LETTERS TO THE EDITOR | MAY 01 2021

Manhattan project patents and S-Numbers explained FREE

Bill Streifer

Am. J. Phys. 89, 451–452 (2021)
https://doi.org/10.1119/10.0003549

LETTERS TO THE EDITOR

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Manhattan project patents and S-Numbers explained

Dear Editor,

In a 2011 Resource Letter, Cameron Reed provided sources on the physics and history of the Manhattan Project, including general works, technical works, biographical and autobiographical works, foreign wartime programs and allied intelligence, technical papers of historical interest, and postwar policy and technical developments.[1]

Among the sources included was a paper titled "Enrico Fermi and the Physics and Engineering of a Nuclear Pile: The Retrieval of Novel Documents," by two Italian physicists from the University of Naples "Federico II," S. Esposito and O. Pisanti, submitted March 7, 2008.[2] Incidentally, Federico II, founded in 1224, is the oldest lay university in Europe.

Reed's "Resource Letter MP-2" said of the above, "The authors described a number of previously uncovered papers and patents that trace the evolution of the work of Fermi and his collaborators in developing reactors."[1] Indeed, the two physicists had discovered at the U.S. Patent Office the paperwork for 15 Fermi patents, filed up to 1952, "the vast majority ranging from 1944 to 1946; All but two dealt directly with nuclear reactors," noting: "In practice, all these patents were issued many years after their application to the competent office, some of them being even posthumous, and were never published…"[1]

The result of a Google Patent search revealed that Enrico Fermi was granted 18 patents through 1952, three from patent offices outside of the United States. The earliest, "Process for the Production of Radioactive Substances," was filed on October 3, 1934. The most recent, "Method of Operating a Neutronic Reactor," was filed on December 1, 1952. Fermi's 18 patents, however, are but a tiny percentage of all patents granted to Manhattan Project scientists.

But what is meant by a "published" patent application? Starting in November 2000, the U.S. Patent Office (USPTO) implemented the publication of patent applications 18 months after their earliest filing date (now defined as the earliest priority date). At some point in the patent process, the USPTO creates a full official copy of the application, complete with a unique publication number. As of the publication date, the patent application can be found by anyone who searches for it (e.g., using Google Patents or Public PAIR). PAIR refers to Patent Application Information Retrieval (at https://portal.uspto.gov/pair/PublicPair).

At this point, it is important to clarify the difference between a patent application and a granted patent. Patent applications, once transformed into granted patents, are published by the USPTO. This has been the case since the 19th Century in the United States. An application, however, can be kept secret under a variety of laws passed in the 20th Century. Manhattan Project patent applications, for example, remained classified until after the war, and in many cases (like Fermi's reactor patent applications) were kept classified until the push for declassification came in the 1950–1960s as part of an attempt to create a domestic private nuclear industry. Their declassification in many cases led to their being granted as a patent.

During the war, Vannevar Bush used the Office of Scientific Research and Development (OSRD) in an attempt to acquire a monopoly on the patent rights for inventions used in the production of nuclear weapons and nuclear energy as a means of maintaining secrecy. Reference 3 contains a fascinating examination of this history.[3]

Since it is impracticable to locate all patents granted to Manhattan Project scientists, I was fortunate to obtain from the Department of Energy (DOE), in 2017, via the Freedom of Information Act (FOIA: HQ-2017–00351-F), a list of approximately 1500 patent applications related to the Manhattan Project.

The first column of the above report is labeled "S-Numbers" (numbered 000001–004432), If each S-Number represents a single patent application, gaps in that numbered list would suggest that many more patents were applied for than were eventually granted. With few exceptions, these patent applications were submitted between 1942 and 1946. Most patents were later granted in the 1950s, some as late as the late-1950s and early-1960s; and were assigned to the Atomic Energy Commission (AEC).

