Patenting the Bomb

Nuclear Weapons, Intellectual Property, and Technological Control

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ABSTRACT

During the course of the Manhattan Project, the U.S. government secretly attempted to acquire a monopoly on the patent rights for inventions used in the production of nuclear weapons and nuclear energy. The use of patents as a system of control, while common for more mundane technologies, would seem at first glance to conflict with the regimes of secrecy that have traditionally been associated with nuclear weapons. In explaining the origins and operations of the Manhattan Project patent system, though, this essay argues that the utilization of patents was an *ad hoc* attempt at legal control of the atomic bomb by Manhattan Project administrators, focused on the monopolistic aspects of the patent system and preexisting patent secrecy legislation. From the present perspective, using patents as a method of control for such weapons seems inadequate, if not unnecessary; but at the time, when the bomb was a new and essentially unregulated technology, patents played an important role in the thinking of project administrators concerned with meaningful postwar control of the bomb.

NO TECHNOLOGY IN THE TWENTIETH CENTURY has been as intertwined with the policies of secrecy as nuclear weapons. In the United States, these weapons have always been manufactured by government monopoly, and the specific information about their manufacture has long been the target of policies meant to cloister that information within the highest levels of classification. The American patent system, on the other hand, has long been regarded as a tool of legal openness: the inventor is granted a temporary monopoly on the production of an invention in return for disclosing how it works.

As such, the patent system is not, from the present point of view, an obvious choice for

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dealing with nuclear secrets. But it is not well known that the United States government filed *thousands* of patent applications—in secret—on all aspects of the development and deployment of the first atomic bombs during the Manhattan Project. Was the U.S. government going to sue the Soviets for infringement if they developed their own bomb? Perhaps demand royalties? Would the government have let conflicting patent claims stand in the way of its nuclear ambitions? What did the patent system provide that could not be better, and more sensibly, achieved by other means? Why conceive of nuclear weapons within a system of intellectual property that now appears so ill adapted to them?

It is an approach that seems at first glance to run counter to every other aspect of security undertaken during the Manhattan Project. Instead of compartmentalizing information relating to bomb design, patenting would serve to centralize it. Instead of using code-names to refer to processes or materials, patents would all have to follow standard technical terminology. Instead of being secured within the barbed-wire fences that surrounded each of the major project production sites, the details of nuclear secrets would be kept in a safe in a government building visited daily by uncleared civilians, the U.S. Patent Office. And perhaps most obviously bizarre: patent laws were in theory supposed to encourage private innovation, and it hardly needs to be stated that this was not in the plans of the civilian and military administrators in charge of the country's atomic weapons program, itself created out of the fear that just such "private innovation" was taking place in Nazi Germany.

Why undertake such a policy? What did it mean to patent the bomb? The question was asked, indeed, when the program's existence was first made public six months after the end of the war. At a hearing before the Special Committee on Atomic Energy in February 1946, the officer in charge of the patent program, Captain Robert A. Lavender, informed the confused senators that the bomb itself had been patented:

> The CHAIRMAN: Now, are there any patent applications covering the making of the bomb?
> Captain LAVENDER: Yes.
> The CHAIRMAN: Are there any patent applications giving the bomb-making details in those patent applications?
> Captain LAVENDER: Well, I think that I had better give you that in executive session if you are going into any of the details of it.
> The CHAIRMAN: Not what details there were, but whether there were any of the details given in the patent application. You don't want to talk about that?
> Captain LAVENDER: Not any more than just to say that the bombs are covered by applications.
> The CHAIRMAN: I wonder what is the necessity for covering the bomb itself by applications for patents?

The perplexed chairman was none other than "Atomic" Senator Brien McMahon, the Connecticut sponsor of what would eventually become the Atomic Energy Act of 1946, the first postwar legislation defining the U.S. nuclear infrastructure. Captain Lavender explained that his office, on behalf of the U.S. government, had filed patent applications for all aspects of bomb manufacture in secret under the authority of the Commissioner of Patents because it had been feared that private inventors might file speculative patent applications and believed that the "first-to-file" status of the U.S. government would help in potential interference lawsuits. Rather than answering the question of why the Manhattan Project had turned to the patent system, Lavender's answer begged it. The senators were skeptical. "I didn't dream, frankly, up until this point," McMahon said, addressing a fellow senator and committee member, "that there was a patent application down there

showing how the bomb was put together. Did you?" "No," the other senator replied. "Personally, I regret it."[1]

As the hearing went on, though, the senators stopped asking *why* it had been done and instead concentrated on *what* had been done and on what *should* be done in the future. The result was the legislative decree that "no patent shall hereafter be granted for any invention or discovery which is useful solely in the production of fissionable material or in the utilization of fissionable material or atomic energy for a military weapon"—a move that attempted to resolve the patent question by removing the issue altogether.[2] As "atomic energy" was then the only field of scientific and technological inquiry in which private patenting was explicitly prohibited by an act of Congress, it was an anomaly noted in many works on patent law and occasionally even in relatively recent court cases relating to patenting and patentability.[3]

The historiography of the atomic bomb is extensive: few topics in the history of science have received such thorough "historical" attention from their earliest inception (indeed, the first draft of the bomb's history was released only days after the Nagasaki bomb itself).[4] There are by now dozens of accounts of the Manhattan Project; most reproduce the sort of heroic, ideas-and-men narrative that has been present since the 1940s, with a heavy emphasis on physics, the wills and actions of individuals, and the idea that the atomic bomb "changed everything." New archival sources have been used in order to further the project of what Hugh Gusterson calls "nuclear salvage history," the attempt to rediscover the scientific authors whose names and activities were obscured or neglected altogether as a result of classification policies.[5] But works have also emerged that challenge this narrative, looking at aspects of the project that have been neglected by the traditional narrative and at the same time interrogating the construction of the narrative itself; they open the possibility that more work on the Manhattan Project can be done without resorting to, or relying on, further "salvage."[6]

The patenting program itself, like the rest of the Manhattan Project, was very large. It

[1] Statement of Capt. Robert A. Lavender, Atomic Energy Act of 1946 Hearings before the Special Committee on Atomic Energy, U.S. Senate, 79th Cong., 2nd sess., on S.1717, Pt. 3, 11 Feb. 1946, pp. 337–358, on p. 347.

[2] "An Act for the Development and Control of Atomic Energy," Public Law 585, 1 Aug. 1946, Sect. 11(a). The word "solely" is worth noting in particular here—technologies with multiple uses could still be patented.

[3] For the former see, e.g., the way it is discussed in Floyd L. Vaughan, *The United States Patent System: Legal and Economic Conflicts in American Patent History* (Norman: Univ. Oklahoma Press, 1956). A prominent example of the latter is its invocation by Chief Justice Warren E. Burger in *Diamond v. Chakrabarty*, 447 U.S. 303 (1980), to indicate that if Congress wanted to it could set biological organisms off-limits from patenting, as it had once done with atomic energy.

[4] Henry DeWolf Smyth, *Atomic Energy for Military Purposes: The Official Report on the Development of the Atomic Bomb under the Auspices of the United States Government, 1940–1945* (Princeton, N.J.: Princeton Univ. Press, 1945). For a critical view of the Smyth Report's influential role in shaping the narrative of the atomic bomb see Rebecca Press Schwartz, "The Making of the Historiography of the Atomic Bomb" (Ph.D. diss., Princeton Univ., in progress).

[5] Hugh Gusterson, "Death of the Authors of Death: Prestige and Creativity among Nuclear Weapons Scientists," in *Scientific Authorship: Credit and Intellectual Property in Science*, ed. Mario Biagioli and Peter Galison (New York: Routledge, 2003), pp. 281–307. For the "standard" narrative see, e.g., Richard G. Hewlett and Oscar E. Anderson, Jr., *The New World: A History of the U.S. Atomic Energy Commission, 1939–1946* (Berkeley: Univ. California Press, 1962); Stéphane Groueff, *Manhattan Project: The Untold Story of the Making of the Atomic Bomb* (Boston: Little, Brown, 1967); Richard Rhodes, *The Making of the Atomic Bomb* (New York: Simon & Schuster, 1986); and Lillian Hoddeson *et al.*, *Critical Assembly: A Technical History of Los Alamos during the Oppenheimer Years, 1943–1945* (New York: Cambridge Univ. Press, 1993).

[6] One important but largely ignored work in this vein is Ruth H. Howes and Caroline L. Herzenberg, *Their Day in the Sun: Women of the Manhattan Project* (Philadelphia: Temple Univ. Press, 1999). Recent works of this sort include Michael D. Gordin, *Five Days in August: How World War II Became a Nuclear War* (Princeton, N.J.: Princeton Univ. Press, 2007); and Schwartz, "Making of the Historiography of the Atomic Bomb" (cit. n. 4).

enjoyed support from such top brass as Vannevar Bush, General Leslie Groves, and even President Franklin D. Roosevelt. It required direct intervention by the Commissioner of Patents, involved a platoon of lawyers spread across the country, and reached outside the confines of the government bureaucracy to grapple with the private sphere. All of this makes it particularly important to note that the existence of such a program is barely mentioned in secondary historical literature, though minor aspects of it occasionally surface as elements in other studies, and no comprehensive picture—or even an acknowledgment of a large, generalized patenting program—has yet emerged.[7] The reason for this lack of attention is, I suspect, at least partly related to the conceptual contradiction at the heart of the program: the deliberate placement of military-technical secrets into a system of legal openness. The traditional historical narrative of the atomic bomb, in which the "special" nature and "taboo" of the bomb are posited as having existed from the first moment, leaves little room for a technique like patent control as a feature of national security.[8]

When scholars talk about nuclear weapons in terms of intellectual property, they almost invariably conceptualize them within the model of trade secrecy. Nuclear weapon designs are conceived of as having a technical epistemology more similar to the formula for a soft drink than the design of an automobile: they are kept in a vault, the monopoly is not guaranteed by law, innovation (among national competitors) is discouraged, and the designs are thought to be at least somewhat concealable (though antisecrecy advocates have often challenged this). The paradigmatic nuclear secret, the Teller-Ulam design of the hydrogen bomb, is generally treated as a formulation of knowledge that could, theoretically, be kept from other parties, though they could—and did—come to the same knowledge independently.[9] Not surprisingly, the choice between two different models of intellectual property for a given technology depends as much on the way the technology will be deployed in the world as it does on the makeup of the technology itself.

This essay attempts to shed some light on the Manhattan Project's patenting program, to look at its motivations, its methods, its results, and, ultimately, its importance. I discuss the patent program in three discrete sections. The first section covers the evolution of patent clauses in research contracts as an attempt by government administrators to articulate a new relationship between federal funding and military-industrial-academic agencies just before and during World War II. The first attempts at government control of research technology by means of patents grew out of tensions that arose in that context, and it was this paradigm that was applied in full force to the patenting of the atomic bomb as the technology came to seem increasingly feasible. The second section examines the

[7] In general, the wartime patent issue surfaces in three ways: as a diplomatic dispute between the United States and the United Kingdom over the validity of French atomic patents; as a series of personal disputes between individual scientists and the federal government over patent rights; and in reference to the privatization of nuclear power as debated in the hearings for the Atomic Energy Act of 1946 and its 1954 amendments. All three of these topics will be discussed and referenced later in the essay, as appropriate.

[8] This omission is not primarily due to a lack of sources; all of the crucial primary sources used for this essay have not only been declassified for many decades but are available on microfilm at many universities worldwide.

[9] A recent article that looks at parallels between trade secrecy and national security secrets is Peter Galison, "Removing Knowledge," *Critical Inquiry*, 2004, *31*:229–243, esp. pp. 238–240. See also, e.g., the discussion of national and military secrecy in Sissela Bok, *Secrets: On the Ethics of Concealment and Revelation* (New York: Vintage, 1989). An interesting discussion of replication and independent discovery in relation to nuclear science is Spencer Weart, "Secrecy, Simultaneous Discovery, and the Theory of Nuclear Reactors," *American Journal of Physics*, 1977, *45*:1049–1060. Finally, there is a controversy over whether the Teller-Ulam design was *truly* independently developed (i.e., whether each country that developed it received some outside assistance in the form of collaboration or espionage), but this is beyond the scope of this essay.

ways in which patent policies that had been developed primarily for application *within* the Manhattan Project began to be used *outside* of the project, as unaffiliated scientists and inventors appeared to pose a threat to the government's patent monopoly. The third section then analyzes the ways in which the patenting program expanded and how it chafed against the ambitions of many Manhattan Project scientists as their research began to get closer to yielding results. In conclusion, I will articulate the reasons why the history of the patenting program, which touches on issues relating to government control, industry and educational contractors, and the autonomy of scientists, also demands a reconsideration of the historical relation of nuclear weapons and the legal mechanisms of their control.

