Neutral Citation Number: [2016] EWHC 756 (Pat)

Case No: HP-2014-000047

IN THE HIGH COURT OF JUSTICE
CHANCERY DIVISION
PATENTS COURT

Royal Courts of Justice
Strand, London, WC2A 2LL

Date: 11 April 2016

Before :

MR JUSTICE ARNOLD

- -

Between :

AMERICAN SCIENCE & ENGINEERING INC.	**Claimant**
- and -	
RAPISCAN SYSTEMS LIMITED	**Defendant**

- -
- -

Iain Purvis QC and **Brian Nicholson** (instructed by **Collyer Bristow LLP**) for the **Claimant**
Daniel Alexander QC and **Andrew Lykiardopoulos QC** (instructed by **Browne Jacobson LLP**) for the **Defendant**

Hearing dates: 11, 14-15, 17 March 2016

- -

Judgment

MR JUSTICE ARNOLD :

Contents

Introduction

1. The Claimant ("AS&E") is the proprietor of European Patent (UK) No. 1 558 947 entitled "X-ray backscatter mobile inspection van" ("the Patent"). AS&E contends that the Defendant ("Rapiscan") has infringed the Patent. Although Rapiscan had previously denied infringement, during the course of the trial Rapiscan admitted that it had committed acts which amounted to infringements if the Patent is valid. Rapiscan contends, however, that the Patent is invalid because all of the claims in issue are obvious in the light of a paper by Roderick D. Swift entitled "Mobile X-ray Backscatter Imaging System for Inspection of Vehicles" published in the Proceedings of the SPIE – The International Society for Optical Engineering conference on Physics-Based Technologies for the Detection of Contraband ("the 1996 SPIE Conference") on 19-20 November 1996 in Boston, United States of America ("Swift"). Although other prior art had also been cited by Rapiscan, it was accepted by counsel for Rapiscan in closing submissions that this did not add anything material to the case based on Swift, and accordingly it is not necessary for me to saying anything more on that subject. There is no challenge to the earliest claimed priority date of the Patent, which is 6 November 2002.

2. There is no dispute in this case as to the applicable legal principles, which are well-established and which I have set out in numerous previous judgments. I shall therefore not repeat them here.

Witnesses

3. AS&E's expert witness was Dr Paul Bjorkholm. He obtained a BA in physics and mathematics from Princeton in 1964, an MA in physics from the University of Wisconsin in 1965 and a PhD for work on a high intensity polarised deuteron source from the same institution in 1969. He was employed by AS&E from January 1970 to December 1989 successively as Scientist, Senior Scientist, Vice President and Senior Vice President. During this period he worked on several projects involving X-ray imaging for medical and security applications, and towards the end of his time at AS&E he was responsible for the development of new technologies for security imaging. During this period AS&E introduced backscatter imaging to the security market. From January 1990 to December 2001 Dr Bjorkholm was employed by EG&G Astrophysics as Chief Technology Officer. During this period he worked on baggage and cargo screening systems. From January 2002 to October 2005 he was employed by Varian Security and Inspection Products working on a high energy inspection system. Since then, he has acted as an independent consultant specialising in high energy X-ray imaging for security and manifest verification. Dr Bjorkholm is a named inventor on a considerable number of patents.

4. Two aspects of Dr Bjorkholm's instructions merit comment. The first is that, rather oddly, he was instructed to consider the position as at the filing date of the Patent, and not the priority date. This did not matter greatly, however, since there was little change in the common general knowledge during the intervening year. I shall address the second aspect below.

5. Counsel for Rapiscan criticised Dr Bjorkholm for having omitted certain matters from consideration in his reports. I do not accept that this is a criticism of Dr Bjorkholm, since it may reflect his instructions. Furthermore, the criticism overlooks the fact that, so far as the most important matter is concerned, namely the skilled person's knowledge of relative motion sensing, although this was not addressed in Dr Bjorkholm's first report, Dr Bjorkholm did address it at least to some extent in paragraph 11(12) of his second report. Counsel for Rapiscan also submitted that it was apparent that Dr Bjorkholm "had a line to stick to". I do not accept this either. I consider that Dr Bjorkholm did his best to assist the court by stating his honest opinions.

6. Rapiscan's expert witness was Dr Richard Lanza. He obtained a BA in physics from Princeton in 1959, an MSc in physics from the University of Pennsylvania in 1961 and a PhD in physics from the same institution in 1966. Since 1966 Dr Lanza has worked at Massachusetts Institute of Technology, first in the Physics Department and more recently in the Department of Nuclear Engineering, where he is currently a Senior Research Scientist. He has provided technical consulting services to AS&E and other companies for detection technologies in the X-ray field since the late 1990s. He is an author of more than 150 published papers and a named inventor on more than 20 patents.

7. Counsel for AS&E accepted that Dr Lanza had done his best to assist the court, but submitted that he had been instructed to consider the wrong question in relation to obviousness. I shall consider this point below.

8. In addition to the two experts, Rapiscan's managing director Francis Baldwin gave factual evidence. Although he was called to give evidence with regard to the issue of

infringement, counsel for AS&E relied upon two aspects of his evidence with respect to the issue of obviousness.

Technical background

9. The following account of the technical background is a synthesis of the accounts given by Dr Bjorkholm and Dr Lanza in their respective first reports.

X-rays and gamma rays

10. X-rays and gamma (or **γ**) rays are both part of the spectrum of electromagnetic radiation, which also includes radio waves and visible light. Radio waves have low frequencies, visible light has higher frequencies, and X-rays and gamma rays have the highest frequencies. X-rays and gamma rays are identical, but are distinguished by their origin:

i) gamma rays are emitted by the nuclei of radioactive atoms; and

ii) X-rays are produced by atomic electrons outside of the nucleus.

11. All electromagnetic radiation has behaviour characteristic of a wave and of a particle. When describing the particle-like behaviour of electromagnetic radiation, it is common to refer to such radiation as being formed of photons. A photon is a quantum of electromagnetic radiation. The energy of photons is measured in electron volts (eV). X-ray and gamma ray beams used in imaging have energies in the range of kiloelectron volts (keV) and megaelectron volts (MeV).

X-ray imaging

12. Because of their high energy, X-ray photons are capable of penetrating materials. Wilhelm Röntgen was the first to recognise this ability. He quickly realised that images could be formed on film that showed the internal structure of a body. X-rays soon became used in medicine and industry. To create an X-ray image, a source of X-rays illuminates the object of interest. Some form of detector then detects the X-rays. Originally this was a film, but nowadays other forms of detector are generally used. The recorded image is of the differential absorption and scattering of the X-rays by the imaged object.

13. Imaging depends on the interaction of photons with matter. All matter is formed of chemical elements, which are in turn formed of atoms. Elements are characterised by their atomic number, often referred to as "Z". The atomic number of an atom is determined by the number of protons in its nucleus. In an uncharged atom, this equates to the number of electrons in the atom's electron shells.

14. When interacting with matter, photons may penetrate the matter (i.e. pass straight through it), may be absorbed by it or may be scattered by it.

15. For present purposes, the relevant type of *absorption* interaction between an incident photon and the matter it interacts with is the photoelectric effect. This occurs when a photon is absorbed by an atom, which in turn emits an electron. The electron emitted as a result of the photoelectric effect creates a vacancy in one of the atom's electron shells. That vacancy is usually filled by an electron from one of the outer shells. This

releases energy, which may be emitted in the form of an X-ray. The energy of an emitted photon is different for each atom, as the energy of the emitted photon depends on the electron binding energies, which in turn depend on atomic number. X-rays emitted as a result of the photoelectric interaction are known as "characteristic" X-rays, and the emission of characteristic X-rays is known as X-ray fluorescence. The photoelectric process predominates when the X-ray has a relatively low energy and where it is interacting with high atomic number materials.

16. For present purposes, the relevant type of *scattering* interaction between an incident photon and the matter it interacts with is Compton scattering (also known as inelastic or non-classical scattering). Compton scattering was discovered and explained by Arthur Compton in 1923. Compton scattering occurs when a photon is deflected from its original direction by an electron, to which the photon transfers a portion of its energy. A photon can be scattered in any direction, though the angular distribution of scatter is dependent on the energy of the incident photon.

