IN THE UNITED STATES DISTRICT COURT

NORTHERN DISTRICT OF ILLINOIS

EASTERN DIVISION

THE UNIVERSITY OF ILLINOIS FOUNDATION, Plaintiff and Counterclaim Defendant, vs. BLONDER-TONGUE LABORATORIES, INC., Defendant and Counter-claimant, vs. JFD ELECTRONICS CORPORATION, Counterclaim Defendant.	Civil Action No. 66 C 567

The continued deposition of DR. PAUL E. HAYES, a witness in the above-entitled cause, taken at the instance of the plaintiff and counterclaim defendant, pursuant to notice and pursuant to the Rules of Civil Procedure for the United States District Courts pertaining to the taking of depositions, before Lucile E. Moore, a notary public in and for the County of Cook and State of Illinois, in Room 279 Illini Union Building, University of Illinois, Urbana, Illinois, commencing at 2:00 o'clock p.m. on December 14, 1966.

LEM/mbs

PRESENT:

MR. BASIL P. MANN
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30 West Monroe Street, 10th Floor,
Chicago, Illinois),

on behalf of the Plaintiff and
Counterclaim Defendant;

MR. ROBERT H. RINES
(Rines & Rines,
10 Post Office Square,
Boston, Massachusetts),

and

MR. RICHARD S. PHILLIPS
(Hofgren, Wegner, Allen, Stellman
& McCord,
20 N. Wacker Drive, Suite 2200,
Chicago, Illinois),

on behalf of the Defendant
and Counterclaimant;

MR. SIDNEY N. FOX
(Silverman & Cass,
105 West Adams Street, Suite 1900,
Chicago, Illinois),

on behalf of Counterclaim
Defendant.

ALSO PRESENT:

MR. ISAAC S. BLONDER

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I N D E X

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PAUL E. MAYES,

having been heretofore duly sworn, testified further as follows:

DIRECT EXAMINATION

BY MR. RINES:

Q Professor Mayes, we wish to thank you for making available to us this morning the laboratory notebooks that we requested and for showing us various antennas in your laboratory.

I would like to ask you a few questions about two or three of those reports, the first being the green, cardboard bound report, about an inch or so thick, bearing the label "LPV-1".

There are, at the commencement, two loose white sheets, and then commencing with the bound material, or clipped material, a yellow sheet bearing the date 6-15-59.

I would like to ask you what that sketch on the yellow sheet dated 6-15-59 is supposed to represent.

A This sketch is an outline of an antenna which describes some of the perimeters that are used in the construction of the antenna. The sketch is not complete in terms of details showing

the elements, but rather just shows the outline of the elements on the antenna.

Q It was our guess that that was probably an antenna of the type either shown in Figure 1 or Figure 2 of Isbell Patent 3,210,767, would that be correct?

A It is of that type. However, there is an indication here that the operation is fundamentally different in terms of the sketch of the current distribution on one of the elements, which shows two zeros of the current between the extremities of the dipole.

Q Would you explain what you mean by "different operation" in this connection?

A This indicates that the dipole was of the order of three half wave lengths long, rather than one half wave length long.

Q But so far as the logarithmic relationship between successive dipoles, successive spacings, and the constructional details, would it be fair to say that this is the construction described in that Isbell patent?

A Yes.

Q Can you tell me in whose hand is the

writing on this first page?

A Not absolutely certain about it, but I think it would be Bob Carrel's.

Q And would the 4 graphs following this first sheet be experimentally obtained plots of the performance of this antenna on the dates indicated thereon?

A Yes.

Q Now we come to a second yellow sheet, bearing the notation at the top "3 lambda over 2" thin linear elements, wherein the dipole elements appear to be bent inward from the in line or straight position shown on the first yellow sheet, 6-15-59, at an angle indicated by the symbol psi.

Can you tell us what that sketch is supposed to represent?

A It is the same antenna structure, basically, except for the tilt forward of the dipole element.

Q Into a V shape?

A Into a V shape, yes.

Q Do you know in whose hand this sketch is?

A I think this is probably also Bob Carrel's.

Q And is it fair to say that the graphs

immediately following this second yellow sheet represent the performance that was obtained with this antenna on the dates indicated thereon?

A Yes.

Q Can you tell us how it happened that Mr. Carrel performed these two sets of tests that we have been discussing, if you recall?

A Well, I remember discussing with Bob some projects that might be worth while looking into at the time that he was casting about for possible thesis material. And this was very soon after Dwight Isbell had developed the log-periodic dipole array, and we thought there was probably a possibility that this antenna was a simple enough structure that mathematical analysis would be possible.

We also discussed the possibility of making some modifications and variations in the antenna for the purpose of achieving operation which was not present in the Isbell antenna. One of the modifications that we discussed was the forward "V"-ing of the elements.

This was tried, first in the fundamental mode operation, and the results were noted as being

interesting for some applications, but not particularly useful for the enhancement of gain, since the gain dropped rather than increasing in that case.

And at that time the idea of the possibility of operating the elements in the three halves wave lengths rather than the half wave length occurred to us, and he performed experiments to verify whether or not this was possible, and also to find out what the performance change was as a function of the angle the elements make with the axis of the structure.

Q That is, if I understand you, the angle of the "V"?

A Yes. Actually the angle that is shown in the drawings is not the included angle of the "V" but is the angle from the normal to the axis of the feeder line to one of the dipole half elements.

Q That angle would be, the angle shown on the sketches would be 180 degrees -- the included angle of the "V" would be 180 degrees minus 2 times this angle psi?

A Yes.

Q You mentioned the thesis of Mr. Carrel; did he actually write a thesis relating to this type antenna?