THE SHORT FORM WITH A LONG REACH: THE EVOLUTION OF NDRC AND OSRD PATENT POLICY

The path to the patent policy of the Manhattan Project starts in its two most relevant predecessor organizations: the National Defense Research Committee (NDRC), founded by an executive order of President Roosevelt in 1940; and the Office of Scientific Research and Development (OSRD), which took over much of the NDRC's responsibilities in 1941, again by Roosevelt's executive order.[10] The influential scientist-administrator Vannevar Bush was the central figure in both organizations—he used his access to Roosevelt to negotiate their creation and his appointment as their head—and it is his individual approach to administering science that we find reflected in the creation of the patent policies that were inherited when the atomic bomb research was taken over by the Manhattan Project from the OSRD in 1943.

As Larry Owens has shown, Bush's unique approach to administering science featured a system of funding and control that used the tools of industry, primarily the contract, rather than the more open-ended tools associated with philanthropy, such as the grant.[11] NDRC patent policy was similarly rooted in contracts, and it was discussed at length by NDRC members even before the committee had been formally organized. Despite his adoption of the methods of big business and the tools of the marketplace, however, Bush was anxious to avoid charges of wartime profiteering, both for his agency and for his contractors, and the NDRC was from the beginning to be run on the principle of "no profit, no loss." When applied to patents, this principle came to be expressed in the "title taking" style of the first NDRC patent clause, adopted in August 1940 with the collaboration of the Commissioner of Patents. In brief, this first clause specified that for all inventions resulting—even in part—from NDRC-financed research, the NDRC retained the discretion to decide whether a patent application would be filed at all and whether the title of

[10] For the definitive administrative history of the NDRC and the OSRD see Irvin Stewart, *Organizing Scientific Research for War: The Administrative History of the Office of Scientific Research and Development* (Boston: Little, Brown, 1948). Stewart's book is also one of the few postwar sources that describes the OSRD patent program in any detail. Stewart was the OSRD Secretary and was often personally involved in patent administration, which helps to explain why he devotes an entire chapter to patent matters, though his account is colored largely by his vantage point and is not comprehensive or reflective.

[11] Larry Owens, "The Counterproductive Management of Science in the Second World War: Vannevar Bush and the Office of Scientific Research and Development," *Business History Review*, 1994, *68*:515–576, esp. pp. 521–526. Also essential for understanding Bush's attitudes toward the wartime funding of research is Nathan Reingold, "Vannevar Bush's New Deal for Research; or, The Triumph of the Old Order," *Historical Studies in the Physical and Biological Sciences*, 1987, *17*:299–344.

said application would go to the government or to the contractor who had developed the invention.[12]

The industrial contractors found this a little hard to swallow. A number of major contractors, including General Electric, RCA, Western Electric, and Westinghouse Electric, refused to sign any contract with these provisions and instead worked under "letters of intent" until the matter was settled to their liking. The objection of the contractors is understandable: the provision explicitly left all decisions relating to patent rights at the discretion of the NDRC. As NDRC Secretary Irving Stewart later characterized it, the NDRC patent provision

> was, in fact, somewhat anomalous. The United States was at peace and many people believed it would not become involved in the war being waged in Europe.. . .In effect NDRC was asking America's leading companies to take their best men off their own problems and put them (at cost) on problems selected by NDRC, and then leave it to NDRC to determine what rights, if any, the companies would get out of inventions made by their staff members.[13]

Furthermore, the War Department and the Navy Department rarely demanded similar concessions, allowing contractors to retain their commercial patenting rights while reserving royalty-free licenses for official military use. The policy was, in short, seen by the experienced industrial contractors as one that put them in an unpleasant and unfamiliar position, where their work for the government offered a relatively limited possibility of future benefits.

Five months later, a compromise was reached to end the contract stalemate. The new patent clause, forged out of lengthy negotiations with the contractors and modeled after Army and Navy patent practices, specified that the contractor's patent obligations to the government were only that

> - the government received an irrevocable right to purchase, for a reasonable price, a license to any invention the contractor held title to that related to the subject matter of the contract;
> - the contractor granted the government a royalty-free license to use any inventions created under the auspices of the contract;
> - the contractor would, prior to final settlement of the contract, disclose all inventions made under the contract's auspices and indicate whether it intended to take out patents on them;
> - and, if the contractor declined to file for a patent for an invention created under the contract, the government would have the right to file for the invention itself but would be required to grant the contractor a nonexclusive, royalty-free license to the invention.[14]

Because this clause contained more stipulations than the first one, it came to be known as the "long form," while the "title taking" clause was known as the "short form," even though it had the longer reach. The contrast between the "long" and "short" clauses is rather dramatic: with the new, "long" form the power relations have been reversed, with the power of discretion in patent arrangements vested in the contractor rather than the NDRC. At most, the NDRC retained the ability to take out a free license on NDRC-funded

[12] Owens, "Counterproductive Management of Science," p. 526 ("no profit, no loss"); and Stewart, *Organizing Scientific Research for War* (cit. n. 10), pp. 221–222.

[13] Stewart, *Organizing Scientific Research for War*, p. 222.

[14] This is my summary and distillation of Stewart, *Organizing Scientific Research for War*, p. 224; it is not a direct quotation, and I have simplified the legal aspects to their basic terms.

inventions and the ability to take full title in inventions only if the contractor decided not to bother.[15]

NDRC contracts did not, however, adopt the new form unilaterally. The "long form" was developed primarily to break the contract deadlock with major industrial contractors—which for the most part it did—and it continued to be used in cases where the contractor was well established in the field of investigation in question, had long-running vested commercial interests in the subject of research, and was using its previously developed research infrastructure for its NDRC work. The "short form" came to be used primarily in "central laboratory" contracts, the instances where the NDRC work was directly involved in establishing a research infrastructure and where commercial interests were less clear or, at the time, completely nonexistent; in most cases this meant research conducted at academic institutions and in fields where there were few if any preexisting groups of research specialists (including radar, rockets, antisubmarine warfare, and, eventually, atomic energy). Over the course of the war, the "long form" was used almost twice as often as the "short form," but the latter covered more of the most memorable wartime creations of the NDRC and the OSRD.[16]

It was in this contractual context, marked by concerns about profit, profiteering, and the obligations of the government, that the early atomic energy work was first situated under the NDRC as part of its S-1 Committee on Uranium. The atomic research was split between the two contract clauses, with those contractors that would qualify as "industrial contractors"—Westinghouse Electric and Standard Oil Development Company being the two largest—primarily using the new "long form" clauses, while the many sites that would qualify as "central laboratories"—mostly a mélange of academic research institutions—continued to use the original "short form" clauses. In practice, though, there were still many academic institutions that maintained "long form" clauses for the time being.

When the Office of Scientific Research and Development was created by Roosevelt in June 1941—at Bush's urging and with him as its head—it adopted the NDRC patent policies wholesale; and as its research establishment expanded beyond the original NDRC work, so did its patent program.[17] By October 1941 a dedicated staff working strictly on patent issues resulting from OSRD contracts had been assembled. After a request to the Secretary of the Navy, Bush received help from Commander (soon to be Captain) Robert A. Lavender, whom he appointed as the OSRD Advisor on Patent Matters (see Figure 1). Lavender, a graduate of the U.S. Naval Academy who also held an M.S. in electronics from Harvard University and a degree in legal studies from George Washington Law School, had over fifteen years of experience in negotiating different types of patent problems for the Navy by the time he arrived at the OSRD.[18] As the Advisor on Patent

[15] In the end there were a total of four variants of the "short" clause: the standard one (described in the text), two more that allowed contractors to retain certain commercial licensing and sublicensing abilities within their fields, and a fourth that helped exempt contractors from liability in the event of their infringement of other patents as a result of using "off the shelf" components in the course of their research. For the purposes of this study the differences are not important. See Statement of Capt. Robert A. Lavender, 11 Feb. 1946 (cit. n. 1), pp. 338–339.

[16] By 1946 the "long form" was used in 1,410 contracts, while the "short form" was used in 780. An additional type of contract clause, not discussed here, was created specifically for penicillin research, allowing commercial researchers to finance more of their research if they desired. See Stewart, *Organizing Scientific Research for War* (cit. n. 10), pp. 224–225.

[17] The NDRC was not dissolved, however; it became an advisory board to the OSRD, with James B. Conant as its head. See *ibid.*, Ch. 4: "NDRC of the OSRD," pp. 52–78.

[18] *Ibid.*, p. 226. Biographical information is from Statement of Robert A. Lavender, Economic Aspects of Government Patent Policies, Hearing before the Subcommittee on Monopoly of the Select Committee on Small

Figure 1. *Captain Robert A. Lavender, head of the OSRD and Manhattan Project patent programs, in 1948. Source: National Air and Space Archives, Fairchild Industries, Inc., Collection, Box 468, Folder 25.*

Matters, he was to serve as the personal representative to Bush on patent issues and became one of the key architects of OSRD patent administration.

Under Lavender the OSRD Patent Division hired patent lawyers—mostly commissioned officers with previous legal training; at its peak the division employed a dozen lawyers with offices in Washington, D.C., Boston, New York, and Chicago.[19] The patent program generally worked in a simple way: as part of the terms of their contracts, contractors were required to submit notice of any potentially patentable invention as an invention report to their OSRD division chiefs, who in turn would forward the material to the patent lawyers in Lavender's Patent Division. The reports were a distilled form of invention priority assignment—a brief description of the invention and a list detailing when the invention was first conceived, with whom it was discussed, whether or not it was

Business, United States Senate, 88th Cong., 14 Mar. 1963, pp. 274–281, on pp. 275–276. Lavender was, at this later date, serving as a witness in relation to U.S. Navy patenting practices.

[19] Stewart, *Organizing Scientific Research for War*, p. 186.

described in an in-house report, and whether it was thought to be of much value—and were to accompany more detailed technical information and laboratory notebooks.[20]

After receiving the reports, the Patent Division would forward them to the branch of the armed services that had a predominating interest in the invention in order to determine whether the patent would be worth pursuing. Through the end of January 1946, the OSRD processed over 6,700 invention reports, of which about 2,600 were by that time definitely covered by patent applications. (The fate of an additional 2,200 had not, at that point, been decided; patent applications were not filed on the remaining reports.)[21]

In the spring of 1942, however, OSRD patent policy with regard to atomic energy research began to become a distinct and separate affair from that pertaining to the rest of the multi-million-dollar research the OSRD was contracting. Until this point, even though atomic energy research was situated somewhat differently within the OSRD hierarchy of research programs, it was not regarded differently in terms of contracting or patent clauses. The reason for the change appears simple enough on the surface—it had become much more realistic to think that the atomic research would yield military results applicable in wartime—but the bigger question remains: Why should atomic bomb research be controlled by different patent policies than, say, work on the proximity fuze, new explosive materials, or submarine research?[22] What makes atomic energy "special" here is that it was, indeed, considered "special" (the "S" in "S-1" stood for exactly that), but that in itself still falls short of answering the question of why *patent* policies would be a major locus of such change.

The specific change took shape as a coup of the "short form": Bush, in collusion with a number of other top S-1 project members—including James B. Conant, Arthur H. Compton, Ernest O. Lawrence, J. Robert Oppenheimer, and Harold Urey—decided that it would be prudent to try to convert all atomic energy–related contracts to "short form" clauses.[23] Bush knew, though, that the university contractors still on the "long form" would be recalcitrant—to say nothing of the industrial contractors, whose earlier refusal of the "short form" still stung. As Bush wrote to Conant in June 1942, it might take "a little pressure to do it"; that "pressure" would be nothing less than executive approval from Franklin Roosevelt himself. In a letter to Roosevelt in the early summer of 1942, Bush hammered out plans to expand the atomic research and also conveyed, as he later reported to Conant, that the OSRD "intended to have complete records of our experimental work so that patents could later be filed, and that I would attempt to see that as much patent control as possible resided in the hands of the government." Roosevelt provided Bush with exactly what he wanted, in the form of a brief memo on a small scrap of White House stationery:

[20] Two invention reports related to the plutonium work conducted at UC Berkeley are contained in *Bush-Conant File Relating the Development of the Atomic Bomb, 1940–1945*, Records of the Office of Scientific Research and Development, RG 227, microfilm publication M1392 (Washington, D.C.: National Archives and Records Administration, 1990?), Folder 6: "Patent Matters [1941–1945]," Roll 2, Target 1, Frames 71, 73. Items from this microfilm publication will hereafter be indicated by the abbreviation **Bush-Conant File.**

[21] Stewart, *Organizing Scientific Research for War* (cit. n. 10), pp. 227–228.

[22] The only other OSRD-financed research program to have program-specific patent issues was radar, but the reason in that instance was overlapping priority claims of MIT and Navy personnel, which owed more to the nature of the research program than to the substance of the technical work.

[23] A summary of these events is in Carroll L. Wilson to James B. Conant, interoffice memorandum, 29 Apr. 1942, Bush-Conant File, Folder 147: "Patents [1942–1944]," Roll 10, Target 5, Frame 298.

> I do not think I have replied to yours of June 19th in relation to the purchase of certain ore in Canada. I agree with you that we should encourage the Canadians to go ahead. Also, I wholly approve your patent control policy. I talked with Mr. Churchill in regard to this whole matter and we are in complete accord. F.D.R.

