The background behind the first airport gun detector

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In 1968, at the request of President Johnson's Science Advisor, I demonstrated the first "gun detector", specifically for security use at public buildings and airports and as a wearable unit for security persons assigned to protect public figures.

The research project for my Master of Science degree in geophysics at Stanford in 1961, was the use of a differential magnetometer, i.e., magnetic gradiometer, for mapping geologic structure in airborne and marine surveys. I approached a nearby company, Varian Associates, the then only commercial manufacturer of airborne magnetometers for geophysical use, to borrow some magnetometers to prove my theory. They agreed to do so in return for which they asked me to file a patent and assign it to them. More specifically, my research project topic was the use of magnetometers and Euler's theorem on differential equations to quantitatively map the depth to magnetic (crystalline) basement rocks that define petroleum basins and within them possible oil-bearing structures.

Varian had, at that very time, signed an exclusive license for a new type of magnetometer invented by Professor Hans Dehmelt, later a Nobel laureate, that employed the same principles of optically-pumping on which the optical laser is based. This magnetometer, using alkali (rubidium, cesium, etc.) vapor or metastable helium, had the highest resolution -- then as well as now -- for measuring magnetic fields from a moving platform, particularly minute changes in the earth's magnetic field.

My first half-dozen years were spent examining applications and writing and presenting perhaps a hundred technical papers on almost every conceivable application of this device and its various implementations. Among my first field experiments was the recorded observations on July 9, 1962 on Frenchman's Hill at Stanford University in Palo Alto, California, of what is called the Electromagnetic Pulse (EMP). This awesome phenomenon was created by a 1.4 million-ton nuclear (W-49) warhead launched from a rocket on a remote Pacific island, Johnston Island, 4,000 miles away which detonated 250 miles above the earth as part of a project sponsored by ARPA of the Department of Defense. As my first published technical paper, these observations described the world-wide magnetic effects of this pseudo-secret experiment, called Project Starfish Prime. Unknown to me or hardly anyone else at that time, the results of this experiment engendered a surprising and profound consequence: the EMP confirmed a predicted damage to ground-based electronics and communications over a 1000-mile radius invoking the DOD to create a network of nodes first called ARPAnet--about 8 years later, with computers, called ***the Internet***.

EMP recorded at Stanford

I consulted with the U.S. Navy to find a couple of lost U.S submarines, the Thresher and Scorpion, the latter near the Azores in 8,000' of water. Later, we worked with the Howard Hughes research group using a deep-towed magnetometer and a large ship, the *Glomar Explorer* on a secret project (code-name *Project Azorian*) to ostensibly find and then vacuum up, *manganese nodules* in 10,000' to 12,000' of water. The manganese nodules, I discovered a decade later, to be a subterfuge to hide the real purpose of the survey: find and retrieve missiles and code books from a sunken Soviet submarine in the Pacific northwest of the Hawaiian Islands. It was detected, brought up by the Glomar Explorer to a shallow depth, but the already mangled sub broke and fell back down.

Later, still working at Varian and simultaneously on my Ph.D. in geophysics at Stanford, I conducted magnetic field research work. Much of what I did involved, in one way or another, applying the high sensitivity of these instruments to a very wide variety of applications, geophysical, archaeological, military. and other such applications. The locations were in the oceans and Bay around San Francisco or at local field sites far from local roads to be free from the magnetic effects from vehicles and other man-induced changes in magnetic field.

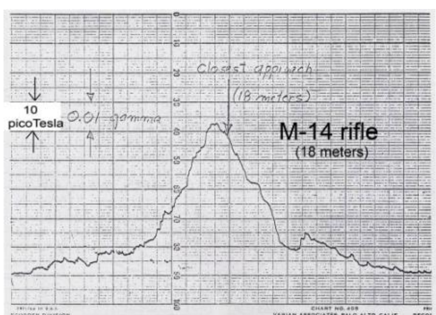
My principal field site was at the Webb Ranch on land leased from Stanford in the hills behind the University campus. For archaeological and other purposes, I had measured strange magnetic anomalies in the soil profile at Webb Ranch for use in archaeology, confirmed decades later as magnetosomes from bacteria that thrive in the upper soil horizons and at sites of human habitation and leave behind--forever—magnetic anomalies detectable in a high-resolution magnetic survey.

