Oliver Evans in the United States and Richard Trevithick in England introduced the relatively high-pressure non-condensing steam engine almost simultaneously at the turn of the nineteenth century. This de-

velopment led to the vast extension in the use of steam power. The high-pressure engines competed in efficiency with the low-pressure type, while their compactness made them more suitable for land and water vehicular transport. But, simultaneously, the scope of the problem faced even by Watt was increased, that is, the construction of boilers that would safely contain the dangerous expansive force of steam. Evans thoroughly respected the potential destructive force of steam. He relied chiefly on safety valves with ample relieving capacity but encouraged sound boiler design by publishing the first formula for computing the thickness of wrought iron to be used in boilers of various diameters carrying different working pressures.⁴

Despite Evans' prudence, hindsight makes it clear that the rash of boiler explosions from 1816 onward was almost inevitable. Evans' design rules were not heeded. Shell thickness and diameter depended upon available material, which was often of inferior quality.⁵ In fabrication, no provision was made for the weakening of the shell occasioned by the rivet holes. The danger inherent in the employment of wrought-iron shells with cast-iron heads affixed because of the different coefficients of expansion was not recognized, and the design of internal stays was often inadequate. The openings in the safety valves were not properly proportioned to give sufficient relieving capacity. Gauge cocks and floats intended to ensure adequate water levels were inaccurate and subject to malfunction by fouling with sediment or rust.

In addition, there were also problems connected with boiler operation and maintenance.⁶ The rolling and pitching of steamboats caused

⁴ Greville and Dorothy Bathe, *Oliver Evans* (Philadelphia, 1935), pp. 151, 253. Also, see Walter F. Johnson, "On the Strength of Cylindrical Steam Boilers," *Journal of the Franklin Institute* (hereinafter cited as "JFI"), X, N.S. (1832), 149. Evans' formula reveals that he considered that a safe design tensile strength for good quality wrought iron was about 42,000 p.s.i. and that a factor of safety of 10 should be used to arrive at a safe shell thickness.

⁵ For reports of defective design and poor quality material see: Charles F. Partington, *An Historical and Descriptive Account of the Steam Engine* (London, 1822), p. 85; Committee on Steamboats *Report*, May 18, 1832 (House of Representatives document 478, ser. 228 [Washington: 22d Congress, 1st session]), pp. 44, 170 (hereinafter cited as "Doc. 478"). Also, *JFI*, VI, N.S. (1830), 44-51; VIII, N.S. (1831), 382; IX, N.S. (1832), 28, 100, 363; X, N.S. (1832), 226-32; XVII, N.S. (1836), 298-302; XX, N.S. (1837), 100, 103.

⁶ For operating difficulties see: Partington, *op. cit.*, p. 118; *JFI*, V, N.S. (1830), 402; VI, N.S. (1830), 9; VIII, N.S. (1831), 277, 289-92; VIII, N.S. (1831), 309, 313, 382; IX, N.S. (1832), 20-22. Also, Secretary of the Treasury, *Report on Steam Engines*, Dec. 13, 1838 (House of Representatives document 21, ser. 345 [Washington: 25th Congress, 3d session]), p. 3 (hereinafter cited as "Doc. 21"). The whole number of steam engines in the United States in 1838 was estimated at 3,010: 800

alternate expansion and contraction of the internal flues as they were covered and uncovered by the water, a condition that contributed to their weakening. The boiler feedwater for steamboats was pumped directly from the surroundings without treatment or filtration, which accelerated corrosion of the shell and fittings. The sediment was frequently allowed to accumulate, thus requiring a hotter fire to develop the required steam pressure, which led, in turn, to a rapid weakening of the shell. Feed pumps were shut down at intermediate stops without damping the fires, which aggravated the danger of low water and excessive steam pressure. With the rapid increase in the number of steam engines, there was a concomitant shortage of competent engineers who understood the necessary safety precautions. Sometimes masters employed mere stokers who had only a rudimentary grasp of the operation of steam equipment. Increased competition also led to attempts to gain prestige by arriving first at the destination. The usual practice during a race was to overload or tie down the safety valve, so that excessive steam pressure would not be relieved.

III

The first major boiler disasters occurred on steamboats, and, in fact, the majority of explosions throughout the first half of the nineteenth century took place on board ship.⁷ By mid-1817, four explosions had taken five lives in the eastern waters, and twenty-five people had been killed in three accidents on the Ohio and Mississippi rivers.⁸ The city council of Philadelphia appears to have been the first legislative body in the United States to take cognizance of the disasters and attempt an investigation. A joint committee was appointed to determine the causes of the accidents and recommend measures that would prevent similar occurrences on steamboats serving Philadelphia. The question was referred to a group of practical engineers who recommended that all boilers should be subjected to an initial hydraulic proof test at twice the intended working pressure and additional monthly proof tests to be conducted by a competent inspector. Also, appreciating the fact that marine engineers were known to overload the safety valve levers, they advocated placing the valve in a locked box. The report of the joint

on steamboats, 350 in locomotives, and 1,860 in manufacturing establishments. The majority of these engines were put into service after 1830. The term "practical engineer" was reserved for a designer or builder of engines, while engine-room operatives were called "engineers." The complaints about the incompetence of the latter are very frequent in the literature.

⁷ *Doc. 21*, p. 3.