A He did, yes. Now, when you say "this type" I presume you are talking about the dipole array?

Q Yes, sir; yes, sir, the antenna that you have just been testifying concerning.

MR. MANN: I think there is some possible confusion here. The antenna that he has immediately been testifying about is that antenna with the swept forward elements.

MR. RINES: Yes, I am talking about the "V" antenna.

MR. MANN: And Mr. Carrell, to my knowledge, in his thesis discusses Isbell's log-periodic dipole array.

THE WITNESS: That's right.

MR. MANN: Not the "V" antenna.

MR. RINES: Have we been supplied with a copy of the Carrel thesis?

MR. MANN: I think so.

THE WITNESS: I do not presume so. It is Technical Report No. 52 on the contract,

so I believe there are no differences other than maybe title page and a few incidental matters between his thesis and this report.

BY MR. RINES:

Q Was any thesis done on the "V" antenna?

A No thesis was actually done on the "V" type. However, we did issue a technical report on the "V" type.

Q And that was one which you also supplied us with?

A Yes.

Q Did Mr. Isbell write a thesis?

A No.

Q Did anyone else, to your knowledge, write a thesis embodying a description of Mr. Isbell's antenna?

A I don't recall any other thesis on Isbell's antenna.

Q Do you recall whether Mr. Isbell discussed with you and Mr. Carrel the possible operation that would result when the dipoles were made longer, that is, not operated in the one half wave length mode, but in the three halves wave length mode?

A How did you phrase that, do I recall --

Q Do you recall whether Mr. Isbell had discussions with you and Mr. Carrel about this?

A He did not have any discussions with us about higher mode operation of the antenna.

Q Was it not the fact that at the time that you had these discussions there were on the market, and had been for some years, other types of television receiving dipole antennas that operated in the three halves wave length mode?

A Containing dipoles operating in the three halves wave length mode, yes.

Q And you were also aware, were you not, of other dipole arrays in which the dipoles, instead of being in line, had been bent forward in "V's" for the purpose of obtaining increased gain and directivity?

A At what time?

Q Before your conversation with Mr. Carrel.

A Before the earliest conversations, no.

Q You had never heard of a fishbone type of antenna?

A I had heard of a fishbone antenna, but not one with V'd elements in it.

Q Perhaps you will tell me what you mean

by "V'd elements"?

A V'd elements, elements in the form of a "V".

Q So you had never heard before of the fact that dipole arrays of in line dipoles had ever been formed from in line positions to parallel V positions for increased directivity and gain?

A I was not aware at the time what the purpose was of doing this.

Q But you were aware that it had been done before?

A I was aware, certainly I had seen antennas of this configuration.

Q Do you now know that at least one of the purposes of those prior antennas being formed with the dipoles in the V shape was for increased gain and directivity?

A Yes.

MR. RINES: May we mark as the next exhibit for identification the first 23 pages of Notebook LPV-1 as B Exhibit No. 45.

(Whereupon, said documents were marked for identification as B Exhibit 45.)

BY MR. RINES:

Q On the third yellow sheet appears the notation, "Psi equals 32.5 degrees." And then follows further graphs.

Is it a correct statement that this means that the particular angle psi, shown on the second yellow sheet, is for these tests adjusted to a value of 32.5 degrees?

A For those immediately following that particular sheet, yes.

Q And this notebook contains different sets of graphs obtained for different values of that angle psi?

A Yes.

Q We would now like to call your attention to a black notebook, bearing no legend, but the first page of which is entitled, "Pattern Modal Log-Periodic LPDA-1".

And we would invite your attention, about midway along the book, to a page bearing at the top the value "t equals .858", and over near the right a value "Z_o equals 100".

Are we correct in assuming that that tau is the same tau mentioned in the Isbell patent

3,210,767?

A Yes.

Q And what is the Z_o?

A Z_o is a characteristic impedance of the feeder line.

Q And therefore on this particular set of data it would mean 100 ohms impedance was measured?

A Yes, well, not measured, was used for the design of the feeder.

Q Was used for the design of the feeder. That clarifies a point for us, Dr. Mayes.

Now, there is a blue notebook, bearing along its binding, "TV6 A & B U-2 Best Patterns". And we call your attention, about quarter-way in the book, to a white sheet of paper, which is entitled "U of I Foundation Project".

Can you clarify for us what this particular material, commencing with this page, represents in terms of "U of I Foundation Project"?

A Well, this particular first page shows some calculations that were made in the design of an antenna for receiving VHF television signals.

Q Would it be fair to say that the previous

test results that we were discussing in the LPV-1 notebook were for the UHF band?

A Those tests were not made with any particular frequency band of operation in mind. In these basic research projects, with no application immediately in mind, we simply use the most convenient set of frequencies for the test in terms of size of models, ease of construction, and so forth.

Q Was it not the fact, though, that the particular frequencies you selected for the test in Notebook LPV-1 did lie in the UHF band?

A I think they exceeded the UHF band, actually. They started in the UHF band and went beyond it.

Q Now, as I understand it, the sheet marked, "U of I Foundation Project" is to be directed to adapting this "V" type construction, as shown in the sketch on the right-hand side, to the VHF band?

A Yes.

Q And it says "VHF only", what does that mean?

A It was designed only for receiving

channels 2 through 13.

Q There appears to be a double boom feed construction shown at the top, in about the center of the page.

Would it be fair to say that the antenna there being tested was of the type shown in Figure 2 of the Mayes and Carrel patent 3,108,280?

A Yes.

Q You may recall at your earlier portion of this deposition, in Chicago, that you stated that you had obtained a grant from the Foundation to adapt this type antenna to television.