Bush was now completely unrestrained: this tiny memo gave him the confidence to declare that he had been given full support for total patent control. "The President," he wrote to the head of the U.K. Privy Council Office, "recognizing this aspect of the subject, has instructed me to acquire for this Office patent rights on this subject to as complete an extent as can be readily attained." "The President," he wrote, imploring University of California treasurer Robert M. Underhill to acquiesce to the "short form," "has fully grasped the significance of the project and the results of its solution and has stated that Government control should primarily be through the administration of patents. He has, therefore, directed me to arrange as far as possible for the vesting in the Government of the titles to the inventions and discoveries made and the patents that may be issued thereon that may be involved in this project." "In my capacity as an agent of the Government I must bear in mind," he wrote in a badgering letter to University of California president Robert Sproul, "that the President has directed me to obtain the assignment of patents in this field to the Federal Government."[24] These appeals to Roosevelt's authority, though not always as immediately effective as Bush had hoped, nonetheless played a key rhetorical role in convincing recalcitrant industry and university representatives to bend to his will.

Bush's aggressive approach in assigning atomic energy patents to the government is worth reflecting on, especially in light of the fact that he is generally remembered as a staunch advocate of allowing government-sponsored researchers to maintain their patent rights. This reputation comes primarily from his wartime congressional debate with Senator Harley M. Kilgore and from the 1945 report *Science—The Endless Frontier*, which outlined a proposal for postwar federal funding of scientific research. In both his showdown with Kilgore and his report, Bush took the position that as long as the government received a free license to use whatever patents contractors developed, it should not otherwise hinder their ability to control their inventions in the marketplace.[25] Bush understood the value of patents, and he took them seriously, long campaigning for patent law reform to prevent what he saw as abuses of the system by large corporations seeking to stifle commercial competition. There is some irony in the fact that, in the context of the Manhattan Project, Bush himself would use the patent system as a way of controlling technology, and this shift in roles was not lost on him. "I suppose that in the process," Bush later wrote of the wartime patent activities, "I personally destroyed more

[24] Vannevar Bush to Conant, memo, "Patent Aspects of S-1," 19 June 1942, Bush-Conant File, Folder 147: "Patents [1942–1944]," Roll 10, Target 5, Frame 293; Franklin D. Roosevelt to Bush, memo, 11 July 1942, Bush-Conant File, Folder 9: "S-1 British Relations Prior to Interim Committee [Folder] No. 1 [1942]," Roll 2, Target 4; Bush to Sir John Anderson, 1 Sept. 1942, Bush-Conant File, Folder 9: "S-1 British Relations Prior to Interim Committee [Folder] No. 1 [1942]," Roll 2, Target 4; Bush to Robert M. Underhill, n.d. [probably ca. late July 1942], Bush-Conant File, Folder 147: "Patents [1942–1944]," Roll 10, Target 5, Frame 288; and Bush to Robert G. Sproul, 13 Oct. 1943, Bush-Conant File, Folder 6: "Patent Matters [1941–1945]," Roll 2, Target 1, Frame 54.

[25] See Vannevar Bush, *Science—The Endless Frontier: A Report to the President by Vannevar Bush, Director of the Office of Scientific Research and Development, July 1945* (Washington, D.C.: Government Printing Office, 1945), esp. Sect. 5 of the proposed outline for the National Research Foundation. On the Kilgore debate and Bush's postwar patent stances see Daniel J. Kevles, "The National Science Foundation and the Debate over Postwar Research Policy, 1942–1945: A Political Interpretation of *Science—The Endless Frontier*," *Isis*, 1977, *68*:4–26, esp. p. 14; and Jessica Wang, *American Science in an Age of Anxiety: Scientists, Anticommunism, and the Cold War* (Chapel Hill: Univ. North Carolina Press, 1999), pp. 25–37.

property in the form of patents than any other man living." Assigning a patent to the government, he later wrote, was the equivalent of destroying it completely from a commercial point of view, and he reflected that "it is paradoxical that I, who am a great believer in the system, should have been called upon to commit this particular sin."[26]

Paradoxical, perhaps, but not incomprehensible. Wartime inventions should not, in Bush's mind, be commercially successful—that would risk accusations of wartime profiteering. Moreover, in the case of atomic energy in particular Bush recognized the lingering question of whether even the aspect of the scientific development that was potentially commercially viable—civilian nuclear power generation—would ever be safe enough to be used by private industry. Writing to Roosevelt in December 1942, he noted, "It is clear that the utilization of atomic power must always be under close government control, not only because of the enormous hazards involved in such a process, but also because a super explosive appears as a possible by-product." The distinction between civilian and military uses of nuclear power, which are often blurred today in discussions of proliferation, was not at all clear in the early 1940s—the first reactors, after all, were developed for military purposes and produced heat energy only as an unwanted by-product. Bush also believed that patent control would facilitate international control of atomic energy. As he wrote to Sir John Anderson of the Privy Council Office in September 1942, explaining his attitude toward patent control:

> I have the strong feeling that much greater progress will be made if each government has in its hands a substantial part of the patent rights arising within the respective countries, for the problem of arriving at sound international relationships will then be much less likely to be complicated by reason of private interest in the outcome. . . . I am inclined to believe that this patent control in the hands of government will prove to be sufficiently strong so that this series of discoveries and inventions cannot be practiced at any point within our respective countries without government license based on the patent status. It would of course be entirely possible to superpose other controls, but the matter becomes somewhat simpler to handle if this is not necessary.[27]

The patent system, as Bush knew and approved, was about technological control. As a patent system advocate, Bush wanted to streamline and improve the system so that small inventors could properly protect their interests against big corporations; as a leader of wartime research, he was happy to use the strength of the government and of the patent system to control what he did not think should be encouraged to function independently in the marketplace. Bush was familiar with patents by the time he was head of the NDRC—his later autobiography describes in detail numerous patent battles in the early radio industry where he made his name—and when confronted with the new question of atomic energy, he understandably reached for the familiar.[28]

[26] In this context, Bush was speaking specifically of the MIT patent program, which also involved assigning inventor patents to the government. See Vannevar Bush, *Pieces of the Action* (New York: Morrow, 1970), p. 84.

[27] Bush to Roosevelt, memo, "Report on Present Status and Future Program on Atomic Fission Bombs," 16 Dec. 1942, in *Correspondence ("Top Secret") of the Manhattan Engineer District, 1942–1946*, microfilm publication M1109 (Washington, D.C.: National Archives and Records Administration, 1980), Folder 25: "Documents Removed from Gen. (L. R.) Groves' Locked Box, Plus Certain Documents of Historical Importance," Roll 3, Target 8; and Bush to Anderson, 1 Sept. 1942, *ibid.*, Folder 16A: "Summary of Facts Relating to Breach of Quebec Agreement," Roll 3.

[28] On the patent battles in the radio industry see esp. Bush, *Pieces of the Action* (cit. n. 26), pp. 197–200. This conclusion about Bush is consonant with Nathan Reingold's thesis that Bush observed a strict line between wartime OSRD policies and peacetime ones and that his reliance on existing legal mechanisms of control could

As his letter to Anderson indicates, Bush saw an intimate connection between patenting and the question of international control of atomic weapons. Before nations could try to work out agreements in relation to atomic energy, they would have to own the technology unambiguously. By doing this through patents, they could also control what was done within their own borders in regard to the technology. If these patents were owned outright by the government, there would be no threat of private industrial interests swaying policy for profit. Finally, accomplishing this control by means of the patent system would eliminate the need to worry about creating new, unprecedented forms of control. While it is easy in hindsight to see flaws with this scheme, from Bush's 1942 vantage point it made at least some sense, though it was far from being a necessary conclusion.

But Bush's attempt to take control of the technology behind atomic energy was not wholly successful. Contract clauses allowed control only over work that had been done under the official auspices of the OSRD; they did not cover situations relating to research done *outside* of the organization, and they did not necessarily apply to research that had been done *before* the inventor in question was part of the project. In both cases, the inventor would be largely beyond the reach of Bush's bureaucratic power and could seriously threaten his attempt at a complete government monopoly on atomic energy. The problem was neither trivial nor hypothetical, and it led to one of the stranger manifestations of wartime patent policy, a true fear of the "lone inventor."

FEAR OF THE LONE INVENTOR: PATENT SECRECY AND THE PRIVATE SPHERE

The "lone inventor" is a common trope used in discussions of patent law, in the same way that the "creative genius" is invoked in discussions of copyright. He is a character who represents the hypothetical beneficiary of a patent system, a legal fiction often trotted out as a rhetorical heuristic for comparing the effects of different interpretations of patent law. And even though it has been more than a century since the corporation has replaced the individual inventor as the primary beneficiary of patents (and copyrights), the "lone inventor" continues to be the "little guy" that politicians claim to care about and the reason to keep incentive-giving patent laws strong.[29] When the patentable subject matter is a nuclear bomb, however, the "lone inventor" turns into something else altogether.

The problem was first raised fairly early, when Bush became aware of the fact that in 1939 a team of French physicists at the Collège de France, led by Frédéric Joliot-Curie, had filed in France and the United Kingdom for a number of patents relating to atomic energy; these covered a wide variety of nuclear technologies, including the basic idea of a nuclear reactor and the means of controlling it (by early 1942, the French were negotiating for nearly a dozen patent applications filed in Britain).[30] In March 1942, around the same time that he was beginning his planning for the coup of the "short form," Bush met with Commissioner of Patents Conway Coe about what they called "the French problem"—one of the members of the Joliot-Curie team had registered their claims with

be interpreted as part of his desire not to disturb the "old order." See Reingold, "Vannevar Bush's New Deal for Research" (cit. n. 11).

[29] On corporations becoming "inventors" see David F. Noble, *America by Design: Science, Technology, and the Rise of Corporate Capitalism* (1977; New York: Oxford Univ. Press, 1979), Ch. 6.

[30] There was, additionally, a patent relating to an atomic explosive, but it was not filed with the British. The best overall coverage of the French patenting dilemma and British approaches to atomic patenting is Margaret Gowing, *Britain and Atomic Energy, 1939–1945* (New York: St. Martin's, 1964), pp. 201–215. For the point of view of the French scientists see Spencer R. Weart, *Scientists in Power* (Cambridge, Mass.: Harvard Univ. Press, 1979), pp. 93–102, 170–177.

the U.S. Patent Office while in Britain and was trying to use them as leverage for French science after the war. The problem was tricky: Bush and Coe did not want simply to give the French scientists patent control over such basic ideas of nuclear physics, but to argue about it publicly would disclose their own secret bomb program. The result the two administrators agreed on was to declare the French patent applications "secret."[31]

The ability to declare "secret" things not created within the confines of the government itself was not straightforward in the United States at this time. There existed, of course, examples of certain types of expression being suppressed during wartime, but with something like patents, where delays in filing or granting can have large economic consequences, such a use of executive power would have been a legal minefield. As such, Bush had requested an audience with no less an authority on patent law than the Commissioner of Patents, noting that the issue involved was "a matter of general policy of some difficulty . . . on which I certainly need your guidance."[32]

Fortunately for Bush, however, U.S. patent law had been specifically amended so as to permit patent applications to be ordered held in secret in extraordinary circumstances. The original legislation had been passed during World War I to allow patents with military implications to be declared "secret" during wartime, and in 1940 and 1941 the statute had been revised to apply during peacetime as well and to have stiffer penalties associated with the violation of secrecy orders (the original penalty having been simply loss of patent title).[33] The result of this legislative action was Public Law No. 700, a bill that allowed the Patent Office (via the authority of the Commissioner of Patents) to declare patent applications secret, preventing both their publication and access in the United States and also blocking their filing outside of the country. The question of whether the application would be granted was put on hold until the secrecy order had been lifted. If the patent was eventually granted, the inventor could then work out problems of interference with subsequently granted patents and could sue for compensation if the government had used the patent in the interim.

The statute and its later revisions each provoked substantial debate in Congress over their effect on the "lone inventor": on the one hand, an order of secrecy could drastically extend the life of the patent itself, since the patent's enforceability countdown did not begin until it was made public and granted; on the other hand, such an order could slow innovation in a field and tie the hands of the inventor, who was not eligible for compensation from the government unless the invention was actually used (inventions declared

[31] Bush to Conway Coe, 30 Apr. 1942, Bush-Conant File, Folder 6: "Patent Matters [1941–1945]," Roll 2, Target 1, Frame 9. Note that I have not found much evidence to indicate that "the French problem" was a motivation for the coup of the "short form" in the first place—in the historical record they appear as independent parallel developments, interconnecting on certain points but not strongly causally linked. It may be that Roosevelt was thinking of "the French problem" in his initial note to Bush mentioning Churchill, cited earlier, though I have not found direct evidence of that.

[32] Bush to Coe, 7 Mar. 1942, Bush-Conant File, Folder 6: "Patent Matters [1941–1945]," Roll 2, Target 1, Frame 4.

