

Order No 94/0896/S1

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IN THE CENTRAL CRIMINAL COURT

Old Bailey,
London EC4

Thursday, 7th October 1993 and
Monday, 11th October 1993

B

BEFORE:

THE HONOURABLE MR JUSTICE BLOFELD

C

REGINA

- v -

MICHAEL SMITH

1hr

D

SIR DEREK SPENCER QC (THE SOLICITOR GENERAL), MR J NUTTING
and MR J KELSEY-FRY appeared on behalf of the prosecution.

E

MR R TANSEY QC and MR G SUMMERS appeared on behalf of the
defendant.

F

Transcript of the palantype notes of DL Sellers & Co
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G

PROCEEDINGS IN CAMERA
CONFIDENTIAL

H

EVIDENCE OF DR MEIRION LEWIS

Thursday, 7th October 1993

A

(IN CAMERA)

DR MEIRION LEWIS, sworn
Examined by Mr Nutting

MR NUTTING: What are your full names, please?

A. Meirion Francis Lewis.

B

Q. What are your qualifications?

A. I have a first degree and doctorate in Physics.

Q. From which university?

A. Oxford University.

C

Q. Did you take a Doctorship of Philosophy?

A. Doctor of Philosophy, yes.

Q. In which discipline?

A. Physics.

Q. What was the subject of the doctorate?

A. The subject concerned microwave ultrasonics, that is ultrasonic waves at microwave frequencies.

D

Q. What are your other qualifications, Dr Lewis?

A. I am a Fellow of the Institute of Physics; that is probably the only other official qualification. I have many years of experience in research in ultrasonics and related devices.

E

Q. Did you join the GEC Hirst Research Centre, that is to say HRC, in 1964?

A. That is correct.

Q. Did you lead a group at the Research Centre primarily concerned with investigation into acoustic wave devices?

A. That is right, both bulk acoustic wave devices and surface acoustic wave devices.

F

Q. As simply as you possibly can, tell us what a bulk acoustic wave is?

A. The devices are concerned with solid media, for example glass or crystals like quartz, and the waves are acoustic waves which are mechanical disturbances. They are like the waves which are travelling through the air from me to you, except that they are travelling through the solid medium.

G

Q. Through the glass or crystal?

A. Glass or crystal or whatever, yes, so one can transmit information on these waves.

H

A Q. We know a little bit about something called a delay line?

A. Yes.

Q. Are bulk acoustic waves used in a delay line?

A. Yes, indeed they are used to delay signals for periods of the order of microseconds.

B Q. They travel through the crystal, reach the end, bounce the wave back again, and then out of the device and into whatever receiving mechanism you are using, radar or whatever else?

A. Yes, that is correct. They may operate in that way; they may have a separate output transducer at the other end.

C Q. What is the advance made by surface acoustic waves?

A. These waves are fundamental, rather similar to the bulk acoustic, waves with the exception that they travel at the surface of the medium rather than within the medium. They are, if you like, like waves on the sea with which we are familiar, where we can feel the disturbance if we are at the surface, but, if we were deep down under the sea, we would not know there was a wave going on. Because they are at the surface, it means that the wave can be tapped with metal electrodes at any point in its path.

D

Q. Pausing there. Relating what you have just said therefore to our delay line, does it mean that, instead of merely being able to bounce it off the end of the line, a fixed distance, you can tap it at various stages along the line and get therefore more than one reading?

E

A. Yes, indeed. If you wanted to make a delay line with many delays, maybe ten or even hundred or a thousand even, one can simply place metal electrodes at various points on the surface and receive signals at the appropriate delay time. That is one of the advantages of surface acoustic devices over bulk acoustic wave devices.

F

MR JUSTICE BLOFELD: Sorry; may I see if I have under understood it; I am pretty slow on this, Dr Lewis. If it is a bulk acoustic wave device, it goes through crystal or glass. Is it always a transparent material as a matter of interest?

G

A. No, it does not have to be; frequently is.

Q. Not necessary. The delay there we heard was because the electrical impulse is changed into a sound wave?

A. Yes.

Q. And it goes through the substance?

A. Yes.

H

- A Q. At a slower speed?
A. Much slower than an electrical wave would be.
- Q. That causes a delay?
A. That is right. The ratio of the speed of sound to the speed of light is about a factor of 100,000.
- B Q. So light goes 100,000 times quicker than sound?
A. Correct, and so a light wave, an electrical wave, light or electrical wave, travelling a distance of a mile is something like equivalent to an acoustic wave travelling an inch or so; they take the same time.
- Q. Electrical and what was the other?
A. Electrical waves and light waves are essentially the same.
- C Q. I follow that. That is the bulk acoustic wave. Now, as to the surface acoustic wave, is that an electrical impulse or?
A. No, no, that is an acoustic wave, and it travels at a very similar speed to the bulk acoustic wave.
- D Q. So it is the electrical impulse that is transformed into an acoustic or sound wave, as I have been calling it?
A. Yes.
- Q. But instead of going through the quartz ----
A. It travels on the surface. It would be like paddling water in a pond and watching the waves run across the surface, and somebody on the other side of the pond receiving them.
- E Q. On the surface of the swimming pool instead of in the middle of it?
A. Yes.
- F Q. I follow that, by being transformed from electrical impulse into a sound wave, that in itself slows it down 100,000 times, so far I was following you. Where I have lost you is: these metal electrodes on the surface, what do they do?
A. Well, the material that one uses is typically quartz. Quartz is a material which is called piezoelectric. The property of piezoelectricity is such that, if you put an electric field -- if you apply some volts to metals -- the material will change its dimensions very slightly, but it does. This is used, for example, in a quartz crystal oscillator in your watch. The quartz is vibrating because an electric field is applied by putting a voltage onto the ----
- G Q. Which makes the watch go?
A. Pardon?
- H

A Q. Which gives energy to make the watch go?
A. It sets the thing vibrating just as, for example, a tuning fork could be set vibrating, and, in that particular case, the frequency of vibration is very well defined.

B Q. What I still do not follow is what the advantage is of setting these surface acoustic waves vibrating?
A. In the bulk acoustic device what one would typically do would be to have a transducer, which is a piece of material like quartz which is at one end. This is stuck onto the delay line medium or evaporated onto it. The delay line medium could then be more or less anything. If you choose to have a (?) for example at the other end, you would have another transducer. So there are two transducers stuck on with glue and electrical signals applied at one end and taken away at the other end.

C
D Now, in the case of surface acoustic wave devices, one uses a slice of quartz, a polished slice, and puts metal electrodes down on to the surface by evaporating the metal. This has another advantage which I have not mentioned so far, which is that you do not need to stick the transducer on because, simply putting metal down, they form a transducer.

Q. So in layman's term?
A. They are easier to make.

E Q. It causes the delay rather more efficiently than the bulk?
A. Well, they are easier to make than the bulk acoustic wave device, but in addition you can have metal electrodes at any point along the surface and take outputs at any point along the surface.

F MR NUTTING: May I help. I wonder whether we could approach it from a practical standpoint. We have understood that these delay lines are used as a method of imitating a set distance as a checking mechanism for a Rapier missile system?
A. That is correct.

G Q. So that you have your what we have learned to call the operator confidence facility sitting next to your Rapier missile battery?
A. Yes.

Q. You want to check that the battery is working. You send a pulse across the few feet to your operator confidence facility and, because the pulse from the radar is converted by the delay line into a sound wave travelling slower ----
A. Right.

H

A Q. ---- the delay line being preset to imitate a set distance of an aircraft several miles away, you know what the setting distance is; and, if you get back the right signal, you know the thing is working properly?

A. That is right, yes.

Q. So that the delay line acts as a checking mechanism for the radar, and imitates an aircraft several miles away?

B A. That is right exactly.

Q. Do I understand you to say, Dr Lewis, that the advantage of the surface acoustic wave, if the delay line is made with the use of surface acoustic wave technology rather than bulk acoustic wave technology, is that you could have aircraft at several preset distances, not just one preset distance?

C A. Yes, indeed. The advantage is that the entire surface is available to be tapped, and you could indeed simulate for example ten aeroplanes at different ranges.

Q. You do not have to bounce it off the end. You can bounce it off an artificial block not just once but, as you say, hundreds nay thousands times?

D A. If you wanted to. However, that is not the only advantage; that is just one of advantage of being able to access the signal at any point in its path.

Q. Now, you have read the papers in this case carefully, have you not?

A. Yes.

E Q. Are there any other advantages relevant for our consideration in this case that we ought to know, before we come to the documentation on the surface acoustic wave devices?

F A. As I intimated just now, the surface of this crystal is available to be tapped at any point. The simplest application to understand is the delay line medium, where you put a signal in radar pulse and take it out later. If in fact you put a series of electrodes on the surface and combine them together, it turns out that this device is selective in the frequencies that it will give an output at, so that one can put many frequencies in and only those that match a pattern of electrodes will come out. The consequences of this is, just as in your radio or television receiver, the aerial will receive all sorts of transmissions, but only the signals you want will be passed through this filter; the ones you do not want are rejected, so it is like tuning into the channel you want.

G

MR JUSTICE BLOFELD: Can I say a SAW enables you to tune in better than a BAW?

H A. The bulk wave device would not be obviously usable as a filter; the surface wave is.

A Q. You cannot tune in with a -- I am calling it a BAW and the other a SAW?

A. Right, not easily. There are ways to do such things but it certainly is not an easy thing.

Q. A BAW enables you to tune in and listen to the radio?

A. The surface acoustic -- it is a fixed filter but it passes a certain number of frequencies and rejects other frequencies.

B

Q. Like you can your tuner; I can understand that one!

MR NUTTING: Any other relevant improvement of a SAW over a BAW?

C

A. Yes, I can spend a week telling you about the advantages of these devices. Again, because you have access to the entire surface and you can put electrodes down at any point you like, you have a very general filter design capability. In fact, in principle, you can use this technology to make any filter response you like. So you can pass this frequency; reject this one; pass this one at half strength; reject this one fully. If you had a long enough substrate, in principle, you could make any filter you like. It is, however, usually better than alternative types of filter. For example, using capacitors that one may be familiar with in radio sets and so on, it has a greater flexibility of design than conventional filter design.

D

Q. So it acts as a very sophisticated filter?

A. Yes.

E

Q. I would like to come to the documents and, in order to spare us going through them in great detail, I know that you have are our request kindly picked from the documents the documents which are particularly sensitive. The jury may be asked at the end of this case to consider the question whether or not any of this material might be useful to a potential enemy of this country. In that context, we are talking about the Russians. So perhaps you would have that test in the back of your mind. Could you help us through the documents, please, and pick out the areas that you regard as sensitive. I think you have made some notes, have you not, for this purpose?

F

A. That is right, yes.

G

MR NUTTING: My Lord, may he refer to those.

MR JUSTICE BLOFELD: Of course, yes.

MR NUTTING (To the witness): Yes. Could you have a copy then of the documentation, blue volume, and turn to page 2.

H

A MR JUSTICE BLOFELD: I am just wondering -- members of the jury, I do not think I have explained that expert witnesses, of which we have seen several and we will see several more, are always entitled to bring into court all their notes. They can look at their statements if they want to, and look at all the back-up material such as their research notes, or indeed refer to papers which the defence have been doing. The reason for that is they are not trying to give you a recollection of facts; they are trying to give you the interpretation of facts from their expertise.

B
C
D Obviously, in quite a number of cases, this means they have to think about it carefully. You cannot give an expert opinion necessarily off the top of your head because you may not have considered all the relevant factors. So that is why the expertise that the defence are relying on is disclosed to the prosecution, so that the prosecution witnesses have a chance to consider it, so that they can give a thought-out response. It is for you to decide in the end whether you accept their evidence or not, but it is obviously sensible, so that you get their thought-out advice. For exactly the same reason the defence have the details from the prosecution, so that they can understand it; otherwise the experts would not be able to grapple with it.

MR NUTTING: ~~Dr Lewis, just finally before we come to the documents, confirm if you would the uses to which these objects can be put. Do they have a commercial application?~~

E A. Yes, they were developed primarily and initially for military applications but, like almost all devices of that kind, they have found commercial applications, so that you find them for example in television sets and video recorders.

Q. ~~I ask the question the wrong way round. They were originally, do I understand you to say, developed for their military potential?~~

F A. Yes, that is right, and, in the days that we are referring to, that was the traditional way that the military did much of the early research and applied new technologies to advanced equipment, and civilian applications followed later.

Q. What are their military application apart from in the delay line of which we know?

G A. There are many such applications. The most important and the first one is in a form of radar which is called pulse compression radar. It is a rather sophisticated device in which one sends a long radar pulse out and uses the surface acoustic wave device to compress it to a very short pulse.

H

A Q. I do not think we need go into the detail.
A. That is one of many.

Q. It has many other uses apart from the delay line in the military?

A. Yes, yes, in filters and in oscillators and many other applications.

B Q. Where would an oscillator be used: in a gun or tank or what?

A. It would be used for example to transmit information; it might be used for example to generate the signal for the radar set itself; because it happens to be a very stable oscillator, it will also be used in receivers.

C Q. Now let us come to the documents, please. The first document is at page 3 and consists of 48 pages. We can see at the very top it says page 1 of 48; is that right?

A. Yes.

Q. We can see who it was issued to in April 1990: Mr Dyer, Mr McClemont and Mr Elson. Mr Elson worked, we know, in the quality assurance department of the Research Centre?

D A. Yes.

Q. Can you remind us who Mr McClemont was.

A. I personally am not familiar with Mr McClemont.

Q. He is an employee of HRC?

A. Oh, yes I am sure he is, yes.

E MR JUSTICE BLOFELD: Sorry, I thought you said you had been joined HRC in 1964?

A. I was at HRC in 1964.

Q. You are not there now?

A. Oh no, no.

F MR NUTTING: I am sorry, I should have covered the point. It is entirely my fault; I am afraid we moved onto something else and I never came back to it. You joined HRC in 1964. How long did you work there for?

A. Until 1972.

Q. Where did you go thereafter?

G A. I joined the establishment which at the time was known as the Royal Radar Establishment, which has subsequently changed its name to the Royal Signals and Radar Establishment and most recently to the Defence Research Agency.

Q. Let us call it DRA because that is the place where your namesake Professor Lewis works?

H A. That is right.

A Q. Professor Keith Lewis whom we saw yesterday or the day before. Is that at Malvern in Worcestershire?
A. That is correct.

Q. The first 48 pages -- can you summarise them for us conveniently?
A. Well, it is a little difficult. It is basically meant to outline the company's capability with respect to surface acoustic devices. As you will gather there are ----
B

Q. Pause there. We have to take a note so, if you could break up the sentences....

C MR JUSTICE BLOFELD: This document outlines the capabilities of?
A. Of the Hirst Research Centre.
Q. In relation to SAWs?
A. Yes.

D MR NUTTING: It contains a flow chart, does it not, for the filters?
A. Yes, a number of flow charts.
Q. Page 21 for example?
A. Yes.

E Q. What is the value of a flow chart?
A. It enables one to understand in outline, in this case for example, how to design, how to process the devices. So that it tells you each step in the procedure. In the case of the design, one for example has a first attempt; measures certain properties; puts a correction in, and so on.

Q. Help us: how useful would this document have been to a researcher in this field in Russia?
A. To a researcher?

F Q. Or a scientist or whoever; to a Russian, but obviously not to a Russian like me. I mean, he would need to understand it?
A. Yes, there are 48 pages in this document, and they describe -- they are intended to describe -- the

G capability of the company in this technology. They therefore emphasise all the good points and all the achievements and all the capability of the company. It is known that the Russians generally have a much lower capability in technology so that, if they were given this up-to-date and detailed information on the position of the GEC, this could indeed be quite helpful to them, to know exactly where the British activity had got to and their capability, and may enable them to advance their own process (if they did not have it) in a shorter period than they would normally have done.
H

A MR JUSTICE BLOFELD: They would know where the British had got to, and it might enable them to advance their capability more quickly than if they had not got this document?

A. That is right, because it is the documentation of a company that is concerned with manufacture. It is not the publication of concepts in literature, which are available to anyone, but we do not give all the details of exactly how you do the job.

B MR NUTTING: What sort of standing does HRC have in the scientific world in this particular area of research?

C A. Well, the General and Electric Company is one of the few remaining large electrical companies in this country. I think I am right in saying that there is only one other company that has a significant activity in this field, the Racal organisation -- and GEC certainly has a wider range of capability than Racal -- but they are the only two significant companies in the country.

Q. How does that standing within this country compare to a western context, the western world as a whole?

D A. This is an embarrassing one to answer because, generally speaking, our research capability is on a par with anything world-wide; generally speaking, our manufacturing capability is much weaker. For example, the world production of these devices is totally dominated by the Japanese and Germans. The production in the UK and the USA tends to be rather for the smaller, specialised components that are required largely for the military market.

E Q. By an objective criteria, how good is the technology employed by GEC; how precise are the SAWs that they manufacture?

F A. Well, they are of world standing. There are not a large number of companies in the world that manufacture these devices. In the US there are perhaps ten or twenty companies of this kind; in the UK there are two. In Germany there is Siemens, which is very proficient, but our capability is on a par with some of the American activity. What we do not have is the experience of really large numbers of mass production devices that the Japanese have.

G Q. Do I understand you to say that is really in a commercial than military context in any event?

A. Yes, I believe the Japanese constitution does not allow these devices to be sold for military purposes.

Q. Is there any information in the first 48 pages that you consider we should bear in mind, particularly in terms of its sensitivity as information?