Was this project done under that grant, as you recall?

A Yes.

Q And the work was done at the Antenna Laboratory at the University of Illinois?

A Yes.

Q In whose hand is the writing on this white sheet of paper we have been referring to?

A I believe there were at least two different people involved in writing this. I believe I recognize my own writing, in terms of the ink figures that appear there.

And I believe I recognize Bob Carrel's writing in some of the pencil notations that appear there.

Q At the bottom of this yellow sheet there appears the notation "S equals .217" with an inch symbol following it.

Would it be correct to say that that calculation of Mr. Carrel's indicated a spacing between the booms shown in the upper part of the sheet of .217 inches?

A It indicates their separation in some manner, I am not sure exactly what the dimension "S" is, but it is somehow indicative of this spacing.

Q That is,"S" would either be measured between the centers of the booms or the space between the booms; you are not sure which it is?

A Well, it must be the latter, because it would not make much sense, I don't believe for it to be the space between the centers.

MR. MANN: I want to object at this point. You are both assuming that it is one or the other. I personally feel that it is neither of those. I seem to recall

some other calculation where "S" is a calculated value which is not directly a measure of space between booms.

Is that not correct, Dr. Mayes?

THE WITNESS: It is true that "S" has been used for other things relative to log-periodic antennas. However, the "S" appears in the formulas for the impedance of a two-wire transmission line.

BY MR. RINES:

Q Spacing, you mean?

A It is the spacing between the centers of the two wires.

MR. MANN: Are you convinced that in this particular case it is --

THE WITNESS: It appears to be the spacing between the centers.

BY MR. RINES:

Q Thank you.

MR. RINES: I would like to have marked for identification this white page as Exhibit B-46 of Notebook TV6 A & B U-2.

(Whereupon, said sheet was marked for identification as Exhibit B-46.)

BY MR. RINES:

Q I would like to show you an advertisement of JFD entitled "Assault on Perfection" appearing in Electronic Service Dealer, Volume 6, No. 7.

And I would like to invite your particular attention to the center diagram and ask whether that particular antenna is familiar to you.

A Yes.

MR. RINES: I would like to mark this "Assault on Perfection" advertisement for identification as Exhibit B-47.

(Whereupon, said document was marked for identification as Exhibit B-47.)

BY MR. RINES:

Q Would it be a fair statement, and I am directing my questions now to the center diagram "JFD LPV-CL COLOR LASER" that the left-hand antenna's portion is a log-periodic "V" type antenna, with spaced booms?

A Yes.

Q And, near the right-hand section, that

there is a UHF log-periodic section connected to this VHF section?

A Yes.

Q The picture is not very clear of this UHF section, and I would ask if you could give me a sketch, because I want to ask some questions about that, of that UHF section.

A Do you want the same number of elements?

Q No, no, but you can if you wish.

You have drawn, say, the upper portion of the dipole array?

A Well, I drew the lower portion as I was looking at it.

Q And there is an upper portion above it?

A Yes.

Q If I looked from the side, what would it look like, the antenna?

A This is not in any degree to scale. Do you want to include the disks in relationship?

A No, not right now.

Now, am I correct that you have drawn, in the right-hand part of this yellow sheet, the bottom array of planar dipole elements, and that the upper array is the same, but displaced back?

A The upper array is the same except turned over, 180 degrees.

Q Turned over, and these particular dipole elements, are they arranged in a log-periodic configuration?

A In what we call a zoned log-periodic configuration.

Q Do the lengths of the successive dipoles vary in accordance with the logarithmic law?

A Over certain regions, yes.

Q And the spacings?

A Yes.

Q And these particular dipoles happen to be made of sheet metal?

A Yes.

Q They look like teeth?

A Somewhat.

MR. RINES: I would like to mark this yellow sheet, concerning which Dr. Mayes has testified, as Exhibit B-48.

(Whereupon, said yellow sheet was marked for identification as Exhibit B-48.)

BY MR. RINES:

Q Is it correct that this antenna is fed from the smallest dipole end?

A Yes.

Q In the material that you supplied us with at the last portion of this deposition, you mentioned, I believe, the early work of DuHamel at the University of Illinois Antenna Laboratories, and later at Collins Radio.

Is this the same DuHamel that you refer to at the top of page 77 of your report which you kindly supplied to us, No. 66-11, "Wave Propogation on Smooth and Periodic Structures and Applications to Antenna Design"?

A Yes.

MR. RINES: I would like to mark the before-mentioned Report No. 66-11 as B-49.

(Whereupon, said report was marked for identification as Exhibit B-49.)

BY MR. RINES:

Q You were mentioned on the first page as the editor, and I wonder if you could just very briefly tell us what was the purpose of this report B-49?

A This report was prepared at the suggestion

of a representative of the National Aeronautics and Space Administration from Goddard Space Flight Center, who had attended a forum on antenna research held in our laboratory the latter part of January of 1963, at which occasion he heard a lecture which I gave, and thought that it should be made available to a number of antenna engineers in the National Aeronautics and Space Administration.

Since that receipt of a grant for doing this, we expanded the effort to include some of the work that was being carried on at the laboratory subsequent to the time of the forum, and this was put into the Report No. 66-11.

Q In this report you reproduce a little later some of the earlier work. It says "Collins Radio Company", which you define as "the first development of wire outline versions", with specific reference to Figure 33.

Is it correct that this is a development of Mr. DuHamel prior to the work that Isbell and you performed in connection with the log-periodic antennas, dipole antennas?

A It is true that this was done by DuHamel and his co-workers. As far as the timing is

concerned I think there was some overlap. I am not sure about the dates.