17. Compton scattering is often divided into three categories:

i) "backscatter": photons which scatter back from the matter with which they have interacted at about 180^{o} from the direction of the incident beam;

ii) "sidescatter": photons which scatter sideways from the matter with which they have interacted at about 90^{o} from the direction of the incident beam; and

iii) "forward scatter": photons which scatter forwards from the matter with which they have interacted.

18. The energy of a scattered photon will always be lower than the energy of the incident photon, and the energy of the scattered photon is determined by Compton's equation. Compton's equation shows that the maximal energy of a photon which is backscattered at 180^{o} from its incident direction is half the maximal energy of a photon which is sidescattered at 90^{o} from its incident direction.

19. The probability of Compton scattering does not itself depend on the atomic number of a material, but in low atomic number materials, as the photoelectric effect is less likely, Compton scattering is the predominant method of interaction. These include organic materials (including human tissue), and explosives.

20. Whenever a beam of photons interacts with matter, photons are attenuated (i.e. removed from the X-ray beam) by the interaction, either by absorption or scatter.

Overview of X-ray imaging: transmission, Compton scatter and CT

21. *Transmission imaging*. The oldest and most well-known form of X-ray imaging is transmission imaging (also known as radiography). This creates images from the X-rays which pass through the object and have not, therefore, been attenuated by absorption or scatter processes. In transmission X-ray (or gamma ray) imaging, a beam source is directed towards an object. The detectors are behind the object, and measure the X-rays that are transmitted through the object.

22. The photoelectric effect has a large effect on transmission images. Accordingly, transmission imaging is good at detecting high atomic number materials such as metals, since these materials absorb a great deal of the X-ray beam before it reaches the detector on the other side, which creates contrast with surrounding air or low-atomic number matter.

23. Transmission imaging uses sources with maximum energy ranges from below 100 keV to several MeV. The greater the energy of the beam, the greater the penetration achieved.

24. *Compton scatter imaging*. In Compton scatter imaging, rather than measuring photons attenuated from a beam as is the case in transmission imaging, one measures photons which are Compton scattered from an object. Compton scatter occurs in all directions, but its angular distribution is energy dependent, and the probability of scatter back towards the origin decreases as the energy levels of the incident photons increase.

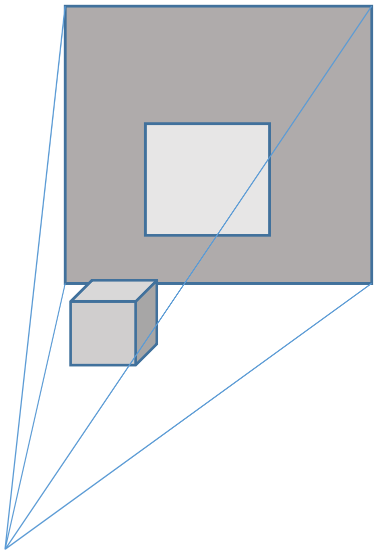
25. Compton scatter can in theory be measured in any direction, but the energy of Compton scattered X-rays is not very high, and these X-rays may themselves be scattered and absorbed within the target object. This means that one can only image a limited depth of an object compared to transmission imaging. Most Compton scatter imaging systems are therefore backscatter systems, though sidescatter and forward scatter systems have been made.

26. *CT scanning*. Computerised tomography or CT scanning is a type of transmission scanning. The first CT scanner was invented by Godfrey Hounsfield at EMI in the early 1970s. CT scanners take a large number of transmission scans ("projections") from different angles and use motion to create scans from different positions. From a series of these, it is possible to calculate the absorption of pixels in a two-dimensional array image ("slice") and, by translating motion, a three-dimensional "voxel" (which is the three-dimensional equivalent of a pixel). These calculations can be used to create a series of two-dimensional images or three-dimensional images of the object or person being scanned. To get a useable CT image, one needs to know very precisely where one is imaging. In CT imaging, small errors in position or detector output create large artefacts in an image, for example rings or lines.

27. By November 2002, CT scanners were well known. They were extensively used for medical imaging, and were also used for imaging baggage. CT scanning provides a detailed three dimensional image, but it is relatively slow and requires access all around the imaged object.

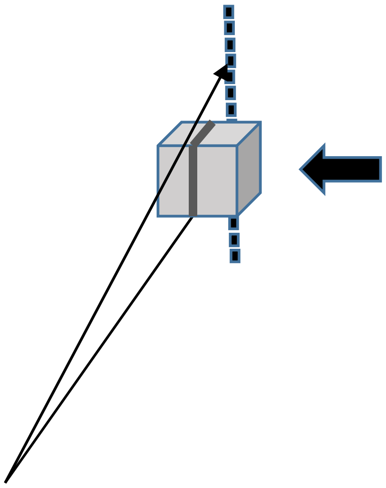
Area, fan beam and flying spot transmission imaging systems

28. *Area imaging*. In area imaging, an X-ray source with a small focal spot (compared to the object being imaged) is used to flood the whole area of the object to be imaged. As the X-rays are absorbed or scattered from the line of sight, a shadow is formed (reduction in the number of line of sight photons reaching the detector). The detector records the two-dimensional shadow pattern as an image. Most medical X-ray machines are area imagers. This is schematically illustrated in Figure 3 to Dr Bjorkholm's first report, which I reproduce below:

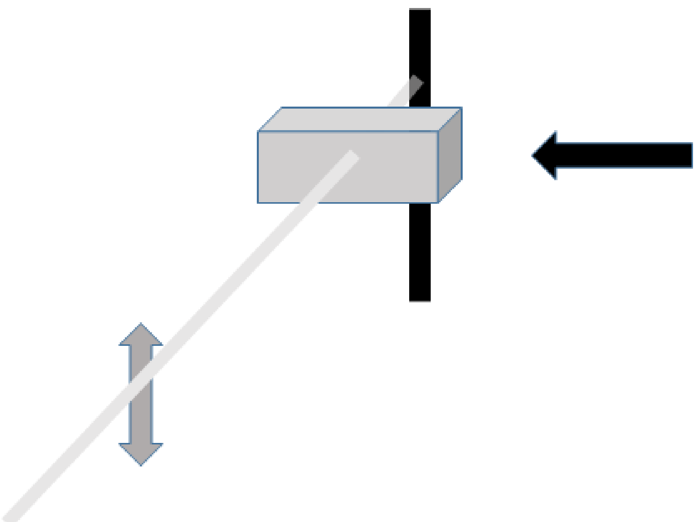


29. The problem with flooding the object with X-rays is that not only the transmitted X-rays reach the detector (these form the image). X-rays scattered from other portions of the object can also be recorded. These scattered photons do not carry image information and form a fog in the image. For most portions of the human anatomy, there are many more scattered photons reaching the receptor than transmitted. This means that the image information is buried in a fog of scatter. To counter this, most medical X-ray imaging uses something called an "anti-scatter grid". This is a box-like structure that allows most of the transmitted photons to reach the image receptor, but blocks the scattered photons. Although anti-scatter grids are effective, they require significantly more radiation dose to the patient.