⁸ Bathe, *op. cit.*, p. 250.

committee incorporated these recommendations, but it stated that the subject of regulation was outside the competence of municipalities. Any municipal enactment would be inadequate for complete regulation. The matter was referred, therefore, to the state legislature, and there it rested.⁹

Similar studies were being undertaken abroad. In England, a fatal explosion aboard a steamboat near Norwich prompted Parliament to constitute a Select Committee in May 1817 to investigate the conditions surrounding the design, construction, and operation of steam boilers. In its report, the committee noted its aversion to the enactment of any legislation but stated that where the public safety might be endangered by ignorance, avarice, or inattention, it was the duty of Parliament to interpose. Precedents for legislation included laws covering the construction of party walls in buildings, the qualification of physicians, and the regulation of stage coaches. The committee recommended that passenger-carrying steam vessels should be registered, that boiler construction and testing should be supervised, and that two safety valves should be employed with severe penalties for tampering with the weights.¹⁰

No legislation followed this report, nor were any laws enacted after subsequent reports on the same subject in 1831, 1839, and 1843.¹¹ The attitude of the British steamboat owners and boiler manufacturers was summarized in a statement that the prominent manufacturer, Sir John Rennie, made to the Select Committee in 1843. There should be, he said, no impediments in the application of steam power. Coroners' juries made such complete investigations of boiler explosions that no respectable manufacturer would risk his reputation in constructing a defective boiler. Constant examination of boilers, he argued, would cause serious inconvenience and would give no guarantee that the public safety would be assured. Admittedly, it would be desirable for steam equipment to be perfect, but with so many varied boiler and engine designs, it would be next to impossible to agree on methods of examination. Besides, he concluded, there were really few accidents.¹²

In this latter remark, Sir John was partially correct. In England, from 1817 to 1839, only 77 deaths resulted from twenty-three explosions.¹³ This record was relatively unblemished compared to the slaughter in the United States, where in 1838 alone, 496 lives had been lost as

⁹ *Ibid.*, p. 255; *JFI*, VIII, N.S. (1831), 235-43.

¹⁰ Parliamentary Sessional Papers, *Report* (1817), VI, 223.

¹¹ *Ibid.* (1831), VIII, 1; (1839), XLVII, 1; (1843), IX, 1.

¹² *Ibid.* (1842), IX, 383-84.

¹³ *Ibid.* (1839), XLVII, 10.

a result of fourteen explosions.¹⁴ The continued use of low-pressure engines by the British; the fact that by 1836 the total number of U.S. steamboats—approximately 750—was greater than the total afloat in all of Europe; and the fact that the average tonnage of U.S. steamboats was twice that of British vessels, implying the use of larger engines and boilers and more numerous passengers, accounted for the large difference in the casualty figures.¹⁵

In France, the reaction to the boiler hazard was entirely different than in Great Britain and the United States. Acting under the authority of Napoleonic legislation, the government issued a Royal Ordinance on October 29, 1823 relative to stationary and marine steam engines and boilers.¹⁶ A committee of engineers of mines and civil engineers prepared the regulations, but the scientific talent of such men as Arago, Dulong, and Biot was enlisted to prepare accurate steam tables.¹⁷ By 1830, amendments resulted in the establishment of a comprehensive boiler code. It incorporated stress values for iron and copper and design formulas for these materials. It required the use of hemispherical heads on all boilers operating above 7 p.s.i. and the employment of two safety valves, one of which was enclosed in a locked grating. Boiler shells had to be fabricated with fusible metal plates made of a lead-tin-bismuth alloy and covered with a cast-iron grating to prevent swelling when close to the fusing point. Boilers had to be tested initially at three times the designed working pressure and yearly thereafter. The French engineers of mines and government civil engineers were given detailed instructions on the conduct of the tests and were empowered to remove any apparently defective boiler from service. The proprietors of steamboats or factories employing boilers were liable to criminal prosecution for evasion of the regulations, and the entire hierarchy of French officialdom was enjoined to report any infractions.¹⁸

Proper statistics proving that this code had a salutary effect in the prevention of boiler explosions are not available. It is certain that some

¹⁴ The number of explosions and the loss of life occasioned thereby, listed throughout this paper, were obtained by a comparison and tabulation of the figures listed in *Doc. 21*, pp. 399–403, and in the Commissioner of Patents, *Report*, Dec. 30, 1848 (Senate document 18, ser. 529 [Washington: 30th Congress, 2d session]), pp. 36–48 (hereinafter cited as “Doc. 18”).

¹⁵ Department of the Interior, Census Office, *10th Census* (Washington, 1883), IV, 6–7; *JFI*, IX, N.S. (1832), 350.

¹⁶ *Archives Parlementaires* (Paris, 1864), III, ser. 2, 732; *JFI*, VII, N.S. (1831), 272.

¹⁷ *JFI*, X, N.S. (1832), 106; *Doc. 478*, p. 145.

¹⁸ *JFI*, VII, N.S. (1831), 272, 323, 399; VIII, N.S. (1831), 32; X, N.S. (1832), 105, 181.

explosions occurred despite the tight regulations. Arago, writing in 1830, reported that a fatal explosion on the "Rhône" resulted from the tampering with a safety valve and pointed out that fusion of the fusible metal plates could be prevented by directing a stream of water on them.¹⁹ Undoubtedly, in some instances the laws were evaded, but Thomas P. Haldeman, an experienced Cincinnati steamboat captain said in 1848 that the code had been effective. He wrote: "Since those laws were enforced we have scarcely heard of an explosion in that country. . . . What a misfortune our government did not follow the example of France twenty years ago."²⁰ Significantly, both Belgium and Holland promulgated boiler laws that were in all essentials duplicates of the French regulations.²¹

IV

From 1818 to 1824 in the United States, the casualty figures in boiler disasters rose, about forty-seven lives being lost in fifteen explosions. In May 1824 the "Aetna," built in 1816 to Evans' specifications, burst one of her three wrought-iron boilers in New York harbor, killing about thirteen persons and causing many injuries. Some experts attributed the accident to a stoppage of feedwater due to incrustations in the inlet pipes, while others believed that the rupture in the shell had started from an old fracture in a riveted joint.²² The accident had two consequences. Because the majority of steamboats plying New York waters operated at relatively low pressures with copper boilers, the public became convinced that wrought-iron boilers were unsafe. This prejudice forced New York boat builders who were gradually recognizing the superiority of wrought iron to revert to the use of copper even in high-pressure boilers. Some owners recognized the danger of this step, but the outcry was too insistent. One is reported to have said: "We have concluded therefore to give them [the public] a copper boiler, the strongest of its class, and have made up our minds that they have a perfect right to be scalded by copper boilers if they insist upon it."²³ His forecast was correct, for within the next decade, the explosion of copper boilers employing moderate steam pressures became common in eastern waters.²⁴

¹⁹ *Ibid.*, V, N.S. (1830), 399, 411.