Q Do you know whether DuHamel started this work prior to Isbell's dates of conception?

A I don't know.

Q In the notebooks supplied to us the earliest work we could find in Mr. Isbell's notebooks that related to the log-periodic dipole concept appears on page 11 of notebook No. 2, which is dated to start with November, 1958.

And unfortunately, there is no date on that page.

Are you aware of any work of Mr. Isbell in connection with such antennas prior to the work referred to on page 11 of Isbell notebook?

A Your specific reference is now to antennas with thin dipole elements, is that correct?

Q Yes.

A This is the first recorded.

Q Are you familiar with DuHamel's work shown in his patent with Ore, No. 3,079,602 that shows in Figure 4 the same antenna that you have illustrated in Fig. 33 of Exhibit B-49?

A Yes.

Q The filing date of the DuHamel and Ore patent is indicated as March 14, 1958.

Would it be fair to say then that to the best of your knowledge the work described in this DuHamel and Ore patent preceded Isbell's work with the thin dipole log-periodic structure?

A Yes, on the basis of this date, yes.

MR. RINES: I would like to mark for identification the DuHamel and Ore patent 3,079,602 as Exhibit B-50.

(Whereupon, said patent was marked for identification as Exhibit B-50.)

BY MR. RINES:

Q So that our nomenclature is consistent, are we agreed that in both the DuHamel and Ore patent Exhibit 50 and your paper Exhibit 49, the Greek letter Alpha is used to represent the angle formed by drawing a line from the smallest antenna end to the widest antenna end on each side of the upper and lower portions of the antenna?

And if that isn't correct, would you tell me how we describe the angle "Alpha"?

A That is a difficult job.

Q Well, what can we say about the angle

Alpha, what does it mean?

A I would say that the angle Alpha is the angle between two lines which pass through the apex of each antenna element, and also through the extremities of each of the teeth.

Q Would you draw that angle Alpha, for example, on the lower section of Exhibit B-48, draw on dotted lines what that angle Alpha might be.

A On this particular structure?

Q Yes, please.

A This is a zoned antenna, there is no angle Alpha for it.

Q Is there an angle Alpha here?

A Well, there is more than one.

Q Would you draw the one which you have shown?

A I mean there could possibly be an angle Alpha, for example, for a certain section of the antenna, and another angle Alpha for some other section of the antenna.

Q Fine, thank you. I am doing this to make sure I understand you.

Is it fair to say that the angle psi

is used both in patent exhibit 50 and patent exhibit 49 to represent the angle included between the upper and lower arrays of this antenna?

A Yes.

Q And in Figure 1 of Exhibit 50 the angle beta is used to represent the angle defined by the center portion of the upper or lower antenna section which increases from the vertex end to the long element, is that a fair statement?

A Yes.

Q Now, in Figure 4 of DuHamel patent, Exhibit 50, and in Figure 33 of your paper, Exhibit 49, that angle beta has been reduced to zero, is that correct?

A Yes.

Q Now, in order for the type of antenna shown in your Figure 33 and in Exhibit 50 to work in accordance with log-periodic principles, is there some critical width to the size of the tooth element, or could antennas be made to operate with elements of different widths?

A They could be --

MR. MANN: Let me make a comment. May I inquire what the objective that you are seeking

here is, Mr. Rines? I mean, we are now discussing an antenna which was described in a paper written, or edited, by Dr. Mayes. This type of antenna is not directly pertinent to anything in suit that I can see. And I am wondering, are you using Dr. Mayes as an antenna expert? If so, I object.

MR. RINES: I would like to call your attention to the first and second paragraphs on page 77 of Exhibit No. 49, after which I think you will remove your objection.

MR. MANN: The first and second full paragraphs?

MR. RINES: Yes.

MR. MANN: It still appears to me that you are using Professor Mayes as an expert.

MR. RINES: I don't have that intention.

MR. MANN: You are so using him. He is either an inventor, in which case he can discuss his own invention, his own patent, or he is a supervisor and he will discuss whatever work was done that he had personal knowledge of.

But I don't see where you are justified

in asking him theoretical questions about the operations of antennas he may have written about, unless you want to use him as an expert.

MR. RINES: I would like to use him as an expert, but you have objected to this.

MR. MANN: I have objected to it, yes, because I don't think he is your expert, and I object to his being used as an expert by you.

MR. RINES: I would be pleased then to ask Dr. Mayes --

MR. MANN: If you pay him for his services as an expert and he is willing to accept the job, then go right ahead.

MR. RINES: I will proceed in another way.

BY MR. RINES:

Q Would you please read the first and second complete paragraphs of your report, B-49, where you evolve from this very DuHamel structure the way in which one could reach a structure that has the form of the Isbell patent, and then I will ask you a question about it.

Is it correct to say that after describing the DuHamel structure of Figure 33, or Figure 4 of

patent Exhibit 50, you have said that the same result as attained by Isbell, which you show in Figure 34, "is achieved if we apply several perturbations to the antenna in Figure 33"?

You do say that?

A Well, you quoted a portion of a sentence.

Q Right.

A Which appears in the report.

Q Right; am I correct then that you tell what are those perturbations that would be necessary to convert from the invention of DuHamel and Ore to the invention of Isbell?

A Yes.

Q And is this correct, that those perturbations are, "If we let the element widths become small and then allow the angle between the planes of elements to go to zero, the result is the familiar log-periodic array of dipole elements shown in Fig. 34. The perturbation just described leads naturally to the transposed feeder line shown in Figure 34."

Are those the perturbations that are necessary in order to become the inventor of Isbell's invention, starting with DuHamel's

Fig. 4 or your Fig. 3?