H A. There are one or two points which I think are particularly significant. On page 13 ----

Q. Can you give us a chance to get to that page.
A. Yes, Page 13, section 1, quartz growth. This refers to the growth of high-purity, synthetic quartz which is radiation hard and is used for high quality SAW filter applications. The material is grown hydrothermally in highly specialised pressure vessels under extremely carefully controlled conditions. Now, the material quartz has been known for many years as a material which is useful for oscillators and for frequency standards.

So, for example, most radios and TVs have some sort of oscillator and quite possibly a quartz crystal oscillator, as indeed does your watch, which is a frequency standard. Certainly all sophisticated communications receivers would rely on quartz crystal as a frequency standard. It is very important in communications and in military situations to ensure that the frequency of your device is accurate. You would not like it if your watch did not give you accurate timing but, if you are relying on communications over a certain channel and the frequency changed so that you moved into another channel, that would be very embarrassing.

Such a change can occur if the quartz crystal is in the vicinity of a nuclear explosion or is exposed to radiation. Exactly why this is so is not known in great detail, but in general terms, if the material is not particularly pure, then the problem is worse. So presumably the impurities are the things that are affected by the radiation and cause the quartz to change. Consequently, if you can grow exceedingly pure material, it will be subject to less change, and it is then called radiation hard, so that it does not change and it is not damaged by nuclear radiation or the kind of radiation one experiences in space.

So GEC has the capability for producing material of extremely high purity and which is radiation hard, and this is of particular importance to military applications and to applications where these crystals would be used in space.

Q. Was this information about GEC's capacity generally known?

A. I was aware of it in the course of my work in the DRA because it was at the timely relevant to the research that I was conducting. To my knowledge, there was considerable secrecy about the existence and the achievement of this material, certainly at a period of a few years ago. To my knowledge it has not been made public.

Q. Is there anything else in those pages that you would wish to draw our attention to in the context of its

A A. sensitivity?
Sensitivity?

Q. Particular sensitivity, I mean.
A. Sensitivity is perhaps the wrong word for what I am about to describe but, on page 19, the mounting material referred to is a material made by Dow Corning.

B Q. Give us a chance to get there. Yes, we see; which describes, you say, the mounting material?

A. Yes.

Q. It is that shaded area to the end on the right-hand side of the diagram; is that right?

A. That is the absorber. I think they may well be the same material.

C Q. All right.

A. The mounting material sticks the substrate to the container.

Q. Yes?

A. And quite possibly the same material would be used on the ends to absorb any unwanted acoustic waves.

D Q. What is the point on this page?

A. The point I make about that is that clearly you have to stick this acoustic wave into the container with something, and you can use almost anything to do the job. However, it turns out that, when you enclose the device in the metal container, the adhesive typically gives off a gas. It is in fact what the glue sniffers sniff. You can smell it, and this has an effect on the surface of the device. A thin layer might for example deposit itself on the surface of the device.

E

F Now, I have said before these are surface acoustic devices and so anything that affects the surface is going to affect the wave; and in fact, in our own research, we spent probably 18 months or two years going up a blind alley, because we thought that the quartz itself was changing, and we were trying to discover why. In fact it turned out that it was the gases that were coming off from the adhesives which were affecting the surface. So what I am coming to is that one needs to have the optimum choice of adhesive and one that does not have gas, or maybe there is something else in it -- I do not know -- but you do not just pick the nearest tube of glue and stick it down, because that will have gas in all probability and affect the device. So, if you know what material behaves well -- and presumably this Dow Corning does -- that is of use to you. This one is referred to again on page 42.

H

- A Q. Substrate adhesive is here described rather than diagrammatically shown, and the substrate adhesive is the Dow Corning 738 RTV silicon rubber compound?
- A. Right. I should say that there is nothing that magic about that material. It is just that one has to go through the experience of testing lots of materials. These have evidently done that and found this is a satisfactory one.
- B Q. Your point is that you might suppose that any old adhesive will do?
- A. Well, that is what we did, and it took us a long time to sort out suitable adhesives.
- C Q. Dr Lewis, is there anything else in the document that we need to know?
- A. I do not think it would be necessary to draw attention to any other specific points, just that there are lots of details of the processes. I think we will come across more of them later, on more important points later on.
- D Q. Then can we turn to page 51. This document runs to page 59, does it not?
- A. Yes.
- Q. We can see that it is in fact a document that is classified in two senses. It has the government classification Restricted and the commercial classification of Commercial in Confidence?
- A. That is right.
- E Q. What is this document exactly, please?
- A. It relates ----
- Q. It is headed Demonstrator Programme Requirement Specification Bandpass Filter Assembly.
- A. Yes, it outlines a programme to build surface acoustic wave filters for use as what is called the IF filter in a receiver.
- F Q. What is the IF filter?
- A. The IF filter is an intermediate frequency filter. In most receivers -- radio, television, radar -- it is normal practice to receive the signal, which may be a very high frequency, and convert it to a lower, intermediate frequency, because this one is easier -- the intermediate frequency is easier to handle and make devices.
- G Q. In what object was this bandpass filter to be incorporated; do we find that on page 53?
- A. Yes at the top of page 53, it indicates that this filter is to form part of the IF receiver incorporated in an airborne guided weapon. The filter determines the system bandwidth.
- H

A Q. What function does the bandwidth perform in the airborne guided weapon?

A. The bandwidth is the width of frequencies that the filter passes. It is like the bandwidth of a television receiver would need to have a sufficiently wide band to cover all the information to form the picture; in a radio receiver it would be a narrower band because you have only got the sound.

B Q. What do you need the band for in an airborne guided weapon?

A. As in anything else, it is to select the frequency that you wish to receive and to reject all other frequencies.

C Q. Why is that essential in an airborne guided weapon?

A. Well it is essential for the same reason that it is for example in your television receiver, that is to say, if you received all television pictures, you would have all the pictures superimposed and you would not be able to see the one you want; you would get lots of interference from the other pictures. So you select the frequency that you wish to receive with that filter.

D Q. Does that tell the guided weapon what to do? Does that actually guide the weapon, or does it perform some other function?

A. It depends what that receiver is for. If it is a radar receiver, which it probably is, the weapon may well be sending out radar paths and then receiving an echo back. That is one possibility, but it does depend on the nature of that weapon, because it could be receiving signals from other sources.

E Q. Can you help us, please, why this would be useful to a potential enemy of this country.

A. Well, generally speaking, you know roughly how communication systems and radar systems work. We all know that radars send out a pulse of energy; they reflect from targets; they come back. You have some measure of what the target is; how far away it is, for example. If someone wished to interfere with the receiver, they would send signals in that they know your system would pass. So, if someone wished -- as indeed the Russians do -- to jam certain radio channels, they would just transmit a lot of noise or whatever at the appropriate frequency. So any information that one can gather about the operating frequencies of systems is of potential value to someone who wishes to disrupt the operation of that system.

G
H Now, normally one would aim to interfere with the main radiation frequency at which the system is working, if you know that. However, there are systems which enable you to overcome that kind of interference

A by changing your own frequency. So you can hop the frequency around, and then someone who wishes to interfere, unless he knew how you were hopping, he would not be able to do all that. However, you are vulnerable at the intermediate frequency because that is a fixed frequency. Now, it is more difficult to get interference signals into the intermediate frequency but nevertheless you are vulnerable at that frequency.

B Q. What is the intermediate frequency?

A. It is the frequency I indicated before. It is not the frequency that the radar would transmit. It is one that -- you convert it down to the intermediate frequency, which in this case is around about 120 Mhz.

Q. Do we find that figure on page 56 of these documents?

C A. The centre frequency is indicated as 120 Mhz on that page, yes.

MR JUSTICE BLOFELD: I do not think I have followed your hopping, Dr Lewis.

A. I beg your pardon?

Q. I have not followed your hopping. I followed that the device has a frequency.

D A. Yes.

Q. And an enemy might send out the equivalent of jamming it, whereupon the frequency can change, which you call a hop.

E A. Ah no, no, forgive me. It would take a little while to explain. If I worked at a fixed frequency, if I transmitted always at 1000 MHz, somebody could learn that and then send in spurious signals. If I were to design my radar such that it worked at 1000 MHz on one pulse, and the next pulse it worked at 1001, jumped to 1010 and then jumped around, the person who was trying to jam me, unless he knew the order in which I would select those frequencies, would not be able to jam me. The only way he could do it would be to jam all frequencies in the hope of getting some energy in to jam me. Now this is much less satisfactory from his point of view because, first of all, there would only be a little bit of energy at the frequency he wished to jam in.

F MR NUTTING: It would only be a little bit of energy at the frequency he wished to jam?

G A. Because he is spreading it over a lot of frequencies; and, secondly, because he may well be jamming other systems including his own, if he is sending out energy at a lot of frequencies.

Q. If he knows what the centre frequency is?

H A. If he knows the frequencies? Well, clearly this helps him in jamming.

- A Q. What is the context of a centre frequency then?
A. Oh, the centre frequency -- we are now talking about the IF filter. You should understand that this is the filter which is in the equipment, and it is operating at a fixed, lower frequency. It is not as easy to get energy into that frequency, but some will come through the antenna system -- always some energy gets through - and, if you can get into there, you can jam the IF stages, which is just as effective as jamming the transmitting frequency. The actual value ----
- B Q. I fear you have lost me, Dr Lewis. I am not sure that I understand the difference between the IF frequencies or the IF mechanism and the other mechanism.
A. It is purely a practical proposition. If we go back for example to the surface acoustic wave devices, if you wish to make one which delayed signals at the radar frequency, and the radar frequency was say 3000 MHz, then it turns out the attenuation would be rather high, particularly for the surface acoustic. If you convert that down to a frequency of 100 MHz, it is much easier; the losses are much lower. So it is much easier to make a delay line, and indeed is much easier to make a filter, at 100 MHz than at 1000 or 3000 MHz.
- C Q. Can we come back to this document.
A. Yes.
- D Q. What is the information here that -- the precise information which would make the jamming. because I understand it is the jamming that we are concerned about?
A. That is.
- E Q. What is the information which would give to the other side the ability more effectively to jam this airborne guided weapon?
A. The centre frequency 120 MHz in this case. But there is other information that could be useful to an enemy to understand a little more about your system.
- F Q. Please?
A. For example it describes the bandwidth 10 MHz. The bandwidth of a system tells you something about how its processing data. So in a radar system the bandwidth will tell you the accuracy with which you can measure the range of a target. If it is a wide band, it turns out you can measure the range very accurately. So, for example, if there are two targets, you would see two targets. If it is a narrow band system, they would get blurred, and you would not know whether there were two or not; they would overlap.
- G

H So in the radar system it would determine the range resolution; in a communications system it would determine the amount of information that could be

A transmitted. So, for example, a television signal might require a bandwidth of the order of 10 MHz, as in this; a radio signal would only require 5 KHz, much

Q. Let us come away from televisions because we are talking about an airborne guided weapon.
A. Yes.

B Q. Now, you have told us that the centre frequency of 120 MHz would be of significance, because it would assist the other side to jam the missile?
A. Yes.

Q. And you told us that the bandwidth figure of 10 MHz would assist in precisely what connection?

C A. It would enable somebody who read this specification to know something about your radar. Generally speaking, anything you know about the enemy's system, weapon systems, is useful information. That would tell the range resolution, if this indeed relates to a radar, which I presume it does. There is further information, namely that group delay matching is important in this application. Would you like me to attempt to ----

D Q. Yes. May I just complete the picture on the radar. Is the radar you are talking about the radar which guides the weapon?

A. Well, it will be guiding the weapon onto the target one way or another.

E MR JUSTICE BLOFELD: Can I interrupt because I am still trying to get it, I am afraid. The radar, the Rapier, is on the ground?

A. No, we are talking about an airborne ----

Q. This is airborne?

A. This is not the Rapier, or I do not think it is related to Rapier.

F MR NUTTING: This an airborne guided weapon, as distinct from the radar in a Rapier missile system, which is essentially ground based.

MR JUSTICE BLOFELD: I see. So this in fact is an offensive weapon that is being shot at the enemy by us?

A. Probably, yes.

G Q. Is that what we come to?

A. Yes.

Q. And if all the systems are working, it is locked onto its target by its radar?

A. In all probability, that is correct, yes.

H

A Q. So it is aimed at moment at some Russian target; that is what we are presupposing?

A. Yes.

Q. Obviously I am presupposing that we are in a state of war, which we are not.

A. Yes.

B Q. The Russians do not want it to hit the target, and therefore they have got to disrupt the radar so that it no longer locks onto the target?

A. Yes, that is correct.

Q. If it does not lock onto the target, it will land somewhere, but the odds are that it will not hit the target; it will fall, explode and either do no damage or less damage?

C A. Yes.

Q. Now, the only way that, as I follow it, the Russians can get into the missiles radar and prevent it from hitting the target onto which it is locked is if it knows the frequency of the radar pulse that that missile is using?

D A. That is a good way of doing it. If you know the frequency that it is operating at, and it is only operating at one frequency, that would be an excellent way of jamming it.

Q. But I gather that is the simple one, but ours are now more sophisticated than that?

E A. Well, unfortunately the way things are, weapon systems get more and more sophisticated. For example, I do not know whether this weapon has this capability or not -- I do not even know what weapon it is -- but it might change its frequencies to prevent people from jamming it in that way. If that is so, then the enemy -- the best he could do would be to jam all frequencies, and that is much less effective because he is not concentrating on the frequencies at which the system is working. But there is another way of jamming it, which is not to use the frequency at which he is transmitting but to inject energy at the intermediate frequency. That is another frequency in the system and that one is a fixed frequency. In all the systems that I am aware of it is much more difficult to get energy in at that frequency but, if you do, you know you will cause disruption.

G

Q. So you have in the missile, as it were, an internal frequency which is fixed, and then you have the radar which comes out, which may go from one frequency to another?

A. It may indeed, yes, yes.

H

A Q. And those frequencies are easier to jam, but it is possible to jam the internal frequency?

A. Right.

Q. If you happen to know ----

A. What it is.

Q. Precisely what it is; but even so, I gather, it is still quite tricky?

B A. The receiver is not designed to receive that frequency but such frequencies always get through to some extent. So it is less effective but it is ----

Q. I understand it more in which case; thank you.

A. There is further information which relates to a quantity called the group delay matching.

C

Q. Yes?

A. I am not familiar with this particular weapon system but this is a somewhat unusual requirement. You notice that the absolute group delay is not important; that is the normal situation. In other words -- I hope you do not mind but I would like to use radio and television analogies when I can; it is meant to help you -- if your television receiver received a signal a fraction of a second later than it ought to, you would never know and you would not care. But there are circumstances in which you would. One of those is if for example you had two receivers and you wished to know the direction of arrival of a signal because, if the wave is coming at you at an angle, it will hit this one first and this one second. If you know -- if these delays are very accurately set, that difference in delay will let you know from which direction the signal is coming at you. So that may very well be why that specification applies in this document.

D

E

MR NUTTING: Why is that useful?

A. Well, because that will tell you the direction in which you ought to steer your missile.

F

Q. Is this the missile that would destroy the airborne guided weapon?

A. Oh no, no, this is the airborne guided weapon itself.

Q. That is why I asked: why is it useful to the other side who have not got the weapon but are seeking to destroy or disrupt it?

G

A. The reason is simply that the document containing that gives them information about the operation of your missile, your guided weapon; that is all.

MR TANSEY: My Lord, I hesitate to rise but, so far as the vast bulk of the evidence given, this is not in his statement. My Lord, it should have been if the prosecution are relying upon it. I make no criticism.

H

A My Lord, we should have a statement setting out a number of these matters and they are just not there. My Lord, it does create difficulties. What I would ask is in fact if this -- if a statement could be served upon us setting this detail out on which the Crown rely.

B MR JUSTICE BLOFELD: It is a bit difficult for this witness now that he is in the witness box. I am afraid I probably, Mr Tansey, may have a share of the responsibility because I have been trying to understand it and asking questions which may have gone away from the tack that the witness was doing. So I am sorry if I have made your task more difficult.

C MR TANSEY: No, no, it is just that literally matters have emerged.

MR JUSTICE BLOFELD: What I will do is let Mr Nutting go on till the short adjournment. I expect between your team you have taken a fairly detailed note of this witness's

MR TANSEY: We have, yes.

D MR JUSTICE BLOFELD: ---- evidence so far. The way Mr Nutting approached it certainly commends itself to me. It sounded as though he was not going to ask Dr Lewis to go through every document but only as it were pick at the highlights. It may be that he is in a position to tell you which other documents he is going to deal with, which may be somewhere in the statement but not highlighted.

E MR TANSEY: It is not merely the matters ----

F MR JUSTICE BLOFELD: Can I leave it for the moment. I have noted your point and I see you want to take instructions on it. Can you, when we rise -- would it help if I rose either now or sat a little later after lunch so you can sort it out, so that you know what is coming?

G MR TANSEY: May I say that would help certainly so far as certain matters are concerned. We may need to consult other persons. For example the matter that has been referred to is nowhere in the proof about group delay matching, group delay dispersion and absolute delay, the significance of all that. My Lord, this is my concern. Certain other matters I can deal with. It is just that extent of the detail now being given in fact goes far beyond what is in the statement, and therefore obviously far beyond what I have been taking instructions about.

H

A MR JUSTICE BLOFELD: I do not think I can help you further. I think the only thing to do is we can carry on for another five or ten minutes. I think the sensible thing is to carry on till one o'clock and, if by five past two you would like a little more time, I will ask the jury to wait and I will not come in either.

B MR TANSEY: Sorry, but we do not have an expert here who can actually deal with these particular parts, and that is the concern.