[33] On the World War I law see Hearings before the Committee on Patents, U.S. House of Representatives, 65th Cong., on H.R. 5269, 13 July 1917, pp. 3–10. On the 1940–1941 revisions see Unpublished Hearings before the Committee on Patents, U.S. House of Representatives, 76th Cong., 3rd sess., on H.R. 9928, 31 May 1940, 3 June 1940); and Hearings before the Committee on Patents, U.S. House of Representatives, 77th Congress, 1st sess., on H.R. 3359 and H.R. 3360, "Preventing Publication of Inventions and Prohibiting Injunctions on Patents," 20 Feb. 1941, 25–27 Feb. 1941, 11–12 Mar. 1941, 19–20 Mar. 1941, 22–23 Apr. 1941, pp. 1–376. Unfortunately, not very much has been written on the early history of secret patents in the United States; the only full-volume work on secret patents that I have come across is specifically on the situation in the United Kingdom, which seems to have developed in a considerably different historical and legal context than the U.S. case: T. H. O'Dell, *Inventions and Official Secrecy: A History of Secret Patents in the United Kingdom* (Oxford: Clarendon, 1994).

secret and not used would not be eligible for compensation). Putting the French patent applications under P.L. 700 removed them from sight and mind—for a while, at least. Even at its most influential, such patent secrecy could only forestall potential legal debates about priority claims pertaining to work on nuclear reactors and nuclear weapons—and only within the reach of U.S. patent law; patent secrecy statutes, even at their worst, could only wield economic threats (denying the granting of a patent in the United States) against foreign inventors. ("The French problem" would evolve into a rather trying diplomatic snafu later in the war, when it was discovered, to the horror of the Americans, that the British had made a secret agreement with the French scientists to share nuclear information in exchange for a guarantee to use the French patents in the postwar period.[34])

At one of their meetings regarding "the French problem," Coe had raised a far-reaching question: whether Bush should consider appointing someone within the OSRD to survey the existing field of patents (the "prior art") relating to fission research. The purpose would be to help the Patent Office examiners in their determination of which non-OSRD patents were worth paying attention to and which might need to be declared secret under P.L. 700. Bush thought it a good idea that applications "which have any significance" to the S-1 project "be withheld from issue," and he recognized that having a reviewer unconnected with other aspects of the wartime project was vital if they were to avoid accusations of conspiring against private inventors for the government's benefit.[35] Though he knew it would be hard to find someone with the appropriate scientific and legal classifications who would be free for the job, Bush thought he might have a candidate directly at hand—directly across the hall from his office, to be exact—who could be lent out for what Bush thought would be a small survey project lasting six weeks at most.[36]

William Asahel Shurcliff was a three-time Harvard graduate, having received his B.A. *cum laude* in 1930, a Ph.D. in physics in 1934, and a degree in business administration in 1935. Before the U.S. entry into World War II, he had been the head of the Spectrophotometric Laboratory at the Calco Chemical Division of the American Cyanamid Company, which was involved in using spectrometry to perform chemical analysis as well as in projects relating to electric amplifiers and camouflage (see Figure 2). He had been in charge of keeping patent records while at Calco and had filed a number of patents himself.

[34] This has been discussed in detail in a number of sources. See, e.g., Hewlett and Anderson, *New World* (cit. n. 5), pp. 284, 331–336; Barton J. Bernstein, "The Uneasy Alliance: Roosevelt, Churchill, and the Atomic Bomb, 1940–1945," *Western Political Quarterly*, 1976, *29*:202–230, esp. pp. 227–228; and Weart, *Scientists in Power* (cit. n. 30), pp. 167, 171–174, 179–180, 205, 234. For more information on the earlier history of the British end of "the French problem" the best source is Gowing, *Britain and Atomic Energy* (cit. n. 30), pp. 201–215. As Gowing puts it, "The French patents run as a leitmotiv through the history of the United Kingdom atomic energy project" (p. 209). Gowing also discusses the tangled case of Anglo-American patent agreements in relation to atomic energy during the war.

[35] Bush to Coe, 23 Apr. 1942, 30 Apr. 1942, Bush-Conant File, Folder 6: "Patent Matters [1941–1945]," Roll 2, Target 1, Frames 14, 9. This latter point, though, would later raise a thorny problem: what if one of the applications in question did contain information that would be of use to OSRD scientists? "Problem as to how to get interesting patent application info not solved," the reviewer would later note in a memo to himself. In practice, though, the issue never came up: there is no evidence that anyone ever tried to patent anything that the reviewer thought the S-1 workers would find really useful. See William A. Shurcliff, memo, "Brief History of WAS S-1 Patent Work" [begun 2 June 1942, added to through at least 30 Sept. 1942], Bush-Conant File, Folder 14: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 2 [1942]," Roll 3, Target 1, Frame 154.

[36] Bush to Coe, 23 Apr. 1942, Bush-Conant File, Folder 6: "Patent Matters [1941–1945]," Roll 2, Target 1, Frame 13.

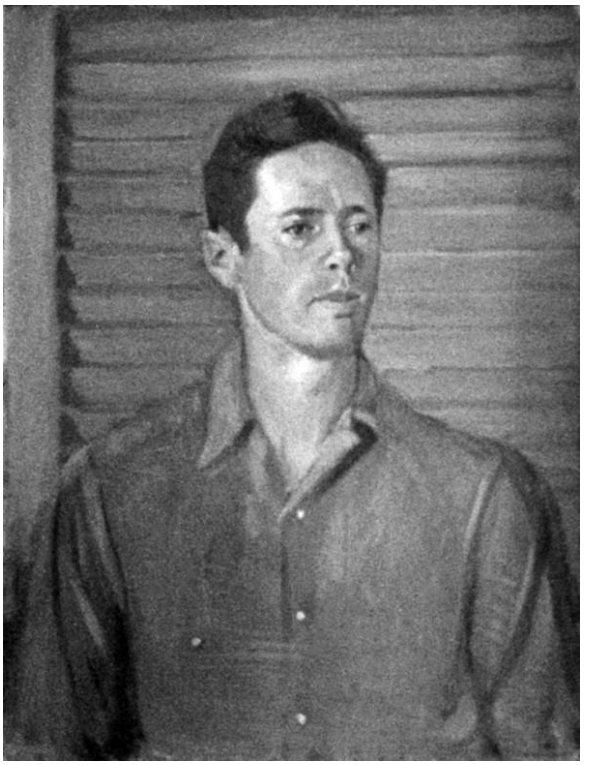

Figure 2. *A painting of William A. Shurcliff from 1948 by his father-in-law, the American artist Charles Hopkinson. Courtesy Arthur and Charles Shurcliff and Arthur Saltzman.*

In early 1942 a friend inside the OSRD suggested that he join the staff, an opportunity he leapt at, having feared that he might be drafted into the Army while at his civilian job.[37]

After working for a few months as a senior technical aide in the Liaison Office of the OSRD, Shurcliff was tapped by Bush in May 1942 to be brought into the S-1 program. His job was to review patents with possible implications for S-1 work, coming from both outside and inside the project, with the goal of helping the Patent Office learn when to apply secrecy orders. "I would be sworn to secrecy," Shurcliff wrote in a memo before beginning the work; and he hinted that even bigger ideas were being floated: "Taking over of [non-OSRD] patents or patent applications by the gov't is not *now* in view. An act of Congress might be required."[38]

By 1 July, as he wrote in a report to Bush, Shurcliff had found about thirty-five applications that were likely to require secrecy orders. He was keeping careful records, utilizing a system of six separate card indexes to keep track of patents, inventors, and subjects. He had also adopted a scientist-centric methodology, examining S-1 reports and "all relevant names" in *Physical Review* articles published between January 1939 and

[37] "Notes on the Training and Professional Experience of Dr. William A. Shurcliff," attached to *ibid.*; and William A. Shurcliff, "William A. Shurcliff: A Brief Autobiography," unpublished MS (Cambridge, Mass., 15 Dec. 1992), copy in Houghton Library, Harvard University, pp. 53–55, 187.

[38] William A. Shurcliff, memo, 14 May 1942, Bush-Conant File, Folder 14: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 2 [1942]," Roll 3, Target 1, Frame 172.

April 1942 to compile a list of six hundred individuals who he thought were doing work in the field of atomic energy (broadly defined). He would soon expand this approach to cover issues of the *Review of Modern Physics* and *Scientific Abstracts*, and he also requested that the National Academy of Sciences send him lists, culled from the Roster of Scientific Personnel, of those who had indicated expertise in nuclear physics and several other fields. His list grew to well over a thousand names by March 1943 and included many of those already employed by the OSRD on nuclear-related research—Enrico Fermi, Ernest O. Lawrence, Emilio Segrè, Leo Szilard, and Harold Urey are just a few of the most recognizable figures. Some on the list were doing wartime research that was not related to S-1 work, among them William Shockley and Robert Van De Graaff (both of whom had patent applications that attracted Shurcliff's attention), while numerous others were unaffiliated with government work—and of these others many were not even in the country (for example, all the members of the Collège de France team).[39] Though Shurcliff focused initially on physicists—no doubt owing to his own training—his scope would, over the course of his study, expand to include other disciplines (and rightly so, given that much of the development of fissile materials involved the work of chemists, metallurgists, and engineers, as well as physicists).[40]

What was initially to be a "survey of the art" became a full program to, as Shurcliff put it, "locate, examine, and make secret all non-gov't-controlled U.S. patent applications related to S-1."[41] Shurcliff would request patent applications from the Patent Office or would receive notice from contractors themselves about applications they were filing on behalf of their personnel.[42] He would then draw up a large list of application numbers on a notepad, penciling in the titles and inventors and labeling them "secrecy recommended" or "secrecy not recommended" (rubber stamps were later utilized for the purpose). If an application was, as he later put it, "hot"—that is, if it "had, or might have, an atomic-bomb connection"—he would designate that it be "put to sleep," which was accomplished by sending a brief letter to Captain Lavender with the specific level of secrecy recommended and an indication as to whether the government should attempt to acquire the title to the patent from the inventor. As the work continued, he and Lavender eventually worked out a standard form for requesting secrecy, on which Shurcliff could simply circle the specific responses ("Secrecy recommended: Yes / No").[43]

[39] Shurcliff, memo [forwarded to both Bush and Conant], "7/1/42 Progress Report on W.A.S. Secrecy Efforts Relating to Patent Applications Bearing on S-1 Subjects," 1 July 1942, Bush-Conant File, Folder 147: "Patents [1942–1944]," Roll 10, Target 5, Frame 291; Shurcliff, memo, "Manner of obtaining names for LAI cards" [2 June 1942, added to through 15 Aug. 1942], Bush-Conant File, Folder 14: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 2 [1942]," Roll 3, Target 1, Frame 150; Shurcliff to Joseph Morris, Roster of Scientific Personnel, National Academy of Sciences, 25 June 1942, Bush-Conant File, Folder 14: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 2 [1942]," Roll 3, Target 1, Frame 82.

[40] On this latter point see esp. Schwartz, "Making of the Historiography of the Atomic Bomb" (cit. n. 4).

[41] Shurcliff to Bush, 25 Sept. 1942, Bush-Conant File, Folder 14: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 2 [1942]," Roll 3, Target 1, Frame 38.

[42] In the beginning, though, Shurcliff had difficulty in getting the Patent Office to forward all of the applications he wanted, and he complained to Bush and the Patent Office about this. Bush stepped in at one point when a patent application Shurcliff had asked to examine was, in the meantime, granted and written about in the *New York Times*. See Shurcliff to A. E. Donnelly, 11 Aug. 1942, Bush-Conant File, Folder 14: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 2 [1942]," Roll 3, Target 1, Frame 45; Bush to Coe, 7 Oct. 1942, Bush-Conant File, Folder 14: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 2 [1942]," Roll 3, Target 1, Frame 27; and "Another Bomb Sight Is Patented: One Device Corrects Plane's Aim," *New York Times*, 4 Oct. 1942, p. A1.

