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The affordable home smoke alarm, Lyman Blackwell- 2015 DiNenno Prize winner

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Abstract

The 2015 Philip J. DiNenno Prize was awarded for the affordable home smoke alarm. This technology developed and implemented by Lyman L. Blackwell and Duane D. Pearsall paved the way for installation of smoke alarms in all residences. This has had a major impact on the reduction of deaths due to fire. The 2015 Philip J. DiNenno Prize was awarded to Lyman L. Blackwell, with ample commendation to his deceased compatriot, Duane D. Pearsall. Contributions were made by Paul Staby, B. K. Sweeney, Rexford Wilson, Myrle Wise, Gus Degenkolb, Eugene Cray, Jack Rhodes, Dick Bright, and Dick Bukowski. This review presents an overview of the background to the technological development and its impact on public safety.

Introduction

The DiNenno Prize recognizes "technical achievement that has made a significant impact on public safe and its implementation by one or several individuals who made significant contributions to that development". The Prize winner must be alive at the time of the award, though deceased contributors are to be well recognized. The DiNenno Prize has been developed by NFPA to recognize and encourage innovations that enhance public safety (http://www.nfpa.org/about-nfpa/awards/dinenno-prize).

The inaugural prize was awarded for **the Affordable Home Smoke Alarm**. The Prize winner was inventor **Lyman Blackwell**, who worked closely with entrepreneur **Duane Pearsall** to develop the affordable home smoke alarm. Together they not only formulated needed technological innovations but also successfully overcame barriers between the laboratory and the marketplace. First developed in the 1960's, the affordable home smoke alarm has had more direct and far-reaching impact on public safety than any other technical fire safety innovation of the past century.

Technical developments usually evolve from a continuum of work performed by many investigators, inventors and entrepreneurs – each improving on the works of others. But sometimes an individual or cluster of workers makes a commitment to game-changing innovation and overcomes seemingly insurmountable obstacles. This happened in the 1960's when entrepreneur **Duane Pearsall** (deceased) and engineer/inventor **Lyman Blackwell** set out to "make a battery-powered detector so inexpensive and easy to install that every household could afford one." Assisted by team members like staff engineer Paul Staby, they began to realize their goal when the new battery-powered home smoke alarm hit the marketplace in 1972.

Impact on public safety

In 1973 the National Commission on Fire Prevention and Control reported the U.S. had the highest per capita fire death rate in the industrialized world [1]. While differing reporting practices made international comparisons difficult, American fire death rates were reported as twice second rated Canada, three times higher than the U.K., four times Japan and over ten times France and Italy [2].

Soon after the home smoke detector hit the marketplace in the 1970's, fire deaths began to decline. Thirty years later American fire deaths had fallen 50%. The per capita death rate had dropped by nearly two thirds - from 35 deaths per 100,000 population down to 13 (Figs. 1 and 2). It's estimated some 60,000 fire deaths did not occur that would have if the death rate had remained constant over these three decades. While the decline in fire deaths can be attributed to a number of factors (like reductions in cigarette smoking), there can be little question the affordable home smoke alarm had major impact. Over the same thirty year period, the

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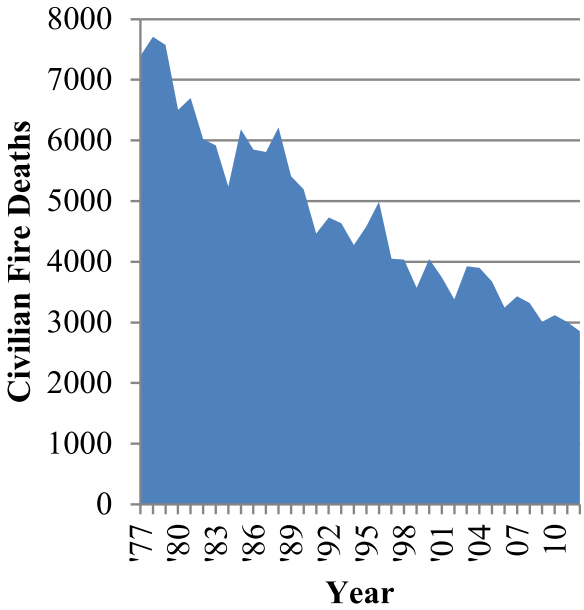

Fig. 1 Trend in US fire deaths [11]

number of households having smoke detectors increased from less than 4% to 94% (Fig. 3).