²⁰ *Doc. 18*, p. 180.

²¹ Parliamentary Sessional Papers, *Report* (1839), XLVII, 180.

²² Bathe, *op. cit.*, p. 237; *JFI*, II (1826), 147.

²³ *Doc. 21*, p. 425.

²⁴ *Ibid.*, pp. 105, 424; *JFI*, XIII, N.S. (1834), 55, 126, 289.

The second consequence of the "Aetna" disaster was that it caught the attention of Congress. A resolution was introduced in the House of Representatives in May 1824 calling for an inquiry into the expediency of enacting legislation barring the issuance of a certificate of navigation to any boat operating at high steam pressures. Although a bill was reported out of committee, it was not passed due to lack of time for mature consideration.²⁵

In the same year, the Franklin Institute was founded in Philadelphia for the study and promotion of the mechanical arts and applied science.²⁶ The institute soon issued its *Journal*, and, from the start, much space was devoted to the subject of boiler explosions. The necessity of regulatory legislation dealing with the construction and operation of boilers was discussed, but there was a diversity of opinion as to what should be done. Within a few years, it became apparent that only a complete and careful investigation of the causes of explosions would give sufficient knowledge for suggesting satisfactory regulatory legislation. In June 1830, therefore, the Institute empowered a committee of its members to conduct such an investigation and later authorized it to perform any necessary experiments.

The statement of the purpose of the committee reflects clearly the nature of the problem created by the frequent explosions. The public, it said, would continue to use steamboats, but if there were no regulations, the needless waste of property and life would continue. The committee believed that these were avoidable consequences; the accidents resulted from defective boilers, improper design, or carelessness. The causes, the committee thought, could be removed by salutary regulations, and it affirmed: "That there must be a power in the community lodged somewhere, to protect the people at large against any evil of serious and frequent recurrence, is self-evident. But that such power is to be used with extreme caution, and only when the evil is great, and the remedy certain of success, seems to be equally indisputable."²⁷

Here is a statement by a responsible group of technically oriented citizens that public safety should not be endangered by private negligence. It demonstrates the recognition that private enterprise was considered sacrosanct, but it calls for a reassessment of societal values in the light of events. It proposes restrictions while still professing un-

²⁵ *Annals of Congress* (Washington: 18th Congress 1st session), pp. 2670, 2694, 2707, 2708, 2765.

²⁶ For the history of the Franklin Institute, see S. L. Wright, *The Story of the Franklin Institute* (Philadelphia, 1938).

²⁷ *JFI*, VI, N.S. (1830), 33.

willingness to fetter private industry. It illustrates a change in attitude that was taking place with respect to the role of government in the affairs of industry, a change that was necessitated by technological innovation. The committee noted that boiler regulation proposals had been before Congress twice without any final action. Congressional committees, it said, appeared unwilling to institute inquiries and elicit evidence from practical men, and therefore they could hardly determine facts based upon twenty years of experience with the use of steam in boats. Since Congress was apparently avoiding action, the committee asserted, it was of paramount importance that a competent body whose motives were above suspicion should shoulder the burden.²⁸ Thus, the Franklin Institute committee began a six-year investigation of boiler explosions.

From 1825 to 1830, there had been forty-two explosions killing about 273 persons, and in 1830 a particularly serious one aboard the "Helen McGregor" near Memphis which killed 50 or 60 persons, again disturbed Congress. The House requested the Secretary of the Treasury, Samuel D. Ingham of Pennsylvania, to investigate the boiler accidents and submit a report.²⁹ Ingham had served in Congress from 1813 to 1818, and again from 1822 to 1829. He was a successful manufacturer who owned several paper mills; he was acquainted with the activities of the Franklin Institute and had written to the *Journal* about steam boiler problems.³⁰ Ingham was thus in a unique position to aid the Franklin Institute committee which had begun its inquiries. Before his resignation from Jackson's cabinet over the Peggy O'Neill Eaton affair, Ingham committed government funds to the Institute to defray the cost of apparatus necessary for the experiments.³¹ This was the first research grant of a technological nature made by the federal government.³²

Ingham attempted to make his own investigation while still secretary of the treasury. His interim report to the House in 1831 revealed that two investigators, one on the Atlantic seaboard and the other in the Mississippi basin, had been employed to gather information on the boiler explosions. They complained that owners and masters of boats

²⁸ *Ibid.*, 34.

²⁹ *Congressional Debates* (Washington: 21st Congress, 1st session), VI, Part 2, 739.

³⁰ *Dictionary of American Biography* (New York, 1932), IX, 473; *JFI*, IX, N.S. (1832), 12 (communicated Oct. 21, 1830).

³¹ *JFI*, VII, N.S. (1831), 42.

