

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

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7 v.

8 RESONANT SYSTEMS, INC.,

9 Patent Owner.

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11 Case No. IPR2024-00983

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

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17 REMOTE DEPOSITION OF BLAKE HANNAFORD, Ph.D., taken
18 by Patent Owner, Resonant Systems, Inc., held remotely
19 via Zoom, taken before Lorie Rhyne, CRR, RPR, CSR No.
20 12905, a Certified Shorthand Reporter for the
21 State of California, commencing on Wednesday,
22 January 29, 2025, 9:00 a.m. Pacific Time.

1 (All Appearances via Videoconference)

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I N D E X

WITNESS: BLAKE HANNAFORD, Ph.D.
EXAMINATION
By Mr. Rubin

PAGE
5

E X H I B I T S
(None Offered.)

1 P R O C E E D I N G S

2

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

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

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

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

15 BLAKE HANNAFORD, Ph.D.,
16 having been duly sworn, testified as follows:

17 THE STENOGRAPHER: Thank you.
18 You can proceed.

19

20 EXAMINATION

21 BY MR. RUBIN:

22 Q. Good morning, Dr. Hannaford.

23 A. Good morning, Mr. Rubin.

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

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

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

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

8 Q. Okay.

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

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

13 Fair to say?

14 A. Very fair.

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

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

21 A. No.

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

24 A. No.

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

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

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

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

8 A. Yes, that is my understanding.

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

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

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

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

24 Okay?

25 A. I will do that.

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

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

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

11 Q. Sure.

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

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

16 Q. Very good.

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

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

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

25 A. Not that I recall right now.

1 Q. Do you have in front of you a copy of the
2 '882 patent? And if you look at it, you'll see that
3 the title of the patent is Oscillating-Resonant-Module
4 Controller.

5 Do you see that?

6 A. I see it. I see that title.

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

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

13 Q. All right.

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

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

19 MR. DEUTSCH: Objection. Form.

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

23 BY MR. RUBIN:

24 Q. Fair enough.

25 What is resonance, then?

1 MR. DEUTSCH: Objection. Scope.

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

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

12 BY MR. RUBIN:

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

16 What is a resonant frequency?

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

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

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.

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

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

7 Do you recall that?

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

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

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

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

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

25 MR. DEUTSCH: Objection. Scope.

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.

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

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

7 Q. Fair enough.

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

10 A. Sure. Sorry.

11 Okay. I am at page 37.

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

19 Do you see that?

20 A. I see that.

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

24 MR. DEUTSCH: Objection. Form.

25 THE WITNESS: I would want to check that to

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

4 BY MR. RUBIN:

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

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

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

12 Q. Okay. So turning back to Alexander.

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

17 MR. DEUTSCH: Objection. Form.

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

21 BY MR. RUBIN:

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

24 Are you there?

25 A. Almost.

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?

1 A. Yes.

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

5 Would you agree?

6 MR. DEUTSCH: Objection. Scope.

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

9 BY MR. RUBIN:

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

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

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

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

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

1 MR. DEUTSCH: Form.

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

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

10 BY MR. RUBIN:

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

15 MR. DEUTSCH: Objection. Form.

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

18 BY MR. RUBIN:

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

23 MR. DEUTSCH: Objection. Form.

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

1 recall, anyway.

2 BY MR. RUBIN:

3 Q. So sitting here today, do you believe that
4 the embodiments taught in Alexander would exhibit
5 resonance associated with the movement of the mover
6 within the stator?

7 MR. DEUTSCH: Objection. Form.

8 THE WITNESS: Again, I don't recall, you
9 know, my report containing any opinion about
10 oscillation in Alexander alone.

11 BY MR. RUBIN:

12 Q. Is it true in a resonant system that the
13 amplitude of oscillations will vary as a function of
14 frequency -- withdrawn.

15 In a resonant system, if an external driving
16 force is applied and the magnitude of that force is
17 kept the same but the frequency of the -- at which the
18 force is applied varies, will the amplitude of
19 oscillations vary as a function of the frequency?

20 MR. DEUTSCH: Objection. Scope.

21 THE WITNESS: Speaking about resonant
22 systems in general and assuming that the frequency --
23 suppose we change the frequency as your question
24 suggests, but assuming that we do it slowly, not sort
25 of instantaneously but we -- for example, we test 100

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

5 BY MR. RUBIN:

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

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

12 MR. DEUTSCH: Objection. Form. And scope.

13 THE WITNESS: My answer is it depends.

14 BY MR. RUBIN:

15 Q. What does it depend on?

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

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

25 How can the peak change depending on losses

1 such as friction or damping?

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

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

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

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

21 MR. DEUTSCH: Objection. Form. And scope.

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

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

4 BY MR. RUBIN:

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

9 (Stenographer clarification.)