Technical achievement

In 1977 Richard Bukowski reported that research was beginning to show that residential smoke detection systems had the potential to save many lives [3]. But they were prohibitively expensive and the standards of the day emphasized heat detection. In a 1974 *Fire Journal* article, Richard Bright, a leading detection researcher at the National Bureau of Standards (now NIST), estimated a cost of $700 to $1200 to protect a typical three bedroom home using the heat detection systems of the day. In the same article he noted "the judicious installation of one or two smoke detectors could be more effective than a house full of heat detectors in alerting dwelling occupants to fire" [4]. As simple as it appears, the battery powered home smoke detector, developed by Lyman L. Blackwell and Duane D. Pearsall, was a key innovation to retrofitting tens of millions of American households with effective smoke alarm protection.

Ionization smoke detectors were found in commercial and industrial applications dating as early as the 1940's. However, these hard-wired systems required significant electrical power and were not practical for residential application, especially retrofitting. Blackwell contributed to making commercial systems more energy efficient through his development of his patented concentric dual chamber ionization detector. [5, 6]. The device was particularly energy efficient due in part to his creative use of an inverted triode design he invented several years earlier.

Blackwell got a running start at creating the home smoke detector using electronics he invented for the B. K. Sweeney Manufacturing Company (e.g. Electrostatic voltage metering device, US Patent 3109141, filed December 5, 1960 and Portable Static Meter for Determining Magnitude and Polarity of Accumulated Electrostatic Charges, US Patent 34496668, filed 3/15/65). He said Sweeney authorized use of the patents at no cost to Statitrol on account of the public safety application. Early Blackwell detector-related patents include US Patent 3735375, Circuit for Detection of Small Resistance Changes in Ionization Chamber Devices filed December 4, 1969 and US Patent 3673586 filed February 19, 1970, Resistance Controlled Timed Pulse Generator.

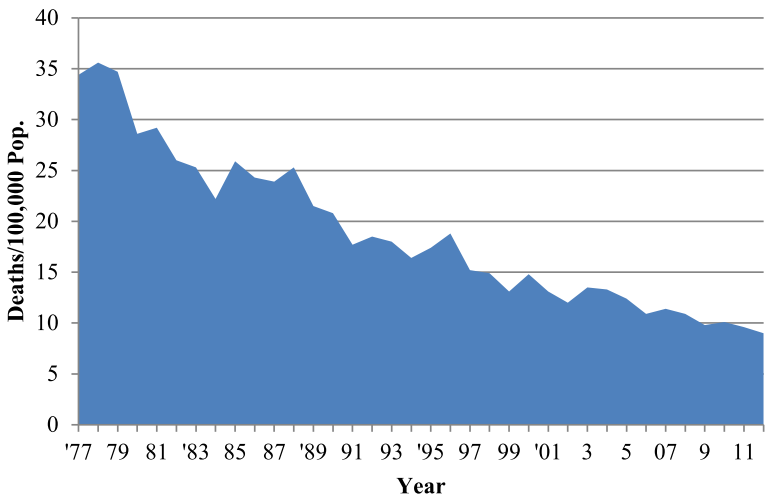

Fig. 2 Trends in per capita fire deaths in the US [12]