³² Arthur V. Greene, "The A.S.M.E. Boiler Code," *Mechanical Engineer*, LXXIV (1952), 555; A. Hunter Dupree, *Science in the Federal Government* (Cambridge, Mass., 1957), p. 50.

seemed unwilling to aid the inquiry. They were told repeatedly that the problem was purely individual, a matter beyond the government's right to interfere.³³ In the following year, the new secretary, Louis B. McLane, circulated a questionnaire among the collectors of customs, who furnished information and solicited opinions about the explosions. Their answers formed the basis of McLane's report to Congress. They mentioned the many causes of boiler explosions. One letter noted that steamboat trips from New Orleans to Louisville had been shortened from twenty-five to twelve days since 1818 without increasing the strength of the boilers. A frequent remark was that the engineers in charge of the boilers were ignorant, careless, and usually drunk.³⁴

This report prompted a bill proposed in the House in May 1832. It provided for the appointment of inspectors at convenient locations to test the strength of the boilers every three months at three times their working pressure, and the issuance of a license to navigate was made contingent upon this inspection. To avoid possible objections on the score of expense, inspection costs were to be borne by the government. To prevent explosions caused by low water supply, the bill provided that masters and engineers be required under threat of heavy penalties to supply water to the boilers while the boat was not in motion.

The half-hearted tone of the House committee's report on the bill hardly promised positive legislative action. The Constitution gave Congress the power to regulate commerce, the report noted, but the right of Congress to prescribe the mode, manner, or form of construction of the vehicles of conveyance could not be perceived. Whether boats should be propelled by wind, paddles, or steam, and if by steam, whether by low or high pressure, were questions that were not the business of Congress. No legislation was competent to remove the causes of boiler explosions, so that steam and its application must be left to the control of intellect and practical science. The intelligent conduct of those engaged in its use would be the best safeguard against the dangers incident to negligence. Besides, the report concluded, the destruction was much less than had been thought; the whole number of explosions in the United States was only fifty-two, with total casualties of 256 killed and 104 injured.³⁵ Supporters of the bill could not undo the damage of the

³³ Secretary of the Treasury, *Report*, March 3, 1831 (House of Representatives document 131, ser. 209 [Washington: 21st Congress, 2d session]), p. 1.

³⁴ *Doc. 478*, p. 44.

³⁵ *Ibid.*, pp. 1-7. Actually, the committee depended for its statistics upon the estimate of William C. Redfield, agent for the Steam Navigation Company of New York, who could hardly have been expected to be impartial. Comparing Redfield's figures with those listed in *JFI*, IX, N.S. (1832), 24-30 and with the sources listed

watered-down committee report, however. The bill died, and the disasters continued.

In his State of the Union message in December 1833, President Jackson noted that the distressing accidents on steamboats were increasing. He suggested that the disasters often resulted from criminal negligence by masters of the boats and operators of the engines. He urged Congress to pass precautionary and penal legislation to reduce the accidents.³⁶ A few days later, Senator Daniel Webster proposed that the Committee on Naval Affairs study the problem. He suggested that all boilers be tested at three times their working pressure and that any steamboat found racing be forfeited to the government. Thomas Hart Benton followed Webster, stating that the matter properly was the concern of the Judiciary Committee. The private waters of states were involved, Benton said; interference with their sovereignty might result. In passing, Benton remarked that the masters and owners of steamboats were, with few exceptions, men of the highest integrity. Further, Benton said, *he* had never met with any accident on a steamboat despite the fact that he traveled widely; upon boarding he was always careful to inquire whether the machinery was in good order. Webster still carried the day, since the matter went to the Committee on Naval Affairs; however, Benton's attitude prevailed in the session, for the reported Senate bill failed to pass.³⁷

V

A program of experiments carried out by the Franklin Institute from 1831 to 1836 was based largely upon the reports of circumstances surrounding previous boiler explosions, the contemporary design and construction of boilers and their accessories, and methods of ensuring an adequate water supply. The work was done by a committee of volunteers led by Alexander Dallas Bache, later superintendent of the U.S. Coast Survey, who, at the time, was a young professor of natural philosophy at the University of Pennsylvania. A small boiler, one foot in diameter and about three feet long, with heavy glass viewing ports at each end, was used in most of the experiments. In others, the zeal of the workers led them to cause larger boilers to burst at a quarry on the outskirts of Philadelphia.

in n. 14, it is clear that he omitted many minor accidents; where the number of casualties were unknown, they were not counted; where they were estimated, Redfield took the lowest estimate.

³⁶ *Congressional Globe*, I (Washington: 23d Congress, 1st session), 7.

³⁷ *Ibid.*, I, 49, 442.

The group's findings overturned a current myth, proving conclusively that water did not decompose into hydrogen and oxygen inside the boiler, with the former gas exploding at some high temperature. The experimenters demonstrated that an explosion could occur without a sudden increase of pressure. Another widely held theory they disproved was that when water was injected into a boiler filled with hot and unsaturated steam, it flashed into an extremely high-pressure vapor, which caused the boiler to rupture. The group proved that the reverse was true: the larger the quantity of water thus introduced, the greater the decrease in the steam pressure.

The Franklin Institute workers also produced some positive findings. They determined that the gauge cocks, commonly used to ascertain the level of water inside the boilers, did not in fact show the true level, and that a glass tube gauge was much more reliable, if kept free from sediment. They found the fusing points of alloys of lead, tin, and bismuth, and recommended that fusible plates be employed with caution, because the more fluid portion of an alloy might be forced out prior to the designated fusion temperature, thus leaving the remainder with a higher temperature of fusion.³⁸ They investigated the effect of the surface condition of the shell on the temperature and time of vaporization, and they determined that properly weighted safety valves opened at calculated pressures within a small margin of error. The results of their experiments on the relationship of the pressure and temperature of steam showed close correspondence with those of the French, although, at this time, values of the specific heat of steam were erroneous due to the inability to differentiate between constant volume and constant temperature conditions.³⁹

Simultaneously, another committee, also headed by Bache, investigated the strength of boiler materials. In these experiments, a sophisticated tensile testing machine was constructed, and corrections were made for friction and stresses producing during the tests. The investigators tested numerous specimens of rolled copper and wrought iron, not only at ambient temperatures but up to 1,300° F. They showed conclusively that there were substantial differences in the quality of domestic wrought irons by the differences in yield and tensile strengths. Of major importance was their finding that there was a rapid decrease in the ultimate strength of copper and wrought iron with increasing

³⁸ In this series of experiments, the committee was actually investigating the solid solutions of these metals and determining points on what would later be called equilibrium diagrams.