Another experiment at the site involved a helicopter which landed there for installation and test of a commercial version of my M.S. invention, the magnetic gradiometer for mapping of potential petroleum deposits – this survey in Dhofar, Saudi Arabia. Later, another helicopter, this one for use by the U.S. Army Fort Belvoir Laboratory utilized experimental results of other magnetometer research work I had conducted in San Francisco Bay, a transverse differential magnetometer installed on booms adjoined to both sides of the cab under the rotor blades for detection, in spite of the presence of magnetic effects of the helicopter, of ground-based weapons and personnel under the jungle canopy along the Ho Chi Minh trail in Cambodia during the Viet Nam war, just prior to the U.S invasion of that country.

Prior to embarking on my search for buried monuments of the Olmec civilizations in the jungles of Mexico, I had measured the magnetic effects of sample pieces of the monuments at Webb to confirm the feasibility of the survey. The actual survey resulted in our discovery in 1968 of one hundred 3,000 year-old Olmec monuments in the jungles of Mexico, the oldest monuments in the Americas.

Breiner at Webb test site, Stanford 1964

Other experiments at Webb included, measuring the magnetic field of the electric currents of the heart to record a magnetocardiogram; earthquake prediction using a 120 mile long magnetometer array one station being Webb Ranch (my Ph.D. thesis); miniature telemetered magnetometer on a dog for mine detection; unique deployments of magnetometers for more accurate surveying; finding and characterizing submarines and their heading; a device for finding tunnels in Viet Nam; to name a few.



(Magnetic Measurements of Light Weapons of U. S. and Communist Bloc Origin, by Sheldon Breiner January 20, 1967)

I had been measuring guns and many other common objects of search since 1961 using a second rubidium magnetometer reference sensor remote to the point of measurement to remove background time variations caused by the daily magnetic micropulsations from the sun. I was easily able to detect an American M-14 rifle being carried 20 meters (65 feet) from the nearest magnetometer. In the mid 1960s during the Viet Nam war, I had access to captured weapons made in Czechoslovakia, Soviet Union and China and learned much about what was magnetically detectable and how to detect, map and even classify hidden weapons, even if I could not see them.

In 1968 after Bobby Kennedy was assassinated, I was asked by William Hewlett of Hewlett Packard, an industrial member of President Johnson's Science Advisory Committee to assist in the task of designing a gun detector. The request was from the White House to show how I had been using magnetometers for years to detect weapons. I showed up at the Executive Office Building next to the White House and was met by Dr. Donald Hornig, the president's Science Advisor. I had brought two optically-pumped magnetometers to demonstrate and teach how such a gun detector would work and its limitations. Because I was not allowed to carry weapons of any kind into the Executive Office Building, I had to simulate the magnetic and size characteristics of small hand guns, using screwdrivers, pliers and files for this purpose. (Guns, for their size, are not very magnetic.)

The main objective, as described to me by Dr. Hornig, was how to detect mostly guns at airports and, public buildings. This translated into a technical problem of how to make a detector that would function in public locales to detect guns or other metallic items in the near vicinity of the detector and not be affected by other moving or stationary metal objects or other electrical or magnetic interference from non-local objects in the vicinity or at unseen distant locations. Another way of expressing the detection objectives was to minimize false positives and, worse, false negatives (letting a gun through without being detected). Since guns were almost always made mostly from steel, one could use a device that detects ferromagnetic objects.