30. *Fan beam imaging*. Fan beam imaging was developed to obviate the problem of scatter in the image. To do this, a thin fan beam of X-rays is formed by a stationary slit in a high atomic number material. Thus a much smaller proportion of photons from the X-ray tube is used than in area imaging. The fan beam strikes the object, and the transmitted radiation is detected by a segmented detector. The object is then moved through the fan and successive measurements are made. Therefore the detector provides the resolution in one dimension, and the motion and successive measurements provide the resolution in the second dimension. In this case, most of the scatter is out of the plane of the fan beam, and therefore does not reach the segmented detector. Thus scatter is rejected by the system design. This is schematically illustrated in Figure 4 to Dr Bjorkholm's first report, which I reproduce below:



31. *Flying spot imaging*. Flying spot transmission imaging was developed by AS&E in the 1970s. In this technique, a thin pencil beam of radiation is created, typically by a rotating collimation disc or "chopper wheel". Thus an even lower proportion of the photons from the X-ray tube are used. This pencil beam repeatedly scans a path that is similar to the fan described above. Again, motion of the object is used to create the second dimension of the image. Because the flying spot provides resolution in one dimension, and motion provides resolution in the other direction, the detector does not need to have any spatial resolution capability. Flying spot technology also rejects scatter very well and reduces the complexity of the detector. It is the only system that has the possibility of making scatter images since it is the only one that illuminates a single location in the object at any given time. This is schematically illustrated in Figure 5 to Dr Bjorkholm's first report, which I reproduce below:



Dual energy imaging

32. In 1985 Gary Barnes**,** a professor at the University of Alabama, presented a dual energy detector that allowed the differentiation of soft and hard tissue components with a single exposure X-ray. Although this technique was developed to improve the interpretation of chest X-rays, the value of this type of imaging was quickly realised by the security

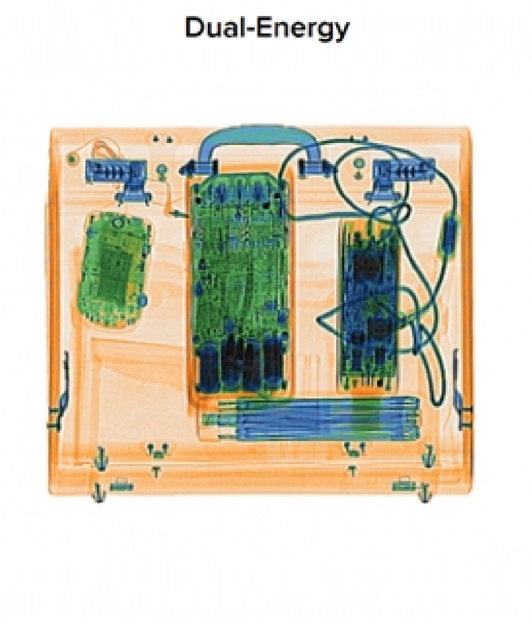
imaging community. If one could differentiate between bone and soft tissue in chest imaging, one should be able to separate organic materials (clothing) and inorganic materials (guns, knives, etc.) in security imaging.

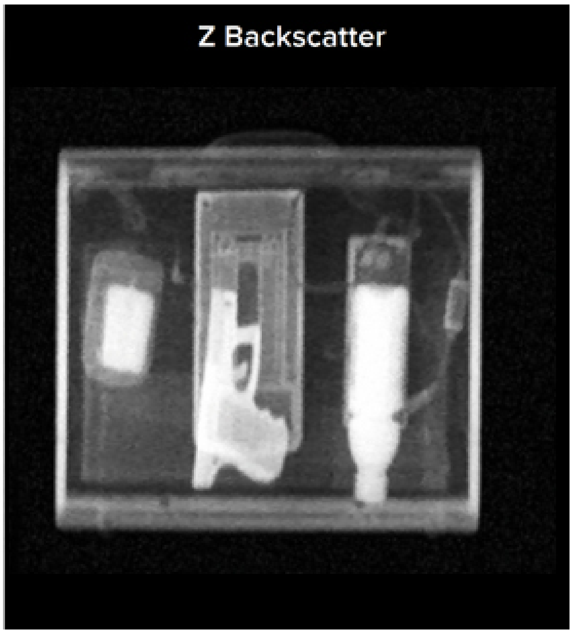
33. Dual energy imaging was quickly exploited for baggage screening by a company known as Astrophysics. Astrophysics built most of the airport X-ray security scanners at that time. Dual energy imaging became the gold standard for baggage screening.

Backscatter imaging

34. AS&E developed flying spot backscatter imaging systems for applications such as baggage scanning in the 1980s. In backscatter imaging, the source and detector are, typically, placed on the same side of the object. The source illuminates the object and the detector measures the backscattered photons. Because the total attenuation coefficient for the exit path will be significantly higher than that for the input path, and because the angle subtended by the scatter detector is smaller the further the photon penetrates into the object, it is very hard to detect scatter from a significant depth in the object. Furthermore, some photons will scatter more than once on their way to the detectors and some photons which were headed to the detectors will scatter away from them. As such, backscatter imaging is essentially a surface imaging technique. Nevertheless, AS&E discovered that, in certain circumstances, backscatter images could visualise organic material that might not be as obvious, or even visible, in a transmission image.

35. The difference between (dual energy) transmission and backscatter imaging is illustrated by the images contained in Figure 8 to Dr Lanza's second report, which he obtained from AS&E's website and were taken by an AS&E baggage scanning system that utilises both dual energy transmission and backscatter imaging. I reproduce these below.





The development of security imaging at airports

36. The history of aviation security has long been a game of cat and mouse between criminals and governments. Generally, the security industry has had to respond to new threats as they arrive and the criminals develop new techniques as given technologies are deployed. The hijacking of aircraft has a very long history dating back to 1931. But until 1971, it had a very low profile. In November 1971 a person identified as "D B Cooper" successfully hijacked a commercial plane for ransom. For the next 17 years, hijacking was generally committed either for money or for political reasons. It was generally countered with a strategy of complying with the hijacker's demands until the plane was on the ground and then attempting to negotiate a solution. This technique was approved by the Federal Aviation Authority ("FAA") in the USA. In addition, security screening was established at checkpoints in airports, including metal detectors and X-ray scanning devices.

37. The market for X-ray scanning devices in the early years was dominated by two players, AS&E and Astrophysics. The Astrophysics systems were fan beam imaging systems early on and dual energy fan beam systems later. The AS&E systems were flying spot systems with backscatter added in later years.

38. On 21 December 1988 Pan Am flight 103 from Frankfurt to Detroit via Heathrow and New York was blown up over Lockerbie in Scotland, killing all 243 passengers and 16 crew and 11 people on the ground. This attack was the first time that terror was the primary purpose behind the attack and the first time that explosives hidden in checked baggage were used as a weapon. The USA responded by developing a list of explosives in various sizes and configurations that were considered a potential threat to aviation and funded research into developing techniques to automatically detect all the explosives on that list in passenger baggage.

39. X-ray imaging was investigated for automatic detection in several different ways. A system for quantifying the average line of sight atomic number and density was developed by Vivid Systems. It consisted of a very carefully calibrated dual energy transmission imaging system. Since the majority of the explosives and configurations of interest had high physical density and a specific range of atomic numbers, it was possible to automatically detect many (but not all) of the explosive devices of interest to the government.

40. The Vivid system, like the dual view dual energy system developed by Astrophysics, was never deployed actively in the USA because it could not meet all the requirements of the FAA. However, Europe took a different view. Many European countries were willing to deploy systems that could meet most, but not all, of the FAA-mandated requirements. Their reasoning was that it was best to deploy what was available then pending further improvements.

41. Another system that was developed was a CT system by a company called InVision. It was like a medical CT in that it rotated around the scanned object and formed images from a large number of different angles. It succeeded because it could measure the physical density of specific locations within the bag. It was theoretically very slow and utilized significant amounts of radiation, but the developers realized that they did not have to scan the bag completely. By taking cross-sectional images spaced apart by a distance less than the minimum size of a threat object, they could be assured of taking

a CT slice through any explosive threat and cut down on the overall scan time and exposure by a factor of five to ten. This met all the FAA requirements. CT scanners are now a common part of airport security screening.

42. This security regime was successful until 11 September 2001, when terrorists hijacked four passenger planes enroute from the East Coast to the West Coast of the USA. They forced their way into the cockpits using simple blades, mace and tear gas. Once in the cockpits, the hijackers took control of the aircraft and used them as flying bombs to crash into the World Trade Center towers and the Pentagon. This led to further consideration of airplane security, but developments after November 2002 are not relevant for present purposes.