³⁹ Franklin Institute, *Report*, March 1, 1836 (House of Representatives document 162, ser. 289 [Washington]).

temperature. Further, they determined that the strength of iron parallel to the direction of rolling was about 6 per cent greater than in the direction at right angles to it. They proved that the laminated structure in "piled" iron, forged from separate pieces, yielded much lower tensile values than plate produced from single blooms. Their tests also showed that special precautions should be taken in the design of riveted joints.⁴⁰

Taken as a whole, the Franklin Institute reports demonstrate remarkable experimental technique as well as a thorough methodological approach. They exposed errors and myths in popular theories on the nature of steam and the causes of explosions. They laid down sound guidelines on the choice of materials, on the design and construction of boilers, and on the design and arrangement of appurtenances added for their operation and safety. Further, the reports included sufficient information to emphasize the necessity for good maintenance procedures and frequent proof tests, pointing out that the strength of boilers diminished as the length of service increased.

VI

The Franklin Institute report on steam boiler explosions was presented to the House through the secretary of the treasury in March 1836, and the report on boiler materials was available in 1837. The Franklin Institute committee also made detailed recommendations on provisions that any regulatory legislation should incorporate. It proposed that inspectors be appointed to test all boilers hydraulically every six months; it prohibited the licensing of ships using boilers whose design had proved to be unsafe; and it recommended penalties in cases of explosions resulting from improper maintenance, from the incompetence or negligence of the master or engineer, or from racing. It placed responsibility for injury to life or property on owners who neglected to have the required inspections made, and it recommended that engineers meet certain standards of experience, knowledge, and character. The committee had no doubt of the right of Congress to legislate on these matters.⁴¹

Congress did not act immediately. In December 1836 the House appointed a committee to investigate the explosions, but there was no action until after President Van Buren urged the passage of legislation

⁴⁰ *JFI*, XVIII, N.S. (1836), 217, 289; XIX, N.S. (1837), 73, 157, 241, 325, 409; XX, N.S. (1837), 1, 73.

⁴¹ *JFI*, XVIII, N.S. (1836), 369-75.

in December 1837.⁴² That year witnessed a succession of marine disasters. Not all were attributable to boiler explosions, although the loss of 140 persons in a new ship, the "Pulaski," out of Charleston, was widely publicized. The Senate responded quickly to Van Buren's appeal, passing a measure on January 24, 1838. The House moved less rapidly. An explosion aboard the "Moselle" at Cincinnati in April 1838, which killed 151 persons,⁴³ caused several Congressmen to request suspension of the rules so that the bill could be brought to the floor, but in the face of more pressing business the motion was defeated.⁴⁴ The legislation was almost caught in the logjam in the House at the end of the session, but on June 16 the bill was brought to the floor. Debate centered principally upon whether the interstate commerce clause in the Constitution empowered Congress to pass such legislation. Its proponents argued affirmatively, and the bill was finally approved and became law on July 7, 1838.⁴⁵

The law incorporated several sections relating to the prevention of collisions, the control of fires, the inspection of hulls, and the carrying of lifeboats. It provided for the immediate appointment by each federal judge of a competent boiler inspector having no financial interest in their manufacture. The inspector was to examine every steamboat boiler in his area semiannually, ascertain its age and soundness, and certify it with a recommended working pressure. For this service the owner paid the inspector \$5.00—his sole remuneration—and a license to navigate was contingent upon the receipt of this certificate. The law specified no inspection criteria. It enjoined the owners to employ a sufficient number of competent and experienced engineers, holding the owners responsible for loss of life or property damage in the event of

⁴² *Congressional Globe*, IV (Washington: 24th Congress, 2d session), 29; VI (Washington: 25th Congress, 2d session), 7-9.

⁴³ The *Moselle* disaster was important because of its effect upon marine insurance policies. The estate of the captain and part owner, Isaac Perrin, sued for recovery under the policy (*The Administrators of Isaac Perrin v. The Protection Insurance Co.*, 11 Ohio [1842], 160). The defense gave evidence that Perrin was determined to outstrip another boat and that when passengers expostulated with him concerning the dangerous appearance of the boiler fires, he swore that he would be "that night in Louisville or hell." Despite proof of negligence on the part of the captain, the court ruled against the insurance company, stating that the explosion of boilers was a risk insured against. The insurance companies, thereafter, moved to exclude boiler explosions as a covered risk. See *Citizens Insurance Co. v. Glasgow, Shaw, and Larkin*, 9 Missouri (1852), 411, and *Roe and Kercheval v. Columbus Insurance Co.*, 17 Missouri (1852), 301.

⁴⁴ *Congressional Globe*, VI, 342.

⁴⁵ *Ibid.*, VI, 455.

a boiler explosion for their failure to do so. Further, any steamboat employee whose negligence resulted in the loss of life was to be considered guilty of manslaughter, and upon conviction could be sentenced to not more than ten years imprisonment. Finally, it provided that in suits against owners for damage to persons or property, the fact of the bursting of the boilers should be considered *prima facie* evidence of negligence until the defendant proved otherwise.⁴⁶

This law raises several questions, because the elimination of inspection criteria and the qualification of engineers rendered the measure ineffectual. Why was this done? Did Congress show restraint because it had insufficient information? Did it yield to the pressure of steamboat interests who feared government interference? Such questions cannot be definitely answered, but there are clues for some tentative conclusions.