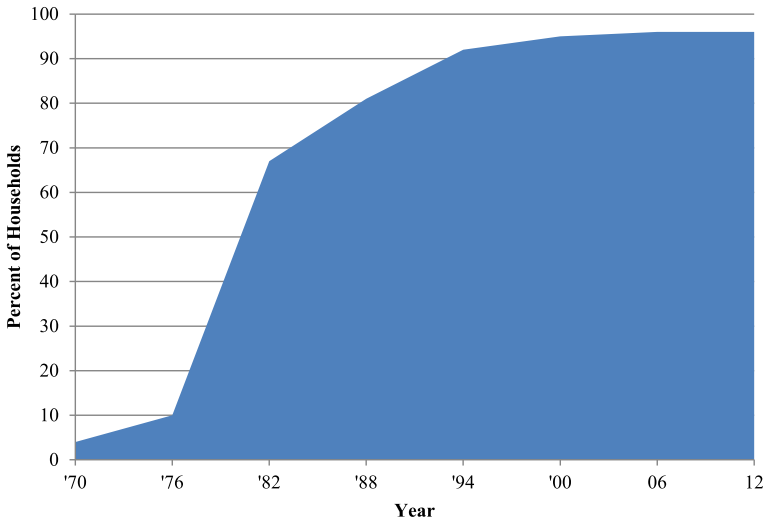

Fig. 3 Trend in the percent of households with smoke alarms in the US. [13, 14]

By the mid-sixties Blackwell had developed the commercial version of the concentric ionization detector and they were at UL for testing and approval. According to Pearsall's Memoir, it was in 1964 that Blackwell presented the battery powered prototype to Pearsall, saying "we ought to try to make a battery-powered detector so inexpensive and easy to install that every household could afford one." This was the "ah-ha moment."

Blackwell then developed a self-powered residential smoke detection system. In this case he relied on the Complemenary Metal Oxide Semiconductor (CMOS) to further reduce energy requirements and make the battery power source more feasible. The US Patent (Blackwell & Staby) [7] reads in part as follows:

"Prior art devices used a supervisory battery as a reference to monitor the condition of a battery used for power, however, if the supervisory battery were to fail, no provision is made for registering an alarm condition for monitoring the main battery which is an obvious deficiency".

"It is thus the primary objective of this invention to provide a battery energy monitoring circuit which derives its own power from the same source as that being monitored and overcomes this deficiency."

"A second object of this invention is to provide a battery energy monitor which will produce its own alarm when the energy of the battery being supervised is reduced to some predetermined level."

The new battery powered home smoke alarm was the first of its kind to receive testing laboratory approval (Factory Mutual - 1972). Shortly thereafter it made its retail debut in the Sears Catalog as the Statitrol Smoke-Gard Model 700. The intellectual property was later sold to Emerson Electric.

Individual roles in the achievement

As mentioned earlier, Lyman L. Blackwell and Duane D. Pearsall were principal to the development and implementation of the affordable home smoke alarm. The role of Blackwell was that of engineering consultant, technical innovator and inventor. Pearsall's focus was on the implementation side of the equation as the entrepreneur, community organizer, marketer and manufacturer. Both were key to achieving the public safety impact described above.

In the 1960's Pearsall was busily at work starting up his first successful manufacturing company called Statitrol Corporation. His product was designed to eliminate static electricity problems in industries like newspaper printing, photo and data processing operations.

Things were going well and the company was starting to turn a profit. Then disaster loomed. Customers were complaining of product failures in the field. Something had to be done, and done fast. Nothing could have been further from Pearsall's attention than smoke detectors.

Pearsall called in his engineer/inventor consultant Lyman Blackwell to help figure out why the ion generator was misbehaving. Pearsall's Memoir reports he stumbled on the idea of detecting smoke particles during one of Blackwell's experiments to measure the flow of ions in the airstream discharging from the generator. He describes this moment as his "point of discovery …the embryonic beginning of the battery operated home smoke detector." [8].With no experience in the field, Pearsall set out to develop a smoke detection business, moving well beyond hard-wired commercial ionization systems which were still too costly for the average homeowner, especially for retrofitting existing homes.

Pearsall forged ahead to develop what would ultimately be a completely self-contained battery powered home smoke alarm system about the size of a coffee cup…that could easily be attached to the ceiling with two screws. Once again Blackwell led the technical effort which culminated in the patented SmokeGard Model 700. Statitrol staff engineer Paul Staby assisted with the self-monitoring circuitry…a key feature for overcoming resistance to the battery power concept.

Pearsall made good progress with his smoke alarm business in a relatively short time – at its peak Statitrol had some 1,000 employees turning out smoke detectors. But the journey from prototype to the marketplace was fraught with barriers to overcome…the NFPA Standard didn't permit battery power, testing labs had no standards upon which to base approvals, state and local codes didn't require home fire alarms, and some fire service leaders were openly opposed.