The development of security imaging at sea ports and border posts

43. Sea ports and border posts on land have their own specific problems. Here the problems tend to be smuggling of illicit materials (particularly drugs), smuggling of illegal immigrants, and smuggling to avoid customs duties or taxes. Again, there were two different technologies utilised, transmission and backscatter X-ray imaging and they evolved somewhat differently. Both technologies faced problems particular to land and sea ports. These ports tend to have limited space available, are gateways for commercial traffic, exist in multiple locations for any border, and are generally constrained by governmental radiation restrictions.

44. The limited space meant that any system had to occupy a small footprint and be able to utilise whatever space was available even if that changed from time to time. This tended to favour systems that could be moved or relocated quickly. “Mobile” systems are able to move from one location to the other using their own locomotion system. “Relocatable” systems can be disassembled (if necessary) and moved using an external locomotion system.

45. The fact that ports are commercial gateways adds significant pressure on the time taken to inspect a piece of cargo. The ports want to move the cargo through as quickly as possible and the inspecting agency wants to inspect as much cargo as it can. These are contradictory goals that have a significant effect on the system design.

46. The fact that there are usually multiple crossings at any given border makes it difficult to cover all crossings without great expense. This became quickly apparent at the US-Mexican border. When inspection systems were deployed at one crossing, the smugglers soon realised this and changed to a different nearby crossing. This had the effect of driving the development of relocatable and mobile systems.

47. Finally, the system development was constrained by the relevant radiation control requirements of each country. Typically, in 2002, the governmental agency controlling radiation levels to the local workers and the population in general was different from the agency in charge of security at the ports. Often, they had very different views of the danger of the radiation. In addition, port workers, not always directly in the inspection area, frequently had radiation concerns. This often led to very strict interpretation of the radiation control laws and led to overly strict control.

X-ray sources

48. The most common type of X-ray source in 2002 was (and remains) an X-ray tube. X-ray tubes have been known for a long time, and their design has not changed much since 1913. X-ray tubes emit X-rays as a result of *bremsstrahlung* ("braking radiation"). In an X-ray tube, this occurs when electrons are emitted from a cathode at one end of the tube, accelerated in the vacuum of the tube by an electric field and bombarded onto a metal target (the anode) at the other end of the tube. When the electrons decelerate ("brake") in the anode, they lose kinetic energy. This energy is converted into photons (i.e. X-rays) which are emitted from the anode in a continuous stream.

49. The voltage differential between the anode and the cathode determines the voltage potential of the X-ray tube. X-ray tubes in 2002 ranged in voltage from below 100 kV to around 450 kV. The choice of tube voltage depended on the imaging problem facing the system designer. For example, in 2002 medical imaging mammography typically used X-ray sources with a maximum voltage of 30 kV, while X-ray sources used in medical CT would typically range from 140 to 160 kV. The X-ray tubes used in security screening in 2002 were the same tubes that are used in medical and industrial imaging, since the latter were much bigger markets.

50. X-ray tubes are, and were in 2002, available in unipolar or bipolar form. In a unipolar tube, one electrode is at zero with respect to ground and the other electrode is at a different potential with respect to ground (which could be the cathode at a negative potential or the anode at a positive potential). In a bipolar tube, the cathode is at a negative potential with respect to ground and the anode is at a positive potential with respect to ground. This allows bipolar tubes to operate at lower potential with respect to ground for the same peak X-ray energy.

51. An advantage of unipolar X-ray tubes is that, by contrast with bipolar tubes, they do not require bulky cables at both ends. Thus unipolar tubes are advantageous for backscatter imaging because the anode end of the tube can be smaller, and unencumbered by cables, which can make it easier to fit the anode at the centre of the chopper wheel.

52. Higher energy X-ray tubes have an advantage over lower energy X-ray tubes in that they are more penetrating, but lower energy X-ray tubes have an advantage over higher energy X-ray tubes in that higher energy tubes are typically larger, heavier and more expensive, and require higher and therefore larger voltage supplies, and require more shielding.

X-ray detectors

53. The first X-ray and gamma ray images were created using film. Film on its own is relatively insensitive to X-rays, however. To reduce the radiation dose to patients, intensifying screens made of a scintillator are used. When scintillators are subjected to X-rays, they emit visible or ultraviolet light as a result of fluorescence. This visible light then exposes the film. Calcium tungstate was the most common scintillator for most of the 20th century, but since the 1970s, rare earth phosphors, including gadolinium oxysulfide (or gadox) have been used.

54. A further development was that of scintillation detectors, which do not use film at all. Scintillation detectors are scintillators coupled with photomultiplier tubes or photodiodes, both of which convert photons into electrons. This electrical signal can then be processed and formed into an image. Scintillation detectors enable the image to be shown on a screen without the need to develop film.

55. By 2002, most transmission imaging systems used a linear array of detectors (i.e. a line of detectors) that corresponded to a collimated fan beam. Linear arrays were used (and continue to be used) in most baggage scanning systems, and were also used in cargo or vehicle scanning systems and in CT scanners.

Imaging and motion

56. When building an image pixel by pixel (using a flying spot system, as usually used for backscatter imaging) or line by line (using a transmission linear array where each line represents a fixed number of pixels), one needs motion to generate a two-dimensional image. When generating images using a linear array for transmission imaging, motion is needed in the direction orthogonal to the linear array to generate a two-dimensional image. When generating images pixel by pixel, motion in two directions is required to generate a two-dimensional image:

    i) motion in one direction to generate each “line” of pixels (for example, the vertical line of pixels created by a sweep of the pencil beam discussed above); and

    ii) motion in a direction orthogonal to the lines of pixels.

57. In either of the above cases, the image would be formed by combining the scanned lines. To achieve the correct aspect ratio in an image, imaging systems are designed so that each of the pixels that form an image generated from line scans represent an equal distance of the scanned object in the two dimensions of the scanned object that the pixel represents.

58. If either the object being imaged or the imager is moving, or both, one needs either to generate an image so quickly that this movement is not relevant or to correct for the movement. Motion which is not sufficiently accounted for may result in an image which is unacceptably distorted, or even no image at all.

59. When using line scans to generate an image, motion can cause compression or stretching of the image. If the imaging system assumes motion, but the motion in the direction orthogonal to the linear array or line of pixels is faster than is assumed by the imaging system, the image will be compressed in this dimension. If the motion in this direction is slower than assumed, the image will be stretched in this dimension.

60. It would have been appreciated in 2002 that, in principle, there were two main ways of ensuring that an image had an acceptable aspect ratio:

    i) by controlling the system to prevent this distortion from occurring in the first place (for example, by fixing the relative motion of the scanner and the inspected object); or

ii) by measuring the relative motion of the imager and the inspected object and using this measurement to correct the aspect ratio of the generated image.

61. The simplest way to use measured relative motion to achieve an acceptable aspect ratio would be in software. That is, the information about relative motion would be used either to interpolate more pixels between the line scans and thereby widen the image (if the image would otherwise appear compressed) or to remove some line scans (if the image would otherwise appear stretched). Another way to use measured relative motion to achieve an acceptable aspect ratio would be to direct the beam so as to prevent unacceptable distortion from occurring, but in 2002 this would have been a difficult task.

62. To create an ideal image, the relative motion between the scanner and object should be orthogonal to the direction of the line scans of the scanner (or as near to orthogonal as possible). In the real world, however, the relative motion of the scanner and the object is not necessarily entirely orthogonal with the direction of the line scans. For example, the relative motion might have an angular component if the track angle of the scanner and object diverge from the orthogonal. It would be desirable to adjust for this vector component if the parameters of the system allowed for variations in it such that the image would be unacceptably distorted. In 2002 accounting for non-orthogonal motion would have been regarded as a complex exercise with a number of variables to take into account.

Motion sensors

63. Motion sensors can be divided into two groups: sensors which are designed to measure the relative motion of two objects which are in contact with one another ("contact sensors"), and sensors which do not require contact between the two objects ("relative motion sensors").

64. A common type of contact sensor is an encoder. An encoder is a device which converts positional information into a signal. Encoders include rotary encoders, which convert information about rotation (such as the rotation of a wheel) into a signal, and linear encoders, which are sensors paired with a scale which output information about linear position. In 2002 encoders were used to measure motion in various scanning systems. For example, in CT systems, encoders were used to measure the rotation of the X-ray source, and the linear position of the bed bearing the object or patient relative to the X-ray source and detectors.