The bill, as originally introduced, was similar to the Franklin Institute proposals, so that the Senate committee to which it was referred possessed the most recent informed conclusions as to the causes of boiler explosions and the means of their prevention. The President's plea to frame legislation in the face of the mounting fatalities undoubtedly persuaded the Democratic majority to act. They were unmoved by a memorial from steamboat interests urging the defeat of the bill.⁴⁷ But the majority was not as yet prepared to pass such detailed regulations as had originally been proposed. In response to a question as to why the provision for the qualification of engineers had been eliminated, the Senate committee chairman stated that the committee had considered this requirement desirable but foresaw too much difficulty in putting it into effect. Further, the Senate rejected an amendment to levy heavy penalties for racing, as proposed by the Whig, Oliver Smith of Indiana. The Whigs appear to have seen the situation as one in which the federal government should use its powers and interpose firmly. Henry Clay, R. H. Bayard of Delaware, and Samuel Prentiss of Vermont supported Smith's amendment, and John Davis of Massachusetts declared that he would support the strongest measures to make the bill effective. Those who had urged rapid action of the bill in the House were William B. Calhoun and Caleb Cushman of Massachusetts and Elisha Whittlesey of Ohio, all Whigs. But at this time the majority hewed to the doctrine that enlightened self-interest should motivate owners to provide safe operation. The final clause, specifying that the

⁴⁶ *U.S. Statutes at Large* (Washington: 25th Congress, 2d session, July 7, 1838), V, 304-6.

⁴⁷ *Congressional Globe*, VI, 265.

bursting of boilers should be taken as *prima facie* evidence of negligence until proved otherwise, stressed this idea.

The disappointment of the informed public concerning the law was voiced immediately in letters solicited by the secretary of the treasury, contained in a report that he submitted to Congress in December 1838.⁴⁸ There were predictions that the system of appointment and inspection would encourage corruption and graft. There were complaints about the omission of inspection criteria and a provision for the licensing of engineers. One correspondent pointed out that it was impossible legally to determine the experience and skill of an engineer, so that the section of the law that provided penalties for owners who failed to employ experienced and skilful engineers was worthless. One critic who believed that business interests had undue influence upon the government wrote: "We are mostly ruled by corporations and joint-stock companies. . . . If half the citizens of this country should get blown up, and it should be likely to affect injuriously the trade and commerce of the other half by bringing to justice the guilty, no elective officer would risk his popularity by executing the law."⁴⁹

But there also was a pained reaction from the owners of steamboats. A memorial in January 1841 from steamboat interests on the Atlantic seaboard stressed that appropriate remedies for the disasters had not been afforded by the 1838 law as evidenced by the casualty figures for 1839 and 1840. They provided statistics to prove that in *their* geographical area the loss of life per number of lives exposed had decreased by a factor of sixteen from 1828 to 1838, indicating that the troubles centered chiefly in the western waters. But at the same time the memorial emphasized that the 1838 law acted as a deterrent for prudent men to continue in the steamboat business, objecting particularly to the clause that construed a fatal disaster as *prime facie* evidence of negligence. They argued that if Congress considered steam navigation too hazardous for the public safety, it would be more just and honorable to prohibit it entirely.⁵⁰

However, it not only was the Congress that was reconsidering the concepts of negligence and responsibility in boiler explosions. The common law also searched for precedents to meet the new conditions, to establish guidelines by which to judge legal actions resulting from technological innovation. A key decision, made in Pennsylvania in 1845, involved a boiler explosion at the defendant's flour mill that killed the

⁴⁸ *Doc. 21.*

⁴⁹ *Ibid.*, p. 396.

⁵⁰ *Memorial*, Jan. 23, 1841 (House of Representatives document 113, ser. 377 [Washington: 26th Congress, 2d session]).

plaintiff's horse. The defense pleaded that any negligence was on the part of the boiler manufacturer. The court, however, ruled otherwise, stating that the owner of a public trade or business which required the use of a steam engine was responsible for any injury resulting from its deficiency.⁵¹ This case was used as a precedent in future lawsuits involving boiler explosions.

VII

Experience proved that the 1838 law was not preventing explosions or loss of life. In the period 1841–48, there were some seventy marine explosions that killed about 625 persons. In December 1848 the commissioner of patents, to whom Congress now turned for data, estimated that in the period 1816–48 a total of 233 steamboat explosions had occurred in which 2,563 persons had been killed and 2,097 injured, with property losses in excess of \$3 million.⁵²

In addition to the former complaints about the lack of proof tests and licenses for engineers, the commissioner's report included testimony that the inspection methods were a mockery. Unqualified inspectors were being appointed by district judges through the agency of highly placed friends. The inspectors regarded the position as a lifetime office. Few even looked at the boilers but merely collected their fees. The inspector at New York City complained that his strict inspection caused many boats to go elsewhere for inspections. He cited the case of the "Niagara," plying between New York City and Albany, whose master declined to take out a certificate from his office because it recommended a working pressure of only 25 p.s.i. on the boiler. A few months later the boiler of the "Niagara," which had been certified in northern New York, exploded while carrying a pressure of 44 p.s.i. and killed two persons.⁵³

Only eighteen prosecutions had been made in ten years under the manslaughter section of the 1838 law. In these cases there had been nine convictions, but the penalties had, for the most part, been fines which were remitted. It was difficult to assemble witnesses for a trial, and juries could not be persuaded to convict a man for manslaughter for an act of negligence, to which it seemed impossible to attach this degree of guilt. Also, the commissioner's report pointed out that damages were given in cases of bodily injury but that none were awarded for loss of life in negligence suits. It appeared that exemplary damages might be effective in curbing rashness and negligence.⁵⁴

⁵¹ *Spencer v. Campbell*, 9 Watts & Sergeants (1845), 32.

⁵² *Doc. 18*, p. 2.

⁵³ *Ibid.*, pp. 18, 78, 80.

⁵⁴ *Ibid.*, pp. 29, 52–53.

