UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

APPLE, INC.,

Petitioner,

v.

RESONANT SYSTEMS, INC.,

Patent Owner.

Case No. IPR2024-00983

U.S. Patent No. 11,152,882

DEPOSITION OF BLAKE HANNAFORD, Ph.D.

CONDUCTED REMOTELY

Wednesday, January 29, 2025

9:00 a.m. Pacific Time

Stenographically Reported By:

Lorie Rhyne, CSR, RPR, CRR

Job No. 108122

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U.S. Patent No. 11,152,882

REMOTE DEPOSITION OF BLAKE HANNAFORD, Ph.D., taken by Patent Owner, Resonant Systems, Inc., held remotely via Zoom, taken before Lorie Rhyne, CRR, RPR, CSR No. 12905, a Certified Shorthand Reporter for the State of California, commencing on Wednesday, January 29, 2025, 9:00 a.m. Pacific Time.

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(All Appearances via Videoconference)

APPEARANCES OF COUNSEL:

For Petitioner:

CRAIG A. DEUTSCH, ESQ.
Fish & Richardson
60 South Sixth Street, Suite 3200
Minneapolis Minnesota 55402
(612) 278-4514
deutsch@fr.com
-and-
THOMAS ROZYLOWICZ, ESQ.
Fish & Richardson
1000 Maine Avenue SW, Suite 1000
Washington, D.C. 20024
(202) 783-5070
rozylowicz@fr.com

For Patent Owner:

NEIL RUBIN, ESQ.
Russ August & Kabat
12424 Wilshire Boulevard, 12th Floor
Los Angeles, California 90025
(310) 826-7474
nrubin@rak.com

Technician:

MATT MILLER

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I N D E X

WITNESS: BLAKE HANNAFORD, Ph.D.

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E X H I B I T S

(None Offered.)

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P R O C E E D I N G S

THE STENOGRAPHER: Good morning. My name is Lorie Rhyne. I am a California Certified Shorthand Reporter and the deposition officer for today's deposition. My CSR license number is 12905.

Can I have the attorneys state their appearances on the record?

MR. RUBIN: This is Neil Rubin of Russ August & Kabat representing the patent owner, Resonant Systems, Inc.

MR. DEUTSCH: This is Craig Deutsch with Fish & Richardson representing Petitioner, Apple. And with me is Tom Rozylowicz, also with Fish & Richardson.

BLAKE HANNAFORD, Ph.D.,

having been duly sworn, testified as follows:

THE STENOGRAPHER: Thank you.

You can proceed.

EXAMINATION

BY MR. RUBIN:

Q. Good morning, Dr. Hannaford.

A. Good morning, Mr. Rubin.

Q. So we've had depositions each of the last two days on IPRs that are related to today's IPR -- or

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IPRs on patents that are related to the patent in today's IPR.

So if I've got my count right, this would be the tenth time you've been deposed, including the last two days' depositions?

A. This will be Number 10, if I recall my own history right, yeah.

Q. Okay.

A. Seven prior to this week, and this is the third this week.

Q. And so you're familiar with the deposition process.

Fair to say?

A. Very fair.

Q. And we've went through, on Monday, some of the ground rules and expectations for that deposition. I don't want to take up anyone's time by repeating those today.

Do you have any questions about the deposition process before we go on?

A. No.

Q. And is there any reason you cannot give complete and accurate testimony here today?

A. No.

Q. Okay. So today we're here for a deposition

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1 in IPR2024-00943 -- or -983, which is an IPR brought by
2 Apple challenging U.S. Patent Number 11,152,882.
3 You recall submitting a declaration on
4 behalf of Apple concerning the '882 patent?
5 **A. Yes.**
6 Q. And do you have a copy of that declaration
7 here with you today?
8 **A. Yes.**
9 Q. And to be clear, you have a paper copy of
10 that declaration?
11 **A. Yes. It's a physical, double-sided hard**
12 **copy.**
13 Q. And I'm going to guess, based on how things
14 went the last two days, that you also have a paper
15 copy -- a paper printed copy of the '882 patent; is
16 that right?
17 **A. Yes, I have that with me too.**
18 Q. And do you have any other printed materials
19 with you here today?
20 **A. No.**
21 Q. And I'm going to guess that you have a
22 laptop with you that's been loaded with copies of the
23 documents that have been filed in the -- with the -- in
24 this IPR proceeding; is that right?
25 **A. Yes. I have a folder that was set up by**

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counsel's team labeled '882 Patent Proceeding, and as far as I can tell, it has everything that I've relied on.

Q. And as you understand it, the documents that are in that folder you just referred to are unmodified copies of documents that have been filed with the PTAB and nothing else?

A. Yes, that is my understanding.

Q. And we're conducting today's deposition over Zoom. I may -- at some point will want to show you documents that you've -- that you don't have in front of you or are on that laptop.

Are you able to open documents that I would share using the chat function in Zoom?

A. I haven't tested that, but I know how to do it. I would click on the document and hope that it opens in the chat, which it usually does, in my experience. You could also share screen, I guess, but that's up to you.

Q. All right. Well, if at any point there -- you encounter any technical difficulties with Zoom or with reviewing any documents that affect your ability to testify, please let me know.

Okay?

A. I will do that.

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Q. Okay. So you said that you have a paper copy of Apple Exhibit 1003, your declaration in this case, in front of you; is that correct?

A. I think so. The -- the exhibit doesn't have the -- the declaration does not have the number you stated on it, but it is definitely in -- filed in the IPR of the '882 patent.

As we did before, we could look -- we could read the attorney docket numbers into the record if you'd like.

Q. Sure.

So is the attorney docket number near the upper right-hand corner of this document 50095-0180IP1?

A. Yes. It's actually on every page, conveniently.

Q. Very good.

And on the front page of your copy in the lower right, there's no identifier that says Apple 1003?

A. There is on the front page an -- that identifier, Apple 1003.

Q. Okay. Are there any errors or things that you'd like to correct that you're aware of in your declaration addressing the '882 patent?

A. Not that I recall right now.

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Q. Do you have in front of you a copy of the '882 patent? And if you look at it, you'll see that the title of the patent is Oscillating-Resonant-Module Controller.

Do you see that?

A. I see it. I see that title.

Q. And you may recall that some of the -- at least some of the claims, you've offered opinions concerning -- use the term "resonant"; is that right?

A. I guess I'd want to look at these claims to be sure, but I wouldn't be surprised if that's right. Sure.

Q. All right.

A. Claim 1 is, "An oscillating resonant module comprising," so it has that word in it, yes.

Q. So as you understand the term "resonant" as it's used in the '882 patent, what does it mean to be resonant?

MR. DEUTSCH: Objection. Form.

THE WITNESS: I would understand that to mean a use of the phenomenon of resonance or reliance on that phenomenon.

BY MR. RUBIN:

Q. Fair enough.

What is resonance, then?

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MR. DEUTSCH: Objection. Scope.

THE WITNESS: Resonance is a very general phenomenon of systems that can -- that have components which store and release energy. So a very typical example is a mass connected to a spring. Both the mass and the spring store energy but in different ways.

Another one is electrical resonance where a circuit is tuned to a frequency with an inductor and a capacitor, and then the mathematics associated with those circuits have very similar properties, which, in many case, cause the system to oscillate.

BY MR. RUBIN:

Q. I think you've offered some opinions about prior art systems that operate at or near a resonant frequency.

What is a resonant frequency?