C MR JUSTICE BLOFELD: You will have to deal with what you can and, if there is something else you cannot deal with, if necessary you will have to address me on it at whatever time it is. I am not going to make a ruling about whether you do it at the moment, Mr Tansey, but maybe I shall change my mind. Members of the jury, you go off to lunch now and come back at five past two. If there will be a delay, we will let you know.

(The jury retired from court)

D MR JUSTICE BLOFELD: Mr Tansey, I think the most sensible thing to do is for me to rise so that you can talk to Mr Nutting. I have no objection to anybody talking to an expert, if you both agree. That may help you to know what is coming.

MR TANSEY: It would certainly help.

E MR JUSTICE BLOFELD: The difficulty about an expert is experts tend to know so much more than we do, particularly when it gets into the sort of field; unless you are a physicist, you do not know about it. They say something; whoever is questioning either thinks they understand more than they do, or feels the witness in fact wishes to make a point that they have not fully appreciated; and, before you know where you are, you have gone into something that is not included in your proof of evidence. It may be, when the time comes and you call any experts yourself, you will be in the same boat; it is difficult to stop that. I see your difficulties. That is why I was encouraging Mr Nutting when he said -- I did not encourage; I just was rather pleased that he was dealing with a few pages.

MR TANSEY: Absolutely, yes.

G MR JUSTICE BLOFELD: I see it in this way that, when it comes to it, it is not for the Crown to have to prove that every single page in this is useful. If they can prove any of it is useful, then that is probably enough. Therefore the precise details of the particular page do at the moment seem to me to be of only some significance. You cannot ignore it altogether; otherwise you just dismiss everything.

H

A MR TANSEY: My Lord, that may become one of the points that in due course one has to consider.

MR JUSTICE BLOFELD: I know if I am going to spend my time talking to you, you will not have a chance to consider it.

(Luncheon Adjournment)

B (In the absence of the jury)

JUDGE HAWKINS: Yes.

C MR NUTTING: May I help. I have spoken to Dr Lewis in confirmation of the rest of the material that he proposes to expand on to the jury, in extension of his statement, and indeed I have communicated that to Mr Tansey. My Lord, I think it really boils down to only the last matter that Mr Tansey was taken by surprise on, and I think that, after Dr Lewis has explained it, perhaps he will not feel so disadvantaged as he otherwise might be. I think he recognised that the other material would be a matter Dr Lewis would cover. May I just, while the jury is out, ask whether any indication could be given as to the requirements of other witnesses today. These are busy and, many of them professional people. I am very anxious not to keep anybody here longer than necessary.

D MR JUSTICE BLOFELD: Can you cross-examine this witness today?

E MR TANSEY: My Lord, I cannot cross-examine about three matters on page 56.

MR JUSTICE BLOFELD: Right.

MR TANSEY: The reason is ----

F MR JUSTICE BLOFELD: That is all right; do not bother about the reason. Can you do it on the rest?

MR TANSEY: May I say I could do, and I am very ready to do so, but I prefer to do it in one go. However, I am ready.

G MR JUSTICE BLOFELD: I suspect you will do it in one go. I expect I am going to say no other witness except Dr Lewis, because I expect he will be another three-quarters of an hour in chief.

MR NUTTING: Yes, I have other things to cover.

MR JUSTICE BLOFELD: You will be a bit of time in cross-examination.

H

A MR TANSEY: I am but, as your Lordship is aware, in respect of these three matters on page 56 to which Mr Lewis gave evidence -- my Lord, in respect of those, we have not been able to locate our expert or speak to him.

MR JUSTICE BLOFELD: I am told he is available at nine o'clock tonight, which is not very convenient for you, but there is nothing I can do about that. But you therefore would like to cross-examine tomorrow.

B MR TANSEY: Yes.

MR JUSTICE BLOFELD: I am thinking of the experts hanging about. We obviously have to go on with Dr Lewis this afternoon. I am happy to fall in with whatever is convenient for both parties.

C MR TANSEY: I put the proposition ----

MR JUSTICE BLOFELD: What I prefer is for you to start your cross-examination today. If there comes a stage when you say, "I cannot take it further today because I have to take further instructions", I shall say that that is fine; carry on tomorrow. If that means we rise at four o'clock rather than half past four, it saves people hanging around. If you think you will be through by half past three, I do not want to waste an hour.

D

MR TANSEY: I do not think so.

MR JUSTICE BLOFELD: Let us take a gamble and say everyone can go till tomorrow. Dr Lewis, can you come back tomorrow?

E THE WITNESS: If necessary.

MR JUSTICE BLOFELD: What is the least inconvenient? We could probably slip you in tomorrow or possibly Monday?

THE WITNESS: I do not think it makes an awful lot of difference to me, if it helps to come back tomorrow.

F

MR JUSTICE BLOFELD: We will let you know at the end of the day; Mr Nutting or some of the will. The only thing that is crossing my mind, Mr Tansey, is that I do not want us to say that Dr Lewis is going to be here tomorrow morning to be greeted by your saying, "I saw my expert late last night and I cannot cross-examine Dr Lewis till he has made further enquiries. If that is a possibility, let us say to Dr Lewis that he is not to come back until you are absolutely ready to ask further questions. Indeed there is a possibility you will not even bother to ask further questions once you have spoken to your expert.

G

MR TANSEY: May I just have one moment. My Lord, we agree with your suggestion that I can leave it till Monday.

H

A That will give us more time to take the pressure off in case further enquiries have to be made.

MR JUSTICE BLOFELD: Dr Lewis, then we certainly will not carry on tomorrow.

THE WITNESS: Okay.

B MR JUSTICE BLOFELD: You will have a chance to get in touch with Malvern. If you tell us a day early next week convenient to you, we will interpose you at 10.30 or as soon thereafter as may be to interpose you. We will get you on early in the morning or indeed two o'clock if that is more convenient for you.

(The jury came into court)

C MR JUSTICE BLOFELD: I will tell the jury we might have a an early day. Members of the jury, the programme for this afternoon is Dr Lewis will go on with his evidence. When he has finished giving evidence for the Crown, he will be cross-examined. There are one or two matters Mr Tansey wants to take further instructions about. I have decided not to carry on with another witness this afternoon because it looks as though Dr Lewis will occupy most of the afternoon. If we find we run out, we will have a little earlier day than usual. I have taken the liberty of thinking you probably would not mind too much.

DR MEIRION LEWIS, continued
Further examined by Mr Nutting

E MR NUTTING: Page 56 in your exhibit bundle. You had pointed out to us, Dr Lewis, the information under group delay matching, and you indicated that that was in information of some use or value. You were going to tell us precisely why, in the simplest terms, it would be of use.

F A. Yes, the reason for this is that group delay matching is not a quantity which is specified in ordinary surface acoustic wave devices and in most other filters. The most probable reason that that group delay matching is there is that the receiver has two antennae and that, by having two, you are able to determine the direction from which a radar signal is arriving at the missile.

G Q. So has it got something to do with the tilt?
A. It would be a feature of the guidance system; that is my guess as to why that is there. It is an unusual parameter, but the important point, I think, to make is that the document as a whole, with data of this kind, together with other data, for example, on the number of devices that are to be produced ----

H

- A Q. Can we take this slowly, because this the general point you make, and this perhaps will be more meaningful to us than the specifications. So can we take this slowly. The general point on the whole document is what?
- A. On the whole document, it is that taken as a whole it indicates the development of this weapon. It gives you information on the frequencies that it uses, or at least the IF frequency. This information on the group delay matching suggests that this is a direction finding radar not a conventional radar, and the additional radar relating to the numbers produced tells you how many of these missiles are going to be produced. So it tells us that Britain is developing this weapon and how many of them and details or some information on how it operates.
- B
- C Q. The figure for the production is 4,000, is not it?
A. That is right, yes.
- Q. Page 54 -- production programme on the left, approximately 4,000 off, commencing late 1985 early, is it, extending over a period of time, three years?
A. Yes.
- D Q. And the document of course was dated, as we saw on the front, January 1982, on page 51. So by 1992, unless this missile had been replaced, you would expect a certain number still to be in operation?
A. That may well be so. I do not know what the missile is.
- E Q. Is there any other matter in the rest of the pages of this fairly extensive bundle of documents that is material that you think is of particular value or use to a potential enemy?
A. There are a number of points which could be of value to a potential enemy. They are not necessarily of the utmost importance, but they could be. For example, on pages 60-66, there is a discussion of the technique for producing the metal films from which the transducers are made. On page 60 too, four metals are mentioned, namely: aluminium, titanium, chromium and silver. Of those metals, the most commonly used in surface acoustic wave devices is aluminium.
- F
- Q. Page 62: materials to be evaporated: aluminium, titanium, chromium and silver?
G A. Yes. Aluminium is the most commonly used material in this technology. Titanium and chromium are used to promote the adhesion of the aluminium. I have personally not heard of the use of silver.
- Q. So?
A. Maybe GEC has discovered that there is some advantage in using silver -- I do not know -- but silver is
- H

A mentioned there. Possibly it has some advantage in these devices.

Q. Yes?

A. Would you like me to go onto another?

Q. I think there is one on page 70.

B A. Page 70 is a picture of the back of the acoustic substrate. When I described the work -- the operation of the surface acoustic wave device -- I have described the surface acoustic running along the surface of this device from one input transducer to the output. In these devices it is normal for there to be an unwanted signal which in fact it is a bulk acoustic wave, the BAW that we heard of. Instead of running along the surface, the wave goes from the bottom, bounces from the bottom back up to the surface, a little like the echo you get if you shout in the valley and hear the echo off the mountain. That wave distorts the performance of the filter, and it is normal practice to roughen the back surface or to add some absorbing material to destroy the effect of that bulk wave.

C Q. I do not think we need to understand why necessarily, but are you saying that it is necessary to have some sort of cross hatching or roughening?

D A. Yes.

Q. Of the device itself?

A. Yes.

Q. To prevent some distortion or other?

E A. Yes, right. And the point about ----

Q. What is the advantage of page 70?

A. The point about this page is that it gives you the detail of what scratches/grooves should be made in the back surface to do a good job at eliminating that unwanted wave. So people know that it is a good thing to do; this gives you the details of how to do it.

F Q. Yes. Page 77?

A. Page 77 relates to orientation measurements on large substrates. Substrates are the materials on which these devices are made. The materials are anisotropic. That means you must put the packing down in the right direction. If you put it down in the wrong direction, it will not work properly; and you determine the direction to put it down on using x-ray on the crystal on which you are making the device. So you x-ray the device to determine the orientation. That is normal procedure with SAW devices. However, there is one class of device which is referred to in this document, which is the manufacture of surface acoustic wave dispersive delay lines.

H

- A Q. Paragraph 2?
A. Yes, and these devices are particularly sensitive militarily, because they are used in the highest performance radar, the radars that will enable you to detect not only distant targets but also they give you good resolution, so that you can determine the structure or how many such distant targets there are.
- B Q. On the basis that the further off the object is -- particularly if there are more than one object far away --the more difficult it is for the radar to transmit back an accurate signal to the operator; is that right?
A. Yes.
- Q. And dispersive delay lines help in reifying a radar to do that job accurately?
C A. Yes, yes.
- Q. Is that it in a sentence?
A. Yes, that is right; you call it reifying. The advent of this technology was major advance in radar. The performance was advanced by something like a hundred in using this technology.
- D Q. Do I understand you to say that getting the orientation of the substrate -- that is to say the actual positioning of the crystal?
A. The angle, yes.
- Q. The angle of the crystal is always critical in the creation of a surface acoustic wave device?
A. It is also always necessary to have it to a certain tolerance, but these devices are especially sensitive because they are especially high performance devices.
- E Q. When you say the devices, you mean the dispersive delay lines?
A. Yes.
- F Q. Well now, Dr Lewis, is there anything else in the rest? I think on page 128 we pick up the point again about the adhesive, do we not?
A. Yes.
- Q. Because we see the name, or a name that is become familiar to us from this morning, Dow Corning?
A. That is right, yes; that is the same material.
- G Q. It relates back to page 19, the diagram.
MR JUSTICE BLOFELD: And 42.
MR NUTTING: Much obliged, my Lord.
A. It certainly relates back to the earlier work, yes.

H

- A Q. It is the Dow Corning adhesive?
A. Yes.
- Q. Apart from that page, is there anything else that we need to look at in order to understand why you say that there is material here which would be of use to the Russians?
A. I do not think so. The only other point is on page 161. Mention is again made of the 120 MHz filter which is intended to form part of the IF receiver.
- B Q. That is the device that narrows the wave down inside the receiver and interprets it?
A. In effect, yes.
- Q. So the beam goes out on a frequency, on one particular frequency on a frequency band of, say -- this is the figure we have become familiar with in this case -- 3.1 to 3.4 or something like that?
A. GHz, yes.
- C Q. It reaches the target and then comes back; and the IF mechanism is the mechanism is that reduces the signal to something which the radar then interprets?
A. Yes, and the filter selects that frequency that you wish and rejects anything else that has come from any other equipment around.
- D Q. So it is an object which makes clearer or in some way refines the message that is being received back?
A. Selects the one you want.
- E Q. Now, apart then from that documentation on SAWs, I think you also were shown some components, were you not, by the police?
A. Yes.
- Q. Will you turn please to the photograph JS/14 at the beginning of the same bundle. Could you just turn, please, to that photograph as well, and have the actual objects in front of you. (Handed) Are there any surface acoustic wave devices there?
A. I am sure there are. They all have their lids on, so I cannot actually see inside them. I am sure they are. They are labelled SAW devices. May I take the lid off one?
- F Q. Please. The one with the green adhesive would probably be the easiest.
- G MR JUSTICE BLOFELD: If they are stuck down, if you have to take it off
A. I think I have to take it from the (Pause) Yes, this is a surface acoustic device, and you can see the cross hatching on the back surface, through the substrate.
- H

A MR NUTTING: Yes, the jury might like to see that, in view of the evidence we have heard. Could they quickly be shown it. (Handed to the learned judge)

MR JUSTICE BLOFELD: This bit is -- sorry I am taking that off. That is the lid, is it?

A. Yes.

B Q. Is that part of it or not?

A. Well, it is just part of the box which protects it from....

Q. Is that the box or is that the device?

A. There is a device within a metal box.

Q. It looks as though the metal box ----

C A. The device is two or so inches long.

Q. That comes out of this box?

A. Well, it is stuck in at the moment with the adhesive that you have mentioned. The device itself looks like a piece of ----

Q. Stuck in for the purposes of this case?

D A. No. The surface acoustic wave device is made on the crystal. This crystal does not rattle around in the box. It is stuck to the base of the box to stop it rattling around.

Q. I see; you mean with the Dow Corning?

A. Yes, yes, presumably so.

E Q. I see. So effectively, if this were to be incorporated in a missile system, it would be incorporated as that?

A. With its lid sealed on.

Q. With its lid on?

A. And there are some small metal connectors poking from the back which would connect to the rest of the kit.

F Q. Yes, I see. (To the jury) When the box is passed round to you, imagine that was open so you have actually seen it. We were told there were other devices which we would need a magnifying glass to see, but that is a device you can see with the naked eye, about two inches long.

G MR NUTTING: Where do the jury look for the cross-hatching?

A. You look through the substrate and see the criss-cross pattern. It is like looking through a sheet of glass to the back face of the sheet. There is metal on the top surface and cross-hatching on the back surface. If you were to look at the transducers themselves, you would need a microscope to resolve the patterns.

H

A MR JUSTICE BLOFELD: Let us hope we do not have to. Are you giving any of these a particular exhibit number or are we taking them from page 1?

MR NUTTING: I think we have in fact labelled them A to P.

MR JUSTICE BLOFELD: So if I say which that 1 is this.... At some stage we will get a list of A to P. This is just a SAW device.

B MR NUTTING: That is M. It might be helpful if we label them. The top left is A. The top line is therefore A, B, C, D; then E to H, line 2; I, J, K, line 3; L, M, N, line 4. On the basis that poor old O always gets left out of the exercise, we have marked the bottom one as P.

C MR JUSTICE BLOFELD: Right.

MR NUTTING: Dr Lewis, would it be necessary, in order for you to tell us which of these apart from M is a surface acoustic wave device, for you to open the rest of them, or can you ----

D A. Well, it would be necessary to do what I have done here.

Q. I see.

A. Some of them are labelled Advanced Technology Component, and no doubt are, but....

E MR JUSTICE BLOFELD: Rather than do it in the witness box, you tell us what they are, Mr Nutting. One of your witnesses can check. If there is a dispute by the defence, it will be put right, but I do not see much point in taking the rest to bits at the moment.

MR NUTTING: J, K, L, M, N and P are all SAWs, and E is a part finished surface acoustic wave device. I hope I have not misstated anything.

F A. I believe that is so, yes.

Q. You are looking at E, the part finished one?

A. Yes, it is just the base; there is no lid on it -- container.

G Q. Assuming that they are -- and we shall hear evidence about it, as I told you -- but assuming they are, can you help us as to whether those all have a military purpose or not?

A. It would not be possible to say definitely so. They are filters, and they could be used in the receivers of other forms of equipment; particularly they could be used, for example, in a civilian radar set.