MR. MANN: I will object to the question. I still think this whole line of inquiry is improper.

In the first place, this document is after the effective date of Isbell's invention.

In the second place, the only thing that I can see that is pertinent about this is your attempt to establish, in Dr. Mayes' opinion, as an expert in this field, what he may have considered the necessary steps. I don't see that it is pertinent, except insofar as his own opinion is concerned.

Now he is not testifying here as an expert, certainly not your expert. He is an inventor, as I said before, and he is a supervisor, and he will testify as to facts, what was done.

And anything beyond that I object to.

BY MR. RINES:

Q Do you know as a fact whether anybody before Isbell suggested taking the structure of Fig. 4 of DuHamel patent Exhibit 50, making the elements of smaller width, and going to an angle psi equal to zero?

A To my knowledge, no, no one suggested it before Isbell.

Q And as a fact witness you have been testifying about Isbell's invention of the log-periodic antenna. By that you mean just such a structure?

A The dipole array.

Q With the elements reduced in width and the angle psi made zero?

A That is the subject of one of Isbell's log-periodic dipole -- or one of his log-periodic antenna inventions.

Q Is that the one of patent 3,210,767?

A Right.

Q Would you be surprised that DuHamel, prior to Isbell, suggested that the angle psi go to zero?

MR. MANN: I object to the question. Has it been established that he suggested this?

MR. RINES: Would you please read column 2, line 53, and column 6, line 16, of Exhibit 50 and see if you can answer your counsel's question.

THE WITNESS: It is here stated that the angle psi can vary from 180 degrees to zero degrees.

BY MR. RINES:

Q Did you know before this moment that DuHamel had recognized that?

A Well, I don't know exactly what you mean by "recognized that."

Q That zero degrees --

A (Continuing) The change in the angle down to small values was actually done by Isbell at the University prior to this work by DuHamel. It is the result that you get when you change the angle to small values which make that particular antenna not useful.

Q Can you call our attention to work done at zero degrees by Isbell prior to DuHamel's work?

A Not exactly at zero, but for small angles, yes, you have a report that documents what happens at small angles.

Q At zero degrees?

A At small angles, approaching zero, but not at zero.

Q What do you mean by "small angles"?

A I don't recall what was the smallest angle that Isbell investigated, but it is documented in his report.

Q The only angles we could find were of the order of 30 degrees. Is that correct to your recollection?

A This may be the smallest angle. I don't recall the smallest angle that he used.

Q It is correct that your report, so far as you know, has no technical errors when you describe the prior art that you have investigated, so far as you know?

A So far as I know it has no technical errors.

Q And the length of the teeth of Fig. 33 of your Exhibit 49 do vary in accordance with the log-periodic law?

A I presume they do, this figure was supplied to us by Collins.

Q And the spacings?

A Yes.

Q In accordance with the log-periodic law?

A Yes.

Q I would like to show you page 6 of Isbell's earlier notebook, called No. 1, AF3220, under date of 2-21-56.

A sketch of an antenna appears in the upper left-hand corner, which appears to be a log-periodic structure. And ask you whether you are familiar with it, and can you tell us what that antenna represents?

A This appears to be a log-periodic sheet metal structure, in which two elements --

MR. MANN: Let me interrupt at this point. I think you should establish a little more basis for Dr. Mayes' familiarity with the document before you ask questions on it.

Is he testifying now as to what he sees for the first time and assumes that he knows, or does he know by having discussed it with Mr. Isbell at the time?

THE WITNESS: I don't recall having talked to Isbell about this antenna, but this was done in 1956, so --

MR. MANN: I don't think that Dr. Mayes has been established to be competent to discuss the antenna.

BY MR. RINES:

Q Did you know about this antenna at that time?

A I expect that I did. I followed pretty carefully most of the work that Isbell did. But I don't recall at this moment exactly what the antenna was, nor a discussion with him about the antenna.

Q Does this refresh your recollection as to the kind of thing you do remember of that era?

A Well, I think I know what this is, but it is more from the standpoint of what I see here rather than what I remember from ten years ago.

Q Would you tell us that?

A This appears to be a log-periodic sheet metal antenna, which has two parts.

I wonder, do you have a copy of Isbell's patent on the earlier log-periodic sstructures that I could refer to, rather than having to describe this thing?

Q I will look.

I am afraid that I don't. I am sorry.

A Well, I will attempt to describe it.

The two pieces here are referred to

collectively as a blade. The blade would be one-half of the log-periodic structure, which is the subject of Isbell's earlier patent under the title of "Unit Directional Log-Periodic Antennas", or a similar title.

In this case one blade has been cut in two pieces along the axis of the structure, and then one-half of the antenna blade has been inserted into -- the teeth have been inserted into the slots on the other half of the antenna blade. And the two have been separated by a 1/16th inch piece of plastic sheet.

Q Is one set fed by one conductor and the interspersed set fed by the second conductor from the small end?

A It is impossible to tell from this drawing; I don't recall.

Q Do you recall in the laboratory whether such was the case?

A I don't recall.

Q Do you find nothing there that refreshes you as to how that was fed?

A Not on this page.

Q On any proximal page?

A No.

Q Is there anyone who worked with Isbell on this directly who is still here at the university?

A Not anyone who is still here at the university.

MR. RINES: Mr. Mann, can you tell us where Isbell is at the present time?

MR. MANN: Somewhere on the West Coast. I could get the information for you, but I don't have it right now.

Haven't we given you that information earlier?

MR. RINES: Not that I am aware of.

MR. PHILLIPS: I don't believe so.

MR. MANN: Maybe that was a different suit, but I could get it.