65. Various types of relative motion sensors were known in 2002, including Doppler, time of flight and phase-shift sensors:

i) The Doppler effect is the change of apparent frequency of a source due to the relative motion of the source and the observer. Doppler velocity sensors emit microwaves or ultrasound and measure the frequency of the reflected radiation. Doppler sensors have long been used to measure vehicle velocity, for example in police radar systems.

ii) "Time of flight" sensors measure distance. These work by sending out a pulse and measuring how long it takes to return. A time of flight sensor can be used to determine velocity by taking successive distance measurements in a known time.

iii) Phase-shift sensors emit a pulse, which is modulated as it is sent out. The reflected pulse is then measured by a sensor, and the difference in phase of the modulation can be used to establish the distance along the beam path. Successive distance measurements in a known time can be used to determine velocity. One type of phase-shift sensor is a LIDAR (laser radar) sensor.

The Patent

66. The specification begins at [0001] by stating that the invention relates to devices and methods for remote sensing and imaging of items concealed in an enclosure or on a person by using scattered x-rays and passive sensing of gamma rays or neutrons from a mobile platform which is unilaterally disposed with respect to a sensed enclosure.

67. The specification then sets out the background to the invention. At [0002] it says that a problem with prior art systems is that they required the inspected objects or persons either to be moved through an inspection system or interposed between a proximal examining component and a distal examining component, one including a source and the other including a detector. It goes on at [0003]:

> "An effective means … is desirable for rapidly and non-intrusively examining personnel as well as the interior of vehicles, cargo containers, or other objects. In particular, with respect to cargo enclosures, it is desirable to detect the presence of people, potential contraband, threats or other items of interest, without imposing the requirements and constraints of current systems. Combining such an examination with passive sensing of radioactive or fissile material would also be advantageous."

68. In the summary of invention, [0006] is a consistory paragraph corresponding to claim 1. The specification goes on at [0007]:

> "In accordance with further embodiments of the invention, the conveyance may include a vehicle capable of road-travel. The source of penetrating radiation may include an x-ray tube, more particularly, a unipolar x-ray tube and one emitting radiation at energies below approximately 350 keV. The source of penetrating radiation may include a rotating chopper wheel emitting radiation to one or both sides of the enclosed conveyance."

69. The specification describes specific embodiments of the invention by reference to three schematic drawings at [0011]-[0034]. For present purposes, it is only necessary to note the following passages:

> "[0018] … preferred embodiments of this invention make use of systems in which detectors are mounted on a mobile platform 10, or conveyance, typically capable of road travel, that traverses a large object to be inspected such as a vehicle or cargo

container 12. Conveyance 10 is characterized by an enclosure 14, here, the skin of a van …

[0019] Contained within enclosure 14 of conveyance 10 is a source 30 …

[0021] Detector modules 100 are carried by conveyance 10 and enclosed within enclosing body 14 and concealed from view from outside the conveyance. …

[0028] The relative motion of conveyance 10 and object 12 may be carefully controlled or may be monitored by sensor 18 which employs any of a variety of sensing methods, such as radar, ultrasound or optical, including laser or LIDAR sensing, all provided as examples only, in order to sense the relative speed of conveyance 10 with respect to object 12. A signal provided by sensor 18 is employed by controller 40 in one or more of the following modalities:

The vehicle speed may be regulated, or, alternatively, the pixel registration may be corrected to compensate for vehicle speed anomalies so as to product aspect-ratio-correct, distortion-free, backscatter x-ray images. …"

<u>The claims</u>

70. Omitting reference numerals and separating the last feature into two integers, claim 1 is as follows:

"1. An inspection system for inspecting an object, the system comprising:

a. an enclosed conveyance having an enclosing body;

b. a source of penetrating radiation contained entirely within the body of the enclosed conveyance for generating penetrating radiation;

c. a spatial modulator for forming the penetrating radiation into a beam for irradiating the object with a time-variable scanning profile;

d. a detector module for generating a scatter signal based on penetrating radiation scattered by contents of the object; and

e. a controller for ascertaining a specified characteristic of the contents of the object based at least on the scatter signal,

f. the detector module is contained entirely within the body of the enclosed conveyance while the conveyance is in motion during the course of inspection,

[g] **characterised in that** the system further comprises a relative motion sensor for generating a relative motion signal based on a relative motion of the enclosed conveyance and the inspected object."

71. Claim 7 is to an inspection system in accordance with claim 1 "wherein the source of penetrating radiation is an x-ray tube limited to emission of x-rays below 350 keV".

72. Claim 11 is to an inspection system in accordance with claim 1 "wherein the source of penetrating radiation emits radiation to two sides of the enclosed conveyance".

73. Claim 16 is a method claim which corresponds to claim 1.

74. Claim 18 is to a method in accordance with claim 16 "further comprising directing the penetrating radiation based at least in part on the relative motion signal".

The skilled person

75. It is common ground the Patent is addressed to a team who are engaged in developing X-ray security scanning systems. The team would be headed by a physicist skilled at designing X-ray imaging systems, together with a supporting team of electrical and mechanical engineers and a computer technician. The physicist would need to understand backscatter systems, even if he or she did not have previous experience of designing one.

76. Although it is common ground that in practice there would be a team of people with different backgrounds, both sides were able to address the issues in this case by calling a single expert. Accordingly, I shall refer for convenience to the skilled person rather than the skilled team.

Common general knowledge

77. There is no dispute that all the matters I have set out under the heading "technical background" would have been part of the skilled person's common general knowledge. There is a dispute between the parties, however, as to the extent to which knowledge of various commercial security imaging systems formed part of the skilled person's common general knowledge.

78. It is common ground that there is a small community of manufacturers. At most, only around two dozen companies had any real presence in the market in 2002. The main players were Science Applications International Corp ("SAIC"), AS&E, Rapiscan, Heimann, EG&G Astrophysics, InVision, Vivid/L3 and Aracor. There were a similar number of university groups interested in the area.

79. It is also common ground that, although the security scanning market is a global one, it was very "US-centric". Because of the relative size of the US Government and military, the USA was the leading national market and was the market driver in terms of development. Moreover, most of the key players were based in the USA or had a US presence. Thus any skilled person working anywhere in the Western world would be interested in developments in the US market, even if they did not intend to enter that market themselves.

80. Before turning to consider the commercial systems that the skilled person would be aware of, it is convenient to note that it is also common ground that the skilled person developing an X-ray security scanner would also have in mind the customer: it is the customer who specifies the functional requirements which the system is to have. In the UK this would be the Home Office. In the USA it would be the US Customs Service, Department of Homeland Security, Department of Defence or the Port Authorities. The skilled person would be aware of the interest at least in the USA in obtaining mobile detection systems.

81. As is again common ground, most of the commercial systems which the skilled team would be aware of were transmission systems. The only company which had commercialised backscatter systems to any appreciable extent was AS&E.

82. Although Dr Lanza in his reports, and in particular his second report, referred to a number of commercial systems, and to a number of publications discussing these systems, having regard to the arguments on obviousness, it is only necessary for me to consider two of them.

83. The first is AS&E's MobileSearch system. This was the system a prototype of which is described in Swift. It is common ground that the skilled person would know not only of MobileSearch's existence, but also its construction and operation (at the level of generality which is material to this dispute). Accordingly, the skilled person would be aware that MobileSearch was a combined backscatter and transmission system (as proposed in Swift).

84. Rapiscan rely upon the fact that an AS&E author stated in an article in the Spring 2001 edition of *Port Technology International*, a widely-read industry journal, that:

> "Should the [MobileSearch] be operated without deployment of the transmission detector boom, the system is also capable of covert operations, scanning cars trucks or containers from one side only in confined locations and ideally suited to the needs of security forces."

I do not understand Rapiscan to contend that this information was common general knowledge, however. In any event, there is no evidence that it was.