H Q. If you are given the opportunity of looking at them, could you tell us whether they are for use in a

- A. military connection?
- A. One would not be able to distinguish between a military radar and a civilian radar, unless of course they happen precisely to match the spec of that airborne weapon, in which case....
- Q. I hope I followed you right. Does that mean they must be SAWs for radar?
- B. A. No, it is possible that there are other applications, but it is probable they are for radar.
- Q. Probable?
- A. Probable, but I can say no more than that.
- MR JUSTICE BLOFELD: What is a civil use for radar?
- A. Airports, for example.
- C. Q. That is the one I think of. Does any other one readily spring to mind?
- A. Marine radars -- ships trying to avoid each other -- but they still hit each other!
- Q. They have radars, yes?
- A. And one day cars will have radars.
- D. MR JUSTICE BLOFELD: I hope it will help us.
- MR NUTTING: Just before we leave SAWs, supposing I wanted to set up a factory or some laboratory manufacturing SAWs, to what extent would the documentation and the components that you looked at assist me to do that?
- E. A. I think they would be of extremely great value to you because, although, for example, I have worked on surface acoustic wave devices for many years, I am not familiar with the details of manufacturing processes and, for example, the cross-hatching details. I would have to do research to find out the best techniques to use to do that. It may not be that sophisticated, but it would take time and cost money to go through that process, and there are quite a few others that you would have to get right to make the most high performance devices.
- F. Q. In the context of that answer, you have already told us that, in relation, for example, to the gluing technique which became a matter of some consequence, it took you something like 12-18 months to resolve difficulties associated with that?
- G. A. In the early days of our research that was so, yes.
- Q. You have told us, in relation to the cross-hatching, that that proved to be crucial in order to avoid distortion in the bulk acoustic wave technology development?
- A. It enables you to get the highest performance from the filter.
- H.

A Q. You told us that there is a component which clearly GEC use, namely silver, which you did not know about?

A. I am not aware of anyone; to my knowledge. I am not aware of anyone who has used silver. I do not know if there is an advantage in it, but it is mentioned in the document and may be....

B Q. If it is used as a metal component, would you expect it to be used unless there was some advantage?

A. No.

Q. How much significance should we attach to the fact that you with your expertise did not know that silver is used in the high performance manufacture of these objects?

A. I am not sure of the point you are trying to make.

C Q. If you did not know about it?

A. Then certainly other people would not, but the thing I am not aware of is just what advantage it gives you. It may be, for example, that it does not degrade in a contaminated atmosphere, or it may be that it has a very low electrical resistance, which may be an advantage. I do not know the advantage and I cannot possibly assess exactly how much of an advantage it is, because I do not actually know what the advantage is that it offers.

Q. All we can say is that this documentation establishes that it is a metal that GEC found was useful as a component?

A. Presumably so, as it is down there, yes.

E Q. May I take you now to something different and specifically, Dr Lewis, to the manuscript document headed Olfactory Research at page 187.

A. Yes.

F Q. Because, lest we thought we had heard the last of them, bulk acoustic wave devices are mentioned on this page in connection with something else; is that right?

A. Yes.

Q. This particular matter is under the heading of Olfactory Research Project, essentially smelling?

A. Yes.

G Q. Four lines from the bottom: "Using bulk acoustic wave devices, the sensitivity is in parts per million. With surface acoustic wave devices this comes down to hundreds of parts per billion"?

A. Yes.

Q. This is deploying these two different devices in order to assist in the detection of gases and other things?

H A. Yes.

A Q. Is there anything on that page -- I have only referred you to those two lines in order to draw your attention to the context, but is there anything on that page that is of any sensitivity?

A. There is a sentence -- this is a handwritten note -- there is a sentence which reads: "Fabrication of these devices is now reproducible." The significance of this ----

B Q. That is just underneath the drawing?

A. Yes, yes. The reason that I think this may be significant is that the principle of operation of these devices has been known for many years. As I have said before, these waves are waves on the surface of the material. They are therefore affected by anything that affects that surface. I have said before that, if the adhesive gases gives off a smell, this can affect the surface. In the present case one is seeking to use that effect to detect gases, and so you put on a layer of a material which absorbs the gas you are interested in. If it comes along, that gas is absorbed, it affects the surface acoustic wave, and you measure this from the performance of the device.

D Now, the principle of that has been known for many years and, as you will gather, from our research we were aware of the fact that gases can affect devices, because that messed up our own measurements. The principles have been known for many years, but one cannot to my knowledge purchase any devices that use this effect. The reason for that -- there are several reasons but one of them is that the devices are not reproducible enough. So you make two devices; they give readings but they do not give identical readings. There are other reasons too. For example, the devices may be sensitive to different kinds of gas, and you are not sure which one has caused the effect. However, reproducibility is one of the factors which has stopped these devices being used during the past 20 years. This sentence plainly ----

F Q. When you say reproducibility, the fact that you have not been ----

A. Make them reproducible. So the fact that GEC has apparently found a way of making these things reproducible tells you that it can be done, and this can be of value if you are researching this kind of technique and you are not having much luck. You do not know whether you will ever make it work or not. Apparently this tells you that it can be done.

G

Q. You say the principles are well-known?

A. Yes.

H

Q. Surface acoustic wave devices can detect gases, but was the fact that GEC had devised a reproducible method for

- A A. these devices publicly known, so far as you are aware?
To my knowledge, I did not know it. I do not think it was.
- Q. Why would knowledge of that fact be of use to someone?
A. Well, the devices would be used to sense gases. There are a number of applications of such devices. In the military context, you would dearly love to have a small component like this, for example, that detected gases on the battle field. You do not want to wear masks all the time. If a device sensed the presence of a poison gas, then you would have to put the protection on. So that is the military application. But there are many special civil applications. Particularly today, in the days of pollution, it would be very nice to have a similar component which simply told you when there was too much carbon monoxide perhaps, for example, or carbon monoxide emission from motor car exhausts.
- C Q. It may be obvious but what would be the value of an enemy of this country knowing that we could detect gases through a surface acoustic wave device on a battle field?
A. Well, it would enable him to make devices that would detect our gases, assuming that we had such gases.
- D Q. Taken overall, please, what do you say about whether it is in the interests of this country for this sort of material, that we have looked at during the course of this morning and this afternoon -- what do you say about this sort of material getting into the hands of someone who is a potential enemy? Is that in the interests of this country in your view or not?
E A. Clearly it is not. I think it is particularly true because the surface acoustic wave devices that we spent most time talking about are primarily used for military purposes. They are very small and rugged, as you have seen in the example, so they fit nicely in machinery that, for example, has a lot of vibration. These things can stand it, and they are small, much smaller for example than electrical circuits which do the same job. That is one of the reasons that they are in current television sets. They are much smaller than their predecessors. So they do have a lot of attractions for use in military and commercial equipment. Clearly it would not be in our interests to help an enemy to develop that technology.
- F Q. There is one matter that, in my anxiety not to take too long, I have neglected to refer to, Dr Lewis. Would you look at page 96 -- back, I am afraid, members of the jury, to the SAW bundle. It is headed Abstract for Inclusion in PD 9002. What is this document, Dr Lewis?
A. It describes the deposition of thin films onto alumina and spinel substrates. It relates to the production of a delay line with a delay of approximately 30
- H

microseconds at a frequency of around 3 GHz.

A

Q. You are referring us to the bottom part of the page, are you?

A. Yes, that is right, yes.

Q. Under typical performance?

A. Yes.

B

Q. Delay of 30 microseconds at reference frequency of 3 GHz with a bandwidth of plus or minus 300 MHz?

A. Yes.

Q. And insertion loss of 26 decibels?

A. Yes.

C

Q. That means the bandwidth, if it is plus or minus 3 GHz would be 2.7 to 3.3?

A. Yes, GHz.

Q. So that is the bandwidth we are talking about in this particular ----

A. Delay line.

D

Q. ---- delay line. Is that document of any sensitivity?

A. Well, I happen to know the prime purpose of devices of this type, which is as the confidence test for the radar in the Rapier missile system. That system works at around about 3 GHz, and the delay of 30 microseconds is the kind of delay that one would encounter in using this device in this system; and, as was explained at the beginning of this morning, if you have a delay line which is capable of handling a signal at the radar frequency, it simulates the operation of the radar in such a way that, if this delay line works properly and gives you the right output, you are pretty confident that your radar system is itself working properly.

E

Q. Now, would you just turn on please to page 194 in the same bundle, 193 and 194. This document, insofar as it

F

specifies a delay line for a Rapier, is a different delay line; is that right?

A. It looks rather similar to me.

Q. But is it operating at the same frequency?

A. 3.1 to 3.4 GHz -- it is a similar band but not identical.

G

Q. Not identical. So it is not the same -- is it the same delay device, the same delay device, or is it operating at a different frequency, or is it a different delay device because it operates at a different frequency? Do you see the point I am ----

A. I am not sure of the point you are making. It is at a slightly different frequency, although there is obviously some overlap of the frequencies.

H

A Q. Does that simply mean that it is set at a different frequency and it is therefore necessarily the same device, the same manufacture of device, or are they completely different devices because you cannot alter the frequency within the device?

A. It is a little difficult to answer your question. I am not sure of the purpose of the question. It sounds to me as if they are very similar devices. There will of course be some difference in behaviour of the devices

B in manufacture, some variation. The particular band that is described here is 3.1 to 3.4. In the previous one it was 2.7 to 3.3. It sounds to me as if probably the application is the same. It may be, for example, that one is a second version of the former, but I cannot actually see the delay mentioned in the ----

C Q. May I ask you then to refer back to page 188.

A. Yes.

Q. Because you see these documents, or the documents we have just looked at at 193-194 are all under the umbrella of this letter requesting the manufacture of two different delay lines, 29 microseconds and 26.4 microseconds?

D A. Yes, yes, microseconds.

Q. And the delay line that we just looked at was 30 microseconds, was it not?

A. The first one we looked at was 30, yes.

Q. Back to page 96, it is a delay of 30 microseconds?

E A. They are slightly different delays but they may very well have the same function in the test system.

Q. Of what?

A. Of the Rapier. I do not think -- I do not myself see that the differences, the 29s and 30s are of extreme significance.

F Q. Yes, I mean the delay governs the preset distance?

A. That it is simulating, yes

MR NUTTING: Yes, thank you very much. Would you wait there, please.

Cross-examined by Mr Tansey

G MR TANSEY: Just following on from that point, we are talking about different delay lines, are we not? Let me just ask you to look at another matter. Insertion loss, page 96 at the bottom, please.

A. Yes.

H Q. We see the insertion loss at the bottom of 96 is 26

- A
- A. decibels; is that?
A. That is right.
- Q. If we go over to page 914, it is 50 and 56 decibels. The second group, second box right-hand side -- we see on the left-hand side insertion loss. Go straight across to the right-hand side. There we have 50, 56 decibels?
- B
- A. Yes.
- Q. So there we have quite different insertion losses?
- A. That is right, yes.
- Q. Are we talking about the same thing?
- A. If you mean are they identical, then clearly those numbers are not.
- C
- Q. Are we talking about the same delay lines?
- A. When you say the same delay lines, they will use the same material -- in all probability they will use spinel material -- but clearly they have different insertion losses. Exactly why I do not know, but they could almost certainly be used for the same purpose.
- D
- Q. But they are not, sorry?
- A. Yes, yes, the point about the radar systems is that they are extremely sensitive. They are designed to detect very low power levels and so, for the purpose of testing a radar set, it would not matter whether the insertion loss were 26 decibels or 50 decibels. As long as you knew what it was supposed to be, that is all that you would need to know. If it gave the right answer, you would know your radar set was working properly; but it looks as if they may be different versions of devices made for the same purpose.
- E
- Q. You see, page 194 is a component specification, is it not?
- A. Yes.
- F
- Q. That is specifying what it actually wants?
- A. Yes, yes, it is indeed.
- Q. If we look at 198 it is asking for a different insertion loss?
- A. It is not asking for it. It is saying typical performance. Since I have actually worked on these devices myself, I know some of the problems here. Making these devices is a high technology business. You have to put down transducers that operate at very high acoustic frequencies, that is, at these radar frequencies of which 3 Ghz is an example, if you could, you would take a piezoelectric material and make it very, very thin, but the thickness that you would need would be less than one micron, that is less than 1,000th of a millimetre.
- H

A It is not practical to make devices that thin, because they fall apart when you try to pick them up. So you make the devices a different way: you sputter, that is essentially you evaporate -- you cause a material to be evaporated and deposited onto the sample. Now, unfortunately, this does not go down and stick on the sample as a perfect crystal. It can go down in something of a mess, and therefore it does not have ideal properties. Consequently, when you make devices from batch to batch, there will be a variation in the insertion loss.

B
C Now, I know from my own work that, on a very good day, you will get insertion loss perhaps 26 decibels. When things are not going so well, you might end up with something which is more like 50, though I must admit that is a fairly high figure. Possibly what has been done here is to say, "We cannot guarantee what the insertion loss is going to be. It might be as good as 26; it might be a lot worse. Therefore we will call for the worst it is likely to be and make that the specification.

D Q. But see ----
A. If you have a more efficient device than you need, you can always make it less efficient; but you cannot do the opposite. So that is a possible explanation for what I have just been outlining.

E MR JUSTICE BLOFELD: So, if I understand it, 96 and 193 may do very much the same job. They are not quite the same. One may be a later version of the other or they may be two separate devices?
A. They could be separate devices but I suspect looking at them that one is the derivative of the other.

F MR TANSEY: I think Mr Swallow told us these are eight components, not the same but eight components tested with the similar range of insertion loss?
A. Which ones?

Q. Page 197.

MR JUSTICE BLOFELD: What did Mr Swallow tell us?

MR TANSEY: That there were eight components tested.
A. Does that mean from a batch of eight?

G Q. From a similar range of insertion loss.
A. Sorry, there were eight components tested with a similar range of insertion loss; is that it?

H Q. Of insertion loss.
A. I think the question I would then ask is: were those eight devices made in one process because, if they were, then I am not surprised that they had similar

A insertion losses. If they were made on separate occasions, then I would expect a greater spread in insertion losses.

MR JUSTICE BLOFELD: Mr Tansey, I expect this is getting somewhere. However, I am just wondering if we are not pursuing it out of scientific interest rather than for the purposes of this case.

B MR TANSEY: I am just pursuing a difference which emerges clearly so far as the documents are concerned, to see whether or not one is drawing the correct conclusion. That is the reason why I am pursuing it at this time.

MR JUSTICE BLOFELD: He has left so many options open that he has not really drawn a conclusion. That is the difficulty at the moment.

C MR TANSEY: I was going to move on from there.

MR JUSTICE BLOFELD: All right.

MR TANSEY: I just want to understand what you were saying about page 13.

D A. Yes.

Q. I think you felt, looking at the first paragraph -- paragraph 1, quartz growth -- the chemistry and materials maintained a facility for the growth of high purity, synthetic quartz, which is radiation hard, and is used for high quality SAW filters and grown hydrothermally in highly specialised pressure vessels", etc -- you thought that was sensitive?

E A. It is indeed sensitive because the radiation hardness is an important aspect of military devices and space devices.

Q. So you certainly would not expect Hirst Research Centre to publicise it then, if it is sensitive?

F A. It is my understanding that they are not publicising it. This document is a submission to ESA.

Q. You are quite right. I am not talking about that. The question was: you would not expect it to publish it, would you?

A. I would not, no.

G Q. Would you look at volume 1 of the Research bundle I, page 5. This is a Tech Brief; you have it, do you?

A. Yes, I have it.

Q. It is a Tech Brief, is not it?

A. Yes.

H Q. This is one that the company will send out to people who contact the information centre at HRC?

- A. Yes.
- A Q. Let us just look at that, can we please. It heads itself as High Quality Quartz. "The material science laboratory at the Hirst Research Centre has developed procedures for the hydrothermal growth of high purity, low defect-content quartz crystals. The high quality of this material will be of benefit in the manufacture of piezoelectric devices. For example, devices made from the quartz show improved frequency stability when exposed to ionising radiation", ie, they are radiation hard. That is what you are concerned about, is it not?
- B A. Certainly, yes.
- Q. Here they are; they are just handing it out?
- C A. Certainly, you are absolutely right. This document is describing the fact that they have worked on such a thing and, although it does not give you details of this, you are perfectly right that that particular ----
- Q. Your point was that what concerned you was the fact that the paragraph in exhibit 13 -- the exhibit that detailed -- that is what concerned you?
- A. That was certainly a factor that concerned me.
- D Q. That people should not know that. Yet here we are; they are giving it out publicly?
- A. What they have described in the Tech Brief is certainly that they are working in that area. That is perfectly true; I am not disputing what you say. They are indicating that they have worked on that. It is certainly an important topic, and it is certainly relevant to military and space applications.
- E Q. You see ----
- A. There is not detail of the extent, of course; nor is there indeed in the document.
- Q. I am just looking at page 13. If we consider it then, it says, "The facility for the growth of high purity, synthetic quartz"?
- F A. Yes.
- Q. That is high quality quartz. We then go on: "... which is radiation hard" -- I read that at the end of the Tech Brief, first paragraph, "radiation hard"?
- A. Yes.
- G Q. It goes on: "... and the material is grown hydrothermally", second line, hydrothermal growth. In the Tech Brief it goes on, further on, about high purity?
- A. I think your point is well made. I am surprised to see this document. I am surprised that they were advertising that capability.

H

A Q. You say it is sensitive, and there we have Hirst ----
A. I assure you it is sensitive. Anything that relates to the stability of quartz crystals in military equipment is sensitive. These people are indicating that they have a way of producing high quality quartz; so be it.

B Q. Well, I have made the point. You say it is sensitive; HRC is just pushing it out?
A. Well, there is nothing totally contradictory about that. For example, if somebody ----

Q. I thought you said just that paragraph in itself was sensitive?
A. At the time that I read it and this morning, I believed it to be so.

C Q. Having seen that HRC -- you worked there; you know about it -- is it careful in what it publishes?
A. I should think so.