MR. RINES: We would very much like to know where Mr. Isbell is.

MR. MANN: I think he is in Washington or Oregon, working for Boeing, or some such, as I remember.

BY MR. RINES:

Q Turning to the Isbell patent 3,210,767, and your patent 3,108,280 --

MR. MANN: May I comment at this point? I believe I told you yesterday, Mr. Rines, that the 3,108,280 patent has been reissued as Reissue 25,740, and in that form will be added to this lawsuit when we amend the complaint.

Rather than clutter up the record with two different numbers, wouldn't you rather refer to the reissued patent?

MR. RINES: I will be glad to.

BY MR. RINES:

Q Referring then to your reissue 25,740, and the Isbell patent 3,210,767, the dipole elements have been illustrated in the form of what looks like wires in the respective figure 1's, and tubes or cylinders in the respective figure 2's, is that correct?

A Yes.

Q Can dipole elements assume other configurations than these and still operate in accordance with the teachings of your patent and the Isbell patent to produce these log-periodic results?

A Would you suggest some other configurations?

Q Can the dipole elements, for example, be

flat sheets of metal, such as the teeth shown in Exhibit 48?

A Yes.

Q Can they be loops of wire defining the boundaries of those teeth, such as DuHamel Fig. 4, Exhibit 50?

A Yes.

Q Can they vary in their thickness, that is, the diameter, if cylindrical, or the width if it is a flat one or a wire outline dipole?

A All these things are possible within the realm of adjusting parameters for proper operation.

Q We reviewed a moment ago, and it seemed to jibe with your recollection, that these concepts of the log-periodic dipole antenna came to Mr. Isbell in or around November, 1958, or thereafter.

And in reviewing the quarterly engineering reports that were kindly supplied to us by the University of Illinois, I think through your office, the first mention that we can find of this work appears to be on page 2 of Antenna Laboratory Quarterly Engineering Report No. 1, "Research

Studies on Problems Relating to Antennas", which I ask the reporter to mark as B-51.

(Whereupon, said page was marked as Exhibit B-51 for identification.)

BY MR. RINES:

Q You notice the reproduction of your signature on the cover page -- that is yours?

A Yes, sir.

Q Are we correct that the statement under 2.3, on page 2, referring to zero tooth width and thin linear elements, relates to the subject matter of the Isbell patent?

A Yes.

Q Zero is really a misnomer, because the teeth of dipole elements always have some width, don't they?

A That is true.

Q And the word "thin" in terms of the width would probably be a better description?

A Yes.

Q Now we come to report No. 2 out of the Antenna Laboratory Quarterly Engineering Report, "Research Problems Relating to ECM Antenna", dated 31 March, 1959.

And we also see a reproduction of your signature.

And I will ask the reporter to mark this report as Exhibit B-52 for identification.

(Whereupon, said report was marked for identification as Exhibit B-52.)

BY MR. RINES:

Q Would you agree that on pages 2 and 3 there is a complete description of the Isbell antenna of patent 3,210,767?

A There is a description; as to the completeness of it I am not sure exactly what you had in mind.

Q Does the diagram on page 3 correspond substantially identically with Figure 1 of the Isbell patent?

A Yes.

Q The logarithmic formula given for taus, and the length variation and the spacing variation?

A Yes.

Q And the end feed at the small end is shown?

A It is not clear from this drawing which end is the feed, although presumably, since there

is a piece of transmission line shown on the small end, it could be read into that figure.

Q And the description being described on the left, does that make clear where the feed is applied?

A I find no reference to the feed point in the description.

Q Can you tell us what is the feeder mentioned here with regard to which the elements are oriented?

A The transmission line, which leads through the structure.

Q Where are the terminals for the beginning of that feeder shown?

A Well, there is a set of terminals shown here, and there is a set of terminals shown here (indicating).

Q Now the terminals at the upper end terminate on the dipole?

A Yes.

Q Where did the terminals at the lower end terminate?

A They terminate on a section of transmission line.

Q Is this mentioned as an end-fire array?

A Yes.

Q Where would that be fed?

A It could be fed either way, I mean it is not definite from reading this as to which end the antenna is actually fed from.

Q What is shown on the diagram with regard to where a length of feeder extending from the antenna occurs?

A Well, there is a piece of transmission line shown in the diagram on the small end.

Q Is there similarly an extension of transmission line No. 14 and 16 shown extending from the small end in Figure 1 of Isbell's patent No. 3,210,767?

A In that case there is an actual generator shown connected to the small end.

Q The generator is 13?

A Yes.

Q And are the numbers 14 and 16, the transmission lines that correspond to these lower ones that you referred to at the small end?

A Yes.

Q Is this a directional antenna, and if

so, in what direction?

A Are you asking whether I know that it is a directional antenna?

Q Yes.

A Yes, it is a directional antenna.

Q We have a date on this report Exhibit 52. I wonder whether you have any recollection of the signing of this report?

A You mean, did I sign it?

Q Yes.

A I presume I did, since my signature appears there. I don't actually remember doing it.

Q What was your custom with regard to the signing of reports such as Exhibits 51 and 52, in connection with the dates given on that?

Did you sign them on or about those dates?

A Well, not necessarily. There is no connection really, other than approximately, within a few weeks of that date usually.

Q And this is not the original document that you signed?

A No, I signed a multilith master.

Q In other words, there was another set of copies of this report that was made first on multilith?

A These are printed by using a multilith master. I actually signed on the master itself and then it was printed from that master.

Q What is the next step that is customarily performed after you have signed the multilith master?

A I don't know, except that they bring me the multilith master, I sign it and they take it away, so what they do with it after that is up to the publications office.