85. The second is SAIC's VACIS range of vehicle and cargo inspection systems, and in particular the Mobile VACIS system (and two related systems known as Railroad VACIS and Military Mobile VACIS). AS&E accepts that the skilled person would know of the existence of Mobile VACIS and that: (i) it was a transmission system; (ii) it utilised a natural radiation (i.e. gamma ray) source; (iii) it comprised an open-backed truck with the source of the radiation deployed on the end of a long boom which extended across the target and detectors positioned on the back of the truck; and (iv) the truck was driven past a stationary target (so-called "drive-by" mode) as shown in the image reproduced below (figure 7 in Dr Bjorkholm's first report).

86. There is a dispute as to whether it was also common general knowledge that Mobile VACIS was capable of being operated in stationary or "drive-past" mode, in which the truck remained stationary while the target moved past it, and was equipped with a Doppler relative motion sensor to measure the speed of the target and to correct the aspect ratio in that mode.

87. Dr Lanza's evidence was that this was common general knowledge. In his first report, the main reasons he gave for saying this were that SAIC was a large player in the market, that it advertised this functionality on its website at the time and that the VACIS systems were popular with US Customs. In his second report Dr Lanza added that the VACIS systems, including Mobile VACIS, had been well publicised and documented in commonly available material prior to 2002. In particular, he referred to (i) a paper presented by SAIC authors at the 1996 SPIE Conference, which was an important and well-attended (including by Dr Lanza) conference, the proceedings of which were published by SPIE, (ii) a paper presented by SAIC authors at the Office of National Drug Control Policy ("ONDCP") International Technology Symposium on Counterdrug Research and Development Technologies in June 2001, another important and very well-attended (including by Dr Lanza and Dr Bjorkholm) conference, (iii) a paper presented by SAIC authors at the 7th International Conference on Applications of Nuclear Techniques in Crete in June 2001, another well-attended (including by Dr Lanza) conference, (iv) an article by SAIC authors in the Winter 2001 edition of *Port Technology International* and (v) an article by SAIC authors in the Spring 2002 edition of *Port Technology International*. The latter article stated that, by then, 21 Mobile VACIS and three Railroad VACIS systems had been deployed in North America and a further 20 Mobile VACIS and 16 Railroad VACIS systems were scheduled to be deployed. In his third report Dr Lanza added that Mobile VACIS had also been the subject of a paper by SAIC authors at the 1997 ONDCP conference, which had been attended by Dr Bjorkholm but not by Dr Lanza. Dr Lanza's evidence on this topic was not challenged in cross-examination.

88. Dr Bjorkholm stated in his third report that he did not agree that all of the information set out in Dr Lanza's second report was common general knowledge, but did not specifically address the suggestion that the stationary mode of operation of Mobile VACIS was common general knowledge as a result of the matters noted above. In cross-examination he accepted that the skilled person would have wanted to familiarise

himself with Mobile VACIS and to identify its technical characteristics and that one would expect the skilled person to have found conference papers of the kind exhibited by Dr Lanza, albeit not all of them. He also said that, to the best of his knowledge, the stationary mode was not actually being used by US Customs at that time.

89. On the evidence I conclude that it was common general knowledge that Mobile VACIS was capable of being operated in stationary mode and was equipped with a Doppler relative motion sensor to measure the speed of the target and to correct the aspect ratio in that mode. I am not satisfied that it was common general knowledge that it was actually being used in that mode.

Construction

90. There is only one issue as to construction, which concerns integer [f] of claim 1. This requires that the detector module is "contained entirely within the body of the enclosed conveyance while the conveyance is in motion during the course of inspection [of the object]". The body is the "enclosing body" previously referred to in integer [a]. It is convenient to address this issue in context after setting out the disclosure of Swift.

Swift

91. Swift introduces AS&E's MobileSearch system, which had been developed as far as a prototype at that time. Section 1.1 explains the general background and mentions AS&E's earlier fixed CargoSearch system for the inspection of vehicles entering the USA from Mexico. CargoSearch was a mixed transmission and backscatter system. Section 1.2 explains backscatter imaging. Section 1.3 explains the importance of mobility. Section 1.4 states that AS&E's objective was to develop a fully mobile, self-contained large-scale system using the 450 kV flying spot x-ray technology that AS&E had developed for CargoSearch. It explains:

> "The prototype system was to have only backscatter imaging capabilities, but was to be designed to enable future upgrading to include transmission imaging, an upgrade which is now in progress. Figure 1 is a photograph of the prototype MobileSearch system…"

92. Section 2.2.1 states that the major X-ray imaging components of MobileSearch are an X-ray source, a power supply and heat exchanger, a shielding and collimation apparatus including a chopper wheel, an array of eight backscatter detectors, data acquisition electronics, an operation and display console and a system of safety devices and interlocks. Most of these components are said to be variations on the CargoSearch components.

93. Section 2.2.2 states:

> "Visually, perhaps the most notable feature of the MobileSearch is its boom and beam catcher assembly, which introduced much design, fabrication, and operational complexity into the equipment. It incorporates support structures, shielding, barriers, mechanisms and motors to stow it below 13.5 feet and to deploy it over 14.5 feet, controls for those mechanisms, and safety

> interlocks. It creates operational complexities to assure continuous spatial clearance during deployment and scanning, which in some cases may altogether preclude the use of ms. It had significant impact on the design and specification of the support vehicle. It adds extra items of maintenance.
>
> To the extent that MobileSearch is a backscatter-only system, there is no functional need for a beam catcher, nor it is required to reduce the radiation to a safe level; its inclusion is almost entirely based on regulatory and end-user requirements. (These issues are discussed in more detail later.) However, an upgrade to include transmission imaging had always been anticipated, and would have required a comparable structure to be provided at that time."

94. Section 2.1 states:

> "The MobileSearch system is designed to stow into a 13'-6" height for over-the-road travel … but to deploy high enough to scan 14' high vehicles. Figure 2(a) shows the scan geometry for inspection of a full-sized (14' high) tractor-trailer. When smaller vehicles such as passenger cars or vans are to be scanned, the upper set of detectors can be deployed outward, over the top as shown in Figure 2(b), to improve the solid angle for collection of the scattered radiation. This feature has proven to provide only a marginal improvement in image quality, and is not often used. Since it comes only at considerable costs in system manufacture, assembly, and operational vigilance, it will be discontinued in future implementation."

It can be seen from Figure 2(b) and Figure 1 that the "deployed outward, over the top" arrangement involves rotating the upper set of four detectors through 90^{o} about their lower axis.

95. Section 2.3 states that MobileSearch comprises a custom-built vehicle which serves three primary functions:

> "(1) it is the truck on which the system is transported to and from the intended operating site, (2) it is a slow-speed bidirectional translation stage to produce the relative motion required to produce a scan and (3) it is the 'facility' to house and provide structural and environment support for the system and its operators".

96. It continues:

> "Bi-directional scanning is driven by a low RPM hydraulic motor coupled through a reduction gear and a transfer case into the truck's rear-axle drive shaft. A power take-off from the truck engine to a hydraulic pump supplies power for the hydraulic motor; electrically actuated valves control the direction and

> speed of travel. The transfer case enables either the truck's engine or the hydraulic motor to be pneumatically clutched into the drive shaft to the rear wheels, and so precludes the possibility of having both power sources connected at the same time."

97. It goes on to explain that the "facility" function is provided by a 24' long truck body divided into two rooms, a source room within which the x-ray generating equipment is contained and a control room. It then states:

> "A 'closet' embedded into the driver's side of the truck body houses the backscatter detectors and their deployment mechanisms. In order to get good detector coverage of the scanned vehicle, all the way from ground level to 14', the closet was extended downward through the floor (to a road clearance of 9") and upward through the roof (to 13'6")."

98. The bi-directional scanning is further described in sections 2.1 and 2.4. Section 2.1 states:

> "Scanning is bi-directional, so alternate passes can be made in the forward and reverse directions. …
>
> MobileSearch has two scan-speed modes, 3"/sec and 6"/sec, but only the faster speed is customarily used, and all results presented herein are at that speed. The faster speed results in higher throughput, the slower speed yields higher image quality."