A. I'll just answer the last question -- subquestion, "What is a resonant frequency?"

So in the systems I described, if you work out differential equations for those systems' motion, you have to put in -- to solve it and figure out how it will oscillate, in particular the frequency at which it will oscillate, you plug in the numerical value of the components, and it turns out that there is a frequency at which it will spontaneously oscillate if energy is

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1 **put into it.**
2 **And that -- that frequency is particular to**
3 **the value of the components, and it's referred to as a**
4 **resonant frequency.**
5 Q. Earlier you referred to a system with a mass
6 and a spring, and you referred to the mass and the
7 spring both storing energy from that system.
8 How does the mass store energy?
9 MR. DEUTSCH: Objection. Form. Scope.
10 **THE WITNESS: It -- as I was -- as I would**
11 **teach -- teach it to students, for example, but also as**
12 **it pertains to this case, a mass stores energy in the**
13 **form of kinetic energy. So when it acquires a**
14 **velocity, it has kinetic energy.**
15 BY MR. RUBIN:
16 Q. And how does the spring store energy?
17 **A. The spring stores energy in proportion to**
18 **how much you stretch it or compress it. The --**
19 Q. And --
20 **A. Yeah. I'm sorry. That's my answer.**
21 Q. All right. And so that energy stored in the
22 spring when it's compressed or stressed -- stretched,
23 is that typically referred to as potential energy?
24 **A. That is often referred to as potential**
25 **energy, yes.**

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Q. So earlier you referred to -- well, withdrawn.

Earlier in response to a question I asked about resonant frequency, you referred to there being a frequency at which a system would spontaneously oscillate.

Do you recall that?

A. I -- I wouldn't -- I wouldn't say spontaneously oscillate. I would say oscillate when some energy is put into it.

Q. Well, I -- I stand corrected about what you actually said. What you actually said is that -- and I'll just quote from the realtime here -- quote, "It turns out there's a frequency" -- let me withdraw and not skip a word when I were to quote you.

Quoting from the realtime transcript, you said, quote, "It turns out that there is a frequency at which it will spontaneously oscillate if energy is put into it," close quote.

So would you agree that for a system to oscillate -- I'm sorry. Withdrawn.

Would you agree that for a system to exhibit resonance, there has to be a frequency at which it will spontaneously oscillate if energy's put into it?

MR. DEUTSCH: Objection. Scope.

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1 **THE WITNESS: I would maybe like to take**
2 **back the word "spontaneous" because I think I used it**
3 **in an ambiguous way there. I mean, it is likely that a**
4 **resonant system is likely to oscillate in response to**
5 **an input of energy at -- at a frequency that can be**
6 **calculated from the equations of the system.**
7 BY MR. RUBIN:
8 Q. And a resonant system will oscillate for
9 some period of time after energy is put into the system
10 without a need for the -- that system to be further
11 driven by some external force.
12 Would you agree?
13 MR. DEUTSCH: Objection. Scope.
14 **THE WITNESS: Yes. That is -- a classic**
15 **example is a resonant system comprising a bell, and you**
16 **hit the bell and input energy to it with your mallet,**
17 **and the bell rings for a while. And a bell is more**
18 **complex than one spring and one mass, but it's the same**
19 **concept with one spring and one mass. It will continue**
20 **to oscillate for a while and die out.**
21 BY MR. RUBIN:
22 Q. So if I could ask you to open up
23 Exhibit 1005. Let me know when you've got that.
24 **A. Okay. I have opened 1005, the Alexander**
25 **reference.**

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Q. And you've offered some opinions concerning obviousness based on this Alexander reference, Exhibit 1005; is that right?

A. I don't believe I've offered an opinion of obviousness using only Alexander, but I have used Alexander in combination.

Q. Fair enough.

If I could ask you to turn to -- in your declaration, to page 37, please.

A. Sure. Sorry.

Okay. I am at page 37.

Q. So the very bottom of that page is the beginning of paragraph 66, and I'll read the first sentence from that paragraph, quote, "In the combined system based on Alexander and Cosper's teachings, the module includes one or more bias members, such as a spring or elastomeric measure -- member, positioned to act on the mover, based on Cosper's suggestions."

Do you see that?

A. I see that.

Q. And so would you agree that Alexander does not describe a bias member, such as a spring or a elastomeric member?

MR. DEUTSCH: Objection. Form.

THE WITNESS: I would want to check that to

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be sure. This -- this -- the sentence you read does not say that. It says the bias member is based on Cosper's suggestions. So that's my opinion there.

BY MR. RUBIN:

Q. So Cosper, for example, depicts a spring in the figure on the -- on the front of the patent; right?

A. You know, I'll just pull it up to be careful, but I think I know what you're referring to.

Yes. Now I have -- I just pulled up Cosper, and there's a very nice clear spring 16 on the first figure.

Q. Okay. So turning back to Alexander.

My question was whether Alexander describes one or more bias members, such as a spring or elastomeric member. And feel free to -- to look at Alexander if you'd like.

MR. DEUTSCH: Objection. Form.

THE WITNESS: I'm looking at it right now. I don't recall seeing a spring or bias member in Alexander.

BY MR. RUBIN:

Q. So if you take a look at Figure 1A in Alexander.

Are you there?

A. Almost.

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1 **Okay. Alexander 1A. I am -- I've got it on**
2 **the screen.**
3 Q. All right. So -- so turning to the
4 description of this figure -- do you see the
5 description of this figure begins on paragraph -- at
6 paragraph 23?
7 **A. I see paragraph 23.**
8 Q. And paragraph 24 begins, quote, "In this
9 embodiment, the linear motor consists of two main
10 parts: a mover and a stator."
11 Do you see that?
12 **A. Yes, I see that sentence of -- that starts**
13 **off paragraph 24.**
14 Q. And so turning back to Figure 1A -- well,
15 actually, let's look at paragraph 23. The sentence
16 that begins at the eighth line of that paragraph reads,
17 quote, "The motor mover can be a longitudinal member
18 that moves inside the cylindrical stator 13."
19 And the next sentence reads, "The motor
20 mover can include a housing tube 4, which contains at
21 least one magnet 7 inside of the housing tube 4."
22 Do you see that?
23 **A. I see it.**
24 Q. So turning back to Figure 1A.
25 Do you see the housing tube 4 labeled?

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A. Yes.

Q. All right. So everything -- so that housing tube 4 and everything contained in it would make up the mover of this embodiment.

Would you agree?

MR. DEUTSCH: Objection. Scope.

THE WITNESS: Looking at this figure right now, yes, I agree.

BY MR. RUBIN:

Q. All right. And that mover moves back and forth inside the cylindrical stator 13; is that right?

A. I believe that's -- yes, I believe that's what's indicated by the arrows labeled 7 -- actually, that's not what's indicated by the arrows, but I also believe that that is where the motion occurs. So, yes, I -- I agree with that.

Q. Okay. Is it your understanding the arrows labeled 7 indicate the orientation of permanent magnets inside the mover?

A. You know, I probably should go check it, but sitting here at this moment, I think that's what they are.

Q. So you haven't offered any opinions in your declaration that the motion of the mover within the stator of Alexander exhibits resonance; correct?

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MR. DEUTSCH: Form.

THE WITNESS: My opinion is limited to the combinations that are listed in the grounds. So I don't recall that I have an opinion about Alexander by itself. Unless we -- let's see if we have the Al- -- an Alexander-only ground.

Yeah, I don't see an Alexander-only ground in my report, so I didn't form that -- an opinion on Alexander alone.

BY MR. RUBIN:

Q. And would you agree that in the embodiments of Alexander, the mover is not going to oscillate unless it's continuously being driven by a force that's provided by the stator coil?

MR. DEUTSCH: Objection. Form.

THE WITNESS: I don't think I've offered an opinion on that question. I'd have to think about it.

BY MR. RUBIN:

Q. Is there anything in Alexander or his teachings that would store energy associated with the motion of the mover aside from the mass of the mover itself?

MR. DEUTSCH: Objection. Form.

THE WITNESS: Again, that's not something that I formed an opinion on, to the best that I can

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recall, anyway.
BY MR. RUBIN:
Q. So sitting here today, do you believe that the embodiments taught in Alexander would exhibit resonance associated with the movement of the mover within the stator?
MR. DEUTSCH: Objection. Form.
THE WITNESS: Again, I don't recall, you know, my report containing any opinion about oscillation in Alexander alone.
BY MR. RUBIN:
Q. Is it true in a resonant system that the amplitude of oscillations will vary as a function of frequency -- withdrawn.
In a resonant system, if an external driving force is applied and the magnitude of that force is kept the same but the frequency of the -- at which the force is applied varies, will the amplitude of oscillations vary as a function of the frequency?
MR. DEUTSCH: Objection. Scope.
THE WITNESS: Speaking about resonant systems in general and assuming that the frequency -- suppose we change the frequency as your question suggests, but assuming that we do it slowly, not sort of instantaneously but we -- for example, we test 100

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different frequencies one at a time or slowly increase the frequency, if the range of frequencies that we test includes the resonant frequency, then, yes, the amplitude will change.