Refusing to take no for an answer, Pearsall set out to make it happen. While he was personally involved every step of the way, part of his genius was an exceptional ability to harness the involvement of other enthusiastic talents – ranging from engineers and marketing professionals to dedicated rank-and-file factory workers and public service advocates.

He assembled an ad hoc cluster of fire community members to help him promote understanding and resolve concerns among fire and building professionals. This included **Rexford Wilson**, consulting fire protection engineer, Denver Fire Chief **Myrle Wise** and **John "Gus" Degenkolb**, retired Los Angeles Fire Department officer and code consultant. Together they talked up the idea, answered technical questions and distributed free prototypes of the detector to movers and shakers in the world of fire safety.

Pearsall and his team would leave no stone unturned, approaching FM despite the fact the laboratory had no history of testing home safety products. As it turned out management took an interest, due in no small measure to altruistic motives of individual FM personnel. In a 1971 internal memorandum from **Approvals Manager Eugene Cray to Vice President Jack Rhodes**, Cray reported an increase in requests for fire alarm systems, in direct proportion to public and government officials' growing concern over the appalling loss of life resulting from home fires. Cray recommended that FM Approvals move into the home fire alarm certification business. Interestingly the first laboratory approval of the battery powered home smoke detector came from Factory Mutual Laboratories (now known as **FM Approvals**), which had never in its 136 year history tested and approved a household product.FM had always focused exclusively on fire equipment for industrial and commercial applications. Within weeks a new residential approval category was authorized by management and, with technical assistance from **Rexford Wilson**, tests of the Statitrol SmokeGard Model 700 were undertaken. FM approval was achieved in 1972. At about the same time, SmokeGard made its retail debut in the Sears & Roebuck Spring Catalog at a list price of $37.88. Underwriters Laboratories tested and listed the SmokeGard in 1974.

Lyman L. Blackwell, P.E., Inventor

In a 2011 YouTube interview (https://www.youtube.com/watch?v=IJ3mUgWC5m0) Lyman Blackwell described his pre-teen inventiveness and curiosity about technologies like radio transmitters and electromagnets. In high school he made money repairing radios, jukeboxes and pinball machines.

After graduating from Canon City, Colorado High School in 1942, Lyman Blackwell attended the US Army Air Forces Technical School in Amarillo, Texas. Soon thereafter he shipped out to join the Allied war effort where he flew 33 bombing missions in the European theatre. After the war he returned to study at the University of Colorado under the GI Bill, earning his BS degree in Electrical Engineering in 1949. He was born with engineering creativity in his DNA and was basically a self-employed inventor his entire life (at age 91 he's still "in the lab" every day).

Blackwell's mainstream career focused mainly on troubleshooting and enhancement of electro-mechanical systems in the food processing, manufacturing and health care industries. Along the way he worked in the hospital environment, assisting with EKG, EEG and radiation detection devices, pacemakers, cobalt therapy and "iron lung machines".

In the 1960's he operated his own company manufacturing Gieger counters which were built around some of his own inventions having to do with the inverted triode. Consulting for the B.K. Sweeney Company, he used similar technology for detecting static electricity in clouds, useful in assessing the risk of lightning strikes in connection with rocket launches at Kennedy Space Center. He also reports accidentally stumbling on the idea that the same technology could be used to detect smoke particles. Indeed he led development of the self-powered home smoke alarm technology that is commonly used today to protect dwellings of all kinds.

Duane D. Pearsall (Deceased 2010), Entrepreneur

If Duane Pearsall were still alive, he would be included as a co-recipient of The DiNenno Prize. While Blackwell performed the technical innovation for the affordable home smoke alarm, Pearsall worked tirelessly to overcome seemingly insurmountable marketplace barriers to implement the technology.

Pearsall graduated from his hometown high school in Pontiac, Michigan in 1940. Like Blackwell, he started earning his own money in his pre-teen years, working as a golf caddie and selling hot dogs. After completing a two year engineering program at General Motors Technical Institute, he served as a US Navy aviator in the war effort. Also, like Blackwell, he attended university under the GI Bill, completing his Business Administration degree at the University of Denver in 1948.