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

13 THE STENOGRAPHER: Thank you.

14 BY MR. RUBIN:

15 Q. Is that right?

16 MR. DEUTSCH: Objection. Form.

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

20 BY MR. RUBIN:

21 Q. That's fair.

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

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

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

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

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

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

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

25 Q. So the first limitation after the preamble

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

4 Do you see that?

5 **A. Yes.**

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

8 BY MR. RUBIN:

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

14 Do you see that?

15 **A. Yes, I see that.**

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

18 Do you see that?

19 **A. Yes.**

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

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

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

25 The first sentence of paragraph 156 on that

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

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

4 MR. DEUTSCH: Objection. Form.

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

7 BY MR. RUBIN:

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

13 Do you see that?

14 **A. I see that.**

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

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

25 Q. And that assumption was necessary because in

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

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

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

13 MR. DEUTSCH: Objection. Form. And scope.

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

18 BY MR. RUBIN:

19 Q. All right. So you'd agree that your
20 obviousness opinion, that Gregorio alone is sufficient
21 to render obvious Claims 1 through 5, 10, 17, 19 and
22 20, depends on the assumption that the phrase in the
23 claims -- "a segment of a space curve" -- encompasses a
24 path that's linear, that has no curve in it?

25 MR. DEUTSCH: Objection. Form.

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

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

12 BY MR. RUBIN:

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

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

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

22 A. I am there.

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

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 --

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

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

5 BY MR. RUBIN:

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

9 Do you recall that?

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

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

15 A. I recall that.

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

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

24 MR. DEUTSCH: Objection. Form.

25 THE WITNESS: There's a lot of discussion of

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

6 BY MR. RUBIN:

7 Q. Fair enough.

8 If you turn to page 84. At the bottom of
9 that page, you provide the text of -- Limitation [1c].
10 Do you see that?

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

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

16 Do you see that?

17 A. I see that.

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

22 Turning to page 85.

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

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?

1 MR. DEUTSCH: Objection. Scope.

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

4 BY MR. RUBIN:

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

8 MR. DEUTSCH: Objection. Form. And scope.

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

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

16 BY MR. RUBIN:

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

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

23 MR. DEUTSCH: Objection. Scope.

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

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

1 again for your time today, Dr. Hannaford.

2 No further questions.

3 **THE WITNESS: You're welcome.**

4 **Thank you, all.**

5 MR. RUBIN: All right. Thank you.

6 THE STENOGRAPHER: Same order as yesterday,

7 Mr. Deutsch?

8 MR. DEUTSCH: Yeah. That's fine.

9 (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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BLAKE HANNAFORD, Ph.D.

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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22
23 Stenographically Reported By:

24 Lorie Rhyne, CSR, RPR, CRR

25 Job No. 108122

1 UNITED STATES PATENT AND TRADEMARK OFFICE

2
3 BEFORE THE PATENT TRIAL AND APPEAL BOARD

4
5 APPLE, INC.,

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8 RESONANT SYSTEMS, INC.,

9 Patent Owner.

10
11 Case No. IPR2024-00983

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

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16
17 REMOTE DEPOSITION OF BLAKE HANNAFORD, Ph.D., taken
18 by Patent Owner, Resonant Systems, Inc., held remotely
19 via Zoom, taken before Lorie Rhyne, CRR, RPR, CSR No.
20 12905, a Certified Shorthand Reporter for the
21 State of California, commencing on Wednesday,
22 January 29, 2025, 9:00 a.m. Pacific Time.

1 (All Appearances via Videoconference)

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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.)

1 P R O C E E D I N G S

2

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

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

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

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

15 BLAKE HANNAFORD, Ph.D.,
16 having been duly sworn, testified as follows:

17 THE STENOGRAPHER: Thank you.
18 You can proceed.

19

20 EXAMINATION

21 BY MR. RUBIN:

22 Q. Good morning, Dr. Hannaford.

23 A. Good morning, Mr. Rubin.

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

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

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

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

8 Q. Okay.

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

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

13 Fair to say?

14 A. Very fair.

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

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

21 A. No.

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

24 A. No.

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

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

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

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

8 A. Yes, that is my understanding.

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

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

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

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

24 Okay?

25 A. I will do that.

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

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

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

11 Q. Sure.

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

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

16 Q. Very good.

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

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

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

25 A. Not that I recall right now.

1 Q. Do you have in front of you a copy of the
2 '882 patent? And if you look at it, you'll see that
3 the title of the patent is Oscillating-Resonant-Module
4 Controller.

5 Do you see that?

6 A. I see it. I see that title.

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

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

13 Q. All right.

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

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

19 MR. DEUTSCH: Objection. Form.

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

23 BY MR. RUBIN:

24 Q. Fair enough.

25 What is resonance, then?

1 MR. DEUTSCH: Objection. Scope.

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

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

12 BY MR. RUBIN:

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

16 What is a resonant frequency?

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

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

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.

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

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

7 Do you recall that?

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

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

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

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

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

25 MR. DEUTSCH: Objection. Scope.

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.