[43] Shurcliff's notes are dispersed throughout Bush-Conant File, Folder 13: "Material from Liaison Office

Shurcliff was quite conscientious about his work, though; he did not impose secrecy where he did not think it reasonably called for, and in a number of cases he later rescinded secrecy orders he had issued when he changed his mind about the importance of the invention in question. In March 1943, for example, he rescinded the secrecy orders on seven patent applications for inventions relating to mass spectrometry because he decided that the applications "should be allowed to mature in the normal and unrestricted manner." The inventions "were at all times only of border-line interest," he wrote, and over the half-year since he had recommended secrecy his interest in the applications had "appreciably decreased." Furthermore, he was beginning to wonder what effect the secrecy program was having on private industry: "The damage done to industry by maintaining the secrecy orders must be increasing, especially in the petroleum industry and in the field of organic chemistry generally, all as attested by recent petitions filed by the individuals or assignees concerned with the cases listed above."[44] Industrial companies had contacted Shurcliff (via Lavender) a number of times, inquiring about the release of their patents, often so that they would be able to file them in other countries (filing in Canada in particular was a major concern). In a number of cases Shurcliff denied the requests flat out: the inventions were deemed too sensitive.[45]

From the point of view of the inventor, an order of patent secrecy could be irritating if not maddening. Contractors, of course, were well aware of why the patent secrecy was being ordered (at the very least, they knew it pertained to a specific secret war project—and they knew the rules of playing the OSRD's game), and their requests for secrecy to be lifted on their applications were primarily related to issues of filing abroad or for insuring that they gained a particular edge in their field. For those who were not associated with the bomb project, though, the orders could be an enigma, especially if the invention itself had no obvious conventional wartime application. The letters (emblazoned with the heading "SECRECY ORDER") came from the Patent Office, not the OSRD, and contained only an explanation of the basic provisions of patent secrecy law (do not publish, do not file an application abroad—or else).[46]

One inventor—a "lone inventor," apparently unaffiliated with any university or industrial

Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 1 [1942–1944]," Roll 2, Target 8; and Bush-Conant File, Folder 14: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 2 [1942]," Roll 3, Target 1. Most are sparse; some contain notes about the specifics of the patent and even small sketches. For the quotation see Shurcliff, "William A. Shurcliff: Brief Autobiography" (cit. n. 37), pp. 59–60. For the standard form see Shurcliff to Robert A. Lavender, form letter, 27 Aug. 1944, Bush-Conant File, Folder 13: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 1 [1942–1944]," Roll 2, Target 8, Frame 814.

[44] Shurcliff to Lavender, 29 Mar. 1943, Bush-Conant File, Folder 13: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 1 [1942–1944]," Roll 2, Target 8, Frame 840. Shurcliff's concern with the petroleum industry and organic chemistry in general probably stems from his correspondence with representatives at Standard Oil Development (Eger V. Murphee and his patent attorney P. L. Young), which had a large contract for developing gas centrifuge enrichment technology (it was not, in the end, used during the war).

[45] E.g., a petition to remove secrecy from an application by Joseph Slepian at Westinghouse Electric for an "Ionic Centrifuge" (which was early on considered a route to uranium enrichment, though it was eventually abandoned as unlikely to produce rapid results) was refused by Shurcliff, who considered this particular application to be "one of the '*more important*' S-1 type applications." He elaborated on the terminology to Lavender: "I believe it is your policy to allow filing of 'important' S-1 type applications in Canada, but not 'more important' applications. Accordingly, I believe the present petition should be refused." Shurcliff to Lavender, 30 Sept. 1942, Bush-Conant File, Folder 14: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 2 [1942]," Roll 3, Target 1, Frame 36.

[46] E.g., Thomas Murphy, Assistant Commissioner of Patents, to Lawrence H. Johnston, 20 May 1953, regarding "Detonating Apparatus" (U.S. App. 165,171; later granted as U.S. Pat. 3,955,505); copy of letter courtesy of Lawrence H. Johnston.

research group—was in fact *encouraged* by the secrecy order, moved to declare his eagerness to lend his services if the government should desire them. On 14 May 1944 this man phoned Shurcliff at his office to inquire about an invention of his on which, he claimed, Shurcliff had recommended a secrecy order. Was the government using it? What action was the government taking with it? Was there any way he could help put it to use? Shurcliff bought some time by telling the caller that he would need to put his questions in writing; two days later he did so, addressing the letter to Shurcliff directly at his OSRD office.[47]

The inventor, Sol Wiczer, was then living in Washington, D.C., and had filed a patent titled "Separation of Isotopes" on 28 November 1942. Along with a large number of other patents on the same subject, it had been reviewed by Shurcliff in February 1943; on his notepad Shurcliff had written that he thought the application was "vague," but it commanded no particular attention apart from a secrecy order (as did practically all isotope separation patents, because the technology is key to uranium enrichment).[48]

The patent secrecy orders themselves were on Patent Office letterhead and were signed by the Commissioner of Patents, with the intent of giving no indication of where the secrecy order had actually originated or what concerns had led to its issuance. So how did this unaffiliated, uncleared, and unknown inventor find out not only what office had issued the secrecy order but precisely *who* had requested it, down to his office phone number? Something had gone horribly wrong. Shurcliff wrote Wiczer an official letter, oozing with governmental formality and faux ignorance, explaining that the Patent Office had issued the secrecy order and that therefore he could be of no assistance—and sent a copy to Lavender. Three days later he wrote a memo to Carroll L. Wilson, Liaison Office head and Bush's executive assistant, outlining in strict chronological order exactly what had happened—"A slightly suspicious incident is described"—and forwarding copies of his and Wiczer's correspondence. He explained that Wiczer's application was "moderately pertinent" to S-1 work and that the application had not indicated an institutional affiliation or any assignees.[49]

The day Wiczer's letter had arrived, Shurcliff's assistant (and eventual heir to the patent censoring job) David Z. Beckler had suggested that "enemy agents might file 'paper' applications on this subject to obtain leads as to U.S. secrecy policy and perhaps additional information." Shurcliff thought this worth considering: he told his superiors that he "could supply names" of all inventors on his lists without institutional affiliations and suggested that either Wilson or Bush himself "may wish to recommend to proper authorities that FBI or other investigations be made of the 10 or 20 'lone wolf' inventors who have filed applications in the 'S-1' field."[50] In the looking-glass world of Manhattan Project security, the much-lauded "lone inventor" was transformed into the much-feared "lone wolf."

Wilson forwarded Shurcliff's memo to Lieutenant Colonel John Lansdale, Jr., head of Manhattan Project security, who promised to look into the situation with Wiczer and expressed eager interest in the list of "lone wolves" and anything providing "factual basis

[47] Sol B. Wiczer to Shurcliff, 16 Mar. 1944, Bush-Conant File, Folder 13: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 1 [1942–1944]," Roll 2, Target 8, Frame 816.

[48] Shurcliff notepad, 1 Feb. 1943, Bush-Conant File, Folder 13: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 1 [1942–1944]," Roll 2, Target 8, Frame 752.

[49] Shurcliff to Wiczer, 17 Mar. 1944, Bush-Conant File, Folder 13: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 1 [1942–1944]," Roll 2, Target 8, Frame 815; and Shurcliff to Wilson, 20 Mar. 1944, Bush-Conant File, Folder 13: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 1 [1942–1944]," Roll 2, Target 8, Frame 811.

[50] Shurcliff to Wilson, 20 Mar. 1944.

for suspicion of a fishing expedition."[51] A special agent made two investigations into Wiczer's past—interviewing an employer and looking in personal records regarding his past employment and education—and determined what had happened: Wiczer had previously worked as a patent examiner and probably had connections within the Patent Office who would have been able to discover that Shurcliff had been his censor. As such, Wiczer was dismissed as a threat, but the larger specter of the "lone wolf" still loomed.

Once the list was actually compiled, Shurcliff's original estimate of "10 or 20" became only seven inventors who were totally unaffiliated, so far as Shurcliff knew, and he forwarded to Lansdale descriptions of their motley mix of inventions. Lansdale never wrote back to let Shurcliff know the results of the "lone wolf" investigations—they appear to have come to nothing, apart from provoking an angry letter from Captain Lavender to General Groves informing him that private patent applications should not be viewed by unauthorized project personnel.[52]

Shurcliff continued his patent censoring job through October 1944, when he was transferred to another office, and the patent watching job was then taken over by his former assistant. In his time as patent censor, Shurcliff "put to sleep" at least 131 patent applications (about half of the total number that he examined) from at least 95 separate inventors—a small percentage of all Manhattan Project patents filed, but still a considerable number in economic terms, since entire industries can rest on only a handful of patent claims.[53]

The "lone wolf" investigation was not simply an instance of wartime paranoia, though the idea that enemy agents would use mock patent applications to probe U.S. bomb development seems far-fetched—especially in retrospect, when we know that all significant wartime nuclear espionage was conducted by Allied forces (the Soviet Union) and in a much more direct fashion (with project participants volunteering information). Looked at one way, the wartime policy was a direct inversion of the traditional values of intellectual property legislation—the sacrosanct "lone inventor" became the "lone wolf," inherently suspect and requiring preemptive investigation on account of his "lone-ness." But it is worth remembering that the "lone inventor" himself is not only a legal and political fiction, but one often used to shroud the deliberately monopolistic aspects of intellectual property systems, where exclusivity is the name of the game. Though the long-term goals of a patent system are to encourage innovation, the methods of producing this all revolve around the short-term discouragement of competition, and there are even entire industries based on either "defensive" patenting (taking out a patent only for its use as a bargaining chip) or "offensive" patenting (taking out a patent only to use it to demand licenses from others).

[51] Wilson to Lt. Col. John Lansdale, Jr., 22 Mar. 1944, Bush-Conant File, Folder 6: "Patent Matters [1941–1945]," Roll 2, Target 1, Frame 77; and Lansdale to Wilson, 4 Apr. 1944, Bush-Conant File, Folder 13: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 1 [1942–1944]," Roll 2, Target 8, Frame 808. For more information on Lansdale see Gregg Herken, *Brotherhood of the Bomb: The Tangled Lives and Loyalties of Robert Oppenheimer, Ernest Lawrence, and Edward Teller* (New York: Holt, 2002), esp. pp. 58–59.

[52] Shurcliff to Wilson, 11 Apr. 1944, Bush-Conant File, Folder 13: "Material from Liaison Office Files—Primarily Shurcliff's Relations to S-1 Activities, Folder No. 1 [1942–1944]," Roll 2, Target 8, Frame 804; and Lavender to Gen. Leslie Groves, 13 Nov. 1944, Bush-Conant File, Folder 6: "Patent Matters [1941–1945]," Roll 2, Target 1, Frame 110.

[53] Shurcliff to David Z. Beckler, memo, "Remarks on Shurcliff's files on S-1-type patent application data and on secrecy recommendations thereon," 31 Oct. 1944, Bush-Conant File, Folder 6: "Patent Matters [1941–1945]," Roll 2, Target 1, Frame 107.

It is this aspect of the patent system that best defines the practices of the wartime OSRD patent policies, with the rather subversive twist that the agency that granted the exclusivity of the patents was in direct collusion with the agency that would benefit from them. Though the OSRD took pains to minimize this obvious conflict of interest by assigning to different people the roles of patent seeking and patent suppressing, in practice the collaboration between them was unmistakable.

But simply to characterize this collusion as an abuse of power would miss what it reveals about the *limits* of power. Despite Bush's belief that atomic research would be of dramatic wartime and postwar importance, when he made forays into matters of private property he did so carefully, within the structure of the existing law. As was previously noted, this is not entirely shocking from the point of view of bureaucratic considerations: after all, it is precisely the importance of the bomb that made Bush particularly inclined not to jeopardize postwar control through sloppy wartime legal handling of private inventors' patent rights. The possibility of real legal problems arising after the expediency of wartime had passed was not unknown to the participants: Lavender had spent much of his earlier work for the Navy handling messy suits resulting from U.S. infringement upon the claims of British inventors during World War I. It is only when we envision the Manhattan Project as a wartime power superior to all others that we risk losing sight of the legal constraints within which much of it took place, which had appreciable effects on policy and practice.

CONTROLLING SCIENTISTS, CONTROLLING THE ORGANIZATION

Bush had hoped that complete patent control could be accomplished through contract clauses and patent secrecy orders—the former would control developments internal to the project, while the latter would control those external to it. Apart from Sol Wiczer, there is no sign that any unaffiliated inventors came close to investigating—much less seriously contesting—the secrecy orders issued during the war, and so in that respect Bush's control scheme was successful. However, he soon found that controlling inventors *within* the organization—the brainy Nobel "prima donnas," as Groves characterized them—was considerably more difficult.

When the OSRD S-1 project was taken over by the Army Corps of Engineers and became the Manhattan Project—a process begun in the summer and fall of 1942 and officially completed by the beginning of 1943—the Manhattan Engineer District (MED) inherited the OSRD's bomb patent policy in its entirety. Patent administration became a vital and ever-enlarging aspect of the Manhattan Project: each of the many development sites had its own patent representative, invention reports streamed in by the thousands, and General Groves himself took a strong personal interest in the program.

Though the policies to discourage "lone inventors" can be seen as an inversion of the traditional values of the patent system, there are many aspects of implementation that were not inverted at all: patents were still about control, but the focus of this control was not just restricting external competition (as between corporations or between nations); it was also a response to a perceived threat from within the research organization itself. These policies in many ways mirror those undertaken in industry from the 1890s onward, as corporations began to replace individuals as the primary title-holders of patents, though in the case of the Manhattan Project the level of internal control is much more explicit, soaked in the rhetoric of national security.