D Q. Why did they publish this then?
A. Well, let me put it to you this way: if they have an advanced computer system, for example, this will be of general use and it will also be of military use. They will publish the fact that they can produce advanced computer capabilities. That most certainly has military relevance; it is also got civilian relevance. So clearly they do not feel themselves that the existence of this information is that sensitive. I accept your point, but my judgment on reading that document there clearly is not identical to theirs and, since they published it, I can only presume that they knew what they were doing.

E
MR JUSTICE BLOFELD: What you are really being asked is: now you have seen these Tech Briefs, which, although they are not, if Mr Tansey will forgive me, they are available to the public if they know how to get hold of them, so they are in the public domain in that sense, do the contents now of that paragraph on page 13 remain in your view sensitive?

F A. Having seen this Tech Brief report, I would say that this statement is not sensitive.

MR TANSEY: I am going to jump around a little bit: olfactory research, page 187.

G MR JUSTICE BLOFELD: By sensitive, Dr Lewis, which is the word we are using -- we are probably misusing it -- I think we are really using it to mean useful to the Russians. I entirely follow that anything can be useful. There may be 101 guides to how to ride a bicycle already published but, if you have detailed accounts of how to ride a bicycle

H MR TANSEY: It might be useful to someone who does not, but one assumes the Russians have some knowledge. If you

A say it is not sensitive, I assume it is not useful to the Russians because they may already know how to ride a bicycle?

A. I am not sure I fully get that.

Q. If they could pick up this information publicly, would the fact that it is included in this document make it useful to the Russians, or would that point have gone completely? It is in that sense that I was using the word sensitive.

B

A. I think to be honest the strength of my original statement is dramatically diluted by that Tech Brief. I mean, the fact that it is in that document, and that that document was sent to the European Space Agency and so on, is all highly pertinent, because there is radiation in space as there might be in a nuclear explosion and so on. But the fact that that document in the Tech Brief could be obtained -- it is not freely obtainable but it could be obtained -- means it could fall into the hands of the Russians, and they could know that GEC was capable of making.

C

Q. Could I summarise it by saying it could still be useful but nothing like as useful as you first thought it was?

D

A. I think that is adequately done. The olfactory?

Q. Yes, that is right, page 187 of the exhibits. What you said -- if I understand again correctly -- is, if we look at the way it has fabrication in the middle of the page, you said that what you thought was sensitive was that fabrication of these devices is now reproducible?

A. Yes.

E

Q. You are not aware of any such device being reproducible?

A. That is right.

Q. Would you look please again at page 417 of volume 1, the volume you have. You see at the top of the page that it has, "The application of SAW resonators as updates of abuse vapour sensors." I am coming down the page. It is an Inspec abstract number, and it is a paper published at the conference at the IEEE 1990 Ultrasonic Symposium Proceedings published in 1990. If we look at the abstract, it says: "An acoustic delay line sensor for the detection of potassium ion concentration in water has been implemented and tested. The device uses", etc.

G

Then we come to the next paragraph. It gives a few more figures. "The operation is reversible and the response is highly reproducible. Measurements have demonstrated a high selectivity of the device with respect to exposure." Then it mentions the composition?

A. Yes.

H

A Q. This says, "Here is an example of an operation which is reversible and the response highly reproducible"?

A. It does indeed.

Q. So it is reproducible, is not it?

A. No, that is what it says.

Q. Are you saying that you do not accept it?

B A. No, absolutely. There are so many points here that I do not know what order to make them in.

Q. Because you are so knowledgeable and we are not, we will get lost. Can I ask you this simple question. Then it says here, that the last the sentence to which I referred ----

A. Right.

C Q. "The operation is reversible and the response is highly reproducible"?

A. Yes.

Q. Are you saying you do not accept it?

A. I have extreme doubt that those claims are valid, but let me start at the beginning.

D Q. Can I just finish off the next sentence; then you can give your answer.

A. Good.

MR JUSTICE BLOFELD: Can I, before you do that at all, just ask you one question. What is this document? Is it a precis of a lecture?

E MR TANSEY: My Lord, it is, yes. It is a well-known Inspec which gives you precis of lectures, and it is all on computer, and that is how one obtains it, by asking ----

F MR JUSTICE BLOFELD: The fact that something is said at a lecture and is well-known and is on computer does not necessarily make it accurate. It may be. Equally, when one is doing a precis, it may be a precis to try and get the main sense. I do not know if this was the full account or if this was a precis.

MR TANSEY: It is exceedingly ----

G MR JUSTICE BLOFELD: Rather like a law report, if it is a short law report -- as you will know, in the Criminal Law Review -- we say it is very short and does not tell us everything. It may be that it is in that category.

H MR TANSEY: My Lord, possibly, but it would seem very unlikely. If one looks at the abstract, it has, "Acoustic delay line sensor with the detection of potassium ion concentration in water".

A MR JUSTICE BLOFELD: You may well be right but it is a precis of a highly erudite lecture of a highly reputable symposium.

MR TANSEY: Yes. (To the witness) Are you saying you do not accept this?

A. Let me tell you why I ----

B Q. Firstly, can I -- before you tell us why, have you ever read the paper?

A. I have not read the paper, no.

Q. So how can you as an expert without having read the paper say you do not accept it?

A. I will tell you why. I do not know how many points to make. Let me start. This device is not a surface acoustic wave device. This device uses bulk acoustic waves. The second point is that it is not sensing gases; it is sensing liquids. So you have a bulk acoustic wave device ----

C

MR JUSTICE BLOFELD: Not sensing gases; it is sensing?

A. Liquids.

D

Q. Yes.

A. Okay, so one is taking a bulk acoustic wave device and one is dipping it in a liquid. This is different from a surface acoustic wave device which is exposed to gases, quite different. The second thing is this that, if you know anything about the scientific literature, there are countless claims that people have solved problems and, when they are examined in detail, those claims are found to be optimistic. You have recently heard on the news of people who have devised a nuclear fusion system operating in a test tube. Those people believe that they did some measurements -- the results looked good and they put it into public. This is true of countless, countless scientific papers. If they look reasonably reproducible, that is to say if they have made two devices that do the same thing, they typically say, "We have made it reproducible." They do not say how many devices they have made.

E

F

G

It is precisely for this sort of reason that documentation of the kind that we have been looking at here from the company is so valuable, because the company will look at a paper like that; they will say, "Look, these chaps claim to have made a reproducible device." They will then put their money in and find out if it is true and if it can be made reproducibly.

H

So papers of that kind are always optimistic by scientists, and I have so much experience that I can assure you I would treat that with a great pinch of salt.

- A Q. So you say, "I treat it with a great pinch of salt"?
- A. Yes.
- Q. Before you would not accept it; which is it?
- A. I think you are a bit pedantic, are you not?
- Q. No, I am asking you a simple question. Do you say it is untrue?
- B A. How can I say it is untrue?
- Q. Right; you cannot.
- A. I say I do not accept the truth of it. That does not mean to say it is a pack of lies. These chaps probably thought it was reproducible having measured a few samples.
- C Q. You said it was a bulk acoustic wave device, did you not?
- A. Yes.
- Q. To try and distinguish it, let us look four lines from the bottom. "SAW chemical sensor identifies response linearity." SAW chemical sensor -- why were you saying it was a bulk acoustic wave if in fact it seems from this document it clearly is a SAW and not a BAW?
- D A. If you read the abstract -- this is the first time I have seen this document or first time I have spent any time on it; I may have scanned through it. I am sorry, the device uses the propagation of sheer horizontal waves, piezoelectric plate. These are actually called -- well, they call them Love waves. They have a number of different properties. There are so many different waves that can propagate in these materials but sheer horizontal tells you that the wave is of a different nature from what is ordinarily meant by a surface acoustic wave. It is in fact that the motion of particles is in a different direction and, as you will see ----
- E
- F Q. Is a BAW referred to anywhere?
- A. It is not.
- Q. Is SAW referred to?
- A. SAW is certainly referred to, but I am not sure why identifiers(?) is; what identifiers actually means in that context. You see, it could be -- please refute what I am saying -- that sentence that says 'identifiers' is really a clue to the reader of the kind of related material to which this paper is related. They are using -- let me put it this way, which perhaps will explain it graphically to you: if you take a surface acoustic wave device of the kind you have seen here, if you put it in water, it will be killed stone dead. They are using a different wave which is derived from bulk acoustic wave. It is
- H

A actually a rather complicated subject, and evidently they are using a wave which was discovered many years ago by Love. It is a complicated wave whose existence depends upon the layer attached to the substrate. It is not a conventional surface acoustic wave, and it is not detecting gases. Have you read the original paper?

Q. Have I read it?

B A. Or your expert?

Q. It is difficult enough reading these!

C MR NUTTING: My Lord, it is all very well to make a joke of it, but my friend has been on notice since 17th August 1992 or soon thereafter, when Dr Meirion Lewis made his statement about this, and there has been plenty of time to go to the source material -- of which this is clearly but a fragment -- and if it is to be relied on, to contradict a scientist like Dr Lewis ----

D MR JUSTICE BLOFELD: Mr Nutting, at the moment it is not relied on. At the moment this is only the basis for a question. I can say to the jury through you that this literature, until such time as somebody gives evidence about it supporting it from their own knowledge -- or, I mean, we may hear a defence expert for all I know who may say something -- what is being put in this does not make it evidence at all. The only evidence comes from the witness.

E MR NUTTING: Yes, but in my submission it is hardly fair to a witness to put a fragment of a document in front of him that is but ----

F MR JUSTICE BLOFELD: It is perfectly fair to put it to him and see if he agrees with it. If he agrees with it, no harm is done. That is why I interrupted to find out the status. It may be the same point occurred to both of us. I can understand two things. I can perfectly well understand why Mr Tansey has not read the entire paper. I can understand equally why Dr Lewis has not read the entire paper. However, if Mr Tansey wants to make more of this particular matter, you are putting him on notice that you are really wanting him to cross-examine having the full paper in front of him.

MR NUTTING: Certainly.

G MR JUSTICE BLOFELD: That seems a perfectly reasonable matter to raise at this stage. Probably Mr Tansey has not got it. Now if anything comes of it he can delay it and get Dr Lewis ----

H MR TANSEY: The prosecution have had these since July. We are now into October.

A MR JUSTICE BLOFELD: Yes, but it is not for the prosecution to develop the defence case.

MR TANSEY: I have noted that.

MR JUSTICE BLOFELD: It never is in any case.

B MR TANSEY: No.

MR JUSTICE BLOFELD: It is called an adversarial system.

MR TANSEY: Indeed the problem is, as your Lordship can see, we ----

C MR JUSTICE BLOFELD: It seems to me that there is a very simple way of doing this without wasting time. I am wondering -- the second point that Dr Lewis has made is that this is referring to liquids not gases. I have no knowledge as to whether in fact you would accept that different considerations apply. If that is the case, does it really matter if that is a variety that could arguably be called a BAW or a SAW because, if liquids and gases are different, it seems to me that you are not comparing like with like.

D MR TANSEY: All I can say ----

MR JUSTICE BLOFELD: Let me try and ask Dr Lewis. (To the witness) Forget whether it is a SAW or a BAW. Does the fact that this is a device that is made for testing liquids not gases make any comparison valid or not?

E A. Well, as you say, they are quite different devices. No doubt the reason that I did not bother to follow this up was that I noted there were such differences when I skimmed this through some months or a year or so ago. I did not bother to follow it up; it just did not look to be relevant.

F MR JUSTICE BLOFELD: I do not think we can take it further than that.

MR TANSEY: I will move on to my next point. You told us then that SAW devices are used quite commonly in televisions and video recorders; they have a significant use in the commercial ----

G MR JUSTICE BLOFELD: We are going away now -- olfactory.

MR TANSEY: My Lord, yes. I may be returning to it. That was just the preliminary point. (To the witness) SAWs are commercially available, are they not?

A. Yes.

H Q. You can buy them. There is literature all about SAWs and bulk acoustic wave delay lines, are there not?

A. Yes.

Q. Companies put out their brochures setting out a number of SAWs and BAWs that are available for people to buy; glossy brochures making them look attractive and beautiful?

A. (Witness nodded)

B. Q. Would you accept that procedures used and the process of making SAWs -- the device fabrication -- that can readily be obtained off from the manufacturer, can it not?

A. I would not think most manufacturers would tell you how they make their devices, no. They might, but I would doubt it.

C. Q. My mistake; I put my question wrongly. The procedures -- for example, using the electronic beam coater referred to in the exhibit here -- one could obtain that, if one wanted it, from the manufacturer?

A. The manufacturer will undoubtedly supply with his device some operating instructions, yes.

D. Q. So for areas like electronic beam coaters -- I use these because they are referred to in the exhibits -- quartz crystal orientators, the precis mask, CB21 wire bonder -- if one wanted information about that, one could just contact the manufacturer and obtain it; that is the position, is it not?

E. A. What you say is pretty close to the truth. The situation is not necessarily identical to what you have said because devices may well be made for example for manufacturing semi-conductor devices, which is the most prolific of these integrated circuits, and to use that same equipment on a surface acoustic wave device may require somewhat different operating conditions; and almost certainly would because the adhesion of the metal to the surface would be different in the two devices. So yes, you will get some guidance as to how to operate the equipment, but how to do it precisely in a optimum manner, for surface acoustic wave devices, you may have to do experimentation of your own to find out the best operating conditions.

F. Q. Would you accept that details of design fabrication and know-how is in the public domain?

A. Design of SAW devices?

G. Q. Yes.

A. Certainly there is an abundance of literature which talks about the design of surface acoustic wave devices and their fabrication. However, that would not allow you to do more than to make a low-grade device.

H. Q. So you accept then that details of design fabrication and know-how can be obtained in the public domain?

- A
- A. Some.
- Q. Do you accept that details of the fabrication processes can be found in the open literature?
- A. Certainly some can, yes. I emphasise some.
- Q. And in fact do you accept ----
- A. You could make a car wheel ----
- B
- Q. I do not think so!
- A. ---- by taking a piece of steel and bending it. You could not make the wheel of a Rolls Royce without a lot of know-how; that is the point.
- Q. I am talking about serious scientific people, not amateurs like myself. I am talking about what is in the open literature.
- C
- A. Yes, the literature tells you, if you were -- I am not sure if you like the analogies but, if you were talking about the car wheel, it might tell you: buy a butt(?) of steel; turn it on the lathe; and turn it up. If you did that, you would not make a wheel like Rolls Royce because they have many years of experience and they have critical ways of doing it and plating it, such that the plating remains intact and so on.
- D
- Q. But certainly as a reasonable starting-off point, development, the details of the fabrication process, some you could find in the open literature?
- A. You can find some, yes.
- E
- Q. You can find flow charts, not in the formal sense, but verbally articulating the steps to follow and take?
- A. Yes, yes.
- Q. Do you accept then that, so far as the exhibit JS/15 -- the SAW devices -- as such are concerned, in fact many of the important parts of the process are not revealed in these pages?
- F
- A. I think -- sorry, are we talking now about pages 1 ----
- Q. I move back to the exhibit page 2-157. What I am putting to you is this, that many or a significant number of important parts of the process are not revealed?
- A. There may be such -- there may indeed be, but could you enumerate any?
- G
- Q. I will do my best: the mask design.
- A. Yes.
- Q. How important is that?
- A. Most important. That will dictate the response of the device.
- Q. Correct, yes. Can you please tell us from where in there we can get that; where it sets out the process
- H

- A A. and the detail of the mask design.
In this document there is not information on how to produce a design to my knowledge. I did not find any information on how to design SAW devices, other than the flow chart, that is to say you do a crude design and then it tells you which corrections to build in, but it does not enable you to make a device to a real specification.
- B Q. It does not tell you how to make the mask design?
A. That is right.
Q. That is what you are saying?
A. It depends, you see. It tells you only in outline form how to do it.
- C Q. You mean a little bit like giving me the wheel?
A. Exactly, exactly. It tells you: put it on the lathe; turn it up; polish it; do this. But you would not be able to actually make it from that.
Q. So you certainly cannot make a sophisticated SAW device without have the mask design?
A. Absolutely.
- D Q. That is missing from this. So you certainly cannot reproduce this device?
A. This document would not provide you with everything you need to set up a SAW device manufacture; that is correct.
- E Q. Is it correct that there is no detail on the design methods?
A. There certainly is, I believe, in the early pages; I believe there is a general outline. It might take a little while to find this. I think it is in the first 50 pages. Yes, I think around about page 21. Yes, page 21 tells you the outline of how to design the device.
- F Q. Yes?
A. So it tells you ----
Q. Yes, the outline, but one needs much more than the outline.
A. The point I was making a little earlier -- yes, you do, yes, of course.
- G Q. You see, it is missing; there is no detail given of the software, is there?
A. No, no.
Q. Is processing the substrate important?
A. Processing to make a good device?
Q. Yes.
A. Processing the substrate, yes.
- H

A Q. That is not here either, as is ----
A. Yes, it is for example ----

Q. Can you show us.
A. For example, the cutting of those slots in the back is an important aspect of the substrate preparation.

B Q. Does that tell to us exactly how to do that?
A. The details of the slots are presented in a figure that we referred to earlier.

Q. Is that sufficient?
A. It certainly would enable me to go away and reproduce that slot structure.

C Q. You could do that?

MR JUSTICE BLOFELD: That is page 70, is it?

A. I think it was. You see, it does not say: cut slots in the back. It does tell you the dimensions of those slots that would do the job.

MR TANSEY: Is that sufficient?

D A. Yes, in my view that would be sufficient.

Q. So we have one page out of them all that gives us something we could make; is that right?

A. No, you have got one page that will do that.

Q. Well, we have one page, right, yes. It tells us nothing about temperature either, does it?

E A. About temperature?

Q. Is that important?

A. Of?

Q. In manufacturing the SAW device -- is that important?

F A. If one is talking about cutting the slots in the back, it would not be of great importance, I should not think.