I presume that within a few days it goes to the printer for publication. This usually occurs after we have had a chance to read the multilith masters and try to correct errors, a proofreading process that may come either before or after the signature, usually before.

Q You have no knowledge yourself then of -- do you know what printer was used?

A No.

Q For printing this Exhibit 52?

A No, I don't.

Q Who would know, do you know?

A Well, I presume that the records would be in our publications office. The personnel of that office usually rotates rather rapidly, so that I don't know whether anyone who is presently there would have been employed in the office at the time of this report and would have personal knowledge of it.

But I presume there are some records in that office, or if not, in the electrical engineering department office.

Q There is at the end of this report a rather -- at least six pages of names of people to whom this report was distributed.

I wonder whether you can tell me what is the general practice with regard to the distribution of this multilith report to these people, who handles that?

A The publications office of the electrical engineering department.

Q Are these reports required to be submitted in order for the University to receive the funds from the government in payment of the quarterly period of work covered by the reports?

Do you know that?

A Well, do you mean at that particular time, do they have to submit this report before they are paid for that period?

Q Yes.

A No.

Q You don't know that?

A To my knowledge, they do not have to submit the report in order to receive payment.

Q The payment just comes automatically whether they submit a report or not?

A Well, the payment I think is made before the work begins, but I am not sure of this. I don't have cognizance of the actual financial details. This is once again the function of our business manager in the department office.

Q Who was the business manager at that time?

A Harold Lawlor.

Q I note from Exhibits 51 and 52 that it appears to take about a month from the end of the report period before the report is prepared and dated.

Is that the usual practice?

A Well, I wouldn't read that into those

particular dates. The contract says that the report should be issued on the last date of the month subsequent to the reporting period. However, this is not meant to imply that this is the actual practice.

Q Well, it certainly seems to have been followed in connection with report No. 52.

A The date was applied then, but that does not necessarily mean that the report was either prepared or distributed on that date.

Q But the contract, to the best of your knowledge, requires that the report be done, be available, at the end of the month, of the last month of the report period, is that correct?

A Well, "requires" is too strong a statement.

Q You used the word. What is the fact, if you know?

A There is a statement in the contract relative to the preparation of the reports on the last date of the month succeeding the reporting period.

However, this is not necessarily meant to imply that that is the actual practice.

Q And in connection with Exhibit 52 that would in fact have been 31 March, 1959?

A That is the date that appears, yes, on the report.

Q That would have been in compliance with the contract?

A That would have been the last date of the month succeeding the reporting period.

Q Thank you.

We were unable to find in any of the technical reports given to us, Professor Mayes, any tests relating to the effect on the variation of the boom spacing of either the Isbell type or your type of antenna on performance.

A Oh, yes.

Q Would you be able to call our attention to that?

A Yes, look in Carrel's thesis TR52.

Q We shall examine that.

A It may be that we supplied you with a Xerox copy because that report has been in terrific demand and has been reprinted several times.

It is possible that we didn't have a bound copy of the technical report to give you.

Q We will look again and see if we can find that, but I don't recollect it.

A It is in his thesis.

Q All right.

A I believe you will also find it in TR-47 on the resonant V antennas.

Q We shall look there again.

(Recess.)

BY MR. RINES:

Q Dr. Mayes has shown us a reproduction of an article entitled, "An Analysis of the Log-Periodic Dipole Antenna of Robert Carrel," which in a footnote is stated to have been presented at the tenth annual symposium on the USAF Antenna Research and Development Program for October, 1960, and has invited our particular attention to page 17.

Would you please explain to us, Dr. Mayes, what page 17 shows?

A This is a plot showing the variation of the mean resistance level of the antenna versus the value of the feeder impedance.

Also, it shows the standing wave ratio with respect to the mean resistance level, also as a function of the feeder impedance.

Q Now the latter curve, relating to the standing wave ratio, here represented by the letters SWR, is the upper, almost horizontal, curve?

A Yes.

Q And the mean resistance level is the upwardly inclining lower curve?

A Yes.

Q Will you tell us how the feeder impedance was varied for these tests from the 50 ohm to the 150 ohm value?

A By changing the spacing between the two booms of the antenna.

Q And that spacing was done between what values of separation, roughly, as you remember?

A I don't remember.

Q Can you find the notebooks that contain the data on the basis of which this curve was plotted?

A I doubt it.

Q Are there other ways to change the feeder impedance than by changing booms?

A By changing the diameter of the boom.

Q Have tests been carried out here at the

University, changing the impedance by changing diameter?

A No, we have used various diameters of booms, but I don't recall any instance where we kept the spacing constant and varied the diameter because this requires building a different antenna every time you want to make a change, whereas it is convenient to change impedance by merely separating the two booms and using a constant diameter.

Q Are there other ways that you have changed the feeder impedance in the University laboratories?

A No, basically the impedance is determined by the diameter of the booms and the spacing, so you either change one or the other.

You could, of course, change it by inserting some inhomogeneity into the line, such as a plastic sheet, or something like that. We have done this but in a very limited manner.

Q What is the conclusion to be drawn from this resistance level curve?

A Well, the mean resistance level is increased, it increases with an increasing feeder impedance level. The mean resistance level is somewhat below the impedance of the feed line which

is used.

Q What was the impedance of the feed line that was used?

A It varies from 50 to 150 ohms in this particular graph.

Q And to what kind of a system was that feeder connected, what was the impedance of the system to which that feeder was connected?

Was it a 75 ohm system?

A Well, it was a coaxial cable that was used because our measuring equipment has coaxial termination.

Q And that had a characteristic impedance of 75 ohms?