Project scientists had their own patent concerns, separate from those of the Manhattan

Project bureaucracy. Nuclear physicists in particular had been taking out patents on their work in a rather systematic fashion since the 1920s, with people like Leo Szilard, Ernest Lawrence, and Enrico Fermi leading the way, although by the time the French scientists were thinking about taking out patents in 1939 the idea was still sufficiently foreign that they had to have a small discussion over its ethical merits first. In most cases the explicit goal seems to have been to try to guarantee that some of the profits made from a scientific invention would be reinvested in science, usually by means of assigning title to a third party such as the Research Corporation in the United States or the Centre National de la Recherche Scientifique in France.[54]

In at least two instances, in particular, impulses of this kind ran into trouble with the Manhattan Project patenting goals.[55] In both cases project scientists attempted to assert their patent ownership rights over the claims of the project patent program, and in both cases the difficulty hinged legally on the fact that the key scientific work involved in the invention happened *before* the scientists were on the OSRD payroll and under the sway of the OSRD "short form" clause. The first of these cases, that of the Hungarian physicist Leo Szilard, has been covered thoroughly elsewhere, and I will summarize it only by saying that Szilard attempted to use his patent claims to the first nuclear reactor as leverage to make more substantial demands for a voice in the growing project. He was, after some negotiation, given a choice between his fight for patent rights and the opportunity to participate in the project at all; in the end he chose the latter, as his goal of gaining more of a voice in the project would not be furthered by his exile from it, and so he more or less relinquished his patent claims.[56]

The second case, almost completely neglected in the secondary literature, is that of the plutonium researchers Glenn T. Seaborg, Emilio Segrè, Arthur C. Wahl, and Joseph W. Kennedy—a tangled three-body problem of scientists, university administrators, and the OSRD. The patents whose ownership was under dispute were extremely lucrative: they covered the production and basic chemistry of plutonium, as well as its basic use as a fissile material. Since the work had been performed before any of the scientists were under

[54] On the French scientists see Weart, *Scientists in Power* (cit. n. 30), pp. 93–96. Weart also offers a good summary of similar approaches by other nuclear physicists: *ibid.*, p. 97; another good source is J. L. Heilbron and Robert W. Seidel, *Lawrence and His Laboratory: A History of Lawrence Berkeley Laboratory* (Berkeley: Univ. California Press, 1989), esp. Ch. 3. Some of these patenting conflicts were in relation to the production of radioisotopes, an early market for nuclear physics. For specifics see Simone Turchetti, "The Invisible Businessman: Nuclear Physics, Patenting Practices, and Trading Activities in the 1930s," *Hist. Stud. Phys. Biol. Sci.*, 2006, *37*:153–172; more generally see Angela N. H. Creager, "Tracing the Politics of Changing Postwar Research Practices: The Export of 'American' Radioisotopes to European Biologists," *Studies in History and Philosophy of Biological and Biomedical Sciences*, 2002, *33*:367–388, esp. pp. 369–371.

[55] There are no doubt other cases as well; the finding aid to the Bush-Conant File indicates that Joseph Slepian was involved in a patent struggle over his centrifuge work (see note 45, above), and a recent essay by Simone Turchetti focuses on a patent struggle with administrators by Enrico Fermi. For the latter see Simone Turchetti, "'For Slow Neutrons, Slow Pay': Enrico Fermi's Patent and the U.S. Atomic Energy Program, 1938–1953," *Isis*, 2006, *97*:1–27; and Turchetti, "Invisible Businessman."

[56] This story was first well told in Carol S. Gruber, "Manhattan Project Maverick: The Case of Leo Szilard," *Prologue*, 1983, *15*(2):73–87; it was subsequently covered in Rhodes, *Making of the Atomic Bomb* (cit. n. 5), pp. 503–507. For a good overview of Szilard's patent history and his own thoughts on patents see the introduction by Julius Tabin to Pt. 5, "Patents, Patent Applications, and Disclosures (1923–1959)," in *The Collected Works of Leo Szilard*, Vol. 1: *Scientific Papers*, ed. Bernard T. Feld and Gertrud Weiss Szilard (Cambridge, Mass.: MIT Press, 1972), pp. 527–531. On the "more or less" aspect see Szilard's remarkable testimony before a frustrated House Committee on Military Affairs, in which he made it apparent that his cooperation was never quite complete: Statement of Dr. Leo Szilard, Hearings before the Committee on Military Affairs on an Act for the Development and Control of Atomic Energy, U.S. House of Representatives, 79th Cong., 1st sess., on H.R. 4280, 18 Oct. 1945, pp. 71–96.

OSRD contract, and while they were in the employ of the University of California, the assignment of the patent rights was more murky than Bush or Lavender would have liked.

Here patent control proved a difficult business, and the name of Roosevelt did not prove to be the universal balm Bush had hoped it would be. Outside of the OSRD, Bush's influence was far more limited than he liked; moreover, this was not an issue he could simply resolve by his standard contract system, and the University of California was a savvy and interested negotiator, well aware of the long-term benefits to be derived from patents developed by its scientists. All of the parties involved in the Seaborg dispute were looking to the future: the scientists wanted assurances of postwar research funding; the University of California saw future revenues in a hypothetical commercial nuclear power industry (and perhaps in radioisotope production); and Bush wanted to maintain his regime of technological control (he made no distinction between civilian and military patents during the war itself) and was not about to let any university administrators stand in his way. Because both the inventors and the Regents of the University of California were looking to a postwar world, the appeal to the requirements of wartime that worked so well with contractors had far less traction; and Bush, in Washington, D.C., was far away—literally, figuratively, and, in many ways, legally. Though he tried to impress Roosevelt's intentions on the other parties, in terms of the law the situation was far from clear cut and required months of negotiations.[57] Both the University of California and the scientists eventually relinquished their claims for the remainder of the war, though the scientists were later compensated $100,000 each for the patents by the Atomic Energy Commission (AEC)—a pittance in comparison to the worth of the patents, but much more than the $1 compensation they would have received under OSRD policy.[58]

This "internal" focus of the program is worth calling explicit attention to: all of the dealings with contracts and patent clauses were meant to strip contractors and inventors of any future claims of control, to avoid just the sorts of complicated and potentially compromising disputes that occurred in the Szilard and Seaborg cases (which, again, were problems only because they involved inventions created outside of contracts). This concern is, as already noted, different from the worry that external forces, such as interference suits, would attempt to control the government's nuclear ambitions, though as the handling of the "lone wolves" and "the French problem" shows this was clearly an issue as well. Patents became, for the project administrators, a convenient way to hedge their postwar bets in controlling this new technology to which they early on attributed twin auras of salvation and apocalypse.

By the time the Manhattan Project's authority was transferred to the AEC, on 1 January 1947, over 8,500 technical reports had been examined by the patent officers, over 6,300 technical notebooks had been scrutinized, and 5,600 different inventions in 493 different subject classes—covering everything "from the raw ore as mined to the atomic bomb"—were docketed by Lavender's office, resulting in some 2,100 separate patent applications being approved for filing, 1,250 of which had actually been filed with the U.S. Patent

[57] The only easily accessible version of this episode is in Glenn T. Seaborg, *The Plutonium Story: The Journals of Professor Glenn T. Seaborg, 1939–1946* (Columbus, Ohio: Battelle, 1994). There are many letters relating to the matter in Bush-Conant File, Folder 6: "Patent Matters [1941–1945]"; and it is briefly discussed in Robert M. Underhill, "Contract Negotiations for the University of California," oral history interview with Arthur Lawrence Norberg, 10 Feb. 1976, Bancroft Library, University of California, Berkeley. There are also many boxes of materials relating to this in the Glenn T. Seaborg Papers at the Library of Congress.

[58] Atomic Energy Commission, *Eighteenth Semi-Annual Report* (July 1955), p. 101. Note that there are some strong parallels to the story of Szilard and Fermi discussed in Turchetti, "'For Slow Neutrons, Slow Pay'" (cit. n. 55). There were a number of other cases of compensation claims reviewed by the AEC Patent Compensation Board in the 1950s; this is an aspect of the postwar history of atomic patents that could benefit from further study.

Office at that point. The magnitude of these numbers, if not immediately obvious, can perhaps be appreciated in light of the fact that the latter number would have been 1.5 percent of all the patent *applications* filed in 1946—more than one out of every hundred—or the fact that if all of the inventions docketed had been patented, they would have represented around 0.8 percent of all the patents *in force* at the time.[59] From an economic point of view, the program was massive: it was a deliberate and successful attempt to obtain the patents not just for key inventions but for the technological contents of numerous new industries in their entirety.

The exact number of applications that have been kept secret is not available, but a rough approximation of the scope can be extrapolated: of the approximately 85 patents, originating from Los Alamos research alone, filed between 1943 and the end of 1946, well over 60 had at least five years between their file and their award dates; well over 35 had at least a ten-year delay.[60] This long delay between filing and award is systemic for Los Alamos patents and is most likely caused by the fact that under P.L. 700 the patents that have been declared secret remain applications until they are declassified and awarded. The longest delay on any atomic patent that has since been issued—that is, on the patent that has thus far spent the longest time under a secrecy order—was nearly sixty years. This patent, filed in September 1945 but not granted until July 2004, was for a chemical process related to gaseous diffusion research done at Oak Ridge during the war.[61]

According to the Department of Energy lawyer who processed this long-delayed patent in its final stages, secret patents of this sort are reviewed annually and checked against changing classification guidance documents to see if they qualify for declassification. If a patent application is then determined to be declassified, the lawyers must decide whether it is a worthwhile expenditure of taxpayer funds to push the old application through to completion. A "small good-faith effort" is made to find the inventor, if he or she is still alive, and inform him or her of the patent's issuance, though this is only for purposes of credit (there is no monetary award of any sort, since the inventor has already signed the patent over to the government).[62]

Sometimes changes in classification guidelines can release what seem to be entire components of Manhattan Project weapons, suggesting an alternative way of viewing the atomic bomb: as a composite of many patents. For example, in May 1976 three secret patents were granted that had obvious implications for the war effort. The oldest was an

[59] For the totals coming out of Lavendar's office see "Manhattan District History: Book I—General, Volume 13—Patents," 31 Dec. 1946, in *Manhattan Project: Official History and Documents* [microform] (Washington, D.C.: Univ. Publications America, 1977), Sect. 5, pp. 1–4. The applications filed with the Patent Office were kept in a separate division reserved for military matters; see *ibid.*, Sect. 3, pp. 1–3. Overall patent figures were compiled from the U.S. Patent Office Web site by Bill Rankin, who generously shared his data. Depending on the years chosen, the figures can look even more impressive (patenting activity in general dropped dramatically during the war), but the most conservative version does enough work by itself.

[60] To obtain these numbers, patent information was extracted with a computer program from Los Alamos National Laboratory's library catalogues and tabulated. There is some evidence that the catalogue has undercounted, though probably not to a statistically significant degree for these dates. In any event, these should be taken as rough values only. Around 1,300 Los Alamos patents from many different years can be found through Los Alamos National Laboratory's online library search engine at http://library.lanl.gov.

[61] James P. Brusie, "Method of Determining the Extent to Which a Nickel Structure Has Been Attached by a Fluorine-Containing Gas," U.S. Patent 6,761,862 (awarded 13 July 2004). The majority of the few other patents that have endured comparable delays, according to the U.S. Patent Office's search engine and Google Patents, are either in the cryptographic field or are not in fact really "delayed"; they are, rather, typographical errors (i.e., the Patent Office has recorded the application date as 1938 when it was actually 1988).

[62] Paul A. Gottlieb, Assistant General Counsel for Technology Transfer and Intellectual Property, U.S. Department of Energy, communication with Alex Wellerstein, Aug. 2006.

application for a "Low Impedance Switch," filed in the name of Donald F. Hornig at Los Alamos in November 1945, which described a device that could close "a plurality" of electrical circuits within the space of 0.05 to 0.5 microseconds (the drawing shows sixteen circuits—a significant number when one knows that the "Trinity" gadget used thirty-two detonators). Then there was a "Detonating Apparatus" application, filed in May 1950 in the name of Lawrence H. Johnston, describing a device used "for detonation of high explosive in uniform timing" by means of a spark gap detonator. Last was a "High Explosive Compound" application, filed in January 1956 under the name of Theodore C. Crawford, describing one particular type of explosive with an alterable detonation velocity, useful for shaping the explosive wave in a very precise manner.[63]

The relevance of these three patents to nuclear weapons design should be fairly obvious—they describe key parts of an implosion nuclear weapon, in which the simultaneous detonation of carefully created explosive lenses is used to compress a plutonium core to supercriticality—though all are described in a generic technical language devoid of direct implications for bomb design, which serves to exempt them from the later ban on patents useful *only* for the detonation of nuclear weapons. Hornig's patent, the detonator, describes the invention in a manner that could hypothetically be applicable in many situations: "In certain types of ordnance and other equipment, it is necessary to energize a relatively large number of electrical circuits within periods of time of the order of 0.05 to 0.5 microseconds. . . . The principal object of the present invention therefore, is to provide improved switching apparatus for effecting the simultaneous closing of a plurality of electrical circuits of the type described above."[64] Nowhere, of course, does it note that among these "certain types of ordnance" is the atomic bomb.