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

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

7 Q. Fair enough.

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

10 A. Sure. Sorry.

11 Okay. I am at page 37.

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

19 Do you see that?

20 A. I see that.

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

24 MR. DEUTSCH: Objection. Form.

25 THE WITNESS: I would want to check that to

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

4 BY MR. RUBIN:

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

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

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

12 Q. Okay. So turning back to Alexander.

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

17 MR. DEUTSCH: Objection. Form.

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

21 BY MR. RUBIN:

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

24 Are you there?

25 A. Almost.

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?

1 A. Yes.

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

5 Would you agree?

6 MR. DEUTSCH: Objection. Scope.

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

9 BY MR. RUBIN:

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

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

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

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

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

1 MR. DEUTSCH: Form.

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

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

10 BY MR. RUBIN:

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

15 MR. DEUTSCH: Objection. Form.

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

18 BY MR. RUBIN:

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

23 MR. DEUTSCH: Objection. Form.

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

1 recall, anyway.

2 BY MR. RUBIN:

3 Q. So sitting here today, do you believe that
4 the embodiments taught in Alexander would exhibit
5 resonance associated with the movement of the mover
6 within the stator?

7 MR. DEUTSCH: Objection. Form.

8 THE WITNESS: Again, I don't recall, you
9 know, my report containing any opinion about
10 oscillation in Alexander alone.

11 BY MR. RUBIN:

12 Q. Is it true in a resonant system that the
13 amplitude of oscillations will vary as a function of
14 frequency -- withdrawn.

15 In a resonant system, if an external driving
16 force is applied and the magnitude of that force is
17 kept the same but the frequency of the -- at which the
18 force is applied varies, will the amplitude of
19 oscillations vary as a function of the frequency?

20 MR. DEUTSCH: Objection. Scope.

21 THE WITNESS: Speaking about resonant
22 systems in general and assuming that the frequency --
23 suppose we change the frequency as your question
24 suggests, but assuming that we do it slowly, not sort
25 of instantaneously but we -- for example, we test 100

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

5 BY MR. RUBIN:

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

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

12 MR. DEUTSCH: Objection. Form. And scope.

13 THE WITNESS: My answer is it depends.

14 BY MR. RUBIN:

15 Q. What does it depend on?

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

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

25 How can the peak change depending on losses

1 such as friction or damping?

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

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

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

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

21 MR. DEUTSCH: Objection. Form. And scope.

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

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

4 BY MR. RUBIN:

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

9 (Stenographer clarification.)

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

13 THE STENOGRAPHER: Thank you.

14 BY MR. RUBIN:

15 Q. Is that right?

16 MR. DEUTSCH: Objection. Form.

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

20 BY MR. RUBIN:

21 Q. That's fair.

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

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

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

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

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

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

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

25 Q. So the first limitation after the preamble

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

4 Do you see that?

5 **A. Yes.**

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

8 BY MR. RUBIN:

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

14 Do you see that?

15 **A. Yes, I see that.**

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

18 Do you see that?

19 **A. Yes.**

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

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

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

25 The first sentence of paragraph 156 on that

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

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

4 MR. DEUTSCH: Objection. Form.

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

7 BY MR. RUBIN:

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

13 Do you see that?

14 **A. I see that.**

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

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

25 Q. And that assumption was necessary because in

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

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

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

13 MR. DEUTSCH: Objection. Form. And scope.

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

18 BY MR. RUBIN:

19 Q. All right. So you'd agree that your
20 obviousness opinion, that Gregorio alone is sufficient
21 to render obvious Claims 1 through 5, 10, 17, 19 and
22 20, depends on the assumption that the phrase in the
23 claims -- "a segment of a space curve" -- encompasses a
24 path that's linear, that has no curve in it?

25 MR. DEUTSCH: Objection. Form.

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

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

12 BY MR. RUBIN:

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

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

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

22 A. I am there.

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

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 --

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

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

5 BY MR. RUBIN:

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

9 Do you recall that?

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

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

15 A. I recall that.

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

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

24 MR. DEUTSCH: Objection. Form.

25 THE WITNESS: There's a lot of discussion of

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

6 BY MR. RUBIN:

7 Q. Fair enough.

8 If you turn to page 84. At the bottom of
9 that page, you provide the text of -- Limitation [1c].
10 Do you see that?

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

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

16 Do you see that?

17 A. I see that.

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

22 Turning to page 85.

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

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?

1 MR. DEUTSCH: Objection. Scope.

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

4 BY MR. RUBIN:

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

8 MR. DEUTSCH: Objection. Form. And scope.

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

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

16 BY MR. RUBIN:

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

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

23 MR. DEUTSCH: Objection. Scope.

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

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

1 again for your time today, Dr. Hannaford.

2 No further questions.

3 **THE WITNESS: You're welcome.**

4 **Thank you, all.**

5 MR. RUBIN: All right. Thank you.

6 THE STENOGRAPHER: Same order as yesterday,

7 Mr. Deutsch?

8 MR. DEUTSCH: Yeah. That's fine.

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

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1 REPORTER'S CERTIFICATE

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

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

17

18

19 WITNESS MY SIGNATURE ON JANUARY 31, 2025.

20

21

22

23

24

25


LORIE RHYNE, CSR, RPR, CRR

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