99. Sections 2.4.1 and 2.4.2 state:

> "Upon completion of warm-up, the closet doors are opened and secured and the detectors themselves can be deployed if only small vehicles are to be scanned."
>
> "All occupants of scanned vehicles are required to exit before a scan is started."

100. Part 3 of Swift discusses radiation safety and certification. Section 3.1 explains that, to meet the requirements for certification as a "cabinet" X-ray system, it was necessary to implement the deployable boom/beam catcher assembly. Section 3.2.2 explains that a beam catcher is not required to reduce the radiation to "a 'safe' level i.e. to the 0.5 milliroentgen/hour limit to which cabinet systems … must comply".

101. Part 5 states that an upgrade to incorporate transmission imaging "and other operational improvements" is in progress.

<u>Obviousness of claims 1 and 16</u>

102. I have identified the skilled person and the common general knowledge above.

The inventive concept

103. The inventive concept of claim 1 is to be found in the claim. Nevertheless, this is one of those cases where it is worth trying to express the concept more simply. I accept counsel for AS&E's submission that it may be summarised as the combination of (i) a vehicle containing a flying spot X-ray source and a backscatter detector, (ii) the source and the detector being entirely enclosed within the body of the vehicle when the vehicle is in motion during the course of an inspection and (iii) a relative motion sensor generating a signal based on the relative motion of the vehicle and the inspected object (thus enabling the aspect ratio of the image to be corrected).

104. The advantage of this arrangement is that it enables a mobile X-ray scanner to be used for covert imaging in three modes: (i) with the vehicle moving past the target ("drive-by" mode), (ii) with the vehicle stationary as the target moves past it (stationary or "drive-past" mode) and (iii) with the vehicle overtaking the target while they are both in motion.

Differences between Swift and claim 1

105. It is common ground that Swift discloses most of the pre-characterising features of claim 1 and that it does not disclose the characterising feature of claim 1, feature (g). There is a dispute as to whether Swift discloses feature (f).

106. AS&E contends that Swift does not disclose feature (f) for two reasons. First, it describes the detectors as housed in a "'closet' embedded into the driver's side of the truck body" which extends "downward through the floor" and "upward through the roof". Secondly, it states that the closet doors are "opened and secured" during scanning. In support of this contention, counsel for AS&E argued that it was clear from the specification at [0021] that the purpose of feature (f) is so that the detectors are "concealed from view".

107. Counsel for Rapiscan argued that the purpose of feature (f) was to differentiate the claimed invention from the prior art described in the specification at [0002] i.e. an arrangement with a distal detector. Furthermore, he pointed out that feature (f) did not say "and concealed from view". Accordingly, he submitted that it was sufficient if the detector module was within the footprint of the vehicle, and that this was disclosed by Swift.

108. In my view the skilled person would understand from the specification that the purpose of feature (f) was not merely to require the detector to be onboard the conveyance, but also to conceal the detector from view. Accordingly, I consider that feature (f) is not disclosed by Swift for the second reason given by AS&E, but not for the first reason. Although the detectors are housed in a closet embedded in the side of the vehicle, such an arrangement could still be used to conceal them from view. Accordingly, I consider that the person skilled in art would regard the detectors as "contained entirely within the body of the enclosed conveyance" if the closet had no doors or the doors were shut. The fact that the closet is to some extent separate from, and extends beyond, the remainder of the vehicle is immaterial. On the other hand, it is clear that the detectors are exposed to view by the opening of the doors during inspection of the target.

General comments on the expert evidence

109. Each party contends that the other party instructed its expert to ask himself the wrong question. Both sides' solicitors proceeded in a carefully structured manner by first asking their expert to consider the person skilled in the art and the common general knowledge, then to consider the prior art relied upon by Rapiscan and only then to consider the Patent. The difference between them was that AS&E's solicitors asked Dr Bjorkholm to consider obvious developments of the prior art before showing him the Patent, whereas Rapiscan's solicitors only asked Dr Lanza to consider the question of obviousness after they had shown him the Patent.

110. In my view there is force in the criticisms which each side levels at the other's approach. The approach adopted by AS&E's solicitors had the advantage that it enabled Dr Bjorkholm to consider obvious developments of the prior art free from knowledge of the Patent; but it meant that he never addressed in his reports the question of whether the differences between Swift and the claimed invention constituted steps which would have been obvious to the person skilled in the art. The mere fact that a step did not occur to Dr Bjorkholm when reviewing the prior art was not sufficient to exclude the possibility that he might agree that it was obvious if asked. Unlike the person skilled in art, real people sometimes miss the obvious.

111. The approach adopted by Rapiscan's solicitors avoided that difficulty. The problem is that, whereas the correct question is whether, *viewed without any knowledge of the claimed invention*, the differences constituted steps which would be obvious, Dr Lanza expressed his understanding of the question he had been asked to consider without referring to the need to exclude knowledge of the claimed invention. Moreover, this does not appear to have been an artefact of the drafting of the report. On the contrary, Dr Lanza confirmed in cross-examination that his approach had been to consider obviousness as if the skilled person had been shown the claims and asked if they were obvious. Thus Dr Lanza does not appear to have understood the importance of trying to avoid hindsight.

Was it obvious?

112. It is convenient to consider the obviousness of features (f) and (g) individually before considering them in combination.

113. *Feature (f).* So far as feature (f) is concerned, it follows from my reasoning above that it would be sufficient to bring Swift within this aspect of the claim to re-design Swift to operate with the doors shut. Rapiscan contends that this would be obvious. Even though it is a small step, I do not accept this. No such suggestion was advanced in any of Dr Lanza's three reports. The idea did not occur to Dr Bjorkholm when he considered obvious developments of Swift. When it was put to him in cross-examination that it would be obvious to operate Swift with the doors shut, he pointed out that it would require a re-design of Swift, since Swift was designed to operate with the doors open (whether or not the upper detectors are deployed outward). This indicated that, if the doors were kept shut, they would attenuate the signal. In other words, one would need not simply to shut the doors, but to replace them with a non-attenuating material in order to obtain a useful image. That invites the question of why the skilled person would do that given that there is no such suggestion in Swift, even though Swift proposes to abandon the facility for outward deployment of the upper detectors.

114. It was also put to Dr Bjorkholm that it was generally obvious to enclose both the X-ray source and the detectors within the body of the vehicle, but Dr Bjorkholm did not agree with this. Again, this suggestion begs the question of the skilled person's motivation. If the skilled person's objective was to get the best possible image, they would not do this.

115. Dr Bjorkholm was then asked to assume that the skilled person wanted to convert Swift into a covert system which enables vehicles to be scanned without alerting the drivers of those vehicles. Dr Bjorkholm agreed that, if the skilled person had first come up with the idea of a covert system, then it would be necessary to find a way to hide the detectors. He did not accept, however, that it was obvious to convert Swift into a covert system.

116. Counsel for AS&E made the following points about the alleged obviousness of converting Swift into a covert system. First, since Swift is a drive-by system in which the drivers are told to vacate their vehicles prior to the scan, it is by definition not covert. Secondly, there is no suggestion at all in Swift that the system should be modified for covert operation. Thirdly, Dr Lanza never suggested that it was obvious to make a covert system at the priority date without knowledge of the Patent. Fourthly, there were no covert X-ray imaging systems in operation at the priority date whether backscatter or transmission. Indeed, apart from AS&E, the industry was producing transmission systems that could never be operated covertly. Fifthly, in order to turn Swift into a covert system, even before considering modifying the detector arrangement so as to keep the detectors hidden in use, the skilled person would first have to get rid of the boom and beam catcher arrangement. Dr Bjorkholm's opinion was that that was not an obvious thing do, because the system would not sell without the boom. Sixthly, Dr Lanza accepted that the idea of using a backscatter-only system to achieve covert surveillance was a valuable idea in 2002.