BY MR. RUBIN:

Q. And in doing the experiment that you just described, how -- well, withdrawn.

In doing the experiment that you just described, would you be able to identify what the resonant frequency is from the -- from observing how the amplitude changes?

MR. DEUTSCH: Objection. Form. And scope.

THE WITNESS: My answer is it depends.

BY MR. RUBIN:

Q. What does it depend on?

A. Resonant systems have a peak, a maximum frequency response, as you sort of suggested just now -- well, you didn't suggest it. But as you vary frequencies -- as you test at various frequencies, you can find a peak, but that peak may or may not be the -- that peak can change depending on another factor in resonant systems, which is losses: friction or damping.

Q. So how can the peak vary as a result of -- withdrawn.

How can the peak change depending on losses

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such as friction or damping?

A. When the losses are very small, very minimal, relative to the energy storage, then two things happen: One is the -- we talked about oscillations persisting in time after energy is no longer supplied, and that effect will last a longer time if there's less friction or damping. It will take longer for the friction or damping to use up the energy and stop the motion. That's one thing.

The second thing that happens is that the peak -- the resonant peak -- the system -- when losses are very low, the system will reson- -- will vibrate very close to its mathematical resonant frequency. But when the losses are bigger, it will shift to a lower frequency of oscillation.

Q. So earlier you referred to resonant systems having a maximum frequency response.

Is that -- is the frequency response you referred to there a ratio of amplitude to the driving force, or what -- what is the frequency response?

MR. DEUTSCH: Objection. Form. And scope.

THE WITNESS: I'm not sure I remember precisely the question I was answering there, but I think I meant that as you vary frequency of your input, like force, the amount -- the magni- -- the amplitude

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of vibration will have a peak at one frequency. It will be maximum compared to the other frequencies at one particular frequency.

BY MR. RUBIN:

Q. So you can determine whether a system is at the resonant frequency by measuring how the amplitude of oscillations vary as the frequency -- the system is driven varies.

(Stenographer clarification.)

MR. RUBIN: How the amplitude of oscillation varies as the frequency at which the system is driven varies.

THE STENOGRAPHER: Thank you.

BY MR. RUBIN:

Q. Is that right?

MR. DEUTSCH: Objection. Form.

THE WITNESS: Sorry. Could you combine it into one -- you know, could you repeat the entire -- the question as you wanted to ask it?

BY MR. RUBIN:

Q. That's fair.

So you can determine whether a system is at the resonant frequency by measuring how the amplitude of oscillations vary as the frequency at which the system is driven varies; correct?

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A. I think to properly clarify this point and answer it, we have to take one slight dive deeper into resonant theory, okay, and that is that the simple form of analyzing a resonant circuit ignores the damping and assumes that it's negligible, okay. So in that case, there is one frequency called the resonant frequency determined by the spring constant and the mass and a simple equation.

When there are losses that are significant, then the frequency is different from that value we calculated at the no-loss condition. And I'm sorry if we're getting stuck on this.

I think a POSITA would know that in these vibrating systems in these patents, we are generally operating with low damping. And so there's a sharp, narrow frequency peak. That is where we want to operate.

But this factor is not really in my opinions as I recall them. So I want to be careful there.

Q. If you could turn to the '882 patent, which I think you have a printed copy of in front of you, and the -- turn to the very end where there are the claims. And look at Claim 1, please.

A. Okay. I am looking at Claim 1 of '882.

Q. So the first limitation after the preamble

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of Claim 1 reads, quote, "an oscillation path, which represents a segment of a space curve, along which a point within a mass moves."

Do you see that?

A. Yes.

MR. RUBIN: And I'll upload a copy of the patent into the chat.

BY MR. RUBIN:

Q. All right. Then turning to Claim 10, the -- it's called -- the third element after the preamble likewise reads, quote, "an oscillation path, which represents a segment of a space curve, along which a point within a mass moves."

Do you see that?

A. Yes, I see that.

Q. So both of the independent claims here use the phrase "a segment of a space curve."

Do you see that?

A. Yes.

Q. And then if you could turn to page 82 of your declaration, please.

A. Okay. Page 82 of my '882 declaration.

Q. The first sentence of that paragraph -- of -- I'm sorry. Withdrawn.

The first sentence of paragraph 156 on that

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1 page reads, quote, "I understand that patent owner has
2 taken a position that the claimed oscillation path
3 encompasses a linear path," close quote.
4 Do you see that?
5 **A. I see that.**
6 Q. Okay. So as -- withdrawn.
7 Do you have an opinion as to whether a
8 person skilled in the art who's read the '882 patent
9 would understand the phrase in the claims "a segment of
10 a space curve" to encompass a linear path?
11 **A. To the best of my recollection, I don't have**
12 **an opinion in my report on that, and I wasn't asked to**
13 **form one.**
14 Q. Sitting here today, do you know whether a
15 person skilled in the art would consider the phrase
16 "segment of a space curve" to encompass a linear path?
17 MR. DEUTSCH: Objection. Form. And scope.
18 **THE WITNESS: I'd have to think about it, I**
19 **think. But I'd think about it in the context of these**
20 **patents and all the things I've considered.**
21 BY MR. RUBIN:
22 Q. So sitting here right now --
23 **A. I wasn't asked to -- sorry. I'm sorry.**
24 Q. So sitting here today, having read and
25 considered the '882 patent and the other materials that

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you cite in your expert report, you don't have a view one way or the other as to whether the phrase "a segment of a space curve" encompasses a linear path?

MR. DEUTSCH: Objection. Form.

THE WITNESS: I don't have an opinion about that.

BY MR. RUBIN:

Q. So in paragraph 156, you say, quote, "a POSITA would have understood that the teachings of Gregorio render Claims 1 through 5, 10, 17, 19 and 20 obvious according to patent owner's proposed interpretation."

Do you see that?

A. I see that.

Q. And so that is -- the opinion that you're offering with respect to Ground 1A is under what you describe as patent owner's position that the phrase "a segment of a space curve" encompasses a linear path; is that right?

A. I was asked under Ground -- you know, to create Ground 2A, I was asked to form an opinion based on assuming the patent owner's proposed interpretation that a straight line is a -- is encompassed by a space curve.

Q. And that assumption was necessary because in

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Gregorio, the path of oscillation is a linear path; is that right?

A. I -- the assumption -- I used the assumption because I was asked to form an opinion about it. I don't have an opinion that the assumption is necessary.

Q. So if you were instead to assume that the phrase "a segment of a space curve" requires a path that is curved, that has a nonzero curvature to it at some point, would you agree that you'd -- under that assumption, you have not -- rather, would you agree that under that assumption, your opinion that Gregorio alone renders certain claims obvious would not apply?

MR. DEUTSCH: Objection. Form. And scope.

THE WITNESS: I -- I admit to being a little confused and not sure that I followed your question. So, again, I'll -- if you don't mind concisely restating what you want the question to be.

BY MR. RUBIN:

Q. All right. So you'd agree that your obviousness opinion, that Gregorio alone is sufficient to render obvious Claims 1 through 5, 10, 17, 19 and 20, depends on the assumption that the phrase in the claims -- "a segment of a space curve" -- encompasses a path that's linear, that has no curve in it?

MR. DEUTSCH: Objection. Form.

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THE WITNESS: I just want to be precise here and -- so I would just repeat that -- my language, "a POSITA would have understood that the teachings of Gregorio renders Claims 1 through 5, 10, 17, 19 and 20 obvious according to patent owner's proposed interpretation."

And I also state in that paragraph that, "I understand that patent owner has taken a position that the claimed oscillation path encompasses a linear path." And that's what I'm calling patent owner's proposed interpretation.

BY MR. RUBIN:

Q. And you haven't offered any opinion in -- in your declaration that it would have been obvious based on Gregorio alone to use an oscillation path that had a curve in it, that -- that is, that had, at some point along the path, a nonzero curvature?