These patents, in combination with Johnston's patent on the exploding bridge-wire detonator used in the "Trinity" and "Fat Man" devices (filed in 1944, granted in 1962) and the patent for the pressure switches used in the bombs dropped on Hiroshima and Nagasaki (filed in the name of Alan N. Ayers in 1946, granted in 1967), allow for a reasonable approximation of how an atomic bomb might look through the eyes of a patent lawyer. The pressure switches patent shows the same distinctive electrical harness that can be seen in pictures of the "Trinity" gadget (see Figures 3 and 4 and cover illustration). Many other Los Alamos patents, especially those awarded long after their applications were filed, are similarly suggestive, describing all aspects of bomb production, from explosive chemistry to reactor cooling, ion sources to electrical circuits, neutron sources to neutron detectors.

Two Manhattan Project scientists independently told me that they were asked to sign off their patent rights to the final bomb itself (both reported that they were promised a single dollar in compensation but never received it). An oral history conducted with another indicates that even something like last-minute changes to the design of the plutonium for

[63] Donald F. Hornig, "Low Impedance Switch," U.S. Patent 3,956,658 (awarded 11 May 1976); Lawrence H. Johnston, "Detonating Apparatus," U.S. Patent 3,955,505 (awarded 11 May 1976); Theodore C. Crawford, "High Explosive Compound," U.S. Patent 3,956,039 (awarded 11 May 1976); Lawrence H. Johnston, "Electric Initiator with Exploding Bridge Wire," U.S. Patent 3,040,660 (awarded 26 June 1962); and Alan N. Ayers, "Pressure Sensitive Switch," U.S. Patent 3,358,605 (awarded 19 Dec. 1967). A description of Hornig's development of the switch is in transcript, Donald F. Hornig Oral History Interview I, 4 Dec. 1968, by David G. McComb, Internet Copy, LBJ Library, Austin, Texas, pp. 3–6. Neither Hornig nor Johnston said that he could recall being made aware of his patent(s) being granted: Donald F. Hornig, communication with Wellerstein, May 2005; and Lawrence H. Johnston, communication with Wellerstein, May 2005.

[64] Hornig, "Low Impedance Switch," col. 1.

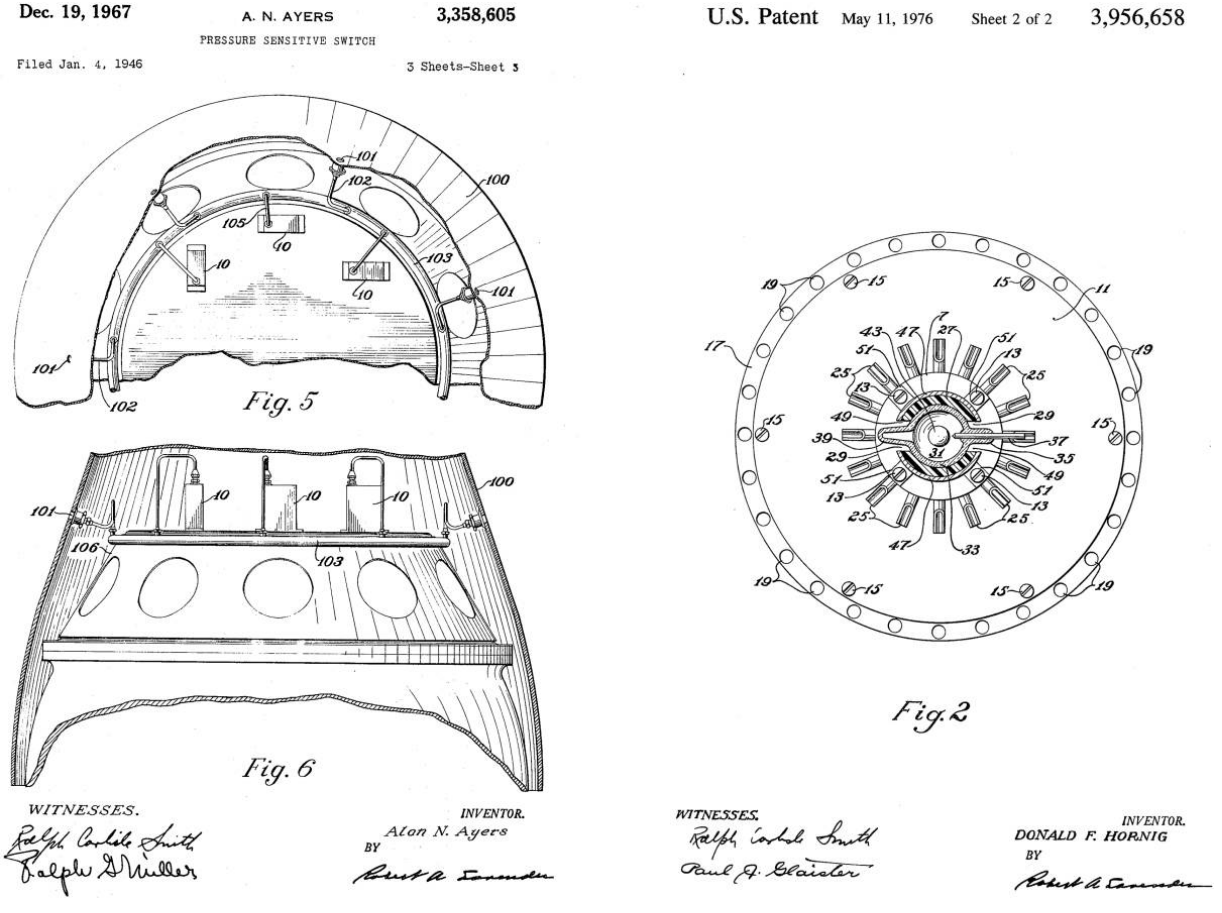

Figure 3. *Images from the "Pressure Sensitive Switch" and the "Low Impedance Switch" patents, showing a firing unit array very similar to that used in the X-Unit of the "Fat Man" bomb and "Trinity" gadget. Source: U.S. Patent Office.*

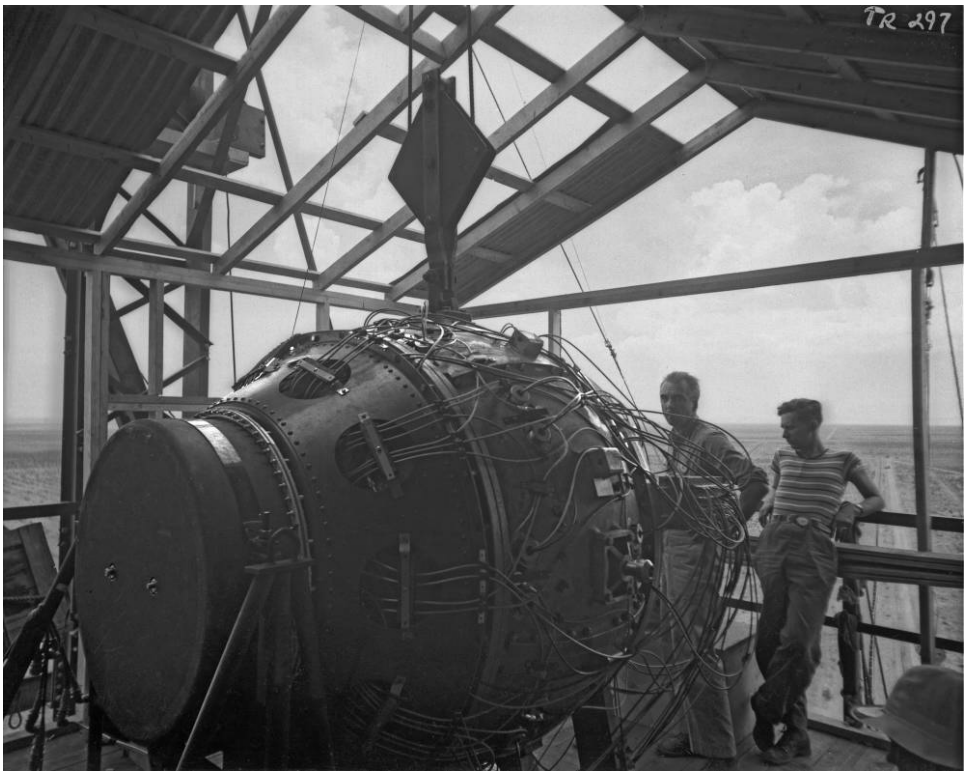

Figure 4. *The "Trinity" gadget detonated on 16 July 1945. The detonating switches are in the X-Unit firing device at the front of the bomb. Note the harness and the cables emanating from it. Source: Los Alamos National Laboratory, photo TR-297, part of collection LA-UR-06-1005.*

the "Fat Man" bomb required a secret patent application.[65] There are certainly patent applications from this period that have not yet been granted, and many (like the above) never will be. But this comes as no great surprise: of course, we reply, the government would never publish something that gave such sensitive information to the world—a response that assumes that a policy of institutionalized secrecy is the obvious approach. But if this is the model for dealing with nuclear weapons, why pursue the patents on such a vast scale? Why patent the bomb, why treat it like any other piece of technological intellectual property?

We have seen so far that these policies were made to control contractors and to control inventors both inside and outside the project; more to the point, the policies were meant to control atomic technology. Because patents did not become one of the major forms of proliferation control in the postwar era, it is easy to write off the patent program as a

[65] Oral communications with Philip Morrison, 9 Feb. 2005, and Robert F. Christy, 5 Dec. 2007. According to Robert Bacher, head of G-Division at Los Alamos during the war, the "Fat Man" core differed from the "Trinity" gadget in that the former "had three pieces instead of two . . . the funny part of it is when you look up the patents, you'll find . . . that little thing there has got a patent on it": Robert F. Bacher, oral history interview with Lillian Hoddeson, 3 Mar. 1986, transcript in the Robert F. Bacher Papers, 10105-MS, Caltech Archives, California Institute of Technology, Pasadena, Box 48, Folder 7, p. 8.

historical anomaly, but only by taking it seriously can we hope to understand its ultimate intent.

CONCLUSION: THE PLACE OF PATENTS IN WARTIME ATOMIC POLICY

In a report to Vice President Henry A. Wallace, Secretary of War Henry L. Stimson, and Chief of Staff General George C. Marshall dated 21 August 1943, Groves included an entire section on the patent program, introduced in powerful language: "If the possibility of world disaster through the development of this superexplosive and its possible military by-products is to be avoided and the enormous hazard involved in preparation minimized, the utilization of atomic power must always be under close control of governments interested in the welfare of mankind rather than in absolute domination and exploitation of other peoples." This rather dramatic statement was immediately followed by what today seems a non sequitur: "If the United States has a strong patent position, the achievement of the above will be facilitated." Lawyers were on the case, Groves explained, and all MED personnel ("both scientific and industrial") had for some time been required to sign over all patent rights to the government. "This program is sound for the war period, which now has first consideration," Groves concluded, "and will lay the groundwork for proper control thereafter." Though much of Groves's report had been cribbed from an earlier one written by Bush, the phrase "possibility of world disaster" was his own, and the level of concern expressed, for all its hyperbole, is commensurate with the scope of the patent-related policy undertaken by the MED, following in the footsteps of the OSRD.[66]

Groves's concern seems misplaced when viewed through modern eyes. The general's intentions to the contrary, patenting did not become a major way of controlling postwar nuclear development—civilian or military, national or international. Instead, U.S. nuclear weapons control during the Cold War took the form of the safeguarding of information (secrecy), attempted monopolies on raw materials, diplomatic agreements, international inspection agencies, and export controls on specific technologies and substances. Patents useful only for nuclear weapons were forbidden by the Atomic Energy Act of 1946. Civilian nuclear power controls took the form of centralized regulatory agencies (such as the Atomic Energy Commission and, later, the Nuclear Regulatory Commission) and operated within a legal framework quite different from patent law. So why did people like Bush and Groves think that patents were a central part of the "groundwork for proper control" of atomic energy during World War II?

Answering this question involves interrogating what exactly "control" means in relation to atomic weapons. Many different policies were undertaken to control atomic energy in the pre-Hiroshima period, and these involved a wide variety of practices and assumptions. Without attempting to provide a comprehensive taxonomy of "control," we can legitimately note that the practices of resource monopolies (entering into exclusive arrange-

[66] Groves and Military Policy Committee to Henry A. Wallace, Henry L. Stimson, and George C. Marshall, memo, "Present Status and Future Program on Atomic Fission Bombs," 21 Aug. 1943, in *Harrison-Bundy Files Relating to the Development of the Atomic Bomb, 1942–1946*, microfilm publication M1108 (Washington, D.C.: National Archives and Records Administration, 1980), Folder 6: "Military Policy Committee Papers—Minutes," Roll 1, Target 6. Cf. Bush to Roosevelt, memo, "Report on Present Status and Future Program on Atomic Fission Bombs," 16 Dec. 1942, in *Correspondence ("Top Secret") of the Manhattan Engineer District, 1942–1946*, microfilm publication M1109 (Washington, D.C.: National Archives and Records Administration, 1980), Folder 25: "Documents Removed from Gen. (L. R.) Groves' Locked Box, Plus Certain Documents of Historical Importance," Roll 3, Target 8.

ments with uranium-producing countries), information limitation policies (compartmentalization, secrecy), personnel evaluation (background investigations and loyalty oaths), site security (barbed-wire fences and posted guards), and diplomacy (international agreements about cooperation and information sharing) constituted some of the basic and well-known categories of controlling the atomic bomb before it had ever been used (and when the most pressing security threat was German knowledge of the program).