Q. Generally in making the components is temperature relevant?

G A. Well, the temperature is relevant, for example, in the method deposition stage, very relevant. I am not sure if it is in there or not actually. I have not made a big song and dance about these aspects of the fabrication because these were not in my judgment the most important, the most sensitive aspects of the device.

Q. Maybe you have not because basically you accept you cannot reproduce a SAW device from this?

H A. You do not have the complete recipe, You have a number of useful aspects of the fabrication.

- A Q. Are you missing a number of critical areas?
A. Yes.
- Q. For example, I think you did mention about quartz stone and that is at the core, is it, of a SAW device?
A. Yes, yes.
- B Q. It gives one no information on how to manufacture the quartz stone, does it?
A. The quartz ordinarily would be purchased from another company. There are suppliers who supply quartz material that has been grown, cut and often polished ready for you to use. The only information it does give is on that high quality radiation hard ----
- C Q. What it does not do is it does not help at all the recipient of the document on how to manufacture the quartz stone, does it?
A. No.
- Q. That is another critical thing that is missing?
A. If you are not prepared to go and buy it on the open market.
- D Q. Does it give you any information on how to produce the quartz substrate?
A. We are talking about the substrate. Sorry, you are distinguishing between the stone and the substrate.
- Q. You would distinguish between them?
A. Yes, indeed. The quartz is normally grown hydrothermally. One has big cylinders under pressure.
- E Q. How long does it take?
A. A long time, maybe a month or two.
- Q. Yes, and it is from there that -- firstly, you have to grow it. Then it is from there that you then obtain the substrate?
A. You size it up and polish it.
- F Q. You have to size it up very carefully?
A. Absolutely.
- Q. You have to know the right angle and such like things?
A. Yes.
- G Q. There is absolutely nothing here to help us, is there?
A. Quite right.
- Q. You are aware as well, are you not, that HRC patents its own SAW filters, are you?
A. I would not be surprised if they do.
- Q. Would you turn to volume 1, page 138. This actually is a patent filed on 17th June 1987, and it is, we can see
- H

A further down, by HRC beside the number 74?
A. Yes.

Q. It sets out a surface acoustic wave filter. We see it gives there various figures, charts, and over the page, etc?

A. Yeah.

B Q. If we look at the top of page 142, top left-hand side, this invention relates to surface acoustic wave, SAW, filters of the kind employing interdigital transducers?

A. Yes.

Q. "It is an object of the present invention to provide a SAW filter exhibiting an intrinsically low insertion loss of such a form as to be capable of being fabricated without the use of a multi-layer fabrication process"?

C

A. Yes.

Q. And coming to 151 ----

D

MR JUSTICE BLOFELD: What is the question about this. Yes, it has been agreed that there is a patent application. I am not certain what you are putting to Dr Lewis as to its relevance to the documents you are considering.

MR TANSEY: What I am putting is that HRC gives patents about its own SAW filters. I am just giving a clear example of that.

E

MR JUSTICE BLOFELD: Are you saying it is one of the SAW filters referred to in the ----

MR TANSEY: No, no, I am not saying that.

A. It has nothing to do with the ones in here.

MR TANSEY: I am not suggesting that at all.

F

MR JUSTICE BLOFELD: What is its relevance?

MR TANSEY: To show, as far as the SAW filters are concerned, that HRC itself is in the business of ----

G

MR JUSTICE BLOFELD: But I thought that was accepted, that SAW filters are in the public domain. HRC has been dealing with SAW filters; I did not think there was any dispute about that.

H

MR TANSEY: The point is that they are obtaining patents for them; thereby it is in the public domain -- clear that HRC is being ----

MR JUSTICE BLOFELD: Sorry, Mr Tansey, if it is one of the SAW filters we are concerned with in these pages, it

A may be very relevant, if not crucial. If it is something else, I do not see it has any relevance at all at the moment.

MR TANSEY: My Lord, one has to show or may have to show that we are not just making an assertion, but clearly HRC in fact is in the business of selling publicly its SAW devices. This is just an example of a patent in question.

B A. HRC -- do you want me to comment on that?

MR JUSTICE BLOFELD: Yes.

C A. I am not sure that HRC actually sells publicly its devices. The General Electric Company does. Most of the devices that HRC makes are research devices, and frequently they are made for experimental purposes or MoD or whatever. I do not think there is any significance to that; it is well-known that they make SAW devices. As to the patent, this is a particular structure of transducers which has a low insertion loss. There are lots of patents taken out by lots of companies and people around the world, on using different patterns of metal to improve the performance of their filters in various ways. This happens to be one which reduces the insertion loss.

D MR TANSEY: Yes, well, my point is, as I put to you already, simply about that. What I want to ask you about is this. Would you look please at 151A. This from the HRC annual report, which is not available to the public at large but is circulated throughout the whole of GEC.

E A. I have this page.

Q. Here we have HRC setting out in this unclassified document, one which is circulated within the whole of GEC, its space qualifications of SAW filters. Does that surprise you?

A. I am -- should I start reading at the lines starting "Space qualification of SAW filters"?

F Q. Yes, that is a good place to start. There are earlier propositions but this one deals with it.

A. I am not sure how far I should read, but it does not say very much. It says that they ----

Q. What it tells us ----

G MR JUSTICE BLOFELD: How far beyond the top of page 12, the first three lines?

MR TANSEY: That is where I finish.

A. You do not want beam masking?

MR TANSEY: No?

H A. That simply tells us, as far as I can see, that GEC has

proposed to the Royal Aircraft Establishment.

A

MR TANSEY: Help us: "Aimed at ESA" -- that is the European Space Agency?

A. That is right, yes.

Q. Let us relate that. The exhibit in this case relates to an application to ESA -- that is the exhibit, not the document there. The exhibit in question is an application to ESA?

B

A. It is not -- I do not think it is an application to ESA. It is an application to the Aircraft Establishment to obtain DTI, that is, British government funding for a programme which is aimed at meeting ESA qualifications.

C

Q. Yes, sorry, I have moved back to the exhibit from there.

A. Sorry, where is the exhibit?

Q. In the other bundle there, page 2.

MR JUSTICE BLOFELD: Page 2-157, the whole of those documents you have been considering.

D

MR TANSEY: At page 2 it gives us the heading, right?

A. That is right, yes.

Q. That this is surface acoustic wave filters for ESA/SCCG qualification approval. Now, ESA we know is the European Space Agency?

A. That is right, yes.

E

Q. SCCG is?

A. I do not know.

Q. I cannot help you either. The European Space Agency in fact deals with civil matters, does it not?

A. I believe it does indeed, yes.

F

Q. And so the document in question, page 2 onwards, Commercial in Confidence, Surface Acoustic Wave Filters for ESA Qualification Approval, Process Identification Document, is for the European Space Agency -- 2-50, sorry.

A. It is to qualify the devices for use in ESA projects, yes.

G

Q. ESA projects are non-military but civil, are they not?

A. Yes.

Q. It is a large organisation, is it not, the ESA?

A. It is, yes.

H

Q. European Space is concerned purely with civilian interests?

- A. As far as I am aware, you are right.
- A
- Q. So could you leave page 2 of the exhibits there and come across now to 151A.
- A. Yes.
- Q. So here we have them announcing their proposal for the funding towards a programme aimed at ESA qualification approval?
- B
- A. Yes.
- Q. That is the same thing, is it not?
- A. Presumably these refer to the same piece of work; I should think so, yes.
- Q. Are you surprised?
- C
- A. I am not sure why I should be.
- Q. Well, there is nothing at all then about what is here that causes any concern?
- A. Well, the document, the 50 pages or so ----
- MR JUSTICE BLOFELD: No, sorry, you are being asked about 151A, the two paragraphs at the bottom of 151A and the three lines at the top of 151B. You are being asked if those, that information ----
- D
- A. If these cause me surprise or concern?
- Q. Yes.
- A. I do not think they cause me a great deal of either, no.
- E
- MR TANSEY: You are not at all concerned by putting here about "The device is in the 200 MHz ... high collectivity ... bandpass filter developed on behalf of ESTEC", no concern at all?
- A. ESTEC is -- can you remind me -- ESTEC sounds as if that probably is European Space again.
- F
- Q. Sorry, I cannot give you the answer to that. Maybe on Monday I can give you the answer.
- A. It is part of the European Space.
- MR JUSTICE BLOFELD: No, you must talk to the Court. You cannot have experts talking across it. It is looks as if everyone is stumped at the moment. I am wondering if his surprise gets us anywhere. What you are really asking is, if that information got to the Russians, would it be useful to them? That is what really what few mean by the word 'surprise'.
- G
- MR TANSEY: The proposition is the fact that it is in the public domain in such clear terms like the Tech Brief, the one I put before.
- MR JUSTICE BLOFELD: I followed the Tech Brief but this is not in the public domain in the same way. This is a
- H

company confidential.

A

MR TANSEY: HRC is ----

MR JUSTICE BLOFELD: That is why it is your use of the word 'surprise' that I am really trying to interpret, what you mean by surprise.

B

MR TANSEY: Well, my Lord, concern.

MR JUSTICE BLOFELD: Supposing he is concerned about it. I am concerned that we are sitting here in any event.

MR TANSEY: Indeed.

MR JUSTICE BLOFELD: So what?

C

MR TANSEY: Indeed, but of course the question is, if in fact we find HRC in an unclassified report is giving information which can readily be seen, it is very hard in our submission to argue that that material comes within the definition of being classifiable etc, because it is in consistent.

D

MR JUSTICE BLOFELD: I do not want to get too much involved in the law. That is what I meant by concerned or surprised. I was probably interpreting it -- do you mean that, if this information got in the hands of the Russians, would you consider it to be useful to them? That is really what you mean by surprise or concern?

E

MR TANSEY: Yes, what I am striving to do is to show here we have on a number of areas ----

MR JUSTICE BLOFELD: I am not concerned with that. What I am concerned about is: you may ask a number of other witnesses about surprise or concern, but it is a concept that you may then take up and totally misunderstand what the witnesses meant. I want to be certain we know what you mean when you ask.

F

MR TANSEY: If I give an example, if one takes page 5 of the Tech Brief, when Dr Lewis ----

G

MR JUSTICE BLOFELD: Mr Tansey, either I am not making myself clear or you are not following me. I am not concerned with the individual matters you have asked this witness and others. "Are you surprised? Are you concerned?" I am wondering what you are actually meaning.

MR TANSEY: If we have a witness saying this is sensitive; should not be handed over ----

H

MR JUSTICE BLOFELD: That is all right. If we can agree that an objective is sensitive, if you like: "Would you

A consider this sensitive? Would you consider this useful to the Russians?" I would know exactly where I was. "Are you surprised? Are you concerned?" I do not know where I am. Do you see the difference?

MR TANSEY: I do, yes.

B MR JUSTICE BLOFELD: I am simply urging you to use -- I do not mind what phraseology you use: "sensitive", "useful to the Russians" seems probably as good as many, or "useful to a competitor".

MR TANSEY: Indeed, yes.

MR JUSTICE BLOFELD: The two may not be necessarily the same.

C MR TANSEY: Of course, yes. The problem is that we have witnesses talking about the matter being sensitive, and they give their reasons why, and we then look at the evidence in the public domain. The proposition is: how can you say it is sensitive when in fact it is there?

D MR JUSTICE BLOFELD: You have an admirable example where Dr Lewis, after he said it was sensitive, when you showed him the Tech Brief, changed it. I changed "sensitive" into "useful"; I thought that was a better concept.

MR TANSEY: Maybe I should not deal with the law at this stage as a proposition. May I say I have now finished the matters in question. I want to go on to the filters and the delay lines, my Lord, and I do need to take further instructions on those.

E MR JUSTICE BLOFELD: All right. I gather, because we talked about this in the absence of the jury, that you cannot actually speak to somebody about this until later tonight, and you do not know if you will be in a position therefore to further cross-examine this witness tomorrow morning or make further enquiries. So, to avoid Dr Lewis coming back and being told tomorrow he is not wanted, we have arranged that he is to go off now and come back when you are ready to cross-examine him further.

MR TANSEY: Yes.

G MR JUSTICE BLOFELD: Hopefully an early day next week when this is still something we can carry on with.

MR TANSEY: Certainly, hopefully by Monday.

MR JUSTICE BLOFELD: Mr Nutting, do you want to re-examine on anything today?

H MR NUTTING: No, but, since your Lordship has arranged that Dr Lewis should return on Monday or some time next

A week, could I ask that the defence obtain a copy of the original document that is referred to in summary form on page 417, so that Dr Lewis may have the opportunity of looking at the original material, and so that we may know where we are and what exactly what is allegedly published in respect of that surface acoustic wave device or plastic or bulk acoustic device, and whether it was a gas or a liquid, and what the matter really revealed, because it is not satisfactory putting to the witness a summary which may or may not be accurate. It can be easily misleading.

B
MR JUSTICE BLOFELD: I have absolutely no idea how readily this document could be obtained. It is obviously desirable that it is obtained.

C
MR TANSEY: Yes.

D
MR JUSTICE BLOFELD: Certainly. I say no more about it. Mr Tansey, a lot of specialist witnesses are being called who are busy people. Once you have taken full instructions on what you want further to ask Dr Lewis, maybe you could tell the Crown approximately how much longer your cross-examination will last, so that they can work their list of witnesses accordingly.

MR TANSEY: Yes.

MR JUSTICE BLOFELD: Members of the jury, would you like to go now. I want to raise one more matter.

E
(The witness's evidence was adjourned until Monday, 11th November)

Monday, 11th November 1993

F
MR NUTTING: Last week we asked Dr Meirion Lewis to come back, and he has done that, and made two further short statements. I propose to call him now. That information should be in your Lordship's bundles now at 349 and 350.

Members of the jury, will you go back to page 51 in the main bundle. You will remember this restricted document about the receiver in airborne guided weapon.

DR MEIRION LEWIS, recalled

G
MR JUSTICE BLOFELD: There is no need for him to be resworn. Dr Lewis, you are still on oath from last time.
A. Yes, yes, of course.

H

Further examined by Mr Nutting

A

MR NUTTING: Dr Lewis, will you have a look at the Restricted document pages 51-59 in the bundle. (Handed) That relates to the bandpass filter assembly for an airborne guided weapon?

A. Yes.

B

Q. Does this document refer to an actual weapon that was produced?

A. I have recently discovered that is so.

Q. Is it in service with our armed forces?

A. Yes, it is.

Q. And what is the name of it?

A. The name is the Alarm missile.

C

Q. What does it do?

A. Its function is to detect and destroy enemy radars.

Q. What use to a potential enemy would be the information which this document contains?

A. As I indicated last Thursday, there is certain information in the document which would facilitate someone who wished to jam that missile.

D

Q. I think you said the information was the?

A. The prime information concerns the IF centre frequency and its bandwidth.

Q. At page 54 of the document we see that the production programme spoken of eight or nine lines up is approximately 4,000 off, and it gives the period over which production was to take place.

A. Yes.

Q. Was the production target attained or something like it?

A. I am afraid I am not familiar with those parameters. The information could be of value in indicating the approximate production quantity of that missile. It is always nice to know the capability of your enemy.

F

Q. Has this weapon been fired in anger?

A. I do not know if it is been fired in anger. It certainly was used very effectively to deter Saddam Hussein from using his radars during the Gulf War. You may recall that those radars were switched off, almost certainly because this missile would have destroyed them, had he switched them on.

G

Q. The second topic I think you have looked into, Dr Lewis, is the original of the summary on olfactory research which was in the Defence Research bundle number 1 at page 417.

H

A MR JUSTICE BLOFELD: Can I just before that -- the Alarm --
I gather from what you have not said, but the inference
is that, if an enemy switches on his radar to try and
protect in this case ----
A. Your aircraft.

Q. Your aircraft?
A. Yes.

B Q. The Alarm missile, by the pulses that the radar is
emitting, can trace the radar and home in on it, can
it?
A. Correct, yes.

Q. Yes, I see, and the Alarm is fired, is it, what, from
the aircraft?
C A. From an aircraft. The normal mode of operation -- and
may I say that the information that I am conveying is
rather sensitive at the moment.

Q. Yes?
A. The normal mode of operation would be for one aircraft
to fly over; dispense these missiles; these missiles
would then take out any radars that came on, and this
would then clear the path for further aircraft.
D

MR JUSTICE BLOFELD: Yes, I see.

MR NUTTING: Yes. May the witness be shown the first Defence
Research bundle at 417 -- an olfactory research
programme. I think, if I can summarise it, that you
were somewhat sceptical about some of the claims made
E in this article or in this summary. Have you, since
you left court, read and analysed the full paper of
which this is a summary?
A. Yes, I have.

Q. Having had the benefit of a full article, has your
scepticism diminished?
F A. The article has in my view vindicated each and every
point that I made during my cross-examination last
Thursday. In particular, the claim to have demonstrated
reproducibility is preposterous. Would you like me to
expand on that?

Q. I would just like your conclusions, if I may, on the --
is it two or three points?
G A. Yes. I criticised the defence position.

MR JUSTICE BLOFELD: "The whole of the operation is
reversible and the response is highly reproducible."
You are saying that when it says "the response is high
reproducible", that is preposterous?
A. Exactly so. There were two other criticisms of the
defence case. One was the nature of the wave. I
H pointed out that the wave killed the bulk of the

A material. It is quite clear from the full document that that is a correct description. Indeed one sentence in the document points out, as I did on Thursday, that, if one used water in a device of this kind, it would in fact kill a surface wave device stone dead. So they are two relatively minor points or perhaps somewhat minor points.