A. Sitting here now, I don't recall that in my opinions.

Q. Turning to the paragraph that begins at the bottom of page 82, paragraph 158.

A. I am there.

Q. The first sentence reads, quote, "Gregorio provides Element [1a] according to patent owner's position in the co-pending litigation that the claimed

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1 oscillation path encompasses a linear path."
2 Do you see that?
3 **A. I see that.**
4 Q. So you would agree that the opinion that you
5 offer that Gregorio, or an obvious modification of
6 Gregorio, satisfies Limitation [1a] -- that depends on
7 your assumption that the claimed oscillation path
8 encompasses a linear path?
9 **A. My opinion doesn't talk about obvious**
10 **modifications. It just says, "Gregorio provides**
11 **Element [1a] according to patent owner's position in**
12 **the co-pending litigation that the claimed oscillation**
13 **path encompasses a linear path."**
14 **So I think that states it plainly.**
15 Q. So your opinion that certain claims are
16 obvious in view of Gregorio stated in Ground 1 -- 2A is
17 based on your opinion that Gregorio by itself satisfies
18 each limitation of those claims; is that right?
19 MR. DEUTSCH: Objection. Form.
20 **THE WITNESS: We're talking about my**
21 **opinions here expressed in this -- these sections --**
22 **this section's Ground 2A, and that's -- like**
23 **paragraph 158. And my opinion is use -- is applying**
24 **the patent owner's position that a linear -- that the**
25 **claimed, you know, curve -- oscillation space curve --**

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that the segment of a space curve encompasses a linear path.

So I was just asked to form an opinion assuming the patent owner's position.

BY MR. RUBIN:

Q. So we talked yesterday about the same Gregorio reference in the context of some opinions that you've offered in IPRs challenging related patents.

Do you recall that?

A. Yes, I do recall talking about Gregorio in the previous depositions.

Q. And you recall that in some of your other IPR declarations, you talk about Gregorio's teachings relating to the back EMF?

A. I recall that.

Q. The grounds of this IPR that involve Gregorio are Grounds 2A, 2B, 2C, 2D and onto 2H. In your discussion of obviousness under those grounds involving Gregorio, I don't see any mention of Gregorio's teachings concerning back EMF.

Do you recall in this declaration pointing to any of Gregorio's teachings concerning back EMF and arguing that claims were obvious under these grounds?

MR. DEUTSCH: Objection. Form.

THE WITNESS: There's a lot of discussion of

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Gregorio here, as you just pointed out, and maybe you can point me to a specific mapping that I've made or -- I can't remember sitting here right now if the EMF that you discussed appears here or not. I can't remember that sitting here right now.

BY MR. RUBIN:

Q. Fair enough.

If you turn to page 84. At the bottom of that page, you provide the text of -- Limitation [1c].

Do you see that?

A. Yes, [1c], bottom of 84.

Q. And so [1c] requires, quote, "one or more sensors that output indications of the positions of the mass within the oscillation path at specific points in time," close quote.

Do you see that?

A. I see that.

Q. And yesterday, if I recall correctly, you offered some testimony that the embodiments of Gregorio that include a -- withdrawn. Let me ask something different.

Turning to page 85.

The first sentence of paragraph 162 reads, quote, "Gregorio provides one or more sensors, such as its 'Hall sensor, optical sensor or other type of

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1 sensing device,' that output indications, including
2 sensed positions [sic], of the positions of the
3 mass/magnet within the oscillation path at specific
4 points in time."
5 Do you see that?
6 **A. Yes.**
7 Q. So in that sentence, I don't see any mention
8 of Gregorio's teachings concerning measuring a back
9 EMF, do you?
10 **A. I agree that I don't see it in**
11 **paragraph 162.**
12 Q. And the section of your declaration that
13 addresses Element [1c] under Ground 2A consists of
14 paragraphs 162, 163 and 164.
15 Do you see any mention of Gregorio's
16 teachings involving measurement of back EMF in any of
17 those paragraphs?
18 MR. DEUTSCH: Objection. Form.
19 **THE WITNESS: I do not see "back EMF" in**
20 **those paragraphs 162 through 164.**
21 BY MR. RUBIN:
22 Q. Now, earlier -- withdrawn.
23 Yesterday I believe you testified that the
24 back EMF would be proportional to the velocity at which
25 the magnet is moving; is that right?

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MR. DEUTSCH: Objection. Scope.

THE WITNESS: Sitting here right now without a transcript, that, I do -- I do recall that.

BY MR. RUBIN:

Q. Okay. So would you agree that Gregorio's back EMF measurement would not provide a measurement of the position of the magnet?

MR. DEUTSCH: Objection. Form. And scope.

THE WITNESS: Very generally, back EMF is caused by a magnet's velocity, and the voltage of a back EMF-based sensor is proportional to the velocity of the magnet relative to a coil. Velocity -- a POSITA would have several means to convert a velocity measurement to a position measurement.

Is -- I'll -- that's my answer, I guess.

BY MR. RUBIN:

Q. Suppose that the only piece of information you had was the back EMF voltage measurement from Gregorio's system at a single point in time.

Would a POSITA have a way of deducing from that single value the position of the mass -- or magnet of Gregorio?

MR. DEUTSCH: Objection. Scope.

THE WITNESS: I -- I don't recall that this is anything that I formed an opinion on in my report.

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1 **Answering your question in the abstract, in a digital**
2 **system, probably not.**
3 **An analog circuit could convert, as I said**
4 **before, by a process known as integration. It could**
5 **convert the velocity signal to a position, and that**
6 **could be sampled at a single point in time.**
7 BY MR. RUBIN:
8 Q. That process of integration would be
9 producing an output signal that depended on the back
10 EMF voltage over some period of time leading up to when
11 the measurement was made; right?
12 **A. Yes. Continuing that abstract example and**
13 **again qualifying it that I don't recall an opinion on**
14 **this, but it would be known to a POSITA that your**
15 **statement was correct. It would require a previous**
16 **history of velocity signals.**
17 MR. RUBIN: So I have no further
18 cross-examination for you right now.
19 I'll pass the witness.
20 MR. DEUTSCH: All right. We've been going
21 for a bit. Let's take a break.
22 **THE WITNESS: Break sounds good.**
23 (A brief recess is taken from
24 10:21 a.m. to 10:32 a.m.)
25 MR. DEUTSCH: All right. Well, thank you

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again for your time today, Dr. Hannaford.

No further questions.

THE WITNESS: You're welcome.

Thank you, all.

MR. RUBIN: All right. Thank you.

THE STENOGRAPHER: Same order as yesterday, Mr. Deutsch?

MR. DEUTSCH: Yeah. That's fine.

(Time noted: 10:32 a.m.)

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ACKNOWLEDGEMENT OF DEPONENT

I, BLAKE HANNAFORD, Ph.D., do hereby acknowledge that I have read and examined the foregoing testimony and the same is a true, correct, and complete transcription of the testimony given by me and any corrections appear on the attached errata sheet signed by me.

_____ _____

BLAKE HANNAFORD, Ph.D. (DATE)

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DEPOSITION ERRATA SHEET

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BLAKE HANNAFORD, Ph.D.

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1 UNITED STATES PATENT AND TRADEMARK OFFICE
2 _____
3 BEFORE THE PATENT TRIAL AND APPEAL BOARD
4 _____
5 APPLE, INC.,
6 Petitioner,
7 v.
8 RESONANT SYSTEMS, INC.,
9 Patent Owner.
10 _____
11 Case No. IPR2024-00983
12 U.S. Patent No. 11,152,882
13
14
15 DEPOSITION OF BLAKE HANNAFORD, Ph.D.
16 CONDUCTED REMOTELY
17 Wednesday, January 29, 2025
18 9:00 a.m. Pacific Time
19
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21
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23 Stenographically Reported By:
24 Lorie Rhyne, CSR, RPR, CRR
25 Job No. 108122

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UNITED STATES PATENT AND TRADEMARK OFFICE

_____

BEFORE THE PATENT TRIAL AND APPEAL BOARD

_____

APPLE, INC.,

Petitioner,

v.