In addition to Enrico Fermi's 18 patents, others were issued to renowned Manhattan Project scientists including J. Robert Oppenheimer, Leo Szilard, and Harold C. Urey. Patents were also issued to relative unknowns such as James I. Hoffman (S-Number 000001), an analytical chemist who was involved in the Manhattan Project from the beginning.[4]

According to an undated AEC report on the purification of uranium oxide (declassified in 1947), "In the early summer of 1941, Leo Szilard (a member of Power Production Subsection of the Uranium Committee) gave a sample of impure uranyl nitrate to the author [James I. Hoffman] and requested the uranium be separated from everything else."[5] Another version of this story appeared in H.D. Smyth's Atomic Energy for Military Purposes (1945), which read, "The use of this method removed the great bulk of the difficulties in securing pure [uranium] oxide and pure materials for the production of [uranium] metal." Hoffman, who filed his patent application on June 17, 1942, was granted a patent for the process on September 28, 1954 (U.S. Patent No. 2,690,376).

Some of the S-Numbers and their associated inventions remain exempt from disclosure in accordance with DOE Exemption (b)(3), information "specifically exempted from disclosure by statute." In the case of nuclear patents, the statute was the Atomic Energy Act of 1954, which includes Restricted Data (RD) or Formerly Restricted Data of three types: (1) the design, manufacture, or use of atomic weapons; (2) the production of special nuclear material; and (3) the use of special nuclear material in the production of energy. Whether it is possible to imagine that the mere "title" of a patent application from the 1940s could possibly contain "Restricted Data," as the DOE censor apparently concluded, I leave to the reader to contemplate.

Later in 2017, that list of Manhattan Project patents was posted to the Wilson Center's "International History Declassified" Digital Archive.[6] Their publication will permit future historians and researchers to obtain formerly classified patent files related to the Manhattan Project, and to dig deeper into the patents of Enrico Fermi and many others, some of which undoubtedly have yet to come to light.

[1]B. Cameron Reed, "Resource letter MP-2: The Manhattan project and related nuclear research," Am. J. Phys. **79**, 151–163 (2011).

[2]S. Esposito and O. Pisanti, "Enrico Fermi and the physics and engineering of a nuclear pile: The retrieval of novel documents," Report Number: DSF-1/2008; e-print arXiv:0803.1145 (physics.hist-ph).

[3]Alex Wellerstein, "Patenting the bomb: Nuclear weapons, intellectual property, and technological control," Isis **99**(1), 57–87 (2008).

[4]"U.S. National Bureau of Standards," Nature **4819**, 929 (1962).

[5]"Purification of Uranium Oxide" (MDDC-777), U.S. Atomic Energy Commission, Technical Information Division, Oak Ridge Directed Operations, Oak Ridge, Tenn., Date of Manuscript Unknown (Declassified on March 18, 1947).

[6]See <https://digitalarchive.wilsoncenter.org/document/165247> for the Department of Energy's "List of U.S. patents related to the Manhattan Project."

Bill Streifer

Bouncing ball impacts

Rod Cross[a)]

School of Physics, University of Sydney, Sydney, NSW 2006, Australia

(Received 22 January 2021; accepted 25 January 2021)

https://doi.org/10.1119/10.0003550

In a recent paper in this journal, Paul Hatchell used a simplified bounce model to describe experimental observations of multiple impacts of a bouncing table tennis ball.[1] The model predicts that the ball will bounce an infinite number of times before it comes to a stop. The same model was used previously, where other balls were predicted to take a finite time to bounce an infinite number of times.[2,3] There are several problems with the model. The first is that the impact of a ball on a horizontal surface takes a finite time, typically a few milliseconds. If a ball bounces an infinite number of times then it will make an infinite number of collisions with the surface so it will take an infinite time to stop bouncing.

Given that a ball will stop bouncing after a few seconds, it is clear that it bounces only a finite number of times. For example, suppose that the coefficient of restitution is 0.5. If the ball is dropped from a height of 1 m, then the height of the bounce will decrease to about 0.01 mm after a few seconds. If the impact time for each bounce is neglected then the bounce height one second later would be 3.7×10^{-46} mm, 34 orders of magnitude smaller than the diameter of a proton. Well before that happens, the impact force on the ball will decrease to a value smaller than the weight of the ball, at which point the ball will stop bouncing.