In this schema, patents filled a gap between the policies of *individual* control, usually ascribed to "secrecy," and the policies of *international* control, usually described in terms of diplomacy, resource monopolies, and, later, export controls. Specifically, patent control was an attempt at *legal* control; that is, it was an attempt to remove any possible legal *problems* for U.S. government ownership of atomic technology during and after the war. The motivation for this ownership imperative shifted from an initial sense of civic responsibility—preventing corporations or individuals from profiting from government-funded research—to later concerns about the maintenance of technological sovereignty on the part of the government against the interests of foreign countries and individual inventors.

In itself, legal control would not be remarkable as a motivation: it becomes interesting only because we do not assume that there would ever be a legitimate legal challenge to the U.S. government's new atomic stockpile. The "special" nature of the bomb is usually implicitly taken to have given the government a blank check in regard to power, but in the period before the bombs were made public Manhattan Project administrators were forced for the most part to use existing legal structures in their efforts to enforce their own control over these new, "special" weapons. In some cases, of course, they were confident about what lines they could cross: in the area of internal security, for example, there seem to have been few quibbles about legality from project administrators. But with intellectual property—an area with a much stronger legal history, and one where wartime overstepping had historically been paid for in the postwar period—their concern is quite evident. The patenting program can be seen as one part of a multifaceted attempt to use ordinary laws to control extraordinary technology.

Though Bush and Groves clearly thought that atomic energy was something unique, they did not have our modern prejudice that all regulation of it would necessarily be unique. Though Bush had pushed for tight wartime secrecy restrictions on bomb information, he—like many project scientists—did not think that perpetual secrecy was likely to be an effective or efficient way of controlling the spread of nuclear weapons in the long run, and—again like many project scientists—he thought that ultimately the latter could be effectively achieved only through international control agreements.[67]

The patent program was, as Bush often reiterated, a form of control—technological control, an investment for the postwar era, a way to make sure that the individual scientists working on the project were not in a legal position to demand too much direct say over it, and a way to keep the government from having to answer to anyone, on a legal level,

[67] On this point see Vannevar Bush and James Conant to the Secretary of War, "Salient Points Concerning Future International Handling of Subject of Atomic Bombs," 30 Sept. 1944, in Record Group 77, Records of the Army Corps of Engineers, Manhattan Engineer District (MED), Harrison-Bundy Files (H-B Files), Folder 69, National Archives, available online through the National Security Archive at http://www.gwu.edu/~nsarchiv/NSAEBB/NSAEBB162/. There is a copious literature on postwar arms control schemes. See, e.g., Hewlett and Anderson, *New World* (cit. n. 5); Martin Sherwin, *A World Destroyed: Hiroshima and the Origins of the Arms Race* (New York: Vintage, 1987); and James Hershberg, *James B. Conant: Harvard to Hiroshima and the Making of the Nuclear Age* (Stanford, Calif.: Stanford Univ. Press, 1995).

in its goal of nuclear monopoly. If, as Bush and many others thought, atomic energy was going to be what separated the haves from the have-nots of the future, and if it could not—and should not—be kept secret indefinitely, then having all of the key patents—reactors, processes, emitters, receivers, switches, bombs, and all—secured in the name of the government of the United States would not only be a prudent use of $2 billion of the taxpayers' money; it would also be good for national security, economic and political. In this sense, the patent program is perhaps a glimpse at a postwar that never happened: a postwar where atomic energy would lead to a complete revitalization of international economies, where international control and shared information would eliminate the need for an arms race, and where the atomic bomb, while special, would be treated more like another technology than an apocalyptic symbol.

But it should not be misconstrued that there was a single bureaucratic impetus behind the program. As this narrative has attempted to show, in many ways the patenting program was an *ad hoc* adaptation of contract policy and intellectual property practices to address a changing menagerie of threats, whether they were accusations of profiteering, challenges by project scientists over ownership of their work (and a say in the project), or French scientists looking to secure postwar information-sharing deals. It is in part this *ad hoc* nature of the program that made it so difficult to understand in the postwar period: once it was assumed that atomic bombs would have to be regulated by legislation that codified their extraordinary status, all of the composite challenges—the ownership disputes, the French patents, the profiteering question—seemed comparatively easy to brush aside.

The patent program did other work for the Manhattan Project bureaucrats as well. For one thing, patent secrecy was, at the time, the only vehicle for achieving long-term, specifically technological secrecy available to administrators bound by a pre–atomic age legislative system: the 1917 patent secrecy statute was, in fact, the first U.S. statute to permit the government to impose secrecy restrictions on what could be entire categories of information developed *outside* of the government, foreshadowing the all-inclusive definitions of secrecy that would later come to fruition in the "born secret" clauses of the Atomic Energy Act of 1954.[68] Patent secrecy was, of course, considerably more limited in scope than the full system of perpetual nuclear secrecy that would materialize under the auspices of the Cold War atomic mentality: its threats were based primarily on the assumption that the denial of a potential patent in the United States would be enough of an economic inconvenience to deter infraction. But patent control allowed the Manhattan Project administrators to reach out into the private sphere, to declare things secret even if they had not been created within the project, and could serve as a stop-gap control measure until full legislation for atomic energy had been passed by Congress.[69]

The significance of the Manhattan Project patent program is, then, twofold. First, within the context of the history of the Manhattan Project itself, it represents one of the many paths to "control" that, in the end, did not become significant in the postwar era. In this, the definition of the bomb as a form of technology with specific authorship and intellectual property implications is one of the many competing definitions that existed in the 1940s,

[68] Arvin S. Quist, *Security Classification of Information*, Vol. 1: *Introduction, History, and Adverse Impacts* (Oak Ridge, Tenn.: Oak Ridge Classification Associates, 2002), p. 26; available online at http://www.fas.org/sgp/library/quist/.

[69] The evolving importance of the "secret" in the early Cold War is well covered in David Kaiser, "The Atomic Secret in Red Hands? American Suspicions of Theoretical Physicists during the Early Cold War," *Representations*, 2005, *90*:28–60.

before a more "Cold War" assessment of it became thoroughly cemented in the early 1950s with the spy trials and the Atomic Energy Act of 1954.

Second, in the context of nuclear historiography in general, the patent program can serve as an example of the ways in which historians, adopting those same visions of the bomb and its meaning that became so prevalent during the Cold War, have managed simply not to see large developments that did not sensibly fit into this model. While the Manhattan Project's massive patent program is emphasized in a number of accounts by participants, almost all subsequent histories omit any mention of it, and those few that do discuss it take notice only where it occasionally intersects with more "traditional" Manhattan Project narratives, as in the context of the struggle between scientists and bureaucrats or the places in which it served as a locus for diplomatic chafing. The patent program can serve as an important reminder of the need to revisit nuclear history, without reading events entirely through the lens of what *did* occur and, in the process, missing many of the other directions that history could have taken.[70] It is, in the end, a provocation to be skeptical of technological determinism, even in the case of an artifact as politically laden as the atomic bomb.

The patent program can be seen as something of a barometer of how administrative attitudes toward the atomic bomb changed over the course of its development. At first work on the bomb was regarded like any other wartime research venture—a speculative approach to an improved form of explosive whose success seemed possible but not necessarily probable. As it became a more realistic possibility, and a more massive development project, patent control became more important and at the same time more exceptional—the atomic bomb became something for which absolute patent control was required, and the act of patenting itself was contorted toward its most monopolistic extremes. Finally, when the bomb became a public reality, and its existence as a "special" technology was cemented after it was credited for Japan's surrender, the patent program—though in many ways an incredible attempt by the federal government to extend its ability legally to control technology—was seen as woefully inadequate, if not a liability. Its increasing omission from contemporary discussions and its almost total absence from the historical literature reinforce the idea that this was an insignificant effort, despite its immense scope and its importance to the leading project scientists and administrators.

In the absence of a clear model for how properly to control a technology that he thought would be revolutionary, and for whose realization he was dependent on expertise outside the government, it is not surprising that Bush looked to the patent system as a potential solution—and not so surprising that Roosevelt gave him the go-ahead. The patent system was a well-established and legally sound approach to technological control, both domestically and internationally, and, faced with a new—but still forming—conception of weaponry and power, Bush—himself an engineer with a rich history of involvement with the patent system—sought mastery first in preexisting systems of technological control while at the same time thinking about what systems would exist in the future.

After the war, all this would change. Attitudes about nuclear weapons policy, though never quite stable, coalesced into a far more rigid model. The notions of "secrecy"

[70] Michael Gordin's recent book on the bombing of Hiroshima and Nagasaki was in a way an inspiration for my thinking about competing visions for the bomb during World War II itself. It makes many salient historiographical points about reading what we know of the outcome back into the narratives of the war, arguing in part for a more epistemically flavored reevaluation of nuclear history, refusing to take for granted the technological uniqueness of the bomb itself and arguing that the construction of such a vision of the bomb must itself be analyzed. See Gordin, *Five Days in August* (cit. n. 6).

(information control) and "security" (physical and personnel control) used in the Manhattan Project seem to have collapsed into each other; and after the "nuclear club" was established the diplomatic and economic policies of international nonproliferation agreements became the new way of envisioning atomic control. Patents had very little to do with this: aside from their inherent limitations of scope, the Atomic Energy Acts effectively took the question of patenting the bomb out of the bureaucratic consciousness and made it a considerably less pressing issue from a security standpoint. Patenting policies within the nuclear complex continued, though it seems from a preliminary analysis that the patenting of inventions that clearly would never be declassified under the new regime of secrecy was more a matter of registering priority—and thus probably of establishing stepping stones for career advancement—than a question of legitimate short- or long-term technological control.[71] At the same time, postwar debates about atomic patent policy would refocus on economics rather than on security.[72] The legacy of the Manhattan Project patenting program seems to have persisted in its successor agencies, but the original impetus had waned.[73] As time went on, the belief that there was a strong connection between military security and patent control in relation to nuclear power faded into irrelevance and, because it defied an easy fit into the traditional narrative of the bomb, became increasingly incomprehensible.[74]

[71] Priority and secrecy relating to nuclear weapons have been provocatively discussed in Gusterson, "Death of the Authors of Death" (cit. n. 5). On behind-the-fence recreations of "open" institutions, such as "classified" journals and the like, much has been written; there is a good bibliography in Peter Westwick, "Secret Science: A Classified Community in the National Laboratories," *Minerva*, 2000, *38*:363–391, n. 1.

[72] Though there were extensive debates about patents in relation to the Atomic Energy Act of 1946 and the revisions of 1954, as the war faded into the background the debates focused almost exclusively on questions of private ownership for economic purposes—and not on security implications. For a discussion of these debates see Hewlett and Anderson, *New World* (cit. n. 5), pp. 495–498, 523–524, 527; James R. Newman and Byron S. Miller, *The Control of Atomic Energy: A Study of Its Social, Economic, and Political Implications* (New York: McGraw-Hill, 1948), Ch. 8; and Richard G. Hewlett and Jack M. Holl, *Atoms for Peace and War, 1953–1961: Eisenhower and the Atomic Energy Commission* (Berkeley: Univ. California Press, 1989), pp. 115–117. Note that Hewlett and Anderson, who are usually quite reliable, take their understanding of the patent issue from Newman and Miller, whose account in turn rests almost solely on Lavender's testimony and for this reason is extremely inadequate in terms of historical context (Newman's account of this matter should be read strictly as the point of view of one of the lawyers responsible for the first Atomic Energy Act, not as a synthetic historical presentation). One of the few instances in which the security question in relation to patents was raised in the postwar period was in the context of a House Un-American Activities Committee attack on David Lilienthal in 1947. See Jessica Wang, "Science, Security, and the Cold War: The Case of E. U. Condon," *Isis*, 1992, *83*:238–269, esp. pp. 244–248; and Creager, "Tracing the Politics of Changing Postwar Research Practices" (cit. n. 54).

[73] For a full discussion of Atomic Energy Commission and Department of Energy patent policies—and struggles—throughout the Cold War see Edward C. Walterscheid, "The Need for a Uniform Government Patent Policy: The D.O.E. Example," *Harvard Journal of Law and Technology*, 1990, *3*:103–166.

[74] A succinct example of precisely *how* incomprehensible it became can be found in Walterscheid, "Need for a Uniform Government Patent Policy." This former Deputy Laboratory Counsel for Los Alamos National Laboratory insists numerous times that the historical MED/AEC/DOE patent policies make little sense from a legal point of view, since "ownership of patent rights has very little to do with protection of national security" (p. 158). Such a point of view, though, had not yet solidified in the years of the Manhattan Project.