RESONANT SYSTEMS, INC.,

Patent Owner.

_____

Case No. IPR2024-00983

U.S. Patent No. 11,152,882

REMOTE DEPOSITION OF BLAKE HANNAFORD, Ph.D., taken by Patent Owner, Resonant Systems, Inc., held remotely via Zoom, taken before Lorie Rhyne, CRR, RPR, CSR No. 12905, a Certified Shorthand Reporter for the State of California, commencing on Wednesday, January 29, 2025, 9:00 a.m. Pacific Time.

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(All Appearances via Videoconference)

APPEARANCES OF COUNSEL:

For Petitioner:

CRAIG A. DEUTSCH, ESQ.
Fish & Richardson
60 South Sixth Street, Suite 3200
Minneapolis Minnesota 55402
(612) 278-4514
deutsch@fr.com
-and-
THOMAS ROZYLOWICZ, ESQ.
Fish & Richardson
1000 Maine Avenue SW, Suite 1000
Washington, D.C. 20024
(202) 783-5070
rozylowicz@fr.com

For Patent Owner:

NEIL RUBIN, ESQ.
Russ August & Kabat
12424 Wilshire Boulevard, 12th Floor
Los Angeles, California 90025
(310) 826-7474
nrubin@rak.com

Technician:

MATT MILLER

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I N D E X

WITNESS: BLAKE HANNAFORD, Ph.D.

EXAMINATION	PAGE
By Mr. Rubin	5

E X H I B I T S

(None Offered.)

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P R O C E E D I N G S

THE STENOGRAPHER: Good morning. My name is Lorie Rhyne. I am a California Certified Shorthand Reporter and the deposition officer for today's deposition. My CSR license number is 12905.

Can I have the attorneys state their appearances on the record?

MR. RUBIN: This is Neil Rubin of Russ August & Kabat representing the patent owner, Resonant Systems, Inc.

MR. DEUTSCH: This is Craig Deutsch with Fish & Richardson representing Petitioner, Apple. And with me is Tom Rozylowicz, also with Fish & Richardson.

BLAKE HANNAFORD, Ph.D.,

having been duly sworn, testified as follows:

THE STENOGRAPHER: Thank you.

You can proceed.

EXAMINATION

BY MR. RUBIN:

Q. Good morning, Dr. Hannaford.

A. Good morning, Mr. Rubin.

Q. So we've had depositions each of the last two days on IPRs that are related to today's IPR -- or

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IPRs on patents that are related to the patent in today's IPR.

So if I've got my count right, this would be the tenth time you've been deposed, including the last two days' depositions?

A. This will be Number 10, if I recall my own history right, yeah.

Q. Okay.

A. Seven prior to this week, and this is the third this week.

Q. And so you're familiar with the deposition process.

Fair to say?

A. Very fair.

Q. And we've went through, on Monday, some of the ground rules and expectations for that deposition. I don't want to take up anyone's time by repeating those today.

Do you have any questions about the deposition process before we go on?

A. No.

Q. And is there any reason you cannot give complete and accurate testimony here today?

A. No.

Q. Okay. So today we're here for a deposition

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1 in IPR2024-00943 -- or -983, which is an IPR brought by
2 Apple challenging U.S. Patent Number 11,152,882.
3 You recall submitting a declaration on
4 behalf of Apple concerning the '882 patent?
5 **A. Yes.**
6 Q. And do you have a copy of that declaration
7 here with you today?
8 **A. Yes.**
9 Q. And to be clear, you have a paper copy of
10 that declaration?
11 **A. Yes. It's a physical, double-sided hard**
12 **copy.**
13 Q. And I'm going to guess, based on how things
14 went the last two days, that you also have a paper
15 copy -- a paper printed copy of the '882 patent; is
16 that right?
17 **A. Yes, I have that with me too.**
18 Q. And do you have any other printed materials
19 with you here today?
20 **A. No.**
21 Q. And I'm going to guess that you have a
22 laptop with you that's been loaded with copies of the
23 documents that have been filed in the -- with the -- in
24 this IPR proceeding; is that right?
25 **A. Yes. I have a folder that was set up by**

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counsel's team labeled '882 Patent Proceeding, and as far as I can tell, it has everything that I've relied on.

Q. And as you understand it, the documents that are in that folder you just referred to are unmodified copies of documents that have been filed with the PTAB and nothing else?

A. Yes, that is my understanding.

Q. And we're conducting today's deposition over Zoom. I may -- at some point will want to show you documents that you've -- that you don't have in front of you or are on that laptop.

Are you able to open documents that I would share using the chat function in Zoom?

A. I haven't tested that, but I know how to do it. I would click on the document and hope that it opens in the chat, which it usually does, in my experience. You could also share screen, I guess, but that's up to you.

Q. All right. Well, if at any point there -- you encounter any technical difficulties with Zoom or with reviewing any documents that affect your ability to testify, please let me know.

Okay?

A. I will do that.

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Q. Okay. So you said that you have a paper copy of Apple Exhibit 1003, your declaration in this case, in front of you; is that correct?

A. I think so. The -- the exhibit doesn't have the -- the declaration does not have the number you stated on it, but it is definitely in -- filed in the IPR of the '882 patent.

As we did before, we could look -- we could read the attorney docket numbers into the record if you'd like.

Q. Sure.

So is the attorney docket number near the upper right-hand corner of this document 50095-0180IP1?

A. Yes. It's actually on every page, conveniently.

Q. Very good.

And on the front page of your copy in the lower right, there's no identifier that says Apple 1003?

A. There is on the front page an -- that identifier, Apple 1003.

Q. Okay. Are there any errors or things that you'd like to correct that you're aware of in your declaration addressing the '882 patent?

A. Not that I recall right now.

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Q. Do you have in front of you a copy of the '882 patent? And if you look at it, you'll see that the title of the patent is Oscillating-Resonant-Module Controller.

Do you see that?

A. I see it. I see that title.

Q. And you may recall that some of the -- at least some of the claims, you've offered opinions concerning -- use the term "resonant"; is that right?

A. I guess I'd want to look at these claims to be sure, but I wouldn't be surprised if that's right. Sure.

Q. All right.

A. Claim 1 is, "An oscillating resonant module comprising," so it has that word in it, yes.

Q. So as you understand the term "resonant" as it's used in the '882 patent, what does it mean to be resonant?

MR. DEUTSCH: Objection. Form.

THE WITNESS: I would understand that to mean a use of the phenomenon of resonance or reliance on that phenomenon.

BY MR. RUBIN:

Q. Fair enough.

What is resonance, then?

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MR. DEUTSCH: Objection. Scope.

THE WITNESS: Resonance is a very general phenomenon of systems that can -- that have components which store and release energy. So a very typical example is a mass connected to a spring. Both the mass and the spring store energy but in different ways.

Another one is electrical resonance where a circuit is tuned to a frequency with an inductor and a capacitor, and then the mathematics associated with those circuits have very similar properties, which, in many case, cause the system to oscillate.

BY MR. RUBIN:

Q. I think you've offered some opinions about prior art systems that operate at or near a resonant frequency.

What is a resonant frequency?

A. I'll just answer the last question -- subquestion, "What is a resonant frequency?"

So in the systems I described, if you work out differential equations for those systems' motion, you have to put in -- to solve it and figure out how it will oscillate, in particular the frequency at which it will oscillate, you plug in the numerical value of the components, and it turns out that there is a frequency at which it will spontaneously oscillate if energy is

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1 **put into it.**
2 **And that -- that frequency is particular to**
3 **the value of the components, and it's referred to as a**
4 **resonant frequency.**
5 Q. Earlier you referred to a system with a mass
6 and a spring, and you referred to the mass and the
7 spring both storing energy from that system.
8 How does the mass store energy?
9 MR. DEUTSCH: Objection. Form. Scope.
10 **THE WITNESS: It -- as I was -- as I would**
11 **teach -- teach it to students, for example, but also as**
12 **it pertains to this case, a mass stores energy in the**
13 **form of kinetic energy. So when it acquires a**
14 **velocity, it has kinetic energy.**
15 BY MR. RUBIN:
16 Q. And how does the spring store energy?
17 **A. The spring stores energy in proportion to**
18 **how much you stretch it or compress it. The --**
19 Q. And --
20 **A. Yeah. I'm sorry. That's my answer.**
21 Q. All right. And so that energy stored in the
22 spring when it's compressed or stressed -- stretched,
23 is that typically referred to as potential energy?
24 **A. That is often referred to as potential**
25 **energy, yes.**

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Q. So earlier you referred to -- well, withdrawn.