The fate of a bouncing ball can be observed clearly by dropping it on a piezoelectric disk to measure the impact force.[4] If the ball is dropped from a very small height then the ball will bounce about ten times before it stops bouncing. The force on the disk drops to zero each time the ball bounces in the air, so the flight time in the air can be measured accurately between each collision. When the bounce height is less than about 0.01 mm, the ball no longer becomes airborne between collisions. Instead, the ball vibrates up and down while maintaining contact with the piezoelectric disk, the average force on the disk being equal to the weight of the ball. In less than one second, the vibrations become too small to measure and the force on the disk settles to a constant value equal to the weight of the ball.

[a)]Electronic mail: rodney.cross@sydney.edu.au

[1]Paul Hatchell, "Investigating t_∞ for bouncing balls," Am. J. Phys. **89**, 147–156 (2021).

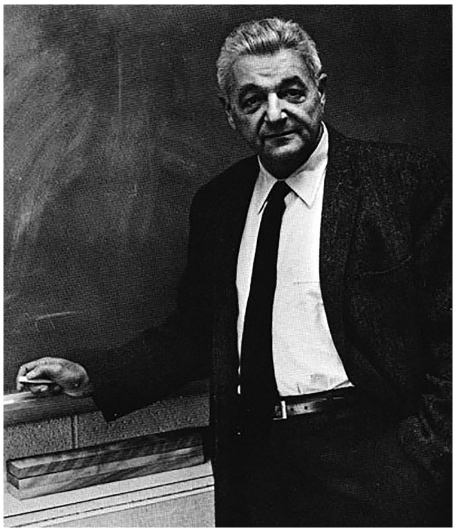
[2]S. K. Foong, D. Kiang, and P. Lee, "How long does it take a bouncing ball to bounce an infinite number of times?," Phys. Educ. **39**, 40–43 (2004).

[3]A. Nordmark and H. Essen, "An impacting linear three body system," Eur. J. Phys. **39**, 015001 (2018).

[4]Rod Cross, "Measuring coefficients of restitution with a piezo disk," Phys. Educ. **55**, 035008 (2020).

Jerrold Zacharias, a passionate educator

(Received 15 March 2021; accepted 16 March 2021)
https://doi.org/10.1119/10.0004126



Dear Editor,

I was a student of Professor Jerrold Zacharias at MIT and am interested in gathering material for an article about the informal but direct ways he influenced the careers of his students and colleagues. A great deal is known about his critical role in changing American science education beginning in the late 1950s. As a principal driver of the Physical Science Study Committee (PSSC) program, he and colleagues in diverse disciplines developed a radically new approach to teaching physics at the high school level—an approach that propelled many young people to pursue careers in physics and other sciences.

Less is known about Zacharias's profound influence on the professional lives and careers of students and colleagues who—like myself—were strongly influenced by his taste and style as experienced in direct interactions. The primary reason I am writing to the *American Journal of Physics* is the hope that readers who knew Zacharias will respond to this letter with their recollections.

There must also be a rich legacy of stories and colorful experiences in the memories of people who interacted with him. I remember such Zacharias aphorisms as, *"What can a fly eat?"* said if a thing of no consequence somehow became important in an argument. Or in response to a study he considered unworthy, he might have said, *"Some people, when they mess up a golf shot, find diamonds in the rough. You found a lot of golf balls."* There are doubtless many other colorful and sometimes profound phrases and situations his former students and colleagues can recall. I would like to know them and include them in the article.

I hope readers of the *American Journal of Physics* who remember Jerrold Zacharias will respond to this letter by sending their recollections to Herb Lison, one of my former students, who is assisting me in this effort, at this email address: lisonh@alum.mit.edu.

Rainer Weiss
Professor Emeritus, Department of Physics, MIT