The toll of life in 1850 was 277 dead from explosions, and in 1851 it rose to 407.⁵⁵ By this time Great Britain had joined France in regulatory action, which the Congress noted.⁵⁶ As a consequence of legislation passed in 1846 and 1851, a rejuvenated Board of Trade was authorized to inspect steamboats semiannually, to issue or deny certificates of adequacy, and to investigate and report on accidents.⁵⁷ The time had come for the Congress to take forceful action, and in 1852 it did.

John Davis, Whig senator from Massachusetts, who had favored stricter legislation in 1838, was the driving force behind the 1852 law. In prefacing his remarks on the general provisions of the bill, he said: "A very extensive correspondence has been carried on with all parts of the country . . . there have been laid before the committee a great multitude of memorials, doings of chambers of commerce, of boards of trade, of conventions, of bodies of engineers; and to a considerable extent of all persons interested, in one form or another, in steamers . . . in one thing . . . they are all . . . agreed—that is, that the present system is erroneous and needs correction."⁵⁸

Thus again, the informed public submitted recommendations on the detailed content of the measure. An outstanding proponent who helped shape the bill was Alfred Guthrie, a practical engineer from Illinois. With personal funds, Guthrie had inspected some two hundred steamboats in the Mississippi valley to ascertain the causes of boiler explosions. Early in the session, Senator Shields of Illinois succeeded in having Guthrie's report printed, distributed, and included in the Senate documents.⁵⁹ Guthrie's recommendations were substantially those made by the Franklin Institute in 1836. His reward was the post as first supervisor of the regulatory agency which the law created.

⁵⁵ *Congressional Globe* (Washington: 32d Congress, 1st session), Appendix, 287.

⁵⁶ *Ibid.*, p. 2426.

⁵⁷ Public and General Acts, 9, 10 Victoria (1846), chap. 1; 14, 15 Victoria (1851), chap. lxxix.

⁵⁸ *Congressional Globe* (32d Congress, 1st session), p. 1669. Organizations of experienced steamboat engineers were formed in many cities during the 1840's to promote safe operation and had attempted on previous occasions to influence Congress to improve the 1838 law, particularly with respect to providing for proof tests, better inspection methods, and the establishment of boards to qualify engineers. See *Relative to Steamboat Explosions* (House of Representatives document 68, ser. 441 [Washington: 28th Congress, 1st session]), which is a petition from a body in the city of Cincinnati.

⁵⁹ *Memorial of Alfred Guthrie, a Practical Engineer*, Feb. 6, 1852 (Senate miscellaneous document 32, ser. 629 [Washington: 32d Congress, 1st session]).

After the bill reached the Senate floor, dozens of amendments were proposed, meticulously scrutinized, and disposed of. The measure had been, remarked one senator, "examined and elaborated . . . more patiently, thoroughly, and faithfully than any other bill before in the Senate of the United States."⁶⁰ As a result, in place of the 1838 law which embodied thirteen sections and covered barely three pages, there was passed such stringent and restrictive legislation that forty-three sections and fourteen pages were necessary.⁶¹

The maximum allowable working pressure for any boiler was set at 110 p.s.i., and every boiler had to be tested yearly at one and one-half times its working pressure. Boilers had to be fabricated from suitable quality iron plates, on which the manufacturer's name was stamped. At least two ample safety valves—one in a locked grating—were required, as well as fusible plates. There were provisions relating to adequate supply of boiler feedwater and outlawing designs that might prove dangerous. Inspectors were authorized to order repairs at any time. All engineers had to be licensed by inspectors, and the inspectors themselves issued certificates only under oath. There were stiff monetary penalties for any infractions. The penalty for loading a safety valve excessively was a two hundred dollar fine and eighteen months imprisonment. The fine for manufacturing or using a boiler of unstamped material was five hundred dollars. Fraudulent stamping carried a penalty of five hundred dollars and two years imprisonment. Inspectors falsifying certificates were subject to a five hundred dollar fine and six months imprisonment, and the law expressly prohibited their accepting bribes.

A new feature of the law, which was most indicative of the future, was the establishment of boards of inspectors empowered to investigate infractions or accidents, with the right to summon witnesses, to compel their attendance, and to examine them under oath. Above the local inspectors were nine supervisors appointed by the President. Their duties included the compilation of evidence for the prosecution of those failing to comply with the regulations and the preparation of reports to the secretary of the treasury on the effectiveness of the regulations. Nor did these detailed regulations serve to lift the burden of presumptive negligence from the shoulders of owners in cases of explosion. The explosion of boilers was not made *prime facie* evidence as in the 1838 law, but owners still bore a legal responsibility. This was

⁶⁰ *Congressional Globe*, (32d Congress 1st session), p. 1742.

⁶¹ *U.S. Statutes at Large* (Washington: 32d Congress, 1st session, Aug. 30, 1852), X, 61–75.

made clear in several court decisions which held that proof of strict compliance with the 1852 law was not a sufficient defense to the allegations of loss by an explosion caused by negligence.⁶²

The final Senate debate and the vote on this bill shows how, in thirty years, the public attitude and, in turn, the attitudes of its elected representatives had changed toward the problem of unrestricted private enterprise, mainly as a result of the boiler explosions. The opponents of the bill still argued that the self-interest of the steamboat companies was the best insurance of the safety of the traveling public.⁶³ But their major argument against passage was the threat to private property rights which they considered the measure entailed. Senator Robert F. Stockton of New Jersey was most emphatic:

It is this—how far the Federal Government . . . shall be permitted to interfere with the rights of personal property—or the private business of any citizen . . . under the influence of recent calamities, too much sensibility is displayed on this subject . . . I hold it to be my imperative duty not to permit my feelings of humanity and kindness to interfere with the protection which I am bound, as a Senator of the United States, to throw around the liberty of the citizen, and the investment of his property, or the management of his own business . . . what will be left of human liberty if we progress on this course much further? What will be, by and by, the difference between citizens of this far-famed Republic and the serfs of Russia? Can a man's property be said to be his own, when you take it out of his own control and put it into the hands of another, though he may be a Federal officer?⁶⁴

This expression of a belief that Congress should in no circumstances interfere with private enterprise was now supported by only a small minority. One proponent of the bill replied: "I consider that the only question involved in the bill is this: Whether we shall permit a legalized, unquestioned, and peculiar class in the community to go on committing murder at will, or whether we shall make such enactments as will compel them to pay some attention to the value of life."⁶⁵ It was, then, a question of the sanctity of private property rights as against the duty of government to act in the public weal. On this question the Senate voted overwhelmingly that the latter course should prevail.⁶⁶

⁶² *Curran v. Cheeseman*, 1 Cincinnati Rep. (1870), 52.