Earlier in response to a question I asked about resonant frequency, you referred to there being a frequency at which a system would spontaneously oscillate.

Do you recall that?

A. I -- I wouldn't -- I wouldn't say spontaneously oscillate. I would say oscillate when some energy is put into it.

Q. Well, I -- I stand corrected about what you actually said. What you actually said is that -- and I'll just quote from the realtime here -- quote, "It turns out there's a frequency" -- let me withdraw and not skip a word when I were to quote you.

Quoting from the realtime transcript, you said, quote, "It turns out that there is a frequency at which it will spontaneously oscillate if energy is put into it," close quote.

So would you agree that for a system to oscillate -- I'm sorry. Withdrawn.

Would you agree that for a system to exhibit resonance, there has to be a frequency at which it will spontaneously oscillate if energy's put into it?

MR. DEUTSCH: Objection. Scope.

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1 **THE WITNESS: I would maybe like to take**
2 **back the word "spontaneous" because I think I used it**
3 **in an ambiguous way there. I mean, it is likely that a**
4 **resonant system is likely to oscillate in response to**
5 **an input of energy at -- at a frequency that can be**
6 **calculated from the equations of the system.**
7 BY MR. RUBIN:
8 Q. And a resonant system will oscillate for
9 some period of time after energy is put into the system
10 without a need for the -- that system to be further
11 driven by some external force.
12 Would you agree?
13 MR. DEUTSCH: Objection. Scope.
14 **THE WITNESS: Yes. That is -- a classic**
15 **example is a resonant system comprising a bell, and you**
16 **hit the bell and input energy to it with your mallet,**
17 **and the bell rings for a while. And a bell is more**
18 **complex than one spring and one mass, but it's the same**
19 **concept with one spring and one mass. It will continue**
20 **to oscillate for a while and die out.**
21 BY MR. RUBIN:
22 Q. So if I could ask you to open up
23 Exhibit 1005. Let me know when you've got that.
24 **A. Okay. I have opened 1005, the Alexander**
25 **reference.**

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Q. And you've offered some opinions concerning obviousness based on this Alexander reference, Exhibit 1005; is that right?

A. I don't believe I've offered an opinion of obviousness using only Alexander, but I have used Alexander in combination.

Q. Fair enough.

If I could ask you to turn to -- in your declaration, to page 37, please.

A. Sure. Sorry.

Okay. I am at page 37.

Q. So the very bottom of that page is the beginning of paragraph 66, and I'll read the first sentence from that paragraph, quote, "In the combined system based on Alexander and Cosper's teachings, the module includes one or more bias members, such as a spring or elastomeric measure -- member, positioned to act on the mover, based on Cosper's suggestions."

Do you see that?

A. I see that.

Q. And so would you agree that Alexander does not describe a bias member, such as a spring or a elastomeric member?

MR. DEUTSCH: Objection. Form.

THE WITNESS: I would want to check that to

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be sure. This -- this -- the sentence you read does not say that. It says the bias member is based on Cosper's suggestions. So that's my opinion there.

BY MR. RUBIN:

Q. So Cosper, for example, depicts a spring in the figure on the -- on the front of the patent; right?

A. You know, I'll just pull it up to be careful, but I think I know what you're referring to.

Yes. Now I have -- I just pulled up Cosper, and there's a very nice clear spring 16 on the first figure.

Q. Okay. So turning back to Alexander.

My question was whether Alexander describes one or more bias members, such as a spring or elastomeric member. And feel free to -- to look at Alexander if you'd like.

MR. DEUTSCH: Objection. Form.

THE WITNESS: I'm looking at it right now. I don't recall seeing a spring or bias member in Alexander.

BY MR. RUBIN:

Q. So if you take a look at Figure 1A in Alexander.

Are you there?

A. Almost.

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1 **Okay. Alexander 1A. I am -- I've got it on**
2 **the screen.**
3 Q. All right. So -- so turning to the
4 description of this figure -- do you see the
5 description of this figure begins on paragraph -- at
6 paragraph 23?
7 **A. I see paragraph 23.**
8 Q. And paragraph 24 begins, quote, "In this
9 embodiment, the linear motor consists of two main
10 parts: a mover and a stator."
11 Do you see that?
12 **A. Yes, I see that sentence of -- that starts**
13 **off paragraph 24.**
14 Q. And so turning back to Figure 1A -- well,
15 actually, let's look at paragraph 23. The sentence
16 that begins at the eighth line of that paragraph reads,
17 quote, "The motor mover can be a longitudinal member
18 that moves inside the cylindrical stator 13."
19 And the next sentence reads, "The motor
20 mover can include a housing tube 4, which contains at
21 least one magnet 7 inside of the housing tube 4."
22 Do you see that?
23 **A. I see it.**
24 Q. So turning back to Figure 1A.
25 Do you see the housing tube 4 labeled?

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A. Yes.

Q. All right. So everything -- so that housing tube 4 and everything contained in it would make up the mover of this embodiment.

Would you agree?

MR. DEUTSCH: Objection. Scope.

THE WITNESS: Looking at this figure right now, yes, I agree.

BY MR. RUBIN:

Q. All right. And that mover moves back and forth inside the cylindrical stator 13; is that right?

A. I believe that's -- yes, I believe that's what's indicated by the arrows labeled 7 -- actually, that's not what's indicated by the arrows, but I also believe that that is where the motion occurs. So, yes, I -- I agree with that.

Q. Okay. Is it your understanding the arrows labeled 7 indicate the orientation of permanent magnets inside the mover?

A. You know, I probably should go check it, but sitting here at this moment, I think that's what they are.

Q. So you haven't offered any opinions in your declaration that the motion of the mover within the stator of Alexander exhibits resonance; correct?

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MR. DEUTSCH: Form.

THE WITNESS: My opinion is limited to the combinations that are listed in the grounds. So I don't recall that I have an opinion about Alexander by itself. Unless we -- let's see if we have the Al- -- an Alexander-only ground.

Yeah, I don't see an Alexander-only ground in my report, so I didn't form that -- an opinion on Alexander alone.

BY MR. RUBIN:

Q. And would you agree that in the embodiments of Alexander, the mover is not going to oscillate unless it's continuously being driven by a force that's provided by the stator coil?

MR. DEUTSCH: Objection. Form.

THE WITNESS: I don't think I've offered an opinion on that question. I'd have to think about it.

BY MR. RUBIN:

Q. Is there anything in Alexander or his teachings that would store energy associated with the motion of the mover aside from the mass of the mover itself?

MR. DEUTSCH: Objection. Form.

THE WITNESS: Again, that's not something that I formed an opinion on, to the best that I can

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recall, anyway.
BY MR. RUBIN:
Q. So sitting here today, do you believe that the embodiments taught in Alexander would exhibit resonance associated with the movement of the mover within the stator?
MR. DEUTSCH: Objection. Form.
THE WITNESS: Again, I don't recall, you know, my report containing any opinion about oscillation in Alexander alone.
BY MR. RUBIN:
Q. Is it true in a resonant system that the amplitude of oscillations will vary as a function of frequency -- withdrawn.
In a resonant system, if an external driving force is applied and the magnitude of that force is kept the same but the frequency of the -- at which the force is applied varies, will the amplitude of oscillations vary as a function of the frequency?
MR. DEUTSCH: Objection. Scope.
THE WITNESS: Speaking about resonant systems in general and assuming that the frequency -- suppose we change the frequency as your question suggests, but assuming that we do it slowly, not sort of instantaneously but we -- for example, we test 100

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different frequencies one at a time or slowly increase the frequency, if the range of frequencies that we test includes the resonant frequency, then, yes, the amplitude will change.