117. In my view it would be technically obvious in the light of Swift to dispense with the boom and beam catcher arrangement for a backscatter-only system, because Swift states in terms that it is not functionally necessary and that it has a number of disadvantages. Whether it would sell is a different question, which would depend to a large extent upon regulatory factors. The fact that the skilled person would be aware that MobileSearch as commercialised retained a boom and beam catcher does not detract from this, because that was a combined backscatter and transmission system and therefore had to have a beam catcher.

118. Apart from that, I accept the points made by counsel for AS&E. In my judgment the proposition that it was obvious to change Swift into a covert system is one that depends on hindsight. I am not persuaded that the fact that AS&E made a throwaway suggestion to that effect in passing in the *Port Technology International* article referred to in paragraph 84 above demonstrates to the contrary, since this does not address the practicalities of such a conversion.

119. *Feature (g)*. It is common ground that the system described in Swift does not require a relative motion sensor because it operates at two fixed speeds. Rapiscan contends that it would be obvious to incorporate a relative motion sensor. In support of this contention, Rapiscan relies heavily on the fact that the Mobile VACIS system incorporated a relative motion sensor.

120. As counsel for AS&E pointed out, Dr Lanza's evidence that it would be obvious to incorporate a relative motion sensor was obvious was predicated upon turning Swift into a drive-past system. I did not understand Dr Bjorkholm to dispute that, if one had decided to turn Swift into a drive-past system, then one obvious way forward would be to use a relative motion sensor to measure the speed of the target vehicle, but he did not agree that it was obvious to turn Swift into a drive-past system.

121. Counsel for AS&E made the following points about the alleged obviousness of converting Swift into a drive-past system. First, Swift does not mention the possibility of a drive-past mode. Secondly, Swift teaches away from a drive-past system because it involves the driver of a target vehicle leaving the vehicle before scanning. Thirdly, there were no mobile drive-past backscatter systems in operation at the priority date. Even in the field of mobile transmission systems, of which there seem to have been several at the priority date, only Mobile VACIS had the capability of being used in drive-past mode. Fourthly, Swift does not lend itself naturally to a drive-past mode of operation. Its two fixed speeds of 3 and 6 inches per second are equivalent to ¼ km/hr and ½ km/hr respectively. Swift indicates that, even at ½ km/hr, the image starts to be degraded. There is nothing in Swift to indicate that higher speeds could be used. By contrast, Mr Baldwin gave evidence was that it was practically impossible to drive a conventional van using its normal transmission system even as slowly as 3.5 km/hr. So in order even to think of changing Swift into a drive-past system, the skilled team would have to conceive of the idea of scanning at speeds perhaps 10 times faster than Swift had regarded as practical. Fifthly, it is not necessary to employ a relative motion sensor in order to achieve drive-past operation. The only existing backscatter system in which the target was moved past a stationary scanner was the fixed CargoSearch system, in which the target was towed slowly through the scanning area at a fixed speed. A relative motion sensor is only required if one wants to allow for the target moving at variable speeds. Sixthly, counsel for AS&E argued that Rapiscan's case amounted to cherry-picking one particular feature of Mobile VACIS and then combining that with Swift while ignoring both the key aspect of Mobile VACIS, namely that it was a transmission system, and Swift's proposal to incorporate transmission imaging.

122. I accept these points. In my judgment the proposition that it was obvious to convert Swift into a drive-past system is again tainted with hindsight.

123. *Features (f) and (g) in combination*. Even if the steps from Swift to features (f) and (g) were individually obvious, I do not consider that it has been shown that the combination was obvious. In order to arrive at the combination, the skilled person would have to conceive of making a mobile, covert, backscatter-only system which could operate in drive-past mode and incorporated a relative motion sensor for that purpose, despite the fact that Swift contains no hint of either covert or drive-past operation and indeed teaches away from both. It is only with hindsight that it can be seen that the necessary changes were relatively simple ones.

124. I would add that there were plenty of obvious avenues of development for Swift that did not require invention. Some of these are flagged up in Swift itself – for example, the introduction of a transmission mode. As Dr Bjorkholm identified when shown Swift before considering the Patent, the skilled person might decide to remove backscatter, might look at improving the mechanics of the system in terms of the boom design and the fold over panels, might develop a better hydraulic drive, possibly with a closed loop speed control, might introduce a better wide-angle tube for use with large vehicles, or

might introduce a remote viewing console. Changing the whole method of operation of the system is far removed from obvious developments such as these.

Secondary evidence

125. Counsel for AS&E posed the familiar question: if the invention was obvious, why wasn't it made before? All the components necessary to make a system falling within the claim were readily available. Furthermore, although the time which elapsed between the publication of Swift (or at least its presentation at a well-attended conference) and the priority date of the Patent was only six years, it is clear from the evidence that the field of security imaging was an active one during that period.

126. Counsel for Rapiscan suggested that the reason why it had not been done before was because AS&E had patent protection for X-ray backscatter systems. Moreover, he submitted that the burden lay on AS&E to show that this was not the case. I regard that as an extraordinary submission. In my judgment it is plain that, where a party which is attacking the validity of a patent on the grounds of obviousness wishes to rely upon a fact as explaining why the invention was not made before the patent, whether that fact relates to the availability of raw materials or a regulatory restriction or a commercial factor or the existence of an earlier patent owned by the patentee or a third party, then the burden of proving the existence and relevance of that fact lies upon that party. Furthermore, in the present case, not only was the suggestion unsupported by any evidence from Dr Lanza, but also when counsel for Rapiscan put the suggestion to Dr Bjorkholm in cross-examination, his evidence was that AS&E had no relevant patent protection. Accordingly, even if the burden lay upon AS&E to prove the negative, AS&E has discharged that burden.

127. Accordingly, I consider that the fact that no-one came up with the invention in the six years following Swift provides modest support for the conclusion that claim 1 was not obvious.

128. Counsel for AS&E also relied upon the commercial success of AS&E's ZBV vehicles which implement the claimed invention. I do not consider that this is open to AS&E since it did not plead any case of commercial success. Nevertheless, I consider it is legitimate for AS&E to rely upon the reaction of its competitor Rapiscan to the invention, as expressed by Mr Baldwin in his second witness statement:

> "6. Like any successful business, Rapiscan UK is always on the lookout for new markets and opportunities. Rapiscan UK's decision to commence the process of designing and marketing a backscatter van was prompted by the realisation that AS&E had a commercial monopoly in this section of the market. Rapiscan UK understood that AS&E had sold in the region of 900 ZBV backscatter vans for a price in the region of $1 million per van having built each van for a cost in the region of $250,000. Accordingly, … Rapiscan UK could see a commercial opportunity. …
>
> 12. … Rapiscan retained a desire to supply a product with functionality that could rival AS&E's ZBV, for which there was clearly a significant market. …"

129. Again, I consider that this provides modest support for the conclusion that claim 1 was not obvious.

Overall conclusion

130. For the reasons given above, I conclude that claim 1 was not obvious in the light of Swift. As is common ground, claim 16 stands or falls with claim 1.

Subsidiary claims

131. Since I have concluded that claim 1 is valid, the question whether the subsidiary claims would be independently valid if claim 1 were invalid is academic. Accordingly I shall confine myself to saying that, if I had concluded that claim 1 was obvious, I would not have held that any of claims 7, 11 or 18 was independently valid. Dr Lanza's evidence as to the obviousness of the additional features required by these claims was unchallenged. I do not regard it as a complete answer to this that his analysis failed to guard against hindsight. So far as claim 7 is concerned, there was nothing inventive about using a lower power X-ray source than 350 keV, which was simply a matter of design choice. As for claim 11, if the skilled person had got that far, the ability to scan from both sides was an obviously desirable feature. As for claim 18, it was common ground between the experts that implementing this feature would be difficult, but the Patent provides no teaching to help. The bare idea of using the relation motion signal to direct the beam would have been obvious since the concept was part of the common general knowledge.

Conclusion

132. For the reasons given above, I conclude that none of the claims of the Patent is obvious over Swift. Accordingly, Rapiscan's counterclaim for revocation is dismissed.