Pearsall's early career was in the commercial HVAC industry, first for Honeywell then his own businesses, Pearsall Company and Statitrol Corporation. He stumbled on the home smoke alarm idea by accident.

In 1980, Pearsall received the Person of the Year Award from the Society of Fire Protection Engineers for his impact on residential fire safety as an entrepreneur.

Paul Staby, Statitrol Engineer

Paul Staby was hired by Statitrol, Corporation "fresh out of college" to assist with finalizing design of the SmokeGard 700 battery-powered home smoke detector and to help optimize product manufacturability. He particularly worked on the self-monitoring circuit and is listed as a co-inventor on US Patent 3778800, "Self-Monitoring Battery Operated Circuit". Within a few years he was promoted to chief engineer and continued hands-on involvement in fine tuning the smoke alarm and protecting Statitrol's intellectual property.

B. K. Sweeney

Recognizing the public safety implications of the battery operated smoke alarm, B.K. Sweeney licensed the use of early Blackwell patents assigned to B.K. Sweeney Manufacturing to Statitrol at no cost. This facilitated the early development of the Statitrol 700 that was inexpensive and easy to install, thus facilitating the introduction of smoke alarm technology into the homes of millions.

Rexford Wilson, Myrle Wise, Gus Degenkolb

As consultants to Statitrol and technical advocates for smoke alarm technologies, these individuals worked within the fire community to develop a consensus for the implementation of smoke alarms in residences.

Eugene Cray and Jack Rhodes, Factory Mutual

As an industrial HPR insurer, FM had been approving industrial fire protection equipment for over a century. FM management took an interest, due in no small measure to altruistic motives of individual FM personnel, in undertaking the testing and approval of the home smoke alarm. They began work on the approval in 1971 and the first approval was completed in 1972.

Richard (Dick) Bright

As a researcher at the National Bureau of Standards, he was a strong technical advocate for smoke alarm technology and residential applications in particular. He had been impressed with an article authored by McGuire and Ruscoe [9] (NRC of Canada) which reported an assessment of 342 residential fire deaths in Ontario from 1956–1960. In this paper the authors evaluated the life-saving potential of a heat detector in every room or a single, or a smoke detector outside the bedrooms and at the head of the basement stairs [10]. Their judgement was that the heat detectors would have reduced the fatalities by 8% and the smoke detectors by 41%. Dick Bright funded research at UL and U. of Mass. that were critical to the establishment of standards for residential smoke alarms. As the Chair of NFPA 74, Standard on the Installation, Maintenance, and Use of Household Fire Warning Equipment, he directed the standards making efforts to include smoke alarms in the 1974 edition of NFPA 74, using the installation locations from the McGuire and Ruscoe paper.

Dick Bukowski

As an engineer at UL, he performed field testing of residential smoke alarms known as the Indiana Dunes Tests. This work was encouraged and funded by Dick Bright at NBS. Based on this work and his work at NBS as a visiting scientist, Bukowski returned to UL to complete development of the listing standard UL 217 in 1974.

Summary

The 2015 Philip J. DiNenno Prize was awarded for the affordable home smoke alarm. This technology developed by Lyman L. Blackwell and implemented by Duane D. Pearsall paved the way for installation of smoke alarms in all residences. This has had a major impact on the reduction of deaths due to fire. The 2015 Philip J. DiNenno Prize was awarded to Lyman L. Blackwell, with ample commendation to his deceased compatriot, Duane D. Pearsall. Significant technical contributions was made by Paul Staby. Other important players in the home smoke alarm movement included B. K. Sweeney, Rexford Wilson, Myrle Wise, Gus Degenkolb, Eugene Cray, Jack Rhodes, Dick Bright, and Dick Bukowski.

Authors' contributions

The initial draft was prepared by DL with CB, MM, PJ, CD providing significant editting for historical completeness and context. All authors read and approved the final manuscript.

Competing interests

The authors declare that they have no competing interests.

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