BY MR. RUBIN:

Q. And in doing the experiment that you just described, how -- well, withdrawn.

In doing the experiment that you just described, would you be able to identify what the resonant frequency is from the -- from observing how the amplitude changes?

MR. DEUTSCH: Objection. Form. And scope.

THE WITNESS: My answer is it depends.

BY MR. RUBIN:

Q. What does it depend on?

A. Resonant systems have a peak, a maximum frequency response, as you sort of suggested just now -- well, you didn't suggest it. But as you vary frequencies -- as you test at various frequencies, you can find a peak, but that peak may or may not be the -- that peak can change depending on another factor in resonant systems, which is losses: friction or damping.

Q. So how can the peak vary as a result of -- withdrawn.

How can the peak change depending on losses

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such as friction or damping?

A. When the losses are very small, very minimal, relative to the energy storage, then two things happen: One is the -- we talked about oscillations persisting in time after energy is no longer supplied, and that effect will last a longer time if there's less friction or damping. It will take longer for the friction or damping to use up the energy and stop the motion. That's one thing.

The second thing that happens is that the peak -- the resonant peak -- the system -- when losses are very low, the system will reson- -- will vibrate very close to its mathematical resonant frequency. But when the losses are bigger, it will shift to a lower frequency of oscillation.

Q. So earlier you referred to resonant systems having a maximum frequency response.

Is that -- is the frequency response you referred to there a ratio of amplitude to the driving force, or what -- what is the frequency response?

MR. DEUTSCH: Objection. Form. And scope.

THE WITNESS: I'm not sure I remember precisely the question I was answering there, but I think I meant that as you vary frequency of your input, like force, the amount -- the magni- -- the amplitude

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of vibration will have a peak at one frequency. It will be maximum compared to the other frequencies at one particular frequency.

BY MR. RUBIN:

Q. So you can determine whether a system is at the resonant frequency by measuring how the amplitude of oscillations vary as the frequency -- the system is driven varies.

(Stenographer clarification.)

MR. RUBIN: How the amplitude of oscillation varies as the frequency at which the system is driven varies.

THE STENOGRAPHER: Thank you.

BY MR. RUBIN:

Q. Is that right?

MR. DEUTSCH: Objection. Form.

THE WITNESS: Sorry. Could you combine it into one -- you know, could you repeat the entire -- the question as you wanted to ask it?

BY MR. RUBIN:

Q. That's fair.

So you can determine whether a system is at the resonant frequency by measuring how the amplitude of oscillations vary as the frequency at which the system is driven varies; correct?

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A. I think to properly clarify this point and answer it, we have to take one slight dive deeper into resonant theory, okay, and that is that the simple form of analyzing a resonant circuit ignores the damping and assumes that it's negligible, okay. So in that case, there is one frequency called the resonant frequency determined by the spring constant and the mass and a simple equation.

When there are losses that are significant, then the frequency is different from that value we calculated at the no-loss condition. And I'm sorry if we're getting stuck on this.

I think a POSITA would know that in these vibrating systems in these patents, we are generally operating with low damping. And so there's a sharp, narrow frequency peak. That is where we want to operate.

But this factor is not really in my opinions as I recall them. So I want to be careful there.

Q. If you could turn to the '882 patent, which I think you have a printed copy of in front of you, and the -- turn to the very end where there are the claims. And look at Claim 1, please.

A. Okay. I am looking at Claim 1 of '882.

Q. So the first limitation after the preamble

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of Claim 1 reads, quote, "an oscillation path, which represents a segment of a space curve, along which a point within a mass moves."

Do you see that?

A. Yes.

MR. RUBIN: And I'll upload a copy of the patent into the chat.

BY MR. RUBIN:

Q. All right. Then turning to Claim 10, the -- it's called -- the third element after the preamble likewise reads, quote, "an oscillation path, which represents a segment of a space curve, along which a point within a mass moves."

Do you see that?

A. Yes, I see that.

Q. So both of the independent claims here use the phrase "a segment of a space curve."

Do you see that?

A. Yes.

Q. And then if you could turn to page 82 of your declaration, please.

A. Okay. Page 82 of my '882 declaration.

Q. The first sentence of that paragraph -- of -- I'm sorry. Withdrawn.

The first sentence of paragraph 156 on that

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1 page reads, quote, "I understand that patent owner has
2 taken a position that the claimed oscillation path
3 encompasses a linear path," close quote.
4 Do you see that?
5 **A. I see that.**
6 Q. Okay. So as -- withdrawn.
7 Do you have an opinion as to whether a
8 person skilled in the art who's read the '882 patent
9 would understand the phrase in the claims "a segment of
10 a space curve" to encompass a linear path?
11 **A. To the best of my recollection, I don't have**
12 **an opinion in my report on that, and I wasn't asked to**
13 **form one.**
14 Q. Sitting here today, do you know whether a
15 person skilled in the art would consider the phrase
16 "segment of a space curve" to encompass a linear path?
17 MR. DEUTSCH: Objection. Form. And scope.
18 **THE WITNESS: I'd have to think about it, I**
19 **think. But I'd think about it in the context of these**
20 **patents and all the things I've considered.**
21 BY MR. RUBIN:
22 Q. So sitting here right now --
23 **A. I wasn't asked to -- sorry. I'm sorry.**
24 Q. So sitting here today, having read and
25 considered the '882 patent and the other materials that

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you cite in your expert report, you don't have a view one way or the other as to whether the phrase "a segment of a space curve" encompasses a linear path?

MR. DEUTSCH: Objection. Form.

THE WITNESS: I don't have an opinion about that.

BY MR. RUBIN:

Q. So in paragraph 156, you say, quote, "a POSITA would have understood that the teachings of Gregorio render Claims 1 through 5, 10, 17, 19 and 20 obvious according to patent owner's proposed interpretation."

Do you see that?

A. I see that.

Q. And so that is -- the opinion that you're offering with respect to Ground 1A is under what you describe as patent owner's position that the phrase "a segment of a space curve" encompasses a linear path; is that right?

A. I was asked under Ground -- you know, to create Ground 2A, I was asked to form an opinion based on assuming the patent owner's proposed interpretation that a straight line is a -- is encompassed by a space curve.

Q. And that assumption was necessary because in

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Gregorio, the path of oscillation is a linear path; is that right?

A. I -- the assumption -- I used the assumption because I was asked to form an opinion about it. I don't have an opinion that the assumption is necessary.

Q. So if you were instead to assume that the phrase "a segment of a space curve" requires a path that is curved, that has a nonzero curvature to it at some point, would you agree that you'd -- under that assumption, you have not -- rather, would you agree that under that assumption, your opinion that Gregorio alone renders certain claims obvious would not apply?

MR. DEUTSCH: Objection. Form. And scope.

THE WITNESS: I -- I admit to being a little confused and not sure that I followed your question. So, again, I'll -- if you don't mind concisely restating what you want the question to be.

BY MR. RUBIN:

Q. All right. So you'd agree that your obviousness opinion, that Gregorio alone is sufficient to render obvious Claims 1 through 5, 10, 17, 19 and 20, depends on the assumption that the phrase in the claims -- "a segment of a space curve" -- encompasses a path that's linear, that has no curve in it?

MR. DEUTSCH: Objection. Form.

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THE WITNESS: I just want to be precise here and -- so I would just repeat that -- my language, "a POSITA would have understood that the teachings of Gregorio renders Claims 1 through 5, 10, 17, 19 and 20 obvious according to patent owner's proposed interpretation."

And I also state in that paragraph that, "I understand that patent owner has taken a position that the claimed oscillation path encompasses a linear path." And that's what I'm calling patent owner's proposed interpretation.

BY MR. RUBIN:

Q. And you haven't offered any opinion in -- in your declaration that it would have been obvious based on Gregorio alone to use an oscillation path that had a curve in it, that -- that is, that had, at some point along the path, a nonzero curvature?