Having considerable experience by then in magnetic detection, I was asked to basically show what I knew about applications of magnetics to gun detection. A magnetometer can easily sense an effect but not necessarily discriminate between a gun on a nearby person or a car or truck on the street outside one hundred feet away, a time-varying DC subway current miles away, elevators, nearby steel girders or time-varying magnetic effects from the sun. My field of interest in magnetics was often to utilize multiple sensors to achieve greater sensitivity by removing the time variations caused by the sun or to minimize the regional gradient of the magnetic field from distant or deep-seated geologic magnetic sources. Using such a differential magnetometer also acts as a distance filter, since the effect of very distant objects whether varying in time or space, is essentially the same as seen by two local sensors. Due to the rapid decrease with distance of a magnetic dipole represented by a local object, the effects of a nearby magnetic object are discernible by one of a pair of differential magnetometers. This, in summary, forms the key technical basis of the magnetometer as a gun detector.

I demonstrated the device to the White House staff, the FBI, Secret Service, FAA, Science Advisory Committee to the President and the Science Advisor to the President.. They came parading through for a day and a half, as I explained the principles of detecting guns, what is detectable and what is not and the limitations. The proposed solution I had demonstrated to detect guns at public meetings and airports, etc. seemed to satisfy most of their needs in a simple, low-cost device with an adjustable sensitivity.

This actual detector I recommended for use was not the expensive, ultra-sensitive rubidium/cesium magnetometer, but rather a set of four differential magnetometers, each comprised of a pair of fluxgate, or other comparable, inexpensive magnetic sensors separated about 4" or so apart, each pair acting as a single sensor at both sides of the frame at the hip level and at armpit level. I recommended that there be no detector below the hip, because it would sound an alarm due to the steel shank on most street shoes. The essential element to allow effective use in the environments posed by the Science Advisor was the exploitation of the differential characteristics of these magnetic sensors, necessary to eliminate or sharply reduce non-local magnetic background noise, both natural and man-made.

This detector is therefore a differential magnetometer. It is technically incorrect to define the detector as a 'metal detector' which is a totally different kind of instrument. The latter does sense the presence of both ferrous and non-ferrous metals, but the effective distance to detectable objects is less. A few facilities now have pulse-type (time-domain) electrical induction systems.

At the request of the Science Advisor, I also designed a device to be worn by Secret Service agents which would give them a confidential warning if they were in the vicinity of someone whom they felt might be carrying a weapon.

In today's environment, the most common magnetically detectable items are street shoes, the pin that holds a watch band to the watch (when moved near the detector frame), key chains (usually not keys), men's metal clip at the top of trousers, cell phones, anything with a spring in it including the clip on a pen or spring in a pen or other similar mechanism and miscellaneous manufactured items. The tiny screw in the corners of eyeglasses is magnetic but very small. All U.S currency is weakly magnetic (black magnetic ink), but not U.S. coins. Stainless steel type 300 and similar alloys are not magnetic, nor is anything made of aluminum, gold, silver, copper (such as rivets in jeans) and such other non-ferrous metals. Many hip joints have weakly-magnetic alloys. Most belt buckles, even massive ones, are made of cast non-ferrous metals and are not magnetic. The magnetic effect diminishes by a factor of 16 every time the distance from the sides of the frame is doubled, or inversely, increases by that factor. Thus, the aforementioned tiny watchband pin could be detected if one's wrist swings closely by the detector frame.

I never attempted to file a patent because I had used such devices routinely for years before that time which probably put it into the public domain.

More info http://www.breiner.com/sheldon/biography.html
ftp://geom.geometrics.com/pub/mag/Literature/AMPM-OPT.PDF
http://www.breiner.com/sheldon/press/merlin.html

This differential magnetometer system was, and remains today, the standard gun detector in use at airports and at public and, some private buildings. While not perfect, the gun detector has functioned well, both in actual detection of weapons as well as acting as a deterrent. However, if one is so inclined, and with evil intent, it is always possible to bypass any type of security apparatus and procedure.