B If we come back to the case of the reproducibility, you may recall that I suggested that the results should be taken with a pinch of salt because, in my experience, the authors would only have used two or three samples to demonstrate this high degree of reproducibility. As it turns out, I was very generous to the authors. The number of samples they used was one. The measurements were taken over a period of several days on one sample. Can I say that C anyone who knows anything about this kind of activity knows that, to demonstrate reproducibility, you have to take measurements on batches of samples. You have to do them in not laboratory conditions but in various environmental conditions -- different temperatures and things like that -- and you have do them over a period of months or years to demonstrate that you have got a D reproducible, useful, manufacturable device.

Scientific literature such as the paper that was cited here -- I am very well aware of the fact that the object of the authors is to be first in the field to get his bid in; first to get acknowledgement of his work. So he publishes his results after preliminary investigations. These investigations are very often E short, as in the case of this particular one. The conclusions that he draws are very often tentative conclusions. He says, "I think it might be this", but he knows very well that it might be something else. But that is the nature of scientific research. You publish quickly to get your name in, and you put your conclusions forward tentatively. In addition you are always optimistic. That is right because scientists F want to read about what might be the best that can come out of their work; but they know very well it will not always happen that way. So scientists learn to interpret the literature, and in this case I think I did that rather effectively.

G Now, the defendant in this case, on the other hand, was a quality assurance man, and he worked in a company. In a company, the object is different from basic scientific research. The object in the company is to demonstrate that you have something which is reproducible and manufacturable, which you can make and which you can sell and upon which you can make a profit. So you do extensive research. So, if somebody from a company -- particularly from a quality assurance H department -- says that a device is reproducible, it is

A based on rather deeper evidence than the paper that the defence cited.

MR NUTTING: Thank you; just wait there.

Cross-examined by Mr Tansey

B MR TANSEY: Dr Lewis, I would like to ask you about the first matter you dealt with, and I just want to understand the evidence and what you said on the last occasion. You said when you gave evidence before -- and please, if I put it incorrectly, do correct me. You based your conclusions on the assumption that the documentation was covering what you called a pulse compression filter or a dispersive delay line; is that right?

C A. I did mention that, but I do not recall that being in the context of either of the documents that we are discussing, that I have just spoken about.

Q. I am talking ----

A. Can we be clear what we are talking about.

Q. I will be quite clear: what I am talking about in the exhibit is basically page 51-to 56, so there is no ----

D A. We are talking about the Restricted document on the guided missile; is that right?

Q. That is right, yes, we are talking about that. Can you just agree with this proposition: were you saying on the last occasion that your inferences were based on the premise that the documentation was talking about pulse compression filters?

E A. No, forgive me, I did mention pulse compression filters but that was in the context of a different document. That was in the context of a document that concerned the precise measurement of the orientation of large SAW substrates.

F Q. Was this -- just to make sure there is no misunderstanding -- where you were referring to page 16? Was it page 16 of the exhibit, just go back to page 16, at the bottom?

A. Is this in the middle of the ESA document?

Q. Yes.

A. No.

G Q. Page 16 at the bottom; it would be you are not referring to that?

A. At the bottom, that is talking about design techniques; is that right?

Q. Yes. If you look at the top, it says, "SAW filters"?

A. Yes.

H

A Q. And six lines down we have, "SAW bandpass filters can have very nearly linear phase shift. On the other hand SAW dispersive delay lines"?

A. Yes.

Q. Which are otherwise known, I believe, as pulse compression filters; is that right?

B A. Well, that is one application of dispersive delay lines, yes.

Q. So when you were talking in terms then of dispersive delay lines, was it to this page that you were specifically referring?

A. No.

C MR JUSTICE BLOFELD: Can we just hold on a second. I actually have no note of him giving any evidence about this specific page. From my note in chief, he went from 1/13-19.

MR TANSEY: My Lord, yes.

D MR JUSTICE BLOFELD: I do not recollect that that page 16 that you are referring to was one that this witness gave any evidence about specifically himself. He may have been referring to it without its being brought to his attention.

MR TANSEY: That may well be the case.

MR JUSTICE BLOFELD: I would not know.

E MR TANSEY: May I say certainly I did not knowingly bring it to his attention on the last occasion.

MR JUSTICE BLOFELD: I do not think either the Crown or you did.

F MR TANSEY: I only mention it because on page 16 it was shown six or seven lines down; we have there the reference to: "On the other hand SAW dispersive delay lines ..."
(To the witness) You were not referring to this page?

A. No.

Q. The documentation here, this Restricted document starts at page 51. This relates to something quite different to as dispersive delay line, does it not?

G A. Yes.

Q. It covers a bandpass filter assembly; that is right, is not it?

A. Yes.

H Q. That is made very clear, just to make sure there is no misunderstanding, at the top of page 52 as well. There we see this specification describes the requirement for

- A a bandpass filter assembly, and turn over the page to page 53 and at the top again it says, "The filter is to form part of an IF receiver incorporated in an airborne guided weapon"?
- A. Yes.
- Q. So clearly so we are talking about the bandpass filter assembly?
- B A. Yes.
- Q. When we move onto the following pages, taking us to page 56, we are talking still about the bandpass filter assembly, are we not?
- A. Yes.
- C Q. The bandpass filter is not part of the radar, is it? May I say, you spoke very quickly the last time, and I am not being critical but I want to make sure there is no misunderstanding. You are not suggesting this is any part of the radar?
- A. It is part of the radar receiver, so it is part of the radar.
- D Q. So it is part of ...?
- A. A traditional radar has a transmitter that sends out a pulse. The pulse is reflected from aeroplanes or whatever and comes back to a receiver.
- Q. Yes?
- A. A receiver then displays the output of that to the operator. So the receiver is an essential part of a conventional radar system. I should say the application here is not quite a conventional radar.
- E Q. Exactly.
- A. But you asked the question: is a receiver part of a radar, and the answer is certainly the receiver is an essential part of a radar set.
- F Q. Now, you said on the last occasion I believe -- again please correct me if I put it wrongly ----
- A. Certainly.
- Q. ---- that one could draw certain conclusions, if you look at page 56?
- A. Yes.
- G Q. From the words from the sections towards the bottom which says, "Group delay, group delay matching and group delay dispersion"?
- A. Yes.
- Q. The conclusions that you said one could draw from it were what?
- A. I said, if you look at this specification, somebody like we can look and form a reasonable picture of what
- H

A is going on in this radar receiver. This relates to the receiver. Remember, I said in a conventional radar there is normally a transmitter and a receiver. This document relates to a receiver. When I looked at the parameters involved, I could see that clearly this item was related to finding the direction of an incoming signal.

B Q. Help us on this then.
A. Yes.

Q. What does group delay refer to; what does that mean?
A. For your purposes, just read delay. It is the delay of a signal.

C Q. Yes, it is the time for a signal to pass through the filter, is it not?
A. It is the time for the signal to pass through the filter; is that what you said?

Q. Yes.
A. That is right, yes.

D Q. So we have beside that absolute delay is not important?
A. That is right.

Q. This is clearly speaking to the manufacturer, is it not, setting out ----
A. To the designer.

E Q. Yes.
A. That is right, yes.

Q. We come to the next point underneath group delay matching.
A. Yes.

F Q. That again is -- and we see beside it devices to be matched to 2.5, is that microseconds?
A. Plus or minus, no, nanoseconds.

Q. Of nominal delay?
A. Yes.

G Q. Again group delay matching really means to the designer etc, trying to keep the devices almost the same, to achieve the same uniformity as far as delay is concerned, as very accurately the same. You will notice the nanoseconds there is not one millionth of a second; it is one thousandth millionth of a second.

Q. So that is giving then very specific instructions to the designer of this item?
A. To make sure that all the filters he made tracked one another.

H

A Q. Yes?
A. It did not matter what the actual delay was but they must all be the same, very accurate.

Q. It says the matching and it sets it out there 2.5 nanoseconds?

A. Yes.

B Q. We then have the third section underneath, and this is group delay distortion?

A. Dispersion.

Q. Sorry, dispersion. What does dispersion mean?

C A. Dispersion means this. If you were to put in a pulse that was very, very narrow -- a very, very short pulse -- that pulse, when it has been through, would not necessarily come out precisely as narrow as it went in. It would get dispersed, so that something that went in of -- I hesitate to use the words but, if it were infinitely narrow when it went in, it would come out broadened by a quantity there, which -- in this case they are asking for that to be less than one nanosecond.

D Q. The position is then that, as a signal passes through, there is a measure of distortion?

A. There is such a thing, yes.

Q. That is right, yes, and so therefore again we have that when one looks at the group delay dispersion; that refers to the distortion of the signal as it goes through. What it is saying is the criteria that you adopt is as said here, plus or minus one nanosecond?

E A. That sign means less than plus or minus one nanosecond.

MR JUSTICE BLOFELD: We have not come across nanoseconds before. How does it go?

A. I did mention it a moment ago.

F Q. I know you did, but not before this afternoon anyhow. Tell us what a nanosecond is, as opposed to a microsecond?

A. A microsecond is one millionth of a second; a nanosecond is one thousandth of one millionth of a second.

G MR TANSEY: So what we have at the bottom is just instructions for the designer. The question I want to put to you is this: those instructions there do not in any way assist in assessing the range of the airborne guided missile, do they, which is what I believe you were suggesting on the last occasion.

MR JUSTICE BLOFELD: The words under group delay dispersion, that is what you are referring to?

H

A MR TANSEY: Group delay, group delay matching and group delay dispersion. (To the witness) I believe you were suggesting, when you gave evidence on Thursday of last week, that from these details one in fact could infer certain characteristics about the weapon?

A. Yes.

Q. For example, I think you said that you suggested you could assess range?

B

A. No, not from those parameters.

Q. Right.

A. You could infer something, because you will notice that the absolute delay is not important. You remember I gave you an analogy: if you have a television set, it would not worry you if you received that signal a fraction of a second later; if a whole signal were around one fraction of a second later. It would worry you if the signal were dispersed and different bits came at different times later. That is what dispersion would mean. Now, in this particular case they are saying, "We do not care what the delay is but the delay must be closely matched in the different devices."

C

D

Q. Exactly.

A. This tells you -- why on earth should someone put tolerance of 2.5 nanoseconds which is a very, very tiny quantity on the matching when the absolute delay does not matter? Do you see the point? Clearly.

E

Q. I see the distinction, but are you saying that it is from that that you are able to infer clear characteristics about the airborne guided missile, for example its range?

A. No, not its range. I did not; I never claimed that I could. What I could tell you was that that was closely related to the ability of this receiver to detect the angle of arrival of the signal. Do you remember I was sort of waving my arms around describing waves coming in?

F

Q. Yes. Could you please tell us which is the specific matter on which you rely which says it assists to determine the angle?

A. Well, you see the point is this: if you had a single receiver on your radar set, it would not worry you too much about the absolute delay. If you knew it was a microsecond, you would say, "I will take that into account when I make my decisions." The fact that those devices have to be matched so closely tells you that you have a number of these on one receiver. The reason that you have a number of them is so that you can take a number of samples of the incoming wave form, and in that way by some means -- and there are various ways of doing it -- you compare the signals from the different receivers, and you can determine the angle at which the

H

A beam is coming in.

A Q. So which specific point then do you rely upon here which says that we can determine the angle?

A. The group delay matching is the statement there, taken in conjunction with the group delay.

B Q. Yes, but group delay matching is just -- as I think we already agreed -- to ensure they match up, which makes sense?

A. Yes.

Q. What is it from that which enables one to infer angle?

A. Well, I did try to explain this to you once before.

C Q. I am sorry, I did not understand it.

A. No, of course. What is more, what I am going describe is only one way, because engineers have devised various ways, but this is the simplest way to understand it. I hope you are not going to tear me to shreds if it sounds too simple to you but, if you imagine you have two receivers where my hands are and a wave comes in from an angle, it will hit one of them first and the next one later; and that would enable you to tell that the wave was coming from that direction. Now, that is one example of a number of techniques that people can use to determine the angle from which the signal is coming in.

D Q. You are saying that you can infer that from what we see here on group delay and group delay matching?

A. Yes, that is what I said last Thursday.

E MR JUSTICE BLOFELD: This document indicates that the receiver can determine something about the angle of the incoming beam; is that really what you are saying?

A. Yes.

F MR NUTTING: Last time he said, "A somewhat unusual requirement to enable the direction of the signal from which the signal comes to be ascertained". That is what I wrote down.

MR JUSTICE BLOFELD: Very much the same, yes.

MR TANSEY (To the witness): Let us move on. Can we jam it?

G MR JUSTICE BLOFELD: Sorry?

THE WITNESS: You are asking me?

MR TANSEY: Yes, can it be jammed?

A. Any receiver can be jammed if you have enough power and you know at what frequencies to jam it.

H

A Q. I am going to ask you about that. We know that the centre frequency is 120 MHz.
A. That is right.

Q. And that this is part of the IF receiver in this airborne guided missile. You said, I believe, on the last occasion, that in order to jam the missile the airborne fired missile you need to be able to jam the front end of the receiver; that is right, is not it?
B A. I think you are distorting my words somewhat.

Q. Sorry, do not let me distort your words; let me put a proposition. In order to jam it you have to be able to jam the front end of the receiver?
A. I did not say that.

C Q. No, I put it to you.
A. If you could jam the front end of the receiver, that would be a jolly good way of jamming it.

Q. Yes, because that is how you jam it, is it not? It is through the front end of the receiver.
A. There are various ways to jam it.

Q. Are you an expert on missile technology?
A. No, I happen to work in a lab where there are a lot of such experts, and I discuss things with them. My expertise is in acoustic wave devices and optical wave devices, but these are applied to radar, and so I obviously learn a few things about the radar.

Q. Are you an expert on the jamming of airborne guided weapons?
A. I do not spend a ~~lot of~~ time on it. I do not, no.

Q. You see, would you accept that 120 MHz signal, which is what we have here for the centre frequency, in fact would never get through; would not pass through the front end receiver in the missile?
A. I see what you are getting at. That is probably true.

F MR JUSTICE BLOFELD: Would not -- the centre frequency of 120?

A. A little bit always gets through. So, if you put enough power, you could indeed jam it with that.

G Q. Sorry, I am trying to write down what was said -- would get through what?

MR TANSEY: The front end receiver.

MR JUSTICE BLOFELD: Is that right?

A. Oh, yes, forgive me, what defence counsel means is the front end antenna.

H

Should be allowed to give an opinion if you can be jammed

- A Q. Yes, I see.
A. Yes, it would be difficult to get a lot of power at the eye of frequency through the front end antenna, yes, that would be right.
- MR TANSEY: Would you accept that the front end receiver ----
A. Antenna, do you mean, yes.
- B Q. All right, antenna, is in fact designed for a much higher frequency?
A. Yes.
- Q. By that, for example, anything between 1-10 GHz, that sort of range?
A. Typically in that range, yes.
- C Q. So we have 120 MHz here, but the front end receiver is designed to accept much higher frequencies, 1-10 GHz. Would you agree that 120 MHz signal would be too low to get through the front end receiver?
A. Well, when you say too low to get through, yes, it would be very heavily attenuated in getting through such a front end antenna. That, of course, is not how one jams a radar of this kind.
- D Q. Would you accept that radio transmissions (sic) for aircraft generally are quite powerful transmitters?
A. Sorry, could you repeat that again.
- Q. That radio transmission for aircraft use quite powerful transmitters?
A. Do you mean radar; do you mean radar transmitters?
- E Q. Yes.
A. Sorry, you said radio -- radar.
- Q. No, sorry, it is radio, yes?
A. Radio, yes. Yes, radio transmitters. Could you repeat the questions.
- F Q. Radio transmissions for aircraft, let us say from the airport to an aircraft, use quite powerful transmitters?
A. Not especially, but I am not sure of the line of questioning. I mean, you are not ----
- Q. Do you accept ----
G A. You are not -- you see a radio transmission, let us say from the ground to an aircraft, would be much weaker than a radar transmitter, because the radio transmitter only has to go from the ground to the aircraft. The radar would have to go from the ground to the aircraft and back to the ground, so that would need to be stronger. But I still do not understand the line of your questioning.
- H

- A Q. Do not worry about that. Do you accept that there are lots of local frequencies at around 120 MHz on the ground; are you aware of that?
- A. There are, yes, I know there are transmitters in that sort of frequency.
- B Q. In fact in this month's Flyer, which is about planes, it says, "Frequency check -- pilot should be aware of recent changes to some services and radio frequencies, for example, a trial change at Oxford, its ATIS service 121.750 MHz ground" -- and do you accept -- I mean from your general knowledge -- that there are a number of local frequencies at around 120 MHz?
- A. Oh, yes.
- C Q. One of the objects of deciding the -- this filter is to protect it against interference?
- A. Correct.
- Q. Interference which might cause for example premature detonation?
- A. Yes.
- D Q. Therefore would you agree that the way it would be designed would be to make sure that nobody could get through to the centre frequency at 120 MHz?
- A. ~~I am sure very, very little energy would ever get through the missile at that frequency, correct.~~
- Q. But I am suggesting to you that it is specifically designed, is it not, to make it almost impossible for 120 MHz signal to get through to jam it?
- E A. I am a scientist, and I will insist at this point on a little bit of precision. You cannot design any system to absolutely block any frequency. That is a physical fact, that it is impossible to have a complete zero over a band of frequencies. I am sorry to say that to you, but I am a scientist. But I suspect that the line of argument that you are pursuing is that you can do a jolly good job of blocking it, and I accept that.
- F Please proceed.
- Q. Thank you. Therefore the design is to achieve that objective, is it not, as far as possible?
- A. For the purposes of this discussion, I will accept that premise.
- G Q. Why is the IF receiver encased in metal?
- A. Sorry, why is it encased in metal?
- Q. Yes.
- A. Primarily to protect it from the atmosphere, and from extraneous radiation, but primarily the atmosphere.
- H Q. And also jamming, is it not, to make sure it cannot be jammed? I that not one of the effects of it?

