Order No 94/0896/S1

IN THE CENTRAL CRIMINAL COURT

Old Bailey,
London EC4

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

BEFORE:

THE HONOURABLE MR JUSTICE BLOFELD

REGINA

- v -

MICHAEL SMITH

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

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

Transcript of the palantype notes of DL Sellers & Co
(Official Shorthand Writers to the Court)
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PROCEEDINGS IN CAMERA
CONFIDENTIAL

EVIDENCE OF DR MEIRION LEWIS

Thursday, 7th October 1993

(IN CAMERA)

DR MEIRION LEWIS, sworn
Examined by Mr Nutting

MR NUTTING: What are your full names, please?
A. Meirion Francis Lewis.

Q. What are your qualifications?
A. I have a first degree and doctorate in Physics.

Q. From which university?
A. Oxford University.

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.

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.

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.

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.

Q. Through the glass or crystal?
A. Glass or crystal or whatever, yes, so one can transmit information on these waves.

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.

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.

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.

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?
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.

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?
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.

Q. At a slower speed?
A 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.

Q. So light goes 100,000 times quicker than sound?
A. Correct, and so a light wave, an electrical wave, light
B 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.

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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.

Q. So it is the electrical impulse that is transformed
D 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
E receiving them.

Q. On the surface of the swimming pool instead of in the middle of it?
A. Yes.

Q. I follow that, by being transformed from electrical impulse into a sound wave, that in itself slows it down
F 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
G 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 ----

Q. Which makes the watch go?
A. Pardon?

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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.

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.

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.

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.

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.

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.

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?
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?
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?
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.

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?
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.

MR JUSTICE BLOFELD: Can I say a SAW enables you to tune in better than a BAW?
A. The bulk wave device would not be obviously usable as a filter; the surface wave is.

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.

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

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

Q. So it acts as a very sophisticated filter?
A. Yes.

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?
A. That is right, yes.

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

MR JUSTICE BLOFELD: Of course, yes.

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

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.

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?

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?

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?

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.

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.

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.

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?
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.

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.

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?
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?
A. That is right.