⁶³ *Congressional Globe* (32d Congress, 1st session), pp. 1741, 2425.

⁶⁴ *Ibid.*, pp. 2426, 2427.

⁶⁵ *Ibid.*, p. 2427.

⁶⁶ The strength of the vote can be gauged by the defeat, forty-three to eight, of a motion to table the bill by Senator Stockton just prior to its passage. The eight

Though not completely successful, the act of 1852 had the desired corrective effects. During the next eight years prior to the outbreak of the Civil War, the loss of life on steamboats from all types of accidents dropped to 65 per cent of the total in the corresponding period preceding its passage.⁶⁷ A decade after the law became effective, John C. Merriam, editor and proprietor of the *American Engineer*, wrote: "Since the passage of this law steamboat explosions on the Atlantic have become almost unknown, and have greatly decreased in the west. With competent inspectors, this law is invaluable, and we hope to hail the day when a similar act is passed in every legislature, touching locomotive and stationary boilers."⁶⁸

There was, of course, hostility and opposition to the law immediately after its passage, particularly among the owners and masters of steamboats.⁶⁹ It checked the steady rise in the construction of new boats, which had been characteristic of the earlier years.⁷⁰ The effect, however, was chastening rather than emasculating. Associations for the prevention of steam boiler explosions were formed; later, insurance companies were organized to insure steam equipment that was manufactured and operated with the utmost regard for safety. In time, through the agency of the American Society of Mechanical Engineers,

were: Bayard (D., Del.), Butler (States Rights D., S.C.), Clemens (D., Ala.), Hale (Antislavery D., N.H.), Hunter (D., Va.), James (Protective Tariff D., R.I.), Pratt (Whig, Md.), and Stockton (D., N.J.). Although these senators represented only states along the eastern seaboard and in the South, it would be difficult to interpret their vote on a geographical basis, since eighteen senators from the same group of states voted against the motion. One might be tempted to ascribe some partisan basis to the vote, since only one Whig joined seven Democrats in supporting the motion. On the other hand, twenty-six Democrats and seventeen Whigs constituted the majority. Of those not voting—seven Democrats and four Whigs—by their comments during prior debates on the measure, Brodhead (D., Pa.) and De Saussure (D., S.C.) appear to have favored the bill, while Gwin (D., Calif.) was against it. The conclusion seems justified that the movement and final step toward positive regulation found support from congressmen of all political postures and from all geographical areas, that it was prompted by the recognition of the inadequacy of the 1838 law as evidenced by the continued severe loss of life, and that congressmen were urged to pass the legislation by constituents who were able to recognize how the problem could be solved.

⁶⁷ *10th Census*, IV, 5.

⁶⁸ L. Stebbins, pub., *Eighty Years' Progress of the United States* (New York, 1864), p. 243.

⁶⁹ Lloyd M. Short, *Steamboat Inspection Service* (New York, 1922), p. 5.

⁷⁰ Department of the Interior, *op. cit.*, IV, 5.

uniform boiler codes were promulgated and adopted by states and municipalities.⁷¹

Thus, the reaction of the informed public, expressed by Congress, to boiler explosions caused the initiation of positive regulation of a sector of private enterprise through a governmental agency. The legislation reflected a definite change of attitude concerning the responsibility of the government to interfere in those affairs of private enterprise where the welfare and safety of the general public was concerned. The implications of this change for the future can be seen by reference to the Windom Committee report of 1874, which was the first exhaustive study of the conditions in the railroad industry that led ultimately to the passage of legislation creating the Interstate Commerce Commission. One section of this report was entitled: "The Constitutional Power of Congress to Regulate Commerce among the Several States." The committee cited the judicial interpretation of the Constitution in *Gibbons v. Ogden*, that it was the prerogative of Congress solely to regulate interstate commerce, and also referred to the decision of Chief Justice Taney in *Genesee Chief v. Fitzhugh*, wherein it was held that this power was as extensive upon land as upon water. The report pointed out that no decision of the Supreme Court had ever countenanced the view that the power of Congress was purely negative, that it could be constitutionally exercised only by disburdening commerce, by preventing duties and imposts on the trade between the states. In fact, the report argued, Congress had already asserted its power positively. Referring to the acts of 1838 and 1852, it stated that "Congress has passed statutes defining how steamboats shall be constructed and equipped."⁷² Thus, the legislation that was provoked by bursting boilers was used as a precedent to justify regulatory legislation in another area where the public interest was threatened.

Bursting steamboat boilers, then, should be viewed not merely as unfortunate and perhaps inevitable consequences of the early age of steam, as occurrences which plagued nineteenth-century engineers and which finally, to a large degree, they were successful in preventing. They should be seen also as creating a dilemma as to how far the lives and property of the general public might be endangered by unrestricted private enterprise. The solution was an important step toward the inauguration of the regulatory and investigative agencies in the federal government.

⁷¹ Greene, *op. cit.*

⁷² *Report of the Select Committee on Transportation to the Seaboard* (Senate Report No. 307, Ser. 1588 [Washington: 43d Congress, 1st session]), pp. 79-92.