- A A. Yes, it would not do any harm, but on the other hand, for example, the surface wave device in your television set is in a metal container in all probability, but that is not likely to be jammed. So it is normal practice to do that.
- Q. Here one is talking about something which one is doing ones utmost to prevent being jammed?
- B A. Correct.
- Q. If you look at page 17, the fifth paragraph
- A. Page 17.
- Q. Fifth paragraph, a very short one under Materials: "Substrates are mounted in bought-in, custom, solid sidewall, metal packages designed for seam sealing"?
- C A. That is right, yes, that is another reason. You can seal these metal packages very easily and effectively.
- Q. Therefore that makes them far less immune to interference?
- A. Do you say far more immune?
- Q. Yes.
- D A. What it primarily does is to make them far more immune to the ingress of water, for example, which would -- but indeed it would help to keep out any radiation, if that is what you are saying, yes.
- Q. Likewise at page 54, the final paragraph there: "Packaging of demonstration hardware -- each filter is to be supplied in hermetically-sealed metal dual in-line package of a size as small as practical"?
- E A. Yes.
- Q. "A hermetically sealed metal dual in-line package"?
- A. Correct.
- Q. Is not the effect of that also to make it much less likely that it can be jammed?
- F A. Hermetic sealing of course is to keep out vapours, but again I am not disagreeing with you; if you keep out vapours and you do so with a metal enclosure, this will also tend to keep out jamming. Of course you have to have leads going through, so signals do get in and out, but yes, so far I am not in dispute with you.
- G Q. Would you accept that basically the whole IF sub-assembly, as we know, the whole IF would be in a metal box which would effectively further screen it against 120 MHz jamming signal?
- A. It would further screen it against any frequency.
- Q. So therefore, if we look at the position so far as this information is concerned, to be able to jam this filter, firstly one would need to be able to get
- H

- A through the front end antenna; you need to be able to jam that first?
A. You would need to pass a signal through that.
- Q. Yes, and you need therefore to be able to get past it?
A. In a sense, yes.
- Q. And we have no information about that, do we?
A. About what?
- B Q. The front end receiver or front end antenna, do we?
A. Well, we know that it operates around the operating frequency of the radar.
- Q. Where do we know that?
A. Well, you would not have a radar if it did not.
- C Q. How does that tell us what the centre frequency is of the receiver?
A. Look ----
- Q. The front end receiver or front end antenna?
A. You see, if the radar -- you just mentioned this yourself -- if the radar is working at a frequency somewhere in the range 1-10 GHz, yes?
- D Q. Yes.
A. Then the antenna will be destined to receive signals in that frequency.
- Q. That is a massive range, is it not?
A. Yes, but, if you want to, you can have an antenna to cover that. But typically it would cover let us say 3-4 GHz; it might be more.
- E Q. But the object is, if you want to jam it effectively ----
A. Yes.
- Q. ---- you have to be able to jam right at the outset, that is the front end receiver or antenna, is it not?
A. Well, I think you misunderstand the problem. You are not jamming an antenna. You cannot jam an antenna. You jam a receiver.
- F Q. Right, so you jam that. How do you jam it if you do not know the centre frequency?
A. You pass spurious signals through it.
- G Q. Yes, but how? How would you know what you are going to get at?
A. You know it because you know the frequency at which you are transmitting. Would you like me to explain how this missile works?

H

- A Q. Is the centre frequency of any relevance to jam the receiver? If you know what the centre frequency of the receiver is, you can jam it; is that the position?
- A. You are getting there. The point is this. You see, all your questioning -- you see, if you explain the line of the questioning, I would be in a better position to explain to you.
- B Q. I am asking you, hopefully, very simple questions.
- A. Yes, you are.
- Q. Obviously a very simple understanding, right? (Laughter) I am saying to you, if you want to jam the receiver, the way to do it is you jam it at the centre frequency?
- A. Well, you might choose to.
- C Q. Is that not the obvious, key way of doing it?
- A. The point is this. Look, I am going to get you off the hook because you are going to go on all afternoon misunderstanding how you jam these devices.
- Q. Okay.
- D A. You seem to be under the impression that, in order to jam the IF section, I have to send the IF frequency at the radar.
- Q. No, no.
- A. Is that your understanding?
- Q. No, not at all. I am suggesting that, before you can even get to the IF frequency of the filter, you have firstly got to get through the front end?
- E A. Antenna.
- Q. You have to do that first?
- A. Yes.
- Q. And you do not know what that is?
- F A. What you do know is the following. You know the frequency that you yourself are transmitting, remember.
- Q. Me being who?
- A. Remember the way ----
- Q. The enemy?
- A. Remember the way this missile is working. The missile is hovering here, waiting for a radar to attack. This radar sends a signal out, in all innocence, looking for targets.
- G Q. Right?
- A. It sends a signal out, let us say, 3 Ghz. This radar receives that signal and says, "Hello, I am going to attack that radar." Now, this radar is in a plight.
- H He would like to get spurious signals into that

A missile, yes?

A

Q. Yes.

A. Now, he happens to know from this document the IF frequency at which that radar works, which this missile receives, okay? So, being a good scientist, he knows that there is another frequency he can get in there, as well as the one he is transmitting. That is called the image frequency, and it is a frequency a little bit offset from the one he is transmitting by the IF frequency. Now, he knows that his own signal is being received, and he knows there is another one just on the other side which will also be received and will also generate the same IF frequency. The radar can therefore happily use his own frequency and send a spurious signal which would jam the IF section of this receiver.

B

C

You see, the receiver, although it is not designed to do it, will always be sensitive to two frequencies: the one you want and the one on the other side of the oscillator, which is the one you do not want. Now, it is destined to reject it, but it never does so effectively, because people cannot make devices that effectively reject these image frequencies.

D

Q. Does this not require the knowledge of the centre frequency of the radar?

A. No, because the radar is sitting there looking round for any frequency. If you happen to be in its band, hard luck, you are liable to be its target.

E

Q. If I know the centre frequency on the ground (inaudible) I know it straight up to jam the radar?

A. I beg your pardon?

Q. If I know the centre frequency of the front end receiver, or the antenna at the front, as you say?

A. Ah, but ----

F

Q. If I know that, I can get in and jam it; that is the first thing I want to do?

A. No, no.

Q. Having the centre frequency, I can do the jamming?

A. No, the first thing you want do is to survive. You are a radar and about to be attacked by this missile. You do not want to jam it; you want to survive.

G

Q. Yes, but if I jam it, it cannot function. That is how you survive, is it not?

A. But you said the first thing you want to do is to jam it; the first thing you want to do ----

Q. Sorry?

H

A. There are various things you can do. You see, the

A first thing -- your main concern is that you survive. One way to do that is to do what Saddam did, which is to say, "My God, I am going to be attacked", and switch my radar off so he cannot get me. But if you decide you must continue to operate, then you must say, "What I will do is -- I am needed to protect something else, so I must sit here, and I am very vulnerable because I am sending up signals which this missile can pick up. Therefore, I simultaneously send out a signal which will jam him and, because I am provided with the information on this IF, I know this other frequency which will get into that receiver, because he is tuned in to...." -- you now, do not forget ----

Q. Well, I suggest that in fact firstly the object is obviously survival?

C A. Yes.

Q. If I know the centre frequency of the missile coming in, the front end receiver?

A. You misunderstand. That missile is looking for frequency; it is not ----

D MR JUSTICE BLOFELD: Can I try and understand. I am not certain I understand at all. We have the aircraft with the radar?

A. It is a missile, yes.

Q. We have got the aircraft with the missile, which is not going to be fired until it has located the radar?

E A. No, no, with respect it quite probably will be fired. Suppose, for example, that we wished to attack Saddam's tanks and he has radars distributed around, and he has missile and batteries around.

Q. Yes?

A. If we send our bombers in, those radars will find those and fire missiles at them.

Q. Yes?

F A. Okay, what do we do? We send in an aircraft that drops these missiles out. These missiles hover around. They do not necessarily go straight to the ground; they just sit there looking. When one of the radars comes on, they recognise this and home in on the radar and destroy it. If they have destroyed all the radars, then the bombers can come in.

G Q. The ground radar, if it is working, if it is being used

A. Yes.

Q. ---- it is trying to locate a target?

A. Yes.

H

A Q. So its own missile system can ---- tack
 A. Attack it.

Q. ---- attack that target? ight
 A. Yes. Are you asking why it does not detect the missile which is going to destroy it? hing

B Q. Yes.
 A. The reason is that it is cleverer than you give it credit for. It does not attack the radar on its main beam; it attacks the radar on a side lobe.

C Q. I see.
 A. The radar -- just as you cannot knock -- I explained to you just now that there is no way -- it is physically not possible to blank out a complete range of frequencies perfectly. So it is not possible to send a radar beam in a given direction perfectly, and not send little bits in directions you do not want. a Dr
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MR TANSEY: So it really means it cannot be attacked at all?
 A. Which cannot be attacked at all?

D Q. The incoming missile; you cannot do it; it is a winner all the way, according to you?
 A. You can jam it, which means you can put spurious signals into it, so that instead of it saying, "I have found this radar and I am going to attack it", you can put so much signal in that its electronics, for example, are overloaded and it does not give any signals out at all. king
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E Q. But in order to do that, they have to be concentrated, do they not? I mean, the signals you point to have to be concentrated; they cannot just cover a massive range; they would not have the power to jam? e; I
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A. Exactly, and that is why the information in this document enables you to concentrate that jamming power on the very frequency to which this missile is vulnerable. st I
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F Q. But it does not do that?
 A. Yes, of course it does.

Q. All it gives you is the frequency of this filter delay. That is what it gives you. It does not give you the frequency of the radar at the head of the missile; it does not give you that. How do you get in there to attack it? nd I
 why,

G A. Sorry, you misunderstand the whole problem. The radar does not have a frequency in the sense you are talking about. It is not an active radar; it is a passive receiver. It is like your radio set. It can receive any frequency according to where you tune it. very
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A Q. How do you attack then the missile? How do you attack it; how do you destroy it?

MR NUTTING: Sorry to interrupt. I wonder if the jury might withdraw for a moment.

MR JUSTICE BLOFELD: Sorry, members of the jury, something has obviously arisen.

B A. Can I mention that the discussion is rather ----

MR JUSTICE BLOFELD: Can you wait for a moment.

(The jury retired from court)

MR JUSTICE BLOFELD: Do you want the witness to stay?

C MR NUTTING: No, he can stay. My instructions from Dr Weatherley are that we are going into some very secret areas. My assessment of it may not be entirely accurate but, with respect to my learned friend, if he knew exactly what questions to ask, to answer the questions accurately, we would not need to trespass into that area. So I am concerned that, because of the way the questioning is being put, we are needlessly going into areas that there is really no need to enter.

D MR JUSTICE BLOFELD: No mileage for the defence, but asking general questions; I follow the point. I think that I have sympathy with you, Mr Tansey, because you like the rest of the bar are not the scientist, and doing the best you can, and you may inadvertently be trespassing into general areas.

E MR TANSEY: I certainly do not want to trespass any more; I just do not. It may be obvious; I do not quite see the significance of the reply.

F MR JUSTICE BLOFELD: At the end of the day what in fact I have really written down, Mr Tansey -- I do not say it is of any help -- despite your cross-examination on all this, Dr Lewis is firmly of the opinion that, if this sheet of paper got into the wrong hands, it would be useful.

MR TANSEY: My Lord, yes.

G MR JUSTICE BLOFELD: I am not attempting to explain, and I have no intention of ever explaining to the jury why, because I am quite certain I shall get it wrong.

MR TANSEY: May I just take some instruction.

MR JUSTICE BLOFELD: Your case is that it would not be very useful. I mean, are you really going to get it much further than that?

H

A MR TANSEY: I thought I ought to put my case and basically, as Dr Lewis says, well, I do not really understand it. I am putting it in the ----

MR JUSTICE BLOFELD: I do not think Dr Lewis is saying he does not understand it.

B MR TANSEY: No, I do not. I basically put it very simply: in order to be able to knock out the missile, you have to know the centre frequency -- I think I have put it already -- of the receiver, of the front end receiver; without that you cannot jam it.

C MR JUSTICE BLOFELD: Have a word with Dr Maher and see if between you all you think you can really take it any further. You are putting your case that this is not as sensitive as Dr Lewis makes it out to be. That is really what it comes to.

MR TANSEY: I put it for the reason that I put to Dr Lewis in cross-examination ----

MR JUSTICE BLOFELD: Yes, yes.

D MR TANSEY: May I just have a moment.

MR JUSTICE BLOFELD: Mr Tansey, I do not think I can really let you have a lengthy consultation, as it were. We have the jury out.

E MR TANSEY: My Lord, I appreciate that. The difficulty is that there is not documentary evidence at all to support the inferences which Dr Lewis is making.

MR JUSTICE BLOFELD: If that is the line you are going on, I do not suppose that will be particularly sensitive. Let us get the jury back and see where you go.

F MR TANSEY: I am not suggesting he is not telling the truth but making the observation that Dr Lewis is making an assertion of fact. In fact within the documents we have there is no evidence to support that proposition. My Lord, that is what I am saying. So in other words it makes it much more difficult, in fact, to be able to cross-examine about the material. As there is allegedly -- I accept, if Dr Lewis says so -- more material of which we do not know -- I believe that is the point I am just seeking some assistance on. I do not want to take a bad point as far as this is concerned, if I can avoid it, my Lord. Could I have a few more moments.

G
H MR JUSTICE BLOFELD: I propose to get the jury back. You can talk to Dr Maher while that happens. I propose to tell the jury that it seems inadvertently we may be now going with Dr Lewis onto matters that are extremely

A sensitive, or I will say nothing if you like to go on and get away from it. I think in fact probably what Dr Weatherley is concerned about, and the Solicitor General is concerned about, is that we do not really want to get involved in how in fact actually you would shoot down the Alarm system. It is something we would prefer potential enemies not to know about. I see Dr Weatherley nodding at the back of the court. I think, if you can keep away from that -- probably your last few questions and mine when I interrupted....

B MR TANSEY: May I say I have almost finished; this is the last matter I was going to.

MR JUSTICE BLOFELD: You have not dealt with the other paper.

C MR TANSEY: That is true, my Lord. The difficulty is that I received this in fact after the Court started.

MR JUSTICE BLOFELD: I am not grumbling. If in fact you or Dr Maher have seen the other paper and do not have any questions on it, then so be it. Whether you have read it or whether you would be any better informed if you had -- but I expect by now Dr Maher has.

D MR TANSEY: I have not really had a chance to talk to him about it.

MR JUSTICE BLOFELD: I want to try and finish this witness today if we possibly can.

MR TANSEY: I totally agree.

E MR JUSTICE BLOFELD: I will rise for five minutes, and you will have to act double quick. Let us get the jury back in at quarter past four and get moving.

(Short Adjournment)

(The jury returned into court)

F MR TANSEY: I only have I believe three more questions.

A. Yes.

Q. It is clear from what you have told us about it -- I ask you no more detail of any kind -- that this is a very special missile. I just leave it like that. Is that a fair way to describe it?

G A. It is an unusual guided missile, yes.

Q. This document does not identify in any way that particular missile, does it?

A. It does not directly do so. If I could elaborate: from the information in that document, I was led to believe that it quite probably was an anti-radar missile.

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- A Q. But the position is that the document, nowhere in all the pages that we have here, refers to the nature of the missile, as we know it, as you have ----
- A. I do not think it refers directly to that point, no.
- Q. There is no name, nothing at all like that about this missile?
- A. No.
- B Q. In fact identification of it would be essential in order to know how to jam it?
- A. It is very nice to know what your enemy has; what kind of missile he has; what frequencies they operate on, and all sorts of parameters of that kind. That is certainly true. The point I would make -- and I think this is a really rather important point -- is that I was not aware of what that was for, that device -- this receiver. Over this weekend I studied those parameters, and I came to the conclusion that in all probability this was an anti-radar receiver. If I can do it, people who are skilled at that, for example Russians -- I am sure they can do it, and they probably have other information to go with it as well.
- C
- D Q. Did you not in fact speak to the manufacturers before you put your conclusion on paper?
- A. I spoke to -- over the weekend I drew this conclusion. Last night I went to the Marconi Company and left some questions which are in writing with the technical director of Marconi, and this morning I phoned him up for the answers to those questions. One of those questions was: is this receiver for use in the Alarm missile, and the answer was yes.
- E *Handwritten scribble*
- Q. I put the proposition to you that, on the papers themselves, they do not identify this particular missile, but you say it is possible to if you could?
- A. If I can make an educated guess that way, others can; and do not forget this is one piece of information that our enemies might have. They probably have lots of other bits of information too from other sources. So they would be in a better position to make that judgment.
- F
- Q. Would it be your view that even to publish the fact that we have an anti-radar missile would be useful to an enemy?
- G A. It is well known that we have anti-radar missiles. You see, the point is -- and I have tried to make this point to you before -- we know what the Russians have, roughly speaking, in the way of tanks and aircraft and things like that; and they know what we have, roughly speaking. What is important is to publish things like the frequencies at which they work, because they tell you how to jam them. The fact that we have missiles everybody knows.
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A MR TANSEY: I have no more questions, thank you.

MR NUTTING: I have no questions.

MR JUSTICE BLOFELD: Thank you very much, Dr Lewis.

(The witness withdrew)

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