A Well, that was either 75 ohms or 50 ohms. I expect it was probably 50. Most of our impedance meters have 50 ohm output.

Q So to work with your 50 ohm equipment it would be highly inefficient to operate except with a feeder impedance that was near the lower end of this curve, around 50 ohms?

A No, I wouldn't say that because the purpose of the equipment was to measure the impedance and we can measure the impedance over a

much wider range than 50 to 150 by using the 50 ohm system.

Q Did you notice any other performance characteristics, radiation characteristics, of the antenna that changed with your change of feeder impedance?

A Our experience was that the radiation pattern depended very little upon changing the characteristic impedance of the feed line.

Q And are there any tests showing that?

A There probably are, but I have not seen any recently.

Q We were unable to find them in the notebooks you gave us.

A Well, I don't believe that there is anything in the notebooks. The only thing that I could find when I went looking through to find this material were patterns.

Q So is it a fair statement to say that we have not yet been able to find any laboratory notebooks or data that supports the changes, if any, in performance of these log-periodic antennas with spacing of the booms?

A Well, this is laboratory information.

Q I am talking about the data on which it is based.

A Oh, the data on which this is based, yes.

Q You can't find that?

A No, I can't find that other than -- you see, part of this information is calculated and part of it is experimental. It is possible that Bob Carrel still has the calculated and the experimental data, I don't know.

He either took it with him or threw it away when he left. That is my guess as to what happened to it.

I have not been able to locate it in our labs.

MR. RINES: Do we know where Robert Carrel is now?

MR. MANN: Well, we know, I mean I have it in my file -- I don't have it with me.

MR. RINES: We would like to find out, please.

I would like to have you mark as Exhibit B-53 the Carrel article entitled, "An Analysis of Log-Periodic Dipole Antennas."

(Whereupon, said article was marked for identification as Exhibit B-53.)

BY MR. RINES:

Q Would you make a quick comparison, please, of the disclosures of your original patent 3,108,280, and Reissue No. 25,740, and see if you find any differences therein?

A Any differences?

Q Yes.

MR. MANN: What is the point of this, Mr. Rines? The differences, if any, are apparent to anybody. I don't see what will be gained here by having Dr. Mayes read them and point out the differences.

The documents speak for themselves.

MR. RINES: I think I am entitled to ask the witness whether he knows of any differences in these two documents from the disclosures.

BY THE WITNESS:

A Well, I don't know of any, but I can read them word by word and see if I can find any.

BY MR. RINES:

Q No, in order to help you on that score, you will notice that in the Reissue Patent 25,740,

the Patent Office has indicated that matter enclosed in heavy brackets appears in the original one but forms no part of the reissue.

There is no matter in heavy brackets in the disclosure of the specifications, so that as far as the Patent Office is concerned they are identical specifications.

MR. MANN: As far as anybody else is concerned, they are identical. I think it is apparent from a cursory examination. I don't see what the point is.

BY MR. RINES:

Q Do you recall the circumstances surrounding the application for this reissue patent?

A Not very clearly. It has been some time. I don't remember exactly when it was done.

Q Do you recall the oath that you executed in order to get the Patent Office to agree to consider reissuing your patent?

A I did execute an oath, yes.

Q Do you recall what the facts in that oath were, the reasons were?

A What the facts were?

Q Yes, the facts set forth in that oath,

why a reissue was to be made?

A No, I don't remember now, I don't remember what the oath stated, no.

Q Do you remember whether you supplied those facts?

MR. MANN: I object to the question; if he doesn't remember the facts, how can he remember whether he supplied them?

MR. RINES: He can certainly know whether he supplied facts and not remember what they are right now.

MR. MANN: Facts in connection with the --

MR. RINES: With the affidavit.

BY THE WITNESS:

A I don't recall the specific instance.

MR. RINES: I would like to call for the production of the affidavit of Mayes and Carrel in their petition for the reissue application.

MR. MANN: Do you mean that you don't have a copy of the file history of this patent?

MR. RINES: I didn't say that. I would like to call for the production of the affidavit and also call for any correspondence between Mr. Mayes and Mr. Carrel relating to

that, relating to those affidavits.

MR. MANN: I don't think you will get that correspondence. I don't know what it is, but I am quite sure that we will take the position that it is privileged communication.

MR. RINES: On what basis?

MR. MANN: He is our client, or an agent of our client.

MR. RINES: I didn't say between you, I said between Dr. Mayes and Mr. Carrel.

MR. MANN: Oh, I am sorry, I thought you said Mr. Smith.

All right, correspondence between whom?

MR. RINES: Any and all correspondence between Dr. Mayes and Mr. Carrel relating to that reissue application or affidavit or oath relating thereto.

And any correspondence relating to this same thing between Mayes and/or Carrel and Mr. Colvin, or the University of Illinois Foundation, as distinguished from its attorneys.

MR. MANN: All right.

BY MR. RINES:

Q Do you recall, Professor Mayes, whether

you had any interferences in connection with your original patent or reissued patent?

A None.

MR. RINES: I want to go on record as thanking your very much for your cooperation, Professor Mayes, and your candor in this deposition.

Unfortunately, I can't close it, because the material that I asked you about that was to be supplied by JFD has not been supplied to us yet. We understand that JFD's counsel is going to have a chance to look that over tonight and hopefully supply it to us.

At present we intend to go on with Mr. Grant tomorrow morning, and maybe he can clarify some of the matters we wish to talk to you about in that connection.

In that event we can close your deposition, but until we are sure of that, we will have to leave it open at this time.

(Whereupon, at the hour of 4:10 p.m., this deposition was adjourned sine die.)