A. Sitting here now, I don't recall that in my opinions.

Q. Turning to the paragraph that begins at the bottom of page 82, paragraph 158.

A. I am there.

Q. The first sentence reads, quote, "Gregorio provides Element [1a] according to patent owner's position in the co-pending litigation that the claimed

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1 oscillation path encompasses a linear path."
2 Do you see that?
3 **A. I see that.**
4 Q. So you would agree that the opinion that you
5 offer that Gregorio, or an obvious modification of
6 Gregorio, satisfies Limitation [1a] -- that depends on
7 your assumption that the claimed oscillation path
8 encompasses a linear path?
9 **A. My opinion doesn't talk about obvious**
10 **modifications. It just says, "Gregorio provides**
11 **Element [1a] according to patent owner's position in**
12 **the co-pending litigation that the claimed oscillation**
13 **path encompasses a linear path."**
14 **So I think that states it plainly.**
15 Q. So your opinion that certain claims are
16 obvious in view of Gregorio stated in Ground 1 -- 2A is
17 based on your opinion that Gregorio by itself satisfies
18 each limitation of those claims; is that right?
19 MR. DEUTSCH: Objection. Form.
20 **THE WITNESS: We're talking about my**
21 **opinions here expressed in this -- these sections --**
22 **this section's Ground 2A, and that's -- like**
23 **paragraph 158. And my opinion is use -- is applying**
24 **the patent owner's position that a linear -- that the**
25 **claimed, you know, curve -- oscillation space curve --**

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that the segment of a space curve encompasses a linear path.

So I was just asked to form an opinion assuming the patent owner's position.

BY MR. RUBIN:

Q. So we talked yesterday about the same Gregorio reference in the context of some opinions that you've offered in IPRs challenging related patents.

Do you recall that?

A. Yes, I do recall talking about Gregorio in the previous depositions.

Q. And you recall that in some of your other IPR declarations, you talk about Gregorio's teachings relating to the back EMF?

A. I recall that.

Q. The grounds of this IPR that involve Gregorio are Grounds 2A, 2B, 2C, 2D and onto 2H. In your discussion of obviousness under those grounds involving Gregorio, I don't see any mention of Gregorio's teachings concerning back EMF.

Do you recall in this declaration pointing to any of Gregorio's teachings concerning back EMF and arguing that claims were obvious under these grounds?

MR. DEUTSCH: Objection. Form.

THE WITNESS: There's a lot of discussion of

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Gregorio here, as you just pointed out, and maybe you can point me to a specific mapping that I've made or -- I can't remember sitting here right now if the EMF that you discussed appears here or not. I can't remember that sitting here right now.

BY MR. RUBIN:

Q. Fair enough.

If you turn to page 84. At the bottom of that page, you provide the text of -- Limitation [1c].

Do you see that?

A. Yes, [1c], bottom of 84.

Q. And so [1c] requires, quote, "one or more sensors that output indications of the positions of the mass within the oscillation path at specific points in time," close quote.

Do you see that?

A. I see that.

Q. And yesterday, if I recall correctly, you offered some testimony that the embodiments of Gregorio that include a -- withdrawn. Let me ask something different.

Turning to page 85.

The first sentence of paragraph 162 reads, quote, "Gregorio provides one or more sensors, such as its 'Hall sensor, optical sensor or other type of

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1 sensing device,' that output indications, including
2 sensed positions [sic], of the positions of the
3 mass/magnet within the oscillation path at specific
4 points in time."
5 Do you see that?
6 **A. Yes.**
7 Q. So in that sentence, I don't see any mention
8 of Gregorio's teachings concerning measuring a back
9 EMF, do you?
10 **A. I agree that I don't see it in**
11 **paragraph 162.**
12 Q. And the section of your declaration that
13 addresses Element [1c] under Ground 2A consists of
14 paragraphs 162, 163 and 164.
15 Do you see any mention of Gregorio's
16 teachings involving measurement of back EMF in any of
17 those paragraphs?
18 MR. DEUTSCH: Objection. Form.
19 **THE WITNESS: I do not see "back EMF" in**
20 **those paragraphs 162 through 164.**
21 BY MR. RUBIN:
22 Q. Now, earlier -- withdrawn.
23 Yesterday I believe you testified that the
24 back EMF would be proportional to the velocity at which
25 the magnet is moving; is that right?

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MR. DEUTSCH: Objection. Scope.

THE WITNESS: Sitting here right now without a transcript, that, I do -- I do recall that.

BY MR. RUBIN:

Q. Okay. So would you agree that Gregorio's back EMF measurement would not provide a measurement of the position of the magnet?

MR. DEUTSCH: Objection. Form. And scope.

THE WITNESS: Very generally, back EMF is caused by a magnet's velocity, and the voltage of a back EMF-based sensor is proportional to the velocity of the magnet relative to a coil. Velocity -- a POSITA would have several means to convert a velocity measurement to a position measurement.

Is -- I'll -- that's my answer, I guess.

BY MR. RUBIN:

Q. Suppose that the only piece of information you had was the back EMF voltage measurement from Gregorio's system at a single point in time.

Would a POSITA have a way of deducing from that single value the position of the mass -- or magnet of Gregorio?

MR. DEUTSCH: Objection. Scope.

THE WITNESS: I -- I don't recall that this is anything that I formed an opinion on in my report.

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1 **Answering your question in the abstract, in a digital**
2 **system, probably not.**
3 **An analog circuit could convert, as I said**
4 **before, by a process known as integration. It could**
5 **convert the velocity signal to a position, and that**
6 **could be sampled at a single point in time.**
7 BY MR. RUBIN:
8 Q. That process of integration would be
9 producing an output signal that depended on the back
10 EMF voltage over some period of time leading up to when
11 the measurement was made; right?
12 **A. Yes. Continuing that abstract example and**
13 **again qualifying it that I don't recall an opinion on**
14 **this, but it would be known to a POSITA that your**
15 **statement was correct. It would require a previous**
16 **history of velocity signals.**
17 MR. RUBIN: So I have no further
18 cross-examination for you right now.
19 I'll pass the witness.
20 MR. DEUTSCH: All right. We've been going
21 for a bit. Let's take a break.
22 **THE WITNESS: Break sounds good.**
23 (A brief recess is taken from
24 10:21 a.m. to 10:32 a.m.)
25 MR. DEUTSCH: All right. Well, thank you

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again for your time today, Dr. Hannaford.

No further questions.

THE WITNESS: You're welcome.

Thank you, all.

MR. RUBIN: All right. Thank you.

THE STENOGRAPHER: Same order as yesterday, Mr. Deutsch?

MR. DEUTSCH: Yeah. That's fine.

(Time noted: 10:32 a.m.)

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REPORTER'S CERTIFICATE

I, LORIE RHYNE, CSR, RPR, CRR, DO HEREBY CERTIFY THAT THE FOREGOING DEPOSITION OF BLAKE HANNAFORD, Ph.D., WAS TAKEN ON JANUARY 29, 2025 VIA ZOOM BEFORE ME AT 9:00 A.M. FOR THE PURPOSE IN THE CAPTION STATED; THAT THE WITNESS WAS FIRST DULY SWORN TO TELL THE TRUTH, THE WHOLE TRUTH, AND NOTHING BUT THE TRUTH; THAT THE DEPOSITION WAS TAKEN BEFORE ME STENOGRAPHICALLY AND AFTERWARDS TRANSCRIBED UNDER MY DIRECTION; THAT THE FOREGOING IS A FULL, TRUE, AND CORRECT TRANSCRIPT OF THE SAID DEPOSITION SO GIVEN; THAT COUNSEL FOR ALL PARTIES WERE PRESENT AT THE TIME OF THE DEPOSITION; THAT THERE WAS A REQUEST THAT THE WITNESS READ AND SIGN THE TRANSCRIPT.

I FURTHER CERTIFY THAT I AM NEITHER OF COUNSEL NOR OF KIN TO ANY OF THE PARTIES TO THIS ACTION, AND AM IN NO WAY INTERESTED IN THE OUTCOME OF SAID ACTION.

WITNESS MY SIGNATURE ON JANUARY 31, 2025.

Lorie Rhyne

LORIE RHYNE, CSR